JUNE 1998

PROVINCIAL EXAMINATION

MINISTRY OF EDUCATION

PHYSICS 12

GENERAL INSTRUCTIONS

1. Insert the stickers with your Student I.D. Number (PEN) in the allotted spaces above and on the **back** cover of this booklet. **Under no circumstance is your name or identification, other than your Student I.D. 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. 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.

5. For each of the written-response questions, write your answer in the space provided in this booklet.

6. 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 .

7. 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.

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

3. 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.

4. 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.

5. **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. Computers, calculators with a QWERTY keyboard, and electronic writing pads will not be allowed. Students must not bring any external devices to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, or external keyboards. Students may have more than one calculator available during the examination. Calculators may not be shared, and communication between calculators is prohibited during the examination. In addition to an approved calculator, students will be allowed to use rulers, compasses, and protractors during the examination.

6. 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.

7. 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.

8. The time allotted for this examination is **two hours**.

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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. A ball is kicked into the air from the surface of a playing field. If friction is negligible, the ball will follow a path that is

    A. circular.
    B. elliptical.
    C. parabolic.
    D. hyperbolic.

2. A rock is thrown from ground level at $18 \text{ m/s}, 25°$ above horizontal. What are the vertical and horizontal components of its launch velocity?

	VERTICAL COMPONENT	HORIZONTAL COMPONENT
A.	16 m/s	7.6 m/s
B.	7.6 m/s	16 m/s
C.	20 m/s	9.3 m/s
D.	9.3 m/s	20 m/s

3. A motorcycle accelerates uniformly from 12 m/s to 30 m/s while travelling 420 m. Its acceleration is

    A. 0.043 m/s^2
    B. 0.050 m/s^2
    C. 0.10 m/s^2
    D. 0.90 m/s^2

4. State whether mass and weight are scalar or vector quantities.

	MASS	WEIGHT
A.	Scalar	Scalar
B.	Scalar	Vector
C.	Vector	Scalar
D.	Vector	Vector

OVER

5. A 72 kg skydiver drops from a helicopter and is accelerating downwards at 8.6 m/s². Find the friction force acting on him.

A. 86 N
B. 620 N
C. 710 N
D. 1 300 N

6. The graph below shows how the force acting on an object varies with distance.
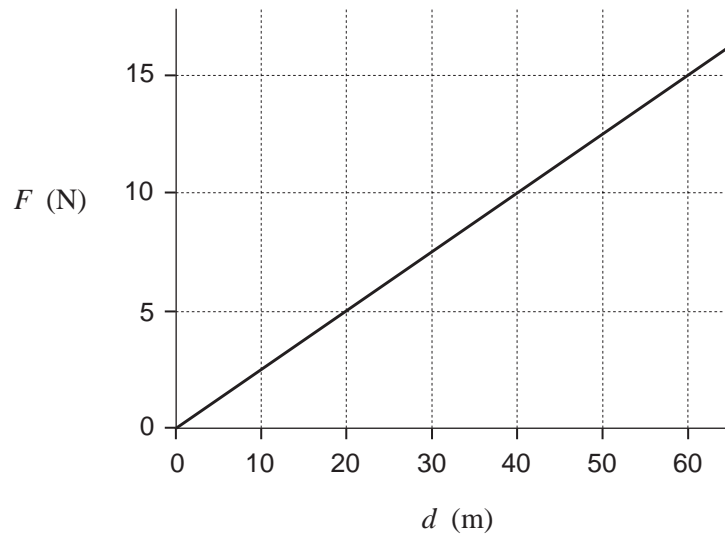
What is the work done in moving the object from 20 m to 60 m?

A. 50 J
B. 100 J
C. 400 J
D. 900 J

7. Which of the following are equivalent units for change in momentum?

A. $kg \cdot m/s^2$
B. $N \cdot s$
C. $kg \cdot s/m$
D. N/s

8. A 1.2 kg ball moving due east at 40 m/s strikes a stationary 6.0 kg object. The 1.2 kg ball rebounds to the west at 25 m/s. What is the speed of the 6.0 kg object after the collision?

