BRITISH COLUMBIA

© 2003 Ministry of Education

Physics 12

AUGUST 2003

Course Code = PH

Student Instructions

1. Place the stickers with your Personal Education Number (PEN) in the allotted spaces above. **Under no circumstance is your name or identification, other than your Personal Education Number, to appear on this booklet.**

2. Ensure that in addition to this examination booklet, you have an **Examination Response Form**. Follow the directions on the front of the Response Form.

3. **Disqualification** from the examination will result if you bring books, paper, notes or unauthorized electronic devices into the examination room.

4. When instructed to open this booklet, **check the numbering of the pages** to ensure that they are numbered in sequence from page one to the last page, which is identified by

   END OF EXAMINATION .

5. At the end of the examination, place your Response Form inside the front cover of this booklet and return the booklet and your Response Form to the supervisor.

Question 1:

1. ⬜ . ⬜

(7)

Question 2:

2. ⬜ . ⬜

(7)

Question 3:

3. ⬜ . ⬜

(7)

Question 4:

4. ⬜ . ⬜

(7)

Question 5:

5. ⬜ . ⬜

(7)

Question 6:

6. ⬜ . ⬜

(9)

Question 7:

7. ⬜ . ⬜

(7)

Question 8:

8. ⬜ . ⬜

(5)

Question 9:

9. ⬜ . ⬜

(4)

PHYSICS 12

AUGUST 2003

COURSE CODE = PH

GENERAL INSTRUCTIONS

1. Aside from an approved calculator, electronic devices, including dictionaries and pagers, are **not** permitted in the examination room.

2. All multiple-choice answers must be entered on the Response Form using an **HB pencil**. Multiple-choice answers entered in this examination booklet will **not** be marked.

3. For each of the written-response questions, write your answer in the space provided in this booklet. Rough-work space has been incorporated into the space allowed for answering each written-response question. You may not need all of the space provided to answer each question.

4. Ensure that you use language and content appropriate to the purpose and audience of this examination. Failure to comply may result in your paper being awarded a zero.

5. This examination is designed to be completed in **two hours**. *Students may, however, take up to 30 minutes of additional time to finish.*

PHYSICS 12 PROVINCIAL EXAMINATION

		Value	**Suggested Time**
1.	This examination consists of **two** parts:		
	PART A: 30 multiple-choice questions worth two marks each	60	60
	PART B: 9 written-response questions	60	60
	Total:	**120 marks**	**120 minutes**

2. The last **three** pages inside the back cover contain the **Table of Constants**, **Mathematical Equations**, **Formulae,** and **Rough Work for Multiple-Choice**. These pages may be detached for convenient reference prior to writing this examination.

3. **A calculator is essential for the Physics 12 Provincial Examination.** The calculator must be a hand-held device designed primarily for mathematical computations involving logarithmic and trigonometric functions and may be capable of performing graphing functions. Computers, calculators with a QWERTY keyboard or symbolic manipulation abilities, and electronic writing pads will not be allowed. Students must not bring any external devices (peripherals) to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, CD-ROMs, libraries or external keyboards. Students may have more than one calculator available during the examination, of which one may be a scientific calculator. Calculators may not be shared and must not have the ability to either transmit or receive electronic signals. In addition to an approved calculator, students will be allowed to use rulers, compasses, and protractors during the examination.

4. a) Final answers must include appropriate **units**.

    b) Marks will not be deducted for answers expressed to **two** or **three** significant figures.

    c) In this examination the zero in a number such as 30 shall be considered to be a significant zero.

5. You are expected to communicate your knowledge and understanding of physics principles in a clear and logical manner. Partial marks will be awarded for steps and assumptions leading to a solution. Full marks will **not** be awarded for providing **only** a final answer.

    If you are unable to determine the value of a quantity required in order to proceed, you may assume a reasonable value and continue toward the solution. Such a solution, however, may not be eligible for full marks.

THIS PAGE INTENTIONALLY BLANK
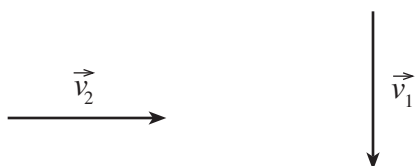
Value: 60 marks (2 marks per question)   **Suggested Time: 60 minutes**
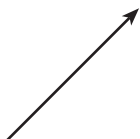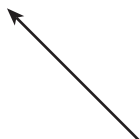
INSTRUCTIONS: For each question, select the **best** answer and record your choice on the Response Form provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. The velocity of a moving object as observed from another moving object is called its

   A.   relative velocity.
   B.   associated velocity.
   C.   differential velocity.
   D.   comparative velocity.

2. Consider the two vectors shown below.
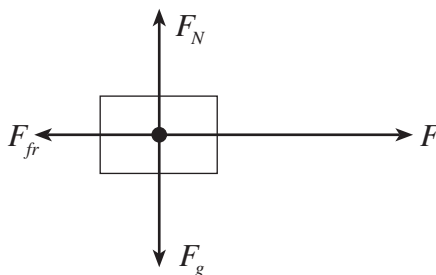
   Which of the choices given best represents $\vec{v_2} - \vec{v_1}$?

   A.   B.   C.   D.

3. A green ball rolls off of the end of a table at 2.5 m/s. The table top is 1.5 m above the floor. How much time passes before the ball hits the floor?

   A.   0.35 s
   B.   0.55 s
   C.   0.60 s
   D.   1.2 s

OVER

4. The free body diagram shown below is for a block being accelerated across a floor to the right by the force F. Which of the following represents the coefficient of friction for this situation?

A. $\dfrac{F}{F_g}$

B. $\dfrac{F_{fr}}{F}$

C. $\dfrac{F_N}{F_g}$

D. $\dfrac{F_{fr}}{F_N}$

5. A 6.0 kg object is projected directly upward with an initial speed of 15 m/s. This object experiences an average air resistance force of 24 N. What is the maximum height reached by this object?

