

AUGUST 1997

PROVINCIAL EXAMINATION

MINISTRY OF EDUCATION, SKILLS AND TRAINING

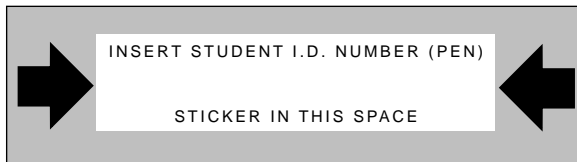
PHYSICS 12

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 **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



_____ - _____

PHYSICS 12 AUGUST 1997 PROVINCIAL

Course Code = PH Examination Type = P

1. _____
(7)

5. _____
(7)

2. _____
(9)

6. _____
(7)

3. _____
(7)

7. _____
(4)

4. _____
(7)

Score **only one** of the following 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)

THIS PAGE INTENTIONALLY BLANK

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

- 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.
- 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.
- 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.
- You are permitted to use rulers, compasses and protractors.
- Final answers must include appropriate **units**.
 - Marks will not be deducted for answers expressed to **two** or **three** significant figures.
 - In this examination the zero in a number such as 30 shall be considered to be a significant zero.
- 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.
- You have **two hours** to complete this examination.

THIS PAGE INTENTIONALLY BLANK

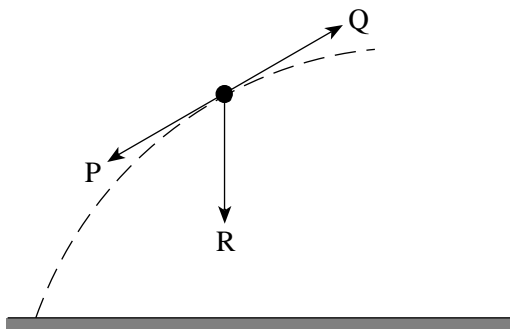
PART A: MULTIPLE CHOICE

Value: 60 marks (2 marks per question)

Suggested Time: 60 minutes

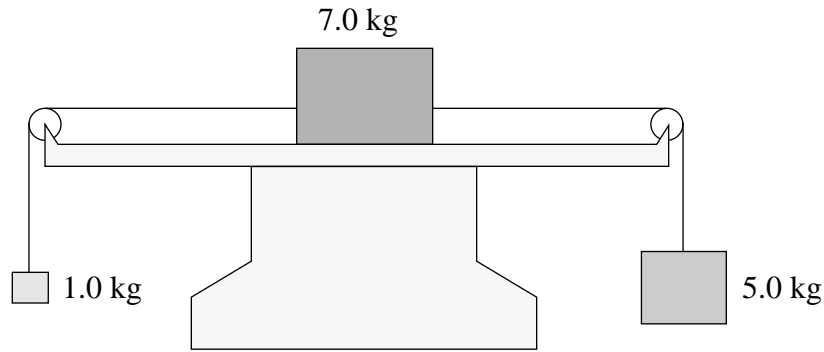
INSTRUCTIONS: For each question, select the **best** answer and record your choice on the Answer Sheet provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. The projectile shown below has an acceleration which is



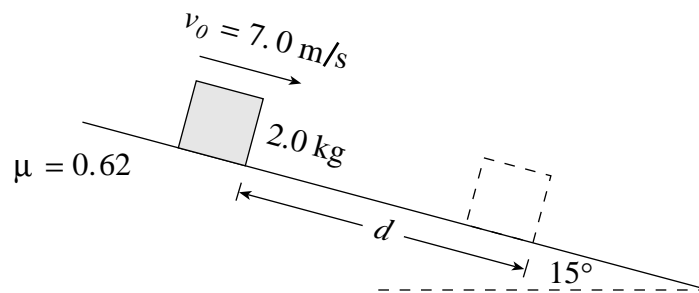
- A. zero.
B. in the direction of P.
C. in the direction of Q.
D. in the direction of R.
2. Which of the following is **not** a statement of one of Newton's laws of motion?
- A. For every action force, there is an equal and opposite reaction force.
B. If no net force acts on an object, the object will remain at rest, or continue to move at a constant velocity.
C. The acceleration of freely falling objects is proportional to their mass.
D. If a net force does act on an object, the object will accelerate in the direction of the net force.
3. An object is launched at 65° to the horizontal with an initial speed of 25 m/s. What is the maximum height reached by this object?
- A. 5.7 m
B. 26 m
C. 32 m
D. 150 m

4. Three blocks have masses 1.0 kg, 7.0 kg and 5.0 kg as shown. The horizontal surface is frictionless.



What is the magnitude of the acceleration of the system?

- A. 3.0 m/s^2
 - B. 3.8 m/s^2
 - C. 6.5 m/s^2
 - D. 7.8 m/s^2
5. A 2.0 kg block is sliding down a 15° incline. The coefficient of friction is 0.62. At some position the block has a speed of 7.0 m/s.



What distance d will this block move before coming to rest?

- A. 2.5 m
- B. 4.0 m
- C. 4.2 m
- D. 7.4 m

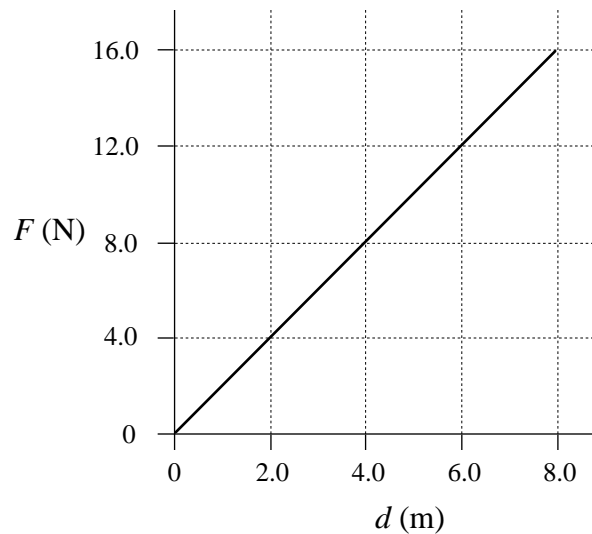
6. Which of the following is a correct unit for impulse?

- A. N
- B. N · m
- C. N/s
- D. N · s

7. A 0.15 kg ball travelling at 25 m/s strikes a wall and bounces back in the opposite direction at 15 m/s. The ball is in contact with the wall for 0.030 seconds. What average force does the wall exert on the ball?

- A. 25 N
- B. 50 N
- C. 1.0×10^2 N
- D. 2.0×10^2 N

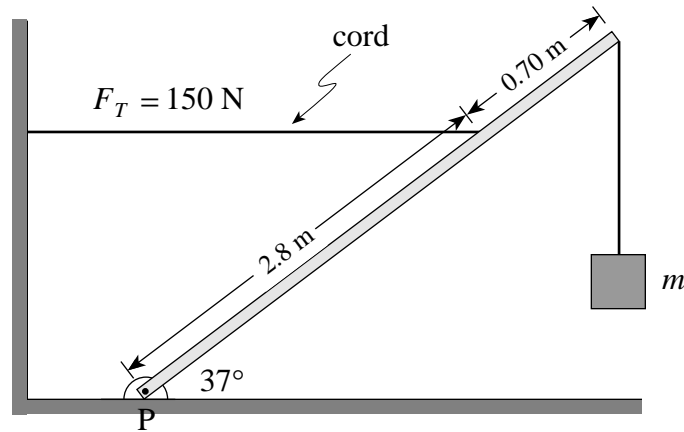
8. The graph below shows the relationship between the force applied and the distance moved for a 3.5 kg object on a frictionless horizontal surface.



If the object was initially at rest, what is its kinetic energy after travelling 8.0 m?

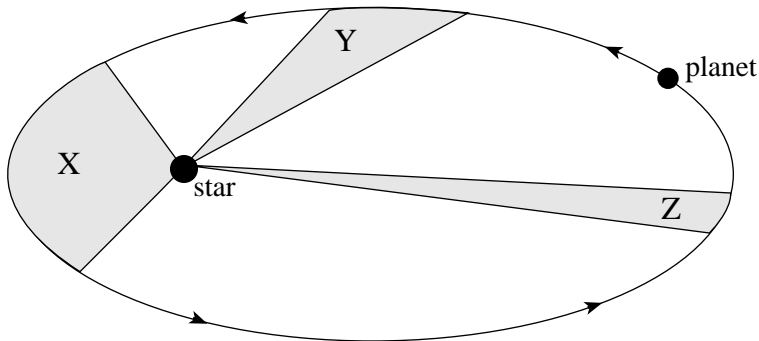
- A. 2.0 J
- B. 32 J
- C. 64 J
- D. 130 J

9. A uniform 3.5 m beam of negligible mass, hinged at P, supports a hanging block as shown.



If the tension F_T in the horizontal cord is 150 N, what is the mass of the hanging block?

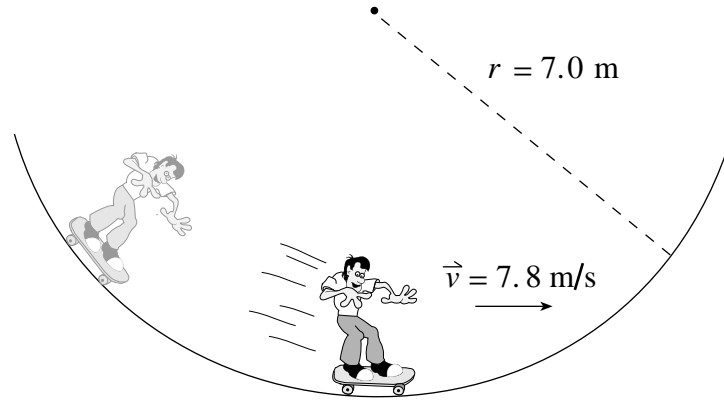
- A. 9.2 kg
 - B. 12 kg
 - C. 16 kg
 - D. 46 kg
10. A planet travels in an elliptical path around a star. The areas X, Y and Z were swept out in equal time intervals.



Which of the following describes the relationship between the areas?

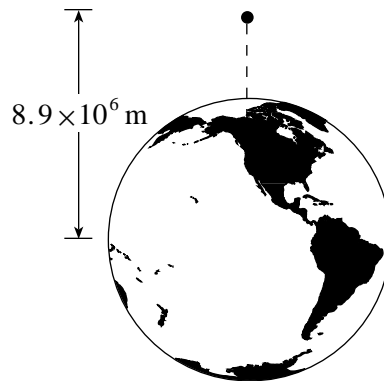
- A. Area X is greater than area Z.
 - B. Area X is equal to the sum of areas Y and Z.
 - C. Area X is less than area Z.
 - D. Area X is equal to area Y which is equal to area Z.
11. A 1 200 kg car is travelling at 25 m/s on a horizontal surface in a circular path of radius 85 m. What is the net force acting on this car?
- A. 0 N
 - B. 8.8×10^3 N
 - C. 1.2×10^4 N
 - D. 3.8×10^5 N

12. A 61 kg skateboarder is moving down a ramp with a 7.0 m radius of curvature. At the bottom of this ramp he reaches a speed of 7.8 m/s.



What upward force acts on the skateboarder at the bottom of the ramp?

- A. $7.0 \times 10^1 \text{ N}$
 - B. $5.3 \times 10^2 \text{ N}$
 - C. $6.0 \times 10^2 \text{ N}$
 - D. $1.1 \times 10^3 \text{ N}$
13. A stationary 25 kg object is released from a position $8.9 \times 10^6 \text{ m}$ from the centre of the earth.

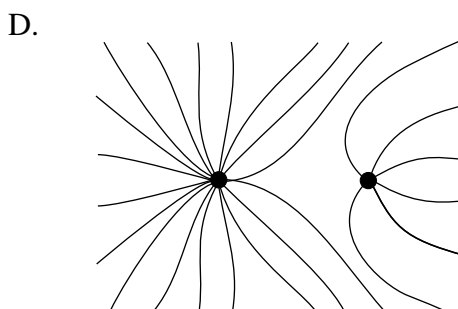
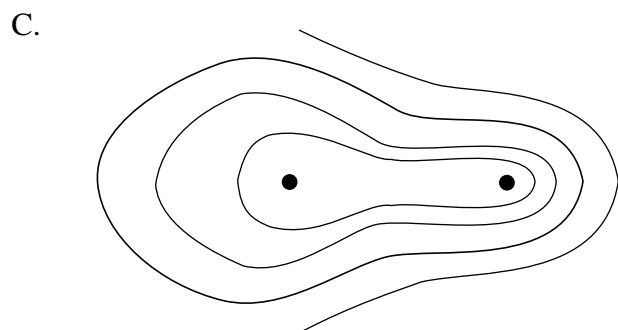
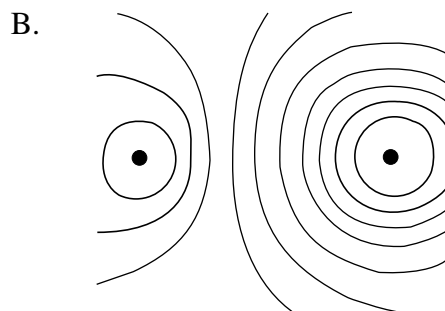
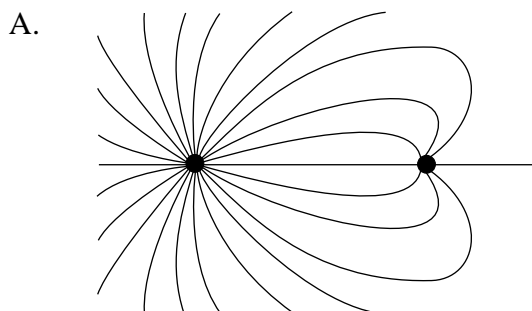


What is the speed of the object just before impact? Ignore air resistance.

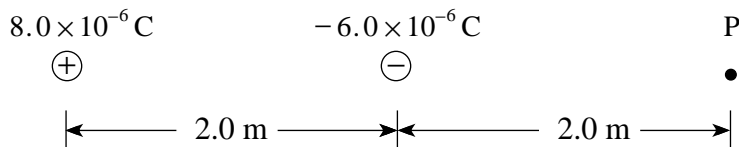
- A. $6.0 \times 10^3 \text{ m/s}$
- B. $7.0 \times 10^3 \text{ m/s}$
- C. $1.3 \times 10^4 \text{ m/s}$
- D. $1.8 \times 10^4 \text{ m/s}$

14. A planet of radius 7.0×10^7 m has a gravitational field strength of 68 N/kg at its surface. What is the period of a satellite orbiting this planet at a radius of 1.4×10^8 m (twice the planet's radius)?
- A. 9.0×10^3 s
 B. 1.3×10^4 s
 C. 1.8×10^4 s
 D. 2.4×10^4 s

15. Which of the following shows the electric field between two opposite charges of unequal magnitude?

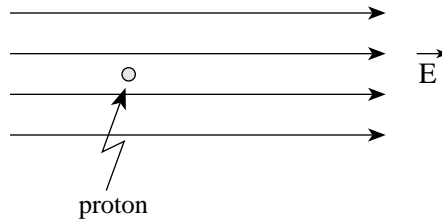


16. What is the magnitude of the electric field at point P due to the two charges shown?



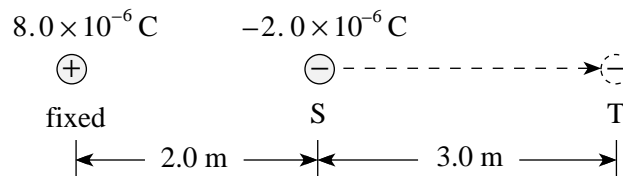
- A. 4.5×10^3 N/C
 B. 9.0×10^3 N/C
 C. 1.4×10^4 N/C
 D. 1.8×10^4 N/C

17. What is the acceleration of a proton in a uniform $2.5 \times 10^5 \text{ N/C}$ electric field as shown below?

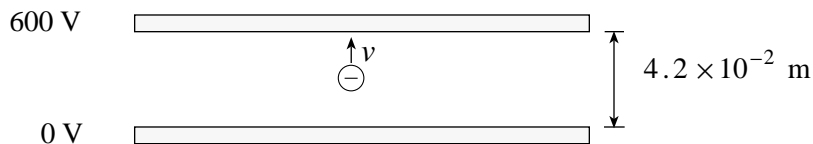


	MAGNITUDE OF ACCELERATION	DIRECTION OF ACCELERATION
A.	$2.4 \times 10^{13} \text{ m/s}^2$	Right
B.	$2.4 \times 10^{13} \text{ m/s}^2$	Left
C.	$1.5 \times 10^{32} \text{ m/s}^2$	Right
D.	$1.5 \times 10^{32} \text{ m/s}^2$	Left

18. How much work is needed to move a $-2.0 \times 10^{-6} \text{ C}$ charge from position S to position T as shown below?



- A. $4.3 \times 10^{-2} \text{ J}$
 B. $4.8 \times 10^{-2} \text{ J}$
 C. $9.1 \times 10^{-2} \text{ J}$
 D. $1.1 \times 10^{-1} \text{ J}$
19. An electron, initially at rest, is accelerated through a potential difference of 600 V as shown.

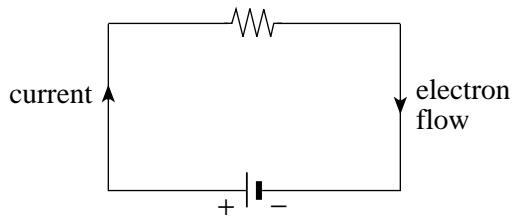


What is the maximum kinetic energy of the electron?

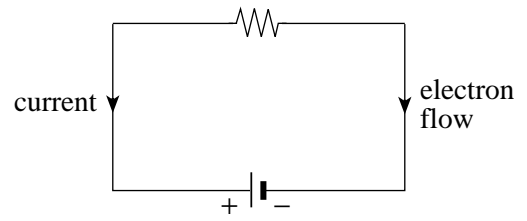
- A. $3.7 \times 10^{-31} \text{ J}$
 B. $9.6 \times 10^{-17} \text{ J}$
 C. $6.0 \times 10^2 \text{ J}$
 D. $1.4 \times 10^4 \text{ J}$

20. Which of the following correctly shows the direction of conventional current and electron flow?

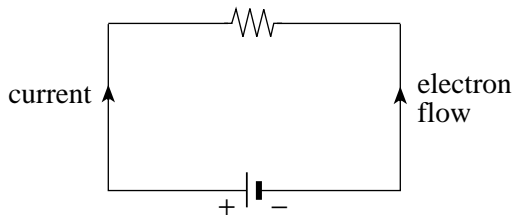
A.



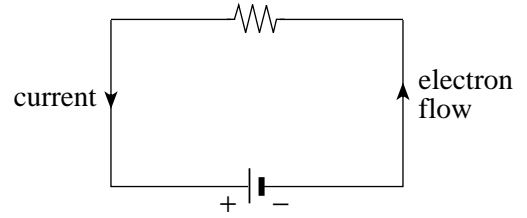
B.



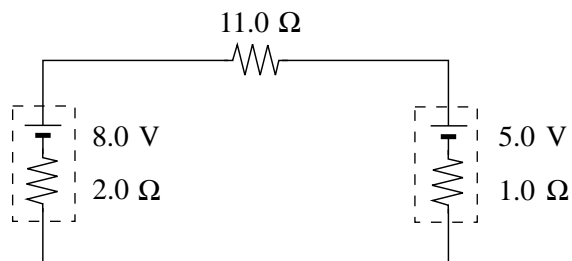
C.



D.

