JUNE 1997

PROVINCIAL EXAMINATION

### MINISTRY OF EDUCATION, SKILLS AND TRAINING

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

    $\boxed{\textbf{END OF EXAMINATION}}$.

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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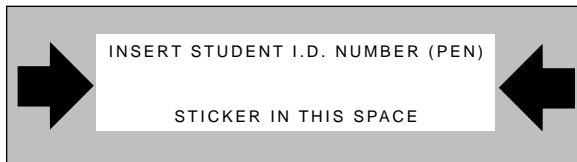
PHYSICS 12 JUNE 1997 PROVINCIAL

Course Code = PH   Examination Type = P

1. _____   5. _____
   (7)   (7)

2. _____   6. _____
   (7)   (7)

3. _____   7. _____
   (7)   (4)

4. _____
   (9)

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

    Section I   Section II   Section III

8. _____
(3)

9. _____   **or**
(4)

10. _____
(5)

11. _____
(3)

12. _____   **or**
(4)

13. _____
(5)

14. _____
(3)

15. _____
(4)

16. _____
(5)

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PHYSICS 12 PROVINCIAL EXAMINATION

		Value	Suggested Time

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

   PART A: 30 multiple-choice questions worth two marks each   60   60

   PART B: 7 written-response questions   48   48

   PART C: Elected topics 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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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 list contains three vector quantities?

    A. force, mass, speed
    B. force, speed, velocity
    C. acceleration, mass, velocity
    D. acceleration, momentum, velocity

2. When a 2.0 kg rock is dropped from a cliff it hits the beach at 24 m/s. At what speed would a 4.0 kg rock, dropped from the same cliff, hit the beach? Ignore friction.

    A. 12 m/s
    B. 24 m/s
    C. 34 m/s
    D. 48 m/s

3. The 4.0 kg block shown accelerates across a frictionless horizontal table at 1.5 m/s^2.
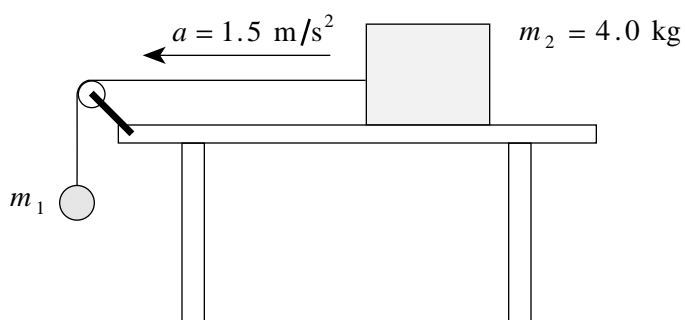
    Find the mass of object m_1.

    A. 0.61 kg
    B. 0.72 kg
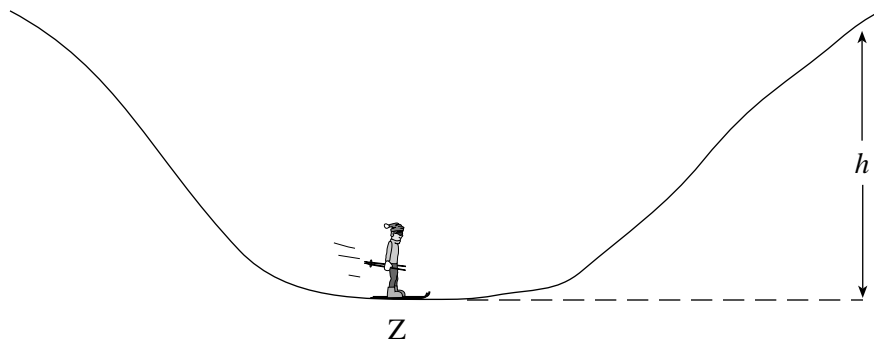   C. 6.0 kg
    D. 26 kg

OVER

4. Pamela swims at 2.8 m/s relative to the water, heading west. The current flows south at 1.2 m/s. Find Pamela's resultant direction.

    A. $23°$ S of W

    B. $25°$ S of W

    C. $23°$ N of W

    D. $25°$ N of W

5. Which equation is a form of Newton's second law?

    A. $\vec{F}_{net} = \dfrac{\overrightarrow{\Delta p}}{\Delta t}$

    B. $W = \Delta E$

    C. $E_k + E_p = E_k{}' + E_p{}'$

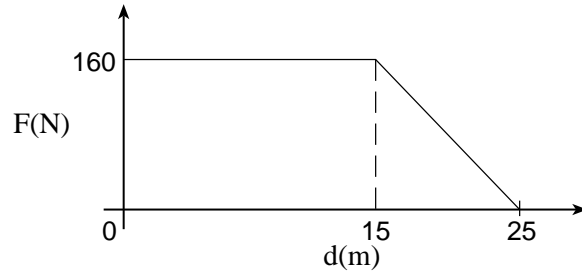   D. $\varepsilon = -N\dfrac{\Delta \Phi}{\Delta t}$

6. René, whose mass is 85 kg, skis down the hill, passing Z with a kinetic energy of $9\ 700$ J.

Z

If friction is ignored, to what maximum height, h, can René ski?

