AUGUST 1995

PROVINCIAL EXAMINATION

MINISTRY OF EDUCATION
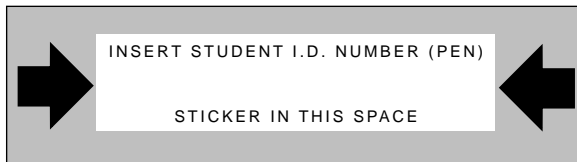
PHYSICS 12

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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PHYSICS 12 AUGUST 1995 PROVINCIAL

Course Code = PH   Examination Type = P

1. _____
(7)

2. _____
(9)

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

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

		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   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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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. A constant force is applied to an object on a frictionless surface, as shown in the diagram below.

Force → ☐

The resulting motion has

   A. constant velocity.
   B. constant momentum.
   C. constant acceleration.
   D. constant kinetic energy.

2. If friction is negligible, which of the following is true for the velocity components of projectiles?

	HORIZONTAL VELOCITY COMPONENT	VERTICAL VELOCITY COMPONENT
A.	constant	constant
B.	constant	changes
C.	changes	constant
D.	changes	changes

3. At what speed must a ball be thrown upwards to reach a maximum height of 25 m?

   A. 2.6 m/s
   B. 22 m/s
   C. 2.5×10^2 m/s
   D. 3.1×10^3 m/s

4. What is the frictional force due to air resistance on a 0.50 kg object falling vertically with an acceleration of 8.5 m/s^2?

   A. 0.65 N
   B. 4.3 N
   C. 4.9 N
   D. 9.2 N

OVER

5. Three masses connected by a light string are arranged on frictionless surfaces, as shown in the diagram below.


$$m_3 = 8.0 \text{ kg}$$

$$m_1 = 4.6 \text{ kg}$$

$$m_2 = 2.4 \text{ kg}$$

25°   70°
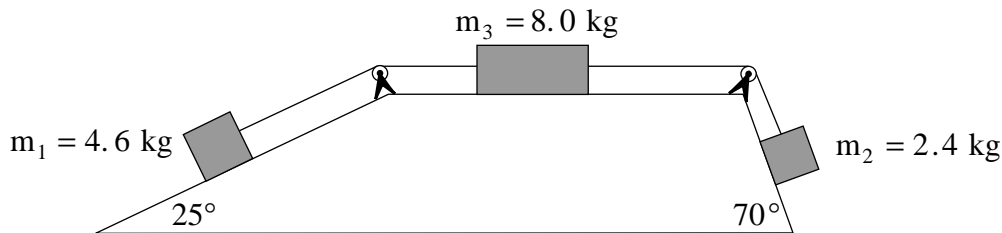
The strings pass over frictionless pulleys. Determine the direction and magnitude of the acceleration of m_1.

	DIRECTION OF m_1	ACCELERATION (m/s^2)
A.	up incline	0.20
B.	down incline	0.20
C.	up incline	0.43
D.	down incline	0.43

6. Two carts collide while travelling on a smooth surface. It is found that the sum of the kinetic energies of the carts after the collision is the same as before the collision. This collision **must** be

    A. elastic.
    B. inelastic.
    C. between carts of identical mass.
    D. between carts that stick together.

7. A 0.15 kg ball moving at 40 m/s is struck by a bat. The bat reverses the ball's direction and gives it a speed of 50 m/s. What average force does the bat apply to the ball if they are in contact for 6.0×10^{-3} s?

    A. 14 N
    B. 2.5×10^2 N
    C. 1.3×10^3 N
    D. 2.3×10^3 N

8. In order to stop two sliding objects, the greater impulse **must** be given to the one having the greater

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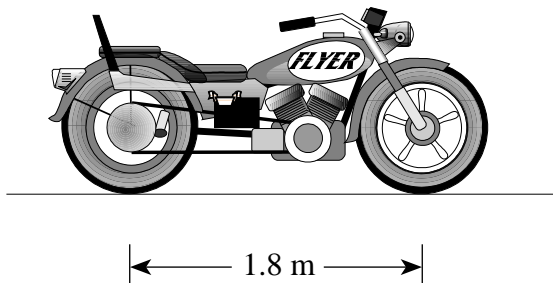   B. speed.
    C. velocity.
    D. momentum.