A. 8.2 m
B. 11 m
C. 16 m
D. 19 m

6. Which of the following correctly identifies momentum and impulse as scalar or vector quantities?
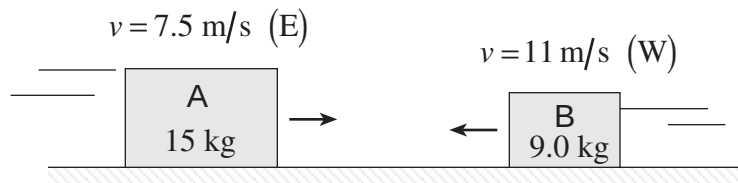
	MOMENTUM	IMPULSE
A.	scalar	scalar
B.	scalar	vector
C.	vector	scalar
D.	vector	vector

7. A 0.26 kg ball travelling due west at 22 m/s was hit by a bat and as a result the ball travelled due east at 18 m/s. If the bat remained in contact with the ball for 0.13 s, what average force did the bat exert on the ball?
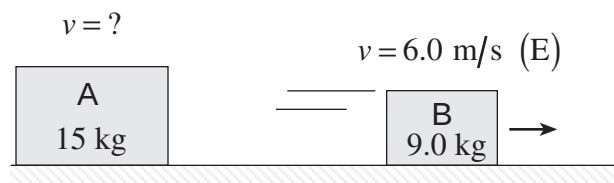
   A. 8.0 N
   B. 80 N
   C. 116 N
   D. 310 N

8. Block A of mass 15 kg is travelling at 7.5 m/s due east when it collides with block B of mass 9.0 kg travelling at 11 m/s due west. Block B bounces back at 6.0 m/s.

Before

$v = 7.5$ m/s (E)

$v = 11$ m/s (W)

| A | | B |
| 15 kg | | 9.0 kg |

After

$v = ?$

$v = 6.0$ m/s (E)

| A | | B |
| 15 kg | | 9.0 kg |
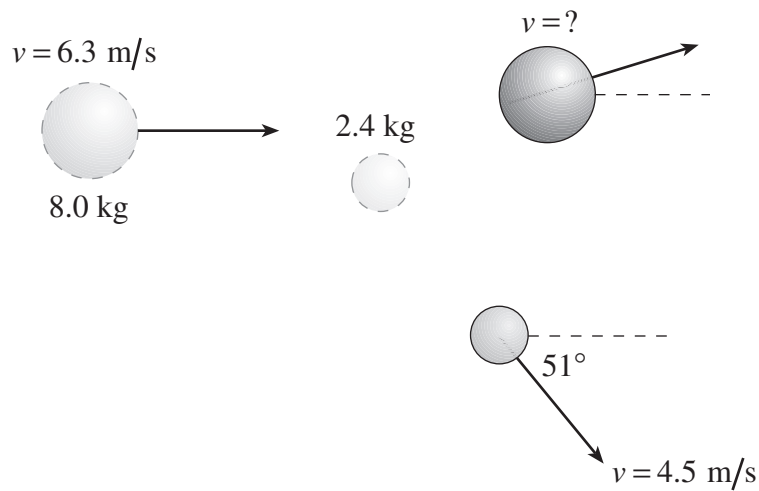
With what speed and in what direction will block A move?

	SPEED	DIRECTION
A.	2.7 m/s	East
B.	2.7 m/s	West
C.	4.5 m/s	East
D.	4.5 m/s	West

OVER
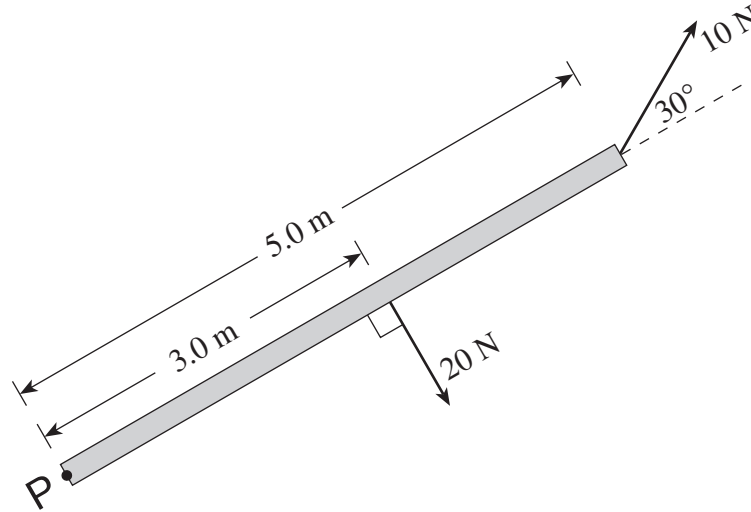
9. An 8.0 kg ball travelling at 6.3 m/s due east strikes a 2.4 kg ball initially at rest. The collision is oblique, causing the 2.4 kg ball to travel at 4.5 m/s at 51° south of east.
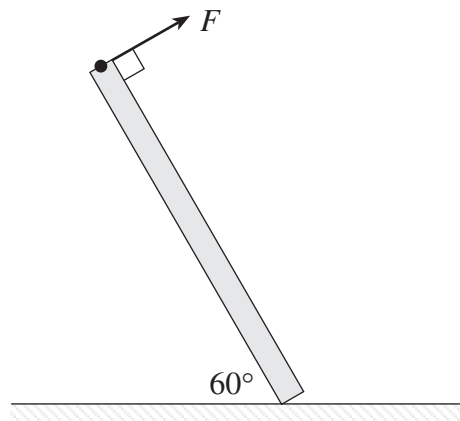
What speed will the 8.0 kg ball have after the collision?

A. 5.0 m/s
B. 5.6 m/s
C. 5.8 m/s
D. 7.7 m/s

10. A physics exam booklet lying on a table in front of you is in translational equilibrium because

A. there are no forces acting on it.
B. the forces acting on it are balanced.
C. the force due to gravity is holding it down.
D. surface friction is preventing it from sliding.

11. Determine the sum of the torques about the point P for the two forces shown below acting on a very light wooden beam. (Ignore its weight.)