    A. 12 m

    B. 15 m

    C. 1.1×10^2 m

    D. 6.6×10^2 m

7. A cyclist travelling at 10 m/s applies her brakes and stops in 25 m. The graph shows the magnitude of the braking force versus the distance travelled.
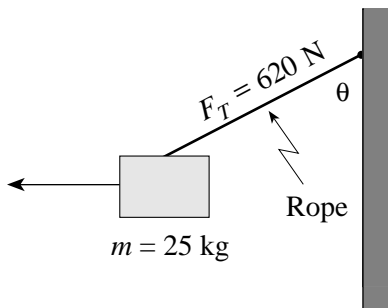

What is the total mass of bike and cyclist?

A. 20 kg
B. 40 kg
C. 64 kg
D. 80 kg

8. Two forces act on an object as shown. Find the magnitude of the third force required to achieve translational equilibrium.

$\vec{F}_1 = 25$ N

$\vec{F}_2 = 40$ N
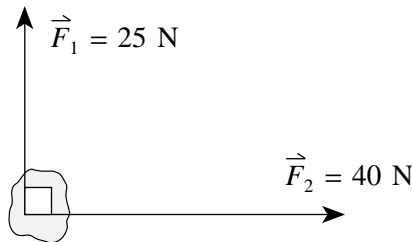
A. 15 N
B. 33 N
C. 47 N
D. 65 N

9. A 25 kg block is pulled by a horizontal force. The supporting rope can withstand a maximum tension force of 620 N.
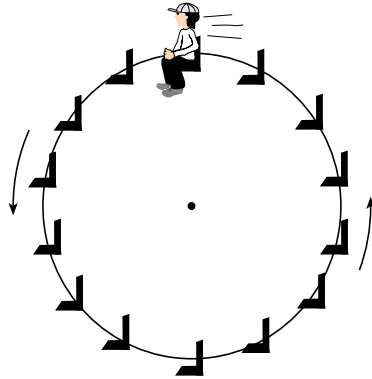

$F_T = 620$ N

θ

Rope

$m = 25$ kg

To what maximum angle, θ, can the block be pulled without the rope breaking?

A. 22°

OVER

- 3 -

B. 23°
C. 67°
D. 88°

10. Hans, whose mass is 50 kg, rides on a ferris wheel in a circular path at constant speed. When he is at the top of the wheel, the seat exerts an upward force of 420 N on Hans.


What is the centripetal force on Hans at the top of the wheel?

A. 70 N
B. 420 N
C. 490 N
D. 910 N

11. A satellite orbits the Earth with a speed of 5.2×10^3 m/s. What is the satellite's distance from the centre of the Earth?

A. 2.8×10^6 m
B. 1.5×10^7 m
C. 3.0×10^7 m
D. 7.2×10^7 m

12. Which of the following statements best applies to an object moving with uniform circular motion?

A. Acceleration is zero.
B. Acceleration is directed outward.
C. Acceleration is tangent to the path.
D. Magnitude of acceleration is constant.

13. A satellite orbits the Sun with a period of 220 days. An asteroid orbits the Sun with twice the orbital radius of the satellite. What is the asteroid's period?

A. 110 days
B. 220 days
C. 440 days
D. 620 days

14. Which diagram shows the electric field between a pair of charged parallel plates?

A.

B.

C.

D.
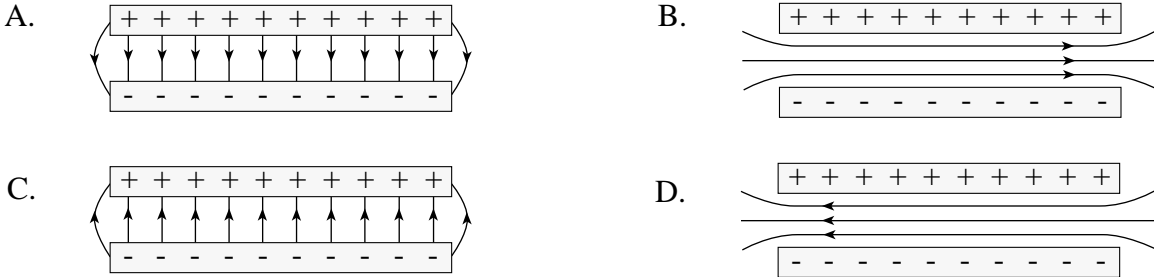
15. In the diagram below, a 2.0×10^{-6} C charge experiences forces of 3.0 N and 8.0 N at its location between charges Q_1 and Q_2.

Q_1 2.0×10^{-6} C Q_2

$F_1 = 3.0$ N $F_2 = 8.0$ N
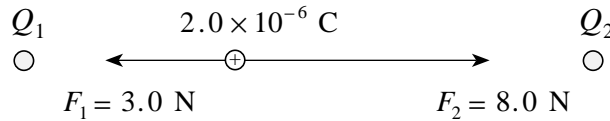
Find the magnitude of the net electric field strength at the location of the 2.0×10^{-6} C charge.

