# XIV. Introductory Physics, Grade 9/10

# *Grade 9/10 Introductory Physics Pilot Test*

The spring 2004 Grade 9/10 MCAS Introductory Physics Test was based on learning standards in the Physics content strand of the Massachusetts *Science and Technology/Engineering Curriculum Framework* (2001). These learning standards appear on pages 68–70 of the *Framework*.

The *Science and Technology/Engineering Curriculum Framework* is available on the Department website at www.doe.mass.edu/frameworks/scitech/2001/0501.pdf.

Because the Grade 9/10 Introductory Physics Test was administered as a pilot test this year, the reporting of results is limited to *Test Item Analysis Reports*. No scaled score or performance level results are available.

## Test Sessions and Content Overview

The Grade 9/10 Introductory Physics Test contained two separate test sessions. Each session included multiple-choice and open-response questions. Common test items are shown on the following pages as they appeared in test booklets.

## Reference Materials and Tools

During Testing, each student taking the Grade 9/10 Introductory Physics Test was provided with a Physics Formula Sheet. A copy of this reference sheet follows the final question in this chapter. Each student also had access to a calculator with at least four functions and a square root key.

No other reference tools or materials were allowed, with the exception of bilingual word-to-word dictionaries used by limited English proficient students.

## Cross-Reference Information

The table at the conclusion of this chapter indicates the Framework learning standard that each item assesses. The correct answers for multiple-choice questions are also displayed in the table.

## HOW TO ANSWER OPEN-RESPONSE QUESTIONS

Be sure to

- read all parts of each question carefully.
- make each response as clear, complete, and accurate as you can.
- check your answers.

# Introductory Physics

## SESSION 1

**DIRECTIONS**

**This session contains ten multiple-choice questions and one open-response question. 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 The force of gravity on an object depends primarily on the object's

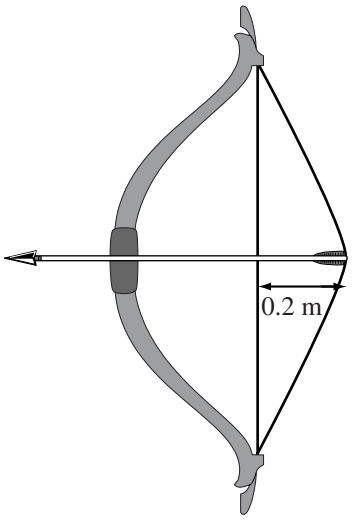
A. density.

B. mass.

C. momentum.

D. volume.

2 An archer pulls back the bowstring to prepare to shoot an arrow as shown below.




She uses an average force of 40 N, moving the bowstring 0.2 m. How much energy is stored in the bow?

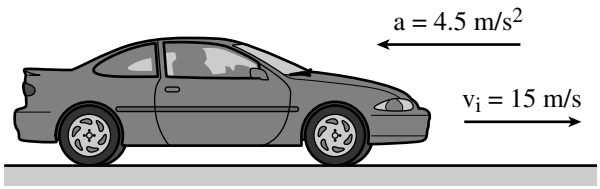
A. 8 J

B. 16 J

C. 24 J

D. 36 J

3 The illustration below shows a car slowing down.




The car was initially traveling at 15 m/s. The car slows with a negative acceleration of 4.5 m/s$^2$. How long does it take the car to slow to a final velocity of 4.0 m/s?

A. 0.89 s

B. 2.4 s

C. 11 s

D. 60 s

4 What is the mass of an asteroid with a speed of 200 m/s and a momentum of 2,000 kg • m/s?

A. 10 kg

B. 1,800 kg

C. 2,200 kg

D. 400,000 kg

5 What property of electromagnetic waves makes it possible to use these waves to transmit information between a space shuttle and NASA mission control centers on the ground?

A. Electromagnetic waves are transverse waves.

B. Electromagnetic waves have very low velocity.

C. Electromagnetic waves are all visible to human eyes.

D. Electromagnetic waves can travel through a vacuum.

6 Which of the following is the **best** example of a wave?

A. a stone rolling downhill

B. a vehicle traveling on a bumpy road

C. a string vibrating on a guitar

D. a grasshopper jumping up and down occasionally

7 Which of the following is certain to change as a ball accelerates?

A. mass of the ball

B. inertia of the ball

C. velocity of the ball

D. force acting on the ball

**Question 8 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 8 in the space provided in your Student Answer Booklet.**

