
XXI. Technology/Engineering,
High School

High School Technology/Engineering Test

The spring 2008 high school MCAS Technology/Engineering test was based on learning standards in the Technology/Engineering content strand of the Massachusetts *Science and Technology/Engineering Curriculum Framework* (2006). These learning standards appear on pages 92–95 of the *Framework*.

The *Science and Technology/Engineering Curriculum Framework* is available on the Department Web site at www.doe.mass.edu/frameworks/current.html.

In *Test Item Analysis Reports* and on the Subject Area Subscore pages of the MCAS *School Reports* and *District Reports*, Technology/Engineering test results are reported under the following four MCAS reporting categories:

- Engineering Design
- Construction and Manufacturing
- Fluid and Thermal Systems
- Electrical and Communications Systems

Test Sessions

The MCAS high school Technology/Engineering test included two separate test sessions, which were administered on consecutive days. Each session included multiple-choice and open-response questions.

Reference Materials and Tools

Each student taking the high school Technology/Engineering test was provided with a plastic ruler and a Technology/Engineering Formula Sheet. A copy of this formula sheet follows the final question in this chapter. An image of the ruler is not reproduced in this publication.

Each student also had sole access to a calculator with at least four functions and a square-root key.

The use of bilingual word-to-word dictionaries was allowed for current and former limited English proficient students only, during both Technology/Engineering test sessions. No other reference tools or materials were allowed.

Cross-Reference Information

The table at the conclusion of this chapter indicates each item's reporting category and the *Framework* learning standard it assesses. The correct answers for multiple-choice questions are also displayed in the table.

Technology/Engineering

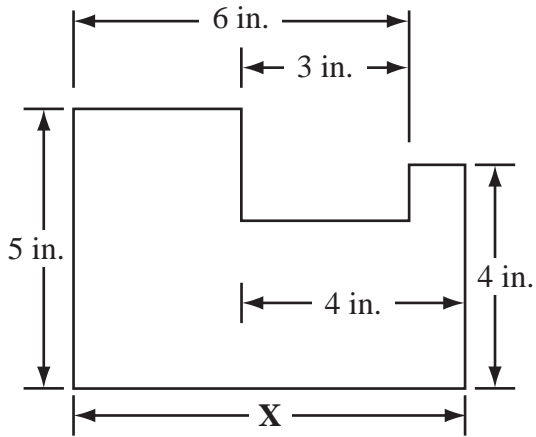
SESSION 1

DIRECTIONS

This session contains twenty-one multiple-choice questions and two open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

- 1 A manufacturer has developed a textured surface for plastic cups. These cups are designed for small children. The manufacturer has produced prototypes. Which of the following is the next step in the engineering design process?
- A. marketing the new textured cups
 - B. developing new textures for cup surfaces
 - C. testing and evaluating the textured prototypes
 - D. redesigning the textured surface on the prototypes
- 2 Television remote controls use infrared signals to allow a viewer to change channels from a distance. Which of the following best describes the operation of the remote control?
- A. decoding and storing
 - B. storing and retrieving
 - C. receiving and decoding
 - D. encoding and transmitting
- 3 What occurs in a fiber-optic cable to allow light to transmit information?
- A. boundary scattering
 - B. energy dissipation
 - C. surface interference
 - D. total internal reflection

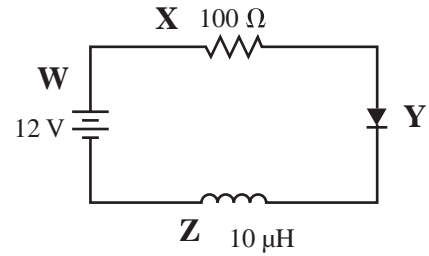
- 4 The dimensioned drawing below shows a grooved block.



Which of the following is length **X** of this block?

- A. 7 in.
- B. 9 in.
- C. 10 in.
- D. 13 in.

- 5 The diagram below represents a circuit with four components labeled W, X, Y, and Z.



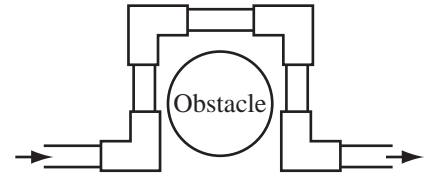
Which of the labeled components provides current to the other components in the circuit?