A. 2.5×10^6 N/C
B. 2.8×10^6 N/C
C. 5.5×10^6 N/C
D. 1.2×10^7 N/C

16. How much work is done moving the -2.0×10^{-6} C charge, Q_1, from S to T in the diagram shown below?

$Q_2 = 8.0 \times 10^{-6}$ C $Q_1 = -2.0 \times 10^{-6}$ C

S   T

5.0 m   2.0 m

A. 5.6×10^{-3} J
B. 8.2×10^{-3} J

OVER
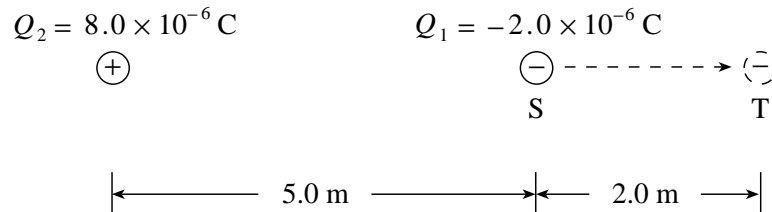
C. 1.2×10^{-2} J

D. 7.2×10^{-2} J

17. A 1.60×10^{-19} C ion is accelerated from rest through a potential difference of 750 V reaching a maximum speed of 8.50×10^4 m/s. What is the mass of this ion?

    A. 9.11×10^{-31} kg

    B. 1.67×10^{-27} kg

    C. 3.32×10^{-26} kg

    D. 4.84×10^{-20} kg

18. How should an ammeter and a voltmeter be correctly placed in a circuit?

	AMMETER	VOLTMETER
A.	In Parallel	In Parallel
B.	In Parallel	In Series
C.	In Series	In Parallel
D.	In Series	In Series

19. The diagram shows a balanced potentiometer. When ε_1 is replaced by a new cell, ε_2, balance is achieved when the contact X is moved 22.0 cm to the right.
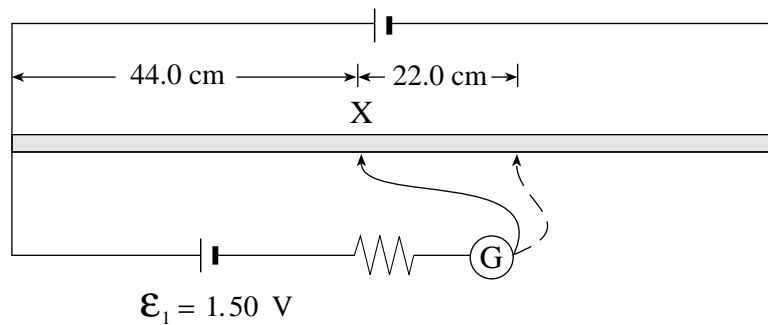
Find the emf of ε_2.

    A. 0.75 V

    B. 1.00 V

    C. 2.25 V

    D. 3.00 V

20. What is the voltage, V, of the power supply shown in the circuit?
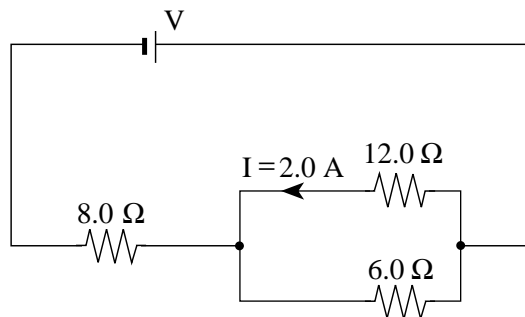
- A. 24 V
- B. 52 V
- C. 72 V
- D. 96 V

21. What is the emf of the battery shown?
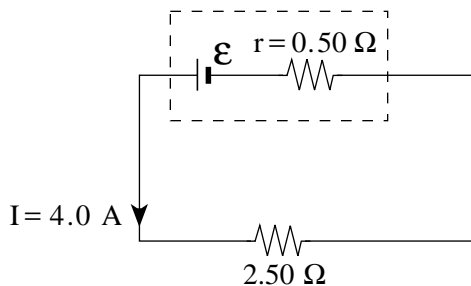
- A. 2.0 V
- B. 8.0 V
- C. 10 V
- D. 12 V

22. Two identical resistors connected in series have a **total** power output of 400 W. Assuming V and R remain constant, what would the total power output be when the resistors are re-connected in parallel?
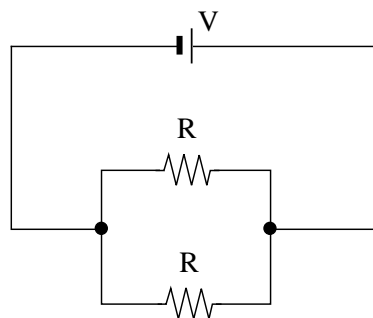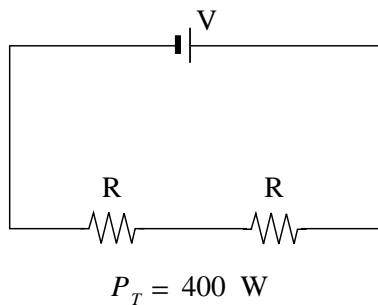
- A. 200 W
- B. 400 W
- C. 800 W

