get into energy math

Pre and Post Exams

Name:_____ Date:_____

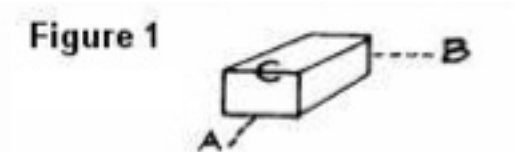
ASSEMBLY TEST

Directions

In this test, you are to figure out how something would look if it were put together properly. The parts to be put together are shown at the beginning of each problem and are followed by five pictures showing five different ways the parts could be put together. Only one of them is correct.

Each part is marked with one or more letters, each of which stands for a place on the part. Letters referring to places that do not show are placed outside the part, with a dotted line pointing to the underneath side, or the place that you can't see.

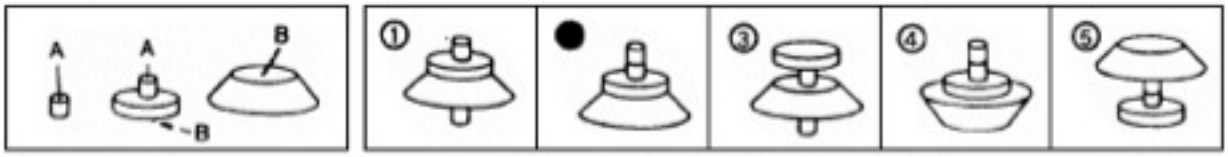
In Figure 1 below, the letter A refers to the bottom of the cube. B points to the back of the cube. C refers to the upper front edge of the cube.



In the test, you are to assemble the parts so that the places having the same letter are put together.

Look at the sample below. Try to figure out which of the five assemblies is correct.

Sample 1



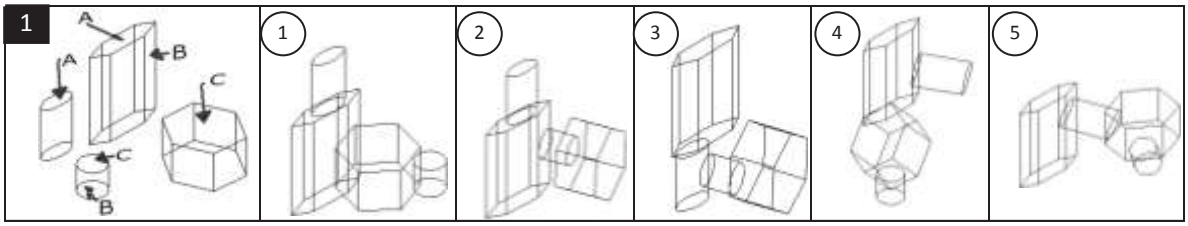
Look at the ends marked A. If the ends marked A were put together, how would they look? Now look at the first of the parts marked B. Note how the dotted line from B points to the underside, which you cannot see.

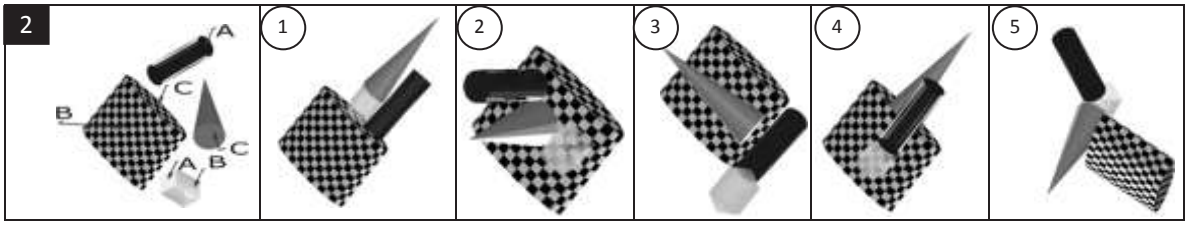
Which of the five pictures shows the two places marked A put together? Of the five, only pictures 2, 4, and 5 have the places marked A put together. Now look at the parts marked B. Which of the pictures 2, 4, and 5 shows the two places marked B put together? Of these three, only picture 2 has the places marked B put together. Therefore, picture 2 is the correct answer. This is the only picture of the five that has all the parts put together in the way the letters show they should be. Therefore, circle 2 has been filled in for Sample 1.

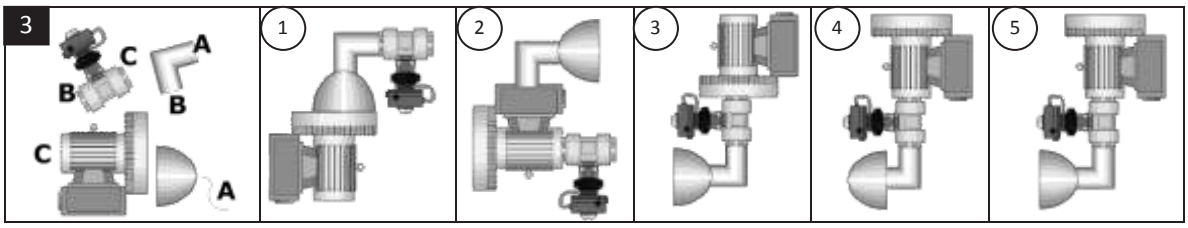
In deciding how the parts should be put together, do not think about what the completed thing is or what it does. Just follow the letters on the parts that show you how they are to be put together.

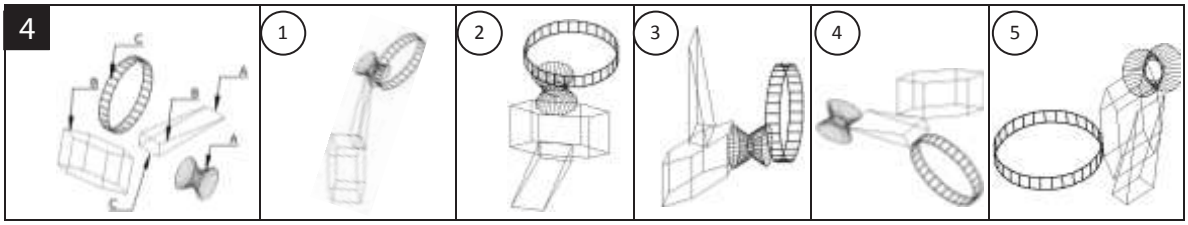
This test has 18 questions. You have a total of 10 minutes to complete the entire test.