- A. W
- B. X
- C. Y
- D. Z

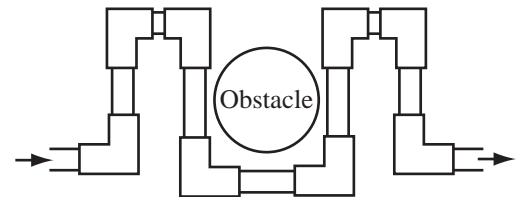
- 6 Which of the following is **not** a use of fiber-optic technology?
- A. to see inside the human body
 - B. to send digital data via land lines
 - C. to transmit signals to satellites in space
 - D. to inspect the internal mechanical parts of an airplane

- 7 A plumber needs to modify a water pipe to go around an obstacle. Which of the following designs should be used in order to **minimize** the resistance to the flow of water?

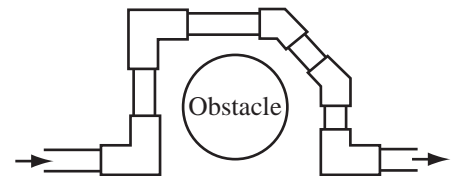
A.



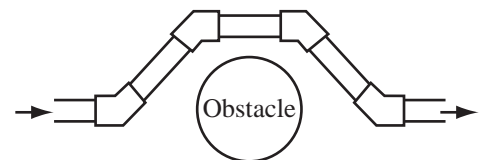
B.



C.



D.



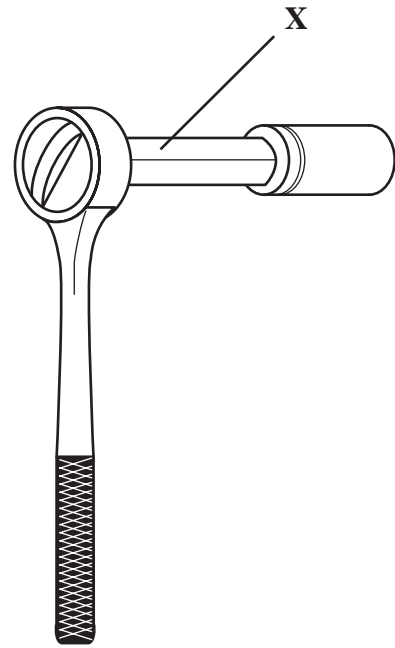
- 8 Advances in military technologies have often led to the development of everyday applications. Early radar systems operators noticed that objects near the radar were often heated when the radar was in use. This observation led to the development of which of the following everyday applications?

- A. microwave ovens
- B. motion detectors
- C. nuclear reactors
- D. solar collector panels

- 9 Which of the following describes how power is transferred in hydraulic and pneumatic systems?

- A. Hydraulic systems use air and pneumatic systems use steam.
- B. Hydraulic systems use liquid and pneumatic systems use air.
- C. Hydraulic systems use steam and pneumatic systems use air.
- D. Hydraulic systems use air and pneumatic systems use liquid.

- 10 A mechanic is using the socket wrench pictured below to install a spark plug.



Which of the following is the primary structural action at point X?

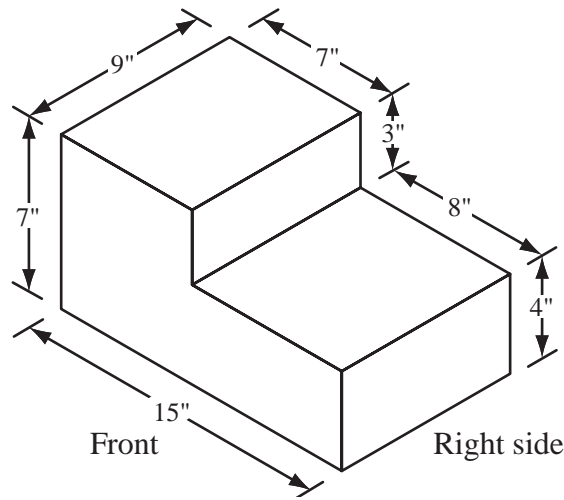
- A. compression
- B. shear
- C. tension
- D. torsion

Question 11 is an open-response question.

