

Mechanical Technician Candidate Handbook

MT CERTIFICATION



Mechanical Technologist Candidate Handbook

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Congratulations on pursuing certification. Certification is a great way to demonstrate competency, show commitment to the profession, and help with job advancement.

This handbook contains information about California Water Environment Association's Technical Certification Program for certification candidates. Please read this entire handbook to become familiar with CWEA's certification policies and procedures. Certification candidates are responsible for knowing the contents of this handbook. Please contact the CWEA office at (510) 382-7800 with any questions.

All policies are subject to change. The most recent edition of this handbook can be downloaded for free on Cert.CWEA.org. Candidates should ensure that they have the most current version as indicated by the date in the title above and at the bottom of each page.

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INTRODUCTION TO THE TECHNICAL CERTIFICATION PROGRAM

CWEA's Technical Certification Program (TCP) develops and administers competency-based certification exams for wastewater professionals in a number of different vocations. The certification program was founded in 1937. The first certification offered was the Wastewater Treatment Plant Operator certification, which was later adopted by the State Water Board. The exams are developed and revised by CWEA Subject Matter Experts under the guidance of exam development professionals. The certifications continue to grow and be refined in accordance with water sector and certification professional practices. Exams are offered throughout the year and are experience based, ranging from entry level to upper management.

CWEA currently certifies over 7,000 individuals. Certification is a great way to demonstrate competency, show commitment to the water profession, and help with job advancement.

TECHNICAL CERTIFICATION PROGRAM Executive Committee

The Technical Certification Program Executive Committee is the governing body of CWEA's certification program. It was created to develop and implement a multilevel technical certification program for individuals employed in the wastewater field. They are responsible for the development and administration of the Technical Certification Program, including the application, examination development, examination administration, and certification renewal process. They develop the guidelines, criteria, and testing procedures that are responsive to the needs of the water quality industry and allow participants to demonstrate technical competence. They are also responsible for maintaining the quality of the examinations through continuous upgrading and review.

For current Committee members, contact the CWEA office.

Overview of the Certification Process

To become certified all applicants must complete the following requirements:

1. Submit an application
2. Pay the application fee
3. Meet the minimum qualifications regarding professional experience
4. Pass the exam

Once an applicant successfully completes the requirements, they will be mailed their certificate. In order to maintain the certification once earned, certified individuals must continue to meet the following recertification requirements:

1. Submit 12 contact hours of continuing education every two years
2. Pay the annual renewal fee

Certifications Offered by CWEA

- Collection Systems Maintenance, Grades 1-4
- Mechanical Technologist, Grades 1-4
- Electrical/Instrumentation, Grades 1-4
- Laboratory Analyst, Grades 1-4
- Environmental Compliance Inspector, Grades 1-4
- Advanced Water Treatment Operator, Grades 3-5
 - Offered in partnership with California-Nevada Section of the American Water Works Association. For more information visit www.AWTOperator.org.

Please note that the **Wastewater Treatment Plant Operator Certification** and **Drinking Water Treatment Plant Operator Certification** are administered by the State of California. To work on a drinking water treatment system, distribution system or in a wastewater treatment plant, an individual must have a valid operator certificate or an operator-in-training certificate from the State Water Board. For information about these programs, please contact the [State Water Board Office of Operator Certification](#).

APPLICATION PROCESS

Submitting an Application

Candidates must submit an application and be approved before they can schedule an exam. Applications can be faxed, emailed or mailed to the CWEA office at any time throughout the year. Applications are reviewed by CWEA TCP Staff and/or Subject Matter Experts. Once the application is processed, candidates are notified of their approval status via email. Please follow all instructions on the application carefully. Incomplete applications may delay approval. The application is available on the Cert.CWEA.org website.

Application Deadlines and Exam Windows

The year is divided into four exam windows, each with an application deadline. Applications are valid for one year from the first date of the applicant’s original exam window. Applicants may transfer exam windows throughout the year, for details see *Transferring Exam Windows* (p. 14).

Exam Windows	Exam Dates	Application Deadlines
FALL	October 1 st – December 31 st	August 31 st
WINTER	January 1 st – March 31 st	November 30 th
SPRING	April 1 st – June 30 th	February 28 th
SUMMER	July 1 st – September 30 th	May 31 st

CWEA Application Fees

Current fees are listed on the application. Valid CWEA members qualify for a discounted member rate. The non-member rate includes a one-year CWEA membership. If an applicant does not wish to take advantage of the membership, they must note it on the application.

Minimum Qualifications: Qualifying Education and Experience

Applicants must meet the minimum qualifications for the exam at the time the application is submitted. The table below gives the combinations of education and/or experience that will satisfy the requirements. There is no education or experience requirement to take any Grade 1 exam, however, the Grade 1 exams test at the level of one year of experience in the field. Education and experience should be relevant to the vocation and reflect the job knowledge for that grade level. Relevancy is at the sole discretion of CWEA. Applicant's experience must be indicated on the application under "Job Duties". Applicants should provide sufficient detail to demonstrate they possess the relevant experience. The best way to provide this information is to include the official job description for the position. Applicants consent to a thorough investigation of employment records and other qualifications in related activities for the purpose of verification of qualifications. CWEA may verify job history by contacting employers.

MT Certification Minimum Qualifications Chart

GRADE 1	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None required to take test	None required to take test
GRADE 2	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None	4 full-time years in vocation
Hold Grade 1 certificate in vocation for year	2 full-time years in vocation
Associate's, or higher degree in related field	2 full-time years in vocation
Bachelor's, or higher degree in related field	1 full-time years in vocation
GRADE 3	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None	6 full-time years in vocation
Hold Grade 2 certificate in vocation for 2 years	4 full-time years in vocation
Associate's, or higher degree in related field	4 full-time years in vocation
Bachelor's, or higher degree in related field	3 full-time years in vocation

GRADE 4	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None	8 full-time years in vocation with 1 year supervising others
Hold Grade 3 certificate in vocation for 2 years	6 full-time years in vocation with 1 year supervising others
Associate's, or higher degree in related field	6 full-time years in vocation with 1 year supervising others
Bachelor's, or higher degree in related field	5 full-time years in vocation with 1 year supervising others

Application Approval

Once an application has been approved, the applicant will receive a Certification Application Approval Notification via email. It is very important that applicants use a current email address when filling out the application. CWEA will only contact applicants in regard to their application status via email. The Certification Application Approval Notification will contain the certification exam the applicant has been approved for, the exam window and CWEA ID number. This ID number is needed when contacting Pearson VUE to schedule an exam appointment.

Rejected Application

Applications will be rejected if applicants do not meet all requirements at the time they apply. CWEA will refund the application fee minus a \$40 admin fee. Refunds are automatically issued within two weeks of rejection to the original form of payment. Candidates may request that their rejected application be reviewed by the Technical Certification Program Executive Committee by submitting a request in writing to tcpcommittee@cwea.org.

Code of Ethics

All CWEA certification holders and applicants are expected to meet the following standards of professional conduct and ethics:

1. To protect public health, themselves, their co-workers, property, and the environment by performing the essential duties of the CWEA certified vocation safely and effectively, and complying with all applicable federal, state and local regulations.
2. To represent themselves truthfully and honestly throughout the entire certification process.
3. To adhere to all test site rules and make no attempt to complete the test dishonestly or to assist any other person in doing so.
4. To refrain from activities that may jeopardize the integrity of the Technical Certification Program.

The CWEA Code of Ethics establishes basic values and standards of conduct for certification applicants and certification holders. Any action of a certification holder or applicant that compromises the reliability of the certification process may be subject to the process described by the Ethics Procedures.

The Ethics Procedures provide a fair process for dealing with ethics complaints. The procedures define the participants in an ethics case and how each case will be handled. Individuals going through the process will be given opportunities to defend themselves and appeal any decisions made. The Ethics Officer handles all official ethics complaints and determines if there is enough merit in each case to follow through with the procedures. If appropriate, the Ethics Officer may suggest mediation to resolve ethics disputes without the formality of going through the entire procedural process. This information is paraphrased for clarity from the 05-01 CWEA Code of Ethics and Ethics Procedures.

A full copy of the policy can be requested by contacting the TCP department.

Some examples of violations would be:

- Providing false work history on an application
- Using prohibited reference materials during a test
- Taking test materials from a test site
- Falsifying documentation of continuing education contact hours

Any action that might undermine CWEA's process of certifying basic minimal competency will be investigated.

Non-Discrimination Policy

CWEA does not discriminate among applicants on the basis of age, gender, race, religion, national origin, disability, sexual orientation or marital status.

Accommodations

In compliance with the Americans with Disabilities Act, reasonable accommodations will be provided for those individuals who provide CWEA with a physician's certificate, or its equivalent, documenting a physical or psychological disability that may affect the individual's ability to successfully complete the certification examination. Written requests for reasonable accommodations must be submitted with the application.

Language barriers and lack of familiarity with computers are not covered under ADA laws.

Privacy

CWEA is committed to protecting privacy. Exam results and any other information regarding an application are confidential and will only be released to the applicant. Basic certification information is available on our [Certification Registry](#). Employers can use the registry to verify an individual's certification status.

Out-of-State Programs

Anyone anywhere in the United States can apply for CWEA certification. Our certifications are specific to the state of California.

CWEA partners with the following water environment associations to administer certification exams for their members:

- Hawaii Water Environment Association
- Michigan Water Environment Association

Candidates wishing to earn certification through one of those associations should be sure to use the correct application that is specific to that association.

Reciprocity

CWEA does not grant certification by reciprocity. For other certification programs that do offer reciprocity, CWEA will provide any information necessary for verification upon request.

SCHEDULING AN EXAM

Scheduling an Exam Appointment

Once an applicant receives the approval notification email, they will be eligible to schedule an exam appointment. Applicants can schedule an exam appointment through [Pearson VUE's website](#) by creating an account or by logging into an existing account. The applicant's CWEA ID number is needed when creating an account. The CWEA ID number can be found in the approval notification email. To schedule an appointment over the phone, call Pearson VUE at 888-749-3881. Test centers are conveniently located throughout the U.S. Locations can be found on [Pearson VUE's Test Center Search](#).

Online Proctored Exams

Online proctoring is available for CWEA exams. If available, candidates will be notified in their approval email of the option to schedule their exam online versus at an in-person test center. Candidates should examine both options before making the choice that is best for them. Candidates will make their selection at the time when they schedule their exam.

Online proctored exams are a convenient way to take an exam at home or at work. Candidates will complete a check in process and are monitored online by a live proctor. **An onscreen calculator and white board are provided, no physical calculators or scratch paper are allowed.**

For more information about the online proctored experience, please see: <https://home.pearsonvue.com/cwea/onvue>. Please review the system requirements and Pearson Vue policies and procedures for online proctored exams before you schedule your appointment. You will be required to accept and comply with these policies.

To take an online proctored exam, candidates must meet the system requirements. If a candidate is testing at work, they should check with their Network Administrator or IT Professional that their system meets the requirements.

It is the candidate's responsibility to ensure they meet the system requirements prior to their appointment time. If a candidate does not meet the system requirements, they will not be able to complete their exam and will need to reschedule.

Canceling an Existing Appointment

To cancel an appointment, applicants must notify Pearson VUE 24 hours before their scheduled appointment time. Failure to notify Pearson VUE at least 24 hours before the existing appointment will result in an \$80 No Show fee. Pearson VUE will send applicants a Cancellation Confirmation to the email on file in their Pearson VUE account.

The following are considered No Shows and will result in an \$80 No Show fee:

- Failing to appear at a scheduled test appointment
- Failing to check-in for an online appointment
- Arriving at the test center without a current, government-issued photo ID
- Arriving at the test center 15 minutes or later to a scheduled test appointment

Applicants must pay the No Show fee to schedule a new test appointment. Applicants should contact the CWEA office to reschedule.

Rescheduling an Exam Appointment

To reschedule an existing appointment within the same exam window, applicants must call Pearson VUE directly at least 24 hours before their existing exam appointment, for details see *Canceling an Existing Appointment* (p. 14).

Applicants must contact the CWEA office to reschedule (transfer) an existing exam appointment to a different exam window. Before contacting CWEA, the applicant must cancel their existing appointment.

Transferring Exam Windows

Applications are valid for one year from the first date of the applicant's original test window. Applicants may transfer exam windows throughout the year. The first transfer is complimentary, subsequent transfers are \$40.

Applicants can request a transfer at any time. If an applicant does not test by the last date of their original exam window, CWEA will automatically initiate a transfer and the applicant will be notified via email.

PREPARING FOR THE EXAM

Mechanical Technologist Certification Scope

Specifications	Grade 1	Grade 2	Grade 3	Grade 4
Brief description of the Grade Level in relation to the job family.	Entry and basic working level.	Skilled or journey level.	Lead/advanced technical level.	Program manager level.
Level of knowledge, skill and ability within the job family, in relation to job tasks, including the taxonomic level of knowledge applied on the job.	Basic knowledge and ability, as needed to safely and effectively perform basic tasks. This includes: recall and recognition, comprehension, and application.	Knowledge and ability to safely and effectively accomplish most technical tasks in the job family. This includes: comprehension, application, and analysis.	Knowledge, skill and ability to safely and effectively accomplish and coordinate complex tasks. This includes: application, analysis and synthesis.	Knowledge, skill and ability to administer, coordinate and manage complex programs across vocations. This includes: analysis, synthesis, and evaluation.
Level of supervision received.	Receives direct supervision.	Receives limited supervision.	Receives general direction.	May receive broad direction.
Level of supervision exercised.	None.	May provide technical direction over other staff.	Will oversee and direct complex tasks performed by others.	Will coordinate program activities within or across vocations.
Level of training provided to other personnel.	None.	May train lower level personnel.	May oversee a training program.	Designs and administers training programs within the job family.
Use of tools.	Will recognize the basic tools of the job family.	Will be able to apply most of the tools used by those in the job family.	Will select tools for individuals and teams in relation to specific problems.	Manages and evaluates systems and facilities.

Specifications	Grade 1	Grade 2	Grade 3	Grade 4
Problem solving and troubleshooting responsibilities.	Follows directions.	Troubleshoots and solves common problems.	Troubleshoots and solves complex problems.	Evaluates program effectiveness and takes corrective actions as needed.
Actions in relation to safety problems.	Recognizes unsafe conditions.	Recognizes and corrects unsafe conditions.	Anticipates and prevents unsafe conditions.	Designs and administers safety programs.
Actions in relation to standard operating procedures (S.O.P.s), laws and regulations.	Has the ability to follow S.O.P.s.	Has the ability to understand and apply S.O.P.s, laws and regulations.	Formulates new S.O.P.s, in compliance with laws and regulations.	Assures program compliance with laws and regulations.
Actions in relation to documentation of work activities.	Completes minimal work process documentation.	Completes routine work process documentation.	Responsible for detailed technical report writing and review.	Responsible for quality assurance of program documentation.

Exam Content

CWEA’s Technical Certification Program Mechanical Technologist exams are based on exam blueprints that outline the exam content and are periodically reviewed by CWEA Subject Matter Experts. An exam blueprint is based on a job task analysis that includes research of the essential duties of a Mechanical Technologist worker at a representative cross-section of systems and facilities in California. The Mechanical Technologist Certifications were last reviewed by Subject Matter Experts in 2014.

The exam content outlines that follows presents content covered on the Mechanical Technologist exams and shows the amount of the exam devoted to each KSA in the column labeled % on the exam.

MT GRADE 1 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Mechanical Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 101**Weight: 4%**

Assist in fabrication used to maintain facilities and equipment using the following methods:

- horizontal welding with acetylene and arc welders
- heating and cutting materials
- familiarity of metal working tools, materials and equipment to use

KSA 101 General Competencies

A journey level Mechanical Technologist is expected to have familiarity with metal fabrication tools

Including:

- oxy-acetylene torches
- arc welders
- various hand and power tools used in the trade

This experience will include the safe operation of all equipment and tools.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 101 Math Competencies

There are no math competencies for this KSA.

KSA 101 Suggested Reading

- Millwrights and Mechanics Guide
- Audel Mechanical Trades Pocket Manual; 4th Ed.; Welding; Page 348 & 350

KSA 102**Weight: 6%**

With an understanding of engine principles perform basic engine maintenance such as:

- replace oil, belts, filters and spark plugs
- obtain oil and fuel samples
- take hydrometer readings of coolant and battery fluids

KSA 102 General Competencies

As an entry level Mechanical Technologist, a person at this level is expected to have familiarity with basic engine maintenance. Tasks such as an oil change, tune-up, and battery service are required.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 102 Math Competencies

There are no math competencies for this KSA.

KSA 102 Suggested Reading

- Millwrights and Mechanics Guide

KSA 103

Weight: 8%

With a basic understanding of pump principles perform maintenance on centrifugal, positive displacement, and vacuum pumps such as:

- servicing, lubricating, and adjusting pumps
- removing and installing packing and most mechanical seals

KSA 103 General Competencies

As an entry level Mechanical Technologist, a person at this level is expected to have a strong basic understanding in centrifugal, positive displacement, and vacuum pump principles. The person should know how to properly and safely adjust, remove, and install most packing and mechanical seals.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 103 Math Competencies

There are no math competencies for this KSA.

KSA 103 Suggested Reading

N/A

KSA 104

Weight: 3%

Assist in the cleaning and repair of wet wells with consideration given to:

- proper application of coating
- basic knowledge of level control
- basic knowledge of odor control

KSA 104 General Competencies

As an entry level Mechanical Technologist, a person at this level is expected to have a strong basic understanding in centrifugal, positive displacement, and vacuum pump principles. The person should know how to properly and safely adjust, remove, and install most packing and mechanical seals.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 104 Math Competencies

There are no math competencies for this KSA.

KSA 104 Suggested Reading

N/A

KSA 105

Weight: 7%

Conduct basic operation and maintenance of pipelines and valves such as:

- changing piping
- installing basic layouts of piping systems such as galvanized, PVC, stainless steel, and copper tubing
- cutting and threading pipes
- making minor modifications to existing piping systems
- identification and application of valve types

KSA 105 General Competencies

A journey level Mechanical Technologist is expected to: know how to measure, prepare, thread or glue piping systems of:

- PVC
- ABS
- Galvanized
- Stainless Steel
- Copper piping

Use of brazing tools, manual and power threading tools, and fitting knowledge is required. Further, the person should be able to identify different types of valves and understand their operation and application.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 105 Math Competencies

There are no math competencies for this KSA, with the small exception of basic computation in addition and subtraction as well as basic measuring using a measuring tape.

KSA 105 Suggested Reading

N/A

KSA 106**Weight: 5%**

Understand and perform the basic operations and maintenance of compressors and blowers including:

- lubrication
- identify types of valves
- types of cooling systems

KSA 106 General Competencies

A journey level Mechanical Technologist is expected to know how to maintain and operate compressors and blowers used in the water and wastewater industry. The person should be able to identify valve types, perform proper lubrication, and have familiarity with applicable cooling systems.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 106 Math Competencies

There are no math competencies for this KSA.

KSA 106 Suggested Reading

Audel Mechanical Trades Pocket Manual; 4th Ed.; Proper Lubrication; Page 135 & Fans; Page 291
Millwrights & Mechanics Guide

KSA 107**Weight: 8%**

Safely and effectively repair and maintain process equipment and related components with a basic understanding of process equipment purpose and function such as:

- chemical feed systems and effects of delivered chemicals on associated equipment
- solids removal systems
- conveyance systems
- digesters and associated systems
- odor control systems

KSA 107 General Competencies

A journey level Mechanical Technologist is expected to demonstrate knowledge of typical water and wastewater equipment. This equipment includes conveyors, digesters, heat exchangers, boilers, and chemical feed systems.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 107 Math Competencies

There are no math competencies for this KSA.

KSA 107 Suggested Reading

Operation of Wastewater Treatment Plant, Vol II
Maintenance Manager's Standard Manual, Westerkamp; Main Boiler Failure Cause and Prevention; Page 532

KSA 108**Weight: 5%**

Perform shop mathematics and techniques to calculate or determine:

- efficiency of pumps
- horsepower
- flow rates
- volumes and area
- measurements
- pressure

KSA 108 General Competencies

A journey level Mechanical Technologist is expected to demonstrate knowledge of mathematically calculating volumes, areas, flow rates, horsepower, and pressure.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 108 Math Competencies

In this KSA, the math competencies needed are the ability to calculate or determine flow rates, horsepower, and efficiency of pumps. An understanding of how to calculate perimeter, volume, and area are also needed.

KSA 108 Suggested Reading

N/A

KSA 109**Weight: 5%**

Safely and effectively repair and maintain equipment with an understanding of basic electrical principles related to mechanical systems such as:

- volts, amps, watts, ohms
- voltage rating
- motor identification
- battery principles

KSA 109 General Competencies

A journey level Mechanical Technologist is expected to have a basic knowledge of electrical principles and terms. Identification of motor style and type is also needed.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 109 Math Competencies

There are no math competencies for this KSA.