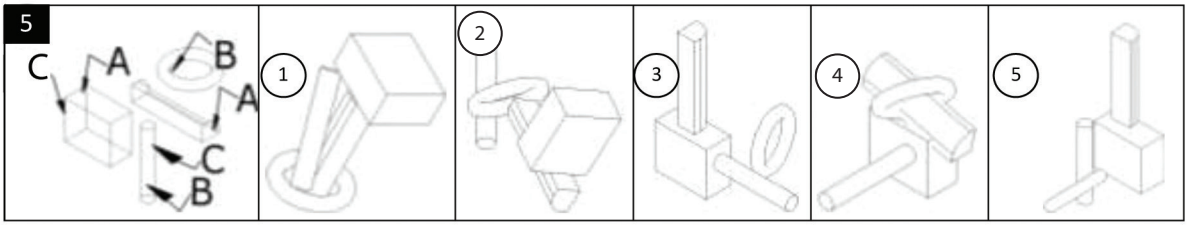
Assembly Part I







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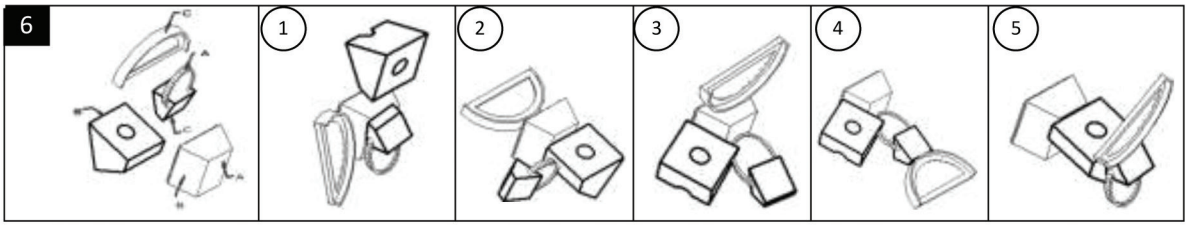
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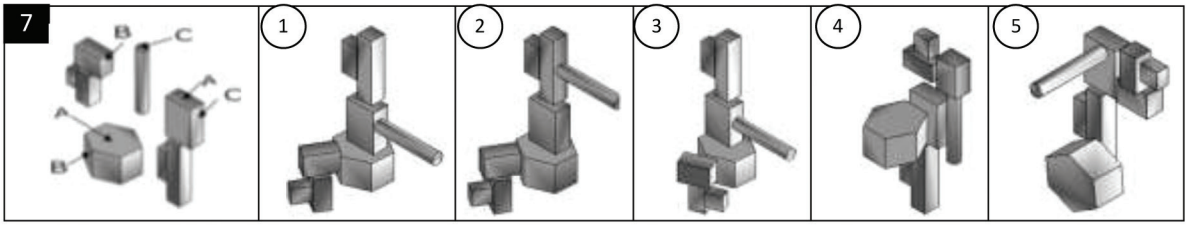
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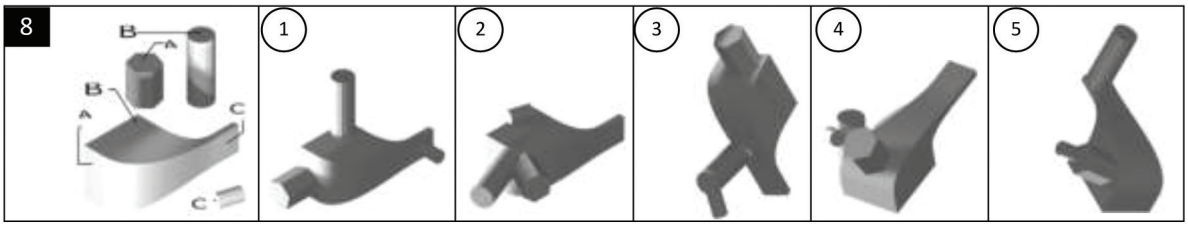
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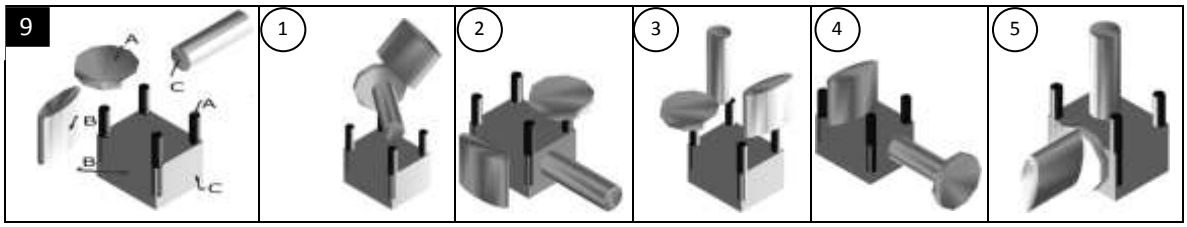
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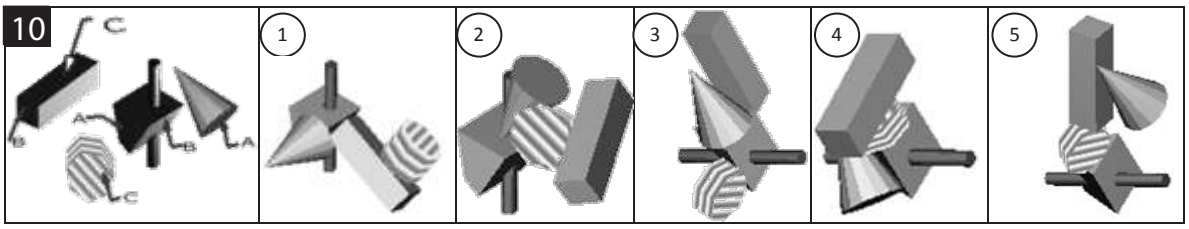
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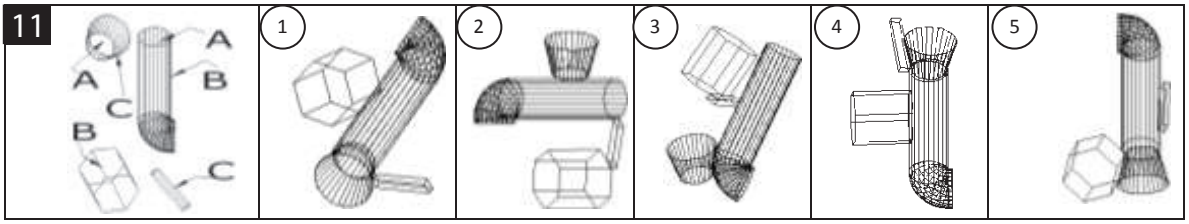
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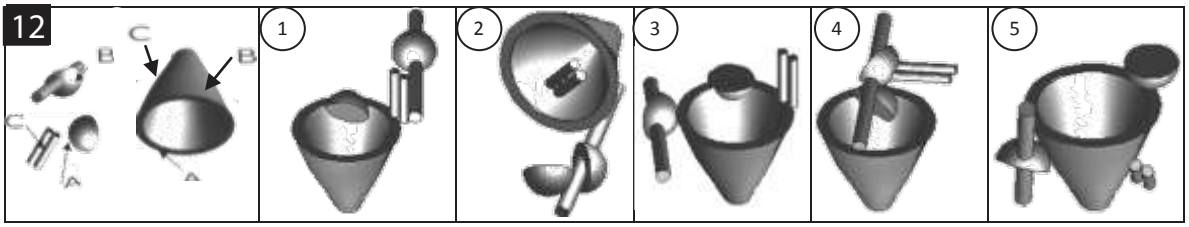
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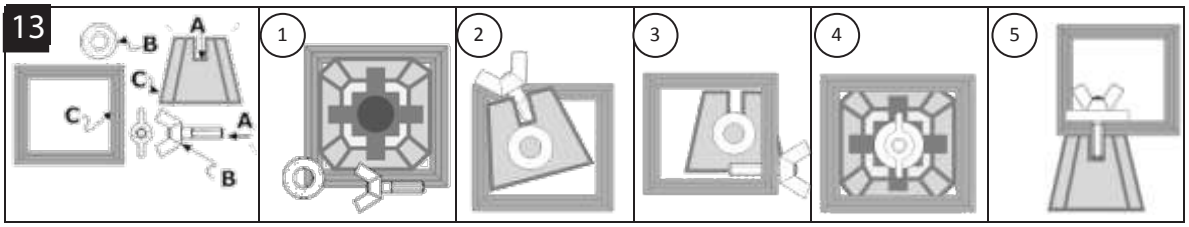
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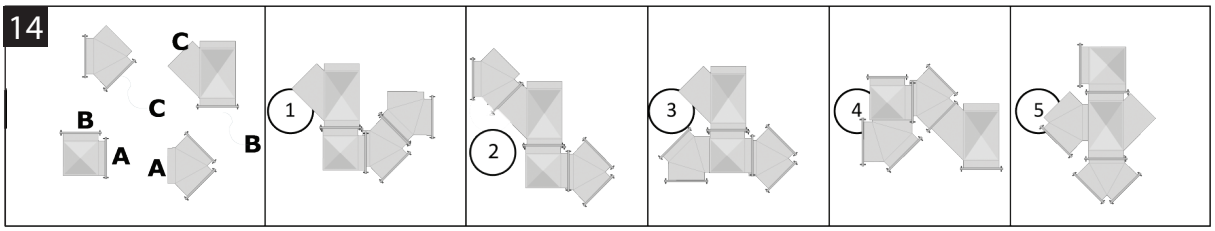
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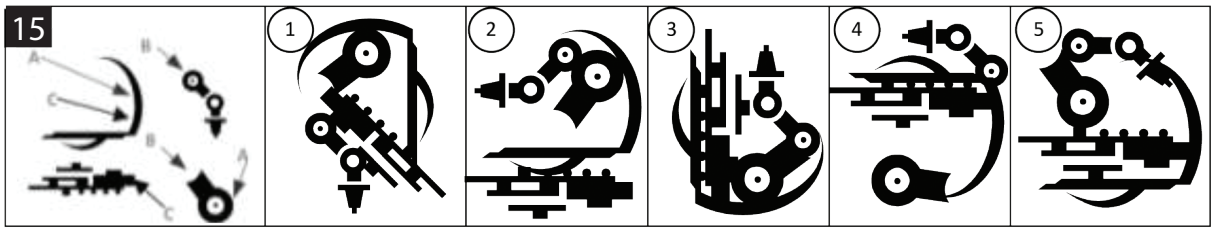
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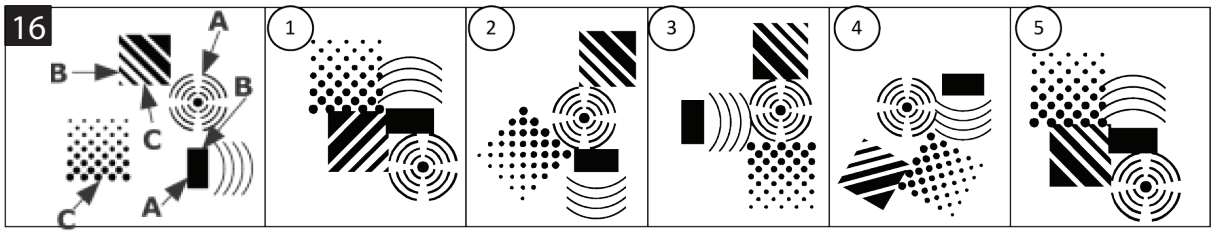
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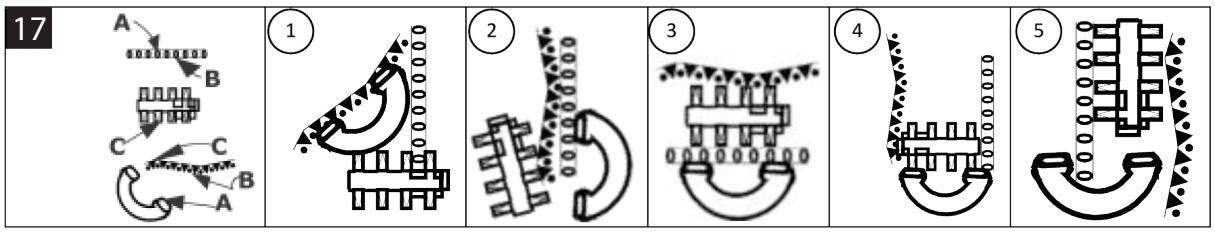
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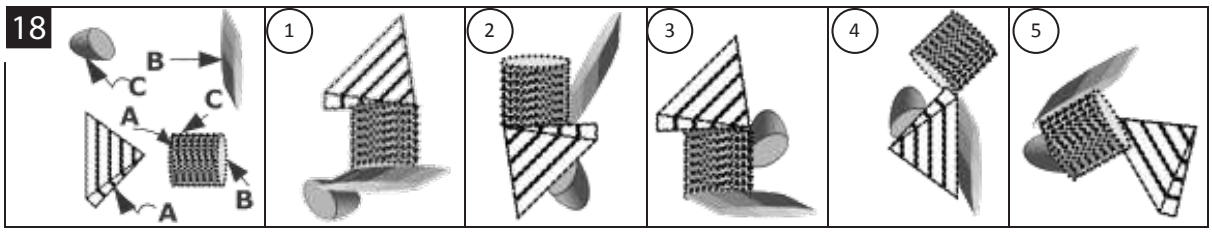
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Name:_____ Date:_____

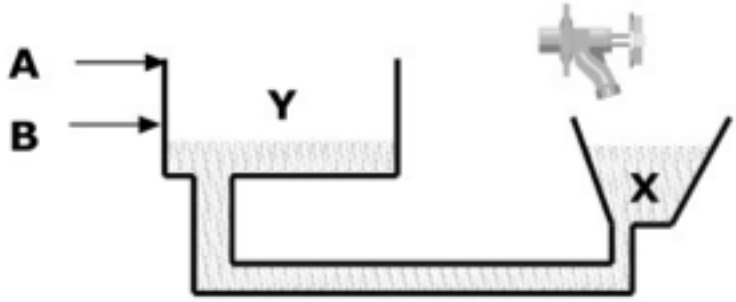
MECHANICAL CONCEPTS TEST PART I

The Mechanical Concepts selection test measures a candidate's ability to understand mechanical principles. Each question contains a pictorial description of a mechanical situation, a question, and three possible answers.

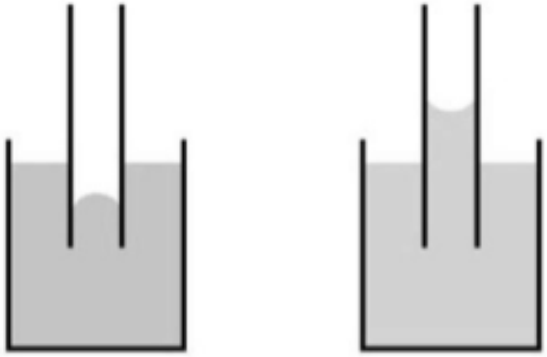
Directions

This is a test of your ability to understand mechanical concepts. Each question has a picture, a question, and three possible answers. Read each question carefully, study the picture, and decide which answer is correct. This test has 26 questions and should take you **13 minutes** to complete.

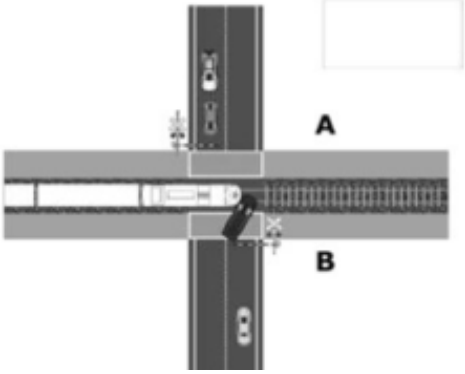
1. The spigot (faucet) shown is turned on, allowing a slight trickle of water to begin filling Tank X. Tank X connects to Tank Y with the piping as shown. The faucet is allowed to stay on until the water completely fills to the top of Tank X. By the time the water reaches the top of Tank X, will the water level in Tank Y be closer to level A or B? (If either are a possibility, mark C.)



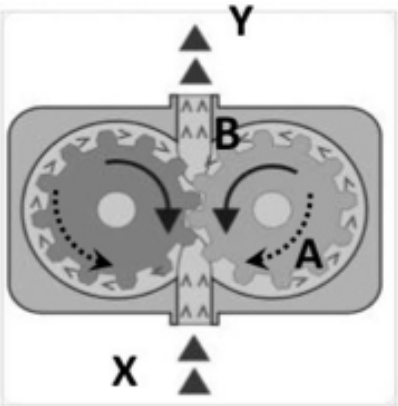
2. In each picture shown, a liquid fills a container that has a tube in the middle. If the containers and their tubes are the same size, with the same volume of liquid placed in each, and the containers are both at sea level, which container (A or B) is more likely to be holding water? (If equal, mark C.)



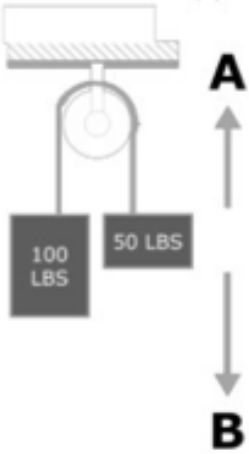
3. When the train hits a stalled car, would it be safer to stand at location A or B to avoid being hit by the car if it moves? Assume the train remains on the track after the collision. (If equal, mark C.)



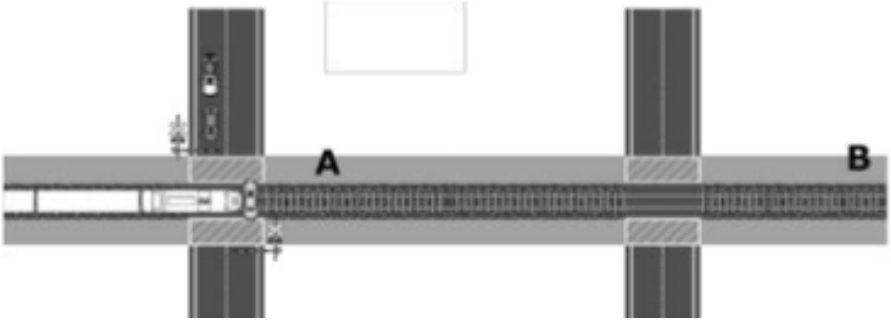
4. Fluid enters the pump in the direction of the arrowheads at position X. Should the internal gears of the pump turn in the direction of the dotted arrows (A) or the solid arrows (B) in order for the liquid to leave the pump at Y? (If either direction will work, mark C.)



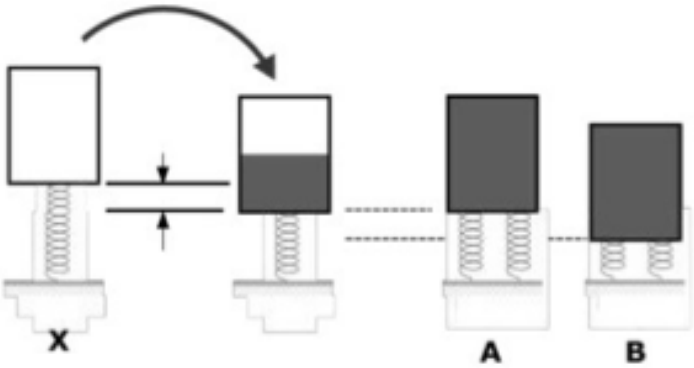
5. Given the pulley loaded as shown, will the 50-pound load accelerate toward A or B? (If neither applies, mark C.)



