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BRITISH COLUMBIA

Physics 12

JANUARY 2001

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 9:

9. . (4)

Question 2:

2. . (7)

Question 3:

3. . (7)

Question 4:

4. . (7)

Question 5:

5. . (7)

Question 6:

6. . (7)

Question 7:

7. . (9)

Question 8:

8. . (5)

PHYSICS 12

JANUARY 2001

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

1. This examination consists of **two** parts:

		Value	Suggested Time
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 also include graphing 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 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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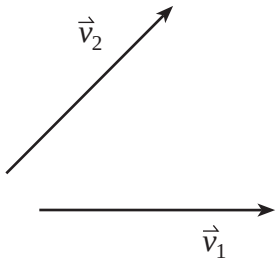
PART A: MULTIPLE CHOICE

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.

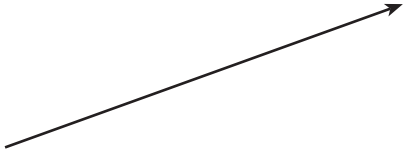
1. Two velocity vectors, v_1 and v_2 are shown.

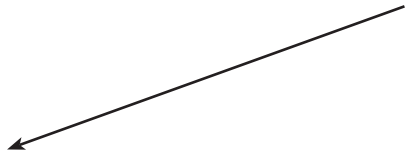


Which of the following best represents the resultant of the addition of the two velocity vectors?

A. 

B. 

C. 

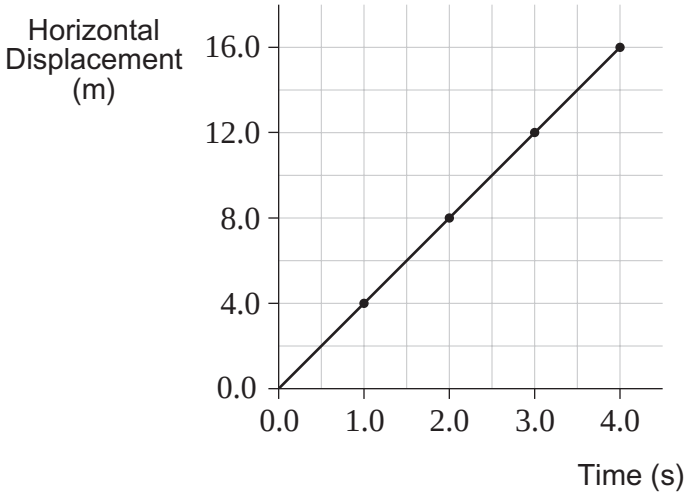
D. 

2. In landing, a jet plane decelerates uniformly and comes to a stop in 38 s, covering a distance of 1 500 m along the runway. What was the jet's landing speed when it first touched the runway?

A. 2.1 m/s
B. 39 m/s
C. 79 m/s
D. 170 m/s

OVER

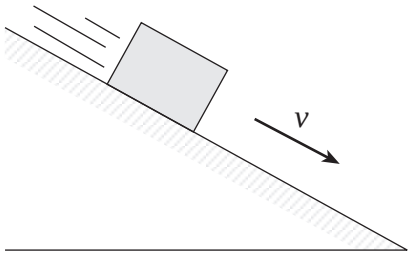
3. A projectile is fired into the air at some angle above the horizontal. The horizontal displacement of the projectile is measured against time in flight and the collected data is shown as a horizontal displacement versus time graph.



Based on this graph, the horizontal velocity of the projectile during this time interval is

A. constant.
B. increasing.
C. decreasing.
D. equal to zero.

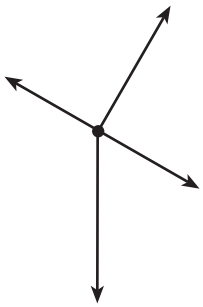
4. An object is sliding down an inclined plane at a constant speed.



Which of the following represents the free-body diagram for the object?

A. 

B. 

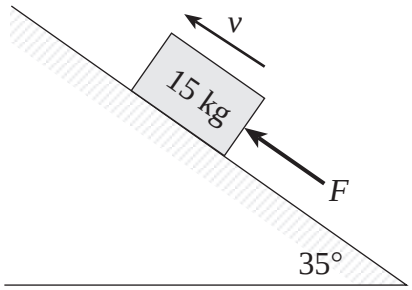
C. 

D. 

5. A 45 kg woman is standing in an elevator that is accelerating downwards at $2.0\ \text{m/s}^2$. What force (normal force) does the elevator floor exert on the woman's feet during this acceleration?

   A. 90 N
   B. 350 N
   C. 440 N
   D. 530 N

6. A 15 kg block is pushed up a $35°$ incline. A friction force of 110 N exists between the block and the incline.



   What minimum force *F*, would be necessary to move the block up the incline at a constant speed?

