INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

JUNE 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.

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FOR OFFICE USE ONLY

INSERT STUDENT I.D. NUMBER (PEN)

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_____ – _____

PHYSICS 12 JUNE 1995 PROVINCIAL

Course Code = PH Examination Type = P

1. _____ (7)

2. _____ (7)

3. _____ (7)

4. _____ (7)

5. _____ (9)

6. _____ (7)

7. _____ (4)

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

Section I		Section II		Section III
8. _____ (3)		11. _____ (3)		14. _____ (3)
9. _____ (4)	**or**	12. _____ (4)	**or**	15. _____ (4)
10. _____ (5)		13. _____ (5)		16. _____ (5)

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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	Optional areas consisting of only written response questions. Answer **only one** section.	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.

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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 Answer Sheet provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. An object is sliding down a smooth incline. If friction is negligible, the object has

   A. constant velocity.
   B. constant momentum.
   C. constant acceleration.
   D. constant displacement.

2. Which of the following is **not** a vector?

   A. mass
   B. impulse
   C. velocity
   D. momentum

3. A passenger jet needs to reach a speed of 100 m/s on the runway for takeoff. If the runway is 2.5×10^3 m long, what minimum average acceleration from rest is needed?

   A. $0.040\ \text{m/s}^2$
   B. $2.0\ \text{m/s}^2$
   C. $4.0\ \text{m/s}^2$
   D. $10\ \text{m/s}^2$

4. Work is measured in which units?

   A. J
   B. N
   C. J/s
   D. $\text{N} \cdot \text{s}$

5. What is the minimum power developed by a 75 kg person who climbs a set of stairs 4.5 m high in 5.0 s?

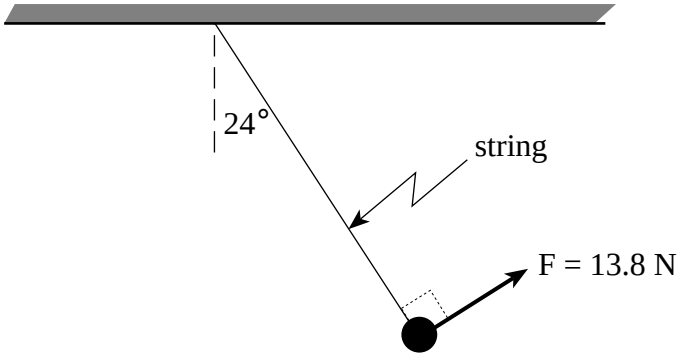
   A. 6.8×10^1 W
   B. 6.6×10^2 W
   C. 1.7×10^3 W
   D. 3.3×10^3 W

OVER

6. A 3.5 kg projectile was launched vertically at 75 m/s. The projectile reached a maximum height of 180 m. How much energy was lost to heat while the projectile was rising?

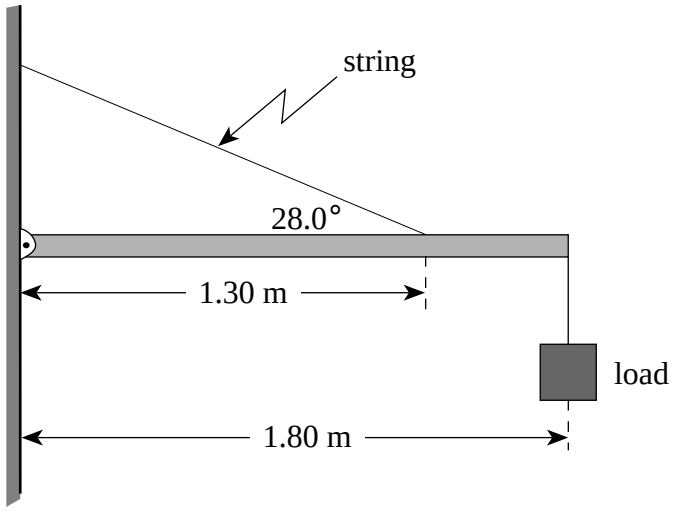
   A. 0 J
   B. 3.7×10^3 J
   C. 6.2×10^3 J
   D. 9.8×10^3 J

7. A mass suspended by a string is held $24°$ from vertical by a force of 13.8 N as shown. Find the mass.



   A. 0.57 kg
   B. 1.5 kg
   C. 3.2 kg
   D. 3.5 kg

8. The diagram shows a horizontal beam of negligible mass. The wall exerts a 42.0 N horizontal force on the lever. Find the weight of the load.

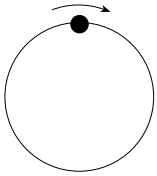


   A. 16.1 N
   B. 22.3 N
   C. 34.4 N
   D. 47.6 N

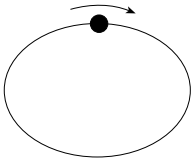
9. An object travels along a path at constant speed. There is a constant net force acting on the object that remains perpendicular to the direction of the motion. Describe the path of the object.