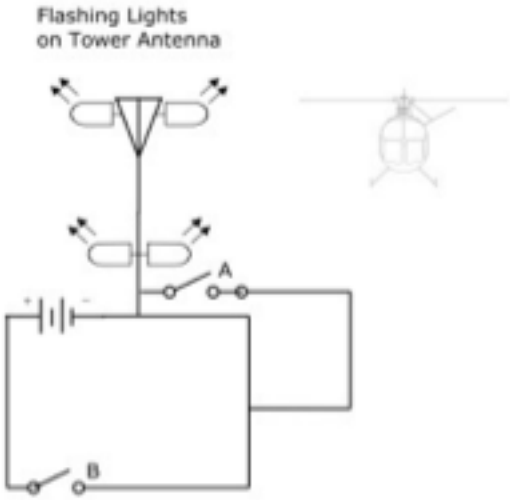
6. As the train hits the stalled car, the train's brakes fail. By crashing into the car, will the train more likely slow to a stop closer to A or B? (If equal, mark C.)



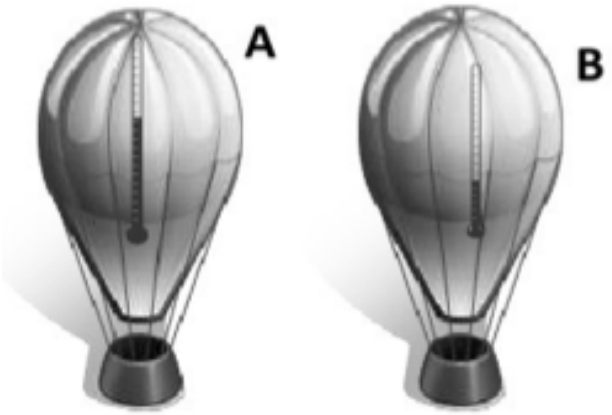
7. A spring supports Tank X. When Tank X fills half-full, the spring compresses as shown. If a second spring is added and the tank is filled completely, will the springs compress as shown in A or B? (If equal, mark C.)



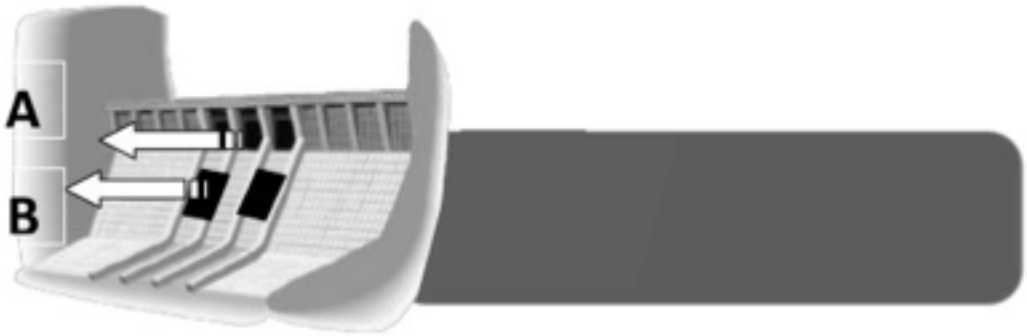
8. Does closing the switch at A or B enable the lights on the antenna to flash and warn the helicopter? (If neither or both, mark C.)



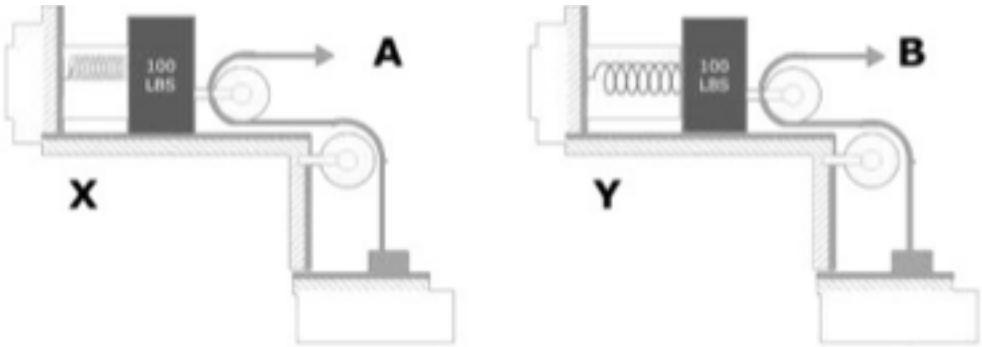
9. For each hot air balloon shown, the thermometer displays the temperature inside the balloon. Which balloon will gain altitude more quickly, A or B? (If equal, mark C.)



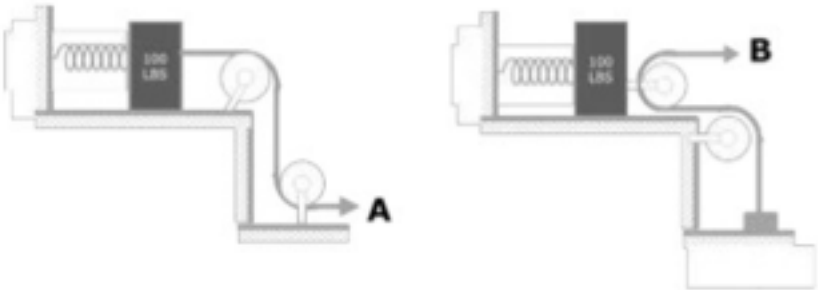
10. The dam releases water through its gates. Will water released at level A or level B jet out with less velocity? (If equal, mark C.)



11. In picture X, a 100-pound mass compresses a coil spring, while the mass attaches to Pulley A. In picture Y, a coil spring is at rest, not compressed and not stretched, but attaches to a 100-pound weight that connects to Pulley B. If Pulley A operates upon release of the spring, will it typically be easier to move the 100-pound block to the right with Pulley A or Pulley B? (If equal, mark C.)

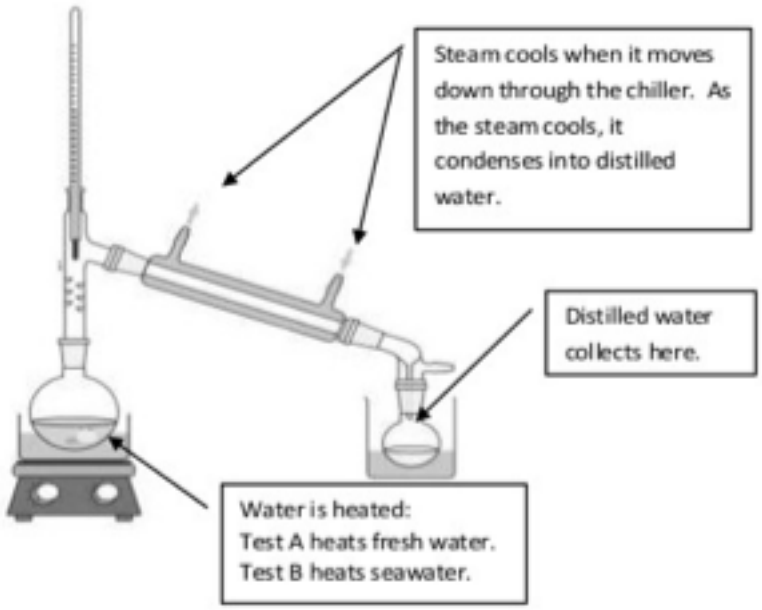


12. Is more force required at A or B to move the 100-pound weight to the right? (If equal, mark C.)

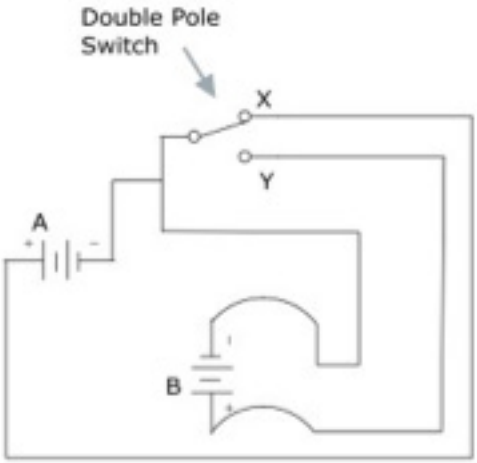


13. The top sprocket gear moves in the direction shown. Will this movement cause the bottom sprocket gear to move counterclockwise toward A, or clockwise toward B? (If the sprocket gear does not move, mark C.)

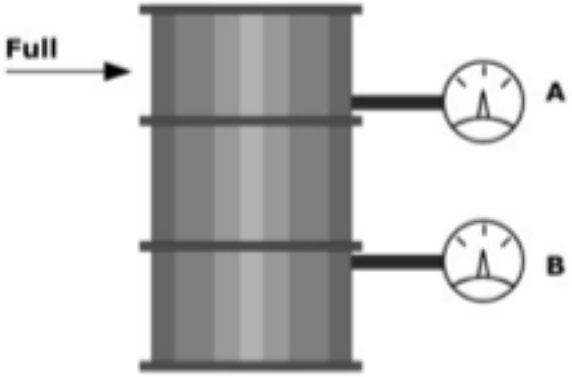
14. Water heats in the beaker until fully evaporated. Steam moves up the vertical tube and then out through the inclined chiller tube toward the beaker. As the steam moves through the chiller tube, it condenses into distilled water. Test A is one case and uses freshwater. Test B is the second case and uses seawater. Which test will produce more distilled water, Test A or B? (If equal, mark C.)



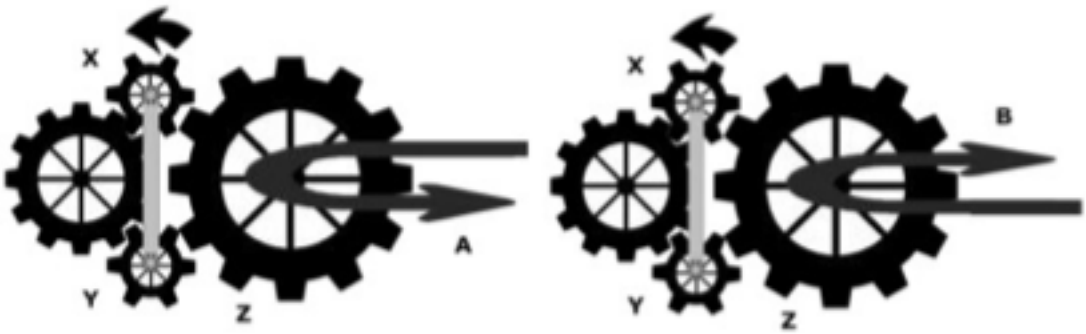
15. Does battery A or battery B power the double pole switch when it is closed to position X? (If either battery powers the switch when it is in position X, mark C.)



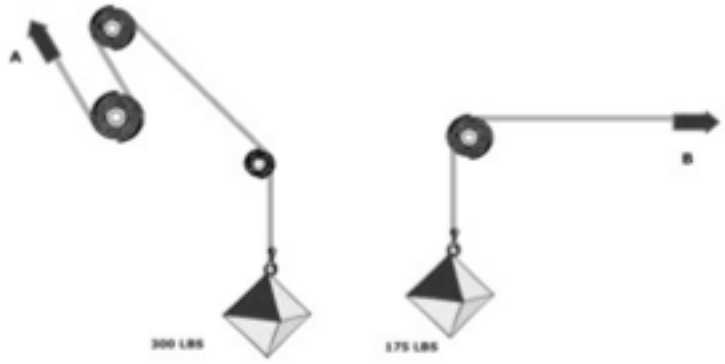
16. Assuming the liquid in the container is level with the Full line and pressure readings are taken when the container is full, will the gauge read a higher pressure at A or B? (If equal, mark C.)



17. The pair of gears X and Y both move in the direction of the arrow (counter-clockwise). When gears X and Y are in motion, will the pulley powered by gear Z move in direction A or B? (If either direction could result, mark C.)

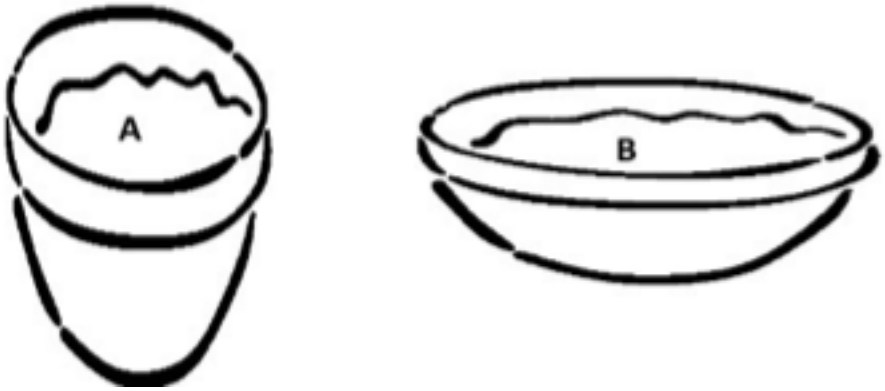


18. Will a motor pulling at point A or at point B require more work to lift the load? In both cases, the pulleys do not move with the load. (If equal, mark C.)