   A. 3.0 m/s
   B. 13 m/s
   C. 15 m/s
   D. 65 m/s

9. In which direction should a force act at point P to hold the boom in equilibrium so that the force will be a minimum?
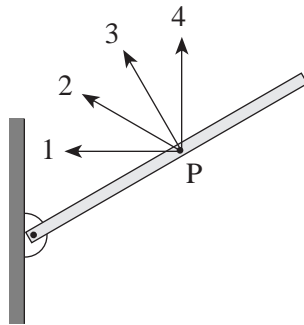
   A. 1
   B. 2
   C. 3
   D. 4

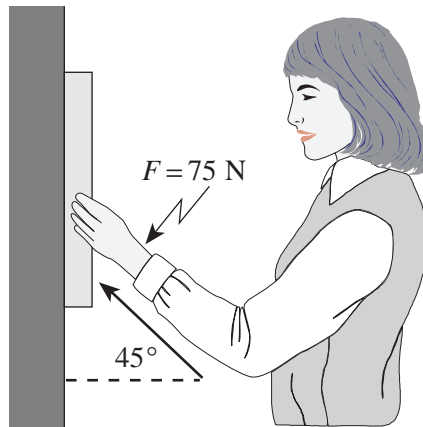10. A uniform 16.0 kg boom of length 4.0 m is supported by a rope as shown.
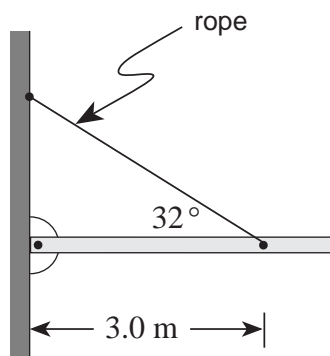
   Find the tension in the rope.

   A. 1.0×10^2 N
   B. 1.2×10^2 N
   C. 2.0×10^2 N
   D. 3.0×10^2 N

OVER

11. An artist must push with a minimum force of 75 N at an angle of 45° to a picture to hold it in equilibrium. The coefficient of friction between the wall and the picture frame is 0.30. What is the mass of the picture?

$F = 75$ N

45°

   A. 1.6 kg
   B. 2.3 kg
   C. 3.8 kg
   D. 7.0 kg

12. Two masses m_1 and m_2 are separated by a distance d. Which of the following would increase the force of gravity acting on m_1 due to m_2?

   A. Increasing d.
   B. Decreasing d.
   C. Decreasing m_1.
   D. Decreasing m_2.

13. What is the magnitude of the centripetal acceleration of the moon as it orbits the earth?

   A. 2.7×10^{-3} m/s^2
   B. 0.16 m/s^2
   C. 1.6 m/s^2
   D. 9.8 m/s^2

14. Oberon is a satellite of the planet Uranus. It has an orbital radius of 5.83×10^8 m and an orbital period of 1.16×10^6 s. What is the mass of Uranus?

   A. 2.6×10^8 kg
   B. 5.9×10^{14} kg
   C. 1.5×10^{17} kg
   D. 8.7×10^{25} kg

15. A satellite orbits the earth with a kinetic energy of 2.0×10^{10} J. Its gravitational potential energy in this orbit is -4.0×10^{10} J. What is the total energy of the satellite?

   A. -6.0×10^{10} J
   B. -2.0×10^{10} J
   C. 2.0×10^{10} J
   D. 6.0×10^{10} J

16. A 450 kg piece of space debris initially at rest falls from an altitude of 6.2×10^5 m above the earth's surface. What is its kinetic energy just before impact with the surface? (Ignore air resistance.)

6.2×10^5 m

7.00×10^6 m

6.38×10^6 m
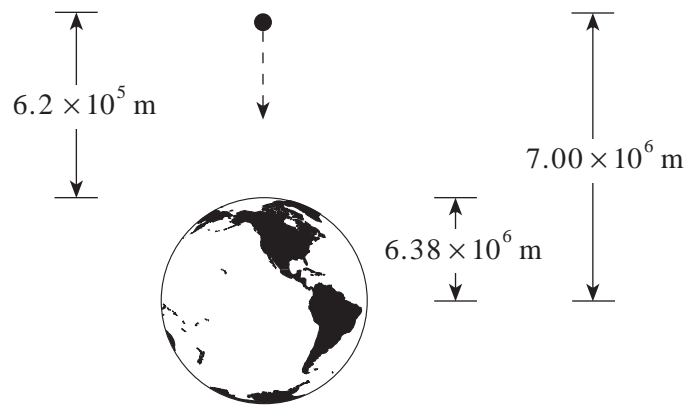
   A. 2.5×10^9 J
   B. 2.7×10^9 J
   C. 2.6×10^{10} J
   D. 2.9×10^{11} J

17. A satellite travels around a planet at 9.0×10^3 m/s with an orbital radius of 7.4×10^6 m. What would be the speed of an identical satellite orbiting at one half this radius?

