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Physics 12

JUNE 2004

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. .

(9)

Question 8:

8. .

(5)

Question 2:

2. .

(7)

Question 9:

9. .

(4)

Question 3:

3. .

(7)

Question 4:

4. .

(7)

Question 5:

5. .

(7)

Question 6:

6. .

(7)

Question 7:

7. .

(7)

PHYSICS 12

JUNE 2004

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. Ensure that your calculator is in degree mode.
3. 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.
4. 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.
5. 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.
6. 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 marks | 60 minutes |
| PART B: 9 written-response questions | 60 marks | 60 minutes |
| | 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.

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PART A: MULTIPLE CHOICE

Value: 60 marks (2 marks per question)

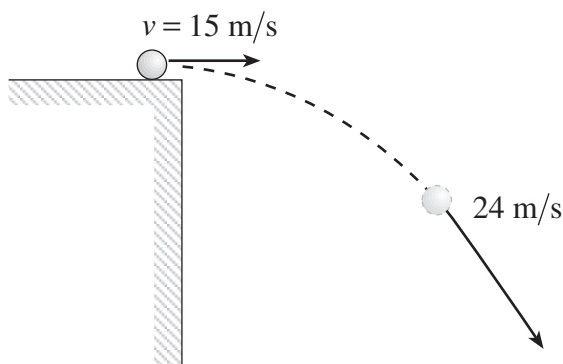
Suggested Time: 60 minutes

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. Which of the following is a scalar quantity?
 - A. work
 - B. force
 - C. velocity
 - D. momentum

2. An astronaut on the moon throws a 5.0 kg wrench vertically upwards with an initial speed of 15 m/s. The acceleration due to gravity on the surface of the moon is one-sixth that on the surface of the earth. What is the maximum height reached by the wrench?
 - A. 25 m
 - B. 46 m
 - C. 69 m
 - D. 75 m

3. A ball rolls off a horizontal roof at 15 m/s.



How far will the ball have fallen vertically when it reaches a speed of 24 m/s?

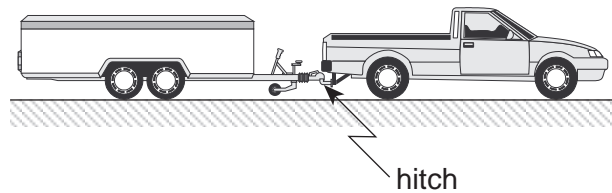
- A. 4.1 m
- B. 18 m
- C. 29 m
- D. 37 m

OVER

4. The units N/kg are used for

- A. net force.
- B. gravitational force.
- C. electric field strength.
- D. gravitational field strength.

5. A 1200 kg trailer is accelerated from rest to 15 m/s in 5.0 s. The average force of friction acting on the trailer is 800 N.



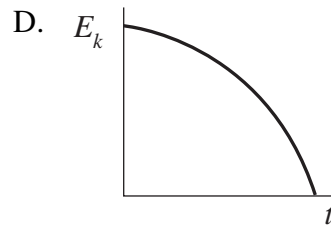
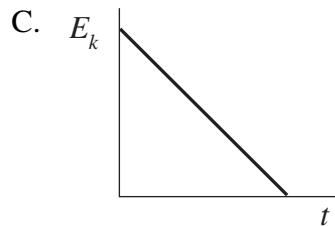
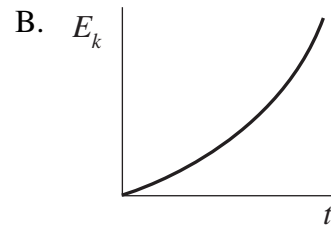
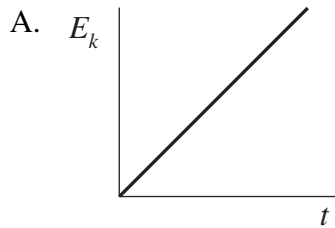
What is the pulling force applied to the trailer through the hitch?