A. linear

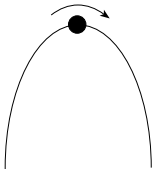
B. circular



C. elliptical



D. parabolic



10. A satellite is placed in orbit around the Sun. The orbital radius of the satellite is twice the orbital radius of the Earth. What is the orbital period of this satellite?

A. 0.50 Earth years
B. 1.6 Earth years
C. 2.0 Earth years
D. 2.8 Earth years

11. Find the gravitational force of attraction between a 75 kg physics student and her 1 500 kg car when their centres are 10 m apart.

A. 7.5×10^{-8} N
B. 7.5×10^{-7} N
C. 740 N
D. 1.5×10^{3} N

12. A spacecraft of mass m is launched from the surface of a planet of mass M and radius r. Upon which of the variables, m, M and r, does the spacecraft's escape velocity depend?

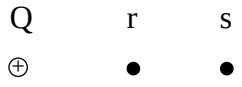
A. m and r
B. M and r
C. m and M
D. m, M and r

OVER

13. A 120 kg astronaut stands on the surface of an asteroid of radius 600 m. The astronaut leaves the surface with 15 J of kinetic energy and reaches a maximum height of 300 m above the surface. What is the mass of the asteroid?

A. 5.6×10^{11} kg
B. 2.2×10^{12} kg
C. 3.4×10^{12} kg
D. 5.1×10^{12} kg

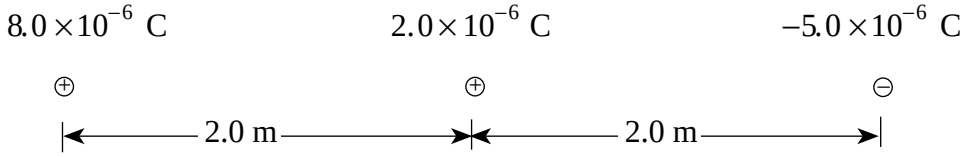
14. The diagram below shows a positive point charge Q.



Which of the following describes the magnitude and direction of the electric field at points r and s?

	Magnitude of field at r and s	Direction of field at r and s
A.	same	away from Q
B.	same	towards Q
C.	different	away from Q
D.	different	towards Q

15. A 2.0×10^{-6} C charge is located halfway between an 8.0×10^{-6} C charge and a -5.0×10^{-6} C charge as shown below.



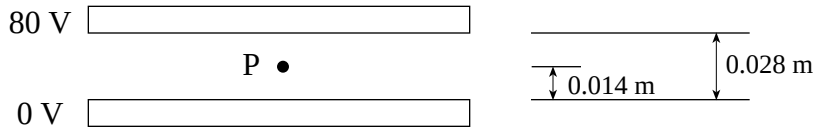
Find the net force on the 2.0×10^{-6} C charge.

A. 1.4×10^{-2} N towards the left
B. 1.4×10^{-2} N towards the right
C. 5.9×10^{-2} N towards the left
D. 5.9×10^{-2} N towards the right

16. What is the electric potential energy of an electron located 5.3×10^{-11} m from the proton in a hydrogen atom?

A. -8.2×10^{-8} J
B. -4.3×10^{-18} J
C. -2.2×10^{-18} J
D. -1.6×10^{-19} J

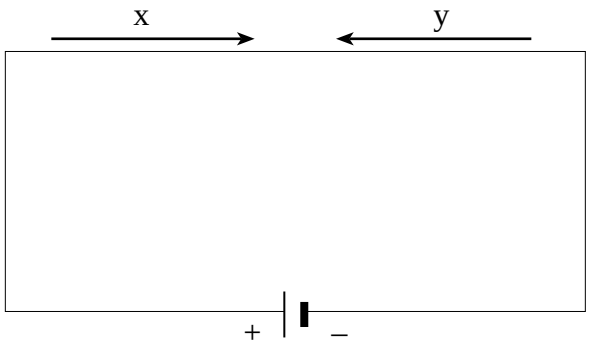
17. Two long, parallel plates are separated by 0.028 m and have a potential difference between them of 80 V, as shown below.



Point P is located midway between the plates. What is the potential difference between point P and one of the plates?

A. 0 V
B. 40 V
C. 80 V
D. 160 V

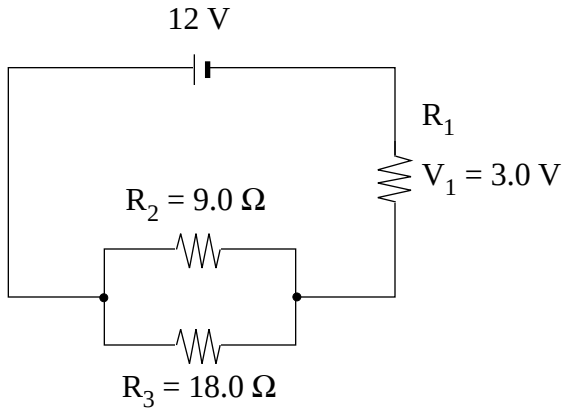
18. In the diagram below, which arrows represent the direction of conventional current and electron flow?