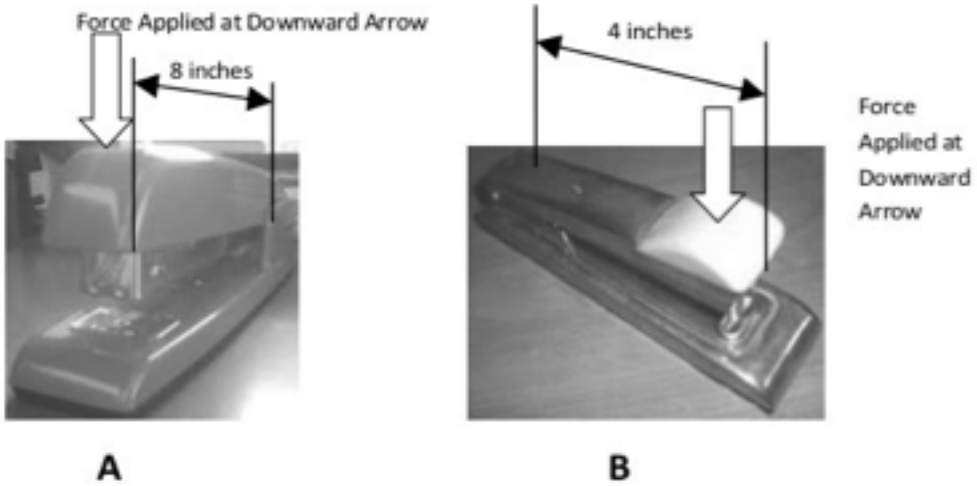


19. A bottle is sealed and then transported from location A to B. At location B, the bottle begins to collapse. Is the altitude higher at location A or location B? (If equal, mark C.)

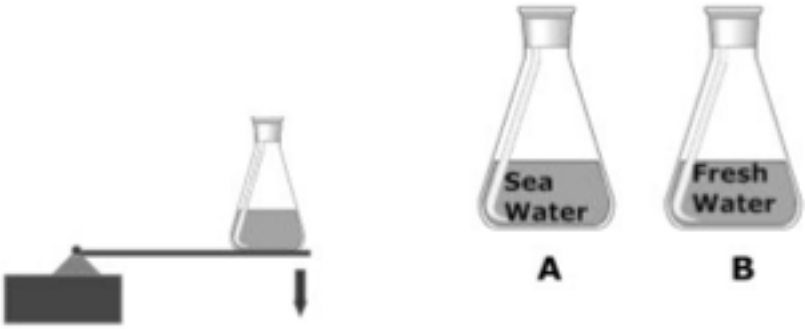
20. Bowls A and B contain the same volume of the same type of liquid. Assume the temperature of the liquid, the bowl, and the outside temperature are all the same. If so, from which bowl will evaporation occur more quickly, A or B? (If equal, mark C.)



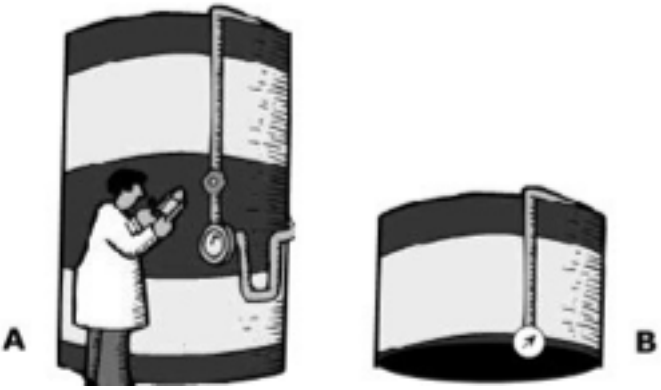
21. Each of the two staples is used to staple together a stack of 20 pages. Stapler A has a greater distance between its open jaw and its pivot point (as shown by the dimension line). Stapler B has a smaller distance between its open jaw and its pivot point (as shown by the dimension line). Which stapler, A or B, will require greater force applied to staple the papers, if the force is applied as shown? (If equal, mark C.)



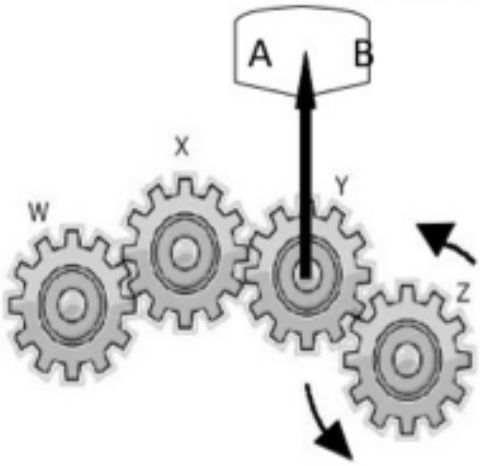
22. A flask containing water is loaded onto the lever at the position shown. If the type of water is seawater (A) or freshwater (B), which flask moves the end of the lever farther down? (If equal, mark C.)



23. Tank A holds exactly twice the volume of Tank B. Both tanks contain the same type and mass (amount) of gas. For the pressure gauge on each tank to read the same, is the temperature higher in Tank A or Tank B? (If equal, mark C.)

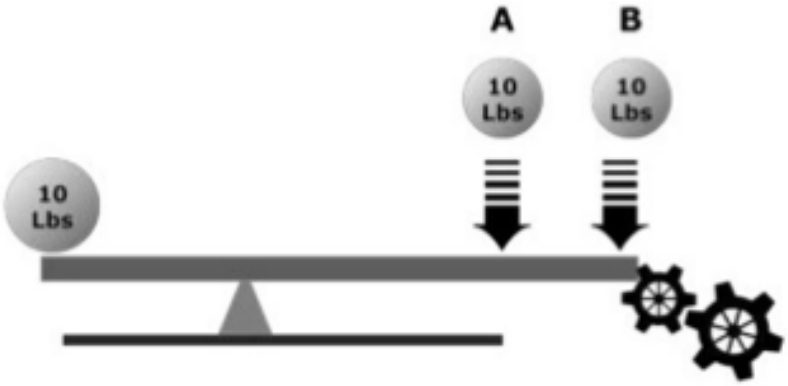


24. Gear Z moves as shown. A gauge pointer attached to Gear Y indicates when it moves and in what direction. When Gear Z rotates counterclockwise, will the gauge pointer attached to Gear Y move toward A or B? (If neither, mark C.)



25. Consider a load applied to each end of the lever in the direction of the arrows shown. Does the load need to be heavier at A or B in order to keep the lever balanced? (If equal loading at each end keeps the lever from moving, mark C.)

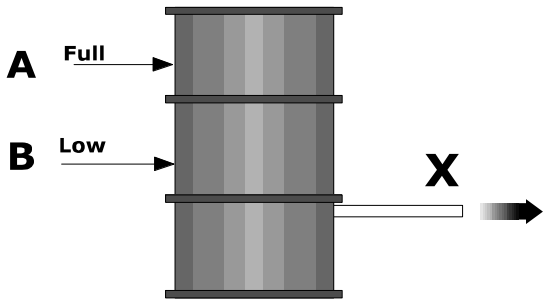
26. If the lever shown is not balanced, it will not make contact with the gears and move them. A 10-pound load sits at the left end. Will placing a 10-pound load at location A or B more likely cause the gears to move? (If equal, mark C.)



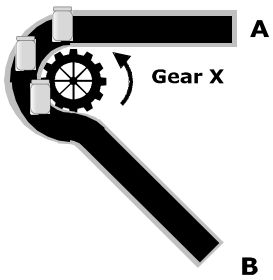
Name:_____ Date:_____

MECHANICAL CONCEPTS PART II

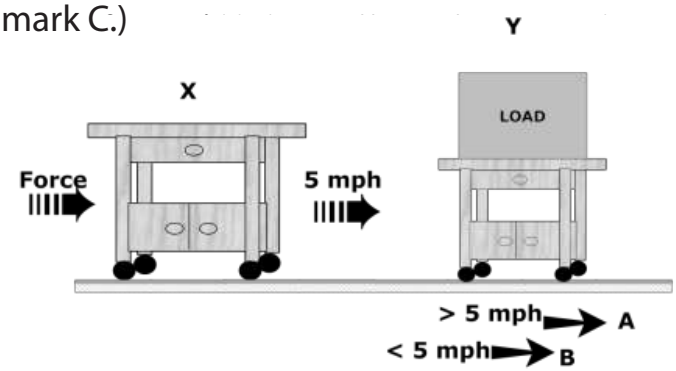
1. The drum of oil is full when filled to level A, and low when filled to level B. When the oil spills out through pipe X, will its flow rate at pipe X's outlet be higher if pipe X was opened when the tank was at A or at B? (If equal, mark C.)



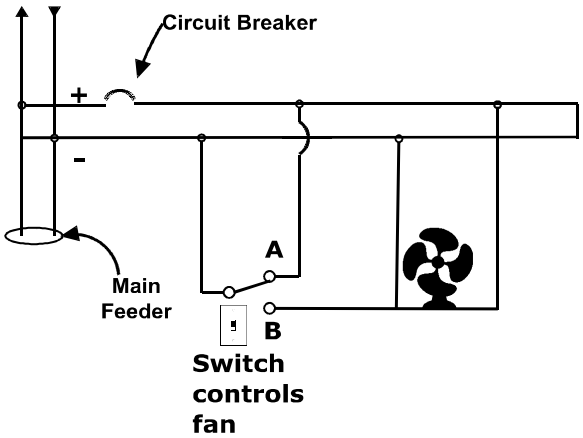
2. When Gear X rotates counterclockwise, the conveyor belt moves the three bottles. Will the bottles travel toward A or B when Gear X rotates? (If either direction is possible, mark C.)



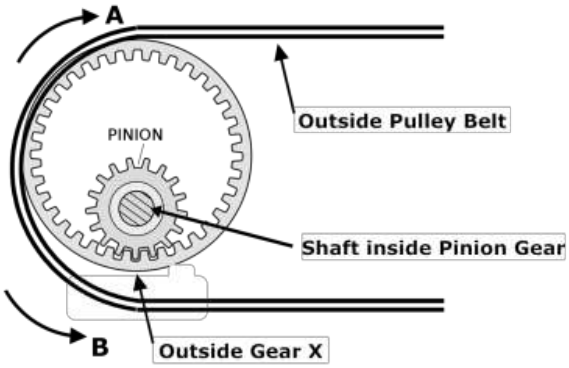
3. Cart X is not loaded and has a mass of 50 pounds. Cart Y is loaded and with its load it weighs 100 pounds. Cart X is given a hard push so that it moves toward Cart Y at a steady 5 mph. After Cart X hits the stationary Cart Y, will its velocity be greater than its original velocity (A) or less than its original velocity (B)? (If neither applies or is possible, mark C.)



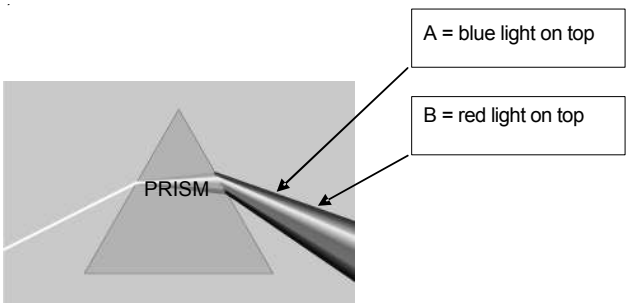
4. Does the switch controlling the fan need to be closed at A or B for the fan to work? (If either, mark C.)



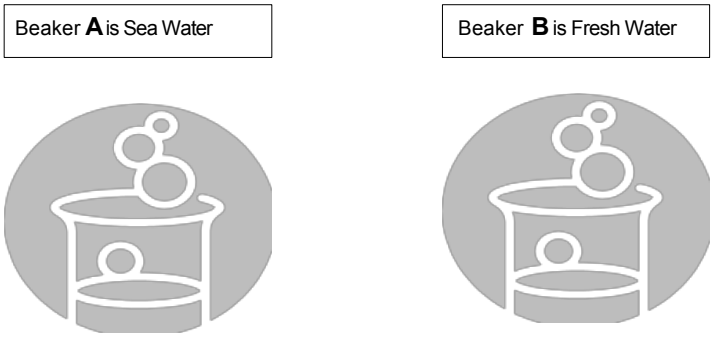
5. When the shaft inside the pinion gear moves clockwise, will the outside pulley belt rotate toward A or B? (If either is possible, mark C.)