9. A uniform 3.0 kg shelf of width 0.50 m is supported by a bracket, as shown in the diagram below.
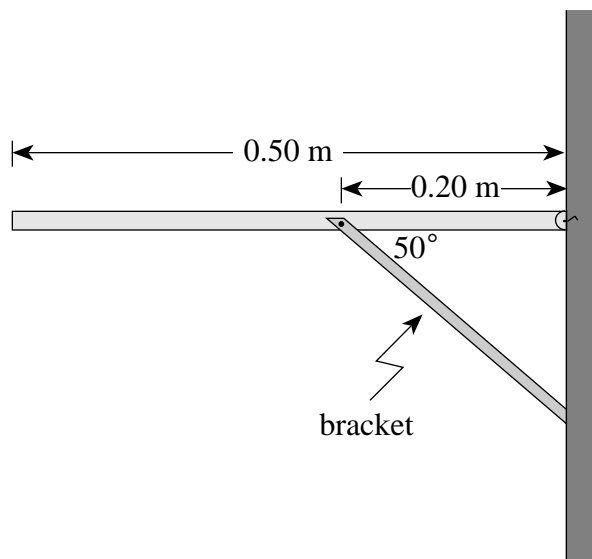
What force does the bracket exert on the shelf?

A. 7.4 N
B. 38 N
C. 48 N
D. 57 N

10. The motorcycle shown has a mass of 200 kg and a wheel base of 1.8 m.

If the rear wheel exerts a 1 200 N force on the ground, find how far the motorcycle's centre of gravity is located from the front wheel.

A. 0.70 m
B. 0.90 m
C. 1.1 m
D. 1.2 m

11. Kepler's third law $\left(r^3 \propto T^2\right)$ can be derived from the law of

  A. inertia.
  B. universal gravitation.
  C. conservation of energy.
  D. conservation of momentum.

12. A planet travels in an elliptical path around a star as shown.
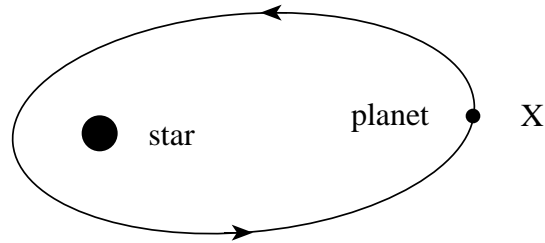
Describe the magnitude of the velocity and the acceleration of the planet at **X**.

	MAGNITUDE OF VELOCITY	MAGNITUDE OF ACCELERATION
A.	least	least
B.	least	greatest
C.	greatest	least
D.	greatest	greatest

13. What is the gravitational field strength at the surface of a star of mass 4.8×10^{31} kg and radius 2.7×10^8 m?

  A. 9.8 N/kg
  B. 4.4×10^4 N/kg
  C. 4.9×10^6 N/kg
  D. 1.2×10^{13} N/kg

14. A stationary object of mass m is on the surface of a planet of mass M and radius r. Which of the following gives the work required to move the object infinitely far away?
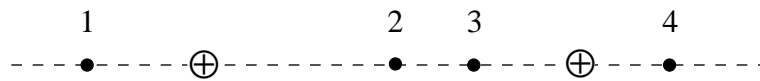
A. $W = \sqrt{\dfrac{GMm}{r}}$

B. $W = \dfrac{GMm}{r}$

C. $W = \dfrac{GMm}{2r}$

D. $W = \dfrac{GMm}{r^2}$

15. Two positive charges, equal in magnitude, are separated as shown below.

In which location would the electric field strength be zero?

A. 1
B. 2
C. 3
D. 4

16. An electron is positioned in an electric field. The force on the electron due to the electric field is equal to the force of gravity on the electron. What is the magnitude of this electric field?

A. 8.93×10^{-30} N/C
B. 5.69×10^{-12} N/C
C. 5.58×10^{-11} N/C
D. 1.44×10^{-9} N/C

OVER

17. Two parallel plates 6.0×10^{-2} m long are separated by 2.5×10^{-2} m and have a potential difference of 850 V. Point **P** is located midway between the two plates as shown below.
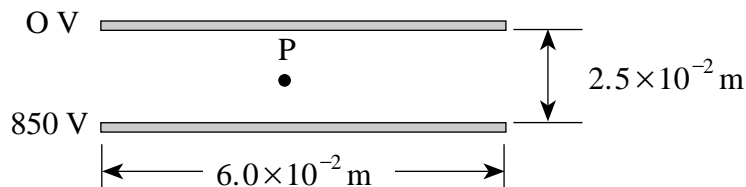
What is the magnitude of the electric field at point **P**?

