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XXI. Technology/Engineering,  
High School

## *High School Technology/Engineering Test*

The spring 2007 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](http://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

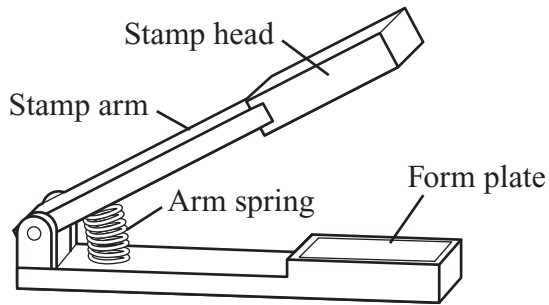
## SESSION 1

### DIRECTIONS

This session contains twenty-three 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 Which of the following would **best** increase the year-round energy efficiency of a building that is subjected to hot summers and cold winters?
- A. black exterior paint
  - B. fiberglass insulation
  - C. large glass windows
  - D. white exterior paint
- 2 Air in a hydraulic brake line causes the brakes to malfunction. Which property of air is **most** responsible for the malfunction?
- A. Air is less visible than brake fluid.
  - B. Air changes volume under pressure.
  - C. Air causes corrosion in the brake line.
  - D. Air changes temperature under pressure.
- 3 Which of the following is a function of a home TV antenna?
- A. transmitter
  - B. storage
  - C. source
  - D. receiver
- 4 In one type of home air conditioner thermostat, the case of the temperature sensor is made of metal. Which of the following is the **best** reason for using metal?
- A. Metal convects heat easily.
  - B. Metal conducts heat quickly.
  - C. Metal consumes heat slowly.
  - D. Metal radiates heat efficiently.

- 5 The drawing below shows a spring-loaded stamping machine.



Which of the following is the **main** function of the arm spring?

- A. to provide increased resistance to the stamping force
- B. to return the stamp arm to an open position quickly
- C. to prevent the stamp head from contacting the form plate
- D. to press the stamp arm toward the form plate automatically

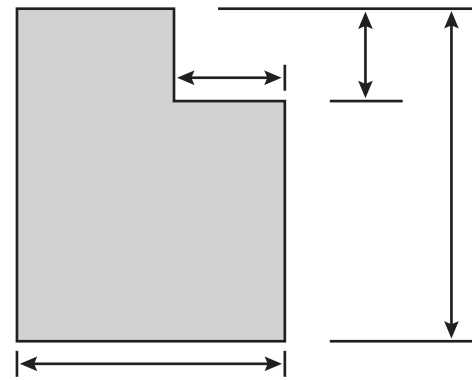
- 6 Which of the following is used to read a compact disc in a compact disc player?

- A. polarization
- B. microwaves
- C. a magnet
- D. a laser

7 Designers need to use a wind tunnel to test the airflow over a new design for an airplane wing. Since the wind tunnel is not large enough to hold the actual airplane wing, the designers will need to use which of the following?

- A. a mockup
- B. a propeller
- C. a scale model
- D. an orthographic projection

8 The drawing below represents a corner brace.



Drawn by: John Q.  
Sheet 1 of 1

Scale 1 cm: 25 cm  
Date 12/10/02

Which of the following is the height of the corner brace?

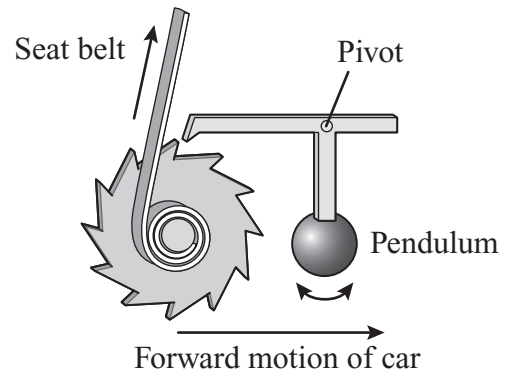
- A. 50 cm
- B. 80 cm
- C. 90 cm
- D. 110 cm

- 9 A circuit has a source with an electrical potential of 12 V. The circuit contains one resistor.

