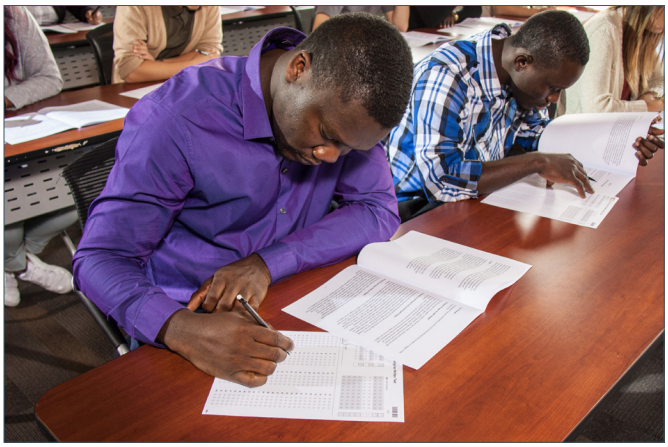
THE FCTC STUDY GUIDE

The FCTC Written Test was developed by the California Firefighter Joint Apprenticeship Committee (Cal-JAC).






PREPARING FOR THE WRITTEN TEST

The FCTC entry-level written test is a general knowledge test with questions and examples tailored to the job of a firefighter. It is designed to assess your ability to process information and think critically. The goal of the test is to measure your knowledge in reading comprehension, ability to recall detailed visual and verbal information, basic mathematics, and mechanical reasoning (ability to understand and apply *mechanical* concepts and principles).

The testing process starts with a 30-minute period in which candidates are given essays to read and study. The information in the essays is necessary to be successful on the test. After the reading period, the essays are collected and the exam begins immediately. Candidates then have two hours to complete 100 multiple-choice questions.

WRITTEN TEST OVERVIEW

The FCTC Written Test will cover subject matter within the following four sections:

Recall and Comprehend Verbal and Visual Information
This section requires candidates to watch two short videos and answer questions based on the scenarios presented.

Apply Mechanical Reasoning
This section presents problems to evaluate a candidate's ability to use reason to identify details within specific mechanical examples. Some questions are presented in a video format and some are included in the test booklet. The topics may include, but are not limited to – Fluid dynamics, levers, belt and pulley systems, rope and pulley systems, and gears.

Solve Mathematical Problems
The math section covers areas such as addition, subtraction, multiplication, division, angles, area, volume, algebra, geometry, and the use of decimals, fractions, and percentages.

Recall and Comprehend Technical Information from Written Materials
This section assesses a candidate's ability to recall detailed information and demonstrate comprehension. Some essays are provided during the first 30 minutes of the exam period and some are included in the test booklet. The essays to be read at the beginning of the exam process cannot be referred to during the test. Answers must be based on recall of material studied during the 30 minutes allotted.

TESTING TIPS AND STRATEGIES

1. **Listen carefully to all directions.** Ask questions if there is something you don't understand.

2. **Read the entire question fully and carefully.** Be sure that you know what the question asks and what the choices say. People often choose wrong answers simply because they failed to read the question in its entirety or the provided answers carefully, or because they chose an answer before reading all options.

3. **Choose the answer that is GENERALLY best.** Answer according to what is generally or usually true, not by what would be true in some particular case. Sometimes there is no answer that is complete, or exactly correct, or always correct. The best answer is the one that is right under ordinary conditions. Here is an example:

The number of days in a year is:
A. 365
B. 366
C. 367
D. 368

The right answer is the one that was true for most years, not the one that was true for leap years.

4. **Understand that these exams aren't designed to trick you.** The goal of the exam is to measure your basic knowledge in reading comprehension, ability to recall detailed information, mathematics, and mechanical reasoning (ability to understand and apply mechanical concepts and principles to solve problems). The math component will cover areas such as addition, subtraction, multiplication, division, and the use of decimals, fractions, and percentages.

5. **Use your time efficiently.** The FCTC written test is not a speed test, but is timed. Candidates are given 30 minutes to read and review the essays at the beginning, and two hours for the actual test. Move along at a pace that will allow you to go back and check your answers.

6. **Don't change answers too much.** When in doubt, your first answer is often correct. Answers that are changed too many times may result in the wrong answer. Eliminate choices you know are wrong. When you have trouble deciding on the best answer but have decided one or two answers are definitely not best, avoid further consideration of those and concentrate on the answers you think might be correct.

7. **Be mindful of questions with absolutes.** Suspect that something may be wrong if any of the answers provided contain broad statements or words like absolutely, always, completely, forever, infinite, never, only, sole, undeniable, or wholly.

8. **If an item is in the form of an incomplete statement, it sometimes helps to try to complete the statement looking at suggested answers.** Then see if the way you have completed the statement corresponds with any of the answers provided. If one is found, it is likely to be the correct one.

9. **Set aside time daily to prepare for the exam.** Study with a friend or a group occasionally; the exchange of ideas will help all involved. Look up new words in the dictionary. Avoid serious study in a position or location that is too comfortable.