   A. $10 \, \text{N} \cdot \text{m}$
   B. $17 \, \text{N} \cdot \text{m}$
   C. $35 \, \text{N} \cdot \text{m}$
   D. $85 \, \text{N} \cdot \text{m}$

12. The 0.10 kg metre stick shown below is held up by the perpendicular force F. The bottom of the metre stick is on the verge of sliding to the right.
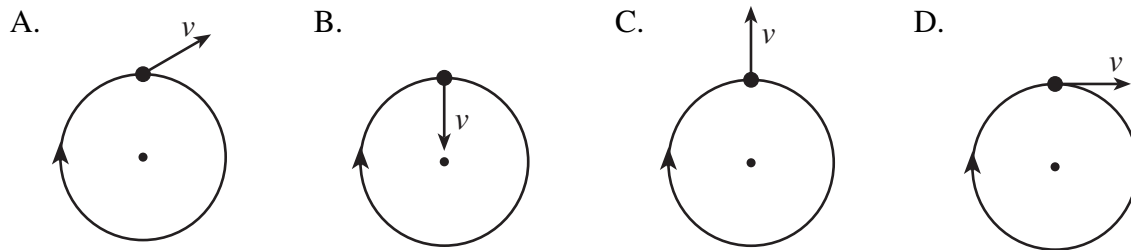
Determine the size of the friction force being provided by the floor.

   A. 0.12 N
   B. 0.21 N
   C. 0.25 N
   D. 0.49 N
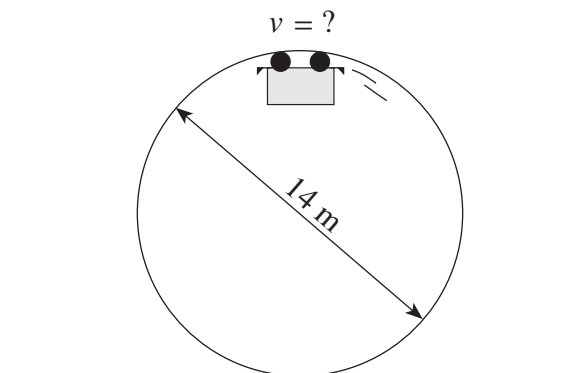
13. Which of the following correctly shows the velocity vector, *v*, for an object in uniform circular motion?

A.   B.   C.   D.

14. An airplane is flying in a horizontal circle at a speed of 86 m/s. The 72 kg pilot does not want his centripetal acceleration to exceed 68.6 m/s^2. What is the minimum radius of the circular path?

   A.   90 m
   B.   110 m
   C.   750 m
   D.   7700 m
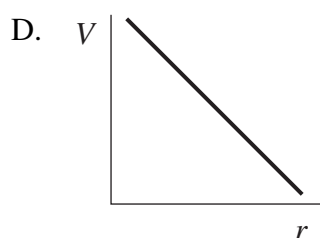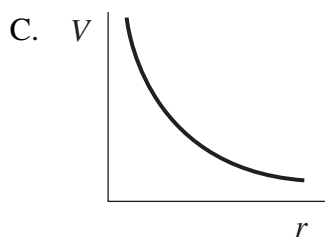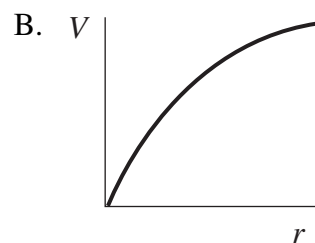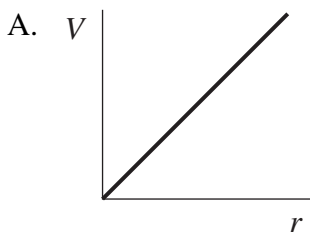
15. A roller coaster car is moving past the top of a loop of diameter 14 m as shown below. The normal force (directed downwards) provided by the track at the top of the loop is equal to one-half the weight of the car.

$v = ?$

14 m

What is the speed of the coaster car at this point?
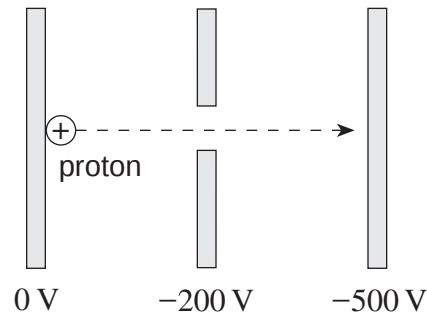
   A.   5.9 m/s
   B.   8.3 m/s
   C.   10 m/s
   D.   14 m/s

16. The earth pulls an apple towards its centre with a force of 4.9 N. Which of the following is correct?

    A. The apple attracts the earth with a force of 4.9 N.
    B. The apple does not exert an attractive force on the earth.
    C. The apple attracts the earth with a force that is less than 4.9 N.
    D. The apple attracts the earth with a force that is more than 4.9 N.

17. A 2500 kg space probe is sitting on the surface of an asteroid of mass 4.8×10^{14} kg. The asteroid has a radius of 3.5×10^{4} m. What is the force of attraction between the space probe and the asteroid?

    A. 2.6×10^{-5} N
    B. 6.5×10^{-2} N
    C. 9.1×10^{-1} N
    D. 2.3×10^{3} N

18. A satellite circling the earth completes each orbit in 5.10×10^{3} s. What is the gravitational field strength at the location of the satellite's orbit?