	CONVENTIONAL CURRENT	ELECTRON FLOW
A.	x	x
B.	x	y
C.	y	x
D.	y	y

OVER

19. Find the current through the battery in the circuit shown below.

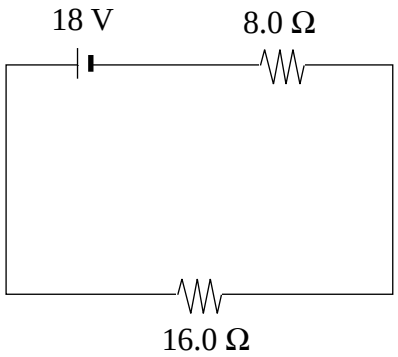


A. 0.33 A
B. 1.5 A
C. 2.0 A
D. 2.5 A

20. A flashlight contains two batteries in series with a bulb of resistance 12 Ω. Each battery has an emf of 1.5 V and an internal resistance of 0.26 Ω. What is the potential difference across the bulb?

A. 0.12 V
B. 1.5 V
C. 2.9 V
D. 3.0 V

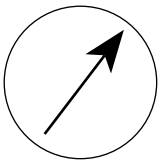
21. Calculate the power dissipated by the 8.0 Ω resistor in the circuit below.



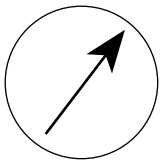
A. 4.5 W
B. 6.0 W
C. 10 W
D. 41 W

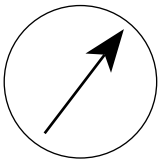
22. Four compasses are placed around a conductor carrying a current into the page, as shown below. Which compass correctly shows the direction of the magnetic field due to the current?

A.

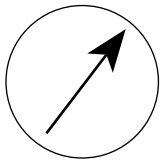


B.





C.

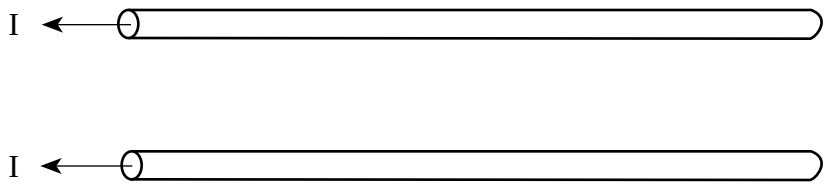


D.

23. What is the radius of curvature of the path of a proton travelling at 4.7×10^{5} m/s in a plane perpendicular to a 0.52 T magnetic field?

A. 2.0×10^{-8} m
B. 5.1×10^{-6} m
C. 9.4×10^{-3} m
D. 1.1×10^{2} m

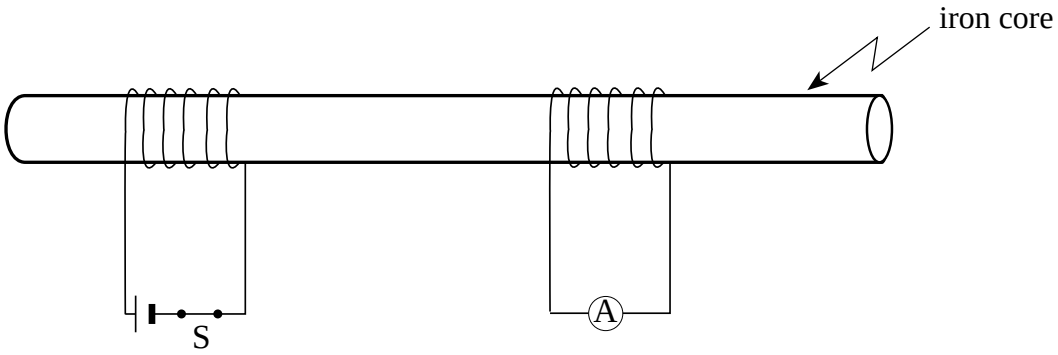
24. Two long, parallel conductors carry the same current I and exert an attractive force F on each other. If the current in both conductors is doubled, what is the new force?



A. 0.5 F
B. 1 F
C. 2 F
D. 4 F

OVER

25. In the following diagram, ammeter A shows a current



A. while switch S remains closed.
B. while switch S remains opened.
C. only while switch S is being closed.
D. while switch S is being opened or being closed.

26. A transformer connected to a 120 V ac source has an output of 24 V ac. If the primary coil has 330 turns, how many turns of wire are there in the secondary coil?