   A. 4.5×10^3 m/s
   B. 9.0×10^3 m/s
   C. 1.3×10^4 m/s
   D. 1.8×10^4 m/s

18. Which of the following best represents the electric field between oppositely charged parallel plates?
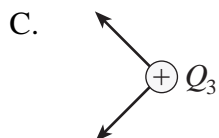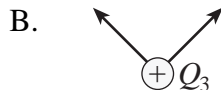
A.

B.

C.

D.
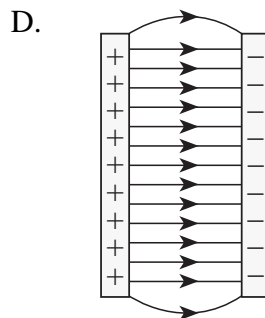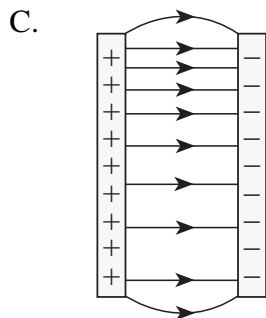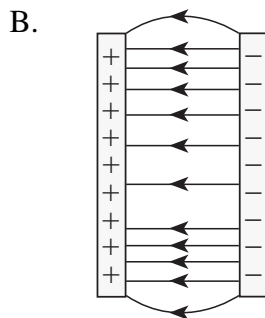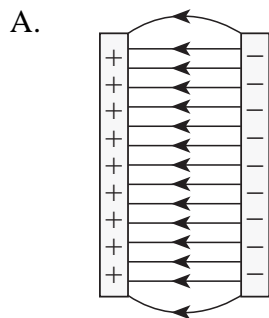
19. Three point charges of equal magnitude but opposite sign are arranged as shown in the diagram below.

$\oplus\ Q_3$

$\oplus$ $\ominus$
Q_1 Q_2

Which of the diagrams below best represents the electric forces acting on Q_3 due to the other two charges?

A. $\oplus Q_3$

B. $\oplus Q_3$

C. $\oplus Q_3$

D. $\oplus Q_3$

20. What is the magnitude of the electric field at point P due to the two charges positioned as shown in the diagram below?

$Q_1 = 6.5 \times 10^{-6}$ C $Q_2 = -2.0 \times 10^{-6}$ C
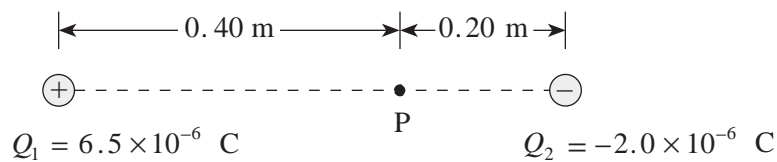
A. 5.6×10^4 N/C

B. 8.4×10^4 N/C

C. 2.4×10^5 N/C

D. 8.2×10^5 N/C

21. In which of the following circuits is the voltmeter placed correctly to measure the terminal voltage of the battery, and the ammeter placed correctly to measure the current through the light bulb (⊖) ?
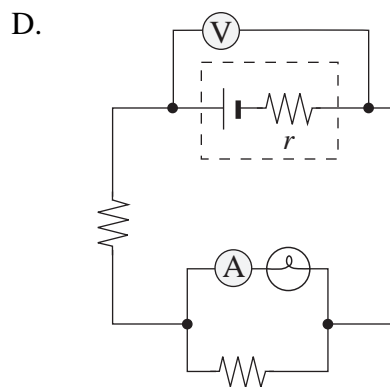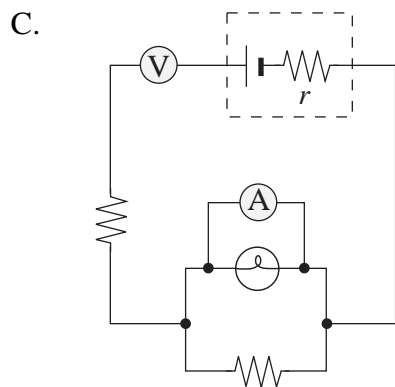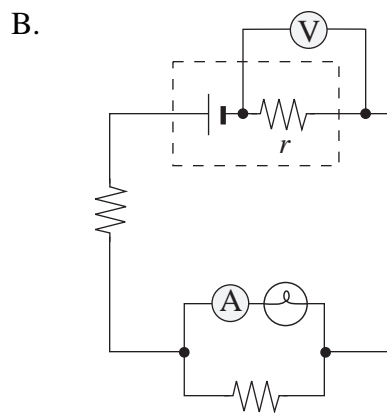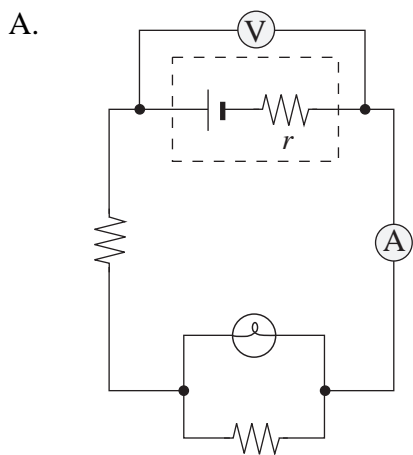
22. What is the current leaving the battery in the circuit below?