    A. 1.4×10^4 V/m
    B. 1.7×10^4 V/m
    C. 3.4×10^4 V/m
    D. 6.8×10^4 V/m

18. A particle with a charge of 2.4×10^{-5} C is accelerated from rest through a potential difference of 6.2×10^4 V. If the final speed of this particle is 9.3×10^3 m/s, what is the mass of the particle?

    A. 7.7×10^{-10} kg
    B. 5.2×10^{-9} kg
    C. 3.4×10^{-8} kg
    D. 1.5×10^{-1} kg

19. Two 3.0×10^{-6} C point charges are placed 5.0 m apart as shown below.
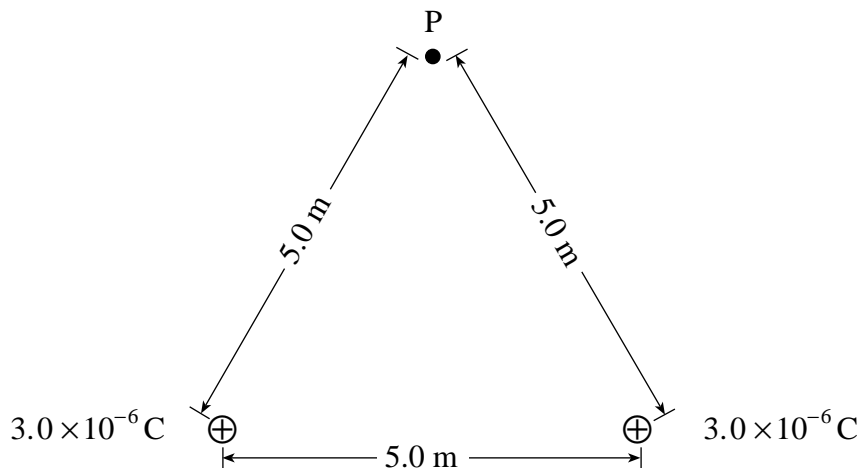
What is the potential at point **P** due to the two charges?

    A. 0 V
    B. 5.4×10^3 V
    C. 7.6×10^3 V
    D. 1.1×10^4 V

20. Which of the following correctly states Kirchhoff's first rule or junction rule?

   A. The magnitude of the current in each wire leaving a junction is always equal.
   B. In a complete circuit, the current leaving the battery must be lost in the circuit.
   C. The sum of the currents leaving the junction is equal to the sum of the currents entering the junction.
   D. The sum of the currents leaving the junction is less than the sum of the currents entering the junction.

21. A 12 V battery is connected to a 20 Ω resistor. How much charge flows through the battery in 3.5 s ?

   A. $2.7 \times 10^{-8} C$
   B. 0.60 C
   C. 2.1 C
   D. 25 C

22. The diagram below shows an 80 cm slide wire potentiometer balanced at 62.3 cm by a 1.38 V cell.
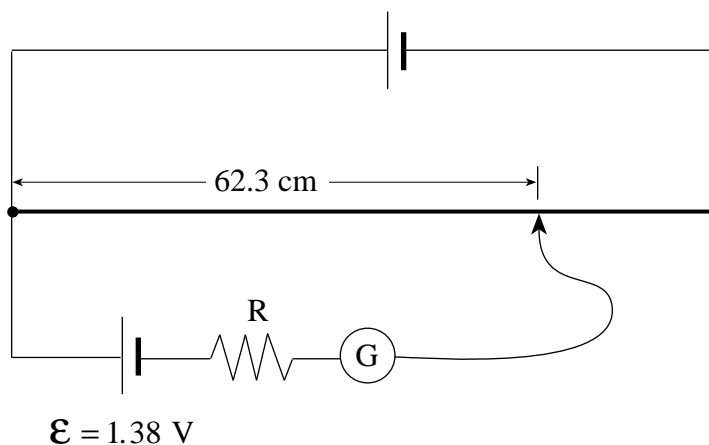
The 1.38 V cell is replaced by a new cell. What is the emf of the new cell if balance is achieved at 41.2 cm?