8 The chart below shows the position of a car moving in a straight line.

**Position of a Car**

| Time (s) | Position (m) |
|---|---|
| 0 | 75 |
| 10 | 125 |
| 20 | 175 |
| 30 | 225 |
| 40 | 275 |

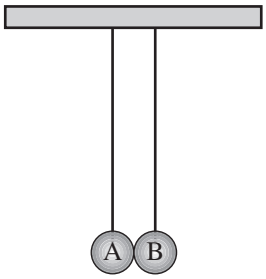
a. Use the data in the chart to draw and correctly label a position versus time graph.

b. Based on the data in the chart, what is the average speed of the car in m/s from 0 s to 40 s?

c. Based on the graph that you have drawn, describe the acceleration of the car.

**Mark your answers to multiple-choice questions 9 through 11 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.**

**9** The diagram below shows two aluminum spheres.




Aluminum sphere A contains a small negative charge and is touched by aluminum sphere B, which has a larger negative charge. Which of the following occurs next?

A. Protons flow from sphere B to sphere A.

B. Protons flow from sphere A to sphere B.

C. Electrons flow from sphere B to sphere A.

D. Electrons flow from sphere A to sphere B.

**10** Which of the following is designed to transform an electromagnetic wave into a mechanical wave?

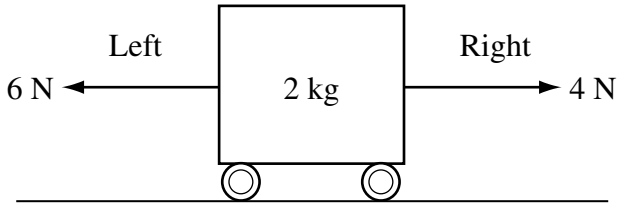
A. a portable radio

B. a television screen

C. a computer monitor

D. a mercury thermometer

**11** Two forces act on the 2 kg box shown below.




A 4 N force acts to the right and a 6 N force acts to the left. What is the net force acting on the box?

A. 10 N to the right

B. 10 N to the left

C. 2 N to the right

D. 2 N to the left

# Introductory Physics

## SESSION 2

**DIRECTIONS**

**This session contains ten multiple-choice questions and one open-response question. 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.**

**12** At a weightlifting competition, two competitors lifted the same weight to the same height. The second competitor accomplished the lift 2 seconds faster than the first competitor. This demonstrated that the second competitor had more

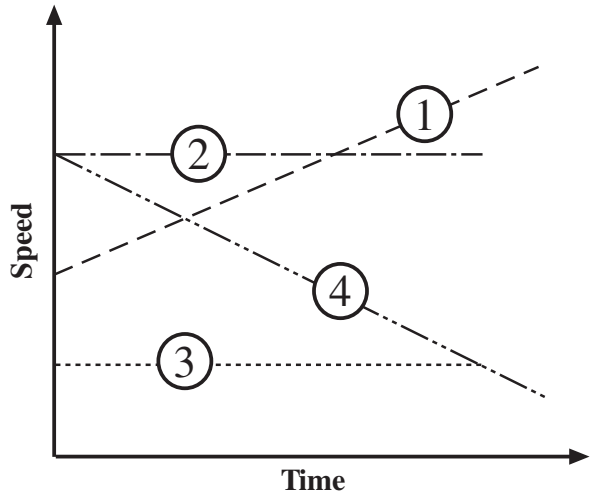
A. energy than the first.

B. inertia than the first.

C. power than the first.

D. work than the first.

**13** The graph below relates speed and time of four cars (1, 2, 3, and 4) traveling along a straight highway.




Which two cars move with zero acceleration?

A. 1 and 4

B. 2 and 3

C. 1 and 2

D. 3 and 4

14 The chart below shows a portion of the electromagnetic spectrum.

| Gamma | X-rays | Ultraviolet | Visible | Infrared | Microwave | Radio |
|---|---|---|---|---|---|---|

A plastic filter is fitted over a light. The light emits white light, but the filter only lets the longest wavelengths of visible light pass through. Which color would a person looking at the filtered light see?

A. green

B. red

C. violet

D. yellow

15 A 72 W navigation unit on a commercial aircraft has a 24 V power supply and uses 3 A of electric current. What is the electrical resistance of the navigation unit?

A. 4 Ω

B. 8 Ω

C. 13 Ω

D. 22 Ω

16 Tides, such as those along the coast of Massachusetts, are caused by gravitational attractions acting on Earth. Why is the gravitational attraction of the Moon a greater factor in determining tides than the gravitational attraction of the much larger Sun?