$P_1 = 60$ W

120 V

$P_2 = 60$ W

$P_3 = 60$ W
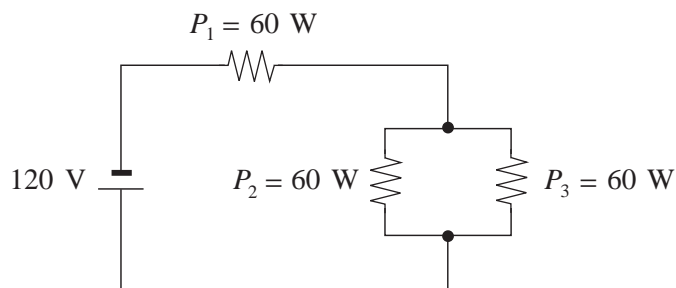
A. 1.3 A
B. 1.5 A
C. 2.0 A
D. 4.0 A

23. Which of the following are correct units for magnetic flux?
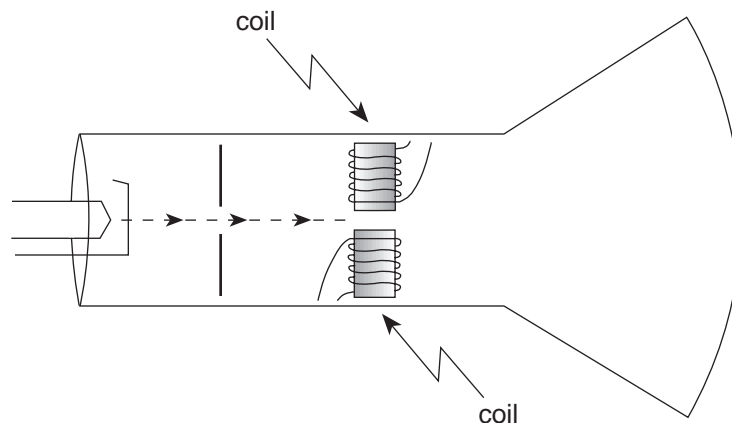
A. T
B. Wb
C. V/m
D. $N \cdot m^2$

24. An electron enters a uniform magnetic field as shown below.

$\vec{B}$

The path of the electron upon entering the field would be

A. linear.
B. circular.
C. parabolic.
D. hyperbolic.

25. The diagram below represents a cross-sectional view from the side of a cathode ray tube. What is the purpose of the coils in a functional cathode ray tube?

coil

coil

A. They increase the speed of the electrons.
B. They focus the electrons into a fine beam.
C. They deflect the electrons into or out of the page.
D. They deflect the electrons toward the top or bottom of the page.

26. A solenoid of length 0.35 m and diameter 0.040 m carries a current of 5.0 A through its windings. If the magnetic field in the centre of the solenoid is 2.8×10^{-2} T, what is the number of turns per metre for this solenoid?

A. 1.8×10^{2} turns/m
B. 7.8×10^{2} turns/m
C. 1.6×10^{3} turns/m
D. 4.5×10^{3} turns/m

27. A 1.2 m length of wire is pulled through a uniform 0.045 T magnetic field at 6.7 m/s as shown. What emf is generated between the ends of the wire?