    A. 3.08 m/s^2
    B. 9.68 m/s^2
    C. 9.72 m/s^2
    D. 9.80 m/s^2

19. Which of the following shows how electric potential varies with distance from a positive point charge?

    A. V

    B. V

    C. V

    D. V
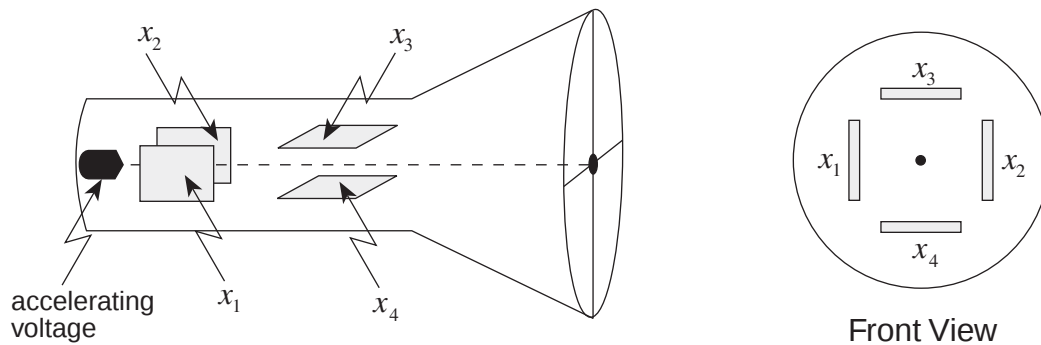
OVER

20. At what speed will a proton, accelerated from rest, hit the plate at the right?

0 V   −200 V   −500 V
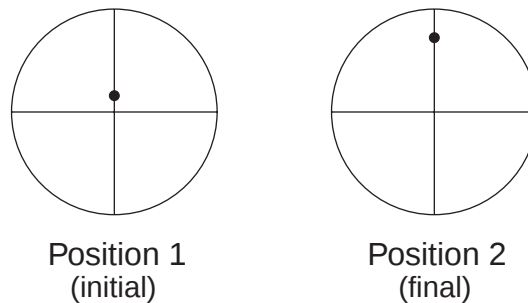
A. 2.2×10^5 m/s
B. 2.4×10^5 m/s
C. 3.1×10^5 m/s
D. 4.4×10^5 m/s

21. Two views of a cathode ray tube are shown below.

Front View
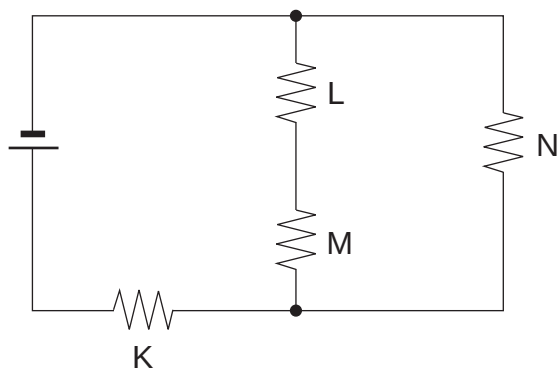
The beam is then adjusted to Position 1 as shown below.

Position 1   Position 2
(initial)   (final)

In order to change the electron beam from Position 1 to Position 2, a student can
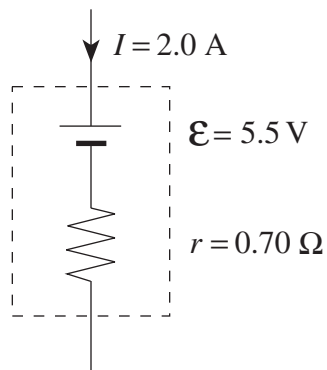
A. make plate x_2 more positive.
B. make plate x_4 more positive.
C. increase the accelerating voltage.
D. decrease the accelerating voltage.

22. All the resistors shown in the circuit have the same resistance value.

Which resistor dissipates the most heat?
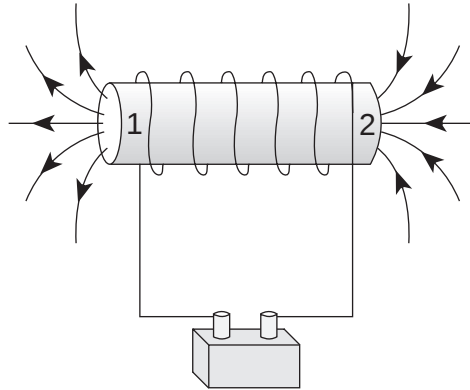
A. K
B. L
C. M
D. N

23. A battery is being charged by a 2.0 A current as shown in the diagram below.

What is the terminal voltage of this battery?

A. 1.4 V
B. 4.1 V
C. 5.5 V
D. 6.9 V

24. Identify the magnetic poles 1 and 2 of the current-carrying solenoid in the diagram below.
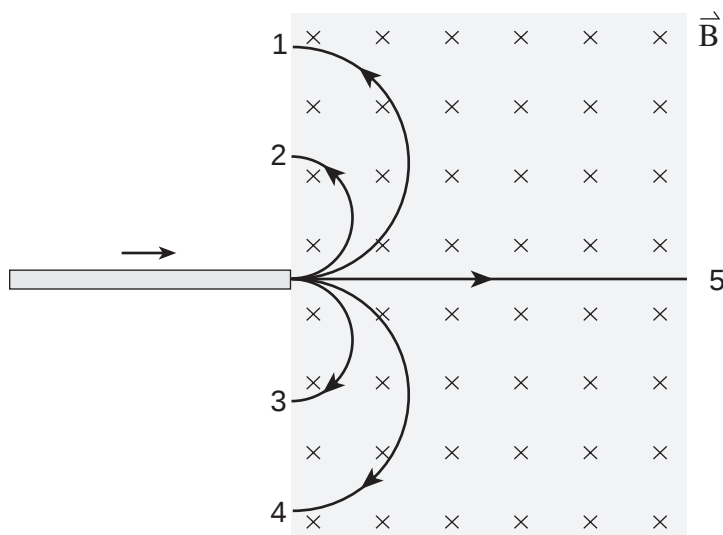
	POLE 1	POLE 2
A.	North	North
B.	North	South
C.	South	North
D.	South	South

25. Determine the direction of the magnetic force on the current-carrying conductor in the diagram below.

A. Towards the left
B. Towards the right
C. Towards the top of the page
D. Towards the bottom of the page

26. A beam made up of ions of various charges and masses enters a uniform magnetic field as shown.
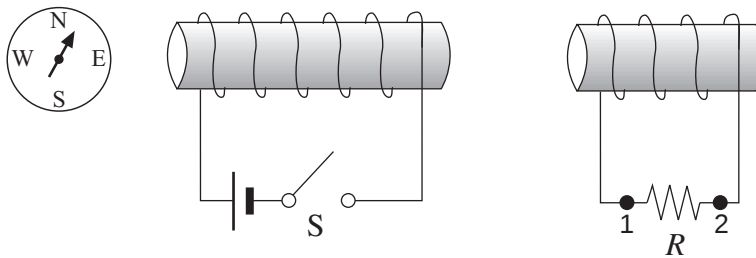
One type of ion is observed to follow path 2. Which path describes the one taken by an oppositely charged ion with twice the mass and twice the charge? (Assume all ions have the same speed.)