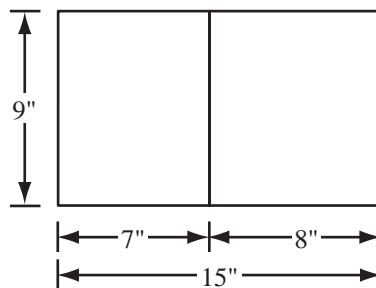
- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 11 in the space provided in your Student Answer Booklet.

11 The drawing below represents an object and its dimensions.



a. Identify which view of the object is shown in the orthographic projection below.



b. Draw and label another view of the object. Include all necessary dimensions in the view.

Mark your answers to multiple-choice questions 12 through 22 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

- 12 An assignment for the design of an emergency light is described in the box below.

Design and build an emergency light. It must have its own battery, provide a bright light, and have a built-in charger. It must be capable of operating while being charged. It must have a watertight enclosure with a handle on the top.

After receiving this assignment, which of the following **most likely** would be the next step in the engineering design process?

- A. testing and evaluation
- B. selecting the best solution
- C. investigation and research
- D. construction of a prototype

- 13 Which of the following devices uses a renewable resource to produce heat?

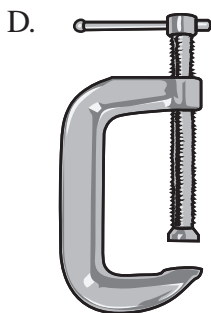
- A. a fuel oil heater
- B. a propane gas burner
- C. a wood-burning stove
- D. a coal-burning furnace

- 14 An engineer suggests using a robotic system to manufacture a particular chemical. Although the chemical will be highly profitable, it will only be made in small amounts.

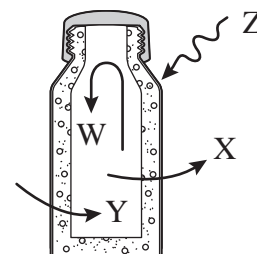
Which of the following is **most likely** the engineer's reason for making the suggestion?

- A. The robotic system can reduce the cost of materials.
- B. The robotic system can increase the cost of production.
- C. The robotic system can increase the selling price of the chemical.
- D. The robotic system can reduce workers' exposure to potentially harmful chemicals.

- 15 A student built a bookshelf. Which of the following is the **best** tool to use to check if the shelf is level?



- 16 The drawing below shows a cross section of an insulated bottle filled with hot coffee. Several arrows labeled W, X, Y, and Z are drawn to show possible paths for heat transfer.



This insulated bottle was filled with hot coffee and allowed to sit at room temperature for several hours. The temperature of the coffee cooled from 86°C to 58°C .

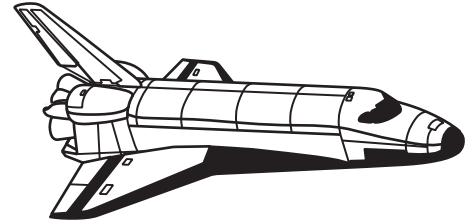
Which of the following **best** represents the heat transfer path by conduction as the coffee cools?

- A. W
- B. X
- C. Y
- D. Z

- 17 Which of the following processes relieves internal stress caused by hardening in a metal tool?

A. compressing
B. extruding
C. shearing
D. tempering

- 18 A drawing of a space shuttle and a summary of its dimensions are shown below.



Shuttle dimensions:

Length = 121 ft.

Height = 57 ft.

Wingspan = 78 ft.

Manny is building a scale model of this space shuttle. What is the approximate height of the model if its length is 13 in.?

- A. 2 in.
B. 4 in.
C. 6 in.
D. 8 in.

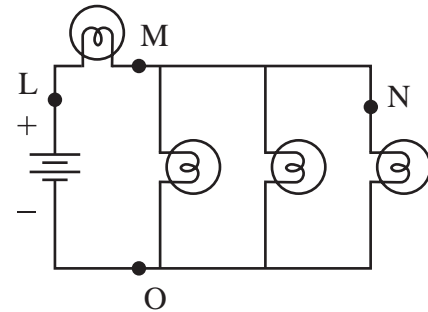
- 19 Silicon carbide (SiC), a ceramic, is used in drill bits. Which of the following is the **most likely** reason that silicon carbide is suitable for this purpose?