D. 1 600 W

23. Identify the poles of the magnets shown.
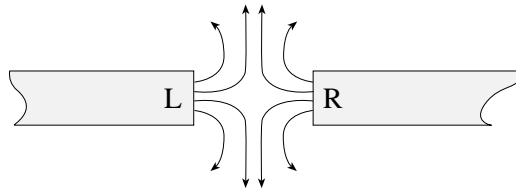
	POLE L	POLE R
A.	North	North
B.	North	South
C.	South	North
D.	South	South

24. The magnetic field 0.30 m from a long straight conductor is 4.2×10^{-4} T.
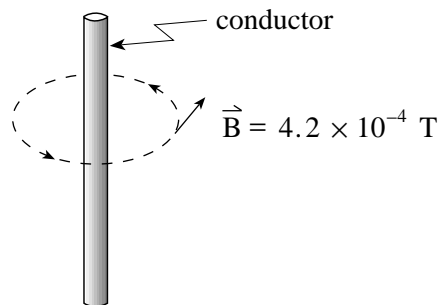
Find the magnitude and direction of the current in the conductor.

A. 100 A up the page
B. 100 A down the page
C. 630 A up the page
D. 630 A down the page

25. A coil of area 0.32 m^2 rotates in a 0.25 T magnetic field. When the current in the coil is 4.8 A, the torque it produces is $55 \text{ N} \cdot \text{m}$. How many windings are there in the coil?

A. 9
B. 21
C. 140
D. 3 300

26. A compass placed on a table points north. In which direction should a conductor, placed **directly above** the compass, carry current in order to reverse the direction of the compass needle?

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

27. In a step-up transformer, how do the primary and secondary voltages, and the primary and secondary currents, compare to one another?

    A. $V_s > V_p$ and $I_s > I_p$
    B. $V_s > V_p$ and $I_s < I_p$
    C. $V_s < V_p$ and $I_s > I_p$
    D. $V_s < V_p$ and $I_s < I_p$

28. When a 9.0 V power supply is connected to a motor whose internal resistance is $0.40\ \Omega$, a current of 1.5 A flows through its windings. Find the back emf of the motor.

    A. 0.60 V
    B. 8.4 V
    C. 9.0 V
    D. 9.6 V

29. As an aircraft flies horizontally over the North Pole, a 0.80 V potential difference is induced across the wings. If the aircraft now slows to one half of the original speed, what will the new potential difference be?

    A. 0.40 V
    B. 0.57 V
    C. 0.80 V
    D. 1.6 V

30. A magnet is moved towards an aluminum ring suspended on string as shown.
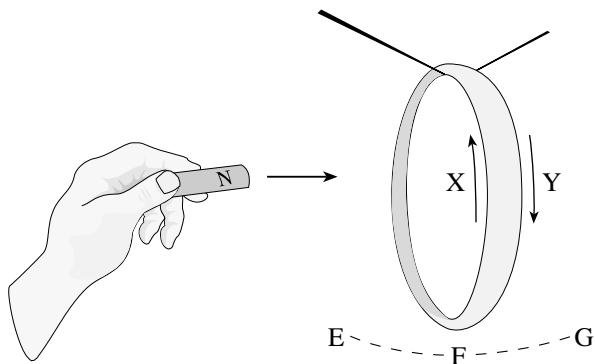
Determine the direction in which current will flow in the ring and the direction in which the ring will move.

	DIRECTION OF CURRENT IN RING	DIRECTION RING WILL MOVE
A.	X	from F towards G
B.	X	from F towards E
C.	Y	from F towards G
D.	Y	from F towards E

This is the end of the multiple-choice section.

Value: 48 marks   **Suggested Time: 48 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. 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. Partial marks will be awarded for steps and assumptions leading to a solution. Such a solution, however, may not be eligible for full marks. **Full marks will NOT be given for the final answer only.**

1. Mike runs horizontally off a cliff at 6.5 m/s and lands in the water 15 m from the base of the cliff.

$v = 6.5$ m/s

├──────── 15 m ────────┤
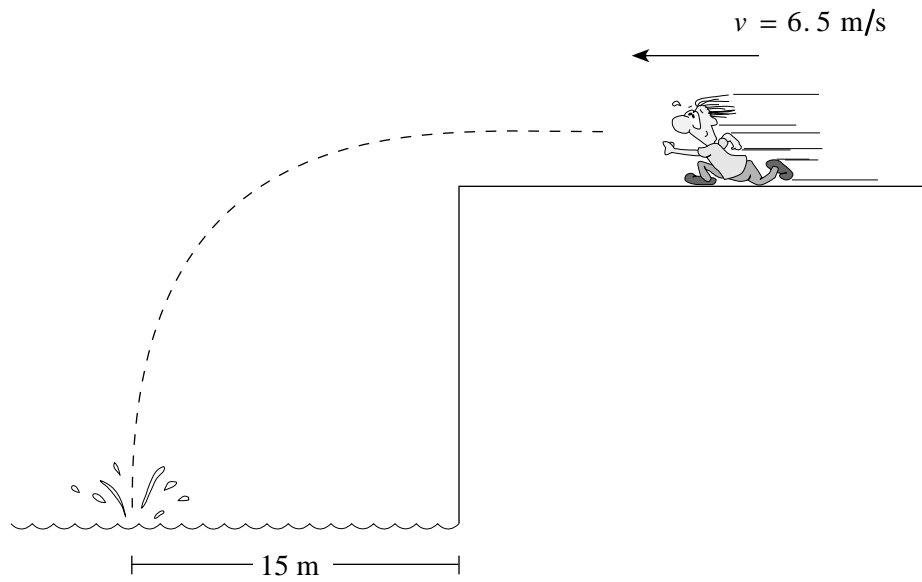
a) How long does it take Mike to hit the water?   **(3 marks)**