$\vec{B}$

1.2 m   6.7 m/s   1.5 m
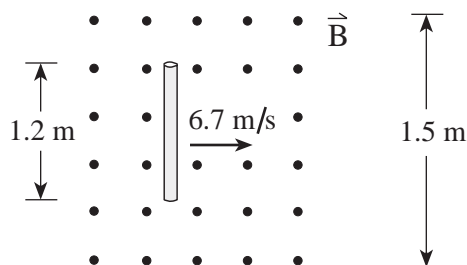
A. 0 V
B. 0.090 V
C. 0.36 V
D. 0.45 V

OVER

- 9 -

28. A dc motor is connected to a 12.0 V power supply. When the armature is rotating, the current through it is 0.78 A and the back emf is 10.6 V. What is the resistance of the armature?

   A. 1.4 Ω
   B. 1.8 Ω
   C. 14 Ω
   D. 15 Ω

29. In which of the following diagrams is the secondary **current** greater than the primary **current**?

A.

B.

C.

D.
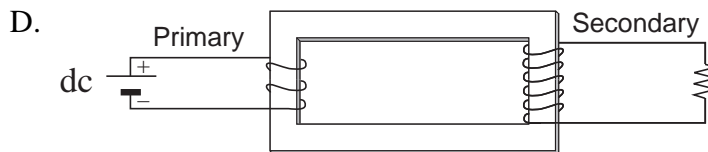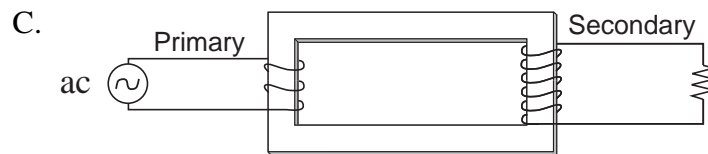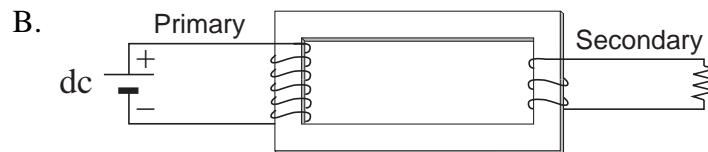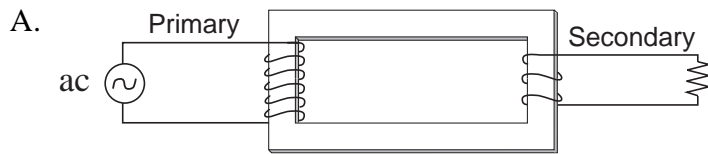
30. An electron circulates in a uniform 5.0×10^{-4} T magnetic field as shown. If the electron has 3.2×10^{-18} J of kinetic energy, what is its radius of orbit, r ?
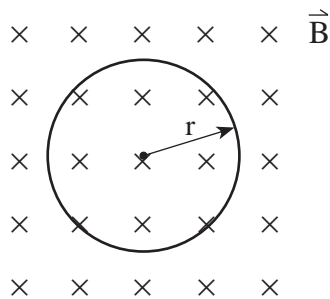
A. 2.3×10^{-7} m

B. 4.6×10^{-4} m

C. 2.5×10^{-3} m

D. 3.0×10^{-2} m

This is the end of the multiple-choice section.
Answer the remaining questions directly in this examination booklet.

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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. Full marks will **not** be awarded for providing a final answer **only**.
	
	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.
	
	Full marks will NOT be given for the final answer only.

1. The diagram shows two objects connected by a light string over a frictionless pulley. Object m_2 is on a frictionless horizontal table. The tension in the string is 24 N.

$m_1 = 3.0$ kg
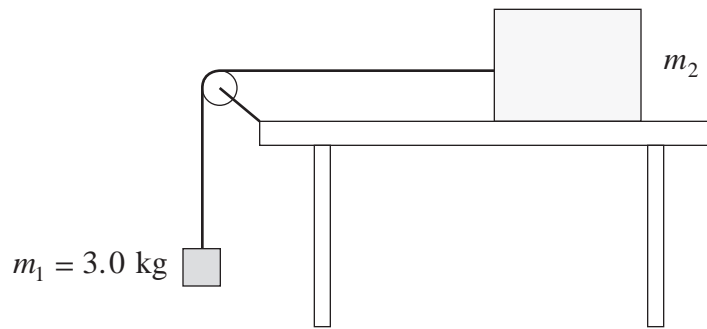
a) Find the acceleration of the system. **(4 marks)**