A. 24 turns
B. 66 turns
C. 330 turns
D. 1 650 turns

27. A 1 700 turn coil of radius 0.25 m, is located in a 0.085 T magnetic field. If the maximum torque on the coil is 250 $\mathrm{N \cdot m}$, what current is in this coil?

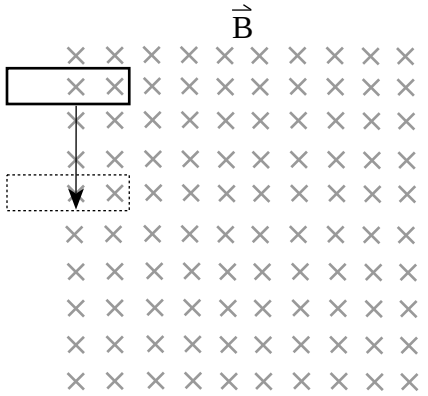
A. 0.11 A
B. 6.9 A
C. 8.8 A
D. 28 A

28. A dc motor is connected to a constant voltage supply. The load on the motor decreases, allowing the motor to rotate faster. How do the back emf and current through the motor change?

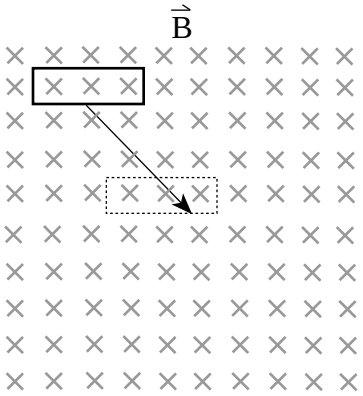
	BACK EMF	CURRENT
A.	decreases	decreases
B.	decreases	increases
C.	increases	decreases
D.	increases	increases

29. In which of the following situations would an induced emf be produced in a rectangular loop of wire? The loop of wire is moved as indicated.

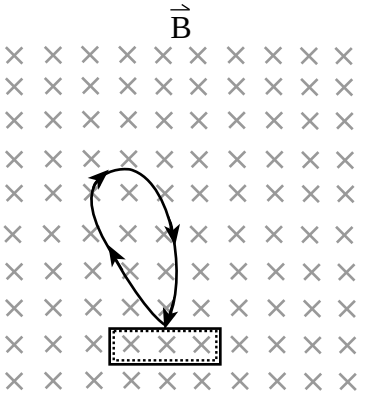
A.



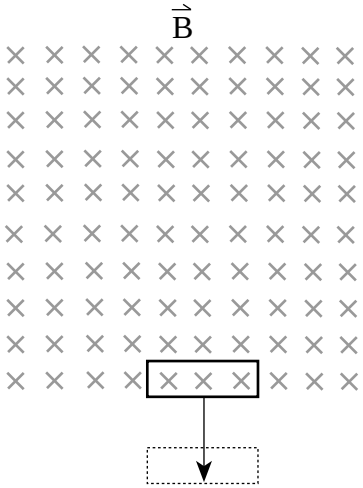
B.



C.

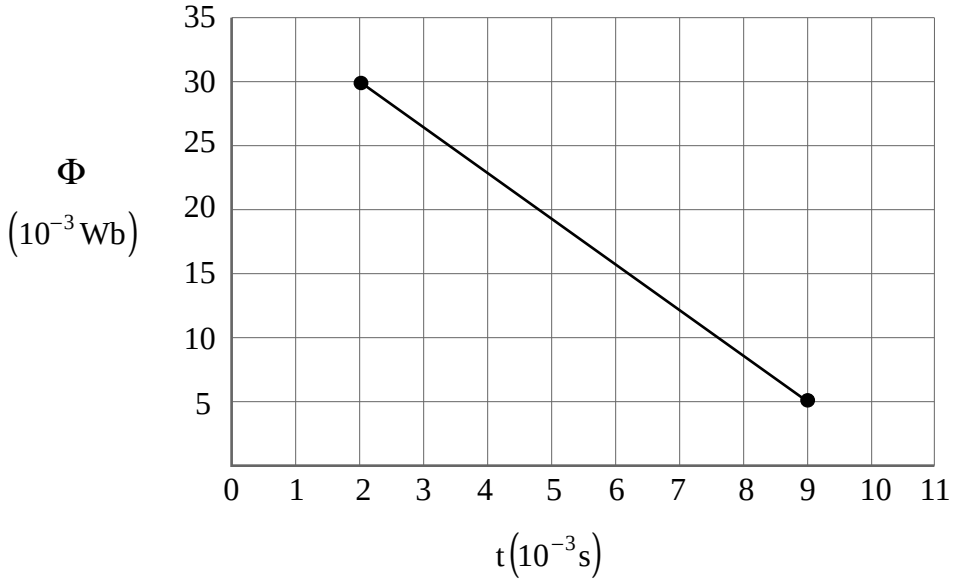


D.



OVER

30. The graph below shows how the magnetic flux through a single loop changes with respect to time.



What is the average emf induced between $t = 2.0 \times 10^{-3}\text{s}$ and $t = 9.0 \times 10^{-3}\text{s}$?