10. **Test day.** Familiarize yourself with the test location. Also check emails; FCTC will send all details regarding parking and building instructions. Candidates are advised to arrive up to 30 minutes early, well rested, and prepared.

STUDY AND PRACTICE MATERIALS BY SECTION

For answers to sample questions in any of the four following sections, please refer to the answer key on page 12.

SECTION 1

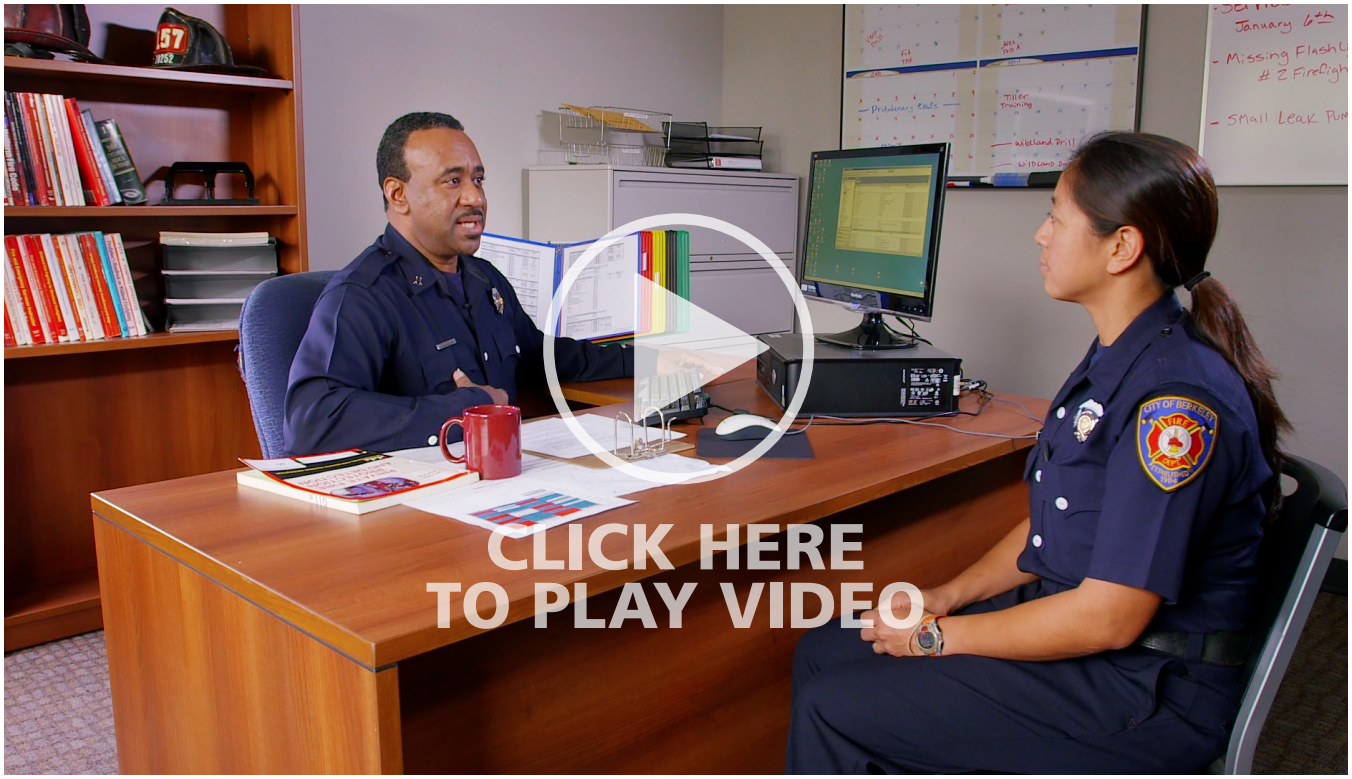
RECALL AND COMPREHEND VERBAL AND VISUAL INFORMATION

The ability to quickly and accurately determine and remember details at an emergency scene is a critical skill for firefighters. All crew members are responsible for contributing to the overall scene size-up, that is they each must see and hear detailed information and communicate that information to the rest of the crew. The scene size-up will determine the response necessary to save lives and avoid injuries.

It is equally important to be able to listen when instructions are given or tasks are assigned. The success of the crew depends on each member doing their assigned task correctly and expediently.

Practice your Verbal and Visual recall skills

The video segment and questions are a sample of how information will be presented during the test. See how many of the questions you can answer after viewing the video. Remember you will only see a segment once during the test.



SAMPLE SCENARIO

SECTION 2

APPLY MECHANICAL REASONING

Firefighter training and job skills require learning methods and procedures for fighting fires and performing rescues. Learning how and when to use hand tools, power tools, firefighting apparatus and equipment is essential for success. Much of the training for these tasks are accomplished using pictures, drawings, and diagrams of three dimensional objects. For instance, a firefighter needs to acquire skill in reading equipment diagrams, instruction manuals, blueprints, and maps. Firefighters must be able to develop a mental image of a three dimensional object, such as a house or a power saw, by looking at a two dimensional picture of the object.