OVER

b) How high is the cliff? **(4 marks)**

ANSWER:	Score for Question 1:
a) time: _____	
b) height: _____	1. _____ (7)

OVER

2. A 5.0 kg object travelling at 1.6 m/s collides with an object of unknown mass m_2 travelling at 2.5 m/s. The two objects stick together and move towards the right as shown in the diagram.

$m_1 = 5.0$ kg

$\vec{v}_1 = 1.6$ m/s

$m_1 = 5.0$ kg

$28°$

$\vec{v}'$

$21°$

$\vec{v}_2 = 2.5$ m/s

m_2

m_2
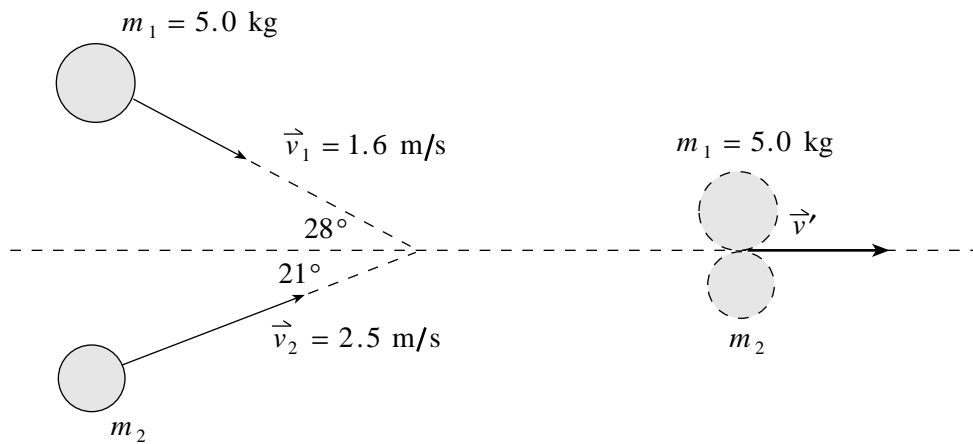
Find the mass of object m_2. **(7 marks)**

ANSWER:	Score for Question 2:
mass: _____	2. _____ (7)

3. The diagram shows the rear door of a station wagon supported horizontally by a strut. The mass of the door is 18 kg and the compression force in the strut is 450 N.
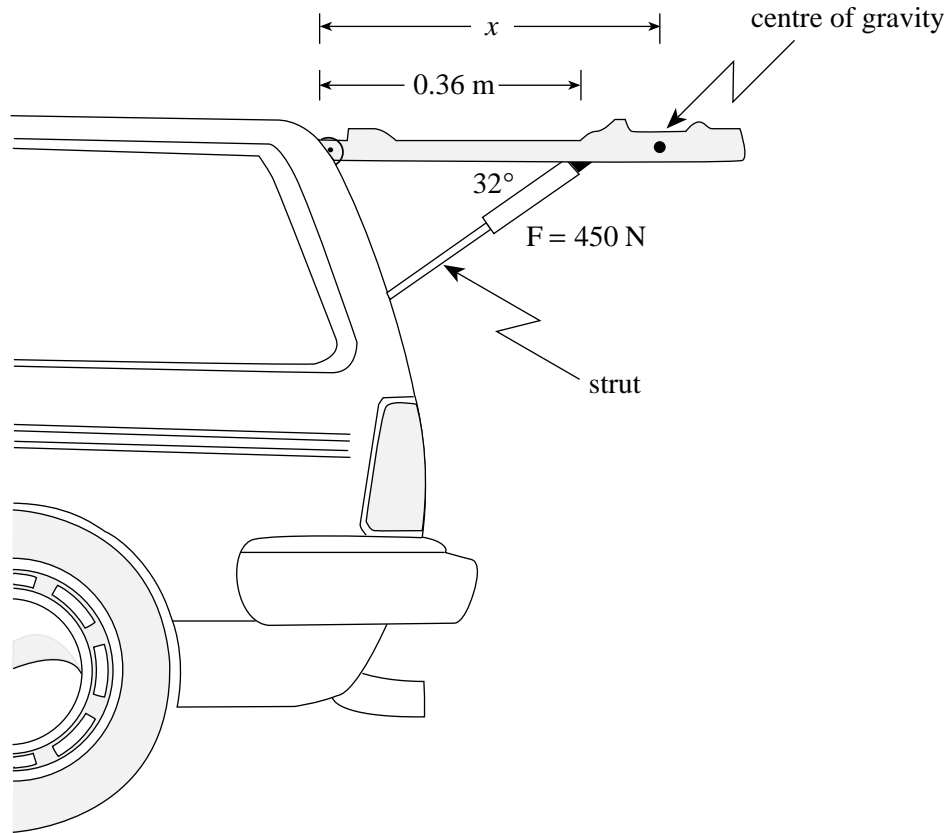
a) Draw and label a free body diagram showing the forces acting on the door.   **(2 marks)**