- A. 800 N
- B. 2800 N
- C. 3600 N
- D. 4400 N

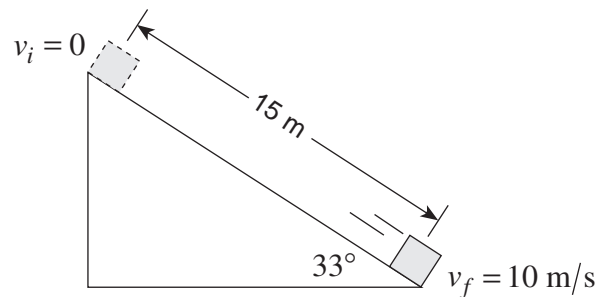
6. ~~According to the work-energy theorem, which of the following is equal to the net work done on an object?~~ **DELETED**

- A. ΔE_k
- B. ΔE_p
- C. $\Delta E_p + \Delta E_k$
- D. $\Delta E_p - \Delta E_k$

7. Which of the following is a graph of E_k vs. time for a ball dropped off a roof? (Ignore air friction.)



8. A 2.0 kg wood block slides down an incline from rest as shown below. Determine the force of friction on the block during the slide if its final velocity at the bottom is 10 m/s.



- A. 4.0 N
 B. 6.7 N
 C. 11 N
 D. 17 N
9. You are pushing a crate across a smooth wood floor with a constant pushing force. The crate is accelerating. Which of the following describes your power output?
- A. increasing
 B. decreasing
 C. increasing then constant
 D. decreasing then constant

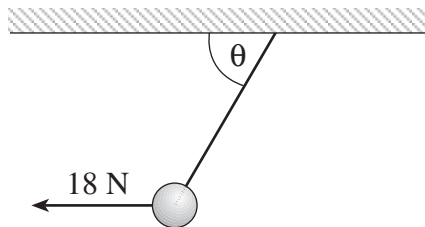
OVER

10. A 25 kg object is moving due north at 33 m/s. If an impulse of 330 N · s is applied at 45° N of W to this object, what is the final velocity of this object?

	SPEED	DIRECTION
A.	33 m/s	45° N of W
B.	33 m/s	78° N of W
C.	43 m/s	45° N of W
D.	43 m/s	78° N of W

11. ~~The sum of the torques on an object is zero about a certain point. The object is in rotational equilibrium. Which of the following statements is correct? DELETED~~
- A. ~~The sum of the torques is zero about no other point.~~
 B. ~~The sum of the torques is zero about all other points.~~
 C. ~~The sum of the forces must be zero at all other points.~~
 D. ~~The sum of the forces must be zero at that certain point.~~

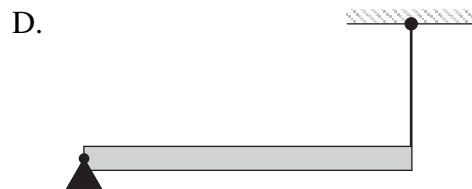
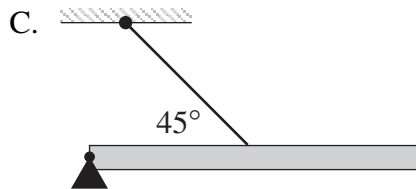
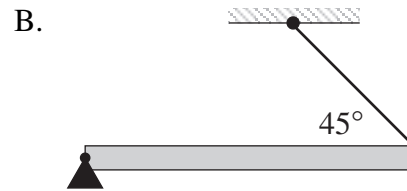
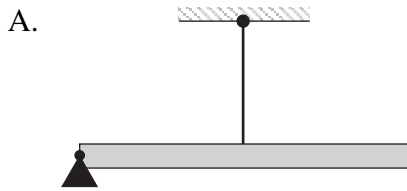
12. A 5.0 kg mass suspended by a rope is pulled to the left by a horizontal force of 18 N.



What is angle θ ?

- A. 16°
 B. 20°
 C. 70°
 D. 74°

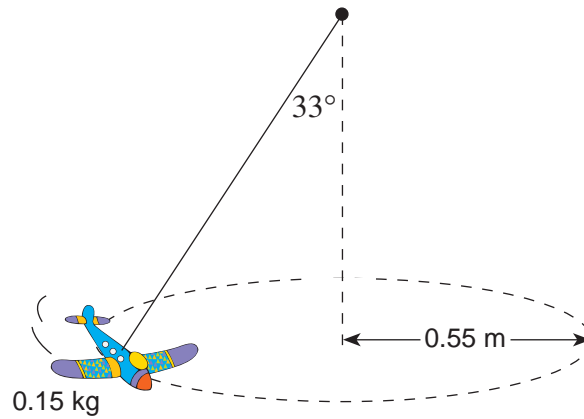
13. A uniform 2.0 m long beam is to be kept horizontal by a cord. In which of the four situations shown below will the tension in the cord be one-half of the beam's weight?