   A. 26 N
   B. 84 N
   C. 150 N
   D. 190 N

7. A crane lifts a 3 900 kg shipping container through a vertical height of 45 m in 8.0 s. What is the minimum average power that the crane motor must supply?

   A. 2.7×10^3 W
   B. 7.7×10^3 W
   C. 2.1×10^5 W
   D. 1.7×10^6 W

OVER

8. Identify momentum and kinetic energy as scalar or vector quantities.

	MOMENTUM	KINETIC ENERGY
A.	scalar	scalar
B.	scalar	vector
C.	vector	scalar
D.	vector	vector

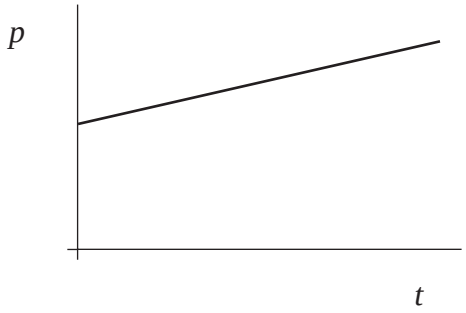
9. A 1.0 kg cart moves to the right at 6.0 m/s and strikes a stationary 2.0 kg cart. After the head-on collision, the 1.0 kg cart moves back to the left at 2.0 m/s and the 2.0 kg cart moves to the right at 4.0 m/s. In this collision

   A. only momentum is conserved.
   B. only kinetic energy is conserved.
   C. both momentum and kinetic energy are conserved.
   D. neither momentum nor kinetic energy is conserved.

10. A 12.0 kg shopping cart rolls due south at 1.50 m/s. After striking the bumper of a car, it travels at 0.80 m/s, $30°$ E of S. What is the magnitude of the change in momentum sustained by the shopping cart?

    A. 8.4 kg $\cdot$ m/s
    B. 9.7 kg $\cdot$ m/s
    C. 11 kg $\cdot$ m/s
    D. 27 kg $\cdot$ m/s

11. The graph below shows momentum, *p*, versus time, *t*, for a spacecraft while it is firing its rocket engines in space.

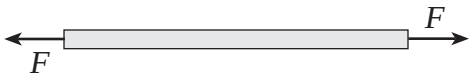


What does the slope of this graph represent?

A. the mass of the spacecraft
B. the velocity of the spacecraft
C. the net force on the spacecraft
D. the work done on the spacecraft

12. A metre stick, as seen from above, is sitting on a table and is then subjected to two forces of equal magnitude as shown. In which case would the metre stick be in rotational equilibrium?

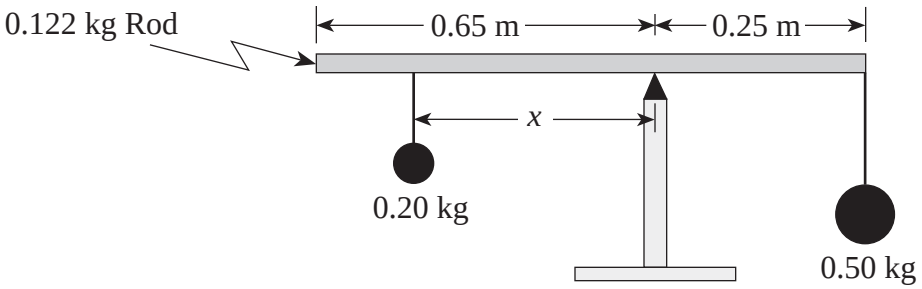
A. 

B. 

C. 

D. 

13. A uniform 0.122 kg rod of 0.90 m length is used to suspend two masses as shown below.



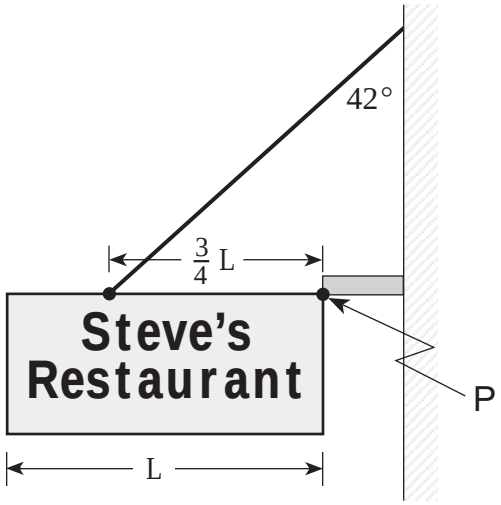
At what distance *x* should the 0.20 kg mass be placed to achieve static equilibrium?

A. 0.30 m
B. 0.50 m
C. 0.63 m
D. 0.75 m

OVER

14. **DELETED**

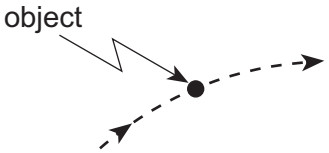
A 7.8 kg restaurant sign is suspended as shown.