OVER

b)   At what distance, x, from the hinge is the centre of gravity of the door located?   **(5 marks)**

ANSWER:	Score for Question 3:
b) distance: _____	3. _____
	(7)

4. a) The space shuttle orbits the Earth in a circular path where the gravitational field strength is 8.68 N/kg. What is the shuttle's orbital radius? **(5 marks)**

b) A space station that has 10 times the mass of the shuttle in a) orbits Earth at the same altitude. How does the orbital speed of the space station compare to that of the shuttle? (Check one response.) **(1 mark)**

☐ The space station's speed is less than the shuttle's speed.

☐ The space station's speed is the same as the shuttle's speed.

☐ The space station's speed is greater than the shuttle's speed.

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

_____

_____

_____

_____

_____

_____

OVER

ANSWER:	Score for Question 4:
a) orbital radius: _____	4. _____ (9)

5. Consider the circuit shown in the diagram below.
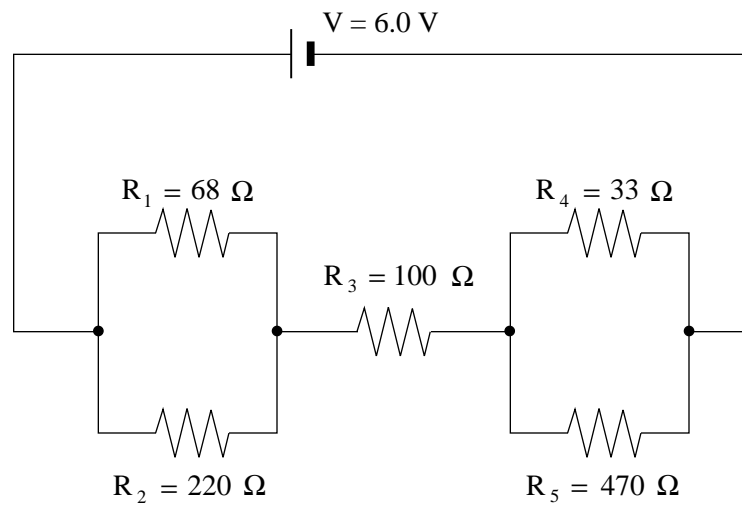
a) What is the total resistance of the circuit?   **(3 marks)**

OVER

b) What is the current through the 100 Ω resistor? **(2 marks)**

c) What is the power dissipated in the 100 Ω resistor? **(2 marks)**

ANSWER:	Score for Question 5:
a) resistance: _____	
b) current: _____	5. _____
c) power: _____	(7)

OVER

6. A proton enters a magnetic field of magnitude 2.4×10^{-2} T at a speed of 5.0×10^5 m/s perpendicular to the field.

    a) What magnetic force acts on the proton?   **(3 marks)**

    b) What is the radius of the proton's circular path?   **(4 marks)**

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

OVER

7. Art and Bill both attempt to move identical 40 kg crates across identical rough surfaces. Art exerts an 80 N force by pushing with a stick. Bill exerts an 80 N force by pulling on a cord. Bill's crate slides across the ground, but Art's will not move.

Art

Bill

30°

30°

m = 40 kg   m = 40 kg
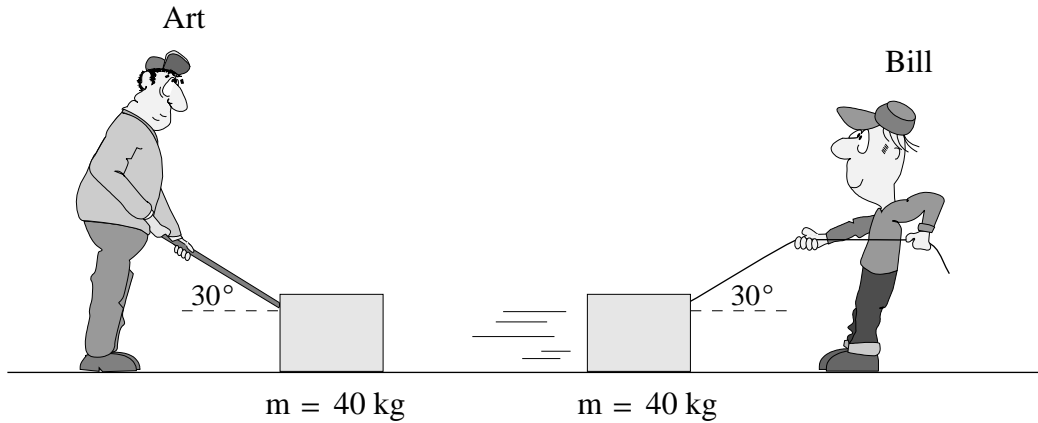
Explain this observation, using principles of physics.   **(4 marks)**

_____

_____

_____

_____

_____

_____

_____

Score for
Question 7:

7. _____
    (4)

This is the end of the written-response section.