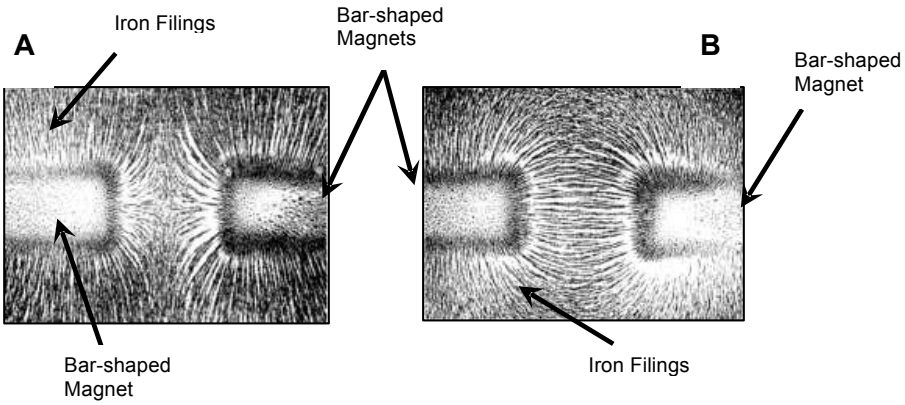
6. A white laser beam is directed toward the prism. As the beam refracts through the prism, the light exiting the prism displays a rainbow of color, including red and blue. Will light exiting the prism be blue on top of the rainbow (A) or red on top of the rainbow (B)? (If either is a possibility, mark C.)



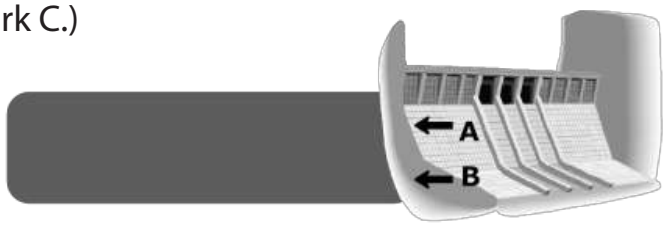
7. Given the same conditions, which beaker will evaporate more quickly over time, A or B? (If equal, mark C.) Beaker A is seawater; beaker B is freshwater.



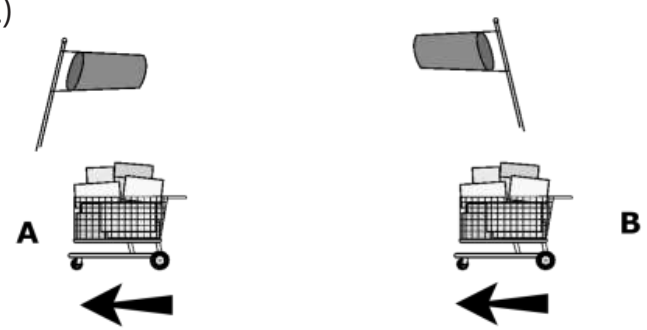
8. The pictures show how iron filings behave when laid over two bar-shaped magnets with ends near each other. The iron filings are shaped as if long, thin needles oriented parallel to the magnetic field lines. In one picture, the magnets are attracted to each other because their opposite poles are close together. In the other picture, the magnets repel each other because their similar poles are close together. From the position of the iron filings in the pictures, which set of magnets has their opposite poles next to each other, A or B? (If both or neither, mark C.)



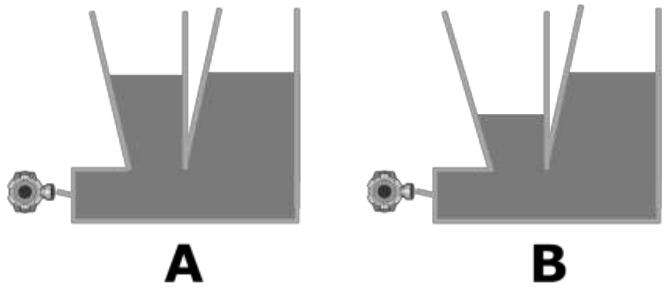
9. If the strength of this dam is based upon the thickness of the material from which it is built, should the dam be thicker at point A (near the top) or point B (near its base) in order to counteract the force of the water behind the dam? (If equal, mark C.)



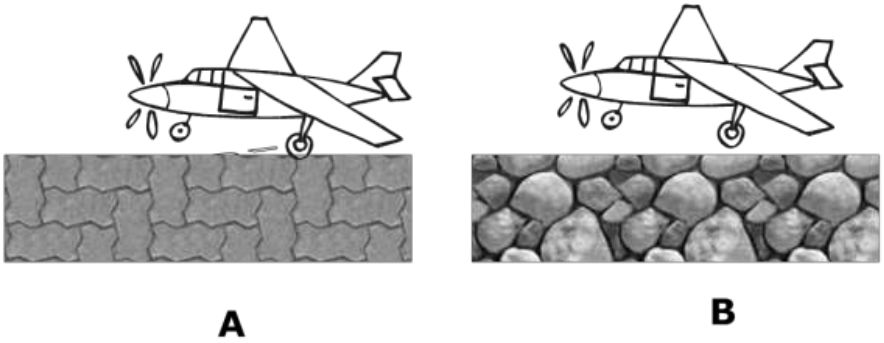
10. Which loaded cart, A or B, will be easier to move in its forward direction? (If equal, mark C.)



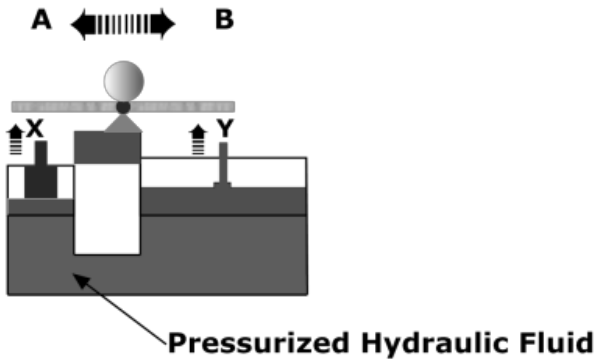
11. The faucet shown fills the container. Does condition A or condition B better represent how the container will fill? (If neither applies, mark C.)



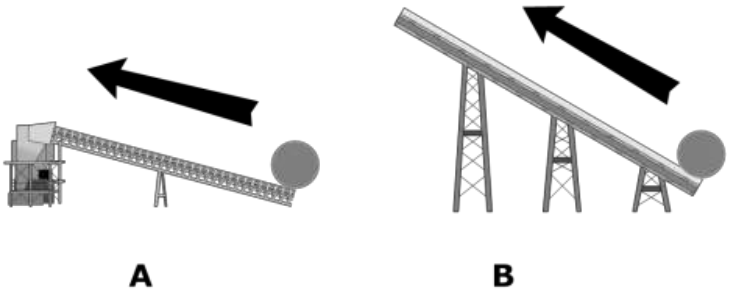
12. Airplanes A and B are the same model, with identical engines, same loaded mass, and same propeller speed. Both are on a level runway. The runway beneath Airplane A is paved. The runway beneath Airplane B is cobblestone. Both airplanes take off at the same time. Which airplane, A or B, is more likely to become airborne first? (If equal, mark C.)



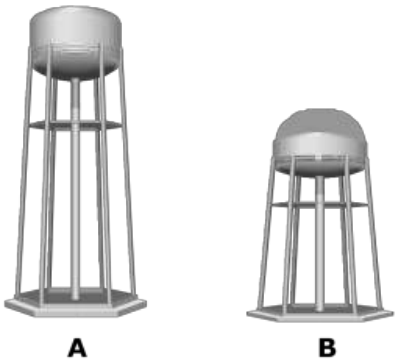
13. Pressurized hydraulic fluid flows freely between the two hydraulic rams X and Y. When the hydraulic rams push upward beneath the lever, it moves. When the lever moves, does the ball resting atop the lever roll toward A or B? (If neither applies, mark C.)



14. Each conveyor belt moves the same load from bottom to top over a total distance of 100 feet. If each conveyor begins at the same time and under the same power, which load will reach the top first? (If equal, mark C.)



15. Water tanks A and B are both installed at sea level with piping to access the water at their base. Which water tank, A or B, will require less power to serve a community at a higher elevation? (If equal, mark C.)



Name:_____ Date:_____

TABLES EXAM
PART I - TABLES

How to Take This Test

These instructions provide an example using the same Table A, shown below:

Table A

Water Analysis of Runoff from 6-3-0 Houactinite Fertilizer Applications in ppm (Parts per Million) for Length of Time

Mineral	Hours		
	2	2.25	2.5
Bicarbonate (HC03)	657.00	655.50	654.00
Boron (B)	0.81	0.82	0.82
Calcium (Ca)	190.00	172.00	154.00

Table A gives you information about the mineral content in water runoff for application of 6-3-0 Houactinite fertilizer (note the title of the table), as measured in ppm (parts per million), for different lengths of time. The conditions are determined by the values in the *first column* on the left side, which shows the type of mineral. The *top row* shows how the mineral content varies depending on the length of time after fertilizer application, as measured in ppm.

For example, to find the mineral calcium (Ca) content in the water runoff after 2.25 hours, read across from calcium (Ca) and down from 2.25. In this case, the calcium (Ca) in the water will be 172 ppm.

Water Analysis of Runoff from 6-3-0 Houactinite Fertilizer Applications in ppm (Parts per Million) for Length of Time

Mineral	Hours		
	2	2.25	2.5
Bicarbonate (HC03)	657.00	6 .50	654.00
Boron (B)	0.81	.82	0.82
Calcium (Ca)	[illegible]	172.00	154.00

Now consider a sample problem that rearranges the information somewhat:

Mineral	Hours	Water Analysis of Runoff from 6-3-0 Houactinite Fertilizer Applications in ppm (Parts per Million) for Length of Time			
		A	B	C	D
Calcium (Ca)	2.5	154.00 ○	657.00 ○	190.00 ○	0.81 ○

The two left-hand columns are Mineral type and the number of Hours. In the row shown, the type of mineral is calcium (Ca) and the number of hours is 2.5. Refer back to the Table A, read across from calcium (Ca) and down from 2.5. See below for how this is done.

Water Analysis of Runoff from 6-3-0 Houactinite Fertilizer Applications in ppm (Parts per Million) for Length of Time

Mineral	Hours		
	2	2.25	2.5
Bicarbonate (HC03)	657.00	655.50	654.[illegible]
Boron (B)	0.81	0.82	0.82
Calcium (Ca)	190.00	172.00	154.00

Now you see that 154.00 is the correct ppm content of calcium (Ca) measured in the water runoff 2.5 hours after application of the 6-3-0 Houactinite fertilizer. Therefore, in this case, you completely fill the circle to the right of 154.00 to show this is the correct answer:

Mineral	Hours	Water Analysis of Runoff from 6-3-0 Houactinite Fertilizer Applications in ppm (Parts per Million) for Length of Time			
		A	B	C	D
Calcium (Ca)	2.5	154.00 ●	657.00 ○	190.00 ○	0.81 ○

BEGIN TEST PART I

Table I is the reference information for the test questions built into the table on the next page. Completing the table on the next page requires looking up 24 sets of information from Table I. The suggested time limit to answer all 24 questions is three (3) minutes. To answer each test question, refer to this table. Select your answer by filling the circle to the right of the answer you choose. Remember, speed AND accuracy are important. Check your work if you have time.