A. $1.2 \times 10^{-4}\text{V}$
B. 1.8 V
C. 3.6 V
D. 25 V

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

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OVER

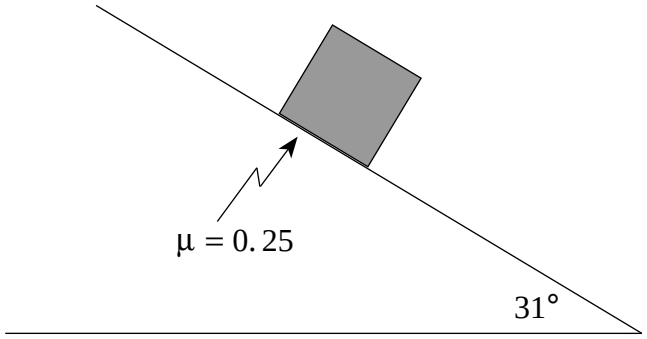
PART B: WRITTEN-RESPONSE

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 the final answer only.

1. An 87 kg block slides down a 31° slope as shown in the diagram below. The coefficient of friction between the block and the surface is 0.25.

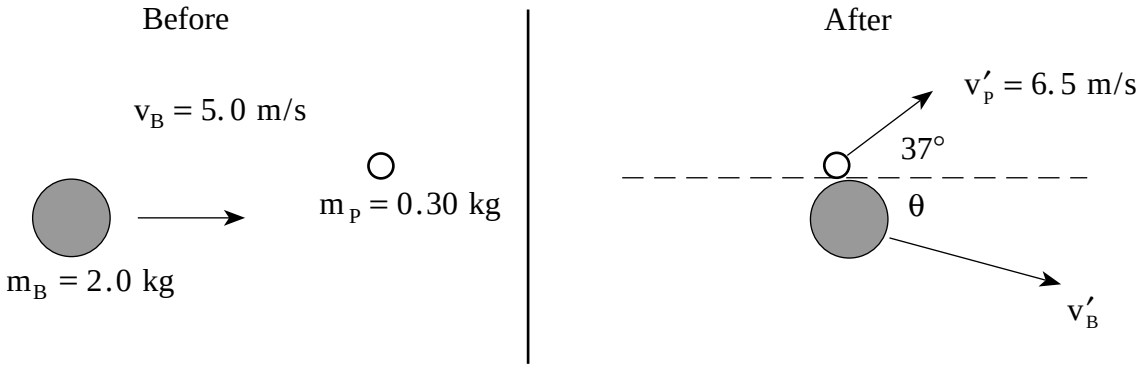


What is the acceleration of the block? **(7 marks)**

ANSWER:	Score for Question 1:
acceleration: _____	1. _____ (7)

OVER

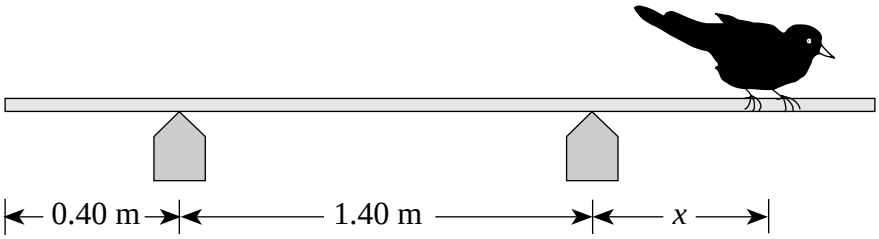
2. A 2.0 kg bowling ball travelling 5.0 m/s collides with a stationary 0.30 kg bowling pin. After the collision, the pin moves at a speed of 6.5 m/s in the direction shown in the diagram. What is the velocity (magnitude and direction) of the bowling ball after the collision? **(7 marks)**



ANSWERS:	Score for Question 2:
magnitude of velocity: _____ direction: _____	2. _____ (7)