b) Find the mass of m_2. **(3 marks)**

ANSWER:

a) acceleration: _____

b) mass: _____

OVER

2. A 250 kg roller coaster passes point A at 12.0 m/s.
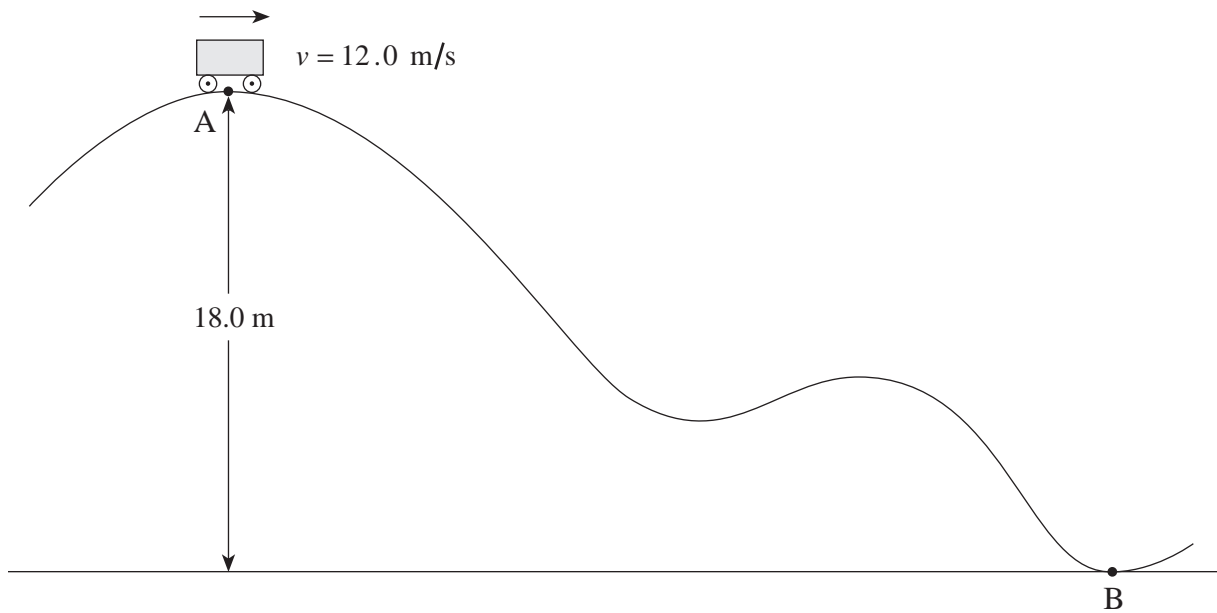
What is the speed of the roller coaster at point B at the bottom of the hill if 8 500 J of energy is transformed to heat during the journey? **(7 marks)**

3. A 25 kg droid rests on a 5.0 m long shelf supported by two cables as shown. The mass of the shelf is 12 kg.
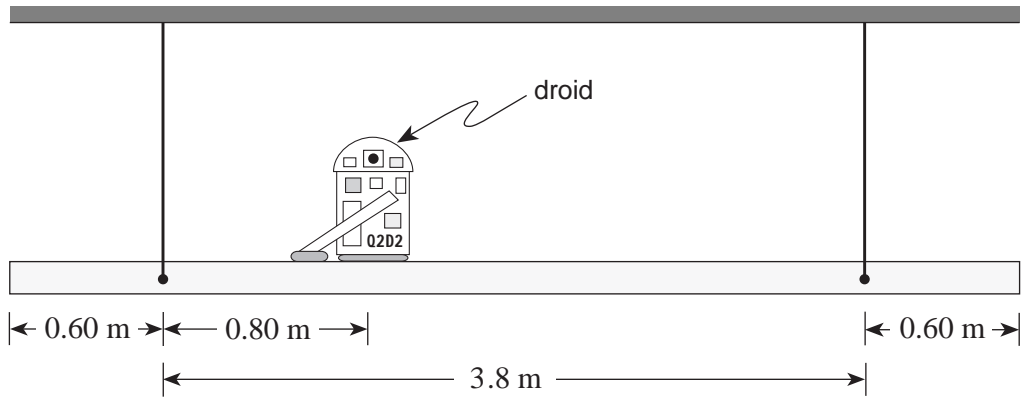
Find the tension in **each** cable. **(7 marks)**

ANSWER:

tension (left cable): _____

tension (right cable): _____

4. A 6.1 kg object on the end of a massless connecting rod moves in uniform circular motion in a vertical circle with radius 1.2 m. The period of revolution is 0.80 s.