Table I

Mineral	Water Analysis of Runoff from 6-3-0 Houactinite Fertilizer Applications in ppm (Parts per Million) for Length of Time							
	Hours							
	2	2.25	2.5	2.75	3	3.25	3.5	4
Bicarbonate (HC03)	657.00	655.50	654.00	643.50	633.00	622.50	612.00	572.00
Boron (B)	0.81	0.82	0.82	0.81	0.80	0.78	0.77	0.65
Calcium (Ca)	190.00	172.00	154.00	138.25	122.50	106.75	91.00	102.00
Calcium Carbonate (CaC03)	539.00	537.50	536.00	527.50	519.00	510.50	502.00	468.00
Chloride	524.00	495.50	467.00	424.75	382.50	340.25	298.00	298.00
Copper (Cu)	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Iron (Fe)	0.12	0.25	0.37	0.50	0.63	0.76	0.89	1.82
Magnesium (Mg)	33.00	32.00	31.00	28.00	25.00	22.00	19.00	20.00
Manganese (Mn)	0.02	0.08	0.13	0.14	0.15	0.15	0.16	0.41
Nitrate (N)	0.90	0.49	0.08	0.08	0.07	0.07	0.06	0.03
Phosphorous (P)	6.37	6.28	6.19	5.89	5.60	5.30	5.00	4.07
Potassium (K)	181.00	189.00	197.00	179.25	161.50	143.75	126.00	116.00
Sodium (Na)	332.00	315.50	299.00	287.50	276.00	264.50	253.00	237.00
Sulfate	390.00	370.50	351.00	309.75	268.50	227.25	186.00	222.00
Total Dissolved Salts (TDS)	2315.00	2236.00	2157.00	2015.50	1874.00	1732.50	1591.00	1571.00
Zinc (Zn)	0.05	0.04	0.02	0.02	0.02	0.01	0.01	0.02

Test Questions

Mineral	Hours	Water Analysis of Runoff from 6-3-0 Houactinite Fertilizer Applications in ppm (Parts per Million) for Length of Time			
		A	B	C	D
Sodium (Na)	4	190.00 ○	237.00 ○	1571.00 ○	0.02 ○
Phosphorous (P)	3.25	0.07 ○	268.50 ○	298.00 ○	5.30 ○
Magnesium (Mg)	2.75	28.00 ○	237.00 ○	0.63 ○	655.50 ○
Calcium Carbonate	3.5	502.00 ○	116.00 ○	189.00 ○	2015.50 ○
Boron (B)	2.25	0.02 ○	0.49 ○	0.41 ○	0.82 ○
Total Dissolved Salts	3.5	622.50 ○	1591.00 ○	0.14 ○	0.37 ○
Manganese (Mn)	2.25	0.08 ○	0.81 ○	572.00 ○	1591.00 ○
Magnesium (Mg)	4	0.04 ○	0.89 ○	20.00 ○	122.50 ○
Nitrate (N)	2.5	33.00 ○	0.01 ○	264.50 ○	0.08 ○
Boron (B)	4	0.01 ○	0.65 ○	527.50 ○	519.00 ○
Zinc (Zn)	2.5	536.00 ○	351.00 ○	0.02 ○	0.81 ○
Calcium (Ca)	3.25	106.75 ○	264.50 ○	222.00 ○	0.04 ○
Bicarbonate (HC03)	2.75	268.50 ○	181.00 ○	6.19 ○	643.50 ○
Calcium Carbonate	4	309.75 ○	495.50 ○	468.00 ○	0.02 ○
Iron (Fe)	2.5	0.37 ○	0.05 ○	33.00 ○	0.01 ○
Chloride	2.25	0.49 ○	2015.50 ○	495.50 ○	0.82 ○
Boron (B)	3	0.89 ○	643.50 ○	0.80 ○	2157.00 ○
Chloride	2.75	19.00 ○	0.65 ○	0.77 ○	424.75 ○
Potassium (K)	2.25	572.00 ○	22.00 ○	0.02 ○	189.00 ○
Copper (Cu)	3	0.02 ○	0.15 ○	315.50 ○	468.00 ○
Iron (Fe)	3.25	524.00 ○	0.76 ○	0.01 ○	0.02 ○
Chloride	3.5	25.00 ○	0.13 ○	332.00 ○	298.00 ○
Copper (Cu)	2.75	0.02 ○	0.80 ○	0.01 ○	0.76 ○
Sodium (Na)	3.5	0.07 ○	5.89 ○	253.00 ○	264.50 ○

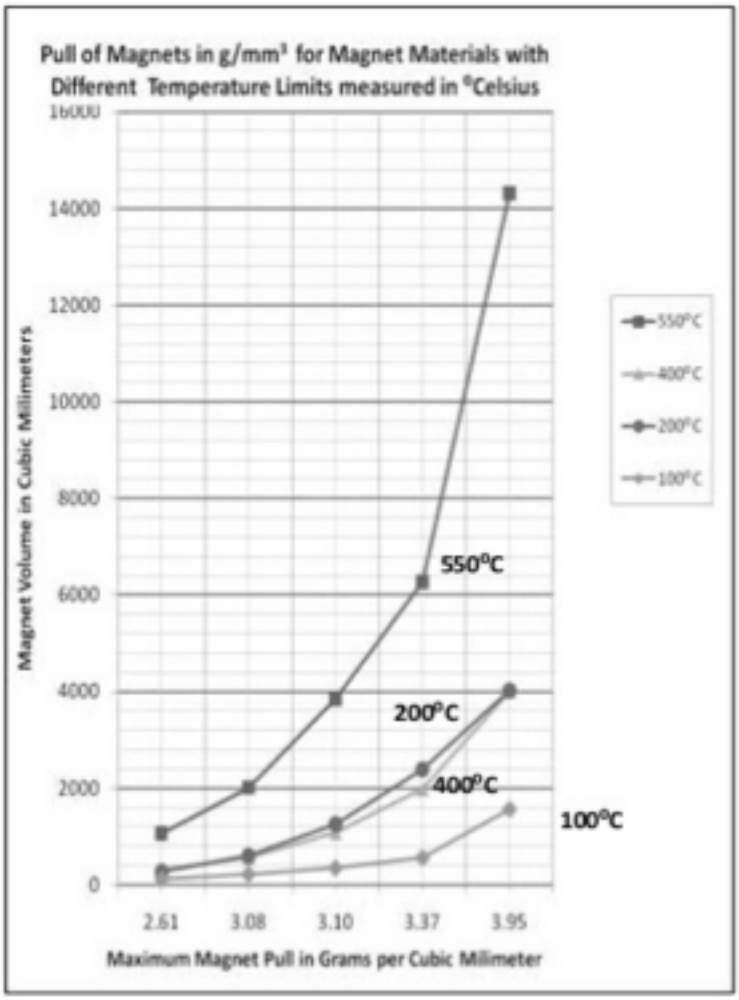
PART II – GRAPHS

How to Take This Test

These instructions provide an example using the sample graph, below, titled "Pull of Magnets in g/mm^3 for Magnet Materials with Different Temperature Limits measured in °Celsius." The size of the magnet differs depending on the line read on the graph. In this graph example, there are four possible magnets with different temperature limits:

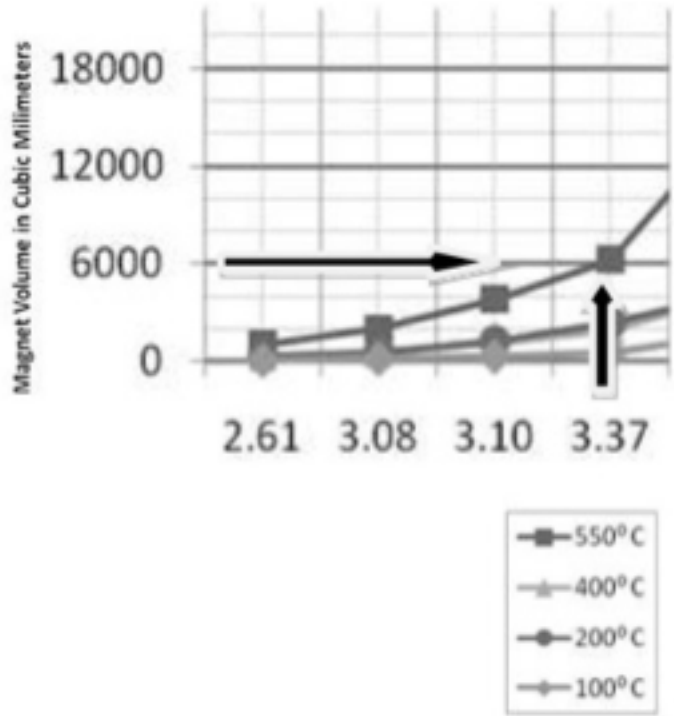
- 550°C shown by a line with square marks
- 400°C shown by a line with triangular marks
- 200°C shown by a line with dot marks
- 100°C shown by a line with diamond marks

Each magnet material has a temperature limit that dictates its size; i.e., "volume in mm^3" for a given strength, or maximum pull, as measured in grams per mm^3. The test evaluates your ability to read the graph and select correct values for two types of tables. Examples begin on the next page.



For the first table type, consider this example:

A magnet size of 6000 mm^3 and maximum strength, or pull, of 3.37 grams per mm^3 match at the line with the square marks. Read across from 6000 and up from 3.37. In this case, the type of magnet material yielding 3.37 grams/mm^3 pull when sized at 6000 mm^3 is the one limited to a temperature of 550°C.



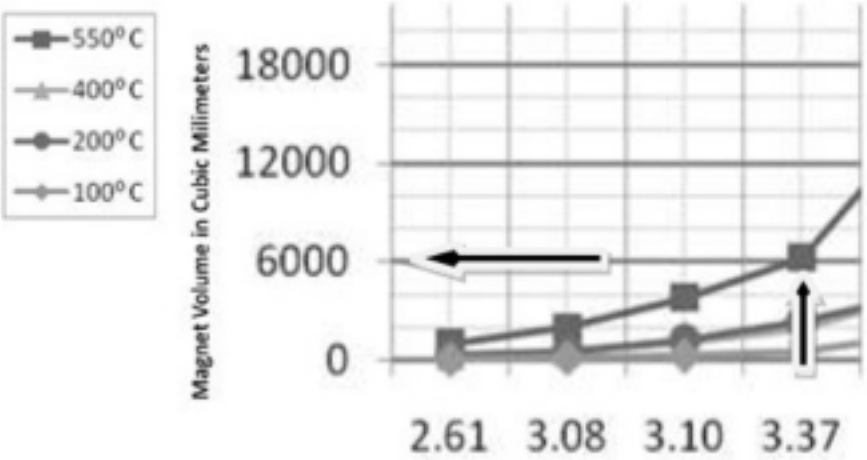
As you can see, the answer for **550°C** has been darkened.

Magnet Size in mm^3	Max Magnet Pull in g/mm^3	100°C	200°C	400°C	550°C
6000	3.37	○	○	○	●

For the second table type, consider this example that rearranges the information somewhat:

The two left-hand columns on the table are Maximum Magnet Pull in grams per cubic millimeter and Temperature Limit for Type of Magnet in degrees Celsius. In the row shown, the Maximum Magnet Pull in grams per cubic millimeters is 3.37 and the Temperature Limit for Type of Magnet in degrees Celsius is 550°C. Refer back to the graph and read up from 3.37 until the line representing the magnet limited to 550°C is intersected. From the point of the intersection, follow the horizontal line to the left to read the size of the magnet in cubic millimeters. Note that each horizontal line marks 2000 mm^3.

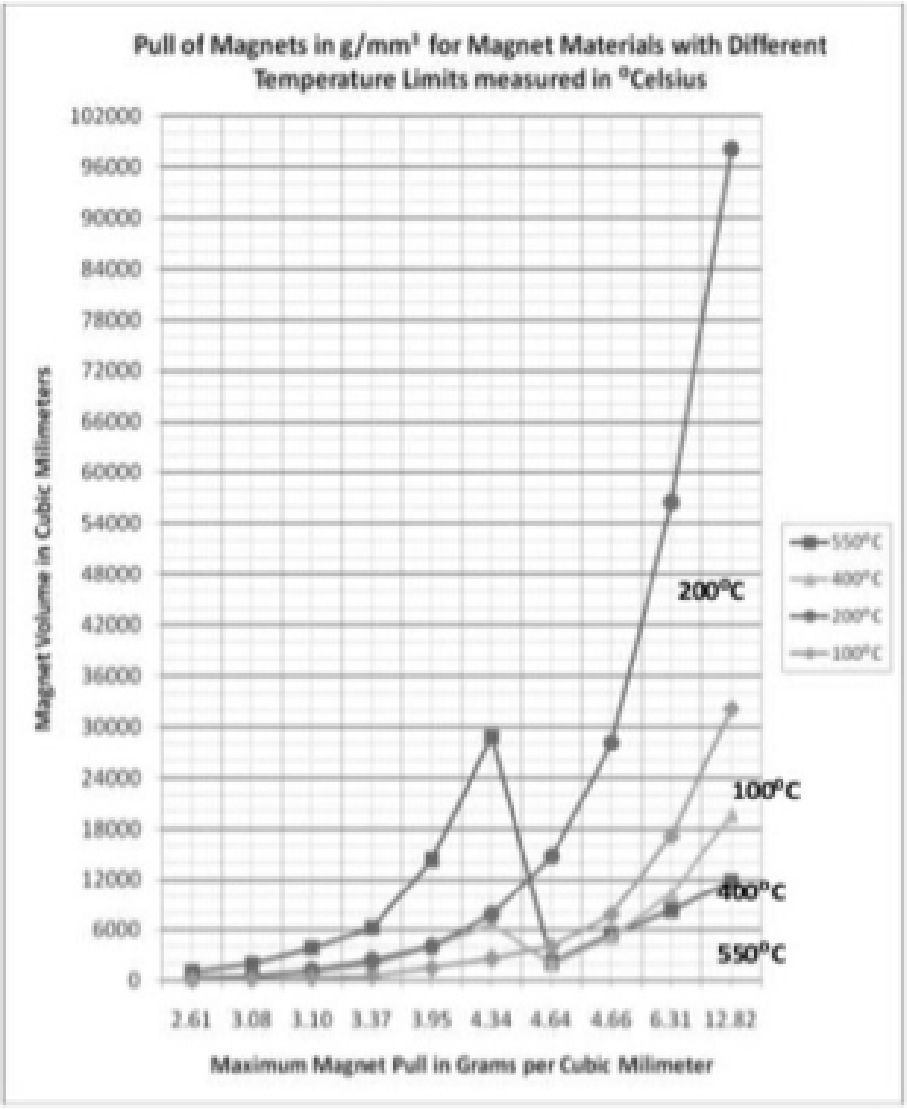
As you can see, the answer for **6000 mm^3** has been darkened.