If a second resistor is added to the circuit in series, what effect will this have on the current in the circuit?

- A. The current will increase.
- B. The current will decrease.
- C. The current will not be affected.
- D. The current will switch from DC to AC.

- 10 The diagram below shows the seat belt mechanism in a car.



Which of the following correctly describes the working of this mechanism?

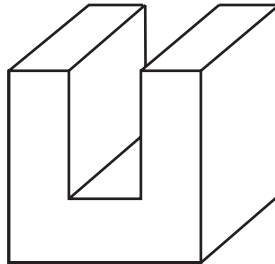
- A. Pulling on the seat belt will move the pendulum forward.
- B. Pulling on the seat belt will move the pendulum backward.
- C. When the pendulum swings forward, the seat belt will latch.
- D. When the pendulum swings backward, the seat belt will latch.

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 shows a U-shaped block made from a cube of metal.



- In your Student Answer Booklet, make a multi-view drawing of this block. Be sure to include a top view, front view, and right side view, and include any hidden lines that are necessary.
- In your Student Answer Booklet, using the same size and scale as in part (a), make an isometric drawing of this block.

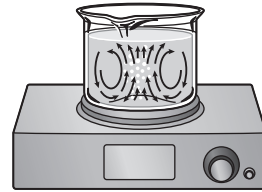
Mark your answers to multiple-choice questions 12 through 24 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

12 In which of the following fluid systems does the fluid remain within the system?

- A. compressed air in a gas station
- B. steam engine on a railroad train
- C. forced hot water heating in a home
- D. forced hot air heating in a car repair shop

13 Which of the following is the best example of heat transfer by convection?

A.



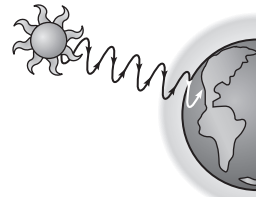
from the lower water to the surface

B.



from the iron to the shirt

C.



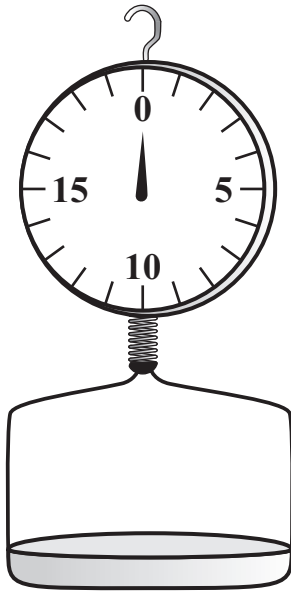
from the Sun to Earth

D.



from the griddle to the eggs

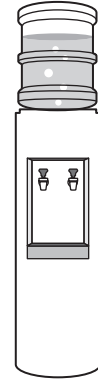
- 14 The figure below represents a spring scale used in a grocery store.



Which of the following properties is **most** important for the spring in this scale?

- A. density
- B. ductility
- C. elasticity
- D. plasticity

- 15 The figure below shows a water cooler.



This water cooler holds a 20-liter water bottle. The cooler weighs 150 lb. with an empty water bottle. Each liter of water weighs 2.2 lb.

What is the live load on the water cooler with a full bottle of water?

- A. 44 lb.
  - B. 152 lb.
  - C. 330 lb.
  - D. 374 lb.
- 16 Digital information is transmitted over fiberoptic cable as pulses of which of the following?
- A. electricity
  - B. light
  - C. microwaves
  - D. sound

17 A structural component for a bridge needs to be especially strong in tension. Which of the following materials would be **most** suitable for this component?

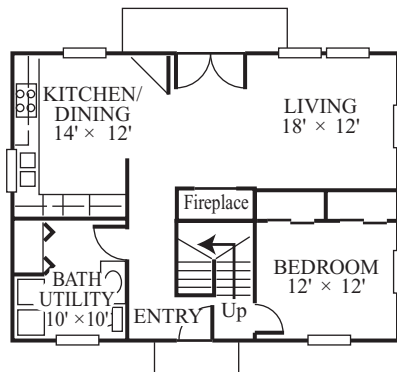
- A. concrete
- B. copper
- C. steel
- D. wood

18 A company sent prototypes of a newly designed hair dryer for trial use to 100 homes along with a satisfaction survey. A month later the company received 82 completed surveys.