KSA 109 Suggested Reading

NEC

KSA 110**Weight: 12%**

Repair and maintain mechanical systems while adhering to industry safety standards and regulations pertaining to CCR Title 8 or equivalent state regulations:

- lock tag verification (LTV) (Lockout/Tagout) and Blocking/Isolation
- confined space
- slip, trip and fall
- proper lifting
- trench safety
- crane safety
- vehicle safety
- tool safety
- stored energy
- proper use of PPE (Personal Protective Equipment)
- chemical safety
- fire safety
- Safety Data Sheet (MSDS)
- gas detection systems
- electrical safety
- traffic control
- rigging safety
- safety in and around wet wells

KSA 110 General Competencies

To spec pumps for given applications, a journey level Mechanical Technologist is expected to have a very strong background in lock out/tag out and all aspects of safety while on the job. The technologist should have a firm understanding of proper safety procedures while in a confined space, a trench, a crane, a vehicle, and in use of tools. A broad base of safety knowledge while working with chemicals, traffic, and electricity is also useful.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 110 Math Competencies

There are no math competencies for this KSA.

KSA 110 Suggested Reading

N/A

KSA 111**Weight: 5%**

Assist qualified person with lifting and moving heavy machinery or equipment with an understanding of:

- crane operations
- rigging and lifting procedures
- forklift operation

KSA 111 General Competencies

Journey level Mechanical Technologists are expected to be well versed in craning operations. Technologist should be aware of proper safety and hand signals.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 111 Math Competencies

There are no math competencies for this KSA.

KSA 111 Suggested Reading

Audel Mechanical Trades Pocket Manual; 4th Ed.; Rigging; Page 362 & 380

KSA 112

Weight: 11%

Repair and maintain mechanical systems with the knowledge of proper use of tools such as:

- hand tools
- power tools
- machine/shop tools
- hydraulic/pneumatic tools
- measurement tools
- computers and systems

KSA 112 General Competencies

Journey level Mechanical Technologists are expected to have a wide based knowledge of a variety of tools that are applicable to the task. These include measurement, shop, hydraulic, power, and hand tools.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 112 Math Competencies

There are no math competencies for this KSA.

KSA 112 Suggested Reading

http://www.engineeringtoolbox.com/us-bolt-head-wrench-size-d_1457.html

KSA 113**Weight: 5%**

Apply appropriate construction methods and materials to perform general maintenance such as:

- pipe fitting
- framing
- concrete forming, pouring, and finishing
- painting/coating

KSA 113 General Competencies

Journey level Mechanical Technologists should have a basic understanding of pipe fittings and how they are used. The person should know how to estimate the amount of paint, concrete, and lumber needed for a job. The person should know how to assemble the materials properly and follow through to the job's completion.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 113 Math Competencies

There are no math competencies for this KSA, with the small exception of basic computation in addition and subtraction.

KSA 113 Suggested Reading

Millwrights and Mechanics Guide; 4th Edition

Pocket Guide to Flanges, Fittings, and Piping Data, R. R. Lee (POCKET GUIDE)

Millwrights and Mechanics Guide, 5th Ed. Chapter 7: Pipe Fitting, page 589

KSA 114**Weight: 6%**

Perform basic level maintenance and repair by interpreting and applying information from:

- operations and maintenance manuals
- basic plant drawings
- equipment specifications
- diagrams
- schematics
- written and verbal design instructions
- understand the purpose of a pump curve

KSA 114 General Competencies

Journey level Mechanical Technologists are expected to have the skills to read and interpret verbal instructions and basic schematics and drawings. An understanding of terminology and symbols are needed to properly apply the information. A grasp of the ideology behind a pump curve and the reason it is used is needed.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 114 Math Competencies

There are no math competencies for this KSA.

KSA 114 Suggested Reading

USA North's California Excavation Manual
Audel Mechanical Trades Pocket Manual; 4th Ed.; Proper Lubrication; Page 135 & Sketching a Diagram Using Simple Instruments; Page 71

KSA 115**Weight: 5%**

Establish and maintain effective working relationships with every person encountered in the workplace to help incorporate the concept of teamwork.

KSA 115 General Competencies

A Journey level Mechanical Technologists is expected to have the skills to develop and maintain inter-personal relations and communications.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 115 Math Competencies

There are no math competencies for this KSA.

KSA 115 Suggested Reading

Maintainability & Maintenance Management, 4th edition, Joseph D. Pattor, Jr.

Industrial Maintenance, 3rd edition, Green/Gosse

Audel Mechanical Trades Pocket Manual; 4th Ed.; Welding: Welding Safety, Page 348

KSA 116**Weight: 5%**

Communicate clearly and concisely in English, both verbally and in writing with respect to:

- completing and accepting work orders
- purchase requests
- warehouse requisition
- accident reporting
- radio and telephone communication
- written and computerized records

KSA 116 General Competencies

A Journey level Mechanical Technologists is expected to have familiarity with the basic use of handheld radios and telephones. A firm grasp of computer use is needed to keep records and complete/accept work orders.

This knowledge is usually gained through:

- trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 116 Math Competencies

There are no math competencies for this KSA, with the small exception of basic computation in addition and subtraction.

KSA 116 Suggested Reading

Manual of Practice II

OSHA 1926

OWTP; Vol. II; 7th Edition; Treatment Plants, Page 741; Procurement Records

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- Operation of Wastewater Treatment Plant, Vol II, 7th Edition, Office of Water Programs
- Millwrights and Mechanics Guide, 4th Edition <http://www.amazon.com/Audel-Millwrights-Mechanics-Guide-Thomas/dp/0764541714>
- Work Area Traffic Control Handbook conforms to the standards and guidance of the CalTrans CA Manual on Uniform Traffic Control Devices, Southern California Chapter APWA, BNi (POCKET GUIDE) <http://www.bnibooks.com/shopexd.asp?id=6471>
- California Manual on Uniform Traffic Control Devices, California Department of Transportation (POCKET GUIDE) <http://mutcd.fhwa.dot.gov/index.htm>
- USA North's California Excavation Manual, Underground Service Alert, USA North (POCKET GUIDE)
- Condensed Hydraulic Data, Cornell Pump Company. (POCKET GUIDE) <http://www.cornellpump.com/lit/pdf/Book-Condensed%20Hydraulic.pdf>
- Valve & Actuator Technology, Wayne Ulanski ISBN-13: 978-0070194779 <http://www.amazon.com/Valve-Actuator-Technology-Wayne-Ulanski/dp/0070194777>
- Pocket Guide to Flanges, Fittings, and Piping Data, R. R. Lee (POCKET GUIDE) ISBN-13: 978-0884153108 <http://www.amazon.com/Pocket-Guide-Flanges-Fittings-Piping/dp/088415310X>

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. Which welding process is most commonly used for small pipe maintenance welding?
 - A. Shielded metal-arc welding
 - B. Gas metal-arc welding
 - C. Gas tungsten-arc welding
 - D. OxyAcetylene gas welding
2. What is the proper definition of an engine?
 - A. It is a machine designed to move a piece of equipment
 - B. It is a machine designed to convert energy into useful mechanical motion
 - C. It is a machine designed to generate heat to create energy
 - D. It is a machine designed to convert gasoline to kinetic energy
3. What is wet stacking and how can it be prevented?
 - A. It is unburned oil collecting in the exhaust- prevent it by using heavier oil.
 - B. It is rain accumulating in the exhaust stack- prevent it by using a rain cap.
 - C. It is unburned fuel collecting in the exhaust due to light or no load conditions.
 - D. None of the above (change due to scrambling answers)
4. To check flywheel face runout, where should the dial indicator be positioned?
 - A. The base on the block and the pointer on the crank shaft.
 - B. The base on the bell housing and pointer on the flywheel face.
 - C. The base on flywheel and the pointer on the bell housing.
 - D. Checking runout is not necessary.
5. If a 38-tooth gear running at 360 rpm is driving another gear at 144 rpm, what is the number of teeth on the driven gear?
 - A. 34
 - B. 95
 - C. 96
 - D. 35

6. Which of the following is required for a sealed ball bearing?
 - A. It must regularly be lubricated
 - B. It will need to be annually inspected
 - C. It does not need to be lubricated under normal use
 - D. Only oil lubrication is necessary
7. A DAFT is an acronym meaning:
 - A. Dissolved Air Flotation Thickener.
 - B. Downstream Aerated Flocculation Tank.
 - C. Direct Air Floating Tank.
 - D. Divided Aerated Friction Temperature
8. What is the governing agency that permits odor control systems?
 - A. EPA
 - B. OSHA
 - C. Health Department
 - D. AQMD
9. At what pressure rating would you use a blower instead of a fan?
 - A. .9 psi
 - B. 7 psi
 - C. 15 psi
 - D. .7 psi
10. Which of the following valves is unsuitable for high-pressure flow?
 - A. A globe valve
 - B. A gate valve
 - C. A needle valve
 - D. A ball valve
11. A sodium hypochlorite tank's full working capacity is 23,000 gallons. Its current level is at 1,200 gallons. How many gallons does the delivery driver need to add to bring it to 70% capacity?
 - A. 14,900 gal.
 - B. 16,100 gal.
 - C. 17,300 gal.
 - D. 21,800 gal.

12. What is the result if $\frac{6}{8}$ " is converted to decimal form?
- A. .75
 - B. .50
 - C. .68
 - D. .80
13. What is the conversion of 100° Celsius into Fahrenheit?
- A. 212°
 - B. 200°
 - C. 100°
 - D. 112°
14. If 17.32 v are applied across a resistance of 50 ohms, how much power is expended in the resistor?
- A. 0.34 watts
 - B. 2.08 watts
 - C. 6.0 watts
 - D. 866 watts
15. A standard steel plate is 4' wide, 8' long, and 1" thick. If steel weighs 490 lbs/ft³, what is the total weight of this plate?
- A. 1,306.6 lbs
 - B. 1,881.6 lbs
 - C. 15,860 lbs
 - D. 18,816 lbs
16. What is the volume in cubic feet of carbon media that is 6' thick in a clarifier that has a 50' diameter and is 20' deep? Round answer to the nearest cubic foot.
- A. 2,946 ft³
 - B. 9,821 ft³
 - C. 11,781 ft³
 - D. 39,286 ft³
17. A 150-watt, 120-volt lamp burns constantly for 8 hours at a rated voltage. What is the energy used in watts/hour?

- A. 800 watts/hour
 - B. 960 watts/hour
 - C. 1,200 watts/hour
 - D. 9,600 watts/hour
18. Which of the following is 12/16 of one inch equal to?
- A. $\frac{3}{4}$ inch
 - B. $\frac{1}{2}$ inch
 - C. $\frac{3}{8}$ inch
 - D. $\frac{16}{32}$ inch
19. The property of an electrical circuit restricts the flow of current and:
- A. conductance.
 - B. inductance.
 - C. resistance.
 - D. kinetic.
20. Which of the following can burn the insulation on the supply connections at the motor starter?
- A. Having the incorrect insulation
 - B. The voltage running through the connections is too high
 - C. The connections are loose or have poor contacts
 - D. The voltage through the connections is too low
21. Where do you start troubleshooting when an electrical motor fails to operate after observing a mechanical failure?
- A. Check the motor leads (Change to match question)
 - B. Press all the resets (Change to match question)
 - C. At the power source
 - D. Check the overloads (Change to match question)
22. What does NEC stand for?
- A. National Electrical Code
 - B. National Engineering Code
 - C. Natural Electronic Computers
 - D. National Electronics Code
23. What is a pipe union typically used for?

- A. It is used to connect pipes
 - B. It is used to bundle pipes on a rack
 - C. It is used to plug a line
 - D. It is used to bend a pipe
24. Which of the following electrical circuits has more than one path for the current to flow?
- A. Indirect circuit
 - B. Parallel circuit
 - C. Short circuit
 - D. Series circuit
25. Overloading of an electrical circuit may be caused by which of the following?
- A. Replacement of a blown fuse
 - B. Leaving a switch open
 - C. Connecting loads that draw too much current
 - D. Placing too many wires in a conduit
26. What type of current is stored in a 9-volt battery?
- A. 9 volts
 - B. Direct current
 - C. Alternating current
 - D. Single phase current
27. What does GFI stand for?
- A. Ground Fault Indicator
 - B. Great Failure Indicator
 - C. Ground Fault Interrupter
 - D. Great Fault Interrupter
28. What does EMT stand for?
- A. Electrical Metal Tubing
 - B. Electrical Measurement Timing
 - C. Electrical Meter Timing
 - D. Electrical Metal Transmitting
29. What device would be used to measure AC current flow in a large diameter conductor?
- A. A solenoid type tester
 - B. A clamp-on type ammeter

- C. An ohmmeter
 - D. A potentiometer
30. What is the purpose of electrical interlock switches on panel doors?
- A. To interrupt local power for personnel protection
 - B. To send an alarm to security
 - C. To turn off the cooling fans since the door is open
 - D. To turn on the panel interior lights
31. Which of the following actions should be taken before working on controls that may disrupt plant operations?
- A. Divert flow (of what?)
 - B. Place the system on manual
 - C. Have an operator present (this is not an action)
 - D. Work efficiently to minimize risk
32. What is the purpose of installing toe boards around the base where guard rails are placed along elevated work areas?
- A. As protection from tools or objects that may roll off
 - B. To provide an area to place your toes when leaning over the handrails
 - C. As a place to clean off the bottom of your shoes
 - D. To keep spilled liquids from falling to the ground
33. What action is necessary before restarting rotating equipment that has recently undergone repair?
- A. Before securing the guards, test that the equipment is functioning properly
 - B. All removed guards must be installed
 - C. Take note that all LOTO procedures have been met before powering up
 - D. Place the guards where accessible during testing
34. What is the main purpose of a confined space safety permit?
- A. It avoids legal responsibility when a fatal accident occurs during the entry.
 - B. It supports limiting the employer's liability for injuries that may occur.
 - C. It informs regulating agencies that dangerous work is being performed.
 - D. It ensures the use of safety precautions and safe procedures.
35. The acronym "LOTO" is used to identify:
- A. Lock Off/Tag Off

- B. Lock Open/Tag Open
 - C. Lock Out/Tag Out
 - D. Last Off/Tag Out
36. What does the acronym SDS represent?
- A. Soils Data Sheet.
 - B. Solids Data Sheet
 - C. Secure Data Sheet
 - D. Safety Data Sheet
37. Which problem will **not** occur when a person works in a very hot area for a prolonged period of time?
- A. heat stroke
 - B. cramps
 - C. exhaustion
 - D. hypothermia
38. When leaving a remote lift station, why is it important to secure the station?
- A. To prevent flooding in the station
 - B. To avoid wasting electricity
 - C. To prevent vandalism and possible injury to trespassers
 - D. To contain odors to avoid it becoming a nuisance
39. What is the purpose of a breakaway switch?
- A. To shut down an engine in the event of a runaway engine.
 - B. To prevent broken belts from injuring bystanders.
 - C. To apply the brakes on a trailer in the event of a trailer release from a vehicle.
 - D. To stop a vehicle in the event of brake failure.
40. According to the image, what does this hand signal indicate?
- A. Raise load slowly
 - B. Lower load slowly
 - C. Turn load to the left
 - D. Turn load to the right
41. According to the image shown, what does the hand signal asking to do during a rigging operation?
- A. Boom up

- B. Extend boom
 - C. Raise boom slowly
 - D. Raise boom and lower load
42. Heavy objects are made mostly of:
- A. copper and tin.
 - B. granite and obsidian.
 - C. iron and steel.
 - D. aluminum and lead.
43. Which threads are tapered to provide a pressure tight and watertight seal?
- A. Round Threads
 - B. UNC/UNF Threads
 - C. Acme Threads
 - D. NPT Threads
44. When installing a bearing with a press fit onto a shaft, the pressure should be applied to:
- A. the loose race.
 - B. the inner race.
 - C. the outer race.
 - D. either race.
45. Which type of saw is used to cut metallic materials?
- A. coping saw
 - B. crosscut saw
 - C. rip saw
 - D. hacksaw
46. What tool would be used to install tight fitting bearings?
- A. A milling tool
 - B. A bearing cage
 - C. A stationary hydraulic press
 - D. A bearing puller
47. Which of the following is most true about a chuck key for a drill press?
- A. It should be riveted in place
 - B. It should be left in the chuck when the drill is removed
 - C. It should be attached to the drill press by a short chain or cable

- D. It should be used only when checking large drills
48. A rotary hammer drill is used to drill:
- A. hard wood.
 - B. stainless steel.
 - C. concrete.
 - D. plastic.
49. A bourdon tube in a pressure gauge is normally of what design?
- A. Spiral
 - B. Helix
 - C. C-shape
 - D. Straight
50. Which tool is most commonly used to machine keyways in hubs or bores?
- A. lathe
 - B. broach
 - C. milling machine
 - D. plasma cutter
51. A fabricated piece of 12-inch diameter pipe, 48 feet long, weighs 35 pounds per lineal foot. What is the weight of the total load?
- A. 420 lbs.
 - B. 576 lbs.
 - C. 1,680 lbs.
 - D. 3,360 lbs.
52. Jaime must paint a 16" wide, red stripe completely around a water tank at a centered height of 18 feet. The tank's dimensions are 25 feet high and 150 feet in diameter. How long, in linear feet, will the stripe be?
- A. 56.52 feet
 - B. 471 feet
 - C. 78.5 feet
 - D. 706.5 feet
53. Why is water commonly omitted from the concrete ratio?
- A. Because the amount of water will not vary regardless of the amount of cement and aggregate used in the mixture.

- B. Because the amount of water used in the mixture is less important than any other ingredient.
- C. Because the amount of water will not vary regardless of the amount of cement and sand used in the mixture.
- D. Because the amount of water used involves a consideration of both the degree of exposure and strength requirements of the complete structure.
54. How much coat is needed to properly protect a tank or channel from deterioration?
- A. Two or more coats
 - B. A thin layer on top of old coat
 - C. One coat
 - D. Two or more coats on top of where the coat is flaking off
55. A scale on a blueprint indicates 1"=2". What does the scale mean?
- A. Each one inch and two inch increment on the print will be marked
 - B. Each line on the print is accurate within one to two inches of the actual line
 - C. Each line on the print is shown twice its actual size
 - D. Each line on the print is shown half its actual size
56. Using the table, calculate the head loss in psi for a 2000 ft section of new 10" Cast Iron pipe with a flow of 650 GPM.
- A. 4.9
 - B. 2.12
 - C. 9.08
 - D. 3.93
57. Which of the following should be used to guide the frequency schedule of a preventative maintenance?
- A. The recommended frequency by the operator of the equipment
 - B. The amount of continuous usage of the equipment
 - C. The recommended frequency indicated on the preventative maintenance log
 - D. The recommended preventative maintenance indicated on the manual
58. Of the following, what is the first step to create a preventative maintenance?
- A. Make a list of equipment that will require preventative maintenance and assign a numbering system for its location.
 - B. Get all the drawings needed, such as the building equipment drawing or other map of

- the plant or process that lists all the equipment and show the location.
- C. Make a field visit to all the equipment that will require preventative maintenance, take down the name plate and other identification characteristics.
- D. Assign frequencies of the plant maintenance activities such as daily, weekly, hours of operation, etc
59. A computerized maintenance management system is a/n:
- A. concept.
 - B. idea.
 - C. wastewater process.
 - D. tool.
60. Of the following, which is the **least** important when accepting a work order from either a superior or from an assigned group work order. Remember to choose the least important.
- A. The tools and parts necessary for the task. That way you will not start a job only to find you are missing items and keep equipment off-line for extended periods of time.
 - B. The need for speedy completion. After all, they are assigned and you want to look good.
 - C. The task and its goal, the procedure and safety requirements of the job.
 - D. Ask questions to clarify what is needed so it is done properly. That way time and effort aren't wasted and equipment potentially damaged.
61. You are working along with a coworker to do a preventative maintenance task and you notice that they are not taking notes for record keeping. Since you know your coworker to be a good team member and will take advice well, which of the following reasons should you give to make sure he takes notes on the maintenance.
- A. Records are needed to show who worked on the maintenance task. Staff needs to be able to record their tasks completed at any time during working hours.
 - B. Records are needed to show the maintenance was done and how quickly it was completed. It proves the effectiveness of the maintenance programs.
 - C. Records are needed to show the type and frequency of maintenance of operating units and to evaluate the effectiveness of the maintenance programs.
 - D. Records are needed to show that the maintenance was completed in a safe manner. All parties involved in the maintenance need to document that no accident occurred.

Answer Key

No.	Answer	KSAs	No.	Answer	KSAs
1	D	101	32	A	110
2	B	102	33	B	110
3	C	102	34	D	110
4	B	102	35	C	110
5	B	102	36	D	110
6	C	103	37	D	110
7	A	104	38	C	110
8	D	104	39	C	110
9	B	106	40	A	111
10	C	106	41	D	111
11	A	107	42	C	111
12	A	108	43	D	112
13	A	108	44	B	112
14	C	108	45	D	112
15	A	108	46	C	112
16	C	108	47	C	112
17	C	108	48	C	112
18	A	108	49	C	112
19	C	109	50	B	112
20	C	109	51	C	113
21	C	109	52	B	113
22	A	109	53	D	113
23	A	109	54	A	113
24	B	109	55	D	114
25	C	109	56	B	114
26	B	109	57	B	114
27	C	109	58	B	114
28	A	109	59	D	116
29	B	109	60	B	116
30	A	110	61	C	116
31	C	110			

Selected Problem Solutions

5. If a 38-tooth gear running at 360 rpm is driving another gear at 144 rpm, what is the number of teeth on the driven gear?
- A. 34
 - B. 95
 - C. 96
 - D. 35

Solution:

Driver Gear x Driver RPM = Driven Gear x Driven RPM

$$38 \times 360 = N \times 144$$

$$13,680 = 144N$$

$$13,680 \div 144 = 144N \div 144$$

$$95 = N \text{ (95 Tooth Gear)}$$

11. A sodium hypochlorite tank's full working capacity is 23,000 gallons. Its current level is at 1,200 gallons. How many gallons does the delivery driver need to add to bring it to 70% capacity?
- A. 14,900 gal.
 - B. 16,100 gal.
 - C. 17,300 gal.
 - D. 21,800 gal.