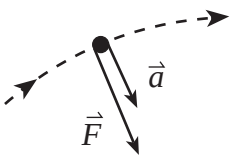
What are the magnitude and direction of the vertical force acting at point P?

	MAGNITUDE OF THE VERTICAL FORCE	DIRECTION OF THE VERTICAL FORCE
A.	25 N	up
B.	25 N	down
C.	51 N	up
D.	51 N	down

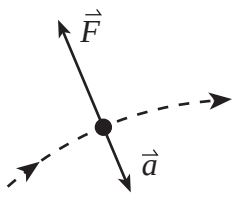
15. Which vector diagram best represents the acceleration, $\vec{a}$, and force, $\vec{F}$, for an object travelling along a circular path?



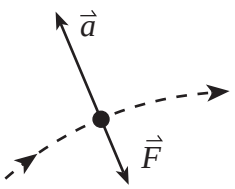
A.



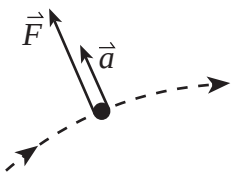
B.



C.



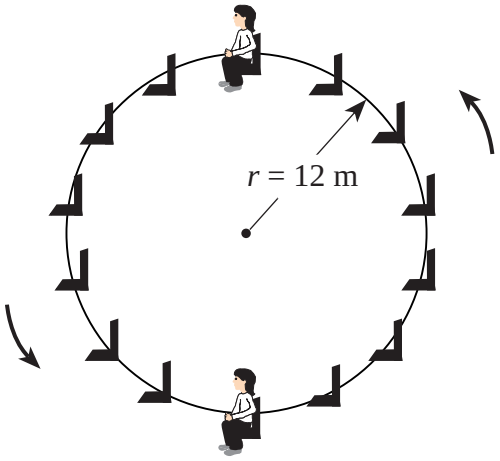
D.



16. An object travels along a circular path with a constant speed v when a force F acts on it. How large a force is required for this object to travel along the same path at twice the speed ($2v$)?

A. $\frac{1}{2}F$
B. F
C. $2F$
D. $4F$

17. The diagram shows a 52 kg child riding on a Ferris wheel of radius 12 m and period 18 s. What force (normal force) does the seat exert on the child at the top and bottom of the ride?



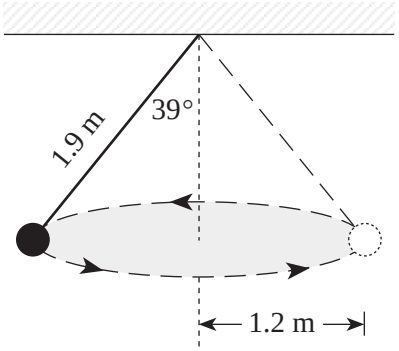
	TOP	BOTTOM
A.	76 N	76 N
B.	430 N	590 N
C.	510 N	510 N
D.	590 N	430 N

18. The equation $E_p = mgh$, in which g is $9.8\ \text{m/s}^2$, can not be used for calculating the gravitational potential energy of an orbiting Earth satellite because

A. the Earth is rotating.
B. of the influence of other astronomical bodies.
C. the Earth's gravity disappears above the atmosphere.
D. the Earth's gravitational field strength varies with distance.

OVER

19. The diagram shows an object of mass 3.0 kg travelling in a circular path of radius 1.2 m while suspended by a piece of string of length 1.9 m. What is the centripetal force on the mass?



A. 19 N
B. 23 N
C. 24 N
D. 29 N

20. Which of the following best describes how electric potential varies with distance in the region around a point charge?

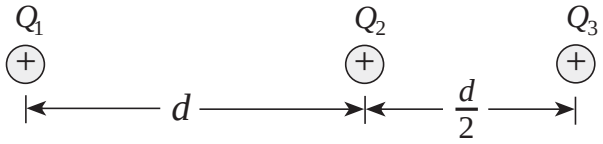
A. $V \propto r$

B. $V \propto \frac{1}{r}$

C. $V \propto r^2$

D. $V \propto \frac{1}{r^2}$

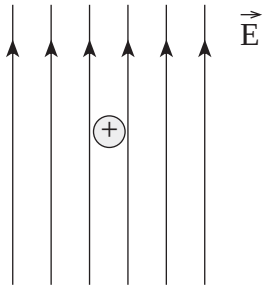
21. Three **identical** positive electric charges are fixed as shown in the diagram below.



What is the direction of the net electric force on Q_2 due to Q_1 and Q_3?

A. to the left
B. to the right
C. the net force is zero
D. cannot be determined

22. In an experiment, a positively charged oil droplet weighing 6.5×10^{-15} N is held stationary by a vertical electric field as shown in the diagram.

