INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

JANUARY 2000

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 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.

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

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PART A: MULTIPLE CHOICE

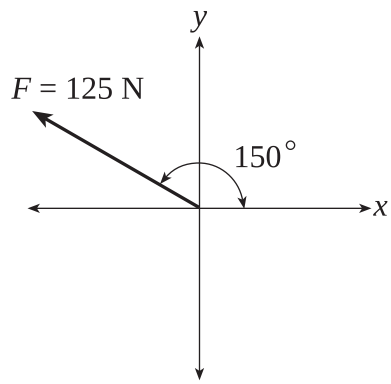
Value: 60 marks (2 marks per question) **Suggested Time: 60 minutes**

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 situations involves the use of kinematics?

   A. Solving a back emf problem
   B. Solving a projectile motion problem
   C. Determining the internal resistance of a cell
   D. Determining the sum of two momentum vectors

2. Consider the diagram below.



   What are the components of the 125 N force?

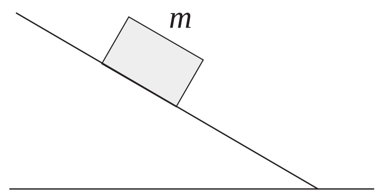
	x–COMPONENT	y–COMPONENT
A.	−62.5 N	72.2 N
B.	−72.2 N	62.5 N
C.	−62.5 N	108 N
D.	−108 N	62.5 N

3. A projectile is launched at $35.0°$ above the horizontal with an initial velocity of 120 m/s. What is the projectile's speed 3.00 s later?

   A. 68.8 m/s
   B. 98.3 m/s
   C. 106 m/s
   D. 120 m/s

OVER

4. A block of mass m remains at rest on an incline as shown in the diagram.



The force acting up the ramp on this block is

A. 0.
B. mg.
C. less than mg.
D. more than mg.

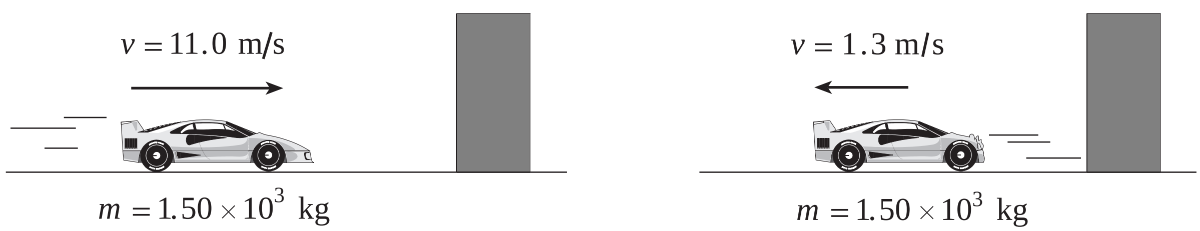
5. What is the minimum work done when a 65 kg student climbs an 8.0 m-high stairway in 12 s?

A. 420 J
B. 520 J
C. 5 100 J
D. 6 200 J

6. Which of the following is equal to impulse?

A. Energy
B. Momentum
C. Change in energy
D. Change in momentum

7. A 1.50×10^{3} kg car travelling at 11.0 m/s collides with a wall as shown.



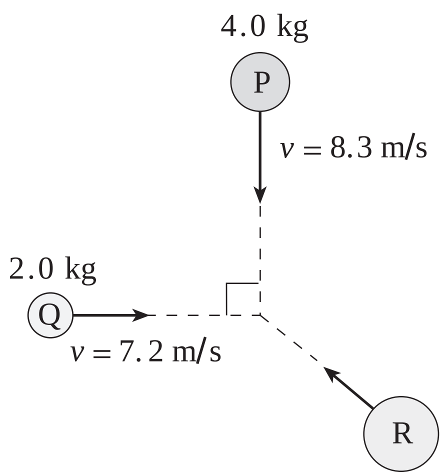
The car rebounds off the wall with a speed of 1.3 m/s. If the collision lasts for 1.7 s, what force does the wall apply to the car during the collision?

A. 8.6×10^{3} N
B. 1.1×10^{4} N
C. 1.5×10^{4} N
D. 1.8×10^{4} N

8. A 1 500 kg car travelling at 25 m/s collides with a 2 500 kg van stopped at a traffic light. As a result of the collision the two vehicles become entangled. With what initial speed will the entangled mass move off, and is the collision elastic or inelastic?

	SPEED	TYPE OF COLLISION
A.	9.4 m/s	Elastic
B.	9.4 m/s	Inelastic
C.	15 m/s	Elastic
D.	15 m/s	Inelastic

9. Three objects travel as shown.

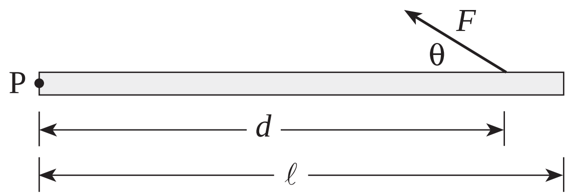


What is the magnitude of the momentum of object R so that the combined masses remain stationary after they collide?

A. 19 kg · m/s
B. 30 kg · m/s
C. 36 kg · m/s
D. 48 kg · m/s

OVER

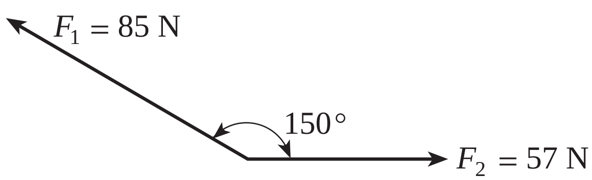
10. A force F is applied to a uniform horizontal beam as shown in the diagram below.



Which of the following is a correct expression for the torque on the beam about pivot point P due to this force?

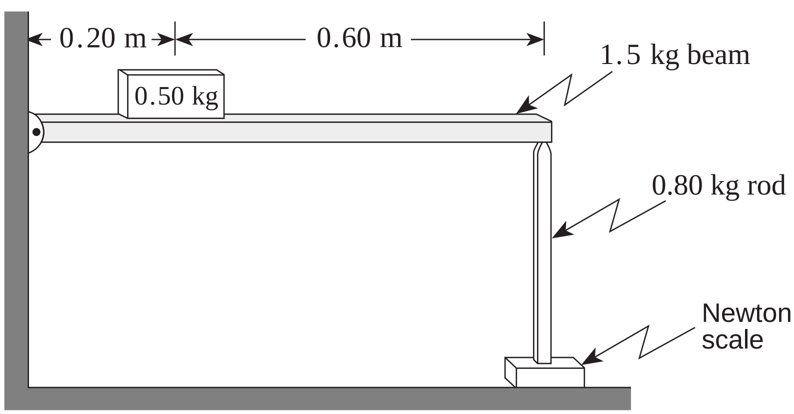
A. $F \sin\theta \cdot d$
B. $F \sin\theta \cdot d/\ell$
C. $F \cos\theta \cdot d$
D. $F \cos\theta \cdot d/\ell$

11. What is the magnitude of the sum of the two forces shown in the diagram below?



A. 46 N
B. 102 N
C. 137 N
D. 142 N

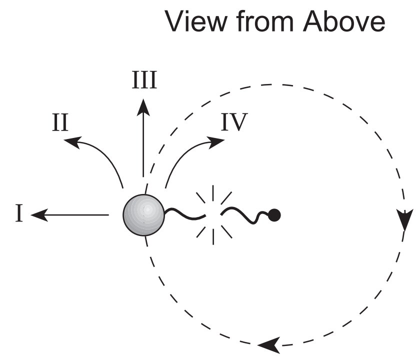
12. A uniform 1.5 kg beam hinged at one end supports a 0.50 kg block. The beam is held level by a vertical 0.80 kg rod resting on a Newton scale at the other end.



What is the reading on the scale?

A. 8.6 N
B. 9.1 N
C. 16 N
D. 27 N

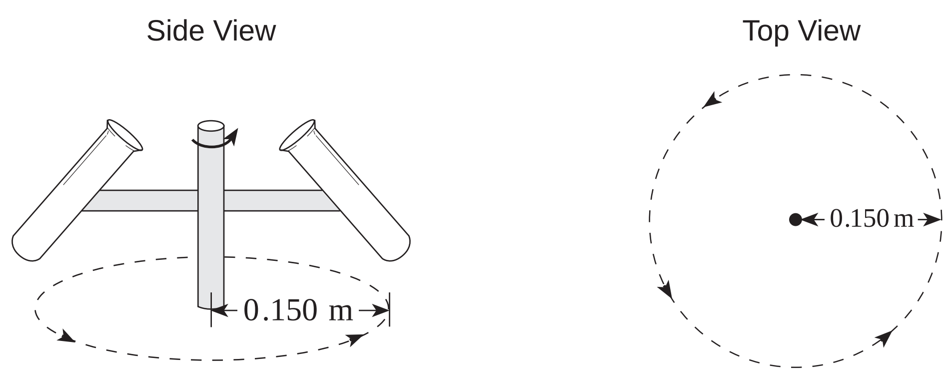
13. A ball attached to a string is swung in a horizontal circle.



Which path will the ball follow at the instant the string breaks?

A. I
B. II
C. III
D. IV

14. A test tube rotates in a centrifuge with a period of 1.20×10^{-3} s. The bottom of the test tube travels in a circular path of radius 0.150 m.

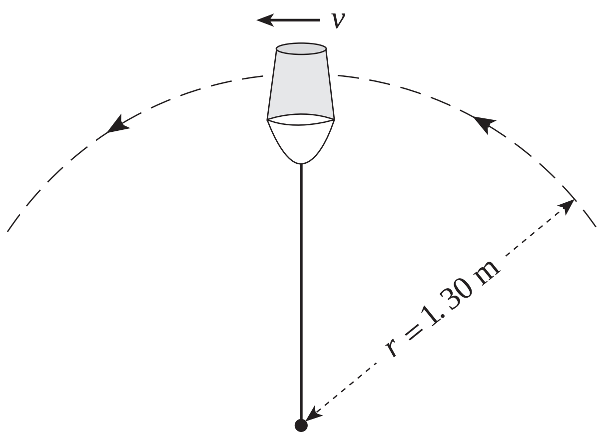


What is the centripetal force exerted on a 2.00×10^{-8} kg amoeba at the bottom of the tube?

A. 9.86×10^{-5} N
B. 2.08×10^{-3} N
C. 8.22×10^{-2} N
D. 4.11×10^{6} N

OVER

15. A physics student swings a 5.0 kg pail of water in a vertical circle of radius 1.3 m.

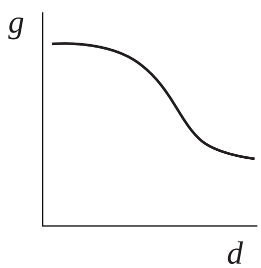


What is the minimum speed, v, at the top of the circle if the water is not to spill from the pail?

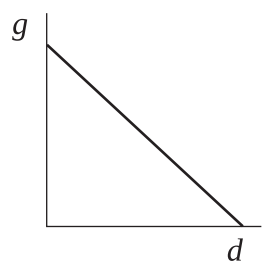
A. 3.6 m/s
B. 6.1 m/s
C. 8.0 m/s
D. 9.8 m/s

16. Which of the following is a correct graph for gravitational field strength, g, versus the distance, d?

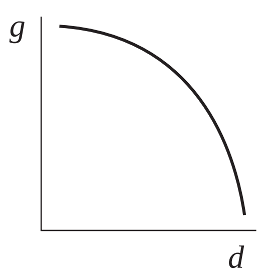
A.



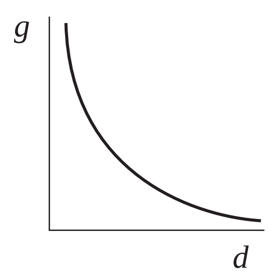
B.



C.



D.



17. *Sputnik I*, Earth's first artificial satellite, had an orbital period of 5 760 s. What was the average orbital radius of *Sputnik's* orbit?

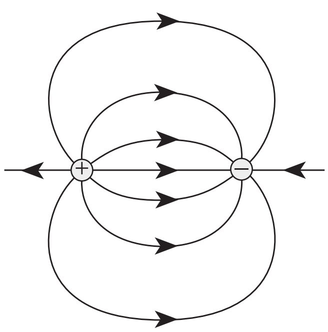
A. 6.38×10^{6} m
B. 6.95×10^{6} m
C. 8.24×10^{6} m
D. 3.84×10^{8} m

18. A 620 kg satellite orbits the earth where the acceleration due to gravity is 0.233 m/s^2. What is the kinetic energy of this orbiting satellite?

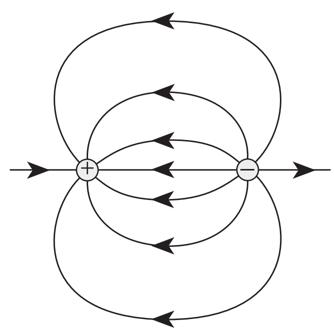
A. -5.98×10^{9} J
B. -2.99×10^{9} J
C. 2.99×10^{9} J
D. 5.98×10^{9} J

19. Which of the following diagrams shows the electric field between two equal but opposite charges?

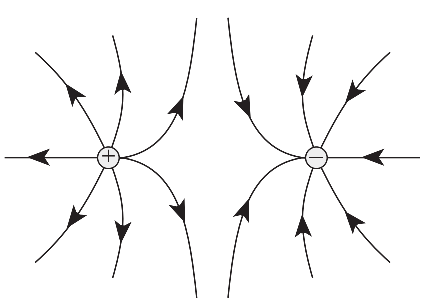
A.



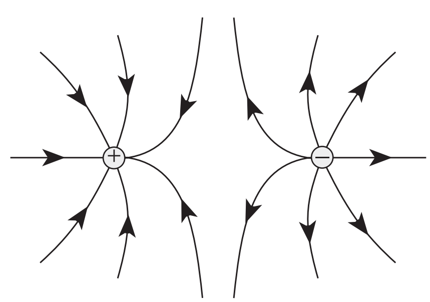
B.



C.

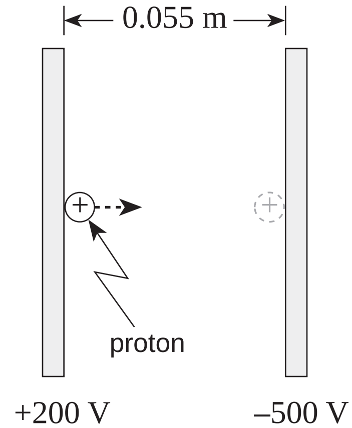


D.



OVER

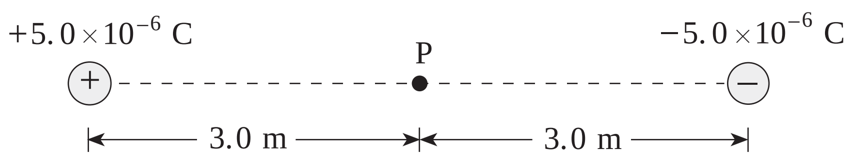
20. A proton initially at rest is accelerated between parallel plates through a potential difference of 700 V.



What is the maximum speed reached by the proton?

A. 8.6×10^{4} m/s
B. 3.1×10^{5} m/s
C. 3.7×10^{5} m/s
D. 1.6×10^{6} m/s

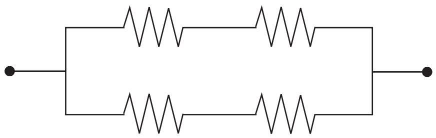
21. What are the magnitudes of the electric field and the electric potential at point P midway between the two fixed charges?



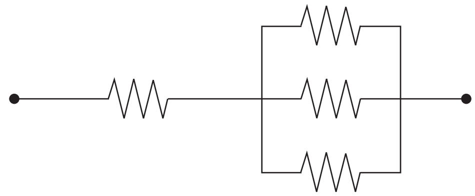
	MAGNITUDE OF ELECTRIC FIELD	ELECTRIC POTENTIAL
A.	0 N/C	0 V
B.	0 N/C	30 000 V
C.	10 000 N/C	0 V
D.	10 000 N/C	30 000 V

22. Which of the following arrangements would draw the largest current when connected to the same potential difference? All resistors have the same value.

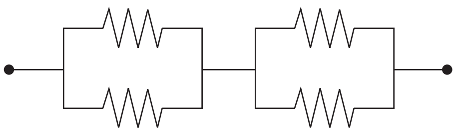
A.



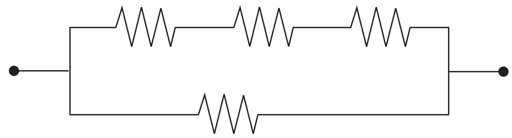
B.



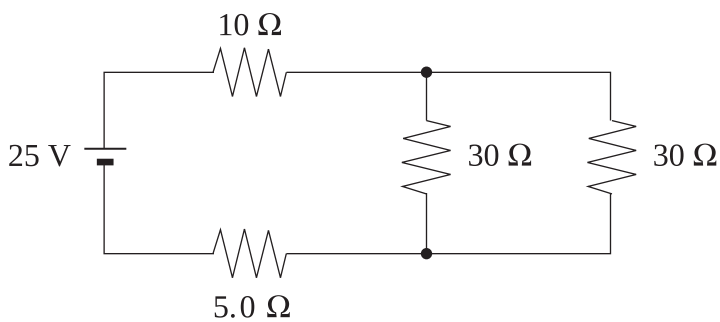
C.



D.



23. What is the power dissipated by the $5.0\ \Omega$ resistor in the following circuit?



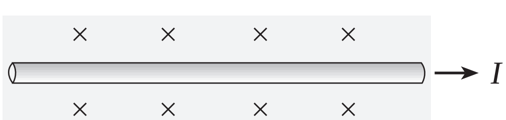
A. 0.56 W
B. 3.5 W
C. 6.2 W
D. 130 W

24. The direction of a magnetic field is determined to be the direction in which

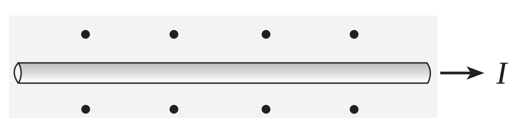
A. a positive charge would tend to move.
B. a negative charge would tend to move.
C. the north end of a compass needle would point.
D. the south end of a compass needle would point.

25. Which diagram shows the magnetic field created near a conductor carrying current towards the right?

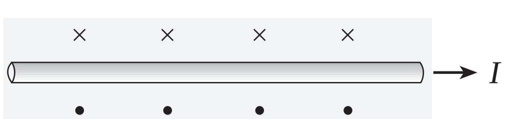
A.



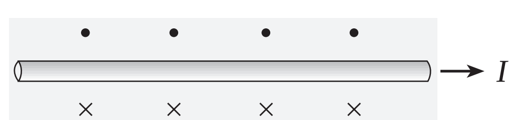
B.



C.

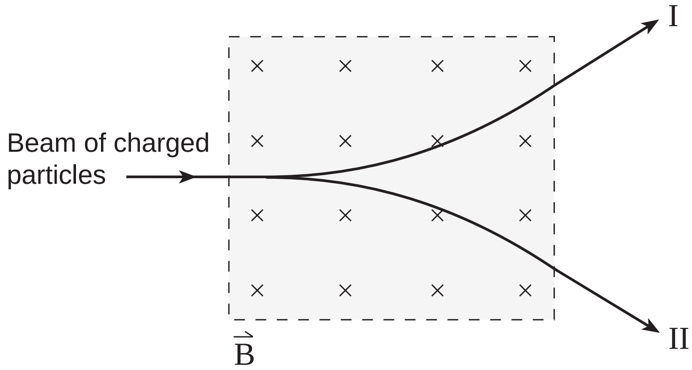


D.



OVER

26. A beam of positively and negatively charged particles enters a magnetic field as shown. Which paths illustrate the positive and negative charges leaving the magnetic field region?



	PATH OF POSITIVE CHARGES	PATH OF NEGATIVE CHARGES
A.	I	I
B.	I	II
C.	II	I
D.	II	II

27. A solenoid has a length of $0.30\ \text{m}$, a diameter of $0.040\ \text{m}$ and 500 windings. The magnetic field at its centre is $0.045\ \text{T}$. What is the current in the windings?

A. $2.9\ \text{A}$
B. $3.0\ \text{A}$
C. $21\ \text{A}$
D. $170\ \text{A}$

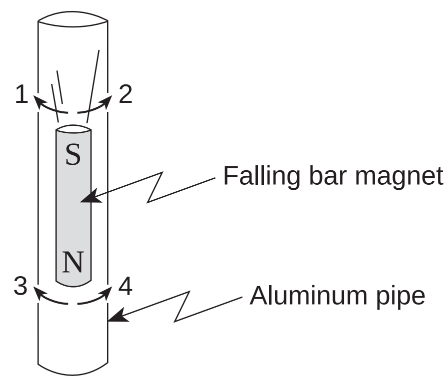
28. An aircraft with a wingspan of 24 m flies at $85\ \text{m/s}$ perpendicular to a magnetic field. An emf of $0.19\ \text{V}$ is induced across the wings of the aircraft. What is the magnitude of the magnetic field?

A. $9.3\times10^{-5}\ \text{T}$
B. $5.4\times10^{-2}\ \text{T}$
C. $6.7\times10^{-1}\ \text{T}$
D. $3.9\times10^{2}\ \text{T}$

29. As a carpenter drills into a beam, friction on the drill bit causes the armature of the drill to slow down. How will the back emf and the current through the armature change as the drill slows down?

	BACK EMF	CURRENT
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

30. The diagram shows a bar magnet falling through an aluminum pipe. Electric currents are induced in the pipe immediately above and below the falling magnet. In which direction do these currents flow?



	ABOVE THE MAGNET	BELOW THE MAGNET
A.	1	3
B.	1	4
C.	2	3
D.	2	4

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

OVER

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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.

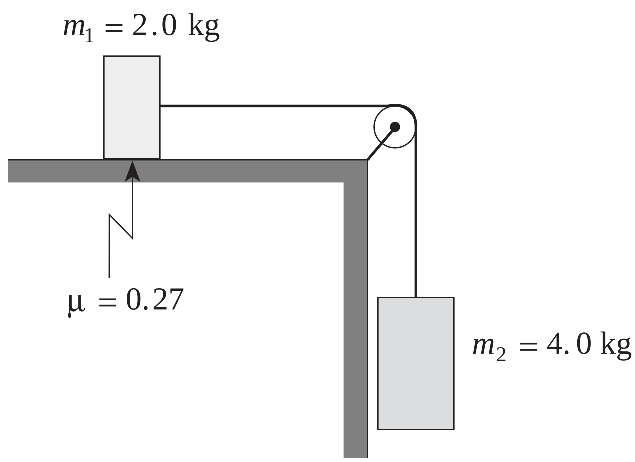
2. a) Final answers must include appropriate **units**.
   b) Marks will not be deducted for answers expressed to **two** or **three** significant figures.
   c) In this examination the zero in a number such as 30 shall be considered to be a significant zero.

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 string over a frictionless massless pulley. There is a coefficient of friction of 0.27 between mass m_1 and the horizontal surface.



a) Draw and label a free body diagram showing the forces acting on mass m_1. **(2 marks)**

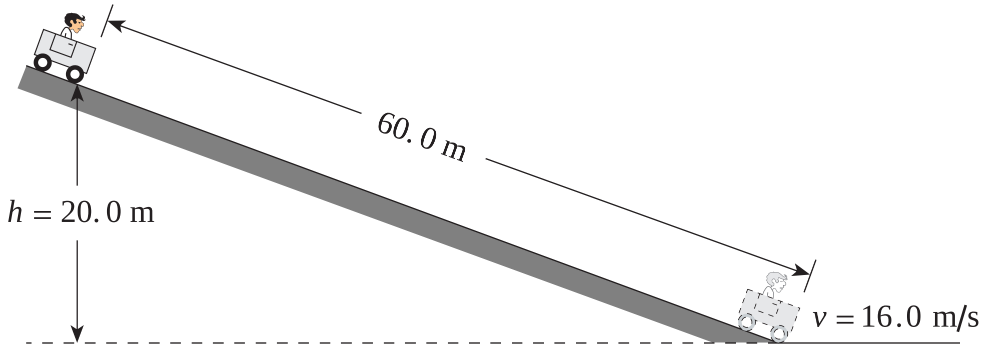
b) What is the acceleration of mass m_2? **(5 marks)**

ANSWER:

b) acceleration of mass m_2: ________________

OVER

2. A 170 kg cart and rider start from rest on a 20.0 m high incline.



a) How much energy is transformed to heat? **(5 marks)**

ANSWER:

a) energy: ____________________

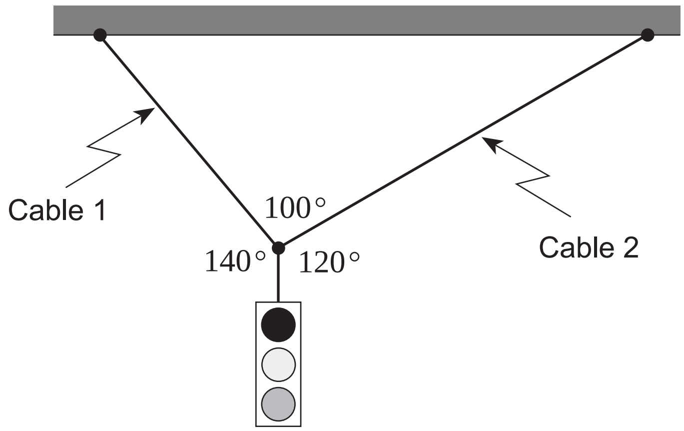
b) What is the average force of friction acting on the cart? **(2 marks)**

ANSWER:

b) average force of friction: ______________

OVER

3. A 35 kg traffic light is suspended from two cables as shown in the diagram.



What is the tension in each of these cables? **(7 marks)**

ANSWER:

Tension in Cable 1: ______________________

Tension in Cable 2: ______________________

OVER

4. A $5.0\ \text{kg}$ rock dropped near the surface of Mars reaches a speed of $15\ \text{m/s}$ in $4.0\ \text{s}$.

a) What is the acceleration due to gravity near the surface of Mars? **(2 marks)**

ANSWER:

a) acceleration: ____________________________

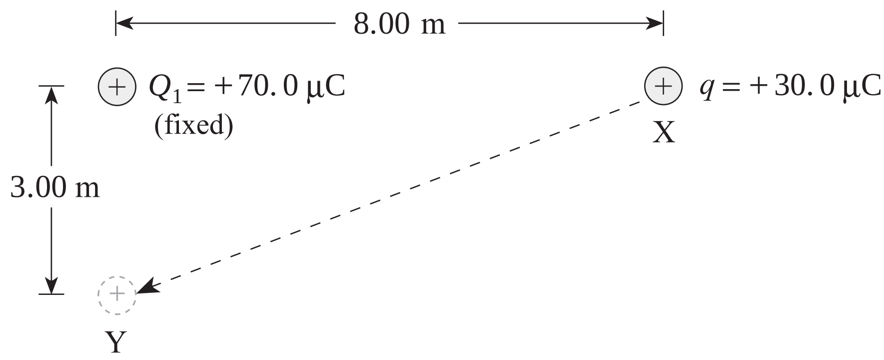
b) Mars has an average radius of 3.38×10^6 m. What is the mass of Mars? **(5 marks)**

ANSWER:

b) mass of Mars: ______________________

OVER

5. A charge q of $30.0\ \mu C$ is moved from point X to point Y.

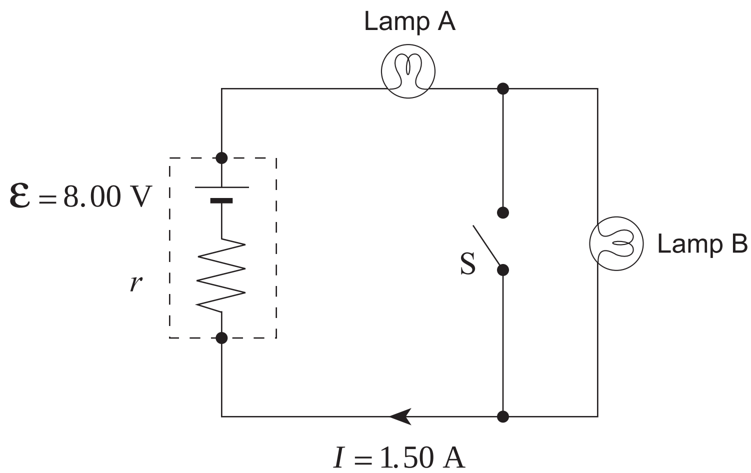


How much work is done on the $30.0\ \mu C$ charge? $\left(1\ \mu C = 1 \times 10^{-6}\ C\right)$ **(7 marks)**

ANSWER: work: ______________________________

OVER

6. The circuit shown consists of an $8.00\ \text{V}$ battery and two light bulbs. Each light bulb dissipates $5.0\ \text{W}$. Assume that the light bulbs have a constant resistance. Switch S is open.



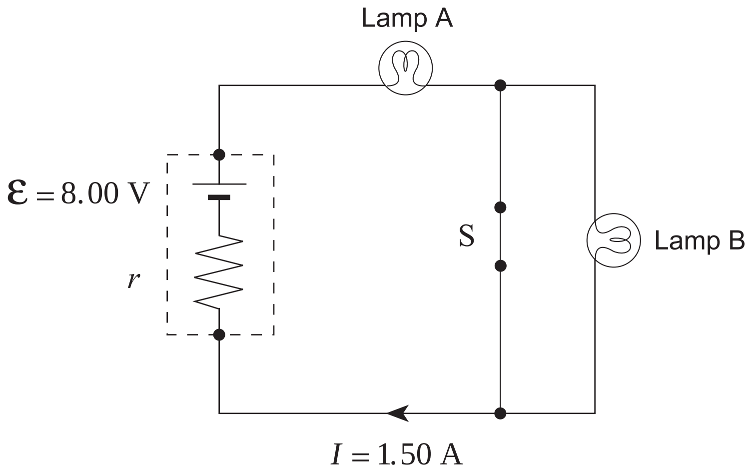
a) If a current of $1.50\ \text{A}$ flows in the circuit, what is the internal resistance r of the battery?

(4 marks)

ANSWER:

a) internal resistance: ____________________

b) The switch S is now closed.



Lamp A will now be

i) ☐ brighter.
☐ the same brightness as before.
☐ dimmer.

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

The battery's terminal voltage will now be

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

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

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

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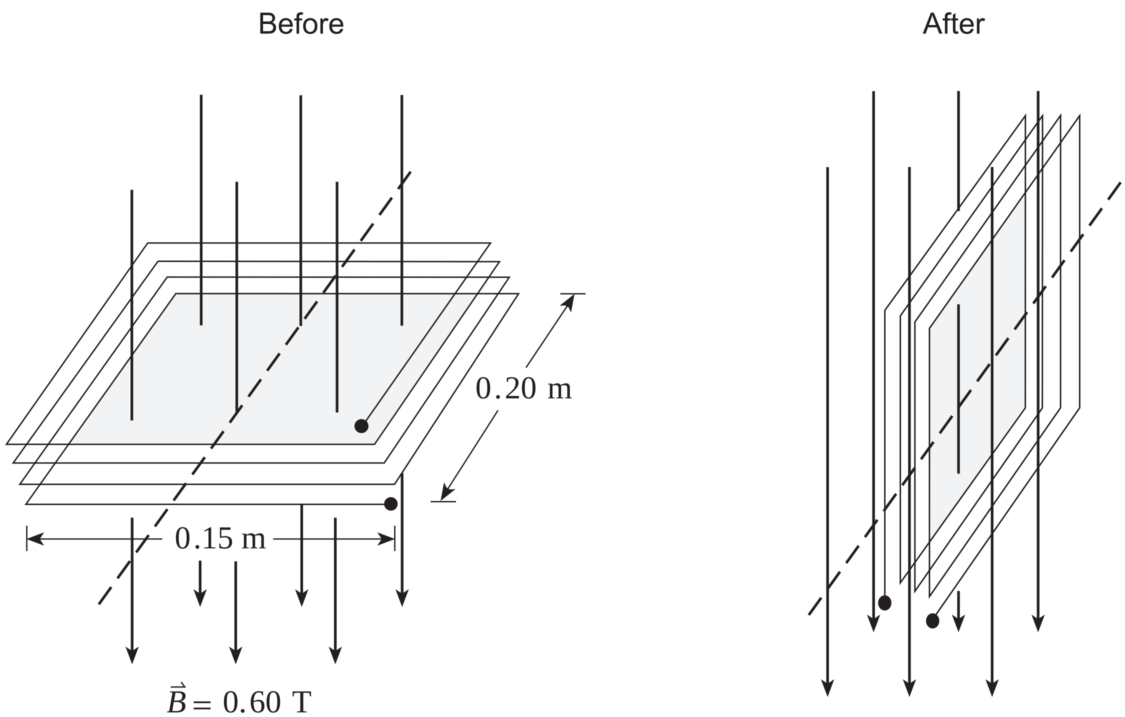
OVER

7. The diagram shows a coil with 25 windings and dimensions 0.15 m by 0.20 m. Its plane is perpendicular to a magnetic field of magnitude 0.60 T.



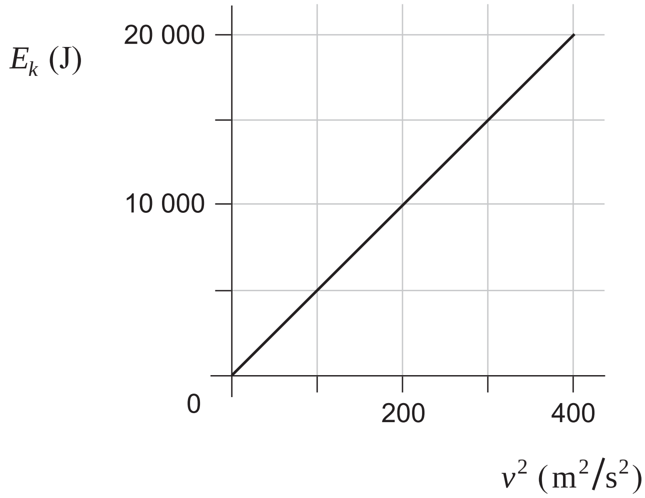
If the coil rotates $90°$ in $4.17 \times 10^{-2}\text{ s}$ so that its plane is now parallel to the magnetic field, what average emf is induced during this time? **(7 marks)**

ANSWER:

average emf: ______________________________

OVER

8. A student plots the graph below, showing the kinetic energy E_k of a motorbike versus the square of its velocity v^2.



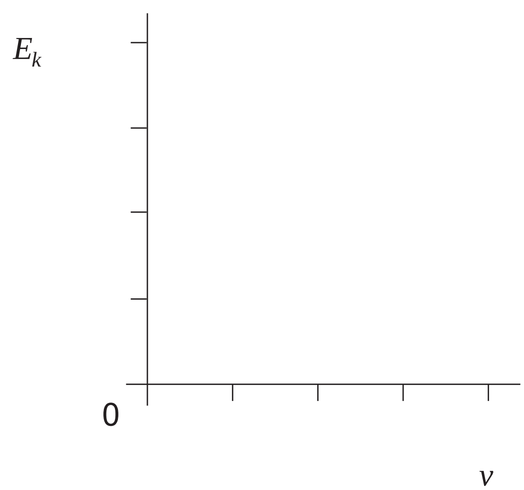
a) What is the slope of this graph? **(2 marks)**

ANSWER:

a) slope: ____________________

b) What does the slope represent? **(2 marks)**

c) Using the axes below, sketch the graph of kinetic energy E_k versus velocity v for this motorbike. There is no need to plot any data points. **(1 mark)**



OVER

9. A classmate insists a book cannot be held against a wall by pushing horizontally as shown in Diagram A. He insists that there must be a vertical force component provided by pushing against the book from below, as shown in Diagram B.

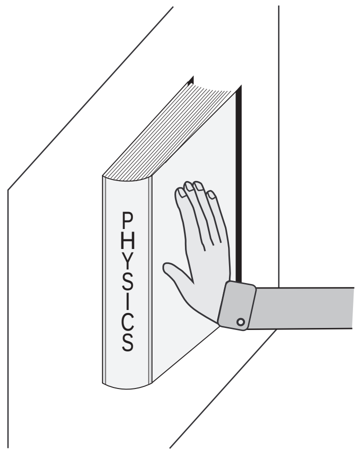


Diagram A

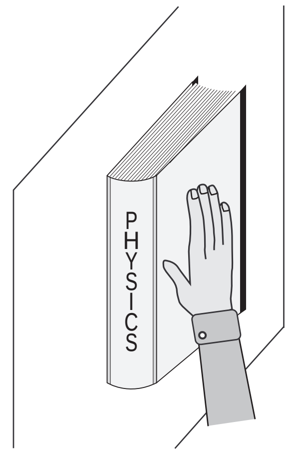


Diagram B

Using principles of physics, show that the situation in Diagram A is reasonable. **(4 marks)**

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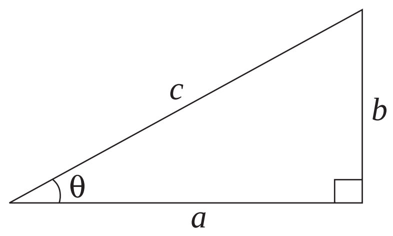
END OF EXAMINATION

TABLE OF CONSTANTS

Gravitational constant	G	$= 6.67 \times 10^{-11}\ \mathrm{N \cdot m^2/kg^2}$
Acceleration due to gravity at the surface of Earth (for the purposes of this examination)	g	$= 9.80\ \mathrm{m/s^2}$
Earth		
radius		$= 6.38 \times 10^{6}\ \mathrm{m}$
radius of orbit about Sun		$= 1.50 \times 10^{11}\ \mathrm{m}$
period of rotation		$= 8.61 \times 10^{4}\ \mathrm{s}$
period of revolution about Sun		$= 3.16 \times 10^{7}\ \mathrm{s}$
mass		$= 5.98 \times 10^{24}\ \mathrm{kg}$
Moon		
radius		$= 1.74 \times 10^{6}\ \mathrm{m}$
radius of orbit about Earth		$= 3.84 \times 10^{8}\ \mathrm{m}$
period of rotation		$= 2.36 \times 10^{6}\ \mathrm{s}$
period of revolution about Earth		$= 2.36 \times 10^{6}\ \mathrm{s}$
mass		$= 7.35 \times 10^{22}\ \mathrm{kg}$
Sun		
mass		$= 1.98 \times 10^{30}\ \mathrm{kg}$
Constant in Coulomb's Law	k	$= 9.00 \times 10^{9}\ \mathrm{N \cdot m^2/C^2}$
Elementary charge	e	$= 1.60 \times 10^{-19}\ \mathrm{C}$
Mass of electron	m_e	$= 9.11 \times 10^{-31}\ \mathrm{kg}$
Mass of proton	m_p	$= 1.67 \times 10^{-27}\ \mathrm{kg}$
Mass of neutron	m_n	$= 1.68 \times 10^{-27}\ \mathrm{kg}$
Permeability of free space	μ_o	$= 4\pi \times 10^{-7}\ \mathrm{T \cdot m/A}$
Speed of light	c	$= 3.00 \times 10^{8}\ \mathrm{m/s}$

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

For Right-angled Triangles:

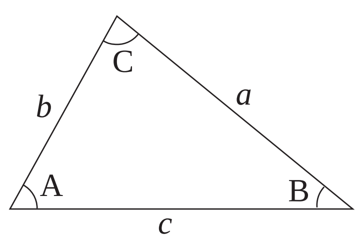


$$a^2 + b^2 = c^2$$

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

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

For All Triangles:



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

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

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

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

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:

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

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:

$$F = k\frac{Q_1Q_2}{r^2} \qquad E = \frac{F}{Q}$$

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

$$E_p = k\frac{Q_1Q_2}{r} \qquad V = \frac{kQ}{r}$$

Electric Circuits:

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

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

Electromagnetism:

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

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

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

$$V_{back} = \varepsilon - Ir$$

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

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

ROUGH WORK FOR MULTIPLE-CHOICE

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)

INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

batch and sequence number

PHYSICS 12

January 2000

Course Code = EN

Use this space if I.D. sticker is **not** available.

WRITE STUDENT I.D. NUMBER (PEN)

IN THIS SPACE