A. It is soft and porous.
 B. It is ductile and magnetic.
 C. It is hard and resists abrasion.
 D. It is brittle and has a low density.

- 20 Wires X and Y are made of the same material. Which of the following could explain why wire X has a **higher** resistance than wire Y?

A. Wire X is colder than wire Y.
 B. Wire X is shorter than wire Y.
 C. Wire X has a different color coating than wire Y.
 D. Wire X has a smaller cross-sectional area than wire Y.

- 21 The diagram below shows a circuit with four identical light bulbs.



To which of the following two points should a voltmeter be attached in order to determine the voltage drop across the entire circuit?

A. points L and M
 B. points M and N
 C. points N and O
 D. points L and O

- 22 When checking e-mail, Maria accesses a powerful computer called a server. The number of messages she can have in an account on the server is primarily limited by which of the following?

A. decoder capacity
 B. retrieval speed
 C. storage capacity
 D. transmission speed

Question 23 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 23 in the space provided in your Student Answer Booklet.

- 23 The illustration below shows a sprinkler system used to water grass.



- Identify the sprinkler system as an open fluid system or a closed fluid system.
- Support your answer to part (a) by describing the difference between an open and a closed fluid system.
- Describe one example of an open fluid system and one example of a closed fluid system. You may not use the sprinkler system as an example.

Technology/Engineering

SESSION 2

DIRECTIONS

This session contains nineteen multiple-choice questions and three open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

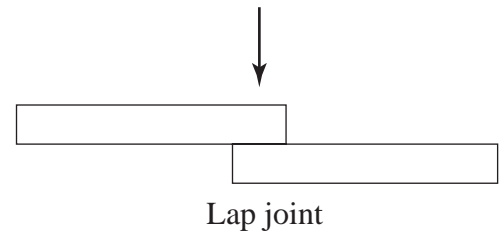
- 24 A homeowner wants to convert her basement into a recreation room. Which of the following is the **best** reason why the homeowner should go to the local city or town hall?
- A. to purchase tools and materials for the project
 - B. to find the most reputable contractor for the project
 - C. to ask for help in estimating the cost of materials and labor for the project
 - D. to check for building codes and safety regulations that apply to the project

- 25 Which of the following types of lifting systems is **best** to use when a heavy load needs to be lifted and held precisely in place for a long period of time?
- A. thermal
 - B. pneumatic
 - C. hydraulic
 - D. centrifugal

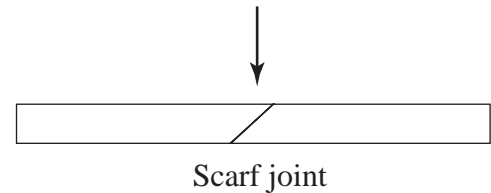
- 26 A joint is subjected to a perpendicular force as indicated by the arrows in the drawings.

Which of the following is the **weakest** type of joint used to assemble parallel wooden parts with adhesives?

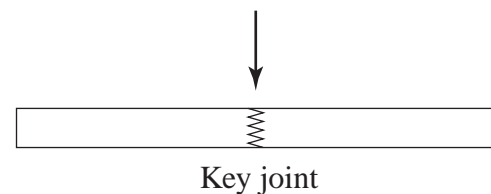
A.



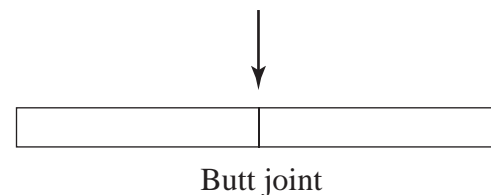
B.



C.



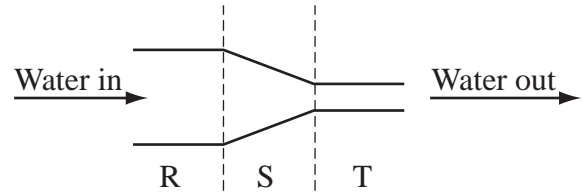
D.