This section is designed to test your skill to visualize and reason how objects work, operate or interact. The concepts covered in the test may include (but are not limited to): fluid dynamics, levers, belt and pulley systems, gears, and rope and pulley systems.

The following examples include some of the concepts in the exam.

GEARS

A gear or cogwheel is a rotating machine part having cut teeth, or cogs, which mesh with another toothed art to transmit torque, in most cases with teeth on the one gear being of identical shape and often also with that shape on the other gear. Two or more gears working in a sequence (train) are called a gear train or, in many cases, a transmission; such gear arrangements can produce a mechanical advantage through a gear ratio and thus may be considered a simple machine.

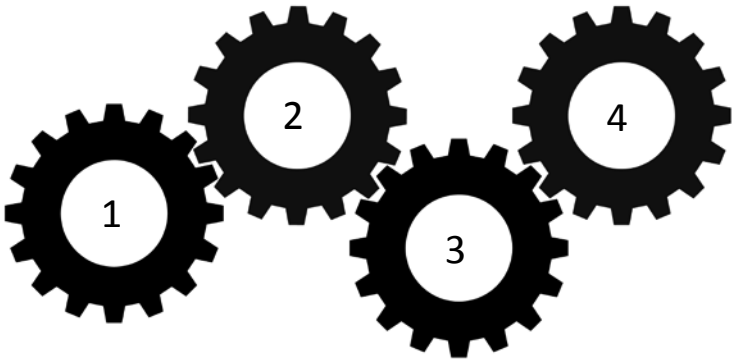
If the gears are touching (meshed) then the adjacent gears move in opposite directions. When there are an odd number of meshed gears then the last gear will always turn in the same direction.

Geared devices can change the speed, torque, and direction of a power source. The most common situation is for a gear to mesh with another gear; however, a gear can also mesh with a non-rotating toothed part, called a rack, thereby producing translation instead of rotation.

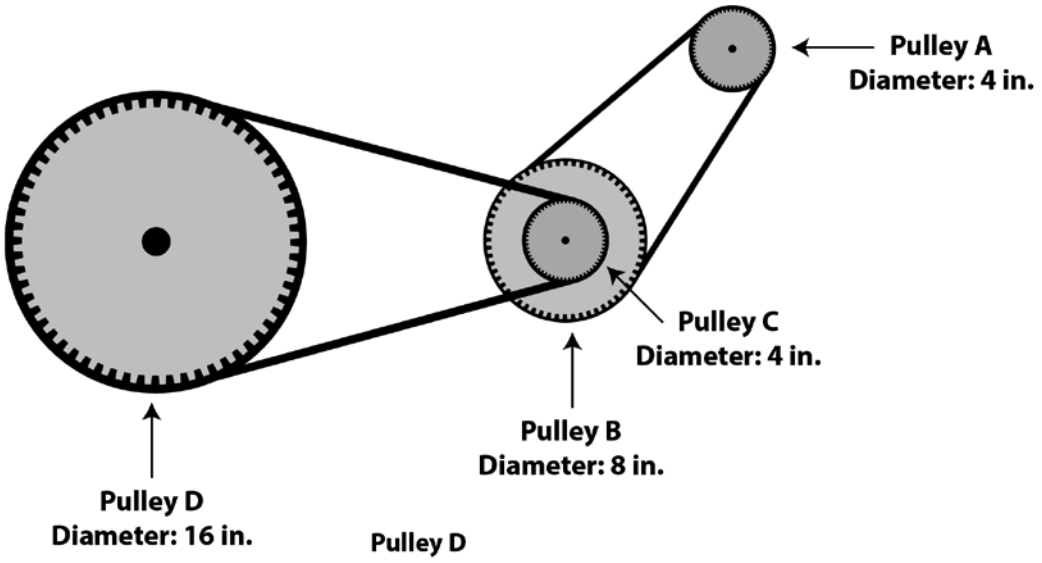
When two gears mesh, and one gear is bigger than the other (even though the size of the teeth must match), a mechanical advantage is produced, with the rotational speeds and the torques of the two gears differing in an inverse relationship.

GEARS

Spur gear: Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radically, and although they are not straight-sided in form (they are usually of special form to achieve constant drive ratio, mainly involute), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts.