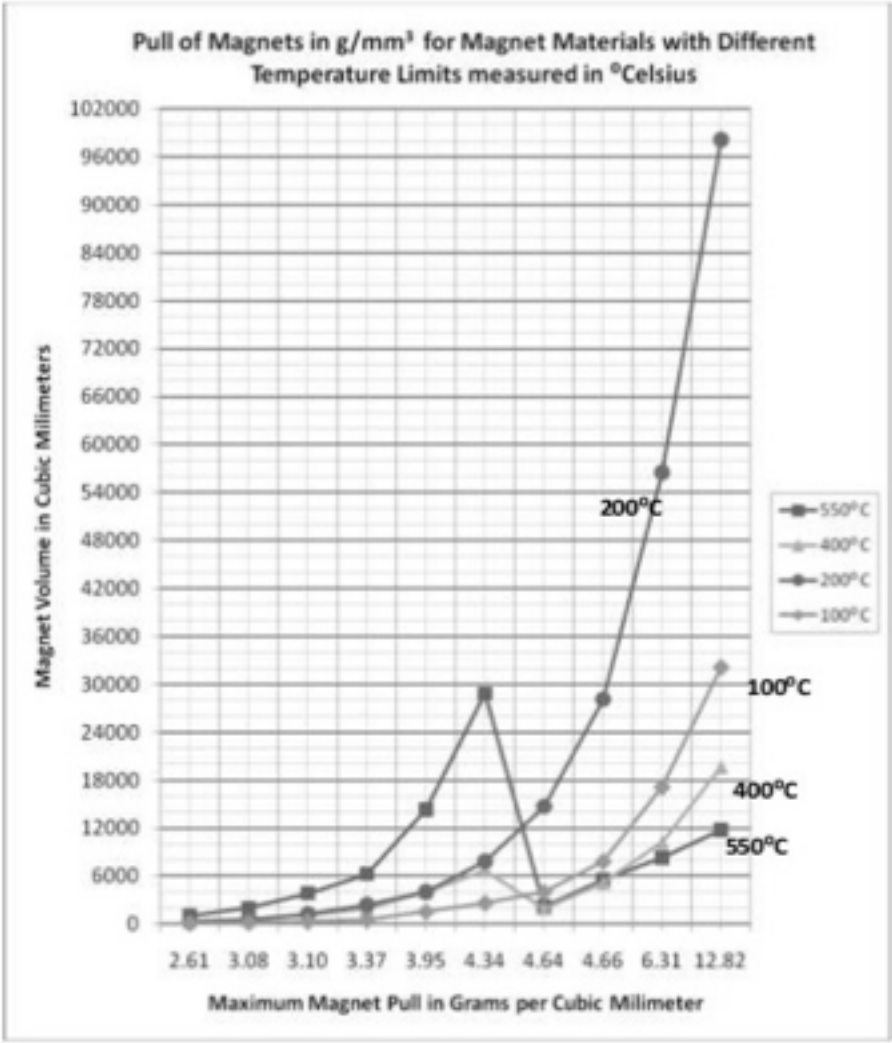
Maximum Magnet Pull in g/mm^3	Temperature Limit for Type of Magnet in °C	Magnet Volume in mm^3				
3.37	550°C	6000 ●	10250 ○	4000 ○	17250 ○	3000 ○

BEGIN TEST PART II

The graphs shown on the next two pages are your source for answering 14 test questions in the two following tables. Complete each question on each table by looking up information from the graph. Try to limit yourself to no more than two (2) minutes total. Fill the circle to the right of your answer choice. Speed AND accuracy are important, so check your work if you have time.



Magnet Size in mm^3	Max Magnet Pull in g/mm^3	100°C	200°C	400°C	550°C
56520	6.31	○	○	○	○
4000	3.10	○	○	○	○
14300	3.95	○	○	○	○
17000	6.31	○	○	○	○
32000	12.82	○	○	○	○
14750	4.64	○	○	○	○
19750	12.82	○	○	○	○



Maximum Magnet Pull in g/mm³	Temperature Limit for Type of Magnet in °C	Magnet Volume in mm³				
3.08	550°C	98250 ○	10250 ○	2000 ○	17250 ○	500 ○
4.34	100°C	2750 ○	3750 ○	2600 ○	98250 ○	2000 ○
3.95	550°C	14000 ○	56500 ○	17250 ○	2000 ○	8250 ○
12.82	400°C	500 ○	2500 ○	6750 ○	14500 ○	19625 ○
3.37	400°C	1000 ○	56500 ○	500 ○	2000 ○	6250 ○
2.61	100°C	0 ○	1500 ○	2250 ○	8250 ○	56500 ○
4.66	200°C	2000 ○	28250 ○	1250 ○	2000 ○	32250 ○

Name:_____ Date:_____

READING COMPREHENSION

The Reading Comprehension selection test measures a candidate's ability to read and understand written materials. The test consists of three reading passages, each followed by several multiple-choice questions about the passage.

This practice test is similar in content and structure to the real selection test. We recommend that you time yourself while taking the practice test to get a feel for how much time you will have to complete the real selection test. It may be to your advantage to complete all practice test questions. Answers and explanations for the practice test questions will be provided by the instructor at the end of the practice test. You should consult these answers only after completing all the practice test questions.

Directions

This is a test of your ability to read and understand written materials. This practice test includes three passages, each followed by questions about the passage. You are to read each passage and then answer the corresponding questions.

All questions should be answered based strictly on the information presented in the passage. Do not answer on the basis of experiences you have had, or any information not specifically presented in the passage. To do so might result in choosing an incorrect answer.

For each question, select the best answer from the choices given. Answer all the questions regarding one passage before moving on to the next. You may look back at the passage while you answer the questions. This practice test has 27 questions and should take you 27 minutes to complete.

PASSAGE 1: ELECTRIC POWER GENERATION

Most electricity is generated by electromechanical generators that are driven by mechanical energy forces. The most common electricity generation mechanical force source is what is referred to as a "steam-electric cycle." Water (in liquid form) is heated in a furnace to produce steam. Steam rushes past the windmill (fan blades of a turbine) connected by a driveshaft to an electricity generator. It is the mechanical force of the steam that rotates the turbines.

The simplest form of a boiler could be a tea kettle. When a tea kettle is placed over a source of heat, the water inside the kettle begins to boil and steam is discharged from the spout. Steam, like controlled wind, can be used to turn blades on a shaft to generate electricity to illuminate a light bulb. Blades turned by steam are the basic principle on which steam power plants operate. The actual equipment in a steam power plant is much more sophisticated, yet the principle remains the same.

A boiler is defined simply as a large vessel enclosed by an assembly of metal tubing in which water is heated and steam is generated and superheated under pressure by the application of additional heat. Although this definition lends itself to a wide interpretation concerning boiler design, the primary purpose remains the same—that of converting water to steam. The boiler must be constructed and operated to separate the vapor phase (steam) in an effective manner from the liquid phase (water). The three basic functions of the boiler are pressure containment, heat transfer, and steam separation.

Typically, a fuel source ignites as it enters the furnace and the heat of the combustion transfers to the water that circulates through the metal tubing in the boiler. This water leaves the boiler as superheated steam, at about 1,000 degrees Fahrenheit, which passes through a turbine and rotates the turbine's fan blades.

The superheated steam from the boiler enters the first stage (high pressure) and goes through a nozzle into the second stage (intermediate pressure). From the second

stage, the steam goes through another nozzle into the third stage (low pressure). As the steam goes through the three stages, it continues to lose temperature and pressure and to expand until it is exhausted from the third stage. This example is a better method for turning the shaft and generator than the simple windmill as describe earlier.

Chemical energy in the form of fuel is converted to heat energy in the form of high temperature-high pressure steam. The steam turns a turbine, thereby converting the heat energy into rotating mechanical energy. The turbine rotor is connected to the rotor of the main power generator. As the turbine rotor turns, so turns the rotor of the generator. The generator rotor is made to produce a magnetic field. The action of the rotating magnetic field changes the mechanical energy into electrical energy, which is sent to the transmission system. Electrical energy is the end product for which the power plant is built.

The power plant main generators produce electrical power, which is conveyed to the transmission system along with electricity produced by the other main generators on the utility's system. Other smaller-sized generators perform other functions in the subsystems with the plant. These subsystems provide the support necessary to control, operate, and maintain the energy conversion processes of the plant.

Answer questions 1-9 based on information presented in Passage 1.

1. Which of the following is NOT a basic function of the boiler?

A. Heat transfer
B. Steam separation
C. Pressure relief valve
D. Pressure containment

2. What happens to the superheated steam?

A. Can be piped to buildings for heating
B. Expands when passing through the turbine
C. It is drier and less likely to condense in the turbine
D. Passes through a turbine and rotates the turbine blades

3. **The power plant main generators produce electrical power. Where is the electrical power sent?**
   A. Transported to subtransmission interconnection switching station
   B. Transported to the transmission system
   C. Conveyed to the subtransmission station
   D. Collected at the substation

4. **What is a vessel in which water is heated and steam is generated?**
   A. Simple boiler
   B. Boiler reactor
   C. Boiler turbine
   D. Boiler generator

5. **What is the simplest form of a boiler?**
   A. Steel box
   B. Tea kettle
   C. Stoker fired furnace
   D. Coal-burning steam boiler

6. **Which of the following is NOT a characteristic of a simple three-stage turbine?**
   A. Loss of pressure
   B. Loss of temperature
   C. Expands until exhausted
   D. Separates the vapor phase

7. **What is the action of a rotating magnetic field?**
   A. Convert all of the input into useful power
   B. Change the mechanical energy into electrical energy
   C. Produce induces current in the armature winding of the stator
   D. Move current when conductors are connected to an external load

8. What type of energy is produced by steam turning a turbine?

A. Mechanical energy
B. Chemical energy
C. Electrical energy
D. Steam energy

9. What is the most common electricity generation mechanical force source?

A. A large vessel enclosed by metal tubing
B. Enclose the fire in a steel box
C. Steam-electrical cycle
D. Coal-burning steam boilers

PASSAGE 2: TRANSMISSION SYSTEM OVERVIEW

Electric power transmission, also referred to as high voltage electric transmission, can be defined as the bulk transfer of electrical energy from power generation plants to substations. The transfer of electrical energy from substations to the customer is referred to as distribution.

Transmission serves two main purposes: to transfer electricity from generation plants and to interconnect various systems. This interconnection of transmission lines is often referred to as the electrical power grid or, simply, "the grid." Most of the power generated in the station passes through the generating plant switchyard to the transmission system.

About 5-8% of the generated power is used within the plant to operate the equipment necessary to run the plant. The switchyard contains all the equipment necessary to transform and route power (buses, circuit breakers, disconnects, transformers, protective relays, monitoring and controlling devices, and insulators and supporting structures), which together move the power from the generator to the transmission system transformers. A bus is a specially designed conductor having low resistance. The switchyard also houses protective relays, monitoring and controlling devices, and insulators and supporting structures, which move the power from the transmission system to the distribution system.

The electric power transmission process is complex when moving electricity through the transmission system. Electricity produced by power generation plants is first routed to substations at or near the plant. These substations use transformers to "step up" the voltage of electricity in preparation of the movement through the transmission lines from one point to another with a minimum loss of electrical energy. Required voltage levels depend on the distance that electricity must travel though the transmission system. Electricity then exits from the transmission system to be further distributed for consumer use at substations where the electricity must go through another transformer to "step down" the voltage to a lower level.

The principle of electric power transmission uses two main types of currents used in electricity applications: direct current (DC) and alternating current (AC). In DC, an electric charge flows in one direction. In AC, an electric charge flows back and forth, rapidly reversing direction many times each second. Whether AC or DC current is used in an electrical application often depends on the type of voltage source.

An AC voltage source reverses the positive and negative terminals many times per second. In the majority of AC circuits, the voltages and currents cycle at a rate of 60 times per second. This cycling is called the frequency. Frequency is measured in cycles per second or hertz (Hz). Commercial power generation companies in the United States utilize a 60-hertz current.

AC transmission lines typically carry a three-phase current, and the voltage varies depending on the particular system or grid. DC transmission towers typically only carry lines in pairs, one positive current and one negative current.