Solution:

23,000 gallons max capacity x 70% desired capacity = 16,100 gallons desired

16,100 gallons desired - 1,200 gallons current level

14,900 gallons needed to add

MT GRADE 2 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Mechanical Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 201

Weight: 4%

Perform fabrication to maintain facilities and equipment using the following methods:

- multi-position welding with acetylene and arc welders
- knowledge of materials and tools to use

KSA 201 General Competencies

A journey level Mechanical Technologist is expected to have a firm understanding and aptitude in regard to arc and oxy-acetylene welding. Knowledge of the materials and tools used in these processes is also needed.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 201 Math Competencies

There are no math competencies for this KSA.

KSA 201 Suggested Reading

KSA 202**Weight: 5%**

With an understanding of engine operations and engine types, perform engine repair and maintenance such as:

- changing oil, belts, filters and spark plugs
- troubleshooting and performing corrections
- obtain hydrometer readings, oil and fuel samples and based on results interpret and correct

KSA 202 General Competencies

A journey level Mechanical Technologist is expected to troubleshoot and perform discovered corrections in engine maintenance and operations. The technologist should be versed in obtaining:

- hydrometer readings
- changing oil
- changing belts
- replacing spark plugs
- replacing filters

The technologist should also know the importance of pulling oil and fuel samples and how to correct the faults they show.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 202 Math Competencies

There are no math competencies for this KSA.

KSA 202 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 2.
California State University Sacramento
Office of Water Programs, 1998. Pg. 89.

KSA 203**Weight: 8%**

With a thorough knowledge of pump principles regarding centrifugal, positive displacement, and vacuum pumps, perform pump maintenance and repair with techniques and principles such as:

- servicing, lubricating, adjusting, maintaining and rebuilding pumps
- removal and installation of packing and mechanical seals
- read and interpret pump curves and efficiencies
- alignment techniques
- vibration analysis
- troubleshooting and performing corrections
- basic pump hydraulics
- complete proper installation and removal techniques
- identify the major components of a pump
- preventative and predictive maintenance

KSA 203 General Competencies

A journey level Mechanical Technologist is expected to have a well defined knowledge base of: Centrifugal, Positive Displacement, and Vacuum Pump principles. The technologist should be experienced in performing pump maintenance and repair, to include:

- packing
- alignment
- vibration analysis
- troubleshooting
- identification
- installation
- removal

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 203 Math Competencies

There are no math competencies for this KSA.

KSA 203 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Manual of Practice-MOP 11, Page 43, Fifth Edition, 1996.

Water Environment Federation. Pg. 191 & 685.

Operations of Municipal Wastewater Treatment Plants; Volume 2.

California State University Sacramento Office of Water Programs, 1998. Pg. 64, 202, 234-237, 239, 244.

KSA 204

Weight: 4%

Clean and repair wet wells with an understanding of methods such as:

- knowledge of proper coating
- repairing and maintenance of level control devices
- septic prevention
- odor control systems
- predictive and preventive maintenance

KSA 204 General Competencies

A journey level Mechanical Technologist expected to perform predictive and preventative maintenance on wet wells. Familiarity with level control, septic prevention, and proper operation is a must.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 204 Math Competencies

There are no math competencies for this KSA.

KSA 204 Suggested Reading

OWTP; Vol. II; 7th Edition; Maintenance, Plant Tanks and Channels; Page 335

KSA 205

Weight: 7%

With knowledge of pipelines and valves, perform maintenance and repair such as:

- change piping
- proficient pipe layout
- piping systems of galvanized, PVC, stainless steel, and copper tubing
- proper connecting techniques
- pipe inspection and repair
- modifying existing piping systems
- knowledge in application of valve, actuators types and associated repairs
- piping support systems
- expansion systems
- technics and devices used to stop/repair leaks

KSA 205 General Competencies

A journey level Mechanical Technologist is expected to know how to measure, prepare, thread or glue piping systems of:

- PVC
- ABS
- Galvanized
- Stainless Steel
- Copper piping

Use of brazing tools, manual and power threading tools, and fitting knowledge is required. Further, the person should be able to identify different types of valves and understand their operation and application

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 205 Math Competencies

There are no math competencies for this KSA.

KSA 205 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 2.

California State University Sacramento

Office of Water Programs, 1998. Pg. 81, 199, & 200

KSA 206

Weight: 7%

Repair and maintain mechanical systems with knowledge of the operation, maintenance and repair of compressors and blowers and associated components such as:

- lubrication
- air receivers and tanks
- types of valves
- cooling systems
- troubleshooting and applying corrections
- control systems
- filtration systems
- predictive and preventive techniques
- vibration analysis

KSA 206 General Competencies

A journey level Mechanical Technologist is expected to have a firm grasp of pneumatic systems. Predictive and Preventative techniques are used often to ensure control, lubrication, and filtration systems are effective. Troubleshooting and applying corrections are also a big area of this KSA.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 206 Math Competencies

There are no math competencies for this KSA.

KSA 206 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 2.
California State University Sacramento
Office of Water Programs, 1998. Pg. 142 & 259.

KSA 207

Weight: 8%

Safely and effectively repair and maintain process equipment and related components with apprentice level knowledge of process equipment purpose and function such as:

- chemical feed systems and effects of delivered chemicals on associated equipment
- solids removal systems
- conveyance systems
- digesters and associated systems
- odor control systems
- aeration systems
- disinfection and de-chlorination
- filtration systems
- settling basins
- storage systems
- predictive and preventive maintenance

KSA 207 General Competencies

A journey level Mechanical Technologist is expected to demonstrate knowledge of typical water and wastewater equipment. This equipment includes conveyors, digesters, heat exchangers, boilers, and chemical feed systems. A good understanding of odor systems, disinfection and de-chlorination systems is also necessary.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 207 Math Competencies

There are no math competencies for this KSA.

KSA 207 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 1 & 2.

California State University Sacramento

Office of Water Programs, 1998. Pg. 41, 79 & 109.

Operations of Municipal Wastewater Treatment Plants; Manual of Practice-MOP 11. Fifth Edition, 1996. Water Environment Federation. Pg. 683.

KSA 208**Weight: 5%**

Perform shop mathematics and techniques to calculate or determine:

- efficiency of pumps and motors
- horsepower (brake and motor)
- flow rates
- volumes and area
- measurements
- drive ratios
- pressure

KSA 208 General Competencies

A journey level Mechanical Technologist is expected to demonstrate knowledge of mathematically calculating volumes, areas, flow rates, horsepower, drive ratios, and pressure.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 208 Math Competencies

In this KSA, the math competencies needed are the ability to calculate or determine flow rates, horsepower, and efficiency of pumps. An understanding of how to calculate perimeter, volume, and area are also needed.

KSA 208 Suggested Reading

http://en.wikipedia.org/wiki/Shaft_alignment

KSA 209

Weight: 3%

Safely and effectively repair and maintain equipment with a knowledge and understanding of electrical principles and practices including:

- Ohms Law
- voltage ratings
- motor identification
- battery principles

KSA 209 General Competencies

A journey level Mechanical Technologist is expected to have a strong knowledge of electrical principles and terms. Identification of motor style and type is also needed.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 209 Math Competencies

There are no math competencies for this KSA.

KSA 209 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 2.

California State University Sacramento

Office of Water Programs, 1998. Pg. 162.

KSA 210**Weight: 10%**

Repair and maintain mechanical systems while adhering to industry safety standards and regulations pertaining to CCR Title 8 or equivalent state regulations:

- lock tag verification (LTV) (Lockout/Tagout) and Blocking/Isolation
- confined space
- slip, trip and fall
- proper lifting
- trench safety
- crane safety
- vehicle safety
- tool safety
- stored energy
- NFPA 70E (National Fire Protection Association)
- proper use of PPE (Personal Protective Equipment)
- chemical safety
- fire safety
- Safety Data Sheet (MSDS)
- gas detection systems
- electrical safety
- traffic control
- rigging safety
- wet well safety
- IIP (Injury Illness Prevention)

KSA 210 General Competencies

To spec pumps for given applications, a journey level Mechanical Technologist is expected to have a very strong background in lock out/tag out and all aspects of safety while on the job. The technologist should have a firm understanding of proper safety procedures while in a confined space, a trench, a crane, a vehicle, and in use of tools. A broad base of safety knowledge while working with chemicals, traffic, and electricity is also useful. The technologist should be comfortable and confident enough to lead others in safety.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 210 Math Competencies

There are no math competencies for this KSA.

KSA 210 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Manual of Practice-MOP 11. Fifth Edition, 1996. Water Environment Federation. Pg. 185.

Operations of Municipal Wastewater Treatment Plants; Volume 2.

California State University Sacramento

Office of Water Programs, 1998. Pg. 355 & 357

KSA 211**Weight: 4%**

Participate in the lifting and moving of heavy machinery or equipment with knowledge and understanding of:

- crane operations
- rigging and lifting
- proper use of forklifts
- use of proper hand signals
- A-frame use
- chain falls/come alongs (cable or chain puller)

KSA 211 General Competencies

Journey level Mechanical Technologists are expected to be well versed in craning operations. Technologist should be aware of proper safety and hand signals. He or She should know how to properly use forklifts and A-frames.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 211 Math Competencies

There are no math competencies for this KSA.

KSA 211 Suggested Reading

Work Area Traffic Control Handbook conforms to the standards and guidance of the CalTrans CA Manual on Uniform Traffic Control Devices, Southern California Chapter APWA, BNI (POCKET GUIDE)

Millwrights and Mechanics Guide; 4th Edition

Millwrights and Mechanics Guide, 5th Ed. Chapter 36: Rigging, page 983

KSA 212

Weight: 10%

Repair and maintain mechanical systems with the knowledge of proper use of tools such as:

- hand tools
- power tools
- machine/shop tools
- hydraulic/pneumatic tools
- measurement tools
- computers and systems
- understanding of ultra-sonic preventative maintenance equipment
- alignment and precision measurement tools

KSA 212 General Competencies

Journey level Mechanical Technologists are required to have a wide based knowledge of a variety of tools that are applicable to the task. These include measurement, shop, hydraulic, power, and hand tools. The technologist should understand and apply principles of an average machine shop and know how to use alignment tools.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 212 Math Competencies

There are no math competencies for this KSA.

KSA 212 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 2.

California State University Sacramento

Office of Water Programs, 1998. Pg. 136.

KSA 213

Weight: 5%

Apply appropriate construction methods and materials with a knowledge of facility maintenance, construction methods and materials, to perform apprentice level maintenance such as:

- pipe fitting
- framing
- concrete forming, pouring, and finishing
- painting/coating
- heating and cooling systems
- plumbing and draining systems
- lighting and electrical
- knowledge of job estimation

KSA 213 General Competencies

Journey level Mechanical Technologists should have a strong understanding of pipe fittings and how they are used. The person should know how to estimate the amount of paint, concrete, and lumber needed for a job. The person should know how to assemble the materials properly and follow through to the job's completion.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations programs

KSA 213 Math Competencies

There are no math competencies for this KSA.

KSA 213 Suggested Reading

N/A

KSA 214

Weight: 5%

Perform apprentice level maintenance and repair by interpreting and applying information from:

- designs and sketches
- written and verbal design instructions
- equipment specifications
- operations and maintenance service manuals
- diagrams
- schematics
- pump curve

KSA 214 General Competencies

Journey level Mechanical Technologists are expected to understand the proper symbols when reading or drawing sketches and schematics. The candidate should be able to easily follow written and verbal instructions.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations Programs

KSA 214 Math Competencies

There are no math competencies for this KSA.

KSA 214 Suggested Reading

N/A

KSA 215**Weight: 4%**

Establish and maintain effective working relationships with every person encountered in the workplace to help incorporate the concept of teamwork.

- planning and scheduling work with other team members
- promoting the agencies core values

KSA 215 General Competencies

A Journey level Mechanical Technologists is expected to work together with other team members, when planning and scheduling work, to help promote the agencies core values.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupational Programs

KSA 215 Math Competencies

There are no math competencies for this KSA.

KSA 215 Suggested Reading

OWTP; Vol. II; 7th Edition; Maintenance, Beware of Electricity; Page 373

KSA 216**Weight: 4%**

Communicate clearly and concisely in English, both verbally and in writing with respect to:

- completing and accepting work orders
- purchase requests
- warehouse requisition
- accident reporting
- radio and telephone communication
- written and computerized records

KSA 216 General Competencies

A Journey level Mechanical Technologists is expected to have familiarity with the basic use of handheld radios and telephones. A firm grasp of computer use is needed to keep records and complete/accept work orders.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations Programs

KSA 216 Math Competencies

There are no math competencies for this KSA.

KSA 216 Suggested Reading

N/A

KSA 217

Weight: 7%

Perform maintenance and repair with an apprentice level knowledge and understanding of power transmission equipment such as:

- types of drives
- gear and pulley ratios
- machine guards
- shafts
- alignment techniques
- types of couplings
- joints
- gear reduction systems

KSA 217 General Competencies

Journey level Mechanical Technologists are expected to have a solid foundation in couplings, gears, pulleys, drives, and gear reduction. The technologist should know proper maintenance procedures for all of the above.

This knowledge is usually gained through:

- apprenticeship trade schools
- military schools
- entry-level in-house training
- Regional Occupations Programs

KSA 217 Math Competencies

There are no math competencies for this KSA.

KSA 217 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 1 & 2.

California State University Sacramento

Office of Water Programs, 1998. Pg. 41 & 255.

Audel Mechanical Trades Pocket Manual; 4th Ed.; Chain Drives; Page 191, 200 & 209

<http://www.brighthubengineering.com/machine-design/47267-what-is-a-reduction-gear/>

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- Operation of Wastewater Treatment Plant, Vol II, 7th Edition, Office of Water Programs
- Millwrights and Mechanics Guide, 4th Edition <http://www.amazon.com/Audel-Millwrights-Mechanics-Guide-Thomas/dp/0764541714>
- Utility Management, Office of Water Programs
- Pump Application Engineering, Hicks and Edwards, <http://www.abebooks.com/servlet/BookDetailsPL?bi=12451114734&searchurl=tn%3DPu mp%2Bapplication%2Bengineering>, ISBN-13: 978-0070287419
- Work Area Traffic Control Handbook conforms to the standards and guidance of the CalTrans CA Manual on Uniform Traffic Control Devices, Southern California Chapter APWA, BNi (POCKET GUIDE) <http://www.bnibooks.com/shopexd.asp?id=6471>
- California Manual on Uniform Traffic Control Devices, California Department of Transportation (POCKET GUIDE) <http://mutcd.fhwa.dot.gov/index.htm>
- Condensed Hydraulic Data, Cornell Pump Company. (POCKET GUIDE) <http://www.cornellpump.com/lit/pdf/Book-Condensed%20Hydraulic.pdf>
- Valve & Actuator Technology, Wayne Ulanski ISBN-13: 978-0070194779 <http://www.amazon.com/Valve-Actuator-Technology-Wayne-Ulanski/dp/0070194777>
- Pocket Ref, Thomas J. Glover (POCKET GUIDE) http://www.amazon.com/Pocket-Ref-Thomas-J-Glover/dp/1885071000/ref=la_B001K7XNGU_1_1?s=books&ie=UTF8&qid=1400171345&sr=1-1
- AWWA Wastewater Operator Field Guide ISBN: 9781583213865 <http://www.awwa.org/store/productdetail.aspx?ProductId=6582>
- Pocket Guide to Flanges, Fittings, and Piping Data, R. R. Lee (POCKET GUIDE) ISBN-13: 978-0884153108 <http://www.amazon.com/Pocket-Guide-Flanges-Fittings-Piping/dp/088415310X>

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. What does the term "arc length" refer to in arc welding?
 - A. The voltage required to maintain an arc
 - B. The amperage peak across the welding arc
 - C. The length of time the arc is maintained during welding
 - D. The distance from the end of the electrode to the surface of the work
2. In DC straight polarity welding:
 - A. the work is the positive pole and the electrode is the negative pole.
 - B. polarity switches back and forth at 60 cycles per second.
 - C. the work is the negative pole and the electrode is the positive pole.
 - D. a shielding gas is required.
3. What safety measure should be considered when chipping slag after stick welding?
 - A. Take precautions against flying debris
 - B. always use a stainless-steel wire brush
 - C. Use a beryllium hammer to avoid sparks
 - D. Use a ball-pen hammer
4. The tungsten electrode used to TIG welding is:
 - A. sometimes used as a filler.
 - B. consumed in the wire feed process.
 - C. a non-filler electrode.
 - D. used as an arc shield.
5. When MIG welding, which of the following is the proper shielding gas?
 - A. Argon for welding stainless steel
 - B. Carbon dioxide for penetrating welds on steel
 - C. Triple-mix (helium+argon+carbon dioxide) when welding aluminum
 - D. Carbon dioxide + helium when welding thin steel plates
6. Which is the best technique when plasma cutting?

- A. Bounce the work tip off the work piece to start the cut
 - B. Hold the torch at a 60° angle to the work piece
 - C. Use clean, dry, air
 - D. Use the maximum air pressure available
7. Which of the following is the best description of a pressure head?
- A. It is equal to static head minus dynamic head.
 - B. It is the amount of energy in water due to water pressure.
 - C. It is the amount of energy in water due to velocity.
 - D. It is equal to the static head plus dynamic head.
8. What is the source of most bearing failure?
- A. Excessive shaft speed
 - B. Improper installation
 - C. Under lubrication
 - D. Some form of contamination entering the bearing
9. Of the following, what is the most likely cause of a pump to quickly become noisy and vibrate?
- A. Over lubrication
 - B. Worn parts
 - C. Loss of foundation bolts
 - D. Cavitation
10. Which of the following is the most probable cause of an air compressor delivering below capacity?
- A. Inadequate lubrication
 - B. Broken or worn valves
 - C. Loose bearings
 - D. Excessive crankshaft end display
11. Which is the best definition of friction, as it relates to machine components?
- A. The resistance to motion between two surfaces in contact.
 - B. Heat created between two surfaces in contact.
 - C. Degradation of lubrication between two surfaces in contact.
 - D. Penetration of lubrication between two surfaces in contact.
12. Which of the following can cause cavitation in a centrifugal pump?
- A. Turbidity of mixture

- B. Restriction of suction piping
 - C. Restriction of discharge
 - D. A worn impeller
13. What can be assumed if a centrifugal pump sounds as if it is pumping rocks?
- A. The pump is excavating
 - B. The pump is cavitating
 - C. The pump is pumping sludge
 - D. The pump is operating as designed
14. Which of the following pumps require priming?
- A. A centrifugal pump
 - B. A rotary pump
 - C. A reciprocating pump
 - D. A gear pump
15. Which of the following defines the rated capacity of a pump?
- A. Electrical consumption and gallons per minute pumped
 - B. Electronic consumption and velocity of flow
 - C. Horsepower and velocity flow
 - D. Gallons per minute pumped and pressure head
16. Closing the discharge valve on an electric motor driven centrifugal pump during pumping will cause the motor's amperage draw to:
- A. decrease.
 - B. increase.
 - C. remain unchanged.
 - D. trip the circuit protection device.
17. What is the most common source of tripping a circuit breaker on an electrical motor driven centrifugal sewage pump?
- A. A plugged discharge line
 - B. A plugged suction line
 - C. Packing binding on the shaft
 - D. Rags or debris binding the pump
18. An impeller in a centrifugal pump has become worn after use. For this pump the amount of energy used to pump the same amount of water as a new similar pump will be:

- A. erratic.
 - B. increased.
 - C. decreased.
 - D. the same.
19. What is the advantage of a split mechanical seal compared to a cartridge mechanical seal?
- A. The seal can be installed without removing the pump.
 - B. Seal water is not required.
 - C. Packing glands are easier to adjust.
 - D. Split in seal allows additional cooling.
20. What is used to adjust the clearance between the impeller and the wear ring in raw wastewater pumps?
- A. A flexible coupling
 - B. A stuffing box
 - C. A jack screws
 - D. A ceramic seal
21. Which of the following is most true about shaft sleeves on raw wastewater pumps?
- A. They allow for replacement for the sleeve instead of the entire shaft.
 - B. They are only used with mechanical seals.
 - C. They are commonly made of Teflon.
 - D. They eliminate the need to replace o-rings in mechanical seals.
22. In mounting a bearing, force should be applied to which ring?
- A. The ring that rotates in the application
 - B. The ring that is stationary in the application
 - C. The inner ring
 - D. The outer ring
23. Lock-out, tag-out is not required to:
- A. clear a blocked pump impeller.
 - B. replace a mechanical seal.
 - C. collect vibrations data from a shaft bearing.
 - D. adjust the tension on a v-belt.
24. In what conditions would you use an open or semi-open impeller pump?
- A. During high volume, low head applications

- B. During low volume, high head applications
 - C. During chemical metering applications
 - D. During grit removal applications
25. Internal leakage in a centrifugal pump with a closed impeller is restricted by the:
- A. wearing rings.
 - B. casing.
 - C. impeller shroud.
 - D. impeller sleeve.
26. The main function of a pump stuffing box is to:
- A. prime the pump.
 - B. protect the pump against leakage at the point where the shaft passes through the pump casing. (too long)
 - C. provide a ball bearing race.
 - D. house the shaft sealing device.
27. Which is the most common type of AC motor used at a treatment plant?
- A. A squirrel cage induction motor
 - B. A wound rotor motor
 - C. A synchronous motor
 - D. A dual winding motor
28. Which of the following is most true when using packing for pump sealing?
- A. It should leak continuously
 - B. It is superior because they do not cause shaft wear
 - C. It should only need adjustment at installation
 - D. They are designed to provide an additional point of shaft support
29. Which of the following is true about the flow capacity of pump?
- A. varies with the square of the speed $Q_2/Q_1 = (N_2/N_1)^2$
 - B. varies inversely with the speed $Q_2/Q_1 = \frac{1}{N_2/N_1}$
 - C. varies directly with the speed $Q_2/Q_1 = N_2/N_1$
 - D. varies inversely with the square of the speed $Q_2/Q_1 = \frac{1}{(N_2/N_1)^2}$
30. Comminutor teeth should be set with how much clearance?