   A. 0.364 V
   B. 0.630 V
   C. 0.913 V
   D. 2.09 V

23. A 660 W electric heater is designed to operate from a 120 V source. If the source voltage drops to 80.0 V, what will be the power dissipated by the same heater? (Assume the resistance of the heater is constant.)

   A. 73.3 W
   B. 293 W
   C. 440 W
   D. 660 W

24. Which of the following is a step-up transformer?

A.

B.

C.

D.
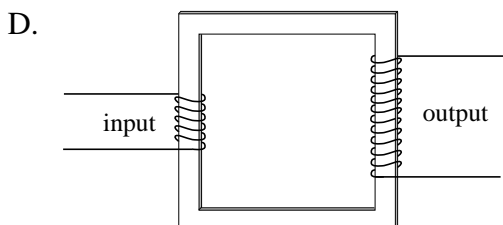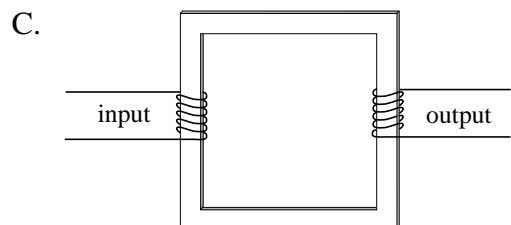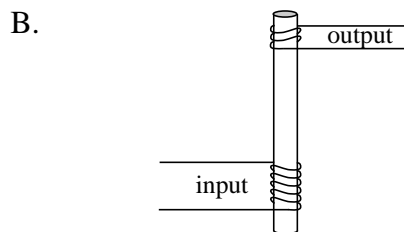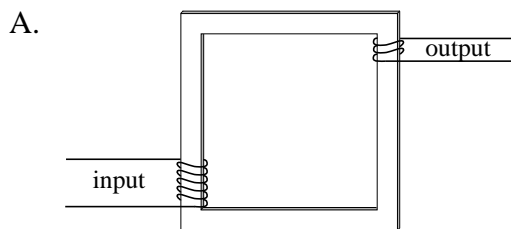
25. A solenoid of diameter 0.018 m is 0.30 m long. A current of 5.3 A is used to create a magnetic field of 0.25 T at the centre of the solenoid. How many turns of wire does this solenoid have?

A. 6.8×10^2
B. 2.1×10^3
C. 1.1×10^4
D. 3.8×10^4

26. A beam of electrons is directed into a uniform magnetic field and deflects as shown in **Figure I**. If a beam of protons with the same speed were to enter this same magnetic field, which of the paths shown in **Figure II** would the protons take?

Figure I
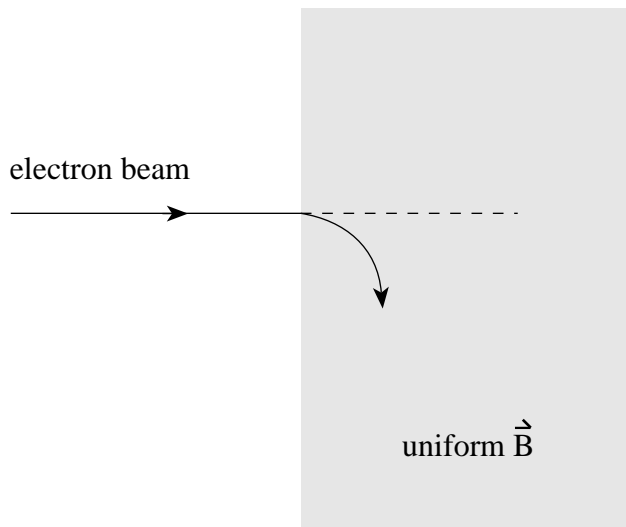
Figure II

A. 1
B. 2
C. 3
D. 4

27. Which of the following graphs **best** shows how the magnetic field **B** varies with the perpendicular distance **d** from a long, straight current-carrying conductor?

A.

B.

C.

D.