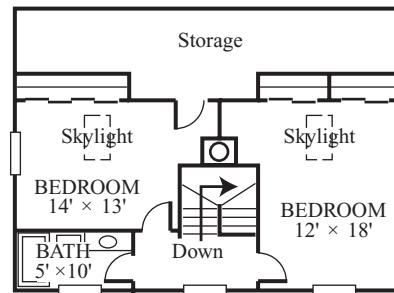
This process is part of which of the following steps in the engineering design process?

- A. developing possible solutions
- B. communicating the solution
- C. researching the problem
- D. evaluating outcomes

19 The floor plans for a house are shown below.



First floor



Second floor

Which of the following houses corresponds to these floor plans?

A.



C.



B.



D.



20 Which of the following processes can be used to make an imprint of a footprint found on a trail?

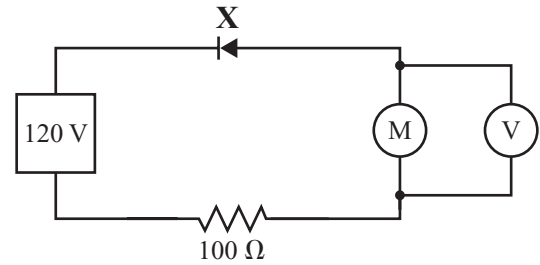
- A. casting
- B. extruding
- C. tempering
- D. thermosetting

21 An architect knows that a home receiving a lot of exposure to the Sun will benefit from the heating effects of sunlight if there is a lot of glass in the home's design.

By which of the following methods will sunlight heat the home?

- A. conduction
- B. convection
- C. evaporation
- D. radiation

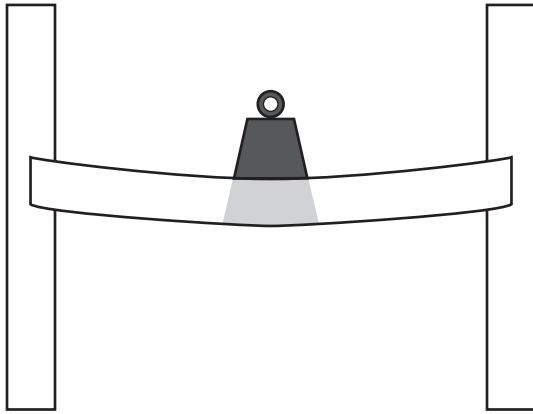
22 The diagram below represents a circuit.



What is the function of the circuit component labeled X?

- A. to restrict current flow in all directions
- B. to restrict current flow in one direction
- C. to increase current flow in all directions
- D. to increase current flow in one direction

- 23 The drawing below represents a beam with a weight resting in the middle.



Which of the following internal stresses occur in the shaded region of the beam when it is stressed by this weight?

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

- 24 Water moving through a fire hydrant with an internal cross-sectional area of about 20 sq. in. goes into a fire hose with a cross-sectional area of about 5 sq. in.

Which of the following is the **best** estimate of the change in speed of the water?

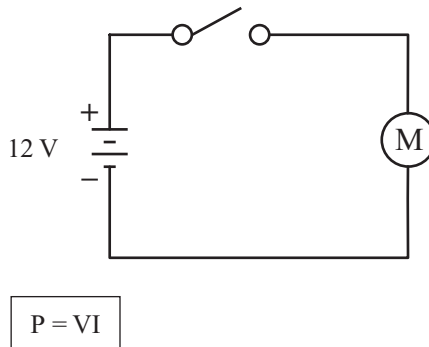
- A. The speed of the water in the hose is 0.25 times the speed of the water in the hydrant.
- B. The speed of the water in the hose is 0.5 times the speed of the water in the hydrant.
- C. The speed of the water in the hose is 2 times the speed of the water in the hydrant.
- D. The speed of the water in the hose is 4 times the speed of the water in the hydrant.