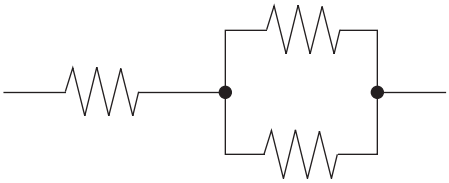


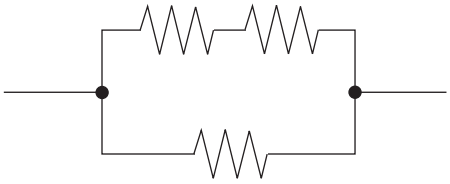
If the electric field strength is 5.3×10^{3} N/C, what is the charge on the oil droplet?

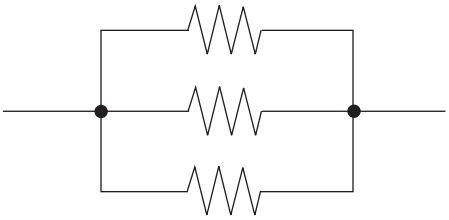
A. 1.2×10^{-18} C
B. 3.4×10^{-11} C
C. 4.1×10^{4} C
D. 8.2×10^{17} C

23. Which of the following combinations of three identical resistors has the least equivalent resistance?

A.


B.


C.


D.


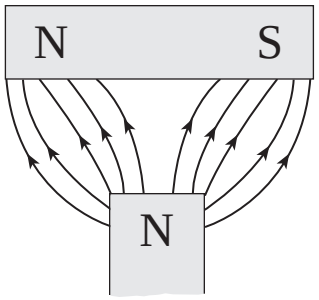
24. An electrical device with a constant resistance draws 0.75 A when connected to a 4.8 V source. What are the current and power for this device when it is connected to a 6.0 V source?

	CURRENT (A)	POWER (W)
A.	0.75	3.6
B.	0.75	5.6
C.	0.94	3.6
D.	0.94	5.6

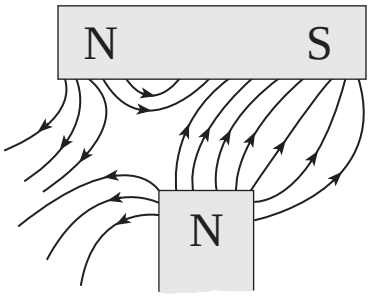
OVER

25. Which of the following diagrams best represents the magnetic field in the region between the two permanent magnets?

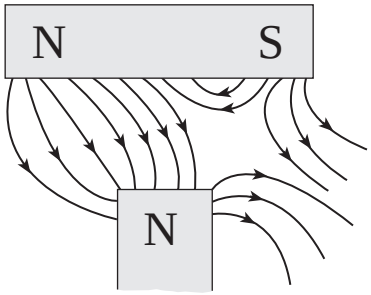
A.



B.



C.



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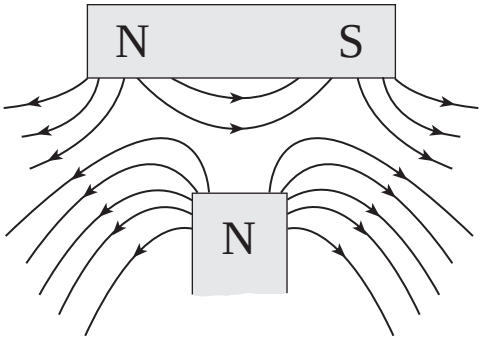
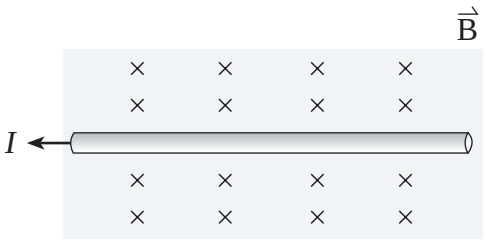


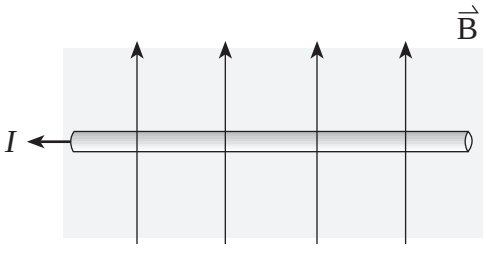
26. In which diagram would the current-carrying conductor experience a magnetic force out of the page?

A.



B.

C.



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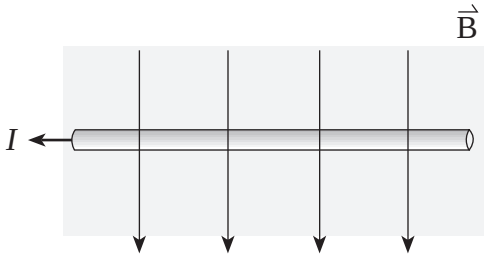
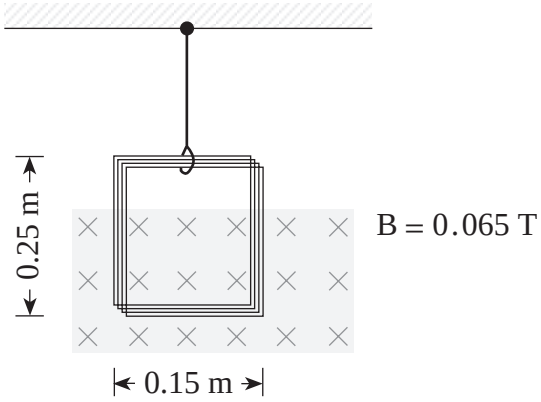