A. Path 1
B. Path 3
C. Path 4
D. Path 5

27. A step-down transformer is required to operate a 12 V, 25 W halogen lamp. Which of the following sets of conditions could apply to this transformer?

A. $N_p = 20, \ N_s = 200$
B. $V_p = 120 \text{ V}, \ I_s = 0.21 \text{ A}$
C. $I_p = 2.1 \text{ A}, \ I_s = 2.1 \text{ A}$
D. $V_p = 120 \text{ V}, \ I_p = 0.21 \text{ A}$

28. A 0.25 m wire is perpendicular to a uniform 0.20 T magnetic field. What force is exerted on this wire when it carries a 15 A current?

   A. 0.12 N
   B. 0.75 N
   C. 3.0 N
   D. 6.0 N

29. As switch S is closed, in what direction does the compass needle point and what is the direction of the current through resistor R?

	COMPASS NEEDLE DIRECTION	CURRENT DIRECTION THROUGH R
A.	west	From 1 to 2
B.	west	From 2 to 1
C.	east	From 1 to 2
D.	east	From 2 to 1

30. One method for determining masses of heavy ions involves timing their orbital period in a known magnetic field. What is the mass of a singly charged ion that makes 7.0 revolutions in 1.3×10^{-3} s in a 4.5×10^{-2} T field?

   A. 2.1×10^{-25} kg
   B. 1.3×10^{-24} kg
   C. 6.5×10^{-23} kg
   D. 5.0×10^{-20} kg

This is the end of the multiple-choice section.
Answer the remaining questions directly in this examination booklet.
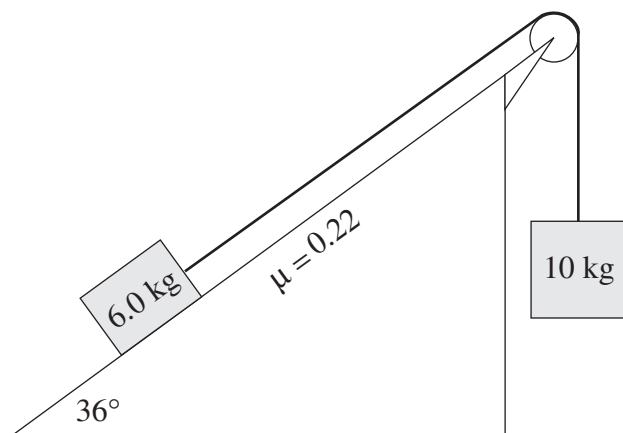
Value: 60 marks   **Suggested Time: 60 minutes**

INSTRUCTIONS:	1. Rough-work space has been incorporated into the space allowed for answering each written-response question. You may not need all of the space provided to answer each question.

2. a) Final answers must include appropriate **units**.
   b) Marks will not be deducted for answers expressed to **two** or **three** significant figures.
   c) In this examination the zero in a number such as 30 shall be considered to be a significant zero.

3. You are expected to communicate your knowledge and understanding of physics principles in a clear and logical manner. Partial marks will be awarded for steps and assumptions leading to a solution.

4. If you are unable to determine the value of a quantity required in order to proceed, you may assume a reasonable value and continue toward the solution. Such a solution, however, may not be eligible for full marks.

5. **Full marks will NOT be awarded for providing only a final answer.**

1. Determine the acceleration of the system of masses shown below when it is released. **(7 marks)**

ANSWER:

acceleration: _____

2. A motor using 3.7×10^3 W is 81% efficient. This motor is pulling a 450 kg block along a horizontal surface. If the coefficient of friction is 0.35, what is the speed of the block?

(7 marks)

motor

450 kg

$\mu = 0.35$

```
ANSWER:


speed:  _____
```
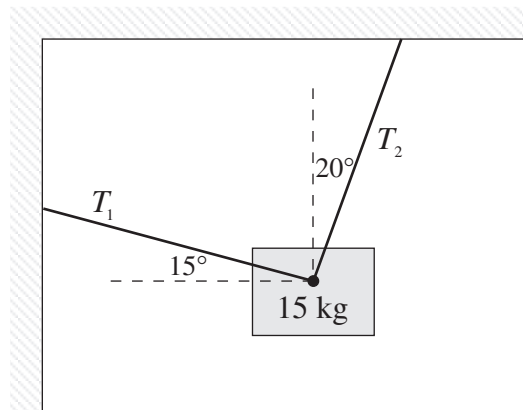
3. A 15 kg store sign is hung using two ropes as shown below. Determine the tension in each rope. **(7 marks)**
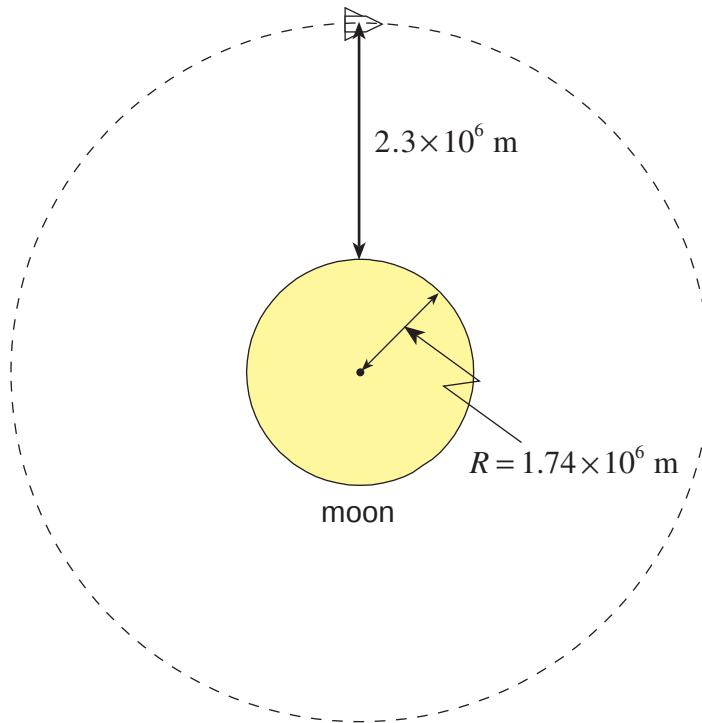
ANSWER:

tension T_1: _____

tension T_2: _____

4. A 1500 kg satellite orbits the moon at an altitude of 2.3×10^6 m.

2.3×10^6 m

$R = 1.74 \times 10^6$ m

moon

What is the period of the satellite? **(7 marks)**
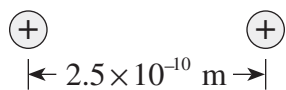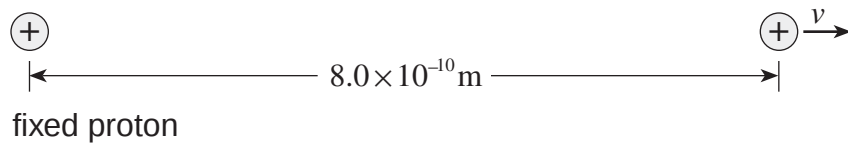
OVER

5. Two protons are initially held at rest 2.5×10^{-10} m apart.

If one of the protons is released as shown below, what is its speed when it is 8.0×10^{-10} m from the fixed proton? **(7 marks)**

fixed proton
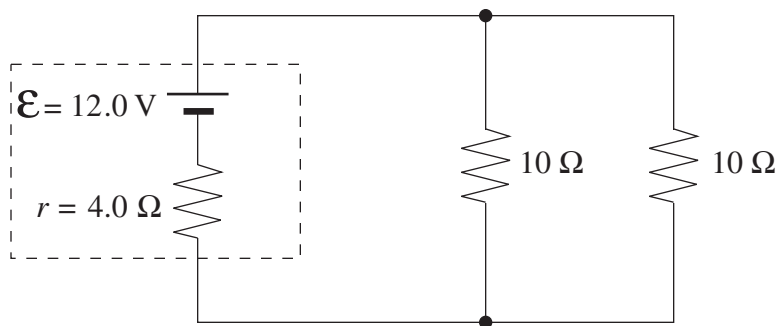
```
ANSWER:


speed of proton: _____
```

6. a) For the circuit below, what is the terminal voltage of the battery?   **(4 marks)**

$\mathcal{E} = 12.0$ V

$r = 4.0$ Ω

10 Ω 10 Ω
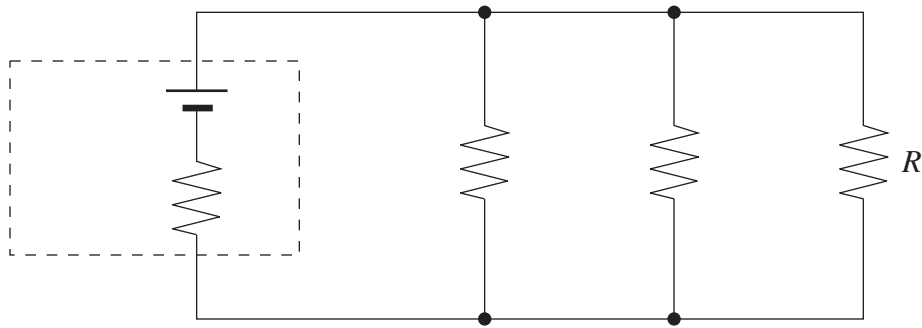
ANSWER:

terminal voltage: _____

b) If resistor *R* is added in parallel to the circuit as shown, what is the effect on the terminal voltage? **(1 mark)**
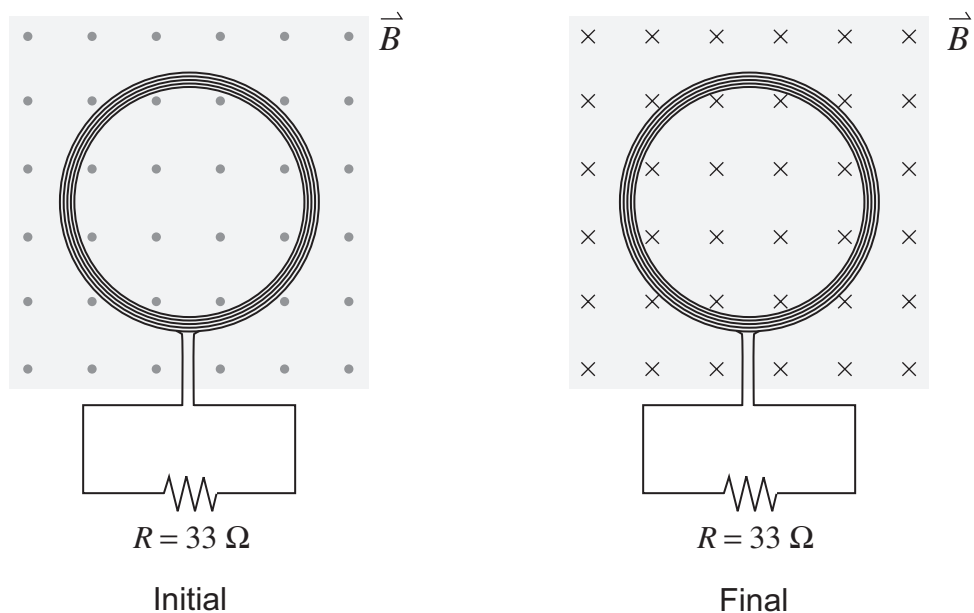
❏ increase
❏ no change
❏ decrease

c) Using principles of physics, explain your choice for b). **(4 marks)**

_____

_____

_____

_____

_____

_____

OVER

7. A 0.120 m diameter coil consisting of 200 loops is placed in a 0.35 T magnetic field. The magnetic field is changed to 0.25 T in the opposite direction in 0.80 s.