14. A 5.0×10^4 kg moonlet travels in a circular path around a planet. The moonlet's orbital radius is 2.5×10^7 m and the orbital period is 3.7×10^5 s. What is the mass of the planet?

- A. 1.1×10^8 kg
- B. 6.8×10^{22} kg
- C. 3.4×10^{27} kg
- D. 2.5×10^{28} kg

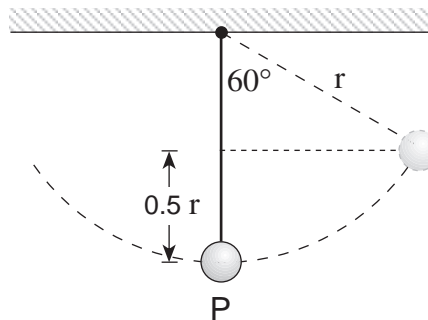
15. A 0.15 kg toy airplane is suspended as shown. It travels in a horizontal circle at a constant speed.



What is the period of the motion of this airplane?

- A. 0.84 s
- B. 1.6 s
- C. 1.8 s
- D. 2.0 s

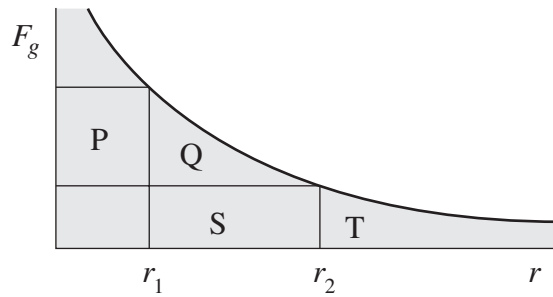
16. A small object of mass m is suspended from a fixed point by a light cord.



The object is raised to an angle of 60° and released from rest. The object moves in an arc of a circle as shown. When the object passes through its lowest position at point P, what is the tension in the cord in terms of the object's weight (mg)?

- A. $0.5 mg$
- B. $1.0 mg$
- C. $1.5 mg$
- D. $2.0 mg$

17. The graph shows the gravitational force between the earth and an object as a function of the distance of separation, r , from the centre of the earth.



As the object is moved from r_1 to r_2 , what is the work done?

- A. Q
B. Q+S
C. P+Q
D. Q+S+T
18. A 200 kg object is released from rest at an altitude of 1.0×10^7 m. What is its impact speed with the earth? Assume no air resistance.
- A. 7.0×10^3 m/s
B. 8.7×10^3 m/s
C. 1.1×10^4 m/s
D. 1.4×10^4 m/s
19. Which of the following is equal to the work required per coulomb to move a positive charge from one position to another in an electric field?
- A. E_p , electric potential energy
B. ΔE_p , change in electric potential energy
C. V , electric potential
D. ΔV , electric potential difference

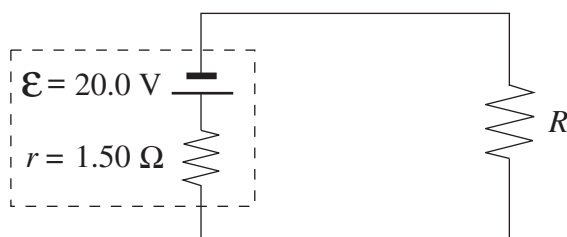
20. The diagram below shows a positive charge located near a smaller (in magnitude) negative charge. In which region is there a point where the electric field due to the two charges is equal to zero?



- A. I
 B. II
 C. III
 D. IV
21. Which of the following is always true for resistors in parallel or in series?