27 Which of the following is a common source of an optical signal transmitted along a fiber-optic cable?

- A. CRT
- B. LED
- C. resistor
- D. transistor

28 The diagram below represents water flowing through a pipe that reduces in diameter.

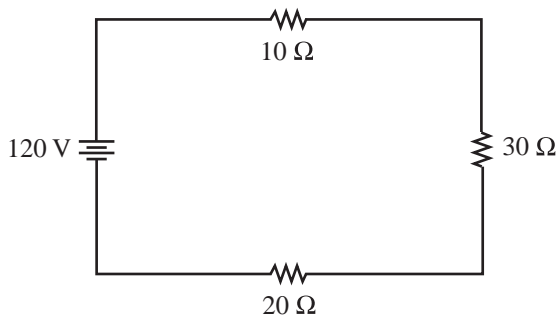


What happens to the water's velocity as the water travels from section R to section T of the pipe?

- A. The velocity increases.
- B. The velocity drops to zero.
- C. The velocity remains the same.
- D. The velocity decreases by three-fourths.

- 29 Lasers are commonly used in which of the following applications?
- A. disposable film cameras
 - B. eye surgery for nearsighted people
 - C. power transmission over long distances
 - D. TV signal transmission over coaxial cables

- 30 The diagram below shows an electric circuit with three resistors.



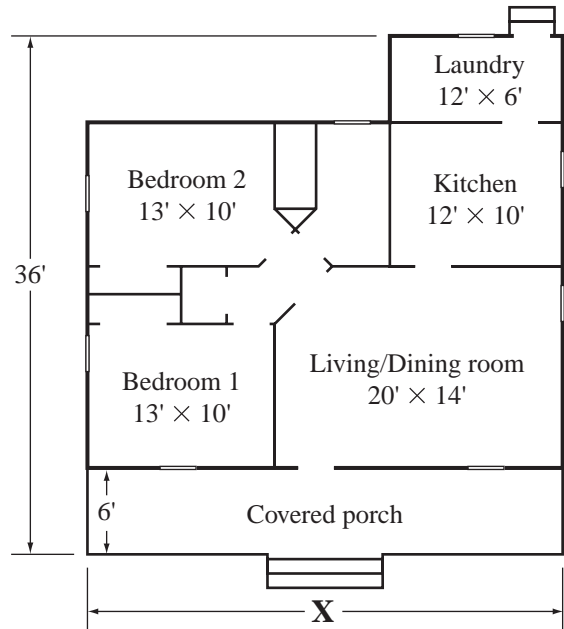
Ohm's law

$$I = \frac{V}{R}$$

What is the current in this circuit?

- A. 2 A
- B. 4 A
- C. 6 A
- D. 12 A

- 31 A house plan is shown below.



According to the plan, what is dimension X of the house?

- A. 22'
- B. 26'
- C. 33'
- D. 36'

- 32 Which of the following is an example of casting?

- A. A steel rod is heated and then rapidly cooled in a tank of water.
- B. A molten alloy is poured into a mold where it cools and hardens.
- C. A plastic pellet is forced through a die into a long, uniform shape.
- D. A metal sheet is passed through smooth rollers to yield a curved piece.

Question 33 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 33 in the space provided in your Student Answer Booklet.

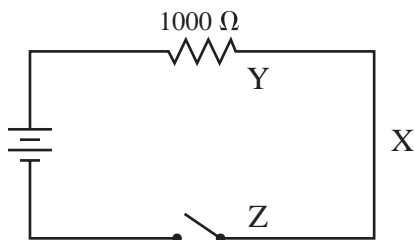
- 33** During the summer, the amount of energy that is required to keep an office building at a comfortable temperature can be large.
- a. Describe **two** cost-effective ways to reduce energy consumption in cooling an office building during the summer.
 - b. Explain, from a scientific standpoint, how **each** of your answers in part (a) helps to reduce energy consumption.

Mark your answers to multiple-choice questions 34 through 43 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

- 34 Which of the following statements **best** describes the functioning of an encoder in a mobile phone?