Question 25 is an open-response question.

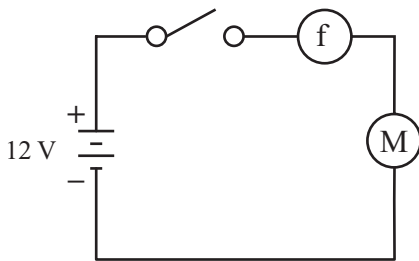
- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 25 in the space provided in your Student Answer Booklet.

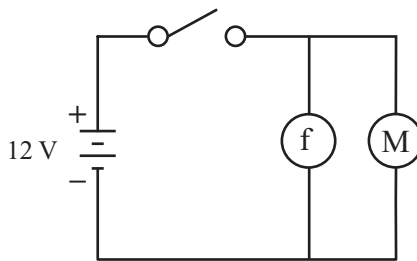
- 25 The diagram below shows a simple circuit that operates a motor.



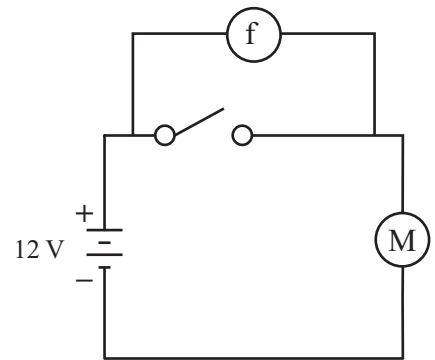
- What is the power consumption of the motor if the current in this circuit is 2.0 A when the switch is closed? Show your calculations and include units in your answer.
- If the voltage of the source is increased, how will the current in the circuit change?
- A fuse is often used to protect a circuit. Which of the following schematics shows a correct placement for the fuse?



Option X



Option Y



Option Z

- Explain your answer to part (c).

# Technology/Engineering

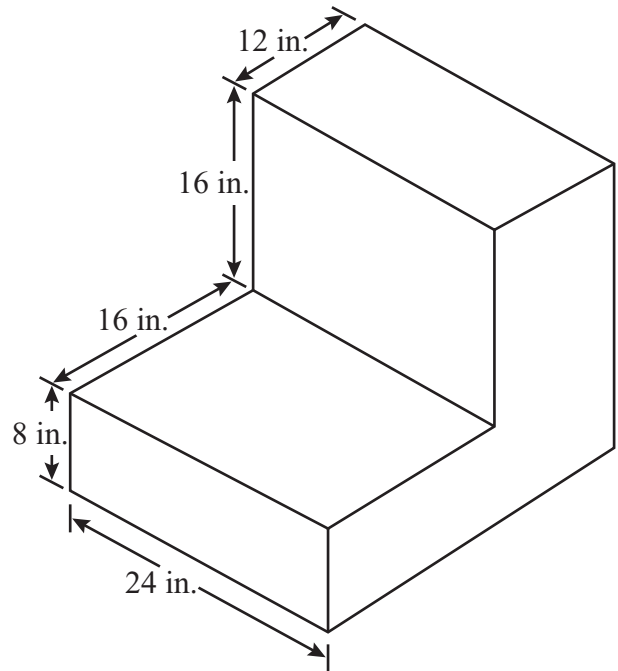
## SESSION 2

### DIRECTIONS

This session contains seventeen 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.

- 26 In which of the following examples would a hydraulic system be useful?
- A. inflating an automobile tire
  - B. lifting a 2-ton piece of machinery
  - C. wiring light bulbs in an electric circuit
  - D. sending millions of messages across the Atlantic Ocean each day

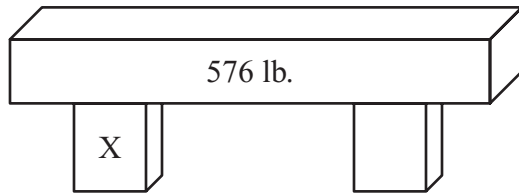
- 27 The drawing below shows an angle block.



This angle block has a width of 24 in. The width of the drawn figure is 1.5 in. Which of the following is the scale used in this drawing?