	RESISTORS IN PARALLEL	RESISTORS IN SERIES
A.	equal currents	equal currents
B.	equal currents	equal voltage drops
C.	equal voltage drops	equal currents
D.	equal voltage drops	equal voltage drops

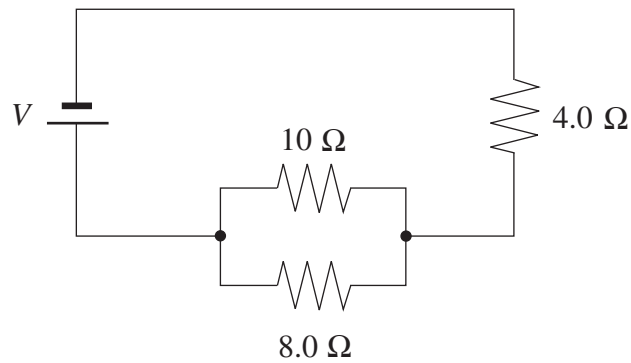
22. In the circuit shown below the voltage loss due to the battery's internal resistance is 2.0 V.



Determine the value of the load resistance R .

- A. 12.0 Ω
 B. 13.3 Ω
 C. 13.5 Ω
 D. 15.0 Ω

23. A resistor is added in parallel to the $4.0\ \Omega$ resistor shown in the diagram below.



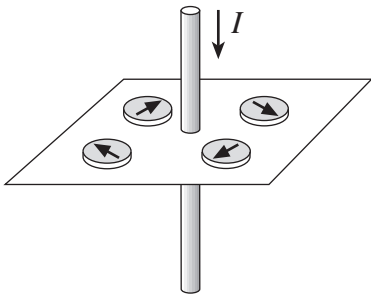
What happens to the power dissipated by the $8.0\ \Omega$ resistor and by the $4.0\ \Omega$ resistor?

	$P_{8.0\ \Omega}$	$P_{4.0\ \Omega}$
A.	decreases	increases
B.	decreases	decreases
C.	increases	increases
D.	increases	decreases

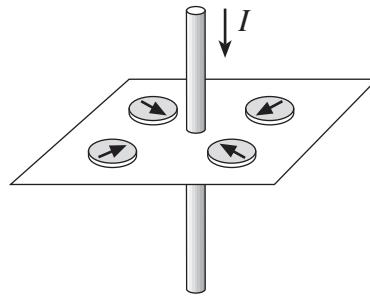
24. Protons and electrons travelling at high speeds enter a magnetic field **parallel** to their direction of travel. Which of the following is correct?
- A. Only protons are deflected.
 - B. Only electrons are deflected.
 - C. Both protons and electrons are deflected.
 - D. Neither protons nor electrons are deflected.

25. Which of the following diagrams best shows the orientation for a set of four compasses placed around a current-carrying wire?

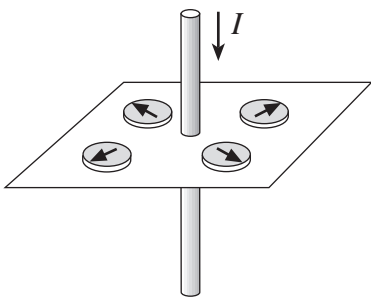
A.



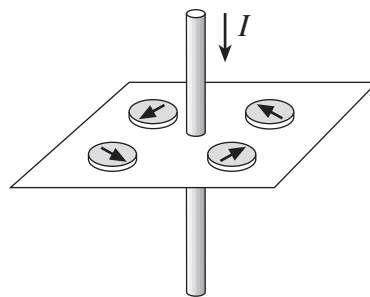
B.



C.



D.



26. An electron travels at a speed of 1.4×10^4 m/s while following a circular path of radius 0.020 m perpendicular to a magnetic field. What is the strength of the magnetic field?

A. 0.0 T

B. 4.0×10^{-6} T

C. 6.3×10^{-3} T

D. 4.1×10^{-2} T

27. A potential difference of 22 V is placed across a 570-turn solenoid that has a resistance of 4.9Ω . The solenoid has a diameter of 0.052 m and is 0.37 m long. What is the magnetic field strength in the centre of this solenoid?