Initial

Final

What is the magnitude of the current through the 33 Ω resistor connected to the coil? (Ignore the resistance of the coil.) **(7 marks)**
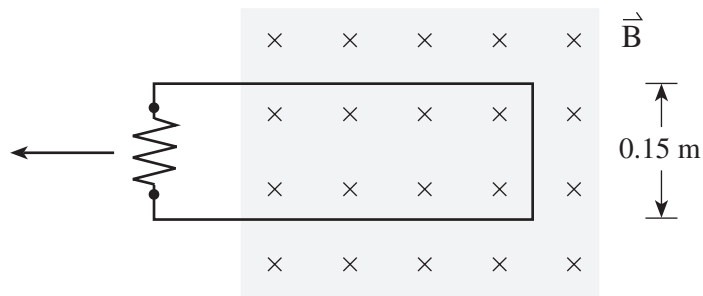
ANSWER:

magnitude of current: _____

8. A conducting loop is pulled at various speeds through a region of constant magnetic field strength.
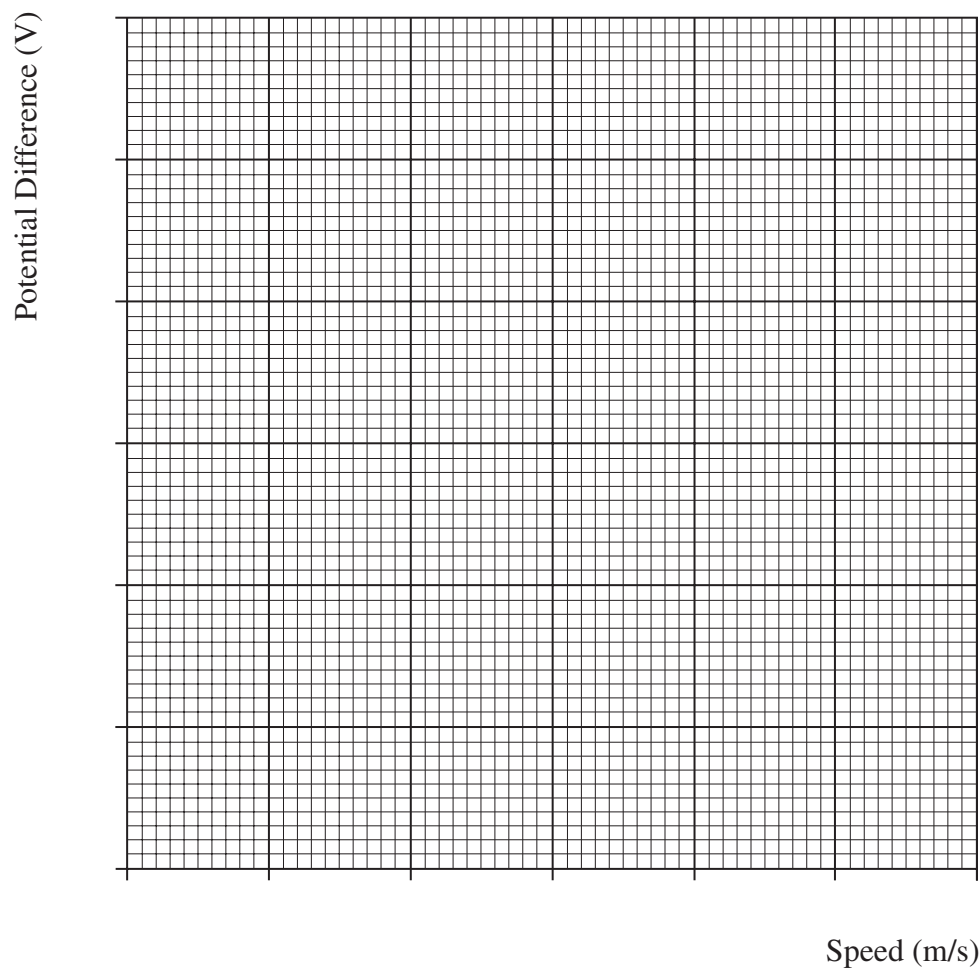
A student measures the potential difference across the resistor in the loop for each trial and records the following data.

POTENTIAL DIFFERENCE (V)	SPEED (m/s)
0.10	1.5
0.17	2.5
0.20	3.0
0.24	4.0
0.34	5.5
0.41	6.0

a) Plot a graph of the potential difference vs. speed. **(2 marks)**

Potential Difference (V)

Speed (m/s)

b) Calculate the slope of your graph. (Include units.) **(1 mark)**

c) What is the strength of the magnetic field? **(2 marks)**
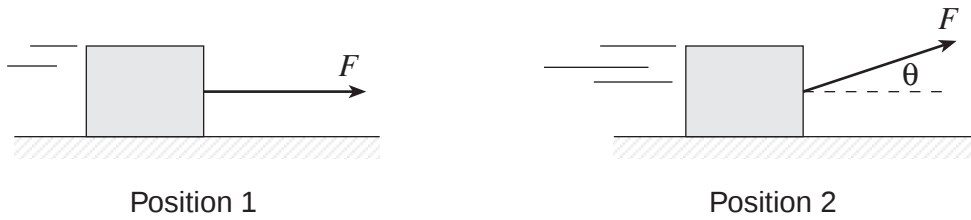
ANSWER:

b) slope: _____

c) strength of magnetic field:

_____

OVER

9. A crate is being accelerated across a rough concrete floor by a rope as shown in position 1 below. It is noticed that when the rope is lifted to a small angle θ as shown in position 2 the acceleration of the crate increases (*F* remains the same).