- A. 1:8
- B. 1:16
- C. 1:24
- D. 1:36

- 28 The diagram below shows a concrete beam supported by two equally spaced columns.



Which of the following is the dead load on column X?

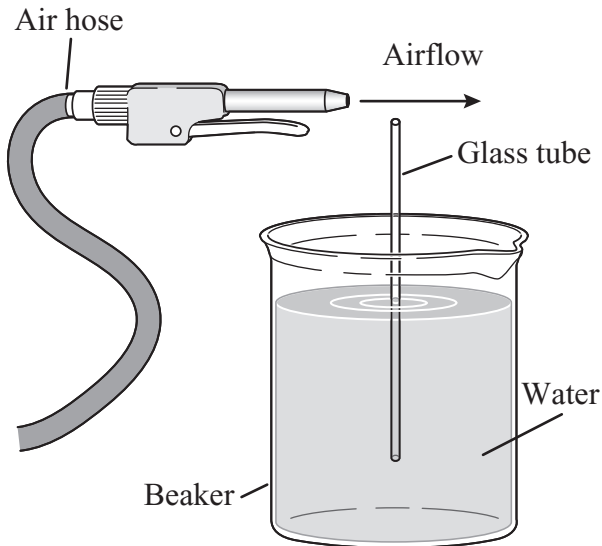
- A. 36 lb.
- B. 144 lb.
- C. 288 lb.
- D. 576 lb.

- 29 An exchange student in Europe calls a friend in Boston. The call travels through a fiberoptic cable under the ocean.

Which of the following components of the communications system converts the student's voice into light pulses that can be carried through the fiberoptic cable?

- A. encoder
- B. retriever
- C. source
- D. decoder

- 30 The diagram below shows an air hose positioned so that a stream of air can be passed above the end of a glass tube. The glass tube is sitting in a beaker of water. Its support is not shown.



According to Bernoulli's principle, what will happen as the stream of air passes over the glass tube?

- A. Turbulence will cause the glass tube to tilt toward the left.
- B. Wind shear will cause the glass tube to break at the lip of the beaker.
- C. Low pressure will develop and cause the water level to rise in the glass tube.
- D. Lift will develop in the glass tube and cause the water in the beaker to overflow.

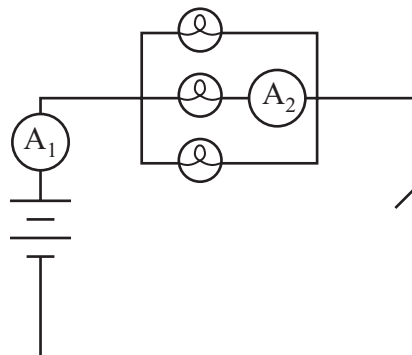
- 31 In the winter, heavy curtains are often hung in front of windows. What effect do these curtains have on heat transfer?

- A. The curtains reduce convective heat transfer.
- B. The curtains increase conductive heat transfer.
- C. The curtains reduce heat transfer from evaporation.
- D. The curtains increase heat transfer from condensation.

32 The owners of a grocery store chain have decided to try a hand-held bar code scanner for customers to use as they shop. After developing the prototype of the hand-held bar code scanner, what is the next step in the new product development?

- A. refining the scanner for production
- B. advertising the scanner in all stores
- C. field testing the scanner in selected stores
- D. mass-producing the scanner for all stores

33 The diagram below represents a parallel circuit.



All three bulbs in this circuit are identical. When the switch is closed, if ammeter  $A_1$  measures a current of 2.0 A, which of the following is the current through  $A_2$ ?