A. 8.7×10^{-3} T

B. 6.2×10^{-2} T

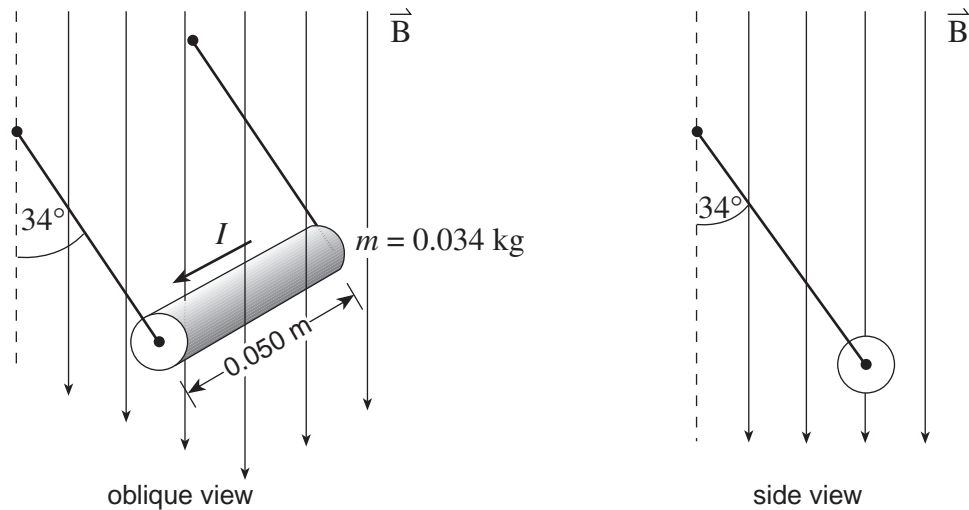
C. 1.2×10^{-1} T

D. 3.0×10^{-1} T

28. A 200-turn copper coil of radius 0.050 m is perpendicular to a 0.087 T magnetic field. The magnetic field collapses to zero in 0.63 s. What was the average induced emf in the coil during the collapse?
- A. 0.0 V
 B. 1.1×10^{-3} V
 C. 0.22 V
 D. 1.4 V
29. The coil of a motor has a resistance of 4.1Ω . The motor is plugged into a 120 V outlet, and the coil develops a back emf of 118 V when rotating at normal speeds. Find the current when the motor first starts up and the current when it is operating at normal speeds.

	CURRENT AT START UP	CURRENT AT NORMAL SPEEDS
A.	0.49 A	0.49 A
B.	0.49 A	29 A
C.	29 A	0.49 A
D.	29 A	29 A

30. A 0.034 kg copper rod is hung by two wires and placed in a constant magnetic field. A current of 14 A runs through the 0.050 m long copper rod, making it hang at an angle of 34° from the vertical as shown below.



What is the magnetic field strength holding the copper rod in this position?

- A. 2.7×10^{-1} T
- B. 3.2×10^{-1} T
- C. 3.9×10^{-1} T
- D. 4.8×10^{-1} T

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

PART B: WRITTEN RESPONSE

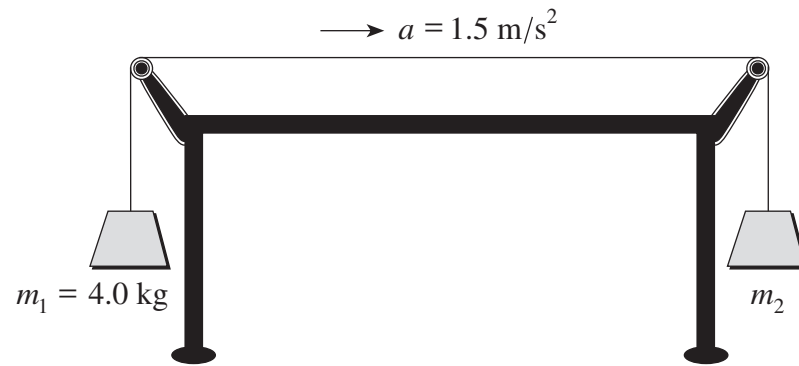
Value: 60 marks

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. Two masses are connected by a light cord passing over frictionless pulleys as shown in the diagram below.



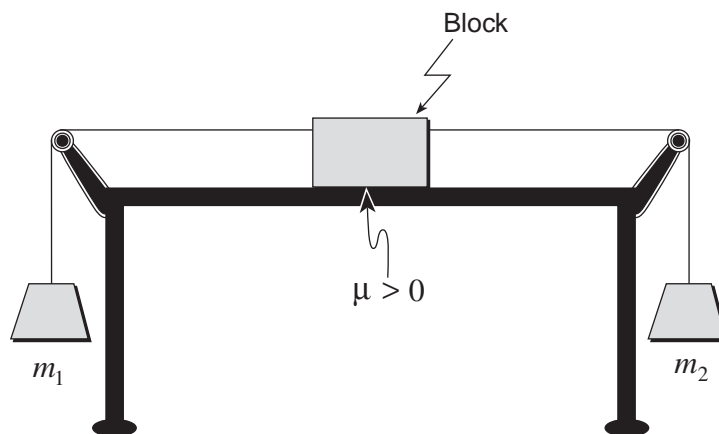
- a) What is m_2 if the system accelerates as shown?