1.2 m

connecting rod

6.1 kg

constant v
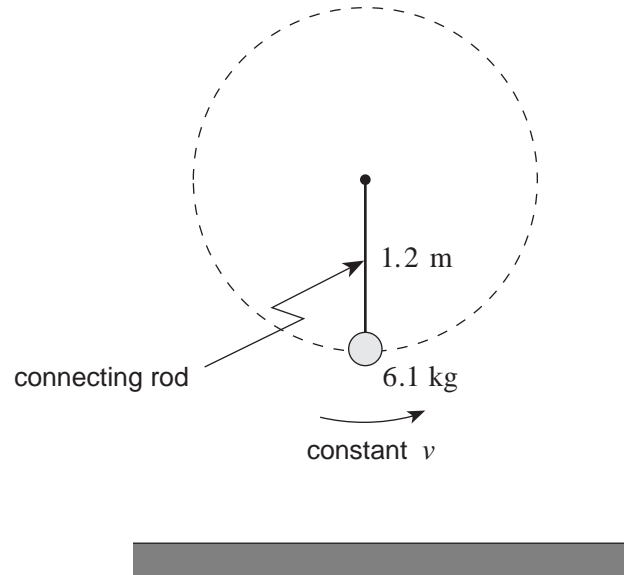
a) Draw and label a free body diagram for the object at the bottom of the circular path.

(2 marks)

b) Calculate the tension in the connecting rod at this position. **(5 marks)**

ANSWER:

b) tension: _____

5. Two point charges Q_1 and Q_2 are arranged as shown in the diagram below.

Q_1

P

$Q_2 = 2.5 \times 10^{-6}$ C

$+$

$\longleftarrow$ 0.60 m $\longrightarrow$ $\longleftarrow$ 0.30 m $\longrightarrow$
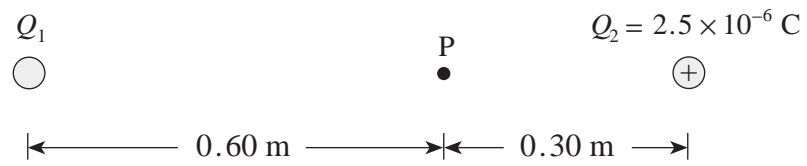
The electric potential at point P due to these charges is found to be 1.9×10^5 V. What are the magnitude and sign of charge Q_1? **(7 marks)**

ANSWER:

magnitude of charge: _____

sign of charge: _____

6. The circuit shown in the diagram below consists of a 9.00 V battery and a 3.50 W light bulb.
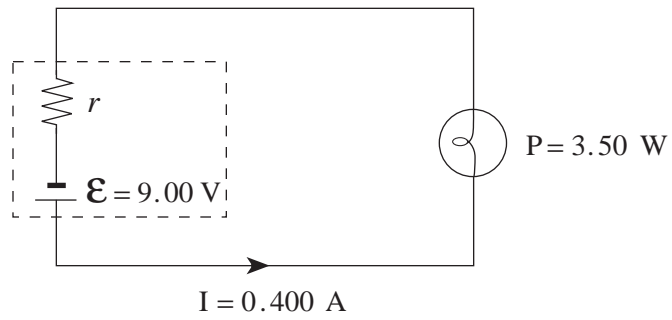
$$I = 0.400 \text{ A}$$

a) If a current of 0.400 A leaves the battery, what is the internal resistance, r, of the battery? **(5 marks)**

b) The light bulb is now replaced by a lower resistance (brighter) light bulb. The terminal voltage will now be

☐ less than before.
☐ the same as before.
☐ greater than before.