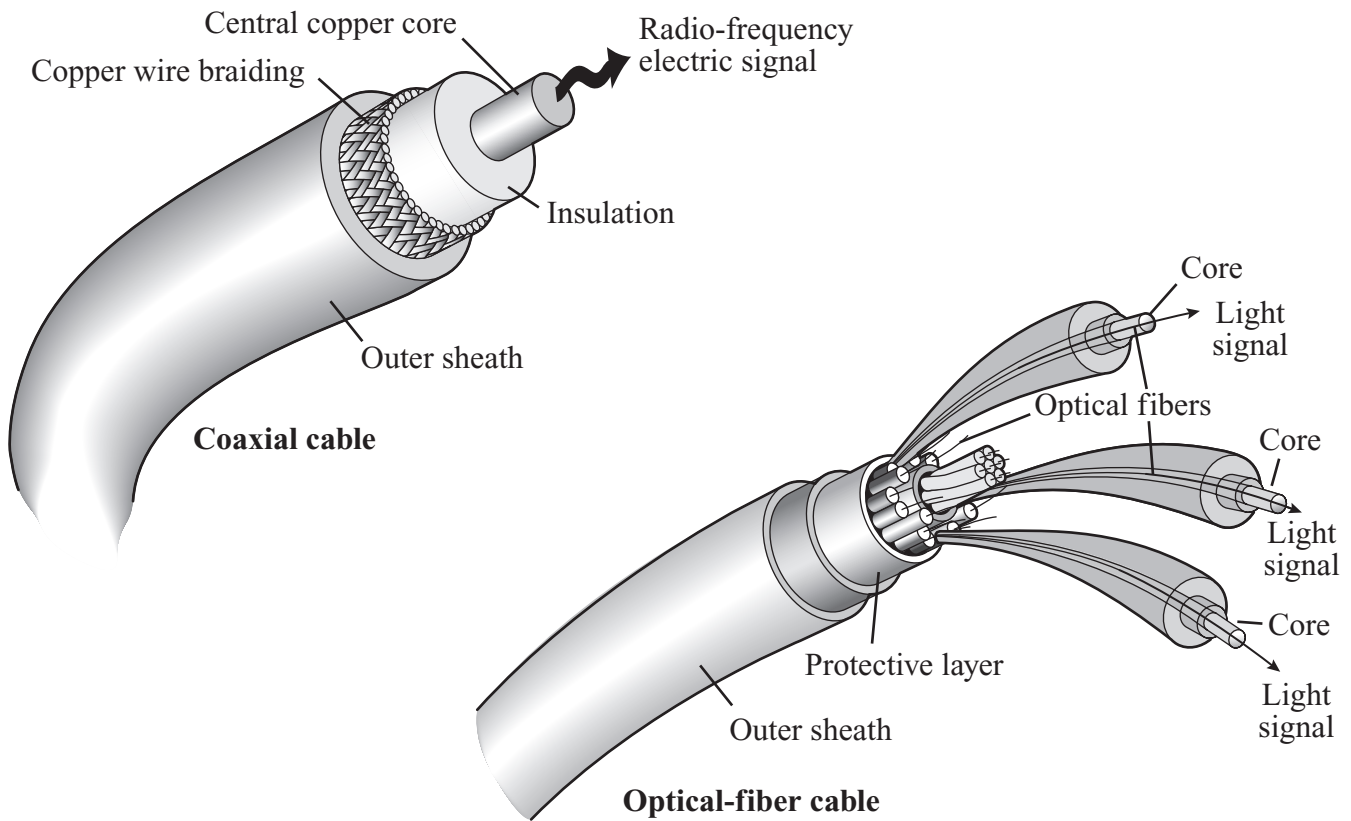
- A. 0.67 A
- B. 1.3 A
- C. 2.0 A
- D. 6.0 A

Question 34 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 34 in the space provided in your Student Answer Booklet.

- 34 The diagrams below represent a coaxial cable and an optical-fiber cable.



In the telecommunication industry, optical-fiber cable is replacing coaxial cable.

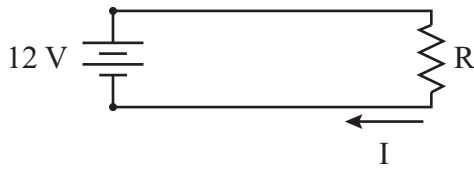
Describe **four** advantages of optical-fiber cable over coaxial cable.

Mark your answers to multiple-choice questions 35 through 37 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.