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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 28)

or

     SECTION II: Fluid Theory (p. 30 to 32)

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. Answer **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. 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.

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 _____.

1.   What is the threshold frequency for a metal with a work function of 2.3 eV?   **(3 marks)**

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

2. Light of wavelength 1.35×10^{-8} m is emitted from a doubly ionized Lithium ion (3 protons) when the electron jumps from quantum level n to ground state $(n = 1)$. What is the value of n?

(4 marks)

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

3. An electron has a de Broglie wavelength of 1.7×10^{-11} m.

a) What is the speed of the electron?   **(3 marks)**

b) To acquire this speed, through what potential difference was this electron accelerated from rest?   **(2 marks)**

ANSWER:	Score for Question 3:
a) speed: _____	10. _____
b) potential difference: _____	(5)

OVER

END OF SECTION I: Quantum Mechanics

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1.   What is the average kinetic energy per molecule of an ideal gas at a temperature of 310 K?

(3 marks)

ANSWER:	Score for Question 1:
average kinetic energy: _____	11. _____ (3)

OVER

2. In the hydraulic brake system shown below, a force of 25 N is exerted on piston A of area 5.0×10^{-4} m^2.
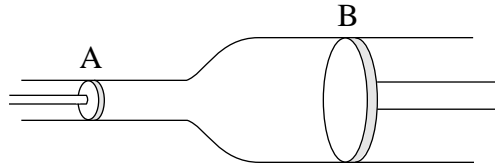
What resulting force would be exerted on the larger piston B if it has an area of 1.1×10^{-2} m^2?

(4 marks)

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

3. An object of unknown material has a mass of 4.30 kg. When the object is submerged in fresh
    water, it has a weight of 39.0 N. What is the density of the object? **(5 marks)**

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

END OF SECTION II: Fluid Theory

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SECTION III: AC Circuitry and Electronics

1. Without feedback, the gain of an amplifier is 85. With feedback, the gain of the amplifier is 65. What is the feedback ratio? **(3 marks)**

ANSWER:	Score for Question 1:
feedback ratio: _____	14. _____ (3)

OVER

2. The following circuit has a resonant frequency of 60 Hz.   **(4 marks)**

$$220 \ \Omega$$

120 V ac

$f_0 = 60$ Hz

L

3.0×10^{-5} F
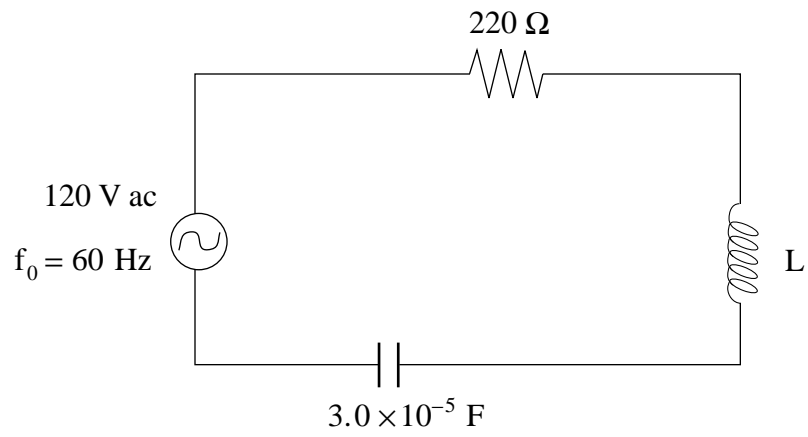
What is the inductive reactance at resonance?

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

3. Switch S in the circuit below has been closed for a long time.
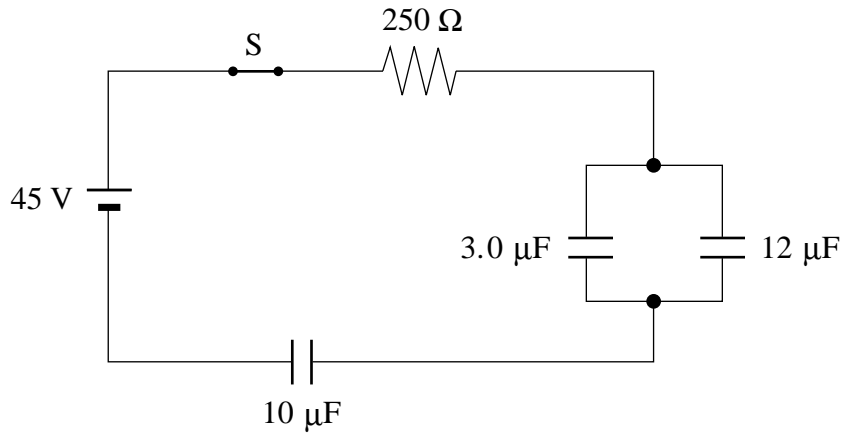
What is the charge on the $3.0 \, \mu F$ capacitor? **(5 marks)**