Position 1   Position 2

Using principles of physics, explain why this is the case.   **(4 marks)**

_____

_____

_____

_____

_____

_____

END OF EXAMINATION
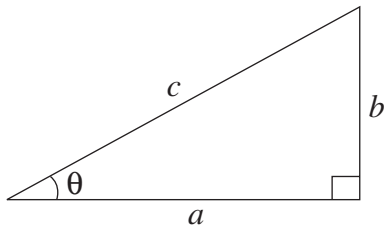
TABLE OF CONSTANTS

Gravitational constant .... $G = 6.67 \times 10^{-11} \, \text{N} \cdot \text{m}^2/\text{kg}^2$

Acceleration due to gravity at the surface of Earth
      (for the purposes of this examination)..................................... $g = 9.80 \, \text{m/s}^2$

Earth
radius	$= 6.38 \times 10^6 \, \text{m}$
radius of orbit about Sun	$= 1.50 \times 10^{11} \, \text{m}$
period of rotation	$= 8.61 \times 10^4 \, \text{s}$
period of revolution about Sun	$= 3.16 \times 10^7 \, \text{s}$
mass	$= 5.98 \times 10^{24} \, \text{kg}$

Moon
radius	$= 1.74 \times 10^6 \, \text{m}$
radius of orbit about Earth	$= 3.84 \times 10^8 \, \text{m}$
period of rotation	$= 2.36 \times 10^6 \, \text{s}$
period of revolution about Earth	$= 2.36 \times 10^6 \, \text{s}$
mass	$= 7.35 \times 10^{22} \, \text{kg}$

Sun
mass	$= 1.98 \times 10^{30} \, \text{kg}$

Constant in Coulomb's Law .... $k = 9.00 \times 10^9 \, \text{N} \cdot \text{m}^2/\text{C}^2$

Elementary charge.. $e = 1.60 \times 10^{-19} \, \text{C}$

Mass of electron... $m_e = 9.11 \times 10^{-31} \, \text{kg}$

Mass of proton .... $m_p = 1.67 \times 10^{-27} \, \text{kg}$

Mass of neutron... $m_n = 1.68 \times 10^{-27} \, \text{kg}$

Permeability of free space... $\mu_o = 4\pi \times 10^{-7} \, \text{T} \cdot \text{m/A}$

Speed of light .... $c = 3.00 \times 10^8 \, \text{m/s}$

You may detach this page for convenient reference.
Exercise care when tearing along perforations.

i

MATHEMATICAL EQUATIONS

For Right-angled Triangles:
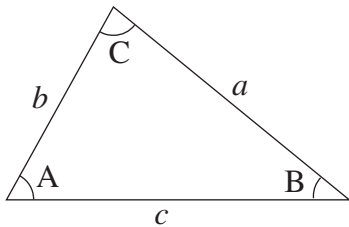
$$a^2 + b^2 = c^2$$

$$\sin\theta = \frac{b}{c} \qquad \cos\theta = \frac{a}{c} \qquad \tan\theta = \frac{b}{a}$$

$$\text{area} = \frac{1}{2}\,ab$$

For All Triangles:

$$\text{area} = \frac{1}{2}\,\text{base} \times \text{height}$$

$$\sin 2A = 2\sin A \cos A$$

Sine Law: $\quad \dfrac{\sin A}{a} = \dfrac{\sin B}{b} = \dfrac{\sin C}{c}$

Cosine Law: $c^2 = a^2 + b^2 - 2\,ab\ \cos C$

Circle:

$$\text{Circumference} = 2\pi r$$

$$\text{Area} = \pi r^2$$

Sphere:

$$\text{Surface area} = 4\pi r^2$$

$$\text{Volume} = \frac{4}{3}\pi r^3$$

Quadratic Equation:

$$\text{If }\ ax^2 + bx + c = 0, \quad \text{then }\ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

FORMULAE

Vector Kinematics in Two Dimensions:

$$v = v_0 + at \qquad\qquad \bar{v} = \frac{v + v_0}{2}$$

$$v^2 = v_0{}^2 + 2ad \qquad\qquad d = v_0 t + \frac{1}{2}at^2$$

Vector Dynamics:

$$F_{net} = ma \qquad\qquad F_g = mg$$

$$F_{fr} = \mu F_N$$

Work, Energy, and Power:

$$W = Fd \qquad\qquad E_p = mgh$$

$$E_k = \frac{1}{2}mv^2 \qquad\qquad P = \frac{W}{t}$$

Momentum:

$$p = mv \qquad\qquad \Delta p = F\Delta t$$

Equilibrium:

$$\tau = Fd$$

Circular Motion:

$$a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$$

Gravitation:

$$F = G\frac{m_1 m_2}{r^2} \qquad\qquad E_p = -G\frac{m_1 m_2}{r}$$

You may detach this page for convenient reference.
Exercise care when tearing along perforations.

Electrostatics:

$$F = k\frac{Q_1 Q_2}{r^2} \qquad E = \frac{F}{Q}$$

$$\Delta V = \frac{\Delta E_p}{Q} \qquad E = \frac{\Delta V}{d}$$

$$E_p = k\frac{Q_1 Q_2}{r} \qquad V = \frac{kQ}{r}$$

Electric Circuits:

$$I = \frac{Q}{t} \qquad\qquad V = IR$$

$$V_{terminal} = \mathcal{E} \pm Ir \qquad P = IV$$

Electromagnetism:

$$F = BIl \qquad\qquad F = QvB$$

$$B = \mu_0 n I = \mu_0 \frac{N}{l} I \qquad \mathcal{E} = Blv$$

$$\Phi = BA \qquad\qquad \mathcal{E} = -N\frac{\Delta\Phi}{\Delta t}$$

$$V_{back} = \mathcal{E} - Ir$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

You may detach this page for convenient reference.
Exercise care when tearing along perforations.