A. an antenna captures a signal
 B. an LCD shows the number being dialed
 C. a microphone converts sound to an electrical signal
 D. a digital signal processor holds frequently dialed numbers

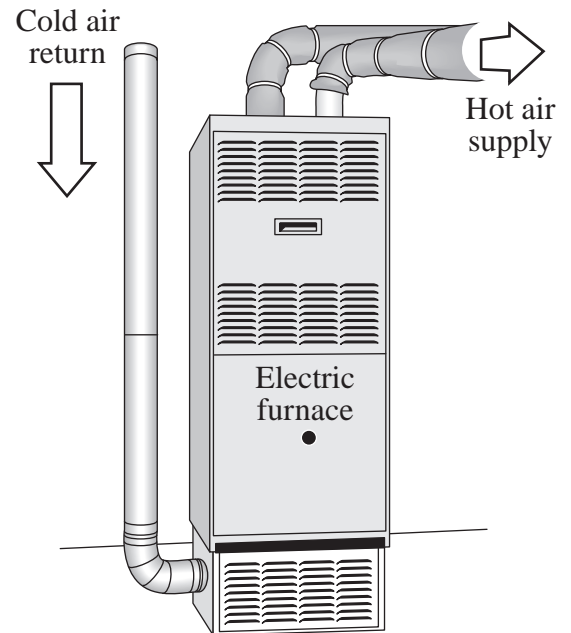
- 35 The diagram below represents a circuit.



In this circuit, X connects components Y and Z. X functions **primarily** as which of the following?

A. switch
 B. source
 C. resistor
 D. conductor

- 36 The diagram below represents an electric furnace.



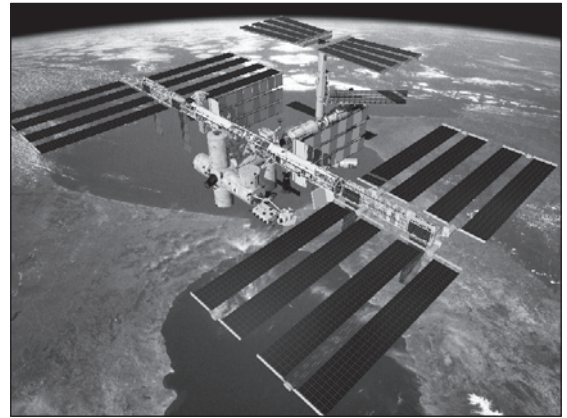
Cold air enters through the cold air return and hot air is blown out the supply duct. Which of the following statements **correctly** describes heat transfer within the furnace?

A. The furnace transfers heat by condensation.
 B. The furnace transfers heat through combustion.
 C. The furnace decreases heat transfer by radiation.
 D. The furnace increases heat transfer through convection.

37 Which of the following is **most likely** to require direct current (DC) for proper operation?

- A. a blender
- B. a flashlight
- C. an electric heater
- D. a microwave oven

38 The picture below shows the International Space Station orbiting Earth.



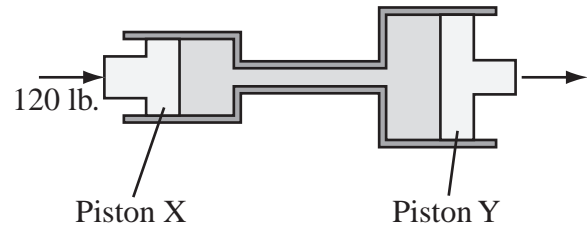
NASA-Johnson Space Center

Which of the following is used to send information from the International Space Station back to Earth?

- A. fiber optics
- B. gamma rays
- C. infrared radiation
- D. radio waves

- 39 Which of the following examples describes a nonrenewable energy system?
- A. Solar panels use energy from the Sun to heat a home.
 - B. Geothermal energy is used to heat water for a building.
 - C. Wind force turns windmill blades connected to a generator to produce electricity.
 - D. Coal is used to convert water into steam that turns turbine blades to produce electricity.

- 40 In the hydraulic system shown below, piston X has a cross-sectional area one-third that of piston Y.



If piston X is subjected to a force of 120 lb., what will be the corresponding force applied to piston Y?