35 Which of the following will offer the **most** resistance to water flow?

- A. a pipe with a large diameter
- B. a pipe with several elbows
- C. a pipe with no corrosion
- D. a pipe that is straight

36 The diagram below represents a circuit.



Ohm's law

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

If the voltage is held constant at 12 V, which of the following describes the effect of doubling the resistance R?

- A. The new current is  $\frac{1}{4}$  of the original.
- B. The new current is  $\frac{1}{2}$  of the original.
- C. The new current is 2 times the original.
- D. The new current is 4 times the original.

37 Carlos wants to use a pneumatic system to operate an assembly line. Which of the following must be included in the pneumatic system?

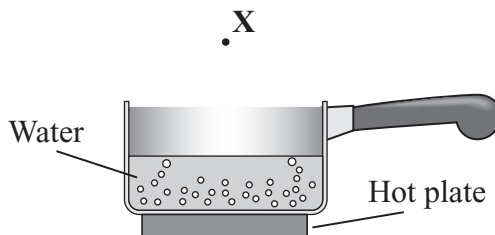
- A. transformers, generators, and turbines
- B. pumps, lines, and oil
- C. motors, gears, and electrical switches
- D. compressors, valves, and air

Questions 38 and 39 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 38 in the space provided in your Student Answer Booklet.

- 38** The diagram below represents a saucepan on a hot plate.



The saucepan is partially filled with water and the hot plate is turned on. After some time, the air at point **X** above the pan becomes hot.

- Explain how heat is transferred from the hot plate to the base of the saucepan.
- Explain how heat is transferred from the base of the saucepan to all of the water in the saucepan.
- Explain how heat is transferred from the hot water to the air at point **X**.

Write your answer to question 39 in the space provided in your Student Answer Booklet.

- 39** Traditionally, automotive companies manufactured car bodies and engines from metals such as steel. Now, some automotive companies have started to manufacture cars with plastic exterior body panels, including doors and fenders.
- From an engineering standpoint, give **one** reason why metals have traditionally been used for body panels in cars.
  - Identify **three** advantages of using plastics for body panels.
  - Explain why automotive companies are not currently able to build engines from plastics.

Mark your answers to multiple-choice questions 40 through 45 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.

40 Which of the following environmental conditions will result in the **most** heat loss from a house on a cool day?

- A. bright sun
- B. heavy fog
- C. high wind
- D. light rain

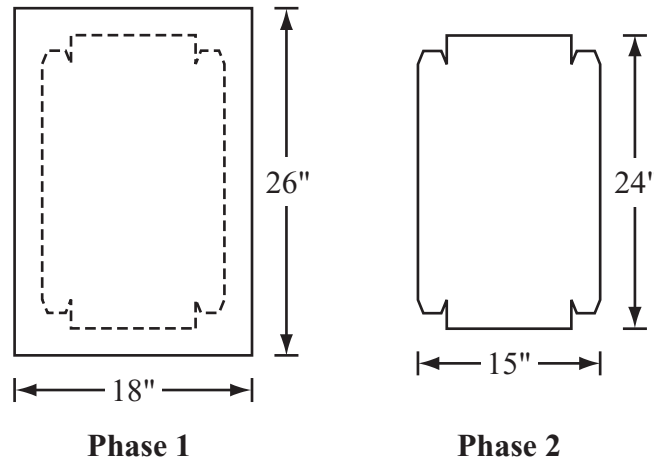
41 Which of the following would be the most important property to test when developing a paper filter for a coffeemaker?

- A. conductivity
- B. density
- C. plasticity
- D. porosity

42 Which of the following materials would probably be used as a conductor of electric current in a computer chip?

- A. glass
- B. rubber
- C. gold
- D. plastic

43 A manufacturing company is producing a metal pan from an  $18'' \times 26''$  piece of sheet metal. Two sequential phases of the production are shown below.



Which of the following processes is completed from Phase 1 to Phase 2?

- A. assembling
- B. separating
- C. finishing
- D. forming

- 44 The figure below shows insulation being sprayed into a wall.

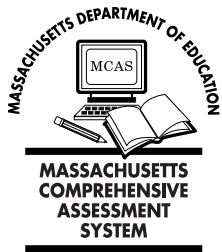


Which of the following is the **most** desirable property of this type of insulation?