OVER

3. A 0.75 kg board of length 2.60 m initially rests on two supports as shown.



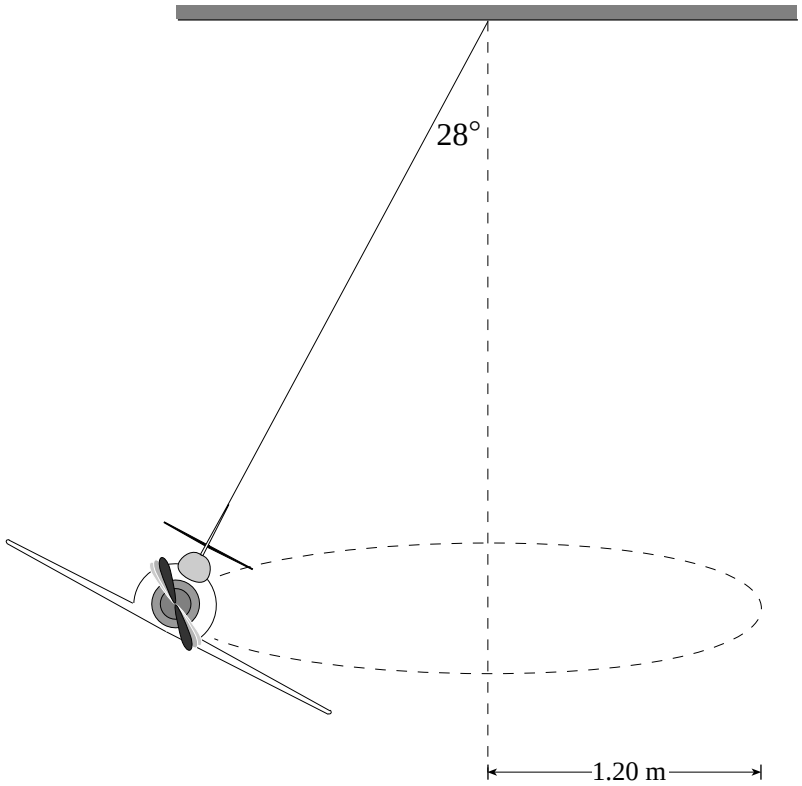
a) What maximum distance, x, from the right-hand support can a 1.20 kg bird walk before the board begins to leave the left-hand support? **(5 marks)**

b) What force does the right-hand support exert on the board at that instant? **(2 marks)**

ANSWERS:	Score for Question 3:
a) distance: _____	3. _____ (7)
b) force: _____	

OVER

4. The diagram shows a toy plane flying in a circle of radius 1.20 m, supported by a string which makes an angle of 28° with the vertical. The tension in the string is 1.80 N.



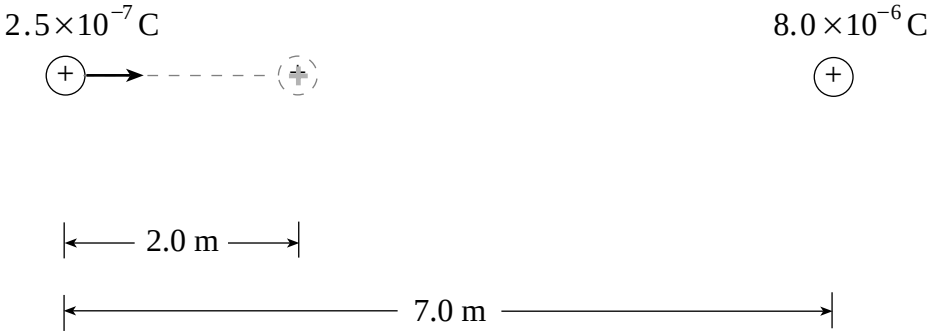
a) What is the mass of the plane? **(3 marks)**

b) How long does the plane take to complete one orbit? **(4 marks)**

ANSWERS:	Score for Question 4:
a) mass: _____	4. _____ (7)
b) time: _____	

OVER

5. a) A $2.5\times10^{-7}\,\text{C}$ charge is initially located $7.0\ \text{m}$ from a fixed $8.0\times10^{-6}\,\text{C}$ charge. What is the minimum amount of work required to move the $2.5\times10^{-7}\,\text{C}$ charge $2.0\ \text{m}$ closer as shown? **(5 marks)**



b) If the $2.5 \times 10^{-7}\,\text{C}$ charge is moved a further $2.0\,\text{m}$ closer to the $8.0 \times 10^{-6}\,\text{C}$ charge, will the additional work required be less than, the same as or greater than the work required in (a)? Using principles of physics, explain your answer. **(4 marks)**

_____

_____

_____

_____

_____

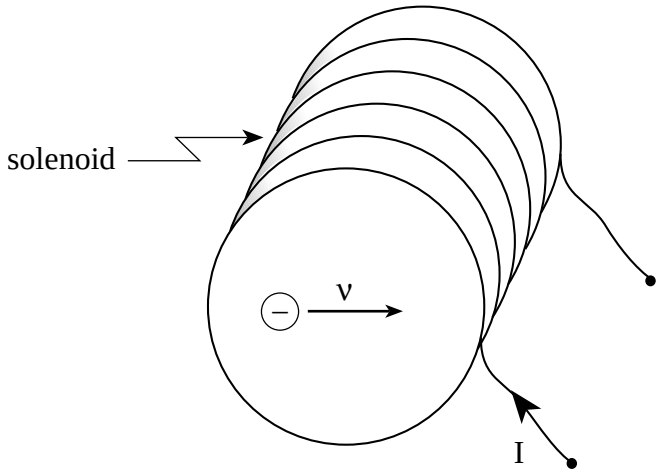
_____

_____

ANSWER:	Score for Question 5:
a) work: _____	5. _____ (9)