- A. .0005 in.
 - B. .005 in.
 - C. .05 in.
 - D. .5 in.
31. A maintenance program consists of two major parts; performing tasks and:
- A. scheduling tasks.
 - B. ordering renewal parts.
 - C. equipment failure analysis.
 - D. completing the paperwork.
32. In which circumstance would pneumatic ejectors be used for?
- A. Situations requiring pumping low flows containing large solids
 - B. Situations requiring pumping high flows containing large solids
 - C. Situations with excessive H₂S environments
 - D. Situations with severe odor problems
33. Seal water is usually plumbed to pumps:
- A. with two stage impellers.
 - B. in high head applications.
 - C. pumping liquids containing grit.
 - D. in high humidity environments.
34. Which of the following is true regarding incline screw pumps?
- A. They have pumping rates inversely proportional to submergence.
 - B. They have operating efficiencies of 75-80%.
 - C. They are susceptible to ragging.
 - D. They are often used in high discharge head applications.
35. V-belts come in various letter designations ranging from "A" through "E". These letter designations identify which of the following?
- A. The belts cross section dimensions
 - B. The maximum speed at which the belt can be used
 - C. The maximum torque the belt will withstand
 - D. The maximum temperature the belt can safely operate
36. What is dry ice used for at a pump shop?
- A. To expel a pump wear ring to ease installation

- B. To freeze the pump wear ring to ease installation
 - C. To freeze shaft bearings to ease installation
 - D. To expel oxygen from a crankcase before filling with oil
37. Which of the following best describes the efficiency of preventative maintenance for plant equipment?
- A. The accumulation and analysis of equipment performance data designed to schedule equipment repairs
 - B. Timely response to equipment failure, returning equipment to service with a minimum of downtime
 - C. Periodic inspection of facilities to discover developing defects that could lead to equipment failures
 - D. Dependent upon just-in-time parts delivery
38. Which of the following is most true about predictive maintenance?
- A. Results in more downtime than preventative maintenance
 - B. Costs less than preventative maintenance
 - C. Ensure less downtime than breakdown maintenance
 - D. Requires more spare parts on hand than breakdown maintenance
39. Which of the following could lead to water hammer in a piping system?
- A. Excessive flow
 - B. Restriction of flow
 - C. Slowly opening a valve
 - D. Rapidly closing a valve
40. Which of the following valves will open or close with a 1/4 of a turn?
- A. A ball valve
 - B. A gate valve
 - C. A needle valve
 - D. A diaphragm valve
41. Short pieces of pipe threaded on both sides are called:
- A. bushings.
 - B. couplings.
 - C. nipples.
 - D. sleeves.

42. A pipe with many connection points to allow multiple flow operations is called a:
- A. gooseneck.
 - B. multi-valve pipe.
 - C. global valve.
 - D. manifold.
43. Which of the following items must be replaced when connecting a new chlorine cylinder?
- A. Fiber washer
 - B. Air and water regulator
 - C. Needle valve seat
 - D. Pressure regulator
44. What is the purpose of the low-pressure check valve on an anaerobic digester?
- A. To prevent air from being drawn into the gas piping by a vacuum condition in the digester
 - B. To prevent the flame from going out
 - C. To eliminate carbon dioxide from the digested gas
 - D. To prevent gas leaks around the shaft seal
45. What are the typical settings for the pressure relief valve on an anaerobic digester? The pressure relief valve setting should:
- A. be lower than the setting for the cover mounted pressure and vacuum relief valve.
 - B. be slightly higher than the setting for the cover mounted pressure and vacuum relief valve.
 - C. be the same as the setting for the cover mounted vacuum relief valve.
 - D. have 12-mm of water column above the lower pressure check valve (all other options are referring to a vacuum)
46. A Parshall flume is used to measure:
- A. liquid flows in an open channel.
 - B. air flows in a heating system.
 - C. water flow in a piping system.
 - D. exhaust emissions.
47. What is the area of a triangle with a base of 15 feet and 4 inches and height of 8 feet and 9 inches?
- A. 67 square feet

- B. 68.5 square feet
 - C. 134.1 square feet
 - D. 137 square feet
48. The exterior walls of an open-top tank are to be painted. If the tank is 25 feet in diameter and 12 feet high, what is the total surface work area of the tank in square feet?
- A. 78.50 ft²
 - B. 113.04 ft²
 - C. 942.48 ft²
 - D. 1,356.48 ft²
49. What is the area of a right triangle below?
- A. 60 square feet
 - B. 67.5 square feet
 - C. 120 square feet
 - D. 135 square feet
50. Which of the following formulas correctly shows the relationship between absolute pressure and gauge pressure?
- A. absolute pressure + atmospheric pressure = gauge pressure
 - B. absolute pressure + gauge pressure = atmospheric pressure
 - C. absolute pressure = gauge pressure + atmospheric pressure
 - D. absolute pressure = gauge pressure - atmospheric pressure
51. How much more water will a 6-inch diameter pipe carry compared to a 3-inch diameter pipe under the same conditions?
- A. 2 times
 - B. 4 times
 - C. 3 times
 - D. 6 times
52. What is most true about the design of flame traps?
- A. It limits the distance a flashback can travel in the gas line.
 - B. It must be located as far as possible from the source of combustion.
 - C. They are designed to instantly shut down the flame in case of an emergency.
 - D. They are subject to failure from condensation of water vapor in the gas.
53. Which of the following should be used for lifting objects with sharp edges at the contact

- points?
- A. A chain
 - B. Leather (obviously wrong)
 - C. A wire rope
 - D. A webbed nylon
54. During a rigging operation, if the weight of an object is not known, how should the qualified rigger obtain the weight of the object?
- A. By referring to the equipment's rigging documents
 - B. By estimating
 - C. By guessing
 - D. By researching the weight on the web
55. You are asked to replace a long fluorescent bulb in the administrative building, where should you place the burnt-out bulb while you install the new one?
- A. On the floor
 - B. On your work cart
 - C. Leaning against the nearest wall
 - D. On the top of the ladder
56. Small by-pass lines are often furnished around large gate valves mainly to:
- A. direct the fluid in the event of the valve getting stuck.
 - B. meter the flow of fluid.
 - C. balance the pressure on the gate when the valve is being opened.
 - D. permit the release of excess fluid.
57. Possibly change to "What tool trues, cleans, and shapes a grinding wheel?"
- A. Wheel Hone
 - B. Wheel Sharpener
 - C. Wheel Dresser
 - D. Wheel Cutter
58. A thread chaser is likely to be used to:
- A. adjust die stocks.
 - B. repair damaged threads.
 - C. remove broken belts.
 - D. flare tubing.

59. An electric hand tool, such as a drill, should never be lifted or carried by its service cord. Which of the following would be the primary reason this is true?
- A. The tool might swing and be damaged by striking some hard object.
 - B. The cord might be pulled off its terminals and become short-circuited.
 - C. The rubber covering the cord might overstretch.
 - D. The tool might slip out of your hand because the cord is slick.
60. For a flow of 160 GPM, what is the pump efficiency?
- A. 25%
 - B. 4.5 %
 - C. 60%
 - D. 90%
61. Without overloading at any place on the figure above and not using the 1.15 safety factor, what HP motor would be required to meet the new operating condition?
- A. 150 HP
 - B. 125 HP
 - C. 100 HP
 - D. The pump cannot make the new operating point. No motor will meet the conditions.

Answer Key

No.	Answer	KSAs	No.	Answer	KSAs
1	D	201	32	A	203
2	A	201	33	C	203
3	A	201	34	B	203
4	C	201	35	A	203
5	B	201	36	B	203
6	C	201	37	C	203
7	B	203	38	C	203
8	D	203	39	D	205
9	D	203	40	A	205
10	B	203	41	C	205
11	A	203	42	D	205
12	B	203	43	A	207
13	B	203	44	A	207
14	A	203	45	A	207
15	D	203	46	A	207
16	A	203	47	A	208
17	D	203	48	C	208
18	B	203	49	A	208
19	A	203	50	C	208
20	C	203	51	B	208
21	A	203	52	A	210
22	A	203	53	A	211
23	C	203	54	B	211
24	A	203	55	B	211
25	A	203	56	C	211
26	D	203	57	B	212
27	A	203	58	B	212
28	A	203	59	B	212
29	C	203	60	C	214
30	B	203	61	A	214
31	A	203			

Selected Problem Solutions

48. The exterior walls of an open-top tank are to be painted. If the tank is 25 feet in diameter and 12 feet high, what is the total surface work area of the tank in square feet?

- A. 78.50 ft²
- B. 113.04 ft²
- C. 942.48 ft²

D. 1,356.48 ft²

Solution:

Area of Cylinder Wall = Circumference x Height

Circumference = Diameter x 3.1416

Circumference = 25 x 3.1416

Circumference = 78.54

Height = 12 feet

78.54 x 12 = 942.48 sq. ft.

51. How much more water will a 6-inch diameter pipe carry compared to a 3-inch diameter pipe under the same conditions?

- A. 2 times
- B. 4 times
- C. 3 times
- D. 6 times

Solution:

Length doesn't matter because question says same conditions.

It's easiest to compare Area of the two.

Circle Area = Radius squared x Pi (3.1416)

---6 inch---

3 inch squared x 3.1416

9 x 3.1416 = 28.2744 sq. in

28.2744 ÷ 7.0686 = 4

---3 inch---

1.5 inch squared x 3.1416

2.25 x 3.1416 = 7.0686 sq. in

28.2744 is 4 times bigger than 7.0686, so the 6-inch pipe will carry 4 times more than the 3-inch pipe.

MT GRADE 3 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Mechanical Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 301**Weight: 5%**

Perform fabrication and design to maintain facilities and equipment using the following methods:

- multi-position welding with acetylene and arc welders
- heating, cutting and bending materials
- proficient use of materials and tools
- material estimation

KSA 301 General Competencies

A journey level Mechanical Technologist is expected to have extensive experience with metal fabrication tools, including:

- oxy-acetylene torches
- welders
- various hand and power tools used in the trade.

This experience will include:

- fabricating replacement parts
- improving upon existing design to adapt existing equipment to updated tasks
- training subordinates
- materials estimation
- safe material handling
- safe operation of all equipment and tools.

KSA 301 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to:

- perform calculations of dimensions to fabricate equipment parts to fit in limited spaces
- determine material required for a job
- determine strength requirements of fabricated parts
- estimate time to complete a job
- safely operate material handling equipment such as cranes, and other lifting equipment.

KSA 301 Suggested Reading

Millwrights and mechanics guide

KSA 302

Weight: 4%

Oversee engine repair and maintenance program including:

- verifying troubleshooting and corrections techniques
- ensuring compliance of air quality regulations
- proficient in the knowledge of engines

KSA 302 General Competencies

A journey level Mechanical Technologist is expected to have extensive experience with:

- engine repair and maintenance
- overhaul/rebuilding
- tuning
- repairs
- training subordinates
- safe operation of all equipment and tools.

The Technologist will also have extensive experience dealing with:

- regulatory agencies responsible for the permitting of engines
- the equipment associated with the engines including regional air quality boards for engine discharges
- water boards for fuel handling and storage.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- Professional trade related agencies.

KSA 302 Math Competencies

There is no specific math competency required however, the incumbent will be expected to:

- perform basic calculations to determine if an engine may be suitable or sized correctly to run a specific piece of equipment
- take measurements when fabricating equipment parts

KSA 302 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 1; OWP 1998. Pg. 41

KSA 303

Weight: 5%

Manage routine operations of the maintenance management program including oversight of:

- planning and scheduling
- maintenance management system and related documentation
- outside contractors
- management of vendors, purchasing, and inventory
- work and project management

KSA 303 General Competencies

A journey level Mechanical Technologist is expected to monitor the performance of others engaged in:

- operation
- maintenance
- repair of mechanical equipment.

This may include tracking status of operation and maintenance activities by utilizing a variety of sources such as:

- daily work logs
- computerized work management programs
- agency specific computerized maintenance management programs.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 303 Math Competencies

Journey level Mechanical Technologists must:

- have excellent mathematical skills
- be able to perform calculations to determine percentage of work completed
- individual performance by crew as compared to established standards
- determine number of work hours/days required to complete required tasks
- develop work schedules based on established performance levels.

KSA 303 Suggested Reading

Operations of Municipal Wastewater Treatment Plants; Volume 1; OWP 1998. Pg. 41.

KSA 304

Weight: 5%

Manage maintenance records with an understanding of:

- documentation requirements and record retention
- knowledge base of equipment and product research
- state and local regulations safety training compliance record keeping requirements

KSA 304 General Competencies

A journey level Mechanical Technologist is expected to be able to:

- document the work of subordinates
- have detailed knowledge of all equipment they work on
- have working knowledge of all pertinent regulations regarding safety training, record keeping and document retention policies

The Technologist is also expected to have the ability to conduct research on:

- machinery and equipment
- comparing features
- costs
- expected life cycles
- maintenance requirements
- other parameters to provide field-level input into upgrades or replacement projects.

This knowledge is usually gained through:

- trade schools
- advanced in-house training
- professional trade related agencies.

KSA 304 Math Competencies

While there are no complex math calculations for this competency, journey level Mechanical Technologists are expected to have an understanding of the basic math required to calculate elapsed time (as it applies to record retention requirements) and scheduling intervals.

KSA 304 Suggested Reading

Maintenance Manager's Standard Manual, Wsterkamp; Part V Equipment Records and Preventative Maintenance, Chapter 18: How to Set-up and Maintain Equipment Records; Page 208 & 210, Chapter 19: How to Establish a Six Step Preventative Maintenance Program; Page 211

KSA 305**Weight: 4%**

Train and mentor staff and assess learning outcomes using the following techniques:

- on the job and hands on training
- tailgate training
- document training
- teaching principles of the operation and maintenance of equipment such as pumps, engines, and electrical systems related to mechanical systems
- independent study
- application of internal training program

KSA 305 General Competencies

A journey level Mechanical Technologist is expected to:

- be proficient in the operation, maintenance and repair of mechanical equipment under their purview
- be able to assess the abilities of, and provide mentoring and detailed training (on-the-job training, tailgate training and classroom study) to subordinate and new staff on any aspect of the trade from basic operating principles to detailed procedures.

The Technologist will be required to possess the competency to:

- monitor and document the progress of those being trained
- adjust the training to deal with personal learning styles
- always set a positive example for the students under their tutelage.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 305 Math Competencies

Journey level Mechanical Technologists must:

- have excellent mathematical skills
- be able to perform calculations to demonstrate and teach principles of the trade, including:
 - dimensions
 - weights
 - volumes
 - and other more complex calculations such as electrical formulas, pump horsepower calculations, gear reduction ratios
- impart this knowledge on subordinate and new employees the Technologist is assigned to mentor and train.

KSA 305 Suggested Reading

OWTP; Vol. II; 7th Edition; Administration, Page 697; Training and Certification

KSA 306**Weight: 9%**

Apply journey level pumping principles and techniques in the repair and maintenance of centrifugal, positive displacement, and vacuum pumps such as:

- servicing, lubricating, adjusting, maintaining and rebuilding pumps
- reading and interpreting pump curves and efficiencies
- performing alignment techniques
- applying in-depth understanding of predictive maintenance techniques such as thermography, vibration analysis, oil analysis (tribology) and equipment trending
- troubleshooting and applying corrections
- repairing and maintaining pump hydraulics
- installation and removal techniques
- root cause analysis

KSA 306 General Competencies

A journey level Mechanical Technologist is expected to:

- be proficient in all maintenance and repair of equipment under their purview
- be able to assess equipment condition
- be familiar with all maintenance practices including:
 - lubrication schedules
 - aligning pumps and motors
 - conducting predictive maintenance activities such as:
 - thermology
 - vibration analysis
 - oil analysis
- monitor equipment trending utilizing maintenance and repair records.
- interpret pump curves
- assist in recommending replacement equipment
- troubleshoot systems and apply corrective actions
- determine the cause of failures and correct these conditions
- be proficient in:
 - servicing, lubricating, adjusting, maintaining and rebuilding pumps
 - repairing hydraulic systems, equipment installation and removal techniques
 - record keeping for equipment maintenance and repair

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training

- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 306 Math Competencies

Journey level Mechanical Technologists must:

- have excellent mathematical skills
- be able to perform calculations of dimensions to fabricate equipment parts to fit in limited spaces:
- determine material required for a job
- determine strength requirements of fabricated parts
- estimate time to complete a job
- safely operate material handling equipment such as cranes and other lifting equipment
- have the ability to compare measurements taken to determine alignment
- have the ability to determine the difference between readings taken and recommended values
- make adjustments to correct any deficiencies

KSA 306 Suggested Reading

N/A

KSA 307

Weight: 4%

Perform journey level maintenance and repair on pipelines and valves such as:

- proficiency in pipe layout
- piping systems
- cutting and threading pipes
- pipe inspection and repair
- modification to existing piping systems
- proficiency in applications of valve, actuators types and associated repairs
- piping support systems
- expansion systems

KSA 307 General Competencies

A journey level Mechanical Technologist is expected to be proficient in all:

- repair
- maintenance
- inspection
- modification of pipe and piping systems including:
 - valves
 - pipe supports
 - expansion joints

The Technologist must have the knowledge of valve actuators and their application, pipeline inspection and pipeline expansion joints and support systems. They will also be proficient in:

- servicing, lubricating, adjusting, maintaining and rebuilding pumps
- repairing hydraulic systems
- equipment installation and removal techniques
- all record keeping for equipment maintenance and repair

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 307 Math Competencies

Journey level Mechanical Technologists must:

- have excellent mathematical skills
- be able to perform calculations of dimensions to lay out piping systems

- fabricate equipment parts to fit in limited spaces
- determine material required for a job
- determine strength requirements of fabricated parts
- estimate time to complete a job
- fabricate threaded pipe fittings
- determine thermal expansion
- have the ability to determine ratios for valve actuators gear reduction drives

KSA 307 Suggested Reading

Millwrights and Mechanics Guide, 4th Edition

Millwrights and Mechanics Guide, 5th Ed. Chapter 28: Pipe Valves, page 634

KSA 308**Weight: 7%**

Maintain and repair compressors, turbines and blowers with journey level knowledge and skill of:

- lubrication
- air receivers and tanks
- types of valves
- principles of cooling systems
- troubleshooting and corrections
- purpose of control systems
- filtration systems

KSA 308 General Competencies

A journey level Mechanical Technologist is expected to:

- be proficient in the maintenance and repair of all equipment under their purview
- be able to assess equipment condition and be familiar with all maintenance practices including:
 - lubrication schedules
 - aligning drive and driven ends of equipment
 - maintenance practices including permitting for air receivers and tanks
- be able to interpret pump curves
- assist in recommending replacement equipment
- troubleshoot systems and apply corrective actions
- determine the cause of failures and correct those conditions

Other responsibilities Mechanical Technicians are required to be familiar with is:

- troubleshooting and diagnosing cooling systems
- filtration systems
- lubrication and fuel systems
- valves of all types
- control systems

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs

- professional trade related agencies.

KSA 308 Math Competencies

Journey level Mechanical Technologists must:

- have excellent mathematical skills
- be able to perform calculations of dimensions to fabricate equipment parts to fit in limited spaces
- determine material required for a job
- determine strength requirements of fabricated parts
- estimate time to complete a job
- safely operate material handling equipment such as cranes, and other lifting equipment
- have the ability to calculate thermal expansion
- determine rations for valve actuators gear reduction drives
- compare measurements taken to determine alignment
- determine the difference between readings taken and recommend values
- make adjustments to correct any deficiencies

KSA 308 Suggested Reading

Valve & Actuator Technology

Operation of Wastewater Treatment Plants

KSA 309

Weight: 9%

Journey level ability to maintain and repair processing equipment such as:

- chemical feed systems and effects on treatment process and associated equipment
- solids removal systems
- conveyance systems
- digesters and associated systems
- odor control systems
- aeration systems
- disinfection and de-chlorination
- filtration systems
- settling basins
- storage systems

KSA 309 General Competencies

A journey level Mechanical Technologist is expected to have in-depth knowledge of all aspects of the treatment process, and the effects these processes can have on all equipment, including:

- chemical feed
- solids removal
- digesters and associated equipment
- odor control
- aeration
- disinfection and de-chlorination
- filtration and settling basins and clarifiers

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 309 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform calculations to determine detention time, flow rates, solids loading rates, chlorination dosages, filter loading rates and chemical feed rates as well as basic dimension and volume calculations.