- A. high retention of water
- B. high thermal expansion
- C. low coefficient of elasticity
- D. low heat transfer coefficient

- 45 Communication satellites have which of the following functions in radio and television broadcasting?

- A. encoder and source
- B. retrieval and source
- C. receiver and transmitter
- D. destination and receiver



# Massachusetts Comprehensive Assessment System

## Technology/Engineering Formula Sheet

### Formulas

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

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

$$P = I \times V$$

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

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### Variables

I = current

r = radius

P = power

R = resistance

V = voltage

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### Definitions

AC = alternating current

psi = pounds per square inch

DC = direct current

$\pi \cong 3.14$

**High School Technology/Engineering  
Spring 2007 Released Items:  
Reporting Categories, Standards, and Correct Answers**

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
1	537	<i>Fluid and Thermal Systems</i>	4.3	B
2	537	<i>Fluid and Thermal Systems</i>	3.2	B
3	537	<i>Electrical and Communications Systems</i>	6.3	D
4	537	<i>Fluid and Thermal Systems</i>	4.2	B
5	538	<i>Engineering Design</i>	1.5	B
6	538	<i>Electrical and Communications Systems</i>	6.4	D
7	539	<i>Engineering Design</i>	1.1	C
8	539	<i>Engineering Design</i>	1.4	D
9	540	<i>Electrical and Communications Systems</i>	5.3	B
10	540	<i>Engineering Design</i>	1.5	C
11	541	<i>Engineering Design</i>	1.3	
12	542	<i>Fluid and Thermal Systems</i>	3.1	C
13	542	<i>Fluid and Thermal Systems</i>	4.1	A
14	543	<i>Construction and Manufacturing</i>	2.1	C
15	543	<i>Construction and Manufacturing</i>	2.4	A
16	543	<i>Electrical and Communications Systems</i>	6.1	B
17	544	<i>Construction and Manufacturing</i>	2.2	C
18	544	<i>Engineering Design</i>	1.1	D
19	545	<i>Engineering Design</i>	1.5	A
20	546	<i>Construction and Manufacturing</i>	7.1	A
21	546	<i>Fluid and Thermal Systems</i>	4.3	D
22	546	<i>Electrical and Communications Systems</i>	5.2	B
23	547	<i>Construction and Manufacturing</i>	2.2	B
24	547	<i>Fluid and Thermal Systems</i>	3.4	D
25	548	<i>Electrical and Communications Systems</i>	5.1	
26	549	<i>Fluid and Thermal Systems</i>	3.2	B
27	549	<i>Engineering Design</i>	1.4	B
28	550	<i>Construction and Manufacturing</i>	2.4	C
29	550	<i>Electrical and Communications Systems</i>	6.3	A
30	551	<i>Construction and Manufacturing</i>	2.3	C
31	551	<i>Fluid and Thermal Systems</i>	4.2	A
32	552	<i>Engineering Design</i>	1.1	C
33	552	<i>Electrical and Communications Systems</i>	5.1	A
34	553	<i>Electrical and Communications Systems</i>	6.5	
35	554	<i>Fluid and Thermal Systems</i>	3.5	B
36	554	<i>Electrical and Communications Systems</i>	5.3	B
37	554	<i>Fluid and Thermal Systems</i>	3.2	D
38	555	<i>Fluid and Thermal Systems</i>	4.1	
39	556	<i>Construction and Manufacturing</i>	7.2	
40	557	<i>Fluid and Thermal Systems</i>	4.3	C
41	557	<i>Construction and Manufacturing</i>	2.1	D
42	558	<i>Electrical and Communications Systems</i>	5.2	C

<b>Item No.</b>	<b>Page No.</b>	<b>Reporting Category</b>	<b>Standard</b>	<b>Correct Answer (MC)*</b>
43	558	<i>Construction and Manufacturing</i>	7.1	B
44	559	<i>Construction and Manufacturing</i>	2.1	D
45	559	<i>Electrical and Communications Systems</i>	6.3	C

\* 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.