- A. 60 lb.
- B. 120 lb.
- C. 360 lb.
- D. 1080 lb.

- 41 An automobile company plans to develop an electric car to sell in urban areas. Which of the following will help the company evaluate the potential market for these cars?

A. field tests
 B. scale models
 C. prototype designs
 D. consumer surveys

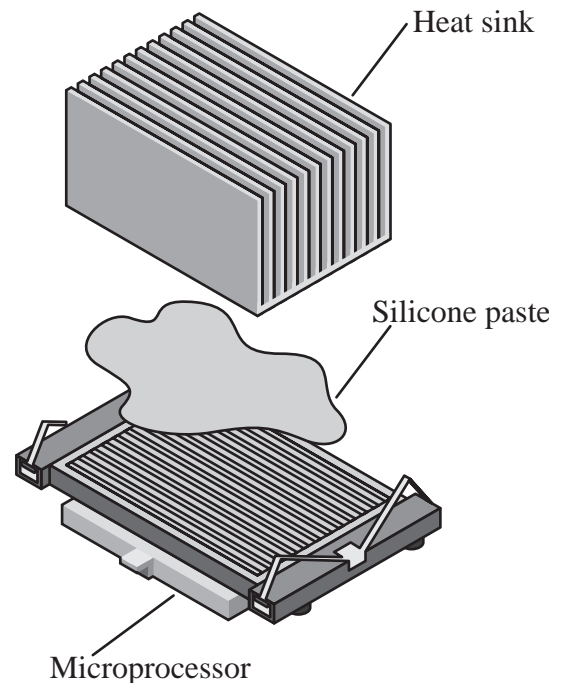
- 42 The information below is found on an engineering drawing of a machine part.

SCALE 1 : 20

If the actual part is 60.0 mm long, how long is the object line that represents the part's length?

A. 1.0 mm
 B. 3.0 mm
 C. 20.0 mm
 D. 60.0 mm

- 43 A heat sink, shown in the diagram below, removes heat from a computer microprocessor while it is running.



A silicone paste is sometimes used to fill in the gap between the heat sink and the microprocessor. Which of the following properties is **most** important for the silicone paste to have based on the heat sink's function?

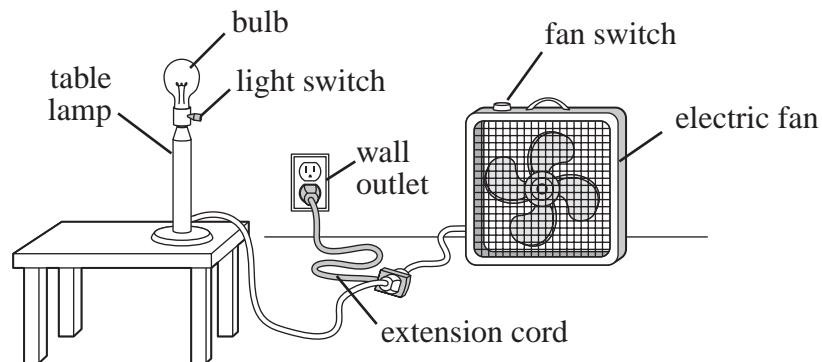
A. high tensile strength
 B. high thermal insulation
 C. high thermal conduction
 D. high compression strength

Questions 44 and 45 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 44 in the space provided in your Student Answer Booklet.

- 44 The illustration below shows electrical appliances in a circuit.

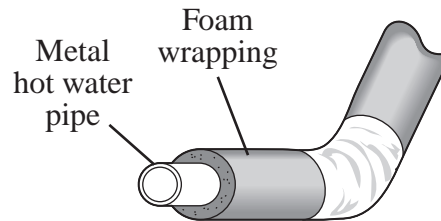


This electric circuit contains two appliances.

- Draw and label a circuit diagram for this circuit.
- Identify: (1) a source; (2) a conductor; (3) a load; and (4) a controller in this circuit.

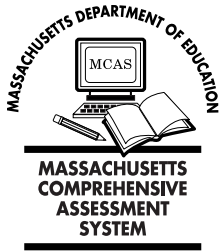
Write your answer to question 45 in the space provided in your Student Answer Booklet.