KSA 309 Suggested Reading

AWWA Wastewater Operator Field Guide

Operations of Municipal Wastewater Treatment Plants; Manual of Practice-MOP 11. Fifth Edition 1996. Water Environment Federation. Page 1090.

KSA 310**Weight: 5%**

Utilize routine shop mathematics and techniques to calculate or determine the following:

- efficiency of pumps and motors
- horsepower (brake and motor)
- flow rates
- volumes and area
- precision measurements (using calipers, micrometers, etc.)
- drive ratios
- estimating staffing levels and scheduling
- materials estimation
- pressure

KSA 310 General Competencies

To spec pumps for given applications, a journey level Mechanical Technologist is expected to have the ability to make complex calculations to determine:

- pump and motor efficiency
- pump horsepower
- motor brake horsepower
- flow rates
- volumes
- areas
- reduction ratios
- pressure

The Technologist is also expected to be able to use various measuring devices (calipers, micrometers, tape measures, and other equipment) to determine lengths, depths, widths and volumes.

Additionally, they may be required to schedule work, determine staffing requirements, and estimate materials for work.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 310 Math Competencies

The Technologist will be required to perform complex equations to determine flow rates, volumes, areas, costs for materials, manpower estimates, and pump and motor horsepower and efficiency.

KSA 310 Suggested Reading

N/A

KSA 311

Weight: 2%

Safely and effectively repair and maintain equipment with a journey level knowledge and understanding of electrical principles and practices including:

- Ohms Law
- voltage rating
- motor identification
- battery principles

KSA 311 General Competencies

Journey level Mechanical Technologists are required to have working knowledge of:

- electrical theory in including Ohms Law
- voltage and current determination
- motor identification
- battery principles

They will have the ability to work safely around electricity and electrical equipment and train subordinate staff to safely work around this equipment.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 311 Math Competencies

The Technologist will be required to perform complex equations to determine voltage, resistance and current.

KSA 311 Suggested Reading

N/A

KSA 312**Weight: 8%**

Repair and maintain mechanical systems while adhering to industry safety standards and regulations with a journey level knowledge and practical application pertaining to CCR Title 8 or equivalent state regulations:

- lock tag verification (LTV)
- confined space
- slip, trip and fall
- proper lifting
- trench safety
- crane safety
- forklift safety
- vehicle safety
- tool safety
- stored energy
- electrical safety
- chemical safety
- fire safety
- Safety Data Sheet (MSDS)
- gas detection systems
- proper use of PPE (Personal Protective Equipment)
- traffic control
- rigging safety
- NFPA 70E (National Fire Protection Association)
- IIP (Injury Illness Prevention)

KSA 312 General Competencies

Journey level Mechanical Technologists are required to be familiar with, and have in depth knowledge of:

- all industry safety regulations as they relate to the maintenance and repair of treatment plant equipment
- Lock Out/Tag Out
- Confined Space Entry
- crane safety
- vehicle safety
- electrical safety
- Personal Protective Equipment
- traffic safety

- Injury and Illness Prevention Programs
- fire safety
- general safety requirements including slip, trip and fall, lifting, trench safety, forklift safety and any other safety regulations that may affect them.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses

KSA 312 Math Competencies

This Technologist shall possess the knowledge of basic to intermediate math to calculate lifting loads, electrical voltage and current, distances and speeds.

KSA 312 Suggested Reading

N/A

KSA 313**Weight: 5%**

Participate in the lifting and moving of heavy machinery or equipment with a journey level knowledge and understanding of:

- directing a qualified crane operator
- rigging and lifting
- proper operation of forklifts
- coordinate communications and personnel involved in the lift
- proper use of chain falls/come along (cable or chain puller)

KSA 313 General Competencies

Journey level Mechanical Technologists are required to be familiar with, and have in depth knowledge of all industry safety regulations as they relate to the operation of equipment used in the lifting and moving of heavy machinery or equipment, such as:

- cranes
- hoists
- fork lifts and other lifting equipment.

The Technician will be familiar with:

- training of subordinate staff rigging and directing crane operations
- operation of cranes
- communication practices when guiding crane operators and use of chain-falls, come-alongs and other cable puller type equipment.

They will also be knowledgeable of licensing requirements and inspection frequencies for lifting equipment and all safety requirements applicable to lifting and hoisting equipment.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 313 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of dimensions, calculate distances, speed lifting loads, and leverage.

KSA 313 Suggested Reading

N/A

KSA 314

Weight: 6%

Proficiently apply and train personnel on the use of tools such as:

- hand tools
- power tools
- machine/shop tools and equipment
- hydraulic/pneumatic tools
- measurement tools
- computers and systems
- ultra sonic preventative maintenance equipment

KSA 314 General Competencies

Journey level Mechanical Technologists are expected to train subordinates in the use of:

- hand tools
- power tools
- machine shop tools and equipment
- hydraulic and pneumatic tools
- measuring tools
- computers and computer systems used in the maintenance trades
- ultrasonic and laser measuring equipment and alignment
- precision measurement tools

The Technologist will be required to possess the competency to monitor and document the progress of those being trained, adjust the training to deal with personal learning styles, and always set a positive example for the students under their tutelage.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 314 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of:

- weights, volumes, flows
- dimensions
- conversions
- distances
- angles
- speeds
- lifting loads
- leverages

KSA 314 Suggested Reading

N/A

KSA 315**Weight: 4%**

Apply appropriate knowledge of facility maintenance, construction methods and materials, to perform journey-level maintenance such as:

- pipe fitting
- framing
- concrete forming, pouring, grouting, and finishing
- painting/coating
- heating and cooling systems
- plumbing and drain
- lighting and electrical
- job and materials estimation
- paving

KSA 315 General Competencies

A Journey level Mechanical Technologists is expected to be proficient in all construction practices, including:

- pipe fittings
- framing
- concrete forming
- pouring
- grouting and finishing
- painting and coating
- heating and cooling systems
- plumbing and drainage systems
- lighting and electrical paving
- metal, plastic and wood fabrication
- job estimating
- materials estimating and ordering manpower allocation
- documentation of work and recordkeeping for equipment maintenance and repair

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 315 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of:

- weights
- volumes
- flows
- dimensions
- conversions
- distances
- angles
- speed lifting loads
- areas
- leverage
- distances and speeds
- percentage of work completed
- individual performance by crew as compared to established standards
- determine number of work hours/day required to complete tasks
- develop work schedules based on established performance levels

KSA 315 Suggested Reading

AWWA Wastewater Operator Field Guide

KSA 316

Weight: 4%

Perform journey level maintenance and repair by interpreting, applying, or developing:

- designs and sketches
- written and verbal design instructions
- equipment specifications
- operation and maintenance service manuals
- diagrams
- schematics
- pump curves

KSA 316 General Competencies

A Journey level Mechanical Technologists is expected to be proficient using all reference sources for maintenance and repair of equipment including:

- working from sketches
- improvement plans
- written and verbal instructions
- equipment manufacturer specifications
- O&M manuals
- diagrams
- schematics
- pump curves

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 316 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of:

- weights
- volumes

- flows
- dimensions
- conversions
- distances
- angles
- speeds lifting loads
- leverage

KSA 316 Suggested Reading

Autocad electrical symbols Affinity laws

Audel Mechanical Trades Pocket Manual. 4th Ed.; Mechanical Drawing; Page 58 & Sketching;
Page 72

KSA 317

Weight: 3%

Establish and maintain effective working relationships with every person encountered in the workplace to help incorporate the concept of teamwork.

- effectively build and lead a team
- positively promote the concept of teamwork
- plan, schedule, implement work with other teams, departments, and contractors
- promote and enforce the agency's core values

KSA 317 General Competencies

Journey level Mechanical Technologists are expected to have the ability to effectively:

- build and lead teams
- promote the concept of teamwork
- promote and enforce the agency's core values in a positive manner

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 317 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of:

- percentage of work completed
- individual performance by crew as compared to established standards
- determine number of work hours/days required to complete required
- develop work schedules based on established performance levels

KSA 317 Suggested Reading

N/A

KSA 318

Weight: 3%

Communicate clearly and concisely in English, both verbally and in writing with respect to:

- completing and accepting work orders
- purchase requests
- warehouse requisition
- accident reporting
- radio and telephone communication
- maintaining written and computerized records
- handling public contacts with tact and diplomacy

KSA 318 General Competencies

Journey level Mechanical Technologists are expected to have the ability to be effective team administrators, providing the tools and training to their staff for:

- material procurement
- accident reporting
- completing work orders and purchase requests
- record keeping to their groups

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- Regional Occupation Programs
- professional trade related agencies.

KSA 318 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of percentage of work completed, individual performance by crew as compared to established standards, determine number of work hours/days required to complete required tasks and develop work schedules based on established performance levels.

KSA 318 Suggested Reading

WEF MOP 11 Manual, sixth edition, page 6-29 OSHA 1926

Antero manual and in-house manual

OWTP; Vol. II; 7th Edition; Administration, Page 708, 711 & 741

KSA 319**Weight: 6%**

Perform maintenance and repair with a journey level understanding of power transmission equipment and techniques such as:

- various types of drives
- gear and pulley ratios
- machine guards
- shafts
- alignment
- vibration analysis
- infrared thermography
- types of couplings
- joints
- gear reduction systems

KSA 319 General Competencies

A journey level Mechanical Technologist is expected to be proficient in the use of:

- hand tools
- power tools
- machine shop tools and equipment
- hydraulic and pneumatic tools
- gear and pulley ratios
- machine guards
- measuring tools
- computers and computer systems used in the maintenance trades.

They will also be experienced in the use of vibration analysis, infrared thermography, ultrasonic and laser measuring equipment and alignment and precision measurement tools.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 319 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of percentage of work completed, individual performance by crew as compared to established standards, determine number of work hours/days required to complete required tasks and develop work schedules based on established performance levels.

KSA 319 Suggested Reading

N/A

KSA 320

Weight: 2%

Assist in the development of, and execution of existing response plans for contingencies and emergency conditions such as natural disasters and catastrophic equipment failures including:

- supervising equipment roll-out and personnel activation
- training staff in emergency response plans procedures
- amending plans to address any deficiencies discovered during training evolutions

KSA 320 General Competencies

Journey level Mechanical Technologists will be familiar with plans for emergency conditions and contingencies, and be able to lead response activities to natural disasters, catastrophic equipment failures and all emergency conditions, including:

- training staff in emergency response activities
- assisting in the development and amending of response plans
- planning and leading emergency response training evolutions
- identifying and rectifying deficiencies in plans discovered during training exercises.

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 320 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform intermediate to advanced calculations of:

- weights
- volumes
- flows
- dimensions
- conversions
- distances
- angles
- speeds lifting loads
- leverage
- distances and speeds

KSA 320 Suggested Reading

Water, Wastewater and Stormwater Infrastructure Management

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- Millwrights and Mechanics Guide, 4th Edition <http://www.amazon.com/Audel-Millwrights-Mechanics-Guide-Thomas/dp/0764541714>
- Maintenance Manager's Standard Manual, 4th Edition
- Audel Mechanical Trades Pocket Manual
- Work Area Traffic Control Handbook conforms to the standards and guidance of the CalTrans CA Manual on Uniform Traffic Control Devices, Southern California Chapter APWA, BNi (POCKET GUIDE) <http://www.bnibooks.com/shopexd.asp?id=6471>
- Valve & Actuator Technology, Wayne Ulanski ISBN-13: 978-0070194779 <http://www.amazon.com/Valve-Actuator-Technology-Wayne-Ulanski/dp/0070194777>
- Pocket Ref, Thomas J. Glover (POCKET GUIDE) http://www.amazon.com/Pocket-Ref-Thomas-J-Glover/dp/1885071000/ref=la_B001K7XNGU_1_1?s=books&ie=UTF8&qid=1400171345&sr=1-1
- AWWA Wastewater Operator Field Guide ISBN: 9781583213865 <http://www.awwa.org/store/productdetail.aspx?ProductId=6582>
- Environmental Laws and Regulations, Navigating the Green Maze, Joseph j. Bernosky, P.E. AWWA ISBN: 9781583218150 <http://www.awwa.org/store/productdetail.aspx?ProductId=24667>
- Manual of Water Supply Practices, AWWA M27 External Corrosion Control for Infrastructure Sustainability ISBN: 9781583219669
- <http://www.awwa.org/store/productdetail.aspx?productid=36972484>
- Pocket Guide to Flanges, Fittings, and Piping Data, R. R. Lee (POCKET GUIDE) ISBN-13: 978-0884153108 <http://www.amazon.com/Pocket-Guide-Flanges-Fittings-Piping/dp/088415310X>

- California Manual on Uniform Traffic Control Devices, California Department of Transportation (POCKET GUIDE) <http://mutcd.fhwa.dot.gov/index.htm>
- Condensed Hydraulic Data, Cornell Pump Company. (POCKET GUIDE) <http://www.cornellpump.com/lit/pdf/Book-Condensed%20Hydraulic.pdf>

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. Why should plans and specifications for wastewater installations be carefully reviewed?
 - A. To identify potential safety hazards
 - B. To ensure consistency of symbols in the P&ID
 - C. To check for proper color-coding of power conductors
 - D. To check for proper color-coding of power conductors
2. As a maintenance supervisor, you must assign someone to be primarily responsible for safety supervision. Which of the following would you consider most appropriate?
 - A. Pick a permanent safety supervisor for planning continuity and better follow-up on reported hazards.
 - B. Rotate the responsibility monthly to ensure everybody has an equal chance to learn the job.
 - C. Assign the job to yourself because no one else has the authority to enforce safety regulations throughout the entire plant.
 - D. Ask for a volunteer since they will be more conscientious and capable than an appointed person.
3. A working centrifugal pump suddenly stopped flowing sewage. Which of the following is the most probable cause?
 - A. Excessive speed of pump
 - B. Air leaking into pump suction
 - C. Worn bearings
 - D. Inadequate air level
4. Periodic inspection and testing of mechanical equipment by the staff at a plant is done mainly to:
 - A. estimate the time before breakdown.
 - B. discover minor equipment faults before they develop into major breakdowns.
 - C. encourage the crew to better understand how the equipment works.

- D. help the crew better understand individual responsibilities.
5. The rated capacity of a pump is usually given in terms of:
- A. electrical consumption and gallons per minute pumped.
 - B. electronic consumption and velocity of flow.
 - C. horsepower and velocity flow.
 - D. gallons per minute pumped and pressure head.
6. Which of the following best describes cavitation within a centrifugal pump?
- A. The pump becoming over-pressurized
 - B. The pump going air bound
 - C. The pumping of entrapped air
 - D. The formation and collapse of vapor bubbles in the pump
7. What causes false brinelling of an anti-friction bearing?
- A. External impact vibration
 - B. Excessive speed
 - C. Excessive heat
 - D. Excessive load
8. Which of the following is not susceptible to corrosion?
- A. Stainless steel
 - B. Aluminum
 - C. PVC
 - D. Copper
9. Which of the following is an advantage to using a mechanical seal versus mechanical packing in a pump?
- A. Ease of installation
 - B. Initial cost
 - C. No leakage
 - D. Vibration dampening qualities
10. Closing the discharge valve on an electric motor driven centrifugal pump during pumping will cause the motor's amperage draw to:
- A. decrease.
 - B. increase.
 - C. remain unchanged.

- D. trip the circuit protection device.
11. Priming is most frequently required in a:
- A. centrifugal pump.
 - B. rotary pump.
 - C. reciprocating pump.
 - D. gear pump.
12. Vertical propeller pumps are classified as:
- A. positive displacement pumps.
 - B. axial-flow or mixed-flow pumps.
 - C. turbine pumps.
 - D. rotary lobe pumps.
13. Cathodic protection uses which type of corrosion to an advantage to protect a metal?
- A. Galvanic
 - B. Interfilm
 - C. Microbiological
 - D. Dissolution
14. When an application calls for fast on-off operation, low pressure drop, good sealing, and flow in both directions, which of the following valves is the best choice?
- A. A gate valve
 - B. A ball valve
 - C. A needle valve
 - D. A globe valve
15. An intercooler is generally found on a/an:
- A. water pump.
 - B. steam pump.
 - C. air compressor.
 - D. air receiver.
16. The function of an unloader on an electric motor-driven air compressor is to:
- A. drain the condensate from the cylinder head.
 - B. prevent excess pressure in the receiver.
 - C. reduce the speed of the motor when the maximum pressure is reached.
 - D. release the pressure in cylinders in order to reduce the starting load.

17. A globe valve is categorized as what type of valve?
- A. cracking
 - B. adjustable
 - C. linear
 - D. rotary
18. A plug valve is categorized as what type of valve?
- A. adjustable
 - B. rotary
 - C. linear
 - D. cracking
19. Fill in the blank with the correct answer. Flowing Fluid in a piping system has _____ and velocity
- A. force
 - B. energy
 - C. resistance
 - D. mass
20. Fill in the blank with the correct answer. Advantage of pneumatic valve actuators is that it may be _____ indefinitely without overheating.
- A. controlled
 - B. stalled
 - C. used
 - D. actuated
21. What would cause blower air system low pressure?
- A. plugged diffusers at air header
 - B. Closed Suction Valve
 - C. diffusers off at air header
 - D. bad drive motor coupling
22. What would cause blower oil system low pressure?
- A. check valve sticks open
 - B. incorrect oil type
 - C. defective bearings
 - D. restricted ventilation

23. For blowers operated under normal service, when should oil for gears and bearings be changed and the filters cleaned? [Numerical order]
- A. Every 2800 hours
 - B. Every 1400 hours
 - C. Every 3200 hours
 - D. Every 9000 hours
24. What is a Venturi meter used to measure?
- A. Flow of sewage
 - B. Pressure of sewage
 - C. Temperature of sewage
 - D. Depth of sewage
25. A Parshall flume is used to measure:
- A. liquid flows in an open channel.
 - B. air flows in a heating system.
 - C. water flow in a piping system.
 - D. exhaust emissions.
26. A tank is 8 feet high and 8 feet in diameter. What is the water depth in feet if the tank is filled with 1,109 gallons of treated water? [Numerical order]
- A. 1.35 feet
 - B. 2.7 feet
 - C. 2.95 feet
 - D. 3.5 feet
27. If water is flowing 18 inches deep through a 2-foot wide channel at a velocity of 1.5 ft./sec., what is the flow of rate in GPM? [Numerical order]
- A. 270
 - B. 2,020
 - C. 2,423
 - D. 24,235
28. Which of the following formulas correctly shows the relationship between absolute pressure and gauge pressure?
- A. absolute pressure added to atmospheric pressure = gauge pressure
 - B. absolute pressure added to gauge pressure = atmospheric pressure

- C. absolute pressure = gauge pressure added to atmospheric pressure
D. absolute pressure = gauge pressure subtracted from atmospheric pressure
29. The ratio of the weight of a substance to the weight of an equal volume of water is called the:
- A. specific volume of the substance.
 - B. specific gravity of the substance.
 - C. velocity of the substance.
 - D. fractional weight of the substance.
30. Which of the following procedures should be taken to calculate the velocity of a fluid in an open channel?
- A. Divide the speed of the fluid by time
 - B. Divide gallons per minute by time
 - C. Divide the distance traveled by time
 - D. Divide the liquid depth by time
31. How much more water will a 6" diameter pipe carry than a 3" diameter pipe under the same conditions?
- A. 2 times
 - B. 4 times
 - C. 3 times
 - D. 6 times
32. Water is flowing through a 24-inch diameter pipe at 2.5 feet per second. What is the flow rate in gallons per minute? [Numerical order]
- A. 3,526 gpm
 - B. 4,490 gpm
 - C. 5,260 gpm
 - D. 7,854 gpm
33. If a digester is 75 feet tall and 150 feet in diameter, what is the volume, in million gallons (MG)? [Numerical order]
- A. 0.26 MG
 - B. 6.61 MG
 - C. 9.91 MG
 - D. 13.25 MG

34. Which of the following is the RPM of a four-pole synchronous motor in the United States?
[Why is this question important?]
- A. 3,600
 - B. 1,800
 - C. 1,200
 - D. 900
35. A circuit has 120 volts applied across a resistance of 6 ohms. What is the current? [Numerical order]
- A. 20 amps
 - B. 50 watts
 - C. 75 watts
 - D. 720 amps
36. A 480-volt system has a resistance of 20 ohms. What is the power consumed, in watts?
[Numerical order]
- A. 20 watts
 - B. 24 watts
 - C. 9,600 watts
 - D. 11,520 watts
37. Which of the following methods is used to protect workers against cave-ins in trenches 5 feet deep or greater?
- A. Locking in and tagging out method
 - B. Laddering method
 - C. Shoring method
 - D. Confined spacing method
38. In order to properly ground portable electric hand tools, it is usually necessary to use a:
- A. three prong plug.
 - B. fuse.
 - C. circuit breaker.
 - D. solenoid.
39. In which of the following locations should the Safety Data Sheets be located?
- A. At the facility library
 - B. In the break room