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

END OF SECTION III: AC Circuitry and Electronics

END OF EXAMINATION

OVER

DATA TABLE

Gravitational constant .... $G = 6.67 \times 10^{-11} \, \text{N} \cdot \text{m}^2/\text{kg}^2$

Acceleration due to gravity at the surface of Earth
      (for the purposes of this examination) .... $g = 9.80 \, \text{m/s}^2$

Earth
      radius .... $= 6.38 \times 10^6 \, \text{m}$
      radius of orbit about Sun .... $= 1.50 \times 10^{11} \, \text{m}$
      period of rotation.. $= 8.61 \times 10^4 \, \text{s}$
      period of revolution about Sun... $= 3.16 \times 10^7 \, \text{s}$
      mass.. $= 5.98 \times 10^{24} \, \text{kg}$

Moon
      radius .... $= 1.74 \times 10^6 \, \text{m}$
      radius of orbit about Earth .... $= 3.84 \times 10^8 \, \text{m}$
      period of rotation.. $= 2.36 \times 10^6 \, \text{s}$
      period of revolution about Earth .... $= 2.36 \times 10^6 \, \text{s}$
   mass.. $= 7.35 \times 10^{22} \, \text{kg}$

Sun
      mass.. $= 1.98 \times 10^{30} \, \text{kg}$

Constant in Coulomb's Law .... $k = 9.00 \times 10^9 \, \text{N} \cdot \text{m}^2/\text{C}^2$
Elementary charge .... $e = 1.60 \times 10^{-19} \, \text{C}$
Mass of electron... $m_e = 9.11 \times 10^{-31} \, \text{kg}$
Mass of proton .... $m_p = 1.67 \times 10^{-27} \, \text{kg}$
Mass of neutron .... $m_n = 1.68 \times 10^{-27} \, \text{kg}$
Permeability of free space .... $\mu_o = 4\pi \times 10^{-7} \, \text{T} \cdot \text{m/A}$

Planck's constant .... $h = 6.63 \times 10^{-34} \, \text{J} \cdot \text{s}$
                                                         $h = 4.14 \times 10^{-15} \, e\text{V} \cdot \text{s}$

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 .... $= -273°\text{C}$

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

TRIGONOMETRIC AND OTHER EQUATIONS
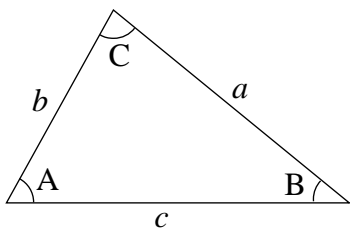
For Right-angled Triangles:
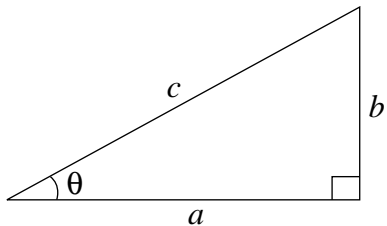
$$a^2 + b^2 = c^2$$

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

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

For All Triangles:

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

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

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

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

Circle:

$$\text{Circumference} = 2\pi r$$

$$\text{Area} = \pi r^2$$

Sphere:

$$\text{Surface area} = 4\pi r^2$$

$$\text{Volume} = \frac{4}{3}\pi r^3$$

Quadratic Equation:

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

EQUATIONS

Note: Vector quantities have not been indicated.

1. **Kinematics:** (for constant acceleration)

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

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

2. **Dynamics:**

$$F_f = \mu F_N \qquad\qquad F_{net} = ma$$

3. **Mechanical Energy and Momentum:**

$$W = Fd \qquad\qquad E_p = mgh \qquad\qquad E_k = \frac{1}{2}mv^2$$

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

4. **Equilibrium:**

$$\tau = Fd$$

5. **Circular Motion and Gravitation:**

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

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

6. **Electrostatics:**

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

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

7. **Circuitry:**

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

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8. Electromagnetism:

$$F = IlB \qquad\qquad B = \frac{\mu_0 I}{2\pi d} \qquad\qquad \tau = NIAB$$

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

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

9. Quantum Mechanics: (Section I)

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

$$E_{k_{max}} = hf - W_0 \qquad\qquad \lambda = \frac{h}{p}$$

10. Fluid Theory: (Section II)

$$\rho = \frac{m}{V} \qquad\qquad PV = NkT \qquad\qquad PV = \frac{1}{3}Nmv^2$$

$$F = \rho Vg \qquad\qquad P = \frac{F}{A} \qquad\qquad P = P_G + P_a$$

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

$$Av = \text{constant}$$

11. AC Circuits and Electronics: (Section III)

$$Q = CV \qquad\qquad E_p = \frac{1}{2}CV^2 \qquad\qquad \tau = RC$$

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

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

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

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