(5 marks)

ANSWER:

a) m_2 : _____

A block is then added to the system.



- b) Adding the block decreases the acceleration of the system. Identify and explain two reasons for this decrease. **(4 marks)**

2. A 4300 kg truck travelling at 21 m/s in the direction of 31° north of east collides with a stationary 1500 kg car. After the collision, the car has a speed of 15 m/s due east. What is the resulting speed of the truck? **(7 marks)**

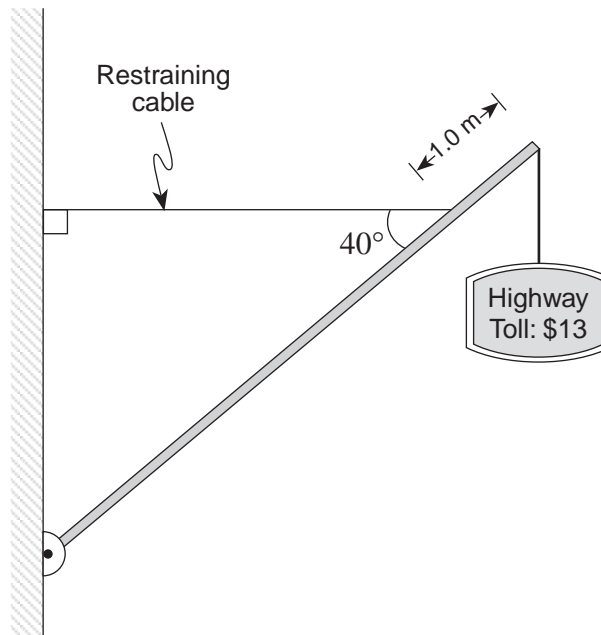
ANSWER:

resulting speed: _____

OVER

3. A sign is suspended from the end of a 6.0 m long uniform pole of mass 25 kg as shown. If the mass of the sign is 36 kg, what is the tension in the horizontal restraining cable?

(7 marks)

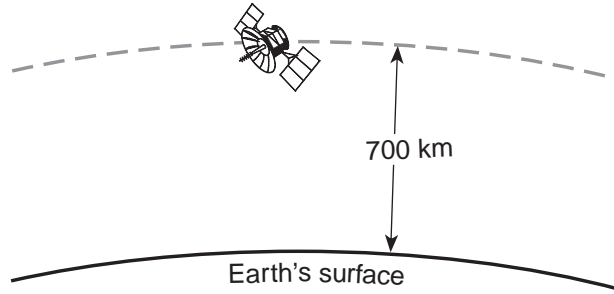


ANSWER:

tension: _____

OVER

4. A 4.20×10^4 kg satellite orbits the earth at an altitude of 700 km (7.00×10^5 m).



a) What is the satellite's orbital speed at this altitude?

(4 marks)

ANSWER:

a) orbital speed: _____

b) What is the satellite's total energy at this altitude?

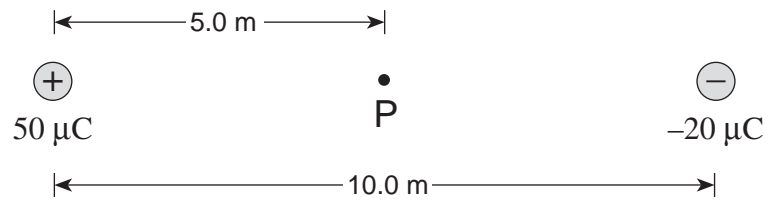
(3 marks)

ANSWER:

b) total energy: _____

OVER

5. a) Determine the electric potential, relative to zero at infinity, at point P, midway between the two charges, shown below. **(5 marks)**