- C. At the work area
 - D. In the manager's office
40. Accidents are less likely to occur if:
- A. employee morale is kept high.
 - B. safety policies are frequently changed.
 - C. safety policies are informal.
 - D. employee input is solicited for safety programs.
41. One volume of liquid chlorine confined in a cylinder under normal pressure will yield approximately how many volumes of gaseous chlorine? [Numeric order]
- A. 300 (unit of measurement)
 - B. 375 (unit of measurement)
 - C. 450 (unit of measurement)
 - D. 535 (unit of measurement)
42. If the contents of a container are described as "toxic", it means they are:
- A. poisonous.
 - B. explosive.
 - C. dangerous.
 - D. volatile.
43. The greatest hazard associated with a liquid polymer spill is:
- A. fire.
 - B. toxicity.
 - C. an explosion.
 - D. slipping.
44. If a person has had contact with chlorine gas and his/her eyes have been exposed to the gas, one should:
- A. apply a weak solution of boric acid to neutralize the chlorine.
 - B. keep the eyes closed and cover both eyes even if only one has been exposed.
 - C. flush the eyes with a weak solution of baking soda to neutralize the chlorine.
 - D. flush the eyes with generous amounts of water for at least 10 minutes.
45. Which item must be replaced when connecting a new chlorine cylinder?
- A. The fiber washer
 - B. The air and water regulator

- C. The needle valve seat
 - D. The pressure regulator
46. Which of the following describes the proper method for lifting a heavy object?
- A. Stand far away from the load with knees bent and the back at a 45 degree angle, lift by straightening the knees and slowly straightening the back.
 - B. Stand close to the load with feet solidly placed and far apart, knees bent, then lift by straightening the legs keeping the body at a 30-degree angle.
 - C. Stand far enough away from the load so that with knees bent the back is at a 45 degree angle, then lift by straightening the back.
 - D. Stand close to the load, with feet solidly placed and slightly apart and knees bent; then lift by straightening the legs, keeping the back as nearly vertical as possible.
47. Magnetic flow meters are classified as what type of meter?
- A. Displacement
 - B. Head area
 - C. Flow velocity
 - D. Differential flow
48. A thread chaser is likely to be used to:
- A. flare tubing.
 - B. adjust die stocks.
 - C. repair damaged threads.
 - D. remove broken belts.
49. A fence is to be installed on the perimeter of a sewer lift station. The sides of the pump station measure 235 feet, 366 feet, 266 feet and 298 feet. If a 20-foot gate is to be installed in the 266-foot section, how many linear feet of fence will be required? [Numerical order]
- A. 1,464 ft.
 - B. 1,145 ft.
 - C. 1,165 ft.
 - D. 1,185 ft.
50. The training room at your plant needs new carpet. If the room is rectangular in shape and measures 30 feet by 54 feet, how much carpet is needed, in square yards. [Numerical order]
- A. 84 yd²
 - B. 180 yd²

- C. 540 yd²
D. 1,620 yd²
51. You change the impeller in a pump that was pumping 500 gpm from 5 inches to 6 inches. With no other changes to the volute or rotational speed, what would you expect the pump output to approach? [Numerical order]
- A. 475 gpm
B. 300 gpm
C. 900 gpm
D. 600 gpm
52. Which screw thread is most commonly used for most applications?
- A. #4 class fit
B. #1 class fit
C. #3 class fit
D. #2 class fit
53. Which of the following describes using staff members to accomplish common objectives?
- A. controlling
B. delegating
C. planning
D. managing
54. Performance appraisal forms should:
- A. not contain a rating scale.
B. be limited to three performance factors.
C. not be open to discussion.
D. make the appraisal process consistent.
55. How should a supervisor address rumors of downsizing that is circulating among staff members?
- A. Find out who is spreading the gossip and inform him/her what she knows
B. Ask a manager for permission to find out who is spreading the rumor
C. Call a meeting to verify the accuracy of the information
D. Ignore the whole thing because the truth will come out soon

56. Due to unusual circumstances, your crew is assigned another job in addition to regular assignments. Management has informed you that no additional help is available and that no overtime is permitted. What is the best course of action for you to take as a supervisor in such a situation?
- A. Inform your crew to work faster in order to complete the additional assigned work.
 - B. Assist your crew in completing the additional assigned work.
 - C. Proceed with the regular assignments and complete as much of the additional assigned work as possible.
 - D. Inform management that your crew cannot complete the additional assigned work.
57. Which is most true about disagreements in the workplace?
- A. It is always detrimental to the work unit
 - B. It is potentially useful
 - C. It is never educational
 - D. It is never appropriate
58. The quality in a supervisor that is most likely to make him or her popular with his or her subordinates is:
- A. efficiency in controlling operations.
 - B. loyalty to agency norms and goals.
 - C. fairness in dealing with personnel.
 - D. attention to the health and safety of employees.
59. Maintenance systems, whether computer generated or manual records, should include (choose best match):
- A. equipment, scheduled maintenance and safety records.
 - B. equipment, scheduled maintenance, work orders and cost records.
 - C. tools, SOPs, and safety records.
 - D. location of equipment, supplier and parts records.
60. A well-completed work order would have (mark least necessary answer):
- A. Written observations that may require further maintenance with parts or a change in the maintenance schedule.
 - B. name of suppliers of parts.
 - C. the initial or name of the person who completed the job.
 - D. the time and date of job completion.

61. Which of the following is used to prevent overloading on mechanical equipment?
- A. A fuse
 - B. A bushing
 - C. A shear pin
 - D. A circuit breaker
62. The symptom that would cause wear on the top surface of a V-belt is:
- A. belt slip.
 - B. worn sheaves.
 - C. rubbing against the guard.
 - D. misalignment.

Answer Key

No.	Answer	KSAs	No.	Answer	KSAs
1	A	303	32	A	310
2	A	304	33	C	310
3	B	306	34	B	311
4	B	306	35	A	311
5	D	306	36	D	311
6	D	306	37	C	312
7	A	306	38	A	312
8	C	306	39	C	312
9	C	306	40	D	312
10	A	306	41	C	312
11	A	306	42	A	312
12	B	306	43	D	312
13	A	307	44	D	312
14	B	307	45	A	312
15	C	308	46	D	313
16	D	308	47	C	314
17	C	308	48	C	314
18	B	308	49	B	315
19	D	308	50	B	315
20	B	308	51	D	316
21	C	308	52	D	316
22	A	308	53	D	317
23	B	308	54	D	317
24	A	309	55	C	317
25	A	309	56	B	317
26	C	310	57	B	317
27	B	310	58	C	317
28	C	310	59	B	318
29	B	310	60	B	318
30	C	310	61	C	319
31	B	310	62	C	319

Selected Problem Solutions

35. A circuit has 120 volts applied across a resistance of 6 ohms. What is the current?

Solution:

$E=IR$ or Voltage = Current x Resistance

120 volts = Current x 6 ohms

120 volts = Current (amps)

6 ohms

20 amps = Current

49. A fence is to be installed on the perimeter of a sewer lift station. The sides of the pump station measure 235 feet, 366 feet, 266 feet and 298 feet. If a 20-foot gate is to be installed in the 266-foot section, how many linear feet of fence will be required?

Solution:

The perimeter of this form is equal to the sum of the sides.

The linear feet of fence required is equal to the perimeter minus the width of the gate.

Perimeter = 298 feet + 266 feet + 366 feet + 235 feet = 1,165 feet

Feet of fence = 1,165 feet - 20 feet

50. The training room at your plant needs new carpet. If the room is rectangular in shape and measures 30 feet by 54 feet, how much carpet is needed? Answer in both square feet and square yards.

Solution:

This is an area problem and the shape is a rectangle.

Area of a rectangle = base x height

Area = 54 feet x 30 feet

Area = 1,620 ft²

Area = 1,620 ft² x 1 yd²

9 ft²

Area = 180 yd²

MT GRADE 4 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Mechanical Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 401**Weight: 11%**

Advanced knowledge of repair and construction of various types of equipment and facilities such as:

- mechanical, hydraulic, pneumatic, chemical, and electrical/instrumentation components
- complex principles of pumping stations
- potable water and reclaimed water facilities
- proper procedures for chemical handling

KSA 401 General Competencies

A journey level Mechanical Technologist is expected to have in-depth knowledge and extensive experience in the repair and construction of all equipment and facilities, including but not limited to:

- mechanical, hydraulic, pneumatic and electrical instrumentation
- potable and reclaimed water facilities
- proper procedures for chemical handling
- pumping station operating principles

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors and professional trade agencies and organizations.

KSA 401 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform complex calculations to determine:

- flow
- pressure
- temperature
- thermal expansion
- area
- develop work schedules based on established performance levels
- motor brake horsepower
- Ohm's Law
- power and voltage requirements
- loads and chemical dosages
- volume

KSA 401 Suggested Reading

MOP II 6th, ed, page 7-13

KSA 402**Weight: 10%**

Manage the safe operation of the maintenance department and maintain appropriate levels of staff safety training with respect to:

- OSHA requirements (Occupational Safety & Health Administration)
- agency policies and procedures
- federal and state regulations

KSA 402 General Competencies

Mechanical Technologists at this level are expected to have in-depth knowledge and extensive experience in the safe operation of the maintenance department, maintaining compliance with all agency policies and procedures, as well as Federal and State OSHA regulations, including staff training, record keeping and other documentation.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors and professional trade related agencies

KSA 402 Math Competencies

There are no specific math competencies for this KSA.

KSA 402 Suggested Reading

MOP II 5-63

California Code of Regulations

Maintenance Manager's Standard Manual, Westerkamp; Guidelines for Selecting and Training Maintenance Personnel; Chapter 3; Page 32

KSA 403

Weight: 6%

Responsible for budget preparation and control such as:

- staffing requirements
- Capital Improvement Plans (CIP)
- equipment replacement programs
- overseeing service contract
- general funding
- technical training of staff
- vehicle replacement program
- power fuel, oil and chemical replacement/funding
- grant funding efforts
- obtaining and reviewing bid submittals

KSA 403 General Competencies

Mechanical Technologists at this level are expected to have in-depth knowledge and extensive experience in budget preparation and control including:

- determining staffing requirements
- technical training of staff
- developing Capital Improvement Plans
- equipment replacement programs
- vehicle replacement programs
- obtaining and reviewing bid submittals.

They are also responsible for oversight of service contracts, general funding of maintenance and repair operations, fuel, oil and chemical replacement funding and grant funding efforts.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors and professional trade related agencies.

KSA 403 Math Competencies

Journey level Mechanical Technologists must have excellent mathematical skills and be able to perform calculations to determine:

- staffing hours
- work completion percentages
- fuel use
- cost estimation for equipment replacement and upgrades
- budgeting calculations for estimated equipment life and remaining life
- cost per unit for various products and services

KSA 403 Suggested Reading

Operations of Wastewater Treatment Plants, Vol II, 7th ed, page 714-15

KSA 404**Weight: 8%**

Direct staff involved in the maintenance and repair of an organization's assets such as:

- mechanical components
- hydraulic components
- pneumatic components
- electrical and instrumentation components
- chemical handling systems
- oxygen injection systems
- central power generation systems
- civil asset management (buildings, pavement, sidewalks, roofs, etc.)

KSA 404 General Competencies

Mechanical Technologists at this level are expected to have in-depth knowledge and extensive experience in the maintenance and repair of all mechanical, hydraulic, pneumatic and electrical components and equipment in their facility. They are also required to have detailed knowledge of:

- chemical handling systems
- oxygen and other chemical injection equipment
- central and emergency power generation systems
- management of facilities and civil assets (buildings, pavement, sidewalks, roofs)
- any other equipment they may be responsible for

KSA 404 Math Competencies

Managers must have excellent math skills and be able to perform complex calculations to determine flow, pressure, temperature, thermal expansion, area, volume, motor brake horsepower, Ohm's Law, power and voltage requirements and loads and chemical dosages.

KSA 404 Suggested Reading

OWTP; Vol. II; 7th Edition; Maintenance, Building Maintenance; Page 335

http://en.wikipedia.org/wiki/Hydraulic_accumulator

http://energysystems.princeton.edu/EnergyResources/GenerElectPower_Shalaan.pdf

KSA 405

Weight: 8%

Manage the planning, scheduling and oversight of complex jobs using effective management principles, processes, and techniques with respect to:

- utilization of personnel, materials, and equipment
- reviewing preliminary design and work specifications
- making recommendations involving modifications to facilities
- coordinating with planning/engineering department
- work done by outside services such as contracting and consulting
- develop scope of work

KSA 405 General Competencies

Mechanical Technologists at this level are expected to have in-depth knowledge and extensive experience in project and design review, making recommendations involving facility modification, coordinating between planning/engineering groups and maintenance groups, oversight of outside consultants and contractors and developing scopes of work for projects. They are also responsible for determining staffing and materials requirements.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors and professional trade related agencies.

KSA 405 Math Competencies

Managers must have excellent math skills and be able to perform complex calculations to determine staffing hours, work completion percentages, and cost estimations for work done by consultants and contractors.

KSA 405 Suggested Reading

OWTP; Vol. II; 7th Edition; Treatment Plants, Page 109; Activated Sludge

Maintenance Manager's Standard Manual, Westerkamp; Constructing Project Planning and Scheduling; Chapter 13; Page 121

KSA 406

Weight: 4%

Overseeing the implementation and management of computer software and hardware systems such as:

- computer maintenance management system
- SCADA (Supervisory Control and Data Acquisition)
- software selection
- hardware replacement
- new technologies
- security systems

KSA 406 General Competencies

Mechanical Technologists at this level are expected to have in-depth knowledge and extensive experience in implementation and management of computerized maintenance management systems (CMMS), supervisory control and data acquisition (SCADA) systems, including software selection, hardware requirements, new technologies and security system requirements.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors and professional trade related agencies.

KSA 406 Math Competencies

Managers must have excellent math skills and be able to perform complex calculations to determine computer hardware and software costs, consultant and integration contractor costs, staffing hours, work completion percentages, and cost estimations for budgeting.

KSA 406 Suggested Reading

N/A

KSA 407**Weight: 6%**

Responsible for the dissemination and adherence of pertinent federal, state and local laws, codes and regulations established by agencies such as:

- DPH (Department of Public Health)
- SWRCB (State Water Resource Control Board)
- NPDES (National Pollutant Discharge Elimination System)
- CAL OSHA (California Occupational Safety & Health Administration)
- FED OSHA (Federal Occupational Safety & Health Administration)
- EPA (Environmental Protection Agency)
- AQMD (Air Quality Management District)
- CARB (California Air Resource Board)

KSA 407 General Competencies

Managers will have extensive knowledge and experience dealing with environmental protection regulatory agencies and maintaining compliance with all Federal, State, municipal and local regulations applicable to their agency. They will also be experienced in disseminating this information to their subordinate staff.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors
- professional trade related agencies
- classes available from the regulatory agencies

KSA 407 Math Competencies

There are no specific math competencies for this KSA.

KSA 407 Suggested Reading

N/A

KSA 408

Weight: 6%

Responsible for the maintenance of operating permits and compliance with regulatory requirements such as:

- pressure vessel permits
- discharge permits
- boiler certifications
- underground fuel and oil storage tanks
- hazardous waste management
- emissions permit (such as Air Quality Management District, California Air Resource Board)
- Emergency Response Plan

KSA 408 General Competencies

Managers will have extensive knowledge and experience dealing with facility operating regulatory agencies and maintaining compliance with all Federal, State, municipal and local facility operation regulations applicable to their agency. They will also be experienced in disseminating this information to their subordinate staff.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors
- professional trade related agencies
- classes available from the regulatory agencies

KSA 408 Math Competencies

There are no specific math competencies for this KSA.

KSA 408 Suggested Reading

<http://www.epa.gov/oust/pubs/musts.pdf>

KSA 409

Weight: 5%

Oversee management and execution of policies relevant to the maintenance department with respect to:

- implementation of goals, objectives, policies and priorities
- establishment and implementation of policies and procedures
- enforcement of policies and procedures
- interpret and communicate applicable policies and procedures to staff, customers, the public, or elected officials.

KSA 409 General Competencies

Managers will have extensive experience in policy development and implementation including goal setting, setting priorities, enforcing agency policies and procedures, interpretation and communication of policies and procedures to staff, customers and the public.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors
- professional trade related agencies
- classes available from the regulatory agencies

KSA 409 Math Competencies

There are no specific math competencies for this KSA.

KSA 409 Suggested Reading

Water, Wastewater and Stormwater Infrastructure Management

KSA 410**Weight: 5%**

Review and provide feedback on blueprints, specifications and maps such as:

- symbols
- sketches
- legends
- blocks
- dimensions

KSA 410 General Competencies

Managers will have extensive experience and knowledge reviewing plans, specifications, blueprints and maps. They will understand symbols, legends, dimensions and street mapping policies.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors
- professional trade related agencies
- classes available from the regulatory agencies

KSA 410 Math Competencies

There are no specific math competencies for this KSA.

KSA 410 Suggested Reading

ANSI standards, OSHA training

AutoCAD symbols

Millwrights and Mechanics Guide, 5th Ed. Chapter 2: Drawings and Sketches, page 23

KSA 411

Weight: 6%

Establish and maintain effective working relationships with those contacted through the course of work such as:

- government officials
- the general public
- internal customer service
- outside agencies
- regulatory bodies
- public safety agencies
- upper management

KSA 411 General Competencies

Managers will have the skills and experience to deal with the public (customers), government officials, internal customers, outside agencies, regulatory agencies, public safety agencies and upper management, and establish working relationships with these individuals and agencies.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors
- professional trade related agencies
- classes available from the regulatory agencies

KSA 411 Math Competencies

There are no specific math competencies for this KSA.

KSA 411 Suggested Reading

Operations of Wastewater Treatment Plants, Vol II, 7th ed., 2007

CSUS Office of Water Programs, page 712, section 20.76

Utility Management- A Field Study Training Guide, 2nd Edition, CSU Sacramento- Office of Water Programs, 2004, Lesson 2, pg. 26.

KSA 412

Weight: 3%

Communicate effectively to audiences with respect to:

- board presentations
- safety presentations
- public speaking obligations
- multi agency meetings
- drafting memo presentations
- bid proposals/purchase justification
- pre-construction job walks
- staffing justifications
- job descriptions
- staff reports

KSA 412 General Competencies

Managers will have the skills and experience to lead:

- presentations to boards
- safety presentations
- multi-agency meetings
- pre construction meetings
- job walks
- presentations at trade shows and conferences
- industry committee meetings

They will also have the ability to comfortably speak to groups when required and be experienced in drafting memos, staffing justifications, staff reports and job description, and presenting these and other administrative documents as required.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- professional trade related agencies
- classes available from the regulatory agencies

KSA 412 Math Competencies

There are no specific math competencies for this KSA.

KSA 412 Suggested Reading

Utility Management; 2nd Ed.; Public Relations; page 26

OWTP; Vol. II; 7th Edition; Administration, Public Speaking; Page 712 & Staffing, Page 692

KSA 413**Weight: 12%**

Supervise, direct and coordinate maintenance department staff including:

- equipment and labor charges
- assigning work priorities
- monitoring workflow
- resolving staffing issues
- designing and administering safety programs
- administration of disciplinary actions
- planning succession management
- completing staff performance evaluation
- select, train, motivate and evaluate
- discipline and terminate
- review and evaluate work product, methods and procedures used to complete work
- handle labor relations
- assist in staff scheduling

KSA 413 General Competencies

Managers will be experienced in:

- directing and coordinating maintenance department staff
- calculating equipment and labor charges
- assigning work priorities
- monitoring workflow
- resolving staffing issues
- designing and administering safety programs
- administration of disciplinary actions
- planning succession management
- scheduling of staff

Managers will also have experience completing staff performance evaluations, selecting, training, motivating and evaluating staff, disciplining and termination of staff, reviewing and evaluating work product, and methods and procedures used to complete work.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors
- professional trade related agencies
- classes available from the regulatory agencies

KSA 413 Math Competencies

Managers must have excellent math skills and be able to perform complex calculations to determine staffing and equipment costs, work completion percentages, and cost estimations for budgeting.

KSA 413 Suggested Reading

Operational of Wastewater Treatment plants, Vol II 5th ed., page 724

OM of Wastewater treatment plants, Vol II, 7th ed., page 719

Public Organization Management, Jamil E. Jeisat

Greenwood Publishing Group, INC

Praeger Publishers, Westport CT 06881-1997, page 227

KSA 414**Weight: 4%**

Maintain and manage organizational structure such as:

- chain of command accountability
- grievance flow
- labor relations

KSA 414 General Competencies

Managers will have the ability and experience to maintain chain of command accountability throughout the organization, ensuring grievances are routed correctly and on time, and ensure any labor relations issues are addressed correctly and at the proper level in the chain of command.