Answer questions 10-18 based on information presented in Passage 2.

10. What type of current is only carried in pairs, one positive current and one negative current, on transmission towers?

A. AC
B. DC
C. HVAC
D. HVDC

11. What is frequency measured in?

A. Reduces voltage between the source and load
B. Measures electrical current waveforms
C. The flow of alternating current
D. Cycles per second

12. Which of the following is the characteristic of DC current as it flows through the electric power transmission lines?

A. Less expensive
B. Lower electrical loss
C. Electric charge flows in one direction
D. Allows large amounts of power over greater distances

13. After entering the substation, what must happen to the electricity before it is distributed for consumer use?

A. Step down the voltage to a lower level
B. Force current through a conductor
C. Adjust voltages for the power grid
D. Decrease energy for delivery

14. What is the purpose of stepping up the electricity voltage?

A. Deliver at required voltage
B. To meet the customer's needs
C. Minimize loss of electrical energy
D. Reduce the resistance in a conductor

15. What is a specially designed conductor having low resistance?

A. Wire
B. Bus
C. Cable
D. Power line

16. What is contained in the switchyard?

A. The equipment necessary to transform and route power
B. Facility increase overall delivery system reliability
C. Facilities for monitoring the system operation
D. Detects abnormalities

17. According to the text, the interconnection of transmission lines is referred to as:

A. Electrical substation switchyard
B. Electrical subtransmission substation
C. Electrical power grid or, simply, "the grid"
D. Electrical generating plant switchyard

18. What is the definition for the term "distribution"?

A. Electric power transmission between substations
B. The transfer of electrical energy from the substation to the customer
C. The transfer of transmission system power to the distant substations
D. The transfer of the interconnection system to the electric power grid

PASSAGE 3: DISTRIBUTION SYSTEM OVERVIEW

The voltages that are required for bulk electricity transmission are too high for most consumer applications. Lower voltage levels are required for electricity to flow safely through smaller cables and distribution lines. At transmission interconnection intervals such as substations, some of the electrical energy is tapped off of the transmission lines. These substations step the voltage down to lower voltage levels with large power transformers.

Substations are interconnected and dispersed among high-voltage transmission lines and distribution lines. They typically consist of one or more power-transformer banks that contain multiple transformers. These transformers are electrical devices that change the alternating current of one voltage to another voltage. A step-down transformer has more turns in the primary winding than in the secondary winding. Voltages are higher in the primary circuit than in the secondary circuit.

These substations vary in size depending on the system they are servicing. Most substations are constructed in an area where the vegetation has been removed, and the lot is filled with gravel and is fenced and gated for safety and security.

Substations are interconnected to the transmission system and distribution system by two methods:

- High-voltage transmission circuits carrying 138 kV or 230 kV directly step down voltage to distribution connections carrying 13 kV.

- High-voltage transmission, circuit-supplying switching stations step down voltages to a subtransmission voltage level commonly in the range of 26 to 34 kV. The subtransmission circuit's voltage level can easily be routed along public streets on wood poles or through underground cables to industrial, commercial, and utility substations. These subtransmission-supplied substations provide system monitoring and control for distribution circuits in the 4 and 13 kV range.

Some customers need higher voltage levels than what is typically provided from a residential distribution circuit but do not need voltages that are high enough to warrant a direct connection to the transmission system. These high-use customers are serviced by special distribution connections at voltages ranging from 7.2 kV to 14.4 kV through a service drop line, which comes from a transformer on or near a distribution pole to the customer's end-use structure.

Residential customers require electricity that is distributed at a reduced voltage, typically 120/240 volts (single phase). This reduced voltage is usually achieved through a pole-mounted or pad-mounted transformer.

In other instances, the service line might be buried, as is the case with underground distribution lines. Residential electrical power is delivered to residential customers through what is referred to as a service drop line, which leads from the distribution pole transformer to the customer's structure via overhead distribution lines.

Answer questions 19-27 based on information presented in Passage 3.

19. How is the voltage reduced to 120/240 volts for residential customers?

A. This reduced voltage is usually achieved at the switching station
B. This reduced voltage is usually achieved at a transmission interconnection substation
C. This reduced voltage is usually achieved from a transformer on or near a distribution pole
D. This reduced voltage is usually achieved through a pole-mounted or pad-mounted transformer

20. What device changes the alternating current of one voltage to another voltage?

A. Substation
B. Transformer
C. Distribution bus
D. Switching station

21. Which of the following is NOT a characteristic of a substation constructed area?

A. Gated for security
B. Fenced for safety
C. Manicured lawn
D. The lot is filled with gravel

22. What is one of two methods a substation is interconnected to the transmission system and distribution system?

A. High-voltage transmission circuits carrying 138 kV or 230 kV directly step down voltage to distribution connections carrying 13 kV
B. High-voltage transmission circuits carrying 38 kV or 110 kV directly step down voltage to distribution connections carrying 4 kV or 13 kV
C. High-voltage transmission circuits carrying 108 kV directly step down voltage to distribution connections carrying 4 kV
D. High-voltage transmission circuits carrying 38 kV directly step down voltage to distribution connections carrying 14.4 kV

23. What happens to this electrical power after it is tapped off the transmission lines at the substation?

A. Step the voltage down to lower voltage levels
B. Routed directly to a building's service line
C. Route power to a specific service area
D. Route power to smaller area

24. What type of service drop line is used for high-use customers?

A. A service drop line with a voltage ranging from 7.2 kV to 14.4 kV
B. A service drop line with a voltage ranging from 3 kV to 13 kV
C. A service drop line with a voltage ranging from 26 kV to 34 kV
D. A service drop line with a voltage of 13 kV

25. How is electrical power delivered to residential customers?

A. A distribution line from a single power source to the customer's structure
B. A service drop line from the distribution pole transformer to the customer's structure
C. A distribution line from a single power source and continue through the service area
D. A service drop line from the secondary distribution lines route power to the customer's structure

26. What component (facility) provides system monitoring and control for distribution circuits in the 4 and 13 kV range?

A. Distribution feeder circuit
B. Substation control house
C. Subtransmission switching station
D. Subtransmission-supplied substations

27. When a high-voltage transmission, circuit-supplying switching station steps down voltages to a subtransmission, what is the voltage range?

A. 4 to 13 kV
B. 7.2 to 14.4 kV
C. 13 to 26 kV
D. 26 to 34 kV

Name:_____ Date:_____

MATHEMATICAL USAGE TEST

The Mathematical Usage selection test measures a candidate's ability to solve basic mathematical problems from information provided at the beginning of the test.

Directions:

This is a test of your skill in working with mathematical formulas. Please read the directions carefully before working the problems. This test has 38 questions and should take you **14 minutes** to complete.

The use of calculators is not permitted.

Use this table to solve problems 1 through 19. For each problem, circle the letter that corresponds to the correct answer. Circle "e" for "none" if none of the answers are right.

1 yard = 36 inches
1 mile/minute = 88 feet/second
1 acre = 10 square chains
1 kilometer = 1,000 meters
1 acre = 43,560 square feet
1 hand = 10 centimeters
1 kilogram = 1,000 grams
1 kilogram = 2.205 pounds
1 mile = 5,280 feet
1 fathom = 6 feet

1 pound = 16 ounces
1 gallon = 3.785 liters
1 gill = 0.25 pint
1 acre = 160 square rods
1 slug = 14.59 kilograms
1 hogshead = 63 gallons
1 rod = 0.25 chain
1 furlong = 40 rods
1 pint = 0.5 quart

1. 0.25 kilometers = _____ meters
   a. 25 b. 125 c. 500 d. 250 e. None

2. 80 square chains = _____ acres
   a. 8 b. 0.8 c. 20 d. 40 e. None

3. 0.5 mile/minute = _____ feet/second
   a. 88 b. 44 c. 22 d. 176 e. None

4. 3 yards = _____ inches
   a. 36 b. 12 c. 108 d. 72 e. None

5. 5 gallons = _____ liters
   a. 16.752 b. 18.925 c. 15 d. 8 e. None

6. 32 ounces = _____ pounds
   a. 0.5 b. 2 c. 10 d. 22 e. None

7. 5 kilograms = _____ pounds

a. 50 b. 112.50 c. 500 d. 11.025 e. None

8. 217,800 square feet = _____ acres

a. 2 b. 5 c. 3 d. 10 e. None

9. 25 quarts = _____ pints

a. 12.52 b. 100 c. 15 d. 50 e. None

10. 6 slugs = _____ kilograms

a. 53.782 b. 64 c. 87.54 d. 83 e. None

11. 8 hogsheads = _____ gallons

a. 185 b. 504 c. 207 d. 115.5 e. None

12. 40 square rods = _____ acres

a. 2 b. 0.25 c. 12 d. 20 e. None

13. 5 slugs = _____ grams

a. 5,689 b. 8,473 c. 72,950 d. 4,750 e. None

14. 15 square chains = _____ square feet

a. 66,340 b. 7,225 c. 49,560 d. 58,870 e. None

15. 30 chains = _____ furlongs

a. 3 b. 5 c. 30 d. 14 e. None

16. 2,000 grams = _____ pounds

a. 4,410 b. 13.9 c. 7.43 d. 0.8 e. None

17. 30 quarts = _____ gills

a. 125.5 b. 240 c. 150 d. 27 e. None

18. 3 miles = _____ fathoms

a. 1,325 b. 560 c. 2,685 d. 2,640 e. None

19. 2 gills = _____ pints

a. 2.5 b. 3 c. 0.8 d. 0.5 e. None

For problems 20 through 30, solve each question for the unknown (X). For each problem, circle the letter in front of the correct answer.

20. $X + 5 = 3$

A. 2
B. -2
C. 3
D. -3

21. $X + 7 = 4$

A. -5
B. 3
C. 5
D. -3

22. $X - 5 = -11$

A. 5
B. 6
C. -6
D. -5

23. $0.04X = 0.08$

A. 2
B. 0.2
C. 4
D. 0.04

24. $2X + 8 = 16$

A. 6
B. 2
C. 4
D. 0.04

25. $4X - 3 = 9$

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

26. $0.02X = 2$

A. 10
B. 100
C. 1,000
D. 10,000

27. $5X - 10 = 15$

A. 5
B. 10
C. 2
D. 20

28. $0.3X = 0.9$

A. 10
B. 0.3
C. 30
D. 3

29. $0.05X + 0.05 = 0.3$

A. 0.05
B. 0.5
C. 5
D. 10

30. $3X + 5 = 26$

A. 7
B. 5
C. 8
D. 10

31. Harry's line crew is measuring the distance for an overhead line job. The line crew determined they needed 1/2 a mile of wire for the job. Since the wire spool is measured in feet, how many feet of wire would the crew have to get from the warehouse to complete the wire pulling job?

A. 5,280 ft
B. 2,500 ft
C. 2,640 ft
D. 1,760 ft
E. none of the above

32. Wanda is taking measurements on a circuit. She has a measurement of 250 milliamps. How many amps would Wanda report for her measurement?

A. 0.250 amps
B. 2,500 amps
C. 250,000 amps
D. 2.50 amps
E. none of the above

33. Ned is completing a splice on an underground cable. When finished, the splice measures 15 centimeters. How long is the splice in millimeters?

A. 1.5 millimeters
B. 1,500 millimeters
C. 0.0015 millimeters
D. 150 millimeters
E. none of the above

34. Fran is working on completing a splice. The directions for the splice say she needs to remove 5 inches of the cable jacket prior to starting the splice, but her ruler measures in centimeters. How many centimeters does Fran have to cut the cable jacket prior to starting the splice?

A. 15.0 centimeters
B. 12.5 centimeters
C. 12.7 centimeters
D. 1.27 centimeters
E. none of the above

35. Tyler is a line helper checking the engine oil in the district's line trucks. The oil container is marked in liters. Tyler has added 6 liters of oil to the trucks. How many gallons of oil has Tyler added to the line trucks?

A. 1.58 gallons
B. 1.46 gallons
C. 1.82 gallons
D. 2.05 gallons
E. none of the above

36. Yolanda is working with a gas crew lowering a steel plate over an open trench in a roadway. The plate weights 350 lbs. How would Yolanda report the weight of the plate in tons?

A. 0.167 tons
B. 0.175 tons
C. 5.71 tons
D. 0.257 tons
E. none of the above

37. Jim's crew is removing condensation from drip traps in several gas lines. The crew removed a total of 15 pints from several drip traps. How many gallons of water should the gas crew report was removed from the gas lines?

A. 3.25 gallons
B. 3 gallons
C. 2 gallons
D. 1.88 gallons
E. none of the above

38. Jack is adding oil to a generator being used for temporary power on a new construction site. Jack added 1.5 liters to the generator. How many milliliters of oil did Jack add?

A. 150 milliliters
B. 1,000 milliliters
C. 1,500 milliliters
D. 1.5 milliliters
E. none of the above