(Check one response.)   **(1 mark)**

c) Using principles of physics, explain your answer to b).   **(3 marks)**

_____

_____

_____

_____

_____

_____

┌───┐
│ ANSWER: │
│   │
│ a) resistance: _____ │
└───┘

OVER

7. A single loop of wire of area 5.0×10^{-3} m^2 and resistance $1.8\ \Omega$ is perpendicular to a uniform magnetic field B. The field then decreases to zero in 1.2×10^{-3} s inducing an average current of 8.3×10^{-2} A in the loop. What was the initial value of the magnetic field B? **(7 marks)**

ANSWER:

magnetic field: _____

8. A gardener does work W pushing a lawnmower a distance d across a lawn.

W (J)	70	140	210	280	350
d (m)	2.0	4.0	6.0	8.0	10.0

a) Plot a graph of W versus d on the axes below. **(2 marks)**

W (J)

d (m)
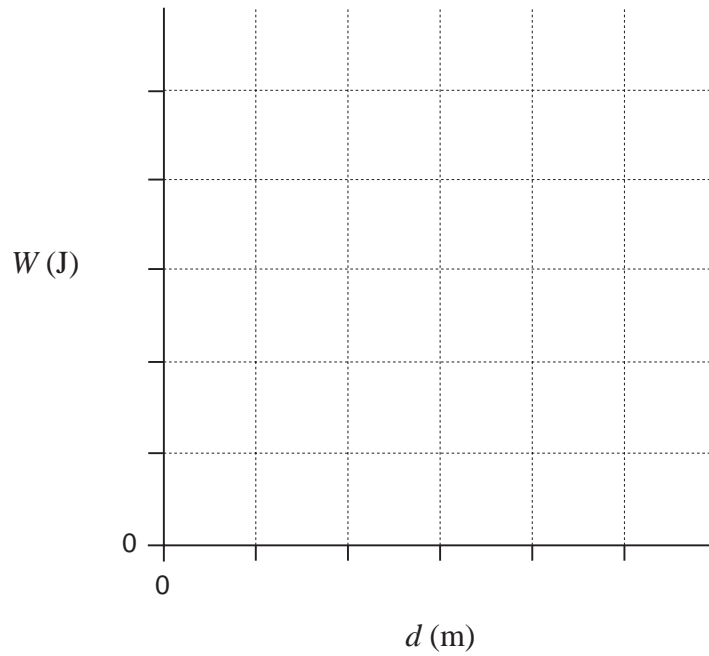
b) Calculate the slope of the line, expressing your answer in appropriate units. **(2 marks)**

c) What does the slope of the line represent?   **(1 mark)**

_____

_____

ANSWER:
b) slope: _____

OVER

9. The front of an automobile is designed to crumple in a collision in order to reduce the injury to the occupants. Discuss briefly the physics of how this design feature improves safety for the occupants. **(4 marks)**

_____

_____

_____

_____

_____

_____

_____

This is the end of the written-response section.

END OF EXAMINATION

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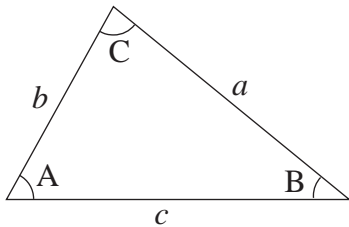
For Right-angled Triangles:
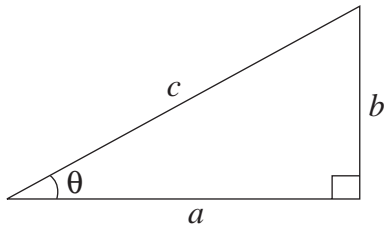
$$a^2 + b^2 = c^2$$

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

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

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: $\quad c^2 = a^2 + b^2 - 2ab\ \cos C$

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:

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

Vector Kinematics in Two Dimensions:

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

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

Vector Dynamics:

$$F_{\text{net}} = ma \qquad F_{\text{g}} = mg$$

$$F_{\text{fr}} = \mu F_{\text{N}}$$

Work, Energy, and Power:

$$W = Fd \qquad E_{\text{p}} = mgh$$

$$E_{\text{k}} = \frac{1}{2}mv^2 \qquad P = \frac{W}{t}$$

Momentum:

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

Equilibrium:

$$\tau = Fd$$

Circular Motion:

$$a_{\text{c}} = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$$

Gravitation:

$$F = G\frac{m_1 m_2}{r^2} \qquad E_{\text{p}} = -G\frac{m_1 m_2}{r}$$

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:

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

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

Electromagnetism:

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

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

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

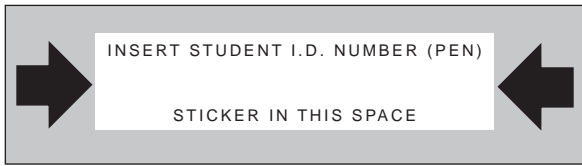$$V_{\text{back}} = \mathcal{E} - Ir$$

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

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