This knowledge is usually gained through:

- advanced in-house training
- college level courses
- vendors
- professional trade related agencies
- classes available from the regulatory agencies

KSA 414 Math Competencies

There are no specific math competencies for this KSA.

KSA 414 Suggested Reading

Operations of Wastewater Treatment Plants, Vol II, 7th ed., page 689
Business Dictionary.com

KSA 415**Weight: 6%**

Oversee the development and implementation of response plans for contingencies and emergency conditions such as natural disasters and catastrophic equipment failures including:

- managing the implementation and execution of emergency response plans and personnel
- developing and implementing requirements for emergency response equipment and facilities
- determining conditions that will warrant activation of emergency response plans
- provide assistance to neighboring agencies where Mutual Aid Agreements exist

KSA 415 General Competencies

Managers will be familiar with plans for emergency conditions and contingencies, and be able to manage and oversee response activities to natural disasters, catastrophic equipment failures and all emergency conditions, including:

- training staff in emergency response activities
- overseeing the development and amending of response plans
- planning and leading emergency response training evolutions
- ensuring any deficiencies identified in plans discovered during training exercises

This knowledge is usually gained through:

- trade schools
- military schools
- advanced in-house training
- college level courses
- vendors
- Regional Occupation Programs
- professional trade related agencies.

KSA 415 Math Competencies

There are no specific math competencies for this KSA.

KSA 415 Suggested Reading

Water, Wastewater and Stormwater Infrastructure Management

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- Operation of Municipal Wastewater Treatment Plants, WEF, Manual of Practice
- California Code of Regulations,
[https://govt.westlaw.com/calregs/Index?bhcp=1&transitionType=Default&contextData=\(sc.Default\)](https://govt.westlaw.com/calregs/Index?bhcp=1&transitionType=Default&contextData=(sc.Default))
- NEC 1999: National Electrical Code (NFPA 70), 2014 Ed.
- Environmental Laws and Regulations, Navigating the Green Maze, Joseph j. Bernosky, P.E. AWWA ISBN: 9781583218150
<http://www.awwa.org/store/productdetail.aspx?ProductId=24667>
- AWWA Wastewater Operator Field Guide ISBN: 9781583213865
<http://www.awwa.org/store/productdetail.aspx?ProductId=6582>
- Manual of Water Supply Practices, AWWA M27 External Corrosion Control for Infrastructure Sustainability ISBN: 9781583219669
<http://www.awwa.org/store/productdetail.aspx?productid=36972484>
- California Manual on Uniform Traffic Control Devices, California Department of Transportation (POCKET GUIDE) <http://mutcd.fhwa.dot.gov/index.htm>
- Condensed Hydraulic Data, Cornell Pump Company. (POCKET GUIDE)
<http://www.cornellpump.com/lit/pdf/Book-Condensed%20Hydraulic.pdf>

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. The impellers of a rotary lobe positive displacement compressor are designed to:
 - A. touch each other as they rotate.
 - B. turn in opposite directions.
 - C. turn in the same direction.
 - D. handle high pressure and high volume.
2. Which if the following methods is the best way to increase pump efficiency therefore potentially reducing a utilities electrical energy costs?
 - A. Use one large pump to pump more volume
 - B. Redesign all facilities for gravity flow conditions only.
 - C. Perform no maintenance to eliminate labor cost.
 - D. Use two or more small pumps instead of one large pump so excess capacity may be turned off.
3. If the speed of a centrifugal pump is decreased by 25% and there is no static head, theoretically, the power will decrease by what percentage?
 - A. 6%
 - B. 25%
 - C. 44%
 - D. 58%
4. Accurate use of a micrometer to measure a bearing fit on a shaft requires consideration of the following:
 - A. brinnelling of shaft.
 - B. amount of shaft dwell.
 - C. size of micrometer display.
 - D. calibration of the micrometer.
5. The crosshead, part of a large reciprocating compressor, is used to:
 - A. take the place of a connecting rod.

- B. act as the joint between the piston rod and the connecting rod.
 - C. act as the joint between the high pressure and low pressure connecting rod.
 - D. act as a counterweight to balance the forces that tend to distort the crankshaft due to centrifugal force.
6. Within a wastewater treatment plant pumping system, select the least energy-efficient way to decrease system pressure.
- A. Install a pressure-limiting and control sensor to turn pumps on and off based on pressure set points.
 - B. Install a variable frequency drive to slow the speed of the pump motor.
 - C. Install a different size pump that is better suited for the capacity and pressure the system is currently operating.
 - D. Close down on a discharge valve and operate closer to the shut-off head.
7. Pump efficiency refers to the efficiency of the:
- A. motor and the pump.
 - B. electrical motor which drives the pump.
 - C. pump and controller (VFD) (delete?).
 - D. pump alone.
8. Which method of measuring levels in a wetwell requires direct contact with the liquid?
- A. Ultrasonic systems
 - B. Microwave systems
 - C. Bubbler systems
 - D. Sonic systems
9. Which of the following process changes is most likely to improve the settling performance of primary settling tanks that are operating at flows greater than their design flow?
- A. Chlorinate the supernatant return from sludge handling processes
 - B. Pre-aerate the raw wastewater flow
 - C. Recycle sludge from the secondary unit to primary tanks for settling
 - D. Install flow equalization basins ahead of primary tanks
10. Steel tanks may be protected from rusting by:
- A. alternately wetting and drying walls.
 - B. maintaining humidity in tanks.
 - C. protective coatings.

- D. washing tank walls.
11. Which of the following causes the greatest pipe friction loss?
- A. Decreasing the rate of flow
 - B. Increasing the temperature of the wastewater
 - C. Decreasing the pressure
 - D. Increasing the velocity of wastewater
12. Treatment basins such as primary sedimentation, grit tanks, aeration tanks, and final clarifier drains:
- A. must be lower than the receiving sump to allow for gravity flow out of the basin.
 - B. need not be valved closed if the drain is higher than the receiving sump.
 - C. must be higher than the receiving sump to allow for gravity flow out of the basin.
 - D. need not be maintained because it is always faster to pump a treatment basin dry than allow it to drain to the receiving sump.
13. Which of the following can be installed to stop water hammer in a pipe line?
- A. A pressure reducing valve
 - B. A rubber expansion joint
 - C. An internal bladder type air chamber
 - D. A flexible coupling
14. A pump operating at 1,770 RPM supplies 6,500 gpm. The suction pressure is 10 psi and the discharge pressure is 75 psi. If the pump is 78% efficient and the motor is 86% efficient, what is the brake horsepower? The specific gravity of the pumped liquid is 1.12.
- A. 276 hp
 - B. 354 hp
 - C. 408 hp
 - D. 463 hp
15. A pump station has six 500 hp pumps that run an average of 5 hours a day each, a 5 hp sump pump that operates for 1.5 hrs/day, twenty 100-watt lights that are always on, and six 300-watt night lights that are on 10 hours a day. What is the monthly operating cost if power cost 8.75 cents per kwh? (A month is 30 days)
- A. \$29,373.75
 - B. \$29,388.44

- C. \$29,514.44
D. \$29,561.69
16. A 1,760 rpm motor is attached to a gear box with a 3.52 to 1 ratio. What is the rpm of the pump attached to the other side of the gear box?
- A. 500 rpm
B. 5,000 rpm
C. 6,000 rpm
D. 6,195 rpm
17. A pump operating at 1,750 RPM supplies 4,500 gpm. The suction pressure is 25 psi and the discharge pressure is 75 psi. If the pump is 78% efficient and the motor is 86% efficient, what is the brake horsepower? The specific gravity of the pumped liquid is 1.15.
- A. 176 hp
B. 194 hp
C. 201 hp
D. 363 hp
18. Part A: What size motor is needed to pump 0.792 MGD against 108.23 PSI?
Part B: What is the cost per 30 day month to operate this pump if the pump runs an average of 5 hours per day and the cost per Kwh is 19.5¢?
- A. Answer to Part A is 35 HP; Answer to Part B is \$764
B. Answer to Part A is 15 HP; Answer to Part B is \$327
C. Answer to Part A is 35 HP; Answer to Part B is \$2546
D. Answer to Part A is 15 HP; Answer to Part B is \$1091
19. Which of the following is most true about problem indicators?
- A. They are the reason a problem exists.
B. They are proven facts bearing on the problem.
C. They are justifiable reasons for the cause of the problem.
D. They are clues to the existence of a problem.
20. A confined space is defined as an area that is large enough for an employee to bodily enter and perform work and:
- A. has limiting or restricted means of entry or exit, and contains or has the potential to contain a hazardous atmosphere.

- B. has limited or restricted means of entry or exit, and is not designed for continuous human occupancy.
 - C. has limited or restricted means of entry or exit, and contains a hazardous atmosphere.
 - D. is not designed for continuous human occupancy, and contains or has the potential to contain a hazardous atmosphere.
21. California Government Code, Section 3100 discusses:
- A. Designation of Employees as Disaster Service Workers.
 - B. Consumption of Drugs and Alcohol in the Workplace.
 - C. Illegal Search and Seizure of Personal Property.
 - D. Environmental Compliance of Machinery and Equipment.
22. Wastewater funding typically:
- A. is a major portion of the Capital Budget.
 - B. is included as a component of general obligation bonds issued to fund wastewater projects.
 - C. is underwritten by initial connection charges.
 - D. is included in wastewater service charges along with the O & M revenues, debt service and emergency contingency funds.
23. A parking lot has a bank of ten 400- watt lights that operate for 10 hours a day. It also has a 150-watt sign that is always on. If power cost \$0.095 per kilowatt-hour (kwh) what is the cost to operate this lot for 30 days? [Numerical]
- A. \$21.66
 - B. \$114.00
 - C. \$124.26
 - D. \$216.60
24. A holding tank requires chlorination to 2.5 ppm. The tank holds 3.5 million gallons. How many pounds of chlorine will be needed? [Numerical]
- A. 8.75 lbs
 - B. 50 lbs
 - C. 73 lbs
 - D. 182 lbs
25. What is the difference between utility power and energy (also known as energy consumption) charges?

- A. Power is the apparent energy consumption while energy is the amount of power used for a period of time.
 - B. Power is the reactive energy consumption while energy is the amount of power used for a period of time.
 - C. Power is the rate of energy consumption while energy is the amount of power used for a period of time.
 - D. Power is the sum of energy consumption over time while energy is the amount of power used for a period of time.
26. With two resistances in parallel, if each dissipates 20 W, the total power supplied by the power source equals:
- A. 10 W
 - B. 20 W
 - C. 40 W
 - D. 80 W
27. Heat causes bearings to:
- A. change color.
 - B. expand.
 - C. contract.
 - D. remain unchanged.
28. Why should plans and specifications for wastewater installations be carefully reviewed?
- A. To identify potential safety hazards
 - B. To ensure consistency of symbols in the P&ID
 - C. To check for proper color coding of power conductors
 - D. To check for proper color coding of power conductors
29. Which of the following does a SCADA system use to transmit general data to field-mounted equipments?
- A. Radio Telemetry Unit
 - B. Radio Transmission Unit
 - C. Remote Transmission Unit
 - D. Remote Terminal Unit
30. Which of the following does Programmable Logic Controllers allow plant personnel to do?
- A. Record multiple flow meters simultaneously

- B. Easily change the control logic used for equipment control
 - C. Monitor plant processes remotely
 - D. Monitor real-time plant energy consumption
31. A computerized maintenance management system is a complex tool:
- A. to be managed by supervisors.
 - B. to be managed by all persons using the system.
 - C. to be managed by qualified personnel only.
 - D. that requires no changes or adjustments.
32. A well-designed maintenance software program is one that:
- A. employs the Unix operating system.
 - B. employs Microsoft's operating system.
 - C. allows the operator to make simple responses to pre-programmed questions.
 - D. is based on a robust Linux server platform.
33. A new way to better use a Maintenance Management System (MMS) to facilitate predictive maintenance is:
- A. having the system recognize when maintenance is required through the use of smart field device technology.
 - B. to automatically generate PM work orders.
 - C. to input equipment manufacturer's recommended maintenance schedule and track against run time values from the SCADA system.
 - D. to use robotic maintenance crews to facilitate repairs.
34. The key to the success of a Maintenance Management System (MMS) is:
- A. system to generate work orders. (not parallel with stem)
 - B. system to confirm work order completion. (not parallel with stem)
 - C. proper use of performance measures.
 - D. adequate spare parts inventory. (not parallel with stem)
35. For utility records and/or rate analyses purposes, customers with similar patterns of water use are usually grouped together into classes. Which one of the following classes is not generally used?
- A. Retail
 - B. Commercial
 - C. Domestic

- D. Industrial
36. The greatest hazard associated with a liquid polymer spill is:
- A. explosive hazard.
 - B. slipping hazard.
 - C. toxic hazard.
 - D. inhalation hazard.
37. Liquid with a pH of 8.0 would be described as:
- A. Hydroxide
 - B. Neutral
 - C. Alkaline
 - D. Acidic
38. You have an electric motor running a positive displacement blower through pulleys and belts at a small wastewater treatment plant. The motor spins at 3450 rpm. There is a 3 inch diameter pulley on the motor. The blower is currently turning at 1170 rpm and is discharging 546 cfm at 12 psi. The plant has low DOs. You can increase the blower output by changing the pulley size at the blower. What size pulley in diameter do you need to change to increase the output to 984 cfm at 12 psi? Round up to the nearest half- inch in your pulley choice.
- A. 4 inch.
 - B. 7.5 inch.
 - C. 5 inch.
 - D. 10 inch.
39. You are painting the outside vertical walls of an above-ground circular clarifier. The concrete on the outside wall of the clarifier is 15 inches thick. It is 15 feet high and 50 feet in diameter, weir to weir. The effluent launder is 2 feet wide. A gallon of paint covers approximately 325 feet. How many 5-gallon cans will you need to requisition?
- A. 2
 - B. 1
 - C. 4
 - D. 8
40. Which one of the following is a mechanic's means of communication and is a standardized form of universal language?
- A. English

- B. drawings
 - C. technical terms
 - D. Mechanics
41. If a digester is 75 feet tall and 150 feet in diameter, what is the volume, in million gallons (MG)?
- A. 0.26 MG
 - B. 6.61 MG
 - C. 9.91 MG
 - D. 13.25 MG
42. To lay out a large square and ensure that the corners are square, carpenters mark points on two legs at 6 feet and 8 feet from the corner. They then measure the straight-line distance (hypotenuse) between these two points. This distance must be:
- A. 10 feet.
 - B. 12 feet.
 - C. 14 feet.
 - D. 16 feet.
43. A tank measuring 8 feet high and 10 feet in diameter is filled with treated water to a depth of 5.11 feet. How many gallons of water are in the tank?
- A. 1926 gallons
 - B. 3000 gallons
 - C. 12002 gallons
 - D. 7681 gallons
44. Nonverbal communication:
- A. mask inappropriate feelings.
 - B. are limited to emotional contexts.
 - C. can transfer more information than verbal communication.
 - D. require good eye contact
45. Artificial barriers to efficient operation of an organization can be broken down through the use of:
- A. memorandums detailing specific organization goals to be changed and the steps to be taken to fulfill new goals.
 - B. multifunction teams that determine how to accomplish change within the organization.
 - C. a newsletter that informs staff of changes coming within an organization.

- D. managed change directed and lead from management within an organization.
46. Which of the following way is an accurate way to judge leadership ability for a candidate being considered for a supervisory position?
- A. Legibility of monitoring reports and daily log entries
 - B. Ability to handle the performance of workers they are to supervise
 - C. Expertise with technical software packages
 - D. Number or work orders completed per sheet
47. An effective employee appraisal program emphasizes the employee's:
- A. goals and performance.
 - B. mistakes.
 - C. attitude.
 - D. attendance record.
48. What should be done if a supervisor suspects that an employee is under the influence of alcohol?
- A. Ignore the employee and discuss this at a time when he/she is not under the influence.
 - B. Tell the employee to drive home and charge the rest of the day to sick leave.
 - C. Call the employee aside and discuss the behaviors that have led you to suspect the problem.
 - D. Fire the employee on the spot for being under the influence at work.
49. Which of the following should an effective employee performance appraisal program emphasize?
- A. Goals and performance
 - B. Mistakes
 - C. Attitude
 - D. Attendance record
50. For which of the following issues would a personnel department require input or assistance from a supervisor?
- A. Writing job descriptions
 - B. Placing classified ads
 - C. Screening applications
 - D. Setting salary schedules
51. The effective supervisor realizes the key to handling grievances is:

- A. asking questions to get the facts.
 - B. establishing the appropriate setting.
 - C. listening effectively.
 - D. ensuring that the grievance is in writing.
52. Management functions are often defined as planning, organizing, directing and controlling. In this context, controlling refers to ensuring that:
- A. all processes are governed by complex feedback control loops.
 - B. the plant's activities contribute to the plant's mission.
 - C. all employees are working toward the same goal.
 - D. competent supervisors are assigned to each department.
53. One method that generally is helpful in encouraging an employee to derive satisfaction from work is giving the employee a(n):
- A. change in position whenever a need for self-expression is indicated. (obviously wrong)
 - B. understanding of the relationship of the job to the whole organization.
 - C. opportunity to demonstrate efficiency in various types of work.
 - D. realization that job security depends on manifest interest in the job.
54. It is generally accepted by psychologists that human behavior is goal-oriented and:
- A. motivated.
 - B. selfish.
 - C. random.
 - D. other-centered.
55. Managers should recognize and stimulate an individual's need for satisfaction by:
- A. rotating work assignments.
 - B. matching authority to responsibility.
 - C. providing continuing technical training.
 - D. documenting all disciplinary actions.
56. Dealing with employee discipline requires:
- A. waiting to be sure there is an issue to address rather than an employee who is just having a bad day.
 - B. consulting with a union representative before addressing the issue with the employee.
 - C. tact and people skill.
 - D. involving human resources before taking the issue up with the employee.

57. Training will succeed when:
- A. a single topic is covered in length to enhance focus of the participants.
 - B. the participants has the opportunity to discuss with others for accuracy.
 - C. multiple topics are covered simultaneously- keeping everyone's interest up.
 - D. the participants believe they can implement the knowledge immediately in their jobs.
58. If an organization's departments are organized by job to be done, this is known as departmentalization by:
- A. customer.
 - B. function.
 - C. product.
 - D. territory.
59. A superintendent leaves a supervisor in charge of a group of employees. Upon returning, he/she finds an employee doing a job contrary to standing instructions. Under normal circumstances, the superintendent should:
- A. direct the employee to the job they were assigned.
 - B. contact the supervisor and demand correction.
 - C. contact the supervisor and ask why.
 - D. do nothing. The responsibility has been assigned to the supervisor.
60. The most important location for an audible and/or visual alarm of excessive H₂S concentration is:
- A. at the process operator's console.
 - B. in the safety department office.
 - C. at the field sensor location.
 - D. in the plant manager's office.

Answer Key

No.	Answer	KSAs	No.	Answer	KSAs
1	B	401	31	C	406
2	D	401	32	C	406
3	D	401	33	A	406
4	D	401	34	C	406
5	B	401	35	A	407
6	D	401	36	B	407
7	D	401	37	C	408
8	C	401	38	C	410
9	D	401	39	A	410
10	C	401	40	B	410
11	D	401	41	C	410
12	C	401	42	A	410
13	C	401	43	B	410
14	B	401	44	C	412
15	D	401	45	B	412
16	A	401	46	B	413
17	B	401	47	A	413
18	A	401	48	C	413
19	D	402	49	A	413
20	B	402	50	A	413
21	A	402	51	C	413
22	D	403	52	B	413
23	C	403	53	B	413
24	C	403	54	A	413
25	C	404	55	B	413
26	C	404	56	C	413
27	B	404	57	D	413
28	A	405	58	B	414
29	D	406	59	C	414
30	B	406	60	C	415

Selected Problem Solutions

15. A pump station has six 500-hp pumps that run an average of 5 hours per day each, a 5-hp sump pump that operates for 1.5 hrs/day, twenty 100-watt lights that are always on, and six 300-watt night lights that are on 10 hours per day. What is the monthly operating cost if power costs 8.75 cents per kwh? (A month is 30 days.)

Power Cost

$$= (\text{quantity} \times \text{watts} \times \text{hrs}) \times \text{cost} \times \text{time}$$

(1000 watts/kilowatts) kwh

$$PC1 = 6 \times (500 \text{ hp} \times 746 \text{ watts/hp}) \times 5 \text{ hrs/day} \times \\ 1,000 \text{ watts/kilowatt} \\ \$0.0875 \times 30 \text{ days} = \$ 29,373.75 \\ \text{kwh}$$

$$PC 2 = 1 \times (5 \text{hp} \times 746 \text{ watts/hp}) \times 1.5 \text{ hrs/day} \times \\ 1,000 \text{ watts/kilowatt} \\ \$0.0875 \times 30 \text{ days} = \$ 14.69 \\ \text{kwh}$$

$$PC 3 = 20 \times 100 \text{ watts} \times 24 \text{ hrs/day} \times \\ 1000 \text{ watts/kilowatt} \\ \$0.0875 \times 30 \text{ days} = \$126.00 \\ \text{kwh}$$

$$PC 4 = 6 \times 300 \text{ watts} \times 10 \text{ hrs/day} \times \\ 1,000 \text{ watts/kilowatt} \\ \$0.0875 \times 30 = \$47.25 \\ \text{kwh}$$

$$\text{Total Cost} = \$29,373.75 + \$14.69 + \\ \$126.00 + \$47.25 = \$29,561.69$$

17. A pump operating at 1,770 RPM supplies 6,500 gpm. The suction pressure is 10 psi and the discharge pressure is 75 psi. If the pump is 78% efficient and the motor is 86% efficient, what is the brake horsepower? The specific gravity of the pumped liquid is 1.12.

$$\text{Brake hp} = \text{flow} \times \text{total head} \times \text{specific gravity} \\ 3,960 \times \text{efficiency}$$

Flow must be in gpm. It is.