- 45 The figure below represents foam wrapped around a metal hot water pipe.



Foam wrapping is often used to surround metal hot water pipes.

- Compare the thermal properties of foam and metal. Explain the purpose of the foam wrapping.
- Describe the physical characteristics of foam and explain how these characteristics make it a good choice when used to wrap a metal hot water pipe.



Massachusetts Comprehensive Assessment System Technology/Engineering Formula Sheet

Formulas

$$V = I \times R$$

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = I \times V$$

$$\text{Area of a circle} = \pi r^2$$

Variables

I = current

r = radius

P = power

R = resistance

V = voltage

Definitions and Abbreviations

AC = alternating current

psi = pounds per square inch

DC = direct current

$\pi \approx 3.14$

**High School Technology/Engineering
Spring 2008 Released Items:
Reporting Categories, Standards, and Correct Answers***

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
1	535	<i>Engineering Design</i>	1.1	C
2	535	<i>Electrical and Communications Systems</i>	6.3	D
3	535	<i>Electrical and Communications Systems</i>	6.5	D
4	536	<i>Engineering Design</i>	1.5	A
5	536	<i>Electrical and Communications Systems</i>	5.2	A
6	537	<i>Electrical and Communications Systems</i>	6.4	C
7	537	<i>Fluid and Thermal Systems</i>	3.5	D
8	538	<i>Engineering Design</i>	1.2	A
9	538	<i>Fluid and Thermal Systems</i>	3.2	B
10	538	<i>Construction and Manufacturing</i>	2.2	D
11	539	<i>Engineering Design</i>	1.3	
12	540	<i>Engineering Design</i>	1.1	C
13	540	<i>Fluid and Thermal Systems</i>	4.4	C
14	540	<i>Construction and Manufacturing</i>	7.3	D
15	541	<i>Construction and Manufacturing</i>	2.5	B
16	541	<i>Fluid and Thermal Systems</i>	4.1	B
17	542	<i>Construction and Manufacturing</i>	7.1	D
18	542	<i>Engineering Design</i>	1.4	C
19	543	<i>Construction and Manufacturing</i>	2.1	C
20	543	<i>Electrical and Communications Systems</i>	5.4	D
21	543	<i>Electrical and Communications Systems</i>	5.1	D
22	543	<i>Electrical and Communications Systems</i>	6.3	C
23	544	<i>Fluid and Thermal Systems</i>	3.1	
24	545	<i>Construction and Manufacturing</i>	2.6	D
25	545	<i>Fluid and Thermal Systems</i>	3.2	C
26	545	<i>Construction and Manufacturing</i>	7.2	D
27	546	<i>Electrical and Communications Systems</i>	6.5	B
28	546	<i>Fluid and Thermal Systems</i>	3.4	A
29	547	<i>Electrical and Communications Systems</i>	6.4	B
30	547	<i>Electrical and Communications Systems</i>	5.3	A
31	547	<i>Engineering Design</i>	1.5	C
32	547	<i>Construction and Manufacturing</i>	7.1	B
33	548	<i>Fluid and Thermal Systems</i>	4.3	
34	549	<i>Electrical and Communications Systems</i>	6.3	C
35	549	<i>Electrical and Communications Systems</i>	5.2	D
36	549	<i>Fluid and Thermal Systems</i>	4.1	D
37	550	<i>Electrical and Communications Systems</i>	5.5	B
38	550	<i>Electrical and Communications Systems</i>	6.1	D
39	551	<i>Fluid and Thermal Systems</i>	4.4	D
40	551	<i>Fluid and Thermal Systems</i>	3.3	C
41	552	<i>Engineering Design</i>	1.1	D
42	552	<i>Engineering Design</i>	1.4	B

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
43	552	<i>Fluid and Thermal Systems</i>	4.2	C
44	553	<i>Electrical and Communications Systems</i>	5.2	
45	554	<i>Construction and Manufacturing</i>	2.1	

* Answers are provided here for multiple-choice items only. Sample responses and scoring guidelines for open-response items, which are indicated by shaded cells, will be posted to the Department's Web site later this year.

