INSERT STUDENT I.D. NUMBER

STICKER IN THIS SPACE

JANUARY 1995

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. **Under no circumstance is your name or identification, other than your Student I.D. Number, to appear on this paper.**

2. Take the separate Answer Sheet and follow the directions on its front page.

3. Be sure you have an HB pencil and an eraser for completing your Answer Sheet. Follow the directions on the Answer Sheet when answering multiple-choice questions.

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

5. 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.

6. At the end of the examination, place your Answer Sheet inside the front cover of this booklet and return the booklet and your Answer Sheet to the supervisor.

THIS PAGE INTENTIONALLY BLANK

FOR OFFICE USE ONLY

INSERT STUDENT I.D. NUMBER

STICKER IN THIS SPACE

_____ – _____

PHYSICS 12 JANUARY 1995 PROVINCIAL
(PHP)

1. _____ (7)

2. _____ (7)

3. _____ (7)

4. _____ (5)

5. _____ (4)

6. _____ (7)

7. _____ (7)

8. _____ (4)

Score **only one** of the following optional sections.

SECTION I		SECTION II		SECTION III
9. _____ (3)		12. _____ (3)		15. _____ (3)
10. _____ (4)	**OR**	13. _____ (4)	**OR**	16. _____ (4)
11. _____ (5)		14. _____ (5)		17. _____ (5)

THIS PAGE INTENTIONALLY BLANK

PHYSICS 12 PROVINCIAL EXAMINATION

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

		Value	Suggested Time
PART A:	30 multiple-choice questions worth two marks each	60	60
PART B:	7 written-response questions	48	48
PART C:	Three sections from which **one** section **only** must be chosen.	12	12
	Total	**120 marks**	**120 minutes**

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

3. 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. An approved scientific calculator is essential for the examination. The calculator must be a hand-held device designed **only** for mathematical computations such as logarithmic and trigonometric functions. It **can be** programmable, but **must not** contain any graphing capabilities. You **must not** bring into the examination room any devices to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, or keyboards.

5. You are permitted to use rulers, compasses and protractors.

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. You have **two hours** to complete this examination.

THIS PAGE INTENTIONALLY BLANK

PART A: MULTIPLE-CHOICE

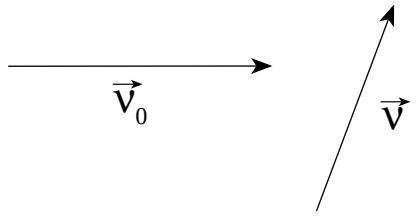
Value: 60 marks (2 marks per question) **Suggested Time: 60 minutes**

INSTRUCTIONS: For each question, select the **best** answer and record your choice on the answer sheet provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

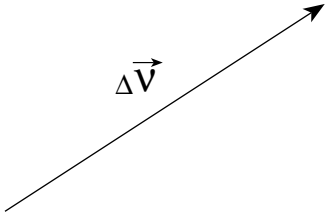
1. Which of the following is a vector quantity?

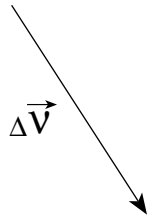
   A. work
   B. speed
   C. acceleration
   D. kinetic energy

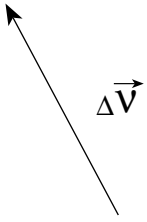
2. Initial velocity vector $\vec{v}_0$ and final velocity vector $\vec{v}$ are shown below.

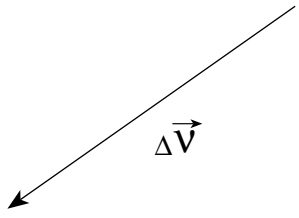


   Which of the following represents the change in velocity $\Delta\vec{v}$?

A.


B.


C.


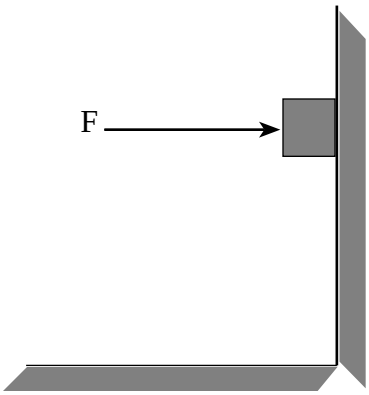
D.


OVER

3. A projectile is launched over level ground with a speed of 240 m/s at $35°$ to the horizontal. If friction is negligible, what is the height of the projectile 17 s after launch?

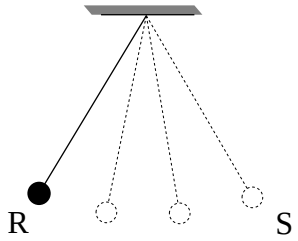
A. 9.2×10^2 m
B. 1.9×10^3 m
C. 2.7×10^3 m
D. 5.5×10^3 m

4. What minimum horizontal force F will **just** prevent the 5.0 kg block from sliding if the coefficient of friction between the wall and the block is 0.65?

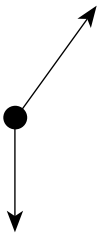


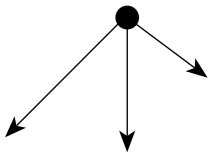
A. 6.4 N
B. 32 N
C. 49 N
D. 75 N

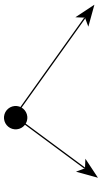
5. A pendulum is swinging freely between points R and S as shown in the diagram below.

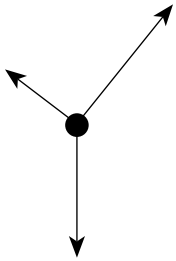


Which of the following diagrams **best** represents the forces acting on the pendulum bob at point R?

A. 

B. 

C. 

D. 

6. Impulse is measured in which units?

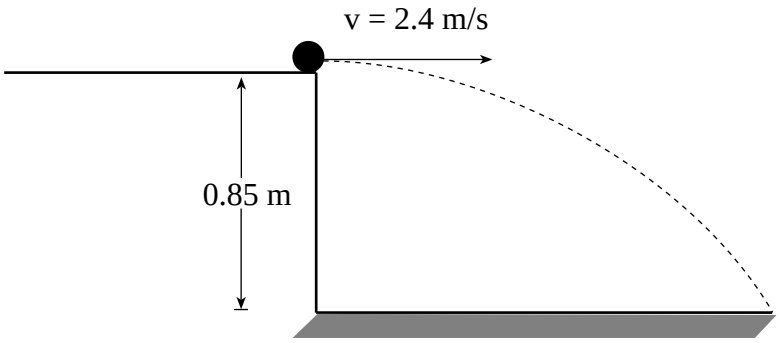
A. J
B. N
C. $N \cdot m$
D. $N \cdot s$

7. How much work must be done to stop an 1 800 kg vehicle travelling at 30 m/s?

A. 1.8×10^4 J
B. 5.4×10^4 J
C. 5.3×10^5 J
D. 8.1×10^5 J

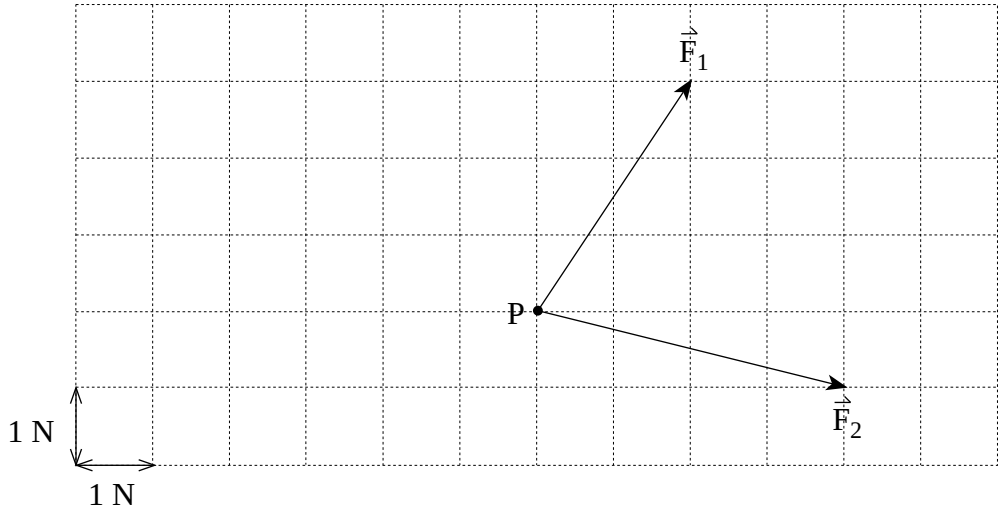
OVER

8. A 0.15 kg ball rolls off a bench at 2.4 m/s as shown in the diagram below. What is the vertical component of the ball's momentum when it strikes the floor 0.85 m below?



A. $0.36\ \text{kg} \cdot \text{m/s}$
B. $0.61\ \text{kg} \cdot \text{m/s}$
C. $0.71\ \text{kg} \cdot \text{m/s}$
D. $1.2\ \text{kg} \cdot \text{m/s}$

9. Two forces act at point P as shown below.

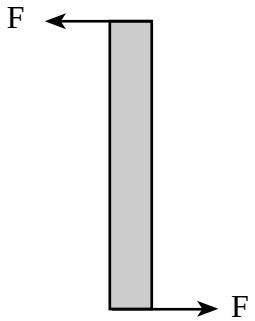


Find the magnitude of the third force required to achieve equilibrium.

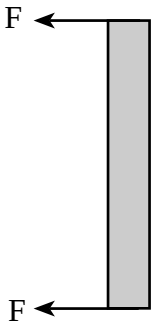
A. 4.5 N
B. 5.5 N
C. 6.3 N
D. 7.2 N

10. Which of the following shows a uniform beam which is in rotational equilibrium but **not** translational equilibrium?

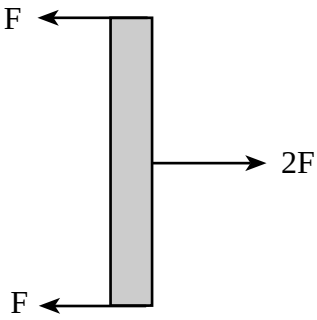
A.



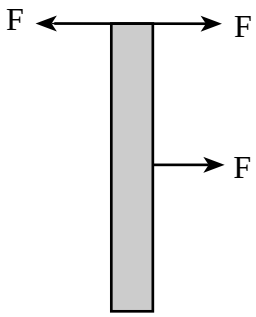
B.



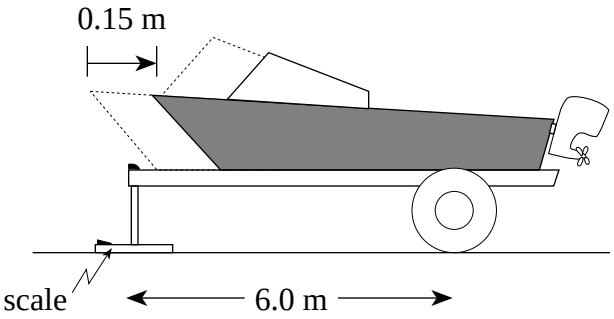
C.



D.



11. A trailer carrying a boat is supported by a scale which initially reads 48 kg. The boat (and therefore its centre of gravity) is moved 0.15 m further back on the trailer. The scale now reads 37 kg. Find the mass of the boat.



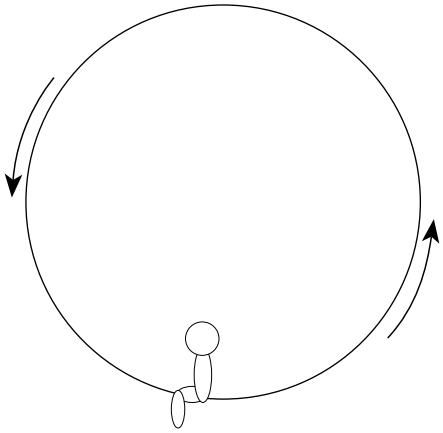
A. 440 kg
B. 1 600 kg
C. 1 700 kg
D. 3 400 kg

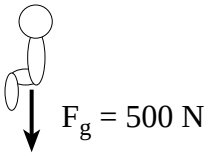
12. The work required to move an object in a planet's gravitational field can be determined graphically by calculating

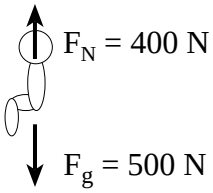
A. the slope of a graph of gravitational force versus separation distance.
B. the area under a graph of gravitational force versus separation distance.
C. the slope of a graph of gravitational potential energy versus separation distance.
D. the area under a graph of gravitational potential energy versus separation distance.

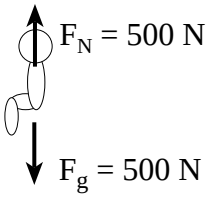
OVER

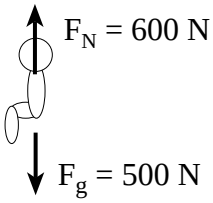
13. A 500 N child travels in a circular path on a ferris wheel. Which free body diagram **best** shows the forces which could act on the child as she passes the lowest point?



A. 

B. 

C. 

D. 

14. A satellite orbits a planet of mass 4.0×10^{25} kg at a velocity of 5.8×10^{3} m/s. What is the radius of this orbit?

A. 6.4×10^{6} m
B. 7.9×10^{7} m
C. 1.6×10^{8} m
D. 1.2×10^{19} m

15. What minimum kinetic energy would a spacecraft of mass 1.2×10^{4} kg need at the surface of the Earth so that it could escape to infinity?

A. 1.1×10^{4} J
B. 1.2×10^{5} J
C. 7.5×10^{11} J
D. An infinite amount

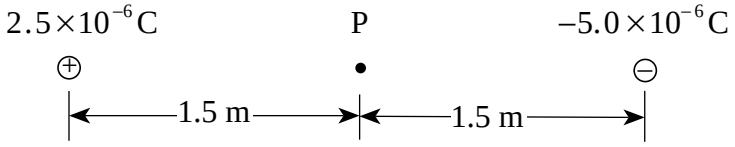
16. A negative charge in an electric field experiences a force accelerating it due south. What is the direction of the electric field?

A. east
B. west
C. north
D. south

17. A -2.3×10^{-6} C charge exerts a repulsive force of magnitude 0.35 N on an unknown charge 0.20 m away. What are the magnitude and polarity of the unknown charge?

	MAGNITUDE	POLARITY
A.	6.8×10^{-7} C	Negative
B.	6.8×10^{-7} C	Positive
C.	1.2×10^{-6} C	Negative
D.	1.2×10^{-6} C	Positive

18. Two point charges, 2.5×10^{-6} C and -5.0×10^{-6} C, are placed 3.0 m apart as shown below.

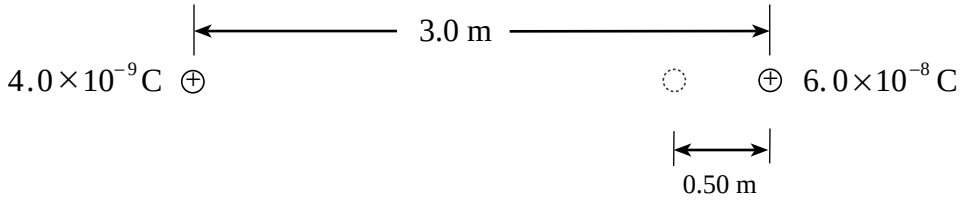


What is the magnitude of the electric field at point P, midway between the two charges?

A. 0 N/C
B. 1.0×10^{4} N/C
C. 2.0×10^{4} N/C
D. 3.0×10^{4} N/C

OVER

19. A 4.0×10^{-9} C charge is initially located 3.0 m from a stationary 6.0×10^{-8} C charge. How much work is required to move the 4.0×10^{-9} C charge to a point 0.50 m from the stationary charge?

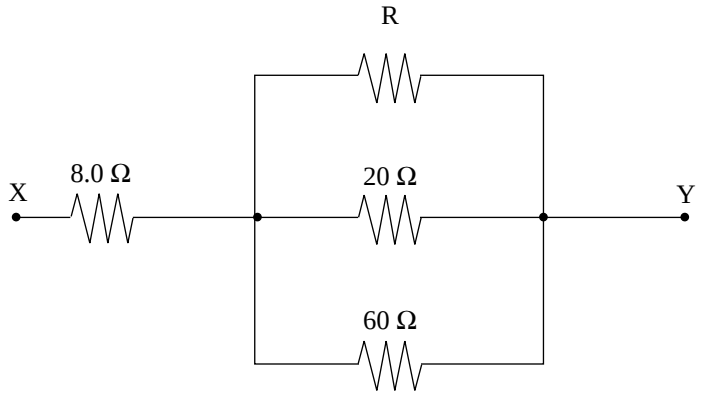


A. 6.0×10^{-7} J
B. 8.6×10^{-7} J
C. 3.6×10^{-6} J
D. 4.3×10^{-6} J

20. Two parallel plates 4.0×10^{-2} m apart have a potential difference of 1 000 V. An electron is released from the negative plate at the same instant that a proton is released from the positive plate. Which of the following **best** compares their speed and kinetic energy as they strike the opposite plate?

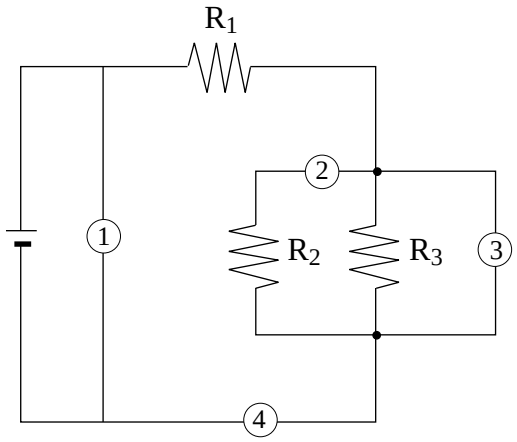
	SPEED OF ELECTRON AND PROTON	KINETIC ENERGY OF ELECTRON AND PROTON
A.	same	same
B.	same	different
C.	different	same
D.	different	different

21. The total resistance between points X and Y is 14.0 Ω. What is the value of R?



A. 6.0 Ω
B. 8.3 Ω
C. 10 Ω
D. 210 Ω

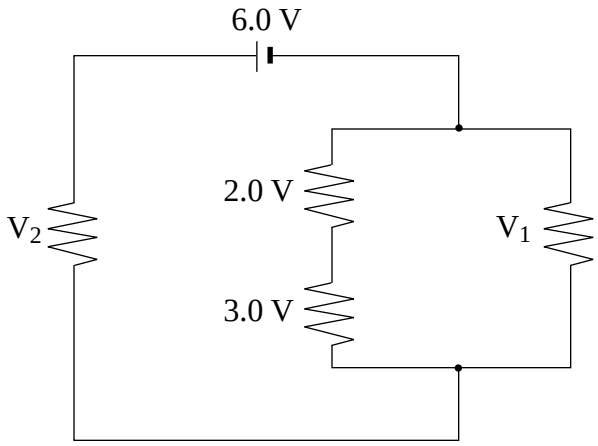
22. The diagram below shows a circuit with four possible meter locations.



In which locations should an ammeter and voltmeter be connected to correctly measure the current through R_2 and the voltage drop across R_2 ?

	CURRENT THROUGH R_2	VOLTAGE DROP ACROSS R_2
A.	2	1
B.	2	3
C.	4	1
D.	4	3

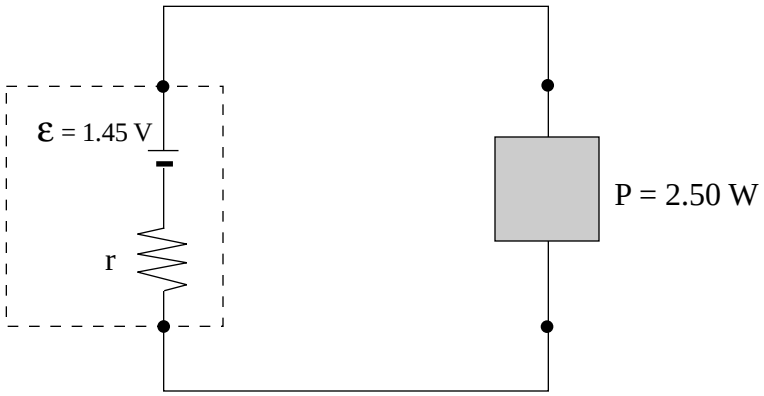
23. What are the potential differences, V_1 and V_2, in the circuit shown below?



	Potential Difference V_1	Potential Difference V_2
A.	1.0 V	5.0 V
B.	1.0 V	6.0 V
C.	5.0 V	1.0 V
D.	5.0 V	5.0 V

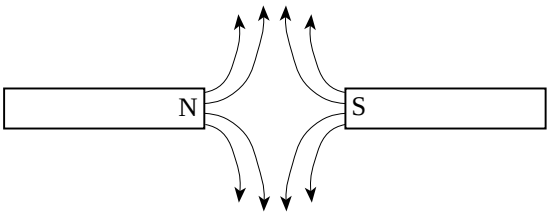
OVER

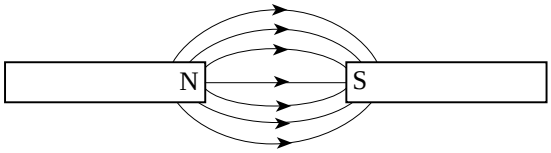
24. A 2.50 W device requires 1.20 V to operate properly. A 1.45 V cell, with internal resistance r, is used to power this device. What value of r enables the cell to provide 1.20 V to the device?

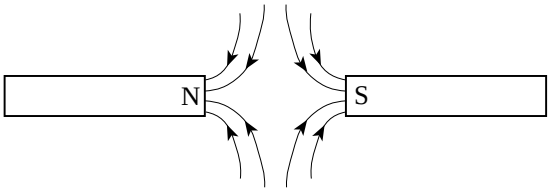


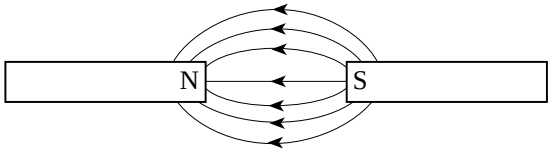
A. 0.120 Ω
B. 0.145 Ω
C. 0.576 Ω
D. 0.841 Ω

25. Which of the following correctly shows the magnetic field between two opposite, magnetic poles?

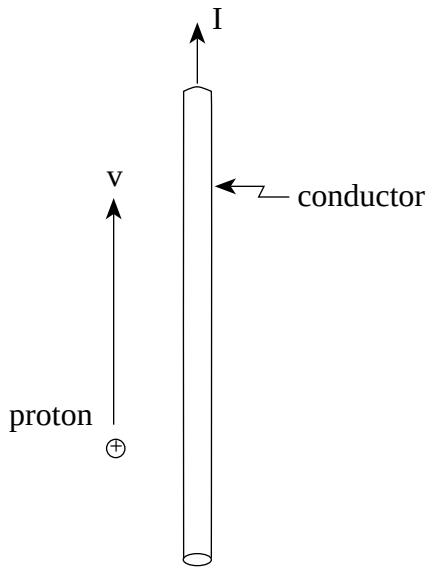
A.


B.


C.


D.


26. A proton moving parallel to a current-carrying wire will experience a force in what direction? (The proton and the wire are both in the plane of the page.)



A. into the page
B. out of the page
C. toward the conductor (to the right)
D. away from the conductor (to the left)

27. A particle with a charge of 3.2×10^{-19} C is moving at 1.2×10^{6} m/s. This particle enters a 0.25 T magnetic field at right angles and travels in a circular path of 0.80 m radius. What is the mass of this particle?

A. 6.7×10^{-27} kg
B. 5.3×10^{-26} kg
C. 6.4×10^{-20} kg
D. 7.7×10^{-14} kg

28. Which of the following is a statement of Lenz's law?

A. The number of magnetic lines perpendicular to the surface area enclosed by a circuit is equal to the flux.

B. An induced current in a closed conducting loop will appear in such a direction that it opposes the change that created it.

C. An emf is produced between the ends of a straight wire when the wire is moving perpendicularly through a uniform magnetic field.

D. The average emf induced in a circuit is proportional to the rate of change of the magnetic flux through that circuit.

OVER

29. A 2.5 m wire moves 77 m/s perpendicular to a uniform 3.8×10^{-6} T magnetic field. What potential difference is induced across the ends of this wire?

A. 0 V
B. 1.6×10^{-19} V
C. 2.0×10^{-8} V
D. 7.3×10^{-4} V

30. A transformer has four times as many turns on the secondary as on the primary. If the primary voltage is 120 V ac, which of the following describes the transformer?

	SECONDARY VOLTAGE	TYPE
A.	30 V ac	step down
B.	30 V ac	step up
C.	480 V ac	step down
D.	480 V ac	step up

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

PART B: WRITTEN-RESPONSE

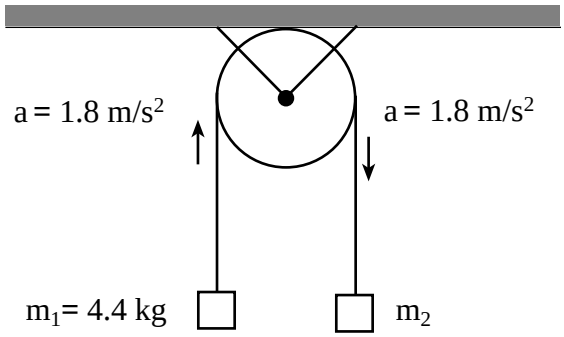
Value: 48 marks **Suggested Time: 48 minutes**

INSTRUCTIONS: Rough-work space has been incorporated into the space allowed for answering each question. You may not need all of the space provided to answer each question. Your numerical answers to problems must contain correct units where appropriate, and must be calculated to two or three significant figures. Since partial marks will be awarded for a partial solution, it is important that you provide a clear indication of the steps leading to your answer.

Full marks will NOT be given for providing only a final answer.

OVER

1. The diagram shows a 4.4 kg mass connected by a string to an unknown mass over a frictionless pulley. The system accelerates at 1.8 m/s^2 in the direction shown.



a) Draw and label a free body diagram for the 4.4 kg mass. **(2 marks)**

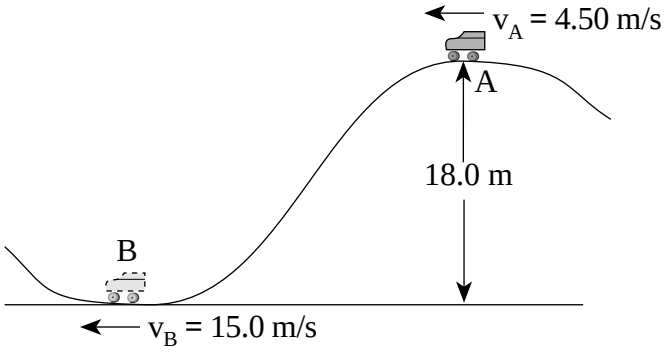
b) Calculate the tension in the string. **(2 marks)**

c) Find mass m_2. **(3 marks)**

ANSWERS:	Score for Question 1:
b) tension _____ c) mass _____	1. _____ (7)

OVER

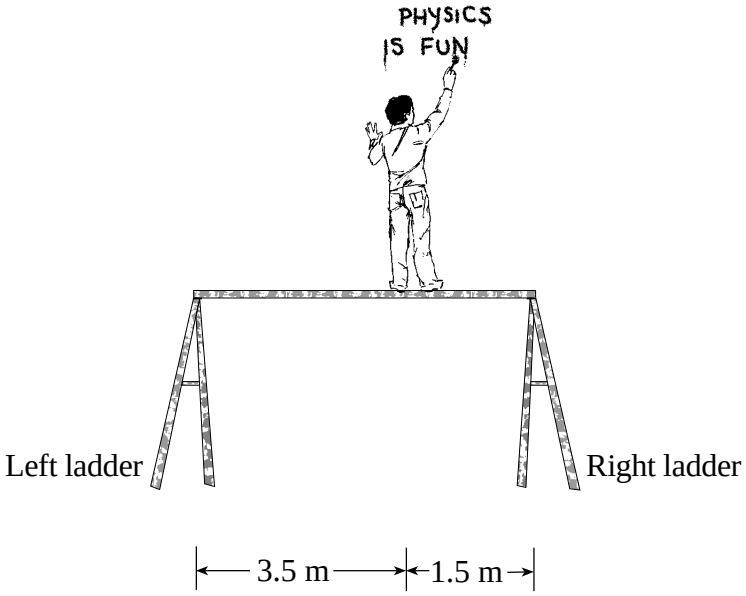
2. A 250 kg roller coaster car travels past points A and B with speeds shown in the diagram below. How much heat energy is produced between these points? **(7 marks)**



ANSWER:	Score for Question 2:
heat energy: _____	2. _____ (7)

OVER

3. A 75 kg painter stands on a uniform 5.0 m board of mass 16 kg supported horizontally by two ladders. Find the forces exerted by each ladder on the board. **(7 marks)**



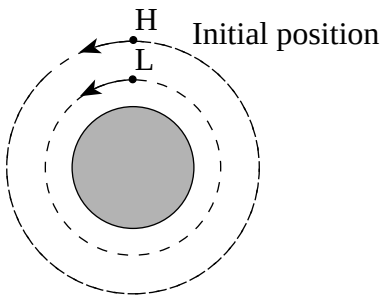
ANSWER:	Score for Question 3:
forces: _____ _____	3. _____ (7)

OVER

4. a) A satellite is placed in circular orbit at an altitude of 4.8×10^5 m above Earth's surface. What is the satellite's orbital period? **(5 marks)**

ANSWER:	Score for Question 4a:
orbital period: _____	4. _____ (5)

b) (i) As shown in the diagram below, two satellites pass over the same point on Earth's surface. Satellite H is in a higher orbit than satellite L.



Which satellite, H or L, completes one orbit first? (Circle one) **(1 mark)**

A. satellite H

B. satellite L

(ii) Using principles of physics, explain your answer. **(3 marks)**

_____

_____

_____

_____

_____

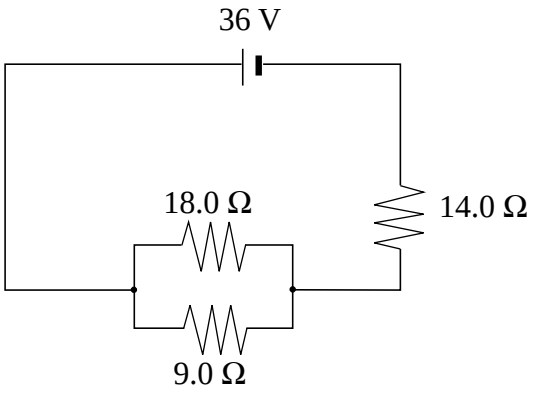
_____

Score for Question 4b:

5. _____
(4)

OVER

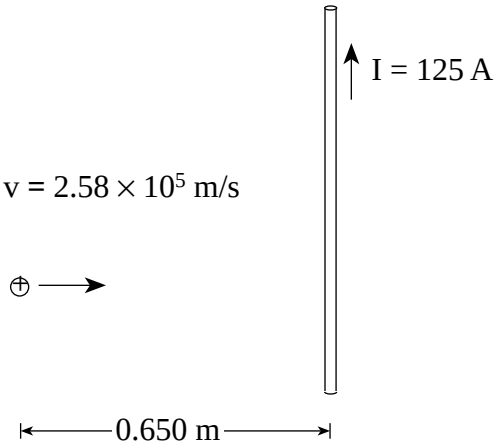
5. What is the power dissipated in the 9.0 Ω resistor in the following circuit? **(7 marks)**



ANSWER:	Score for Question 5:
power dissipated : _____	6. _____ (7)

OVER

6. A proton is traveling at 2.58×10^5 m/s towards a conductor carrying a current of 125 A. What is the magnitude of the magnetic force acting on the proton 0.650 m from the conductor? **(7 marks)**



ANSWER:	Score for Question 6:
magnetic force: _____	7. _____ (7)

OVER

7. When an electric drill turns at normal operating speeds, there is little heat produced in the motor windings. When drilling harder material, the drill motor turns much slower than normal and overheats. Using principles of physics, give an explanation for the increased heat in the windings.

(4 marks)

_____

_____

_____

_____

_____

_____

Score for Question 7:
8. _____ (4)

PART C: ELECTED TOPICS

Value: 12 marks **Suggested Time: 12 minutes**

INSTRUCTIONS

1. Choose **only one** section from the three sections in this part of the examination.

   SECTION I: Quantum Mechanics (p. 28 to 30)

   or

   SECTION II: Fluid Theory (p. 31 to 33)

   or

   SECTION III: AC Circuitry and Electronics (p. 34 to 36)

2. If you answer questions in more than one section, only the answers in the first section chosen will be marked.

3. Do **all** of the questions in the section that you choose. **Write your answers in the space provided in this booklet.**

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

5. Your numerical answers to problems must contain correct units where appropriate, and must be calculated to two or three significant figures.

6. Since partial marks will be awarded for a partial solution, it is important that you provide a clear indication of the steps leading to your answer.

   Full marks will not be given for providing only a final answer.

I have selected SECTION _____.

OVER

SECTION I: Quantum Mechanics

1. What is the wavelength of a proton traveling at 2.70×10^5 m/s ? **(3 marks)**

ANSWER:	Score for Question 1:
wavelength: _____	9. _____ (3)

2. An ionized lithium atom has one electron and a nucleus with three protons and four neutrons. What is the energy of an electron in the first excited state (n = 2) ? **(4 marks)**

ANSWER:	Score for Question 2:
energy: _____	10. _____ (4)

OVER

3. Light shines on a metal surface that has a work function of $2.60\ \text{eV}$. The light has a wavelength of $400\ \text{nm}$. What is the maximum speed of photoelectrons ejected from the surface by this light?

(5 marks)

ANSWER:	Score for Question 3:
maximum speed: _____	11. _____ (5)

END OF SECTION I: Quantum Mechanics

SECTION II: Fluid Theory

1. A block of wood floats in water with $1.71\,\text{m}^3$ of its volume submerged. Find the buoyant force acting on the block of wood. **(3 marks)**

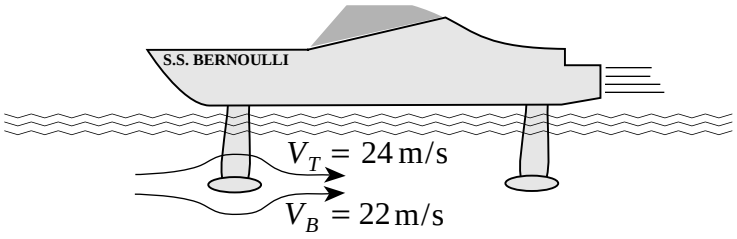
ANSWER:	Score for Question 1:
force: _____	12. _____ (3)

OVER

2. A sealed cylinder contains $0.82\,\text{m}^3$ of an ideal gas at $18°\text{C}$. When the cylinder is heated, a piston allows the gas to expand at constant pressure to a new volume of $0.93\,\text{m}^3$. Find the new temperature of the gas. **(4 marks)**

ANSWER:	Score for Question 2:
temperature: _____	13. _____ (4)

3. The diagram shows a hydrofoil, a vessel supported by an underwater "wing". Water flows over the top surface of the wing at 24 m/s and under the bottom surface at 22 m/s. Find the pressure difference between the surfaces of the wing. **(5 marks)**



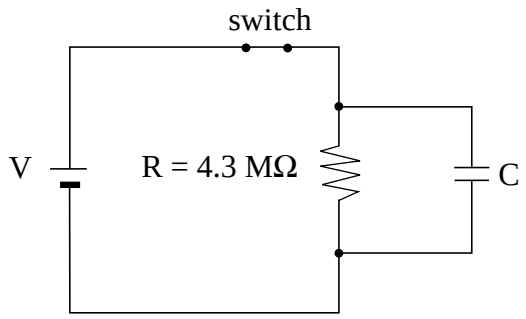
ANSWER:	Score for Question 3:
pressure difference: _____	14. _____ (5)

END OF SECTION II: Fluid Theory

OVER

SECTION III: AC Circuitry and Electronics

1. The diagram below shows a circuit in which the switch has been closed for a long time.

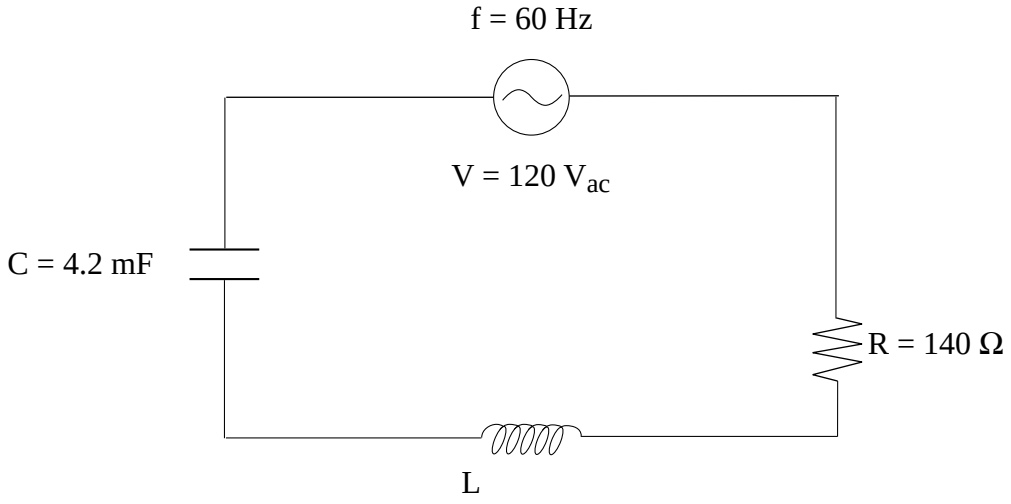


When the switch is opened, it takes 8.0 s for the voltage across the capacitor to drop to 37% of the battery voltage V. What is the capacitance, C, of the capacitor? **(3 marks)**

ANSWER:	Score for Question 1:
capacitance: _____	15. _____ (3)

SECTION III: Continued

2. The diagram below shows an LRC circuit that has a resonant frequency of 60 Hz.

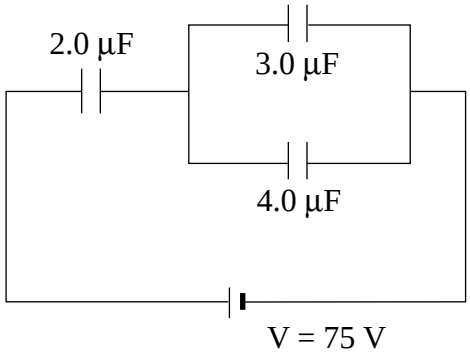


What is the inductive reactance for this circuit at the resonant frequency? **(4 marks)**

ANSWER:	Score for Question 2:
inductive reactance: _____	16. _____ (4)

OVER

3. What is the maximum charge on the $3.0\ \mu F$ capacitor? **(5 marks)**



ANSWER:	Score for Question 3:
maximum charge: _____	17. _____ (5)

END OF SECTION III: AC Circuitry and Electronics

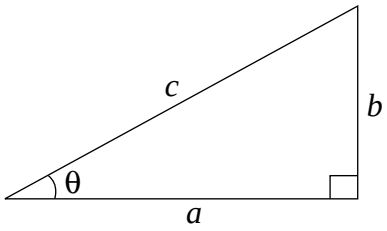
END OF EXAMINATION

REFERENCE SHEET 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	$= 4\pi \times 10^{-7}\ \text{T}\cdot\text{m/A}$
Planck's constant	h	$= 6.63 \times 10^{-34}\ \text{J}\cdot\text{s}$
	h	$= 4.14 \times 10^{-15}\ \text{eV}\cdot\text{s}$
Speed of light	c	$= 3.00 \times 10^8\ \text{m/s}$
Rydberg's constant	R	$= 1.097 \times 10^7\ \text{m}^{-1}$
Unified atomic mass unit	u	$= 1.66 \times 10^{-27}\ \text{kg}$
Boltzmann's constant	k	$= 1.38 \times 10^{-23}\ \text{J/K}$
Gas constant	R	$= 8.31\ \text{J/mol}\cdot\text{K}$
Density of water		$= 1.00 \times 10^3\ \text{kg/m}^3$
Density of air		$= 1.29\ \text{kg/m}^3$
Standard atmospheric pressure		$= 1.01 \times 10^5\ \text{Pa}$
Volume of one mole of gas at STP		$= 22.4\ \text{L}\ (2.24 \times 10^{-2}\ \text{m}^3)$
Avogadro's number	N	$= 6.02 \times 10^{23}\ \text{particles/mol}$
Absolute zero		$= -273\ ^\circ\text{C}$

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

For Right-angled Triangles:

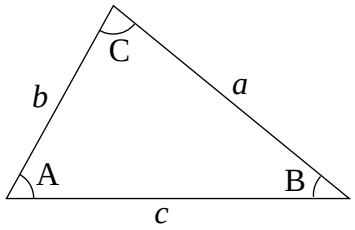


$$a^2 + b^2 = c^2$$

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

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

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

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:

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

EQUATIONS

Note: Vector quantities have not been indicated.

1. Kinematics: (for constant acceleration)

$v = v_0 + at$ $\quad v_{av} = \dfrac{v + v_0}{2}$ $\quad v^2 = {v_0}^2 + 2ad$

$d = v_0 t + \dfrac{1}{2} a t^2$

2. Dynamics:

$F_\mathrm{f} = \mu F_\mathrm{N}$ $\quad F_\mathrm{net} = ma$

3. Mechanical Energy and Momentum:

$W = Fd$ $\quad E_\mathrm{p} = mgh$ $\quad E_\mathrm{k} = \dfrac{1}{2} m v^2$

$P = \dfrac{W}{t}$ $\quad p = mv$ $\quad \Delta p = F_\mathrm{net} \Delta t$

4. Equilibrium:

$\tau = Fd$

5. Circular Motion and Gravitation:

$a_\mathrm{c} = \dfrac{v^2}{r} = \dfrac{4\pi^2 r}{T^2}$ $\quad F = G\dfrac{m_1 m_2}{r^2}$

$E_\mathrm{p} = -G\dfrac{m_1 m_2}{r}$ $\quad r^3 \propto T^2$

6. Electrostatics:

$F = k\dfrac{Q_1 Q_2}{r^2}$ $\quad E = \dfrac{V}{d}$ $\quad V = \dfrac{kQ}{r}$

$E_\mathrm{p} = k\dfrac{Q_1 Q_2}{r}$ $\quad F = QE$ $\quad V = \dfrac{\Delta E_\mathrm{p}}{Q}$

7. Circuitry:

$Q = It$ $\quad V = IR$ $\quad P = VI$

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

8. Electromagnetism:

$F = IlB$ $\quad B = \dfrac{\mu_0 I}{2\pi d}$ $\quad \tau = NIAB$

$F = QvB$ $\quad B = \mu_0 n I \left(where\ n = \dfrac{N}{l} \right)$ $\quad \Phi = BA$

$\mathcal{E} = -N\dfrac{\Delta\Phi}{\Delta t}$ $\quad \mathcal{E} = Blv$ $\quad \dfrac{V_s}{V_p} = \dfrac{N_s}{N_p}$

9. Quantum Mechanics: (Section I)

$E = hf$ $\quad c = f\lambda$ $\quad E_n = (-13.6eV)\dfrac{Z^2}{n^2}$

$E_{k_{max}} = hf - W_0$ $\quad \lambda = \dfrac{h}{p}$

10. Fluid Theory: (Section II)

$\rho = \dfrac{m}{V}$ $\quad PV = NkT$ $\quad PV = \dfrac{1}{3}Nmv^2$

$F = \rho Vg$ $\quad P = \dfrac{F}{A}$ $\quad P = P_G + P_a$

$PV = nRT$ $\quad P + \dfrac{1}{2}\rho v^2 + \rho gh = \text{constant}$ $\quad E_k = \dfrac{3}{2}kT$

$Av = \text{constant}$

11. AC Circuits and Electronics: (Section III)

$Q = CV$ $\quad E_p = \dfrac{1}{2}CV^2$ $\quad \tau = RC$

$X_C = \dfrac{1}{2\pi fC}$ $\quad Z = \sqrt{R^2 + (X_L - X_C)^2}$ $\quad X_L = 2\pi fL$

$f_0 = \dfrac{1}{2\pi\sqrt{LC}}$ $\quad \beta\ (\text{current gain}) = \dfrac{\Delta I_C}{\Delta I_B}$ $\quad A_f = \dfrac{A}{1-\beta A}$

$(\text{where } \beta = \text{ feedback ratio})$

ROUGH WORK FOR MULTIPLE-CHOICE

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