Head must be in feet. This has to be calculated from given parameters.

Pump efficiency must be in decimal form.

$$78\% = 0.78$$

$$\text{Specific gravity} = 1.12$$

RPM information is not needed.

$$\begin{aligned} \text{Head} &= (\text{discharge psi} - \text{suction psi}) \times 2.31 \\ &= (75 \text{ psi} - 10 \text{ psi}) \times 2.31 \\ &= 150 \text{ ft} \end{aligned}$$

$$\begin{aligned} \text{Brake hp} &= 6500 \text{ gpm} \times 150 \text{ ft} \times 1.12 \\ &= 3,960 \times 0.78 \end{aligned}$$

$$\text{Brake hp} = 354 \text{ hp}$$

23. A parking lot has a bank of ten 400-watt lights that operate for 10 hours a day. It also has a 150-watt sign that is always on. If power costs \$0.095 per kilowatt-hour (kwh), what is the cost to operate this lot for 30 days?

This is a power cost problem. You need to use a separate equation for each type of power use and then add the results together. This problem has two power uses: ten 400-watt lights and one 150-watt sign.

Power Cost

$$= (\text{quantity} \times \text{watts} \times \text{hrs}) \times \text{cost} \times \text{time}$$

(1000 watts/kilowatts) kwh

$$\begin{aligned} \text{PC 1} &= 10 \times 400 \text{ watts} \times 10 \text{ hrs/day} \times \\ &= 1,000 \text{ watts/kilowatt} \\ &= \$0.095 \times 30 \text{ days} = \$114.00 \\ &= \text{kwh} \end{aligned}$$

$$\begin{aligned} \text{PC 2} &= 1 \times 150 \text{ watts} \times 24 \text{ hrs/day} \times \\ &= 1000 \text{ watts/kilowatt} \\ &= \$0.095 \times 30 \text{ day} = \$10.26 \\ &= \text{kwh} \end{aligned}$$

$$\text{Total cost} = \text{PC1} + \text{PC2} = \$114.00 + \$10.26$$

$$\text{Total cost} = \$124.26$$

24. A holding tank requires chlorination to 2.5 ppm. The tank holds 3.5 million gallons. How many pounds of chlorine will be needed?

Dose in pounds

$$= \text{concentration in ppm} \times \text{capacity in MG} \times 8.34 \text{ pounds} \\ \text{ppm} \times \text{MG}$$

$$\text{Dose} = 2.5 \times 3.5 \times 8.34$$

$$\text{Dose} = 73 \text{ pounds}$$

MT FORMULA SHEET

1 cubic foot	1,728 cubic inches	
1 cubic foot	7.48 gallons	
1 cubic foot of water	62.43 pounds	
1 gallon of water	8.34 pounds	
1 cubic foot/second	448.8 gallons/minute	
1 MGD	694 gallons/minute	
1 horsepower	33,000 foot-pounds/minute	
1 psi	2.31 feet of water	
1 kilowatt	1000 watts	
1 horsepower	746 watts	
1 horsepower	42.45 Btu/minute	
1 MGD	1.55 cubic feet/second	
1 Btu	778 foot-pounds	
1 watt	3.412 Btu/hour	
1 thermal unit	100,000 Btu	
π	3.14	
Coefficients of thermal expansion	Steel: 0.00000633/°F Brass: 0.00001/°F	

<i>Circumference</i> _{circle} = $\pi \times \text{diameter}$	<i>Volume</i> _{rectangular solid} = $\text{length} \times \text{width} \times \text{height}$
<i>Area</i> _{triangle} = $\frac{\text{base} \times \text{height}}{2}$	<i>Volume</i> _{triangular solid} = $\frac{\text{base} \times \text{height} \times \text{length}}{2}$
<i>Area</i> _{circle} = $\frac{\pi}{4} \times \text{diameter}^2$	<i>Volume</i> _{cylinder} = $\frac{\pi}{4} \times \text{diameter}^2 \times \text{height}$
<i>Area</i> _{circle} = $0.785 \times \text{diameter}^2$	<i>Volume</i> _{cylinder} = $\pi \times \text{radius}^2 \times \text{height}$
<i>Area</i> _{rectangle} = $\text{base} \times \text{height}$	<i>3 phase V A</i> = $V \times A \times 1732$
<i>Area</i> _{circle} = $\pi \times \text{radius}^2$	<i>Flowing quantity</i> = $\text{Area} \times \text{Velocity}$
$A = \pi r^2$	<i>Efficiency</i> = $\frac{\text{work output}}{\text{work input}}$
<i>Perimeter</i> _{rectangle} = $2 \times (\text{length} + \text{width})$	<i>Energy</i> = $\text{power} \times \text{time}$
<i>Thermal expansion</i> = $\text{coeff. of thermal expansion} \times \text{length} \times \Delta T$	
<i>Hydrostatic force</i> = $\text{column area} \times \text{column height} \times \text{fluid density}$	
<i>Motor horsepower</i> = $\frac{\text{flow} \times \text{head} \times \text{specific gravity}}{3960 \times \text{efficiency pump} \times \text{efficiency motor}}$	
<i>Brake horsepower</i> = $\frac{\text{flow} \times \text{head} \times \text{specific gravity}}{3960 \times \text{efficiency}}$	
<i>3 phase A</i> = $\frac{746 \times \text{horsepower}}{1.732 \times V \times \text{efficiency} \times \text{power factor}}$	
<i>Brake horsepower</i> = $\frac{\text{water horsepower}}{\text{efficiency}}$	
<i>Water horsepower</i> = $\frac{\text{flow} \times \text{total head} \times \text{specific gravity}}{3960}$	
$V = d/t$	

CREATING A STUDY PLAN

Completing a Gap Analysis

CWEA certification exams are experience based. The Gap Analysis Tool is designed to help candidates identify which grade level is best suited to their current level of experience, and where they may be lacking sufficient experience.

This free self-evaluation is available on the [CWEA website](#) for all vocations.

Candidates are encouraged to develop their own personal study plan based on individual needs, experience and knowledge. Candidates should seek as many different study materials as possible as well as attend educational events and on-the-job training. This is especially important for areas in which the candidate is not adequately prepared.

CWEA's exams do not correspond directly to any specific textbook, educational course, or program. Instead, the exams are based on an analysis of the duties commonly performed in actual practice.

CWEA Local Section Training

It is the goal of CWEA's Technical Certification Program to operate in line with established best practices for certification programs. As such, CWEA is careful to separate its education and training activities from its certification program to ensure that no conflict of interest exists. Any educational materials or trainings that are designed to prepare candidates for an exam are developed and conducted by individuals that do not have access to the exams.

CWEA Local Sections host education and training events throughout the year that focus on the job duties tested by our certifications. These trainings are limited based on demand and volunteer availability.

Local Section trainings can be found on the [CWEA Events Website](#). For questions about a Local Section training, please contact the Local Section directly. Contact information for individual Local Sections can be found in our [Directory](#).

TEST SITE INFORMATION

Test Site Admission

Applicants are required to show at least one current, valid, government-issued photo identification, such as a state driver’s license or ID, or passport. A temporary license is acceptable if there is an expiration date, or if it is accompanied by paperwork explaining an expiration date.

Calculators Allowed

An onscreen calculator with basic and scientific capability is available on all CWEA exams. Applicants may bring a handheld calculator to a test center as long as it is from the CWEA approved calculator list:

Casio	All FX-115 models (any Casio calculator with FX-115 in its name)
Texas Instruments	All TI-30x and TI-36x models
Sharp	EL models <i>except</i> EL-W516B and EL-W535B

Pearson VUE’s Candidate Rules Agreement

Pearson VUE maintains its own rules regarding professional examinations. All applicants are required to sign the [Candidate Rules Agreement](#) at the test center prior to sitting the exam. Applicants are responsible for knowing and complying with these rules. CWEA recommends all applicants familiarize themselves with this agreement prior to testing.

AFTER THE EXAM

Exam Result Notification

Applicants will see their result on the screen immediately after the exam is submitted. An Official Score Report will be printed out and given to the applicant before they leave the test center. Additional copies can be obtained by logging into the [Pearson VUE user account](#). All results are confidential and will only be released to the applicant. No results will be given over the phone, by fax or email.

Exam Appeal Policy

All appeals must be submitted within two weeks of the exam date. Appeals will be reviewed by CWEA staff and/or Subject Matter Experts. Candidates will be updated on the status of their appeal within 4-6 weeks, and they will be notified in writing when a decision has been made. Once an appeal has been processed, candidates cannot submit a new appeal for the same exam.

Candidates cannot submit an appeal simply because they did not pass the exam.

Candidates can appeal under the following justifications:

Exam Delivery Appeal

Candidates may appeal testing conditions severe enough to have caused a major disruption of the examination process. CWEA staff will review the appeal and consult our exam administrator, Pearson VUE, to investigate the appeal if necessary. Please note, under Pearson VUE's candidate agreement, candidates must notify the proctor immediately during the exam of any issues to open a claim documenting the incident. If candidates did not notify the proctor during the exam, an appeal may still be submitted but may be dismissed if CWEA cannot verify the validity of the complaint.

Exam Question Appeal

If the candidate wishes to comment on specific exam questions, they may flag the question during the exam using the Flag to Enter a Comment function. Candidates are allowed to add comments about any question as long as there is time remaining. All comments will be reviewed and considered by the Technical Certification Program as part of the ongoing exam

review and development process. Candidates that wish to submit an appeal of their exam results, must complete the form below within two weeks of their exam date. Candidates that wish to have specific comments considered in support of their appeal should indicate so on the appeal form.

Non-substantive appeals or appeals without just cause will be automatically rejected. If candidates are not satisfied with the outcome of their appeal, they may submit a request for review by the Technical Certification Program Executive Committee at tcpcommittee@cwea.org. The committee's decision will be final.

All communication related to certification decisions and appeal results with the Technical Certification Program Executive Committee must be sent in writing to tcpcommittee@cwea.org. We ask that candidates do not contact committee members directly.

The appeal form can be accessed here: [CWEA Exam Appeal Form](#).

Retest Application

If the candidate does not pass the exam the first time, they can submit a retest application along with the appropriate fees. The candidate will be required to skip at least one exam window before they are eligible to retest. If the candidate tested within the first 15 days of a window, they are not required to skip an exam window. Under no circumstances are candidates allowed to sit for the same exam twice in the same window. There are no exceptions to this policy.

To be eligible to use the retest application form, candidates must submit the application within one year of their original exam date. Candidates must meet the minimum qualifications of the exam for which they are applying. CWEA may require candidates to fill out a full application with job history to verify candidates meet the minimum requirements. Use of a retest application does not guarantee approval for any exam.

Receiving the Certificate and Blue Card

Certificates and Blue Cards will be issued to all candidates who pass their exam. The certificate contains the certification number and expiration date. The Blue Card contains the expiration date, contact hour due date and contact hour period. These documents are mailed along with

the Score Report within 4 weeks to the address on file with CWEA. Candidates are responsible for making sure this address is current.

MAINTAINING CERTIFICATION

How to Renew

All certifications must be renewed annually. Certifications expire one year from the last day of the month in which the certification was earned. Renewal notices are mailed to certification holders three months before the expiration date. Certification holders can pay their renewal online by logging into their mycwea.org account or by mailing their renewal notice with a check or credit card information to the CWEA office.

Certification holders are required to meet Continuing Education (CE) requirements. This requirement is met by completing 12 contact hours (1.2 CEUs) of vocation-related education or training every two years. For more information about earning contact hours, for details see *Earning Contact Hours* (p. 165).

Not meeting these requirements by the expiration date will cause the certification to expire. Certifications that have been expired for more than three months are subject to a \$25 late fee. If a certification holder does not meet the renewal requirements within two years of their expiration date their certification will permanently expire. To become certified once again, the individual must re-apply for certification and pass the exam. It is the certification holder's responsibility to ensure that his or her certification remains valid. There are no exceptions to these policies.

Renewal Fees

Current fees are listed on the CWEA website. Valid CWEA members qualify for a discounted member rate. The non-member rate includes a one-year CWEA membership. If an applicant does not wish to take advantage of the membership, please inform CWEA.

Continuing Education (CE) Requirement

Certification holders are required to meet Continuing Education (CE) requirements. This requirement is met by completing 12 contact hours (1.2 CEUs) of vocation-related education or

training every two years. Certification holders may submit up to 50% (6 contact hours) of the required contact hours in safety related training. One contact hour is defined as 50 minutes of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction.

Contact hours must be earned within the contact hour period. Hours are earned on the date of completion of the educational or training program. The program may begin before, but must be completed during the contact hour period. If a certification holder will not earn the required hours within their contact hour period, they must notify CWEA before the period ends if they wish to remain certified, for details see *Temporary Deactivation* (p. 166).

Individuals holding more than one CWEA certification can apply the same contact hours to each certification as long as the training is relevant to each vocation. Training is acceptable as long as it is related to the vocations in which certification is held. CWEA may send contact hour certificates to Subject Matter Experts to determine relevancy.

In-house training can be used to meet this requirement as long as standard Safety Tailgate meetings do not exceed 50% (6 contact hours). In-house training includes any training that is conducted by an employer, or a trainer contracted by an employer.

Earning Contact Hours

Contact hours may be earned by any of the following activities:

- Attendance at educational/training programs, including in-house training
- Teaching, instructing or presenting educational/training material (1 hour per 25 min)
- Developing and reviewing CWEA certification exam content as a Subject Matter Expert (1 hour per 25 minutes)
- Authorship of published books or articles (2 hours per book or article)
- Retesting and passing the relevant CWEA certification exam (12 hours)
- Membership in professional membership organizations (.5 hours per year, per membership, with a maximum of 6 hours per contact hour period)

CWEA may require and request additional documentation to assess the authenticity and/or relevance of these activities.

This information is paraphrased for clarity from the 02-03 TCP Re-Certification Policy; a full copy of the policy can be requested by contacting the TCP department.

Contact Hour Documentation

Proof of contact hour completion for an educational/training program must meet these following guidelines:

- The name of the training organization
- The training title
- The name of the attendee who completed the program
- The number of contact hours earned
- The date of completion
- An official signature or stamp from the training organization, instructor's signature is acceptable

For other continuing education activities, CWEA may request additional information. Any documentation that does not meet these guidelines will not be accepted. It is the certification holder's responsibility to retain verification of records documenting earned contact hours and submit proof to CWEA.

Contact Hour Audit

Audits are conducted on a regular basis by CWEA to ensure that certification holders are complying with the continuing education requirement and that the documentation meets the guidelines. Certification holders are randomly selected for an audit of contact hours. The audit reviews the relevancy of the trainings to the vocation, and the dates in which the contact hours were earned to ensure that they fall within the appropriate contact hour period.

Selected participants will be notified via email that they have either successfully passed the audit, or that CWEA requires further information.

Temporary Deactivation

The Temporary Deactivation program is for certification holders that will not meet the continuing education requirement for recertification by their expiration date. Under this program, certification holders can request that CWEA temporarily deactivate their certification for up to two years from their expiration date. This grants the individual extra time to earn the required contact hours. During the time of temporary deactivation, the CWEA certification is invalid and may not be used. Certification holders can apply for reactivation once they fulfill all

requirements. Certification must be in good standing to qualify for this program. For more information including current fees, or to request an application for temporary deactivation, contact the CWEA office.

The application must be submitted before the certification expiration date. There is no exception to this policy.

Reinstating Certification

If a certification expires, it is invalid until all recertification requirements are met. There is a three-month grace period before a certification is considered lapsed. Once a certification becomes lapsed, the certification holder will need to pay a \$25 late fee in addition to meeting the renewal requirements. Certification will remain lapsed for up to two years from the expiration date. If a lapsed certification is not renewed within the two-year period, the certification becomes permanently expired.

Expired Certification

Certificates expired for two years, or longer, cannot be reinstated under any circumstances. To become certified once again, the individual must re-apply for certification and pass the exam. It is the certification holder's responsibility to ensure that his or her certification remains valid. There are no exceptions to these policies.

Retiring Certification

Certification holders can request that CWEA retire their certification at the time it expires if they no longer wish to hold it. Once a certification has been retired, the certification will no longer be valid and CWEA will cease all communications regarding the certification. A retired certification can be reactivated only if the certification holder has met all renewal requirements within the appropriate timeframe and the certification has not permanently expired.

EXAM DESIGN AND FORMAT

Exam Design

All certification exams are designed to test knowledge required to perform the essential duties of a job at a given grade level with minimum acceptable competence. Exams are created by Subject Matter Experts under the guidance of exam development professionals.

Exam content is developed from a job task analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California. All exam items are written by subject matter experts based on the content outline established by the job task analysis. These items are used to create the exam forms. The pass point for each exam is based on difficulty, using the Modified Angoff Method, for details see *Pass Point* and *How Pass Points are Set* (p. 169).

Exam Delivery Mechanism

All exams are computer-based format and are available in the English language only. Exams are delivered at Pearson VUE testing centers or via Pearson VUE's online testing platform On Vue.

Exam Format

All certification exams are in multiple-choice format. Multiple-choice is considered the most effective format for use in standardized tests as it allows for greater content coverage for a given amount of testing time and improves competency measurement reliability. Multiple choice questions range in complexity from simple recall of knowledge to the synthesis and evaluation of the subject matter.

Weighting

The percentage of the exam that covers a particular content area is referred to as its weighting. Weightings are established through a Job Task Analysis and are based on the frequency and criticality of the task. A weighting is approximate and shows the relative importance of a particular area compared to the other portions of the exam. Weightings are

indicated on the content outline for each exam and can be found in the preparation materials. Each weighting on the actual certification exam may vary slightly.

Pass Points

An exam pass point is the minimum score required to pass a certification exam. The pass point is also known as a cut score or passing score. Candidates should try to score as high as possible on their exam. Pass points for CWEA certification exam vary with each exam form. The pass point for each vocation, grade level and exam form is set independently.

How Pass Points are Set

A modified Angoff Method is used to determine the pass point for each version of each exam. The modified Angoff Method uses expert judgments to determine the difficulty level of the exam. The easier the exam, the higher the pass point. Likewise, the more difficult the exam, the lower the pass point.

The following is a basic outline of the modified Angoff Method (some details have been omitted):

1. A group of Subject Matter Experts (SMEs) independently rate each exam question within a given exam. The ratings are defined as the probability, or likelihood, that a minimally competent person with the requisite education and experience will answer the question correctly. A minimally competent person is defined as someone who adequately performs all job functions safely and requires no further training to do so.
2. The SMEs review each exam question as group. A consensus is reached for the rating of each exam question. During this time the SMEs review comments submitted in writing by exam-takers. Any exam question that is judged to be ambiguous, has more than one correct answer, or has no correct answers is eliminated from the scoring process for that exam. These exam questions are then revised for future use, re-classified, or deleted from the exam item bank.
3. After the data are refined, the final step is to calculate the mean, or average, of all the exam question ratings. This becomes the overall pass point estimation.

Why Use Modified Angoff?

Each version of a given certification exam pulls questions from an exam item bank. Each of these questions varies in difficulty. Because a different mix of questions is used in each exam form, the overall difficulty level is not fixed. Thus, it is important to make sure that the varying difficulty level is reflected in the pass point of each exam to ensure that results are reliable. Exam reliability is concerned with the reproducibility of results for each version of a given exam. In other words, for an exam to be reliable it must yield the same result (pass or fail) for the same individual under very similar circumstances. For example, imagine a candidate takes an exam at a certain grade level and passes it. Immediately after completing the exam, the candidate takes the same grade level exam, but a different version. If the exam is reliable they will achieve the same result: pass. If they do not, it is likely that the exam is not a reliable measure of minimal competency.

By taking into consideration the difficulty level of an exam, the modified Angoff Method significantly increases the reliability of the exams. Also, since each exam is adjusted for difficulty level, each exam version has the same standard for passing. Thus, exam-takers are treated equitably and fairly, even if they take different versions of the exam.

There are other methods for setting pass points. However, for the type of exams administered by CWEA, the modified Angoff Method is the best.

Exam Scoring

All exams are electronically scored by Pearson VUE. Most exam items are valued at one point unless otherwise stated on the exam. After exams are scored, total points are compiled, and an overall score is calculated as the sum of all points earned on the exam. If the overall score is equal to, or greater than the established pass point, the candidate has passed the exam. Each question is worth 1 point. Total points possible for each exam are as follows:

- Grade 1 – 100 points
- Grade 2 – 100 points
- Grade 3 – 100 points
- Grade 4 – 100 points

Summary of Certification Activities

A summary of certification activities for each vocation is available upon request. The summary includes the number of candidates examined, pass/fail statistics, and the number of individuals currently certified. To request this information, please contact the CWEA office.