ANSWER:

a) electric potential: _____

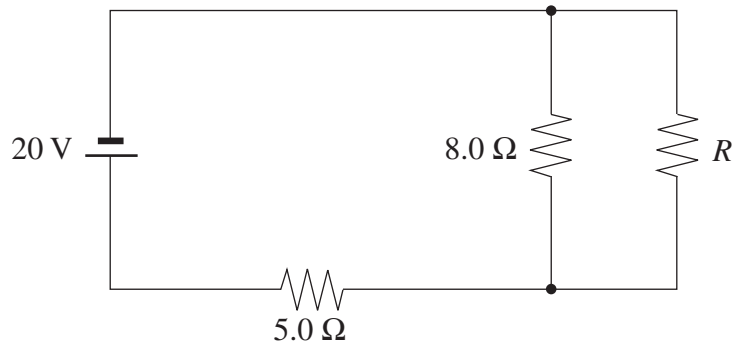
- b) How much work would it take to move a $-15 \mu\text{C}$ charge from point P to a position infinitely far away? **(2 marks)**

ANSWER:

b) work: _____

OVER

6. The $8.0\ \Omega$ resistor in the circuit shown below dissipates $45\ \text{J}$ of heat energy in $5.0\ \text{s}$. Determine the value of the resistor R . **(7 marks)**

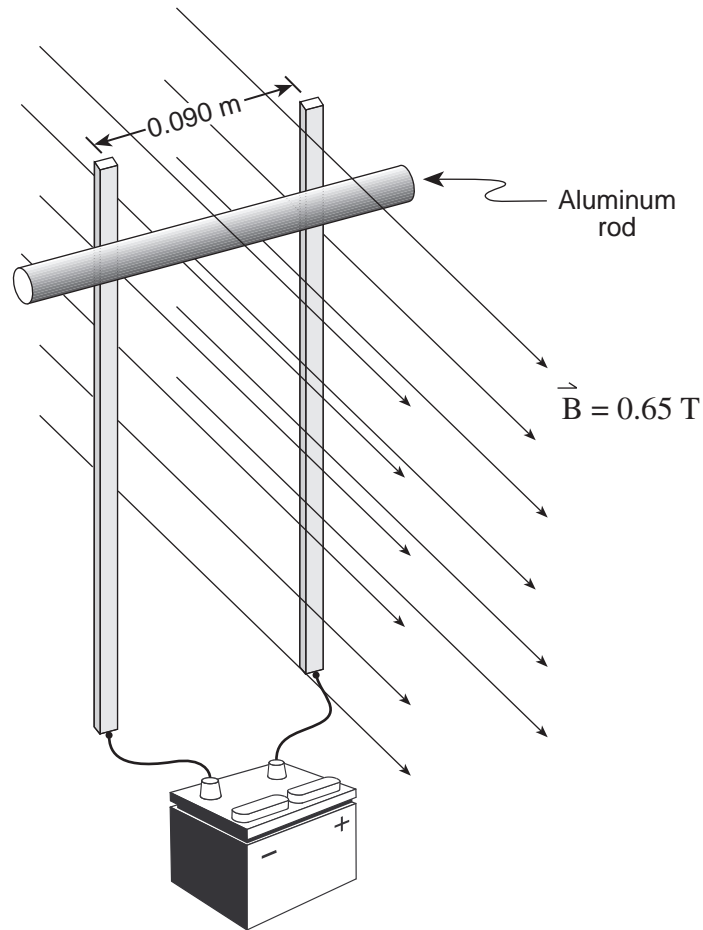


ANSWER:

value of resistor: _____

OVER

7. A 0.13 kg aluminum rod maintains contact with two vertical metal rails. A voltage is applied across the metal rails and a horizontal magnetic field of 0.65 T exists across the whole apparatus as shown.



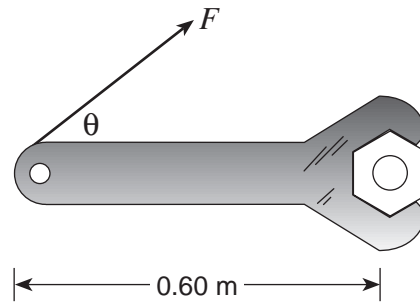
What current must flow through the aluminum rod to have it remain stationary? **(7 marks)**

ANSWER:

current: _____

OVER

8. A student uses a wrench to apply a constant force to turn a nut. He applies the force at various angles and measures the amount of torque produced at each of the angles.