OVER

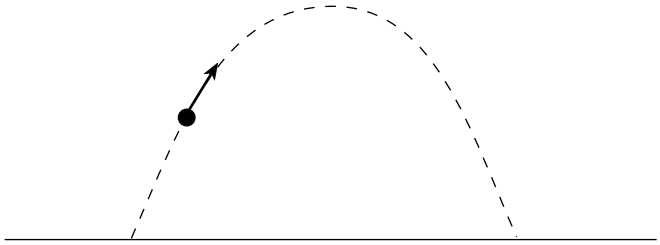
6. A $0.400\ \text{m}$ long solenoid has $6\,720$ turns of wire. A current of $14.5\ \text{A}$ flows in the solenoid. An electron inside the solenoid travels perpendicular to the axis of the solenoid with a speed of $6.50 \times 10^5\ \text{m/s}$. What is the magnitude of the magnetic force acting on the electron? **(7 marks)**



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

OVER

7. The diagram below shows projectile motion in the absence of friction.



This motion can be analyzed in terms of horizontal and vertical velocity components. Explain the behavior of these velocity components, using principles of physics . **(4 marks)**

Score for Question 7:

7. _____ (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. 26 to 29)

   or

   SECTION II: Fluid Theory (p. 30 to 33)

   or

   SECTION III: AC Circuitry and Electronics (p. 34 to 37)

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 the final answer only.

I have selected SECTION _____.

OVER

SECTION I: Quantum Mechanics

1. What is the de Broglie wavelength of a 0.16 kg hockey puck shot by Pavel Bure at 42 m/s?
(3 marks)

ANSWER:	Score for Question 1:
wavelength: _____	8. _____ (3)

2. A metal surface has a work function of 3.43 eV. If electromagnetic radiation with a wavelength of 277 nm strikes the surface and ejects electrons, what is the maximum speed of the ejected electrons? **(4 marks)**

ANSWER:	Score for Question 2:
maximum speed: _____	9. _____ (4)

OVER

3. An electron of a hydrogen atom makes a transition from the fifth excited state (n = 6) to the first excited state (n = 2). What is the wavelength of the emitted photon? **(5 marks)**

ANSWER: wavelength: _____	Score for Question 3: 10. _____ (5)

END OF SECTION I: Quantum Mechanics

OVER

SECTION II: Fluid Theory

1. The blade of Pavel Bure's skate exerts a force of $340\ \text{N}$ on a $5.0 \times 10^{-4}\ \text{m}^2$ section of the ice surface. What pressure does this blade exert on the ice? **(3 marks)**

ANSWER:	Score for Question 1:
pressure:_____	11. _____ (3)

2. Gas inside a rigid sealed container is initially at a pressure of 1.01×10^5 Pa and a temperature of $25^\circ C$. If the gas is cooled to $-35^\circ C$, what is the new pressure of the gas? **(4 marks)**

ANSWER:	Score for Question 2:
pressure: _____	12. _____ (4)

OVER

3. A small 180 kg boat has a volume of $2.1\ m^3$. How much mass could this boat hold before sinking in fresh water? **(5 marks)**

ANSWER:	Score for Question 3:
mass: _____	13. _____ (5)

END OF SECTION II: Fluid Theory

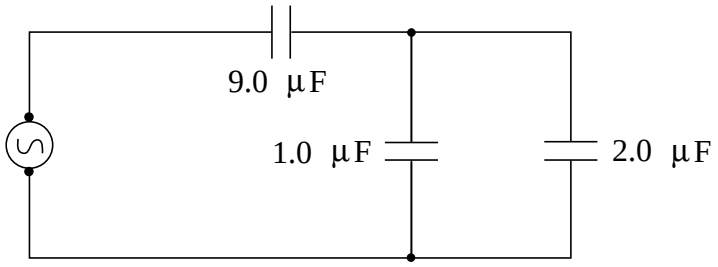
OVER

SECTION III: AC Circuitry and Electronics

1. In a transistor, the collector current is found to vary from 1.10 mA to 1.50 mA when the base current varies from $4.3\mu A$ to $7.3\mu A$. What is the current gain of the transistor? **(3 marks)**

ANSWER:	Score for Question 1:
current gain: _____	14. _____ (3)