BELT & PULLEY SYSTEM



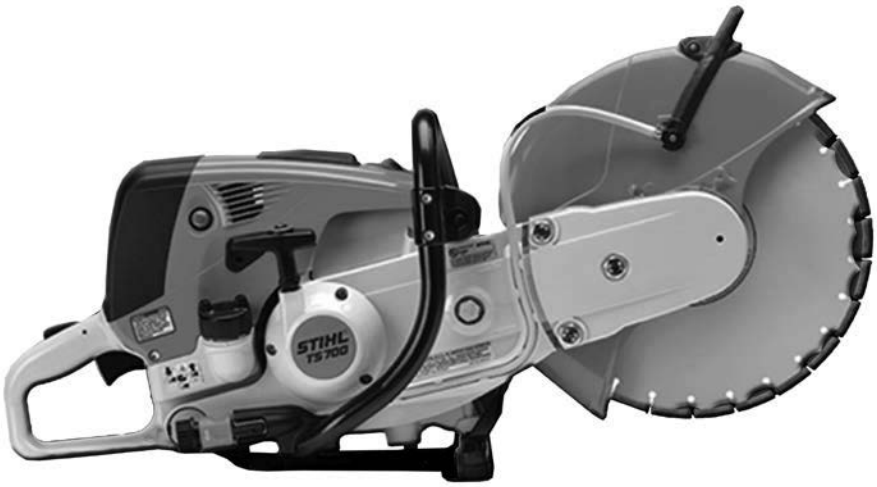
A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realized.

In this system, assume that the linked pulleys (B and C in the example) run at the same rpm, since they are attached to the same shaft.

Break the problem down into parts, and calculate them in order:

- Diameter of pulley A/diameter of pulley B = 4/8, so pulley B will run1/2 as fast as pulley A. 400/2 = 200 rpm
- You already know that pulley C runs at the same speed as pulley B
- Diameter of pulley C/diameter of pulley D = 4/16 = 1/4, so pulley Dwill run 1/4 as fast as pulley C
- 200/4 = 50 rpm

BELT & PULLEY SYSTEM



A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realized.

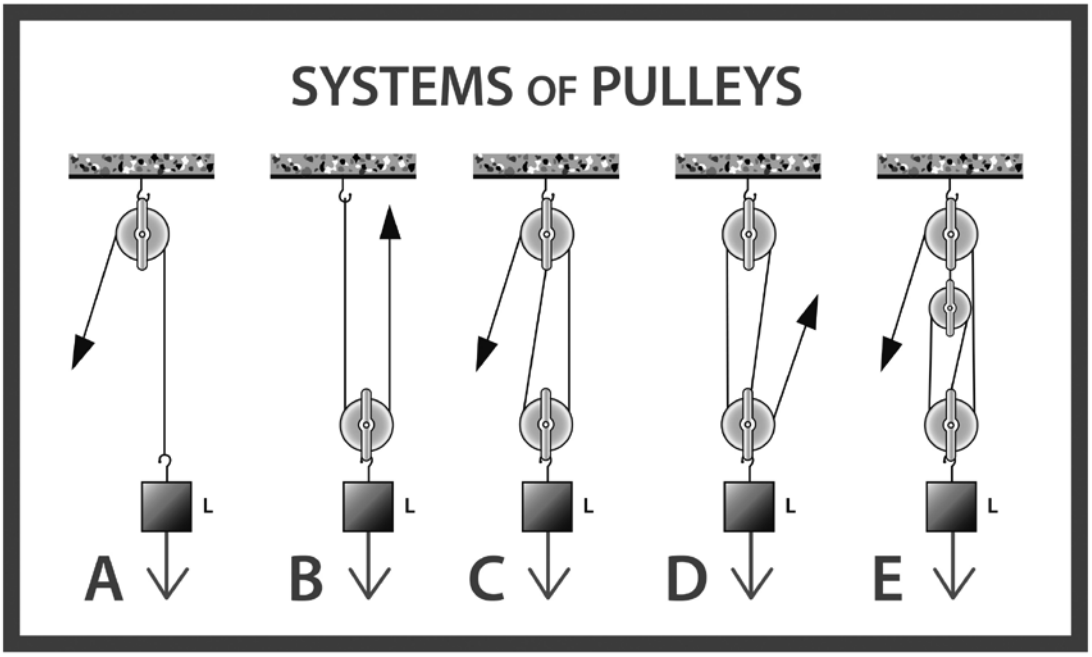
A belt drive is analogous to that of a chain drive, however a belt sheave may be smooth (devoid of discrete interlocking members as would be found on a chain sprocket, spur gear, or timing belt) so that the mechanical advantage is approximately given by the ratio of the pitch diameter of the sheaves only, not fixed exactly by the ratio of teeth as with gears and sprockets.

ROPE & PULLEY

A pulley is a wheel on an axle of shaft that is designed to support movement and change of direction of a cable of belt along it's circumference. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power.

A pulley may also be called a sheave or drum and may have a groove between two flanges around it circumference. The drive element of a pulley system can be a rope, cable, belt, or chain that runs over the pulley inside the groove. Pulleys are assembled to form a block and tackle in order to provide mechanical advantage to apply large forces. Pulleys are also assembled as part of belt and chain drives in order to transmit power from one rotating shaft to another.

ROPE & PULLEY



A rope and pulley system –that is, a block and tackle– is characterized by the use of a single continuous rope to transmit a tension force around one or more pulleys to lift or move a load–the rope may be a light line or a strong cable.