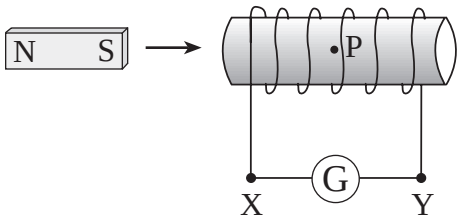
27. A coil of 25 turns of wire is suspended by a thread. When a current flows through the coil, the tension in the thread is reduced by 4.0×10^{-2} N.



What are the magnitude and direction of the current?

	MAGNITUDE OF CURRENT	DIRECTION OF CURRENT
A.	0.16 A	clockwise
B.	0.16 A	counter-clockwise
C.	4.1 A	clockwise
D.	4.1 A	counter-clockwise

28. A bar magnet is moving toward a solenoid.



What is the direction of the current through the galvanometer and what is the direction of the magnetic field produced by this current at location P inside the solenoid?

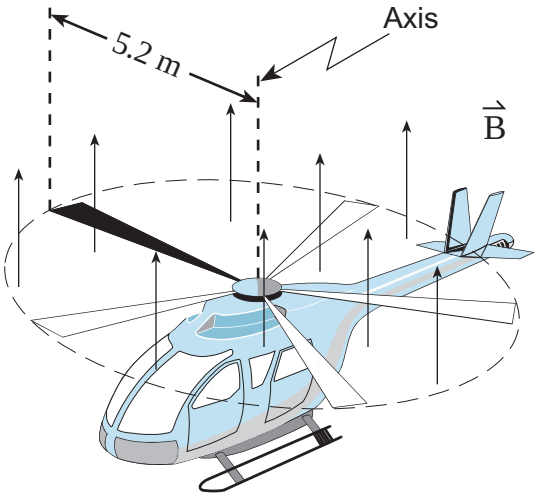
	DIRECTION OF THE CURRENT THROUGH THE GALVANOMETER	DIRECTION OF THE MAGNETIC FIELD AT P
A.	From X to Y	Right
B.	From X to Y	Left
C.	From Y to X	Right
D.	From Y to X	Left

OVER

29. A dc motor has a resistance of $2.0\ \Omega$. When connected to a 12 V source, with the motor rotating at its operational speed, a back emf of 5.5 V is generated. What is the current in the motor at operational speed?

A. 2.8 A
B. 3.3 A
C. 6.0 A
D. 8.8 A

30. The 5.2 m long metal rotor blades of a helicopter spin at 6.0 revolutions per second perpendicular to the earth's magnetic field of 4.7×10^{-5} T.



What is the magnetic flux swept out by the rotor blades in one revolution and what is the emf induced between the axis and tip of a rotor blade?

	MAGNETIC FLUX	EMF INDUCED
A.	4.0×10^{-3} Wb	2.4×10^{-2} V
B.	4.0×10^{-3} Wb	4.0×10^{-3} V
C.	2.4×10^{-2} Wb	2.4×10^{-2} V
D.	2.4×10^{-2} Wb	4.0×10^{-3} V

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.

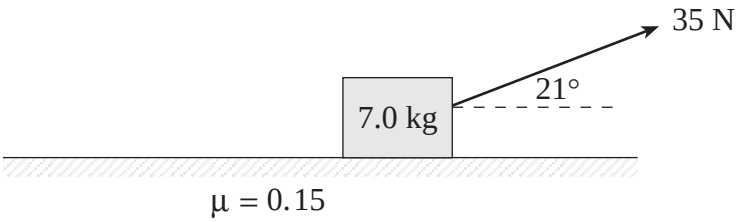
3. You are expected to communicate your knowledge and understanding of physics principles in a clear and logical manner. Partial marks will be awarded for steps and assumptions leading to a solution.

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.**

OVER

1. A 35 N force applied at $21°$ to the horizontal is used to pull a mass as shown.



The coefficient of friction between the floor and the mass is 0.15.

a) Draw and label a free body diagram showing the forces acting on the mass. **(2 marks)**

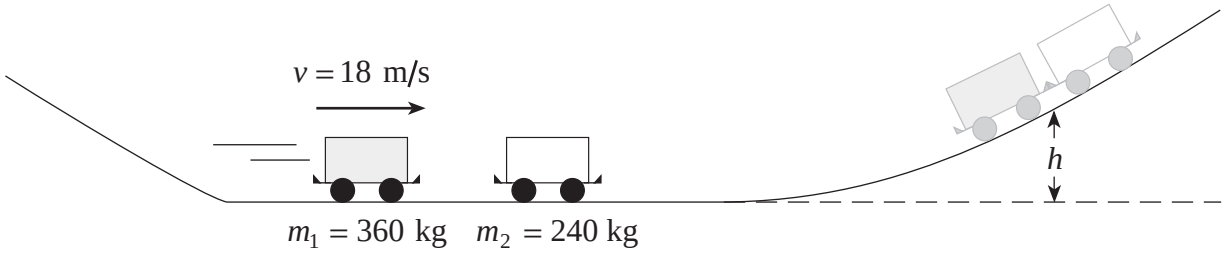
b) What is the acceleration of the mass? **(5 marks)**

ANSWER:

b) acceleration: _____

OVER

2. A 360 kg roller coaster car travelling at 18 m/s collides inelastically with a stationary 240 kg car on a section of horizontal track as shown in the diagram below.



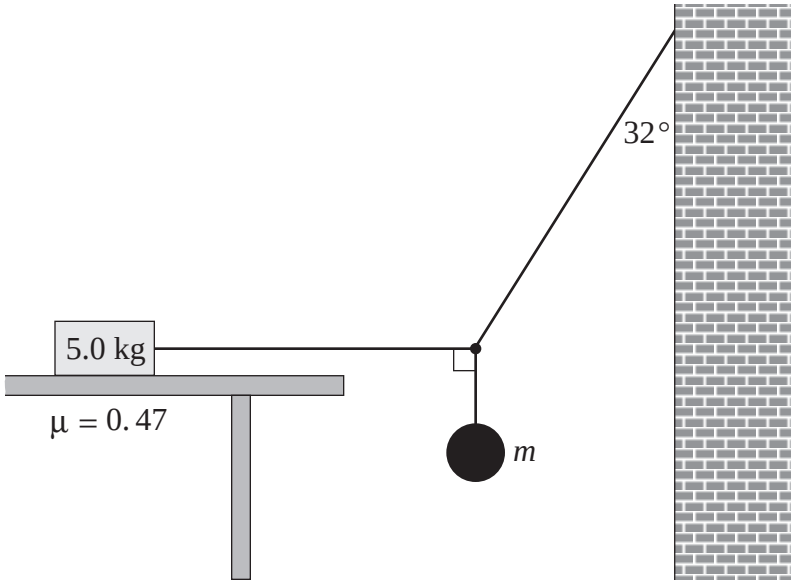
To what maximum height, h, do the combined cars travel before rolling back down the hill? (Assume no friction.) **(7 marks)**

ANSWER:

maximum height: _____

OVER

3. An object of mass, *m*, is suspended by two cords connected to a wall and to a 5.0 kg block resting on a table as shown.



A coefficient of friction of 0.47 exists between the 5.0 kg block and the table. What is the maximum mass, *m*, that can be hung from the cords before the 5.0 kg block begins to move?

(7 marks)

ANSWER:

maximum mass: _____

OVER

4. a) Mars has a mass of 6.37×10^{23} kg and a radius of 3.43×10^{6} m. What is the gravitational field strength on its surface? **(4 marks)**

b) What thrust force must the rocket engine of a Martian lander exert if the 87.5 kg spacecraft is to accelerate upwards at $1.20\ \text{m/s}^2$ as it leaves the surface of Mars? **(3 marks)**

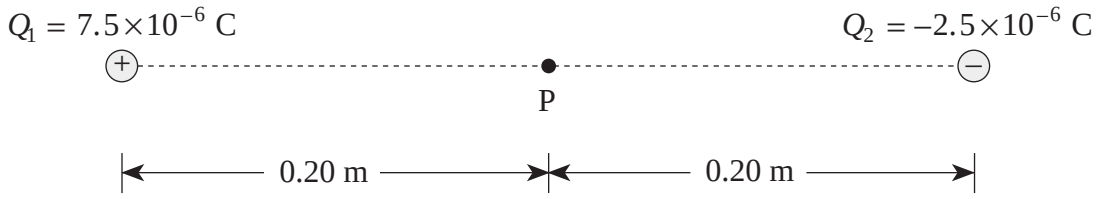
ANSWER:

a) gravitational field strength: _____

b) thrust force: _____

OVER

5. Electric charges are arranged as shown in the diagram below.



What is the electric field (magnitude and direction) at point P midway between the charges?

(7 marks)

ANSWER:

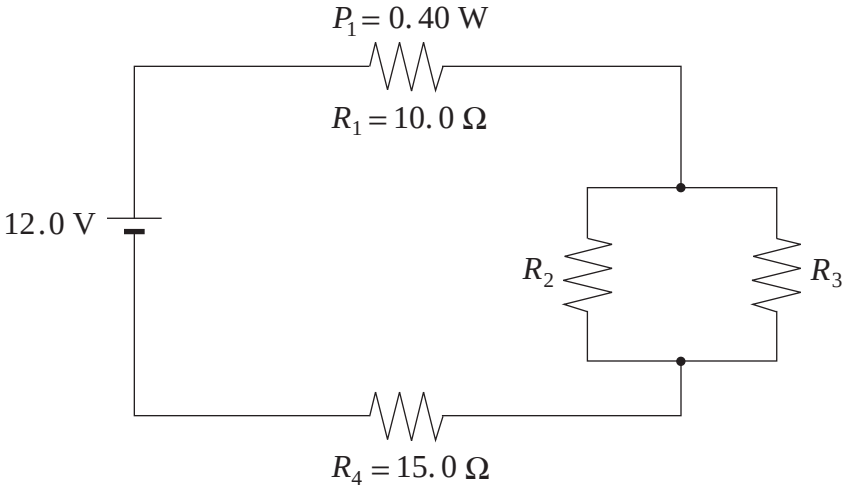
electric field:

magnitude: _____

direction: _____

OVER

6. In the circuit below, resistor R_1 dissipates $0.40\ \text{W}$. Resistors R_2 and R_3 are identical.



What is the resistance of R_2? **(7 marks)**

ANSWER:

resistance: _____

OVER

7. a) A proton moves with a speed of 3.6×10^5 m/s at right angles to a uniform 5.0×10^{-5} T magnetic field. What is the radius of curvature for the motion of the proton? **(5 marks)**

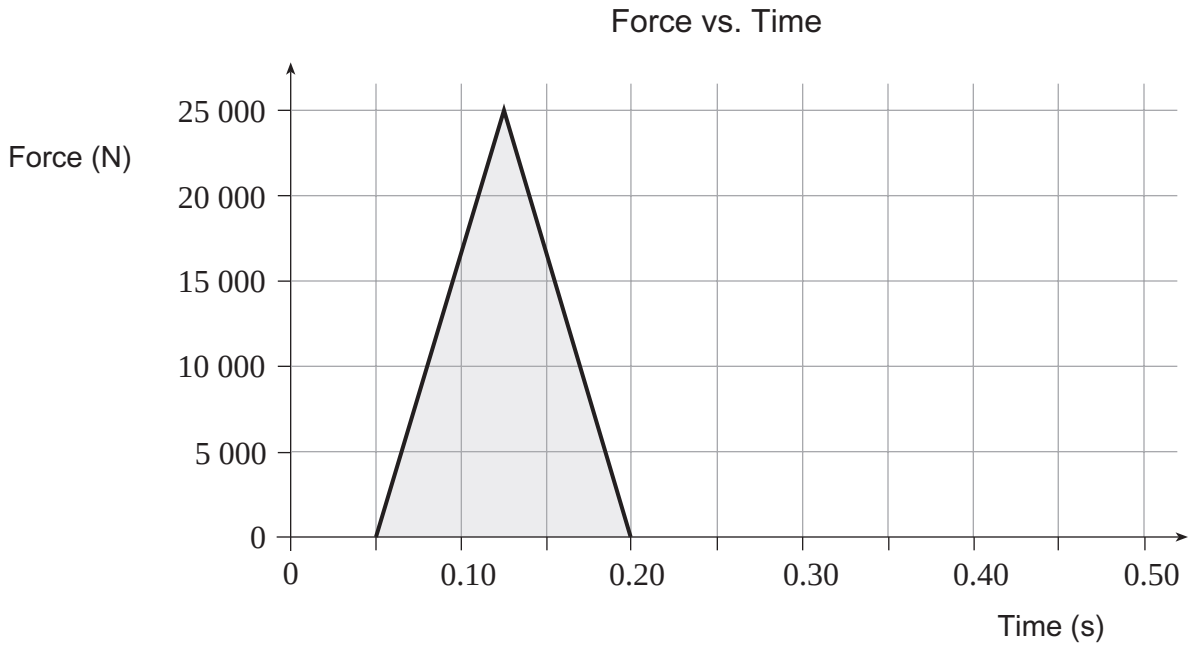
b) Describe the path of the proton in the magnetic field and use principles of physics to explain the proton's motion. **(4 marks)**

ANSWER:

a) radius of curvature: _____

OVER

8. During a motor vehicle accident an unbelted passenger experienced a force which varied with time as shown on the graph.



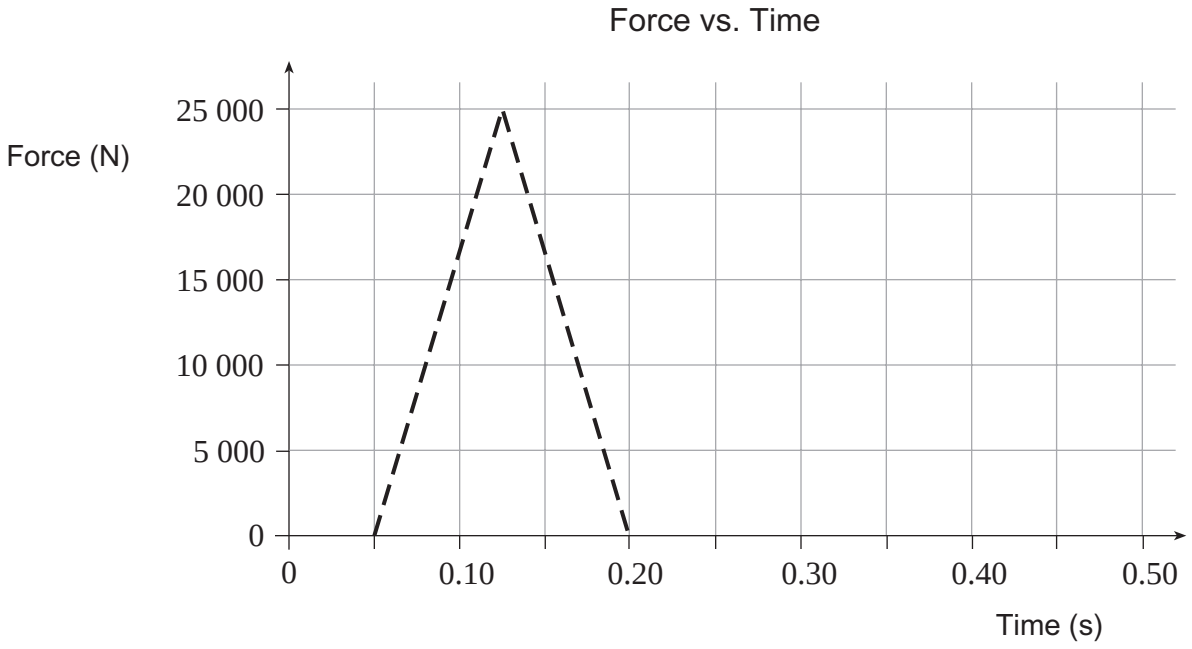
a) Calculate the area of the shaded region in the graph. **(1 mark)**

b) What does this area represent? **(2 marks)**

_____

_____

c) If the passenger was wearing a seatbelt properly, the maximum force would have been one third the force experienced without the seatbelt. Sketch on the graph below how the force on the belted passenger might have varied with time. **(2 marks)**

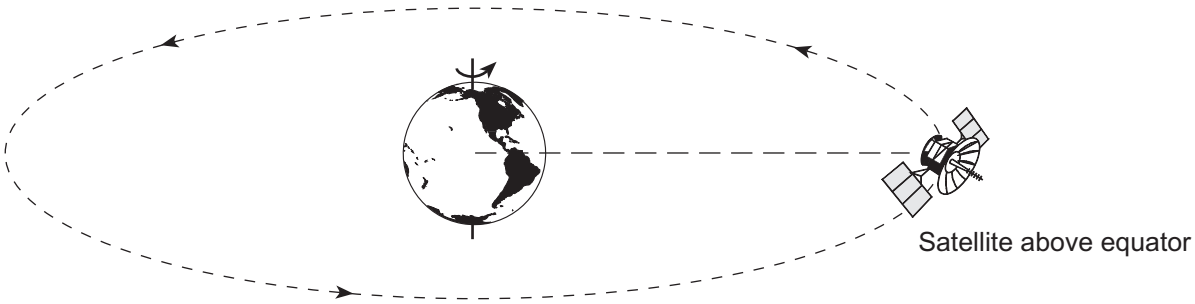


ANSWER:

a) area: _____

OVER

9. Geostationary satellites appear to remain stationary to an observer on Earth. Such satellites are placed in orbit far above the equator.



Using principles of physics, explain why such satellites all have the same orbital radius.

(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	μ_o	$= 4\pi \times 10^{-7}\ \text{T} \cdot \text{m/A}$
Speed of light	c	$= 3.00 \times 10^{8}\ \text{m/s}$

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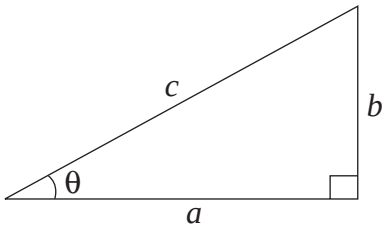
For Right-angled Triangles:

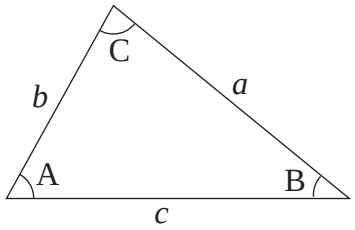


$$a^2 + b^2 = c^2$$

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

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

For All Triangles:



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

$$\sin 2\text{A} = 2\sin\text{A}\cos\text{A}$$

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

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

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:

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

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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:

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

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

Electromagnetism:

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

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

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

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

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

ROUGH WORK FOR MULTIPLE-CHOICE

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