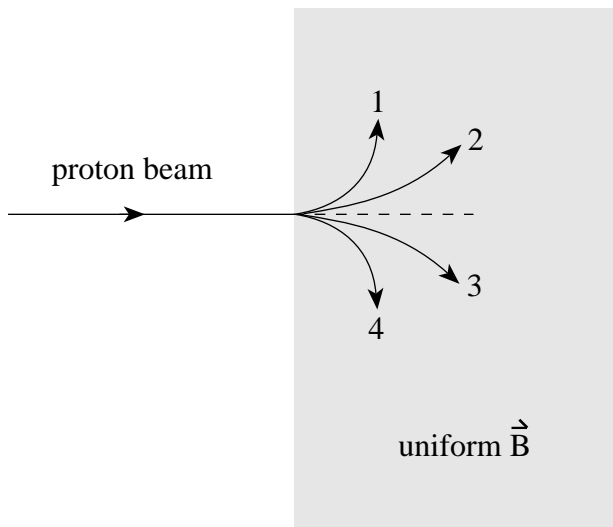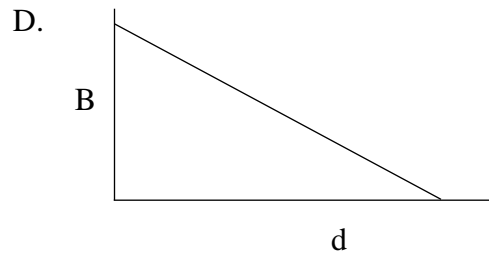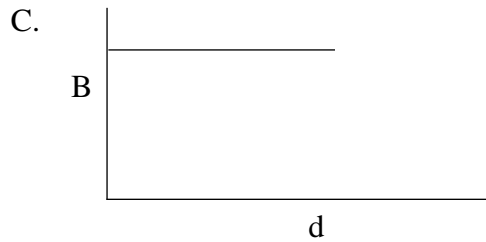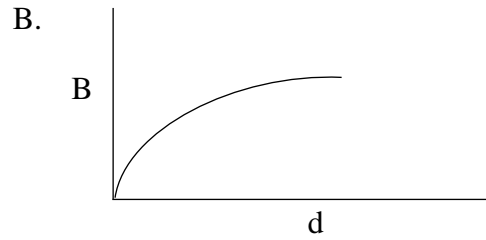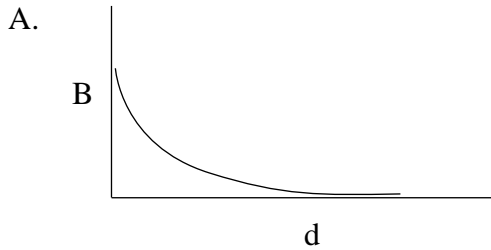28. For what type of input current will the output current in a transformer be zero?

    A. dc
    B. ac
    C. increasing dc
    D. decreasing dc

29. A motor designed to operate on 120 V draws a current of 33 A when it first starts up. At its normal operating speed, the motor draws a current of 2.7 A. What is the back emf at normal operating speed?

    A. 9.8 V
    B. 110 V
    C. 120 V
    D. 130 V

30. A 35 loop square coil 0.12 m on a side is positioned in a 0.050 T magnetic field. A 0.20 kg mass is suspended from one side of the coil as shown in the diagram below.

$0.12\ m$

N

S

$m = 0.20\ kg$

axis of rotation
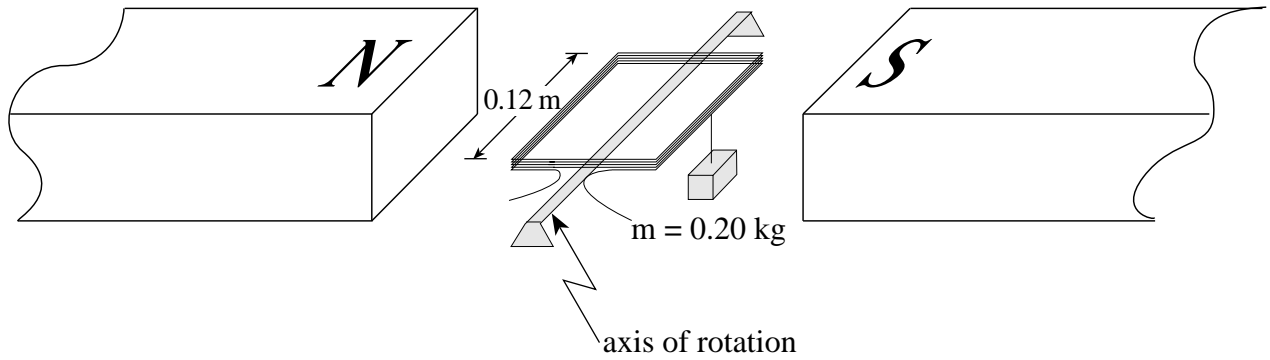
How much current must pass through the coil in order for the coil to remain horizontal?