If the rope and pulley system does not dissipate or store energy, then its mechanical advantage is the number of parts of the rope that act on the load.

LEVER

A lever is a machine consisting of a beam or rigid rod pivoted at a fixed hinge, or fulcrum. A lever amplifies an input force to provide a greater output force, which is said to provide leverage. The ratio or the output force to the input force is the mechanical advantage of the lever.

Three classes of levers: Levers are classified by the relative positions of the fulcrum and the input and output forces. It is common to call the input force the effort and the output force the load or the resistance. This allows the identification of three classes of levers by the relative locations of the fulcrum, the resistance and the effort.

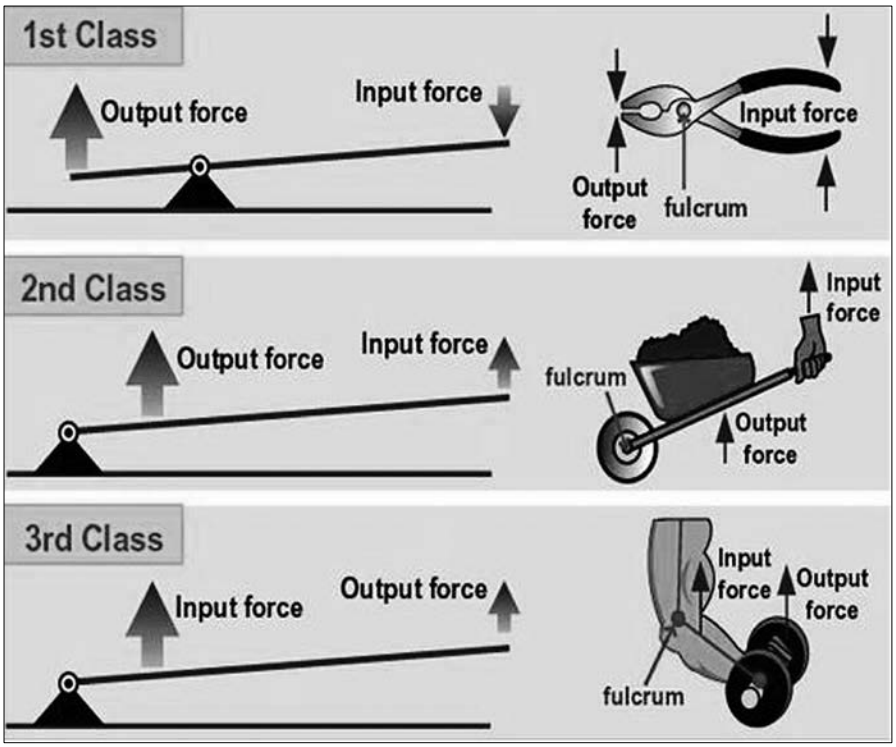
Class 1: Fulcrum in the middle: the effort is applied on one side of the fulcrum and the resistance on the other side, for example, a seesaw, a crowbar or a pair of scissors. Mechanical advantage may be greater or less than 1.

Class 2: Resistance in the middle: the effort is applied on one side of the resistance and the fulcrum is located on the other side, for example, a wheelbarrow, a nutcracker, a bottle opener or the brake pedal of a car. Mechanical advantage is always greater than 1.

Class 3: Effort in the middle: the resistance is on one side of the effort and the fulcrum is located on the other side, for example, a pair of tweezers or the human mandible. Mechanical advantage is always less than 1.

LEVER

The 3 Classes of Levers



These cases are described by the mnemonic fre 123 where the fulcrum is in the middle for the 1st class lever, the resistance is in the middle for the 2nd class lever, and the effort is in the middle for the third.

FLUID DYNAMICS

Remember that head is the pressure created by the force of gravity and is a function of the difference in elevation between intake and the output. Normally head pressure is measured in pounds per square inch. Fortunately for us Newton realized that the force of gravity is a constant and therefore it is possible to exactly calculate the pressure that gravity will create given a given vertical drop.

The formula for determining head pressure is really pretty simple:
1 vertical foot = 0.433 pounds per square inch
1 psi = 2.31 vertical feet