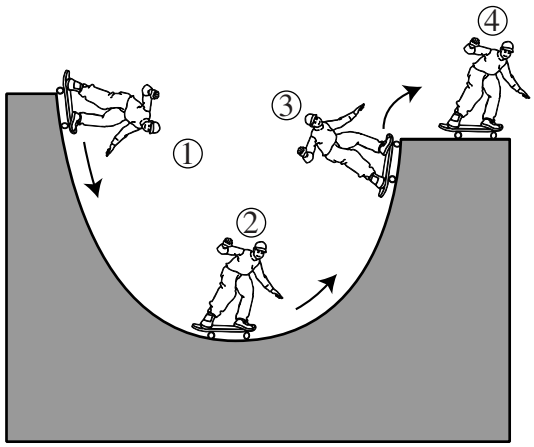
A. Earth is much closer to the Moon than to the Sun.

B. The Sun's gravity is a factor only during the day.

C. The Moon's core has a much greater density than the Sun's core.

D. The Sun's mass is smaller than the mass of the Moon.

17 A skateboarder travels from location 1 to location 4 as shown below.




At which location does the skateboarder have the **most** kinetic energy and the **least** potential energy?

A. 1

B. 2

C. 3

D. 4

**Question 18 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 18 in the space provided in your Student Answer Booklet.**

18 The table below shows initial data from a laboratory demonstration.

| Material | Mass (kg) | $T_{initial}$ (°C) | Specific heat J/kg • °C |
|---|---|---|---|
| **Water** | 0.35 | 30 | 4190 |
| **Glass beaker** | 0.50 | 30 | 500 |
| **Copper pipe** | 0.06 | 550 | 386 |

In the demonstration, a heated 0.06 kg copper pipe was dropped into a beaker of water. Students in the class were asked to predict the final temperature of the beaker of water when it reached equilibrium with the copper pipe.

a. If this demonstration took place in a closed insulated beaker, instead of in an open beaker, what would be the relationship between the heat lost by the copper and the heat gained by the water and glass?

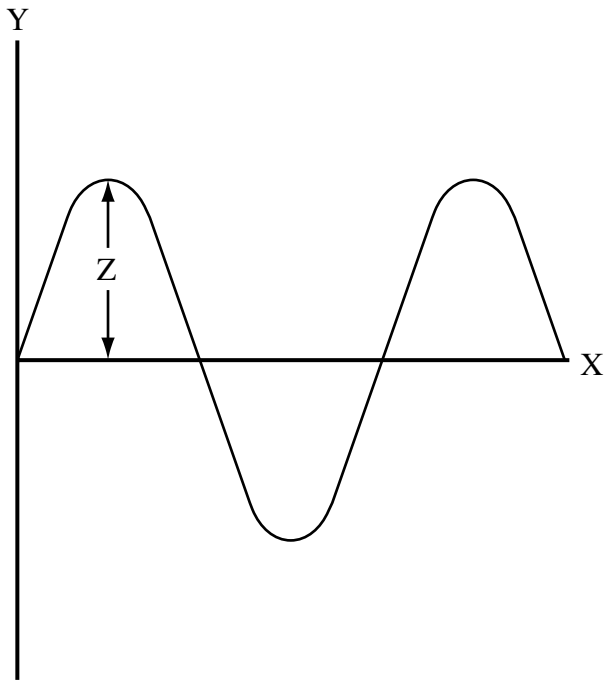
b. Which material in the table above requires the **most** heat for a given change in temperature?

c. The students found that the measured temperature was lower than they predicted. How would the students **best** explain this difference from the predicted temperature?

d. Assume a heated 0.12 kg copper pipe was used instead of the given pipe. How would this change affect the final temperatures of the water and of the glass beaker?

**Mark your answers to multiple-choice questions 19 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.**

19 The diagram below shows a wave trace.




Distance Z is a measure of

A. amplitude.

B. frequency.

C. wavelength.

D. wave speed.

20 A bowling ball with a mass of 8.0 kg rolls down a bowling lane at 2.0 m/s. What is the momentum of the bowling ball?

A. 4.0 kg • m/s

B. 6.0 kg • m/s

C. 10.0 kg • m/s

D. 16.0 kg • m/s

21 A party shop delivers helium-filled balloons to homes and businesses. The owners realize from experience that on hot summer days they should inflate the balloons only three-quarters full. On cold winter days they can fully inflate the balloons. Which of the following is the **best** hypothesis to explain this observation?