A. 2.3 A
B. 4.7 A
C. 9.3 A
D. 330 A

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

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. A projectile is launched over level ground at 35 m/s at an angle of 24° above the horizontal. Friction is negligible.

   a) What is the time of flight of this projectile? **(3 marks)**

b) What is the velocity (magnitude and direction) of this projectile 2.5 s after launch?

(4 marks)

<table>
<tr><td>ANSWERS:

a) time: _____

b) velocity – magnitude: _____
                  – direction: _____</td><td>Score for
Question 1:

1. _____
    (7)</td></tr>
</table>

OVER

2. A 150 kg roller coaster car passes the crest of a hill at 15.0 m/s.

v = 15.0 m/s

A

24 m

B
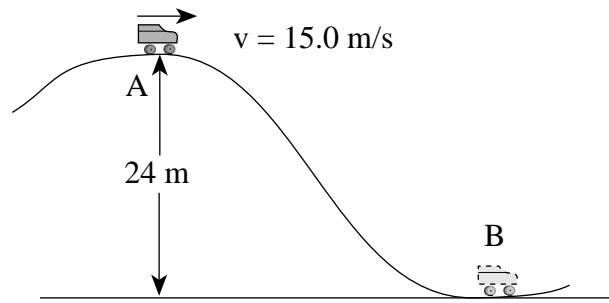
a) What is the speed of the car at point **B** at the bottom of the hill? (Neglect friction.)**(5 marks)**

b) i) If the mass of the roller coaster car is increased by adding a passenger, how will the speed at **B** now compare to your answer for part a)? (Circle one.)   **(1 mark)**

   A. equal to
   B. less than
   C. greater than

   ii) Explain your answer using principles of physics.   **(3 marks)**

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

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

OVER

3. A 60 kg block rests on the ground. A student exerts a 320 N force on the block by pulling on a rope, but friction prevents the block from moving.
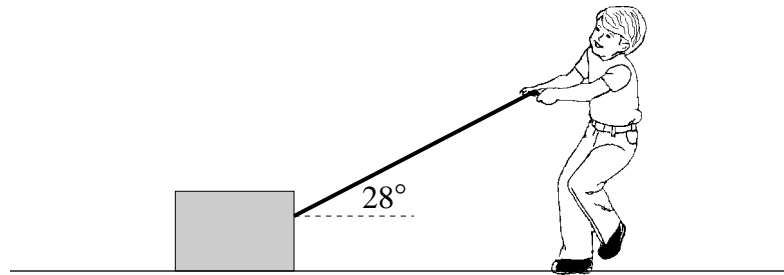
a) Draw and label a free body diagram showing all forces acting on the block. **(2 marks)**

b) Calculate the force of friction on the block. **(2 marks)**

c) Calculate the normal force exerted by the ground on the block. **(2 marks)**

d) Calculate the minimum coefficient of friction between the block and the ground. **(1 mark)**

ANSWERS:	Score for Question 3:
b) force of friction:_____	
c) normal force: _____	3. _____
d) coefficient of friction: _____	(7)

OVER

4. A 1 250 kg rocket rests on the surface of the Earth. To what maximum distance from the Earth's centre would the rocket be lifted if 2.5×10^{10} J of work were done on it? **(7 marks)**

ANSWER:	Score for Question 4:
distance: _____	4. _____ (7)

OVER

5. A battery with an emf of 12.0 V and an internal resistance r is connected to a circuit as shown below.
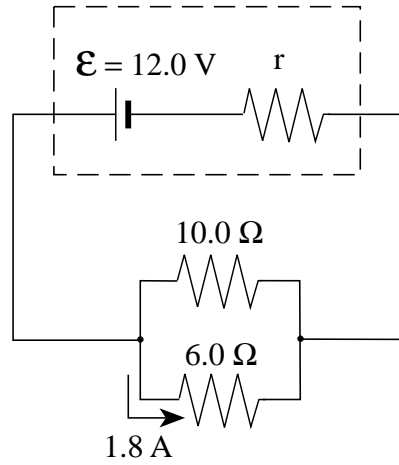
If the current through the 6.0 Ω resistor is 1.8 A , what is the internal resistance r ? **(7 marks)**

ANSWER:	Score for Question 5:
internal resistance: _____	5. _____ (7)

6. A solenoid of length 0.85 m has a radius of 0.10 m . A current of 25 A flows through its
    7 600 turns. Within this solenoid, a 0.12 m wire moves as shown and develops an
    emf of 0.055 V across its ends.
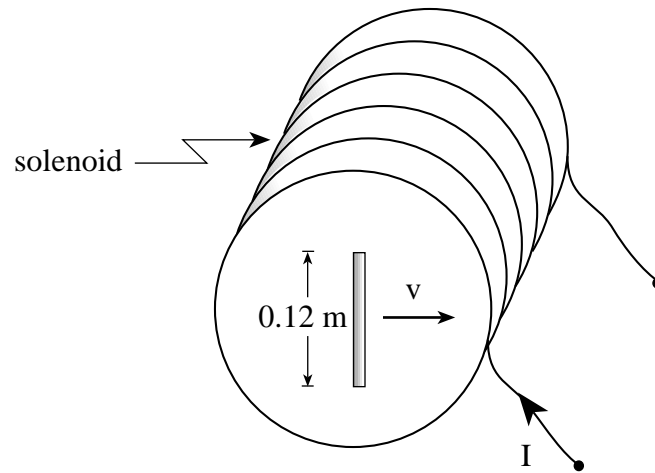
With what speed does the wire move perpendicular to the solenoid's magnetic field?   **(7 marks)**

ANSWER:	Score for Question 6:
speed: _____	6. _____
	(7)

OVER

7. A heavy object initially hangs from a piece of thread. When the object is drawn aside and released, the thread is observed to break before the object reaches its lowest point. Using principles of physics, explain why the thread was strong enough to initially suspend the mass but not strong enough to support it when swinging. **(4 marks)**
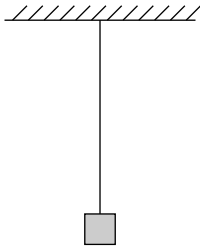
Object suspended
in equilibrium
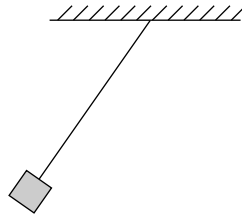
Object released
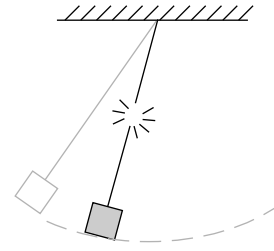
Thread breaks

_____

_____

_____

_____

_____

_____

_____

_____

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 _____.

SECTION I: Quantum Mechanics

1. What is the momentum of a photon whose frequency is 5.89×10^{15} Hz ?   **(3 marks)**

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

2. The electron of a singly ionized helium (He^+) atom makes a transition from the first excited state $(n = 2)$ to the fourth excited state $(n = 5)$. He^+ has two protons and two neutrons in its nucleus. How much energy was absorbed by this helium ion?   **(4 marks)**

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

OVER

3. A metal surface has a work function of 2.33 eV. What wavelength of light will cause this surface to emit electrons with a maximum speed of 1.44×10^6 m/s? **(5 marks)**

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

END OF SECTION I: Quantum Mechanics

OVER

1. At what temperature will the average translational kinetic energy of a gas molecule
    be 5.8×10^{-21} J ?   **(3 marks)**

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

2. Water in a pipe has a speed of 4.5 m/s at **A** and a speed of 6.2 m/s   at **B** as shown below.

A

4.5 m/s

B

6.2 m/s
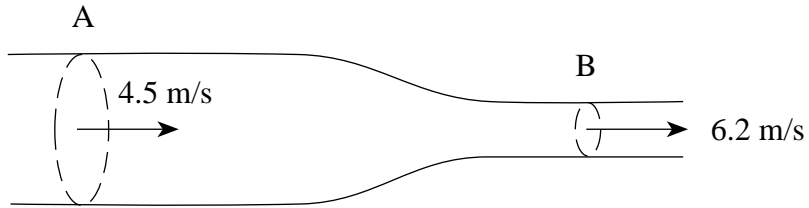
If the cross-sectional area of the pipe at **A** is 3.0×10^{-3} m^2, what is the area of the pipe at **B**?
(4 marks)

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

OVER

3. An airplane of mass 950 kg has wings with a total surface area of 12 m^2 . If air passes under the wings at 55 m/s, how fast must the air pass over the wings if the lift force produced is to balance the weight of the airplane? **(5 marks)**

ANSWER:	Score for Question 3:
speed of air:_____	13. _____ (5)

END OF SECTION II: Fluid Theory

SECTION III: AC Circuitry and Electronics

1. The diagram below shows a circuit used to charge a capacitor.
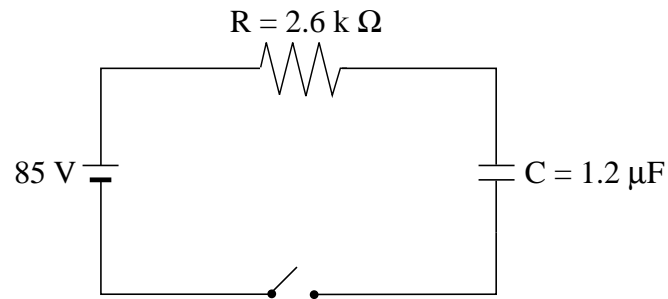
When the switch has been closed for several minutes, what will be the charge on the capacitor?

(3 marks)

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

2. An amplifier has a gain of 30 without feedback and a gain of 12 with feedback. Calculate the
     feedback ratio.   **(4 marks)**

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

OVER

3. What is the rms voltage across the capacitor in the diagram shown below? **(5 marks)**

$f = 60$ Hz

$V_{rms} = 120\,\text{V}$

$C = 14\,\mu\text{F}$

$R = 180\,\Omega$

$L = 0.85$ H
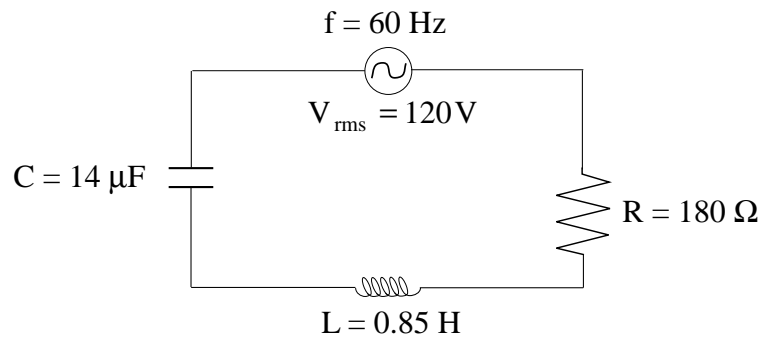
ANSWER:	Score for Question 3:
rms voltage: _____	16. _____ (5)

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·m²/kg²

Gravitational constant .... G $= 6.67 \times 10^{-11}$ N·m²/kg²

Acceleration due to gravity at the
surface of Earth (for the
purposes of this examination) .... g $= 9.80$ m/s²

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·m²/C²

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/m³

Density of air .... $= 1.29$ kg/m³

Standard atmospheric pressure .... $= 1.01 \times 10^{5}$ Pa

Volume of one mole of gas at STP .... $= 22.4$ L (2.24×10^{-2} m³)

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.

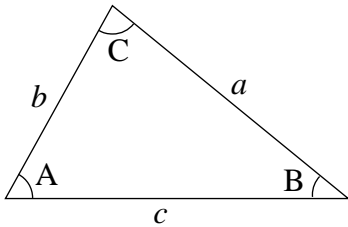# TRIGONOMETRIC AND OTHER EQUATIONS

For Right-angled Triangles:
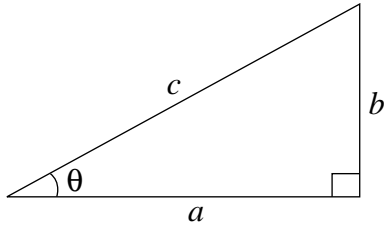
$$a^2 + b^2 = c^2$$

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

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

For All Triangles:

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

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

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

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

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:

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

EQUATIONS

Note: Vector quantities have not been indicated.

1. Kinematics: (for constant acceleration)

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

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

2. Dynamics:

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

3. Mechanical Energy and Momentum:

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

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

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:

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

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

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

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)

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

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

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

$$Av = constant$$

11. AC Circuits and Electronics: (Section III)

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

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

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

$$(where\ \beta =\ feedback\ ratio)$$

You may detach this page for convenient reference.
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