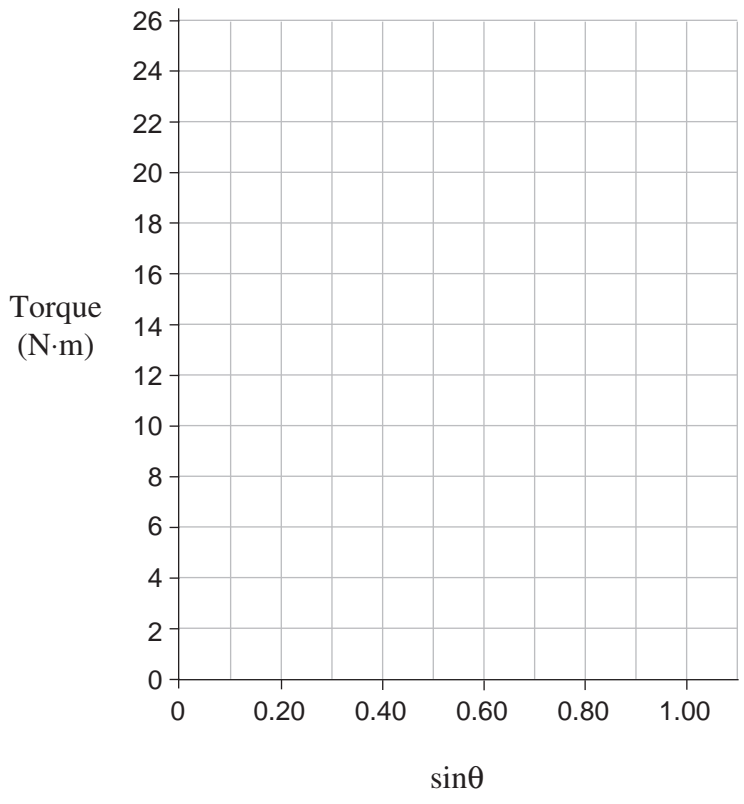


The torque data collected by the student along with the sine of the angles is shown below:

TORQUE (N·m)	4.0	11	17	22	25
SIN θ	0.14	0.42	0.66	0.86	0.98

- a) Plot a graph of torque versus $\sin \theta$ on the graph below.

(2 marks)



b) Calculate the slope of your line including units.

(1 mark)

ANSWER:

b) slope of line: _____

c) Use the slope of your graph to determine the amount of constant force the student used throughout his experiment.

(2 marks)

ANSWER:

c) constant force: _____

9. A small plastic ball carrying a positive charge is held near a fixed large positively charged sphere as shown below. It is then released. Explain how and why the acceleration of the plastic ball changes as it moves away from the sphere. **(4 marks)**



END OF EXAMINATION

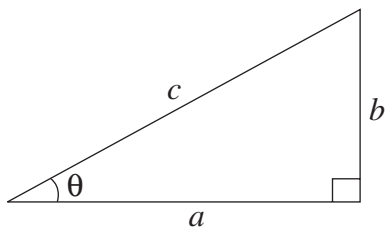
TABLE OF CONSTANTS

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.**

MATHEMATICAL EQUATIONS

For Right-angled Triangles:

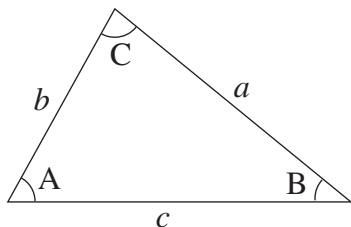


$$a^2 + b^2 = c^2$$

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

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

For All Triangles:



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

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

$$\text{Sine Law: } \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

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

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:

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

Vector Kinematics in Two Dimensions:

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

$$v^2 = v_0^2 + 2ad \qquad d = v_0t + \frac{1}{2}at^2$$

Vector Dynamics:

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

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

Work, Energy, and Power:

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

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

Momentum:

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

Equilibrium:

$$\tau = Fd$$

Circular Motion:

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

Gravitation:

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

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

Electrostatics:

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

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

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

Electric Circuits:

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

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

Electromagnetism:

$$F = BIl \quad F = QvB$$

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

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

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

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

ROUGH WORK FOR MULTIPLE-CHOICE

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