A. The helium gas is more active in the winter season.

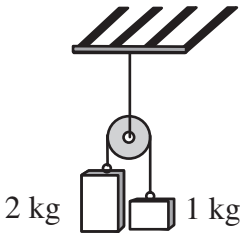
B. Air outside the balloons leaks into the balloons.

C. As the temperature increases, the helium in the balloons expands.

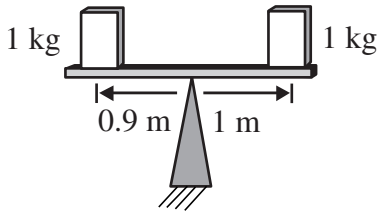
D. Outdoor air pressure in the summer is less than indoor air pressure.

22 Which of the following arrangements will remain stationary unless an external force acts on it? Assume there is no friction.

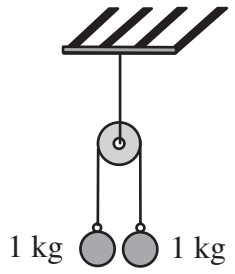
A.



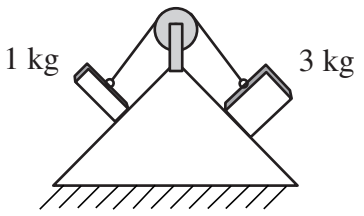

B.




C.




D.



# Massachusetts Comprehensive Assessment System
## Introductory Physics Formula Sheet

## Formulas

Average Speed $= \frac{\Delta d}{\Delta t}$

Average Acceleration: $= \frac{\Delta v}{\Delta t}$

$v_f = v_i + a\Delta t$

$\Delta d = v_i\Delta t + \frac{1}{2}a(\Delta t^2)$

$v_f^2 = v_i^2 + 2a\Delta d$

$F = ma$

$F = G\frac{m_1 m_2}{d^2}$

$KE = \frac{1}{2}mv^2$

$PE = mg\Delta h$

$W = F\Delta d$

$P = \frac{W}{\Delta t}$

$p = mv$

$V = IR$

$P = IV$

$Q = mc\Delta T$

$v = f\lambda$ and $\lambda = \frac{c}{f}$

## Variables

a = acceleration
c = specific heat
d = distance
$\Delta d$ = change in distance
f = frequency
F = force
$\Delta h$ = change in height
I = current
KE = kinetic energy
$\lambda$ = wavelength
m = mass
p = momentum
P = power
PE = gravitational potential energy
Q = heat
R = resistance
$\Delta t$ = change in time
$\Delta T$ = change in temperature
v = velocity
$\Delta v$ = change in velocity
V = voltage
W = work

**Subscripts:**
i = initial and f = final as subscripts

## Definitions

G = Universal gravitational constant $= 6.67 \times 10^{-11}\ \frac{N \cdot m^2}{kg^2}$

c = speed of electromagnetic waves $= 3.00 \times 10^8$ m/s

$g \approx 10\ m/s^2$ $\quad 1\ N = \frac{1\ kg \cdot m}{s^2}$ $\quad 1\ J = 1\ N \cdot m$ $\quad 1\ W = \frac{1\ J}{s}$

# Grade 9/10 Introductory Physics
# Spring 2004 Released Items:
# Standards and Correct Answers

| Item No. | Page No. | Standard | Correct Answer (MC)* |
|---|---|---|---|
| 1 | 311 | 1.5 | B |
| 2 | 311 | 2.1 | A |
| 3 | 312 | 1.3 | B |
| 4 | 312 | 2.5 | A |
| 5 | 312 | 6.2 | D |
| 6 | 313 | 4.1 | C |
| 7 | 313 | 1.7 | C |
| 8 | 314 | 1.4 | |
| 9 | 315 | 5.1 | C |
| 10 | 315 | 4.4 | A |
| 11 | 315 | 1.8 | D |
| 12 | 316 | 2.4 | C |
| 13 | 316 | 1.1 | B |
| 14 | 317 | 6.1 | B |
| 15 | 318 | 5.4 | B |
| 16 | 318 | 1.11 | A |
| 17 | 318 | 2.2 | B |
| 18 | 319 | 3.3 | |
| 19 | 320 | 4.2 | A |
| 20 | 320 | 2.5 | D |
| 21 | 321 | 3.1 | C |
| 22 | 321 | 1.6 | 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 website later this year.