FLUID DYNAMICS

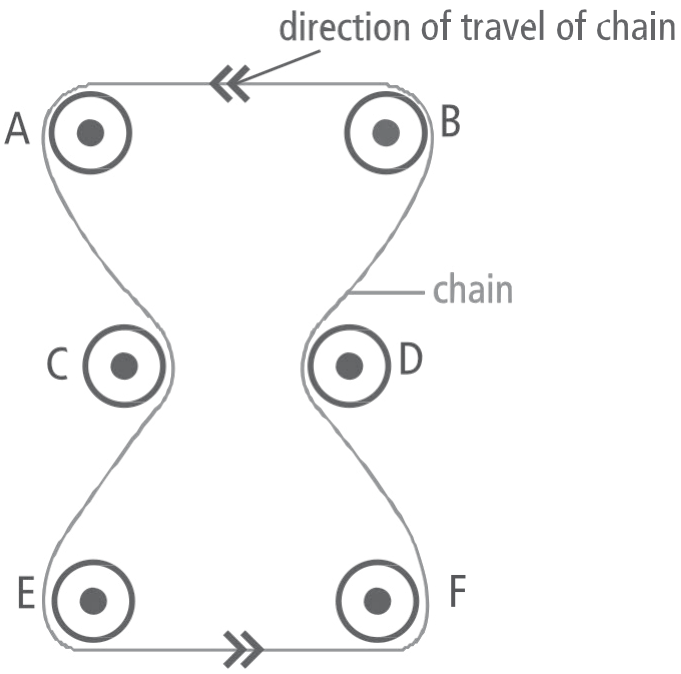
Feet Head of Water to PSI				
Feet Head	Pounds Per Square Inch		Feet Head	Pounds Per Square Inch
1	0.43		100	43.31
2	0.87		110	47.64
3	1.30		120	51.97
4	1.73		130	56.3
5	2.17		140	60.63
6	2.60		150	64.96
7	3.03		160	69.29
8	3.46		170	73.63
9	3.90		180	77.96
10	4.33		200	86.62
15	6.50		250	108.27
20	8.66		300	129.93
25	10.83		350	151.58
30	12.99		400	173.24
40	17.32		500	216.55
50	21.65		600	259.85
60	25.99		700	303.16
70	30.32		800	346.47
80	34.65		900	389.78
90	38.98		1000	433.00
NOTE: One foot of water at 62 degrees F = 0.433 PSI. To find the PSI for any feet head not listed, multiply the feet head by 0.433.				

Water head pressure is static pressure caused by the weight of water solely due to its height above the measuring point. The pressure at the bottom of a 40 foot lake or a 40 foot high thin tube would be identical, since only height is involved. The value may be expressed as pounds per square inch (psi) or inches of water column pressure. This basic calculation is widely used to solve many different practical problems involving water and other liquids.

Basic calculations: measure the height of the water above the desire measuring point in inches or feet. Divide the depth in inches by 27.71 inches/psi, or the depth in feet by 2.31 feet/psi which are the English unit conversion factors. The result is the water head pressure expressed in psi.

Use the calculation to solve a practical problem. An example would be a 150 feet measured water height in a municipal water tower. You would divide 150 feet by 2.31 to obtain the value of static pressure at ground level of about 65psi.

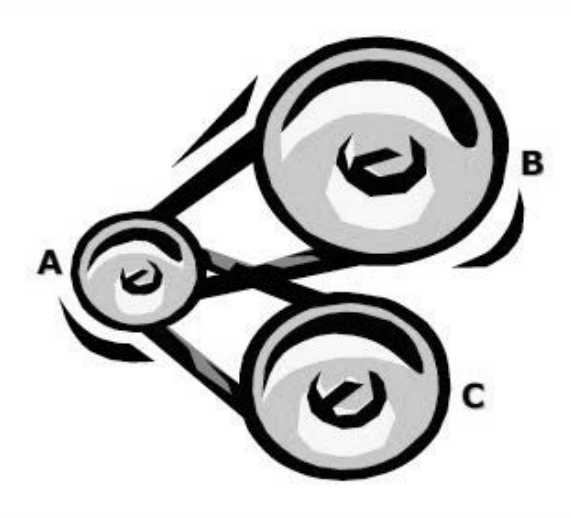
BELT PULLEY SYSTEM



Question 1

In the diagram shown, which gears are turning clockwise?

A. A, C and F
B. B, D and F
C. C and D
D. E and F

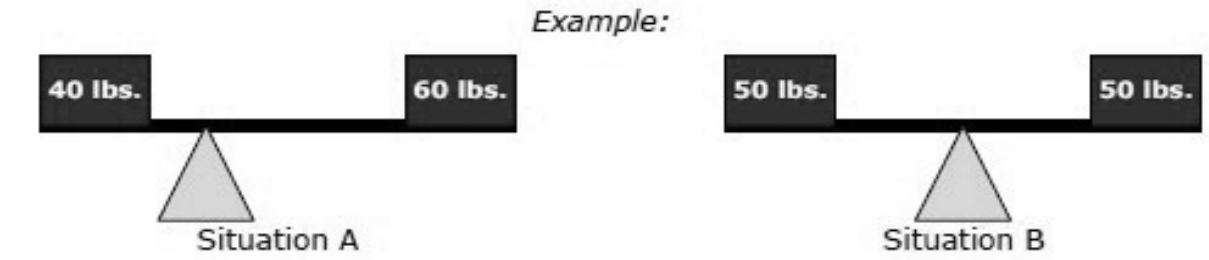


Question 2

Which of the pulleys will complete the most revolutions per minute?

A. Pulley A
B. Pulley B
C. Pulley C
D. The pulleys will make an equal number of revolutions per minute

SINGLE LEVER

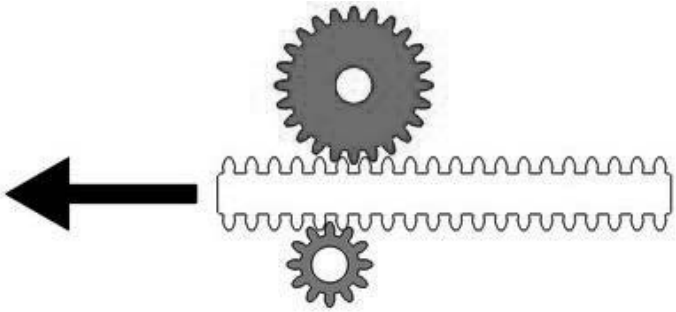


Question 3

Of the two situations depicted above,

A. only A is physically possible.
B. only B is physically possible.
C. both A and B are physically possible.
D. it is impossible to tell which of the two is possible.

GEARS



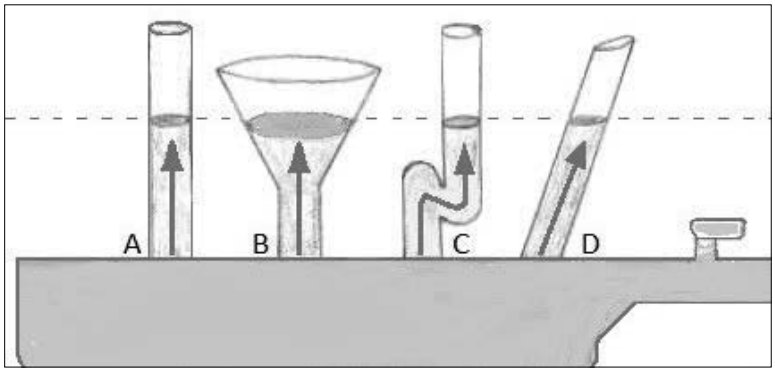
Question 4

The diagram shows two fixed cogwheels which can only rotate around their own axis. A rack is inserted between the two cogwheels and is moved in the direction shown by the arrow.

What are the directions of movement and velocities of the cogwheels?

A. Same direction, same velocities
B. Same direction, different velocities
C. Different directions, same velocities
D. Different directions, different velocities

FLUID DYNAMICS



Question 5

When the supply hose is turned on and the bottom container is filled with water, which tube will fill with the most water?

A. Both A & B
B. B
C. Both C & D
D. They will all fill equally

SECTION 3

SOLVE MATHEMATICAL PROBLEMS

This section of the written test measures your mathematical skills. Firefighters perform a wide variety of duties. Often the tasks that must be completed require using basic math. Formulas needed for specific tasks, such as hydraulics, are taught on-the-job. However, those formulas and many routine tasks require understanding and application of basic mathematical concepts. The math functions covered in this exam include:

- Addition/Subtraction
- Multiplication/Division
- Fractions/Decimals
- Percentages
- Angles
- Area
- Volume
- Algebra/Geometry

There are numerous sources of materials and information for basic math (websites, colleges, libraries, etc.). Choose the books, materials and methods that best suit your learning style to brush up on your math skills.

There are 20 word problems to solve on the test. The examples below represent the questions that appear on the exam.

SAMPLE QUESTIONS

1. If a tank with a 12’ diameter holds 670 gallons per foot of depth, how many gallons will a tank with a 12’ diameter hold if it is 4’ deep?

A. 2,280
B. 2,430
C. 3,040
D. 2,680

2. During a preplan process of a building, you must obtain the square footage. You have a strip mall with two occupancies. One occupancy measures 96’ x 52’ and the other measures 114’ x 52’. What is the approximate square footage for this building?

A. 13,000 square feet
B. 11,000 square feet
C. 12,000 square feet
D. 10,000 square feet

SECTION 4

RECALL AND COMPREHEND TECHNICAL INFORMATION FROM WRITTEN MATERIALS

Firefighters must read and comprehend volumes of technical materials. Nearly every working day includes some training or education classes, drills or assignments. The subjects cover a broad range of topics that include fire behavior, hazardous materials chemistry, emergency medicine, building construction, response considerations, apparatus and equipment use, maintenance and troubleshooting, just to name a few.

Some essays are provided during the first 30 minutes of the exam period and some are included in the test booklet. The essays to be read at the beginning of the exam process cannot be referred to during the test. Answers must be based on recall of material studied during the 30 minutes allotted. The essays that are included in the exam booklet are available for referral when answering questions.

Read the following essay and answer the questions without looking back at the essay to simulate the essays and questions from the first 30 minutes of the exam period.

SCBA USE AND HAZARDOUS CONDITIONS ESSAY

There are numerous types of Self Contained Breathing Apparatus (SCBA) found within the fire service. They can range from low pressure systems to high pressure. There are numerous components to an SCBA including the first stage pressure regulator, second stage regulator, high pressure air tank, harness, mask, heads up display device, voice amp, low air alarm and personal alarm safety device (PASS).

PASS devices are mandatory on all SCBA's and can be actuated by air or battery. The PASS device is an audible warning system designed to let the firefighter know when they are low on air. PASS devices usually sound at 500 psi and let off an audible warning for 15-30 seconds. The PASS device cannot be turned off and can only be disarmed by turning off the SCBA unit or via refill of the tank above 500 psi. It should be a fundamental rule in firefighting that no one be permitted to enter any potentially toxic atmosphere, such as an interior or exterior fire attack, below-grade rescue, or hazardous materials emergency, unless equipped with a protective breathing apparatus. SCBAs vary in weight and can be as heavy as 50 pounds or as light as 32 pounds.

The lungs and respiratory tract are more vulnerable to injury than any other body part. The gases encountered in fires are dangerous in one way or another. Smoke can carry numerous dangerous particles; some of those particles can include carbon, tar, and dust floating in a combination of heated gases. Some of the suspended particles in smoke are merely irritating, but others may be lethal. The size of the particle determines how deeply into the unprotected lungs it will be inhaled.

There are four common hazardous atmospheres associated with fires or other emergencies. These atmospheres include the following: oxygen deficiency, elevated temperatures, smoke and toxic atmospheres with fire. An example of a toxic atmosphere would be the buildup of carbon monoxide. This colorless, odorless gas is caused by incomplete combustion and is the number one cause of fire related deaths.

The combustion process consumes oxygen while producing toxic gases. When oxygen concentrations are below 18 percent, the human body responds by increasing its respiratory rate. Oxygen deficiency can also occur in below-grade locations, chemical storage tanks, grain bins, silos, and other confined spaces.

SAMPLE QUESTIONS:

1. There are numerous components to an SCBA including:
   A. A harness
   B. A low air alarm
   C. A second stage regulator
   D. All of the above

2. The PASS device is a/an _____ warning system designed to let the firefighter know when they are low on air.

   A. Respiratory
   B. Pressure
   C. Regulator
   D. Audible

3. The PASS device cannot be turned off and can only be disarmed by turning off the SCBA unit or via:

   A. Refill of the tank above 300 psi
   B. Refill of the tank above 450 psi
   C. Refill of the tank above 500 psi
   D. Refill of the tank above 550 psi

4. Unless equipped with a protective breathing apparatus, it should be a fundamental rule in fire fighting that no one be permitted to enter any potentially toxic atmosphere, including a/an:

   A. High angle emergency
   B. Above-grade emergency
   C. Low angle emergency
   D. Hazardous materials emergency

5. The _____ are more vulnerable to injury than any other body part.

   A. Lungs and respiratory tract
   B. Heart and liver
   C. Brain and kidney
   D. Eyes and ears

6. There are _____ common hazardous atmospheres associated with fires or other emergencies.

   A. 2
   B. 3
   C. 4
   D. 5

7. The hazardous atmospheres associated with fires or other emergencies include the following:

A. Oxygen Deficiency
B. Elevated Temperatures
C. Smoke and Toxic Atmospheres
D. All of the above

8. When oxygen concentrations are below _____ percent, the human body responds by increasing its respiratory rate.

A. 18
B. 20
C. 22
D. 24

9. _____ is the number one cause of fire-related deaths.

A. Carbon monoxide
B. Carbon dioxide
C. Nitrogen dioxide
D. Hydrogen chloride

10. Which colorless odorless, gas is caused by incomplete combustion?

A. Carbon monoxide
B. Carbon dioxide
C. Nitrogen dioxide
D Hydrogen chloride

SECTION 2

APPLY MECHANICAL REASONING

Question 1
ANSWER C

Gears C and D. At least one gear in each of the other answers is turning counterclockwise. It helps to follow the direction of the chain, which is connected to all of the gears.

Question 2
ANSWER A

Notice that pulley A is the smallest of the three pulleys in the group. Because of its size, it has a shorter distance to travel to complete one revolution. Another way to phrase the question would be to ask which pulley is moving fastest, in which case, the same thought process is used.

Question 3
ANSWER B

In Situation B, the length of the lever on both sides of the fulcrum is equal, as is the weight supported on each side. This represents a "balanced" situation. It is physically impossible for the lever to remain balanced in Situation A because there is more weight on the right side. Even if the weights of the load were equal, the lever would still not balance because the right side of the lever is longer than the left side.

Question 4
ANSWER D

The large cogwheel will turn clockwise at a slower velocity than the small cogwheel, which will turn counterclockwise. The smaller the wheel, the higher the velocity.

Question 5
ANSWER D

As liquid fills the bottom container, pressure causes the liquid to rise in each tube equally. The liquid reaches the same level in all of the tubes without regard to the shape or angle of the tube.

SECTION 3

SOLVE MATHEMATICAL PROBLEMS

1. D
2. B

SECTION 4

RECALL AND COMPREHEND TECHNICAL INFORMATION FROM WRITTEN MATERIAL

1. D
2. D
3. C
4. D
5. A
6. C
7. D
8. A
9. A
10. A