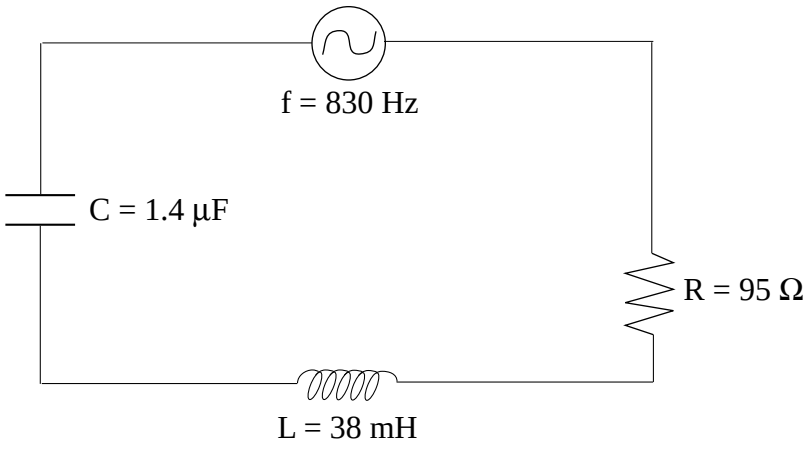
2. What is the total equivalent capacitance of the circuit shown below? **(4 marks)**



ANSWER:	Score for Question 2:
capacitance:_____	15. _____ (4)

OVER

3. Calculate the impedance of the circuit shown below. **(5 marks)**



ANSWER: impedance: _____	Score for Question 3: 16. _____ (5)

END OF SECTION III: AC Circuitry and Electronics

END OF EXAMINATION

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DATA TABLE

Gravitational constant	G	$= 6.67 \times 10^{-11}$ N•m^2/kg^2
Acceleration due to gravity at the surface of Earth (for the purposes of this examination)	g	$= 9.80$ m/s^2
Earth		
radius		$= 6.38 \times 10^6$ m
radius of orbit about Sun		$= 1.50 \times 10^{11}$ m
period of rotation		$= 8.61 \times 10^4$ s
period of revolution about Sun		$= 3.16 \times 10^7$ s
mass		$= 5.98 \times 10^{24}$ kg
Moon		
radius		$= 1.74 \times 10^6$ m
radius of orbit about Earth		$= 3.84 \times 10^8$ m
period of rotation		$= 2.36 \times 10^6$ s
period of revolution about Earth		$= 2.36 \times 10^6$ s
mass		$= 7.35 \times 10^{22}$ kg
Sun		
mass		$= 1.98 \times 10^{30}$ kg
Constant in Coulomb's Law	k	$= 9.00 \times 10^9$ N•m^2/C^2
Elementary charge	e	$= 1.60 \times 10^{-19}$ C
Mass of electron	m_e	$= 9.11 \times 10^{-31}$ kg
Mass of proton	m_p	$= 1.67 \times 10^{-27}$ kg
Mass of neutron	m_n	$= 1.68 \times 10^{-27}$ kg
Permeability of free space	μ_o	$= 4\pi \times 10^{-7}$ T•m/A
Planck's constant	h	$= 6.63 \times 10^{-34}$ J•s
	h	$= 4.14 \times 10^{-15}$ eV•s
Speed of light	c	$= 3.00 \times 10^8$ m/s
Rydberg's constant	R	$= 1.097 \times 10^7$ m^{-1}
Unified atomic mass unit	u	$= 1.66 \times 10^{-27}$ kg
Boltzmann's constant	k	$= 1.38 \times 10^{-23}$ J/K
Gas constant	R	$= 8.31$ J/mol•K
Density of water		$= 1.00 \times 10^3$ kg/m^3
Density of air		$= 1.29$ kg/m^3
Standard atmospheric pressure		$= 1.01 \times 10^5$ Pa
Volume of one mole of gas at STP		$= 22.4$ L $(2.24 \times 10^{-2}$ m$^3)$
Avogadro's number	N	$= 6.02 \times 10^{23}$ particles/mol
Absolute zero		$= -273$ ˚C

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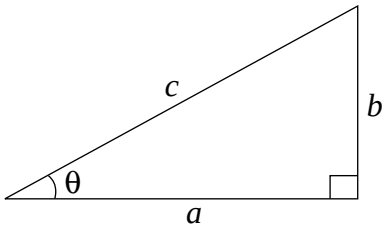
Exercise care when tearing along perforations.

For Right-angled Triangles:

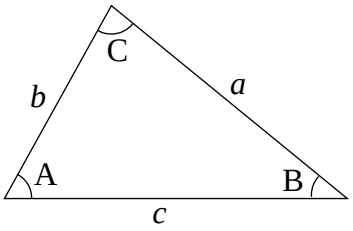


$$a^2 + b^2 = c^2$$

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

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

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

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:

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

EQUATIONS

Note: Vector quantities have not been indicated.

1. Kinematics: (for constant acceleration)

$$v = v_0 + at \qquad v_{av} = \frac{v + v_0}{2} \qquad v^2 = {v_0}^2 + 2ad$$

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

2. Dynamics:

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

3. Mechanical Energy and Momentum:

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

$$P = \frac{W}{t} \qquad p = mv \qquad \Delta p = F_\mathrm{net} \Delta t$$

4. Equilibrium:

$$\tau = Fd$$

5. Circular Motion and Gravitation:

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

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

6. Electrostatics:

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

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

7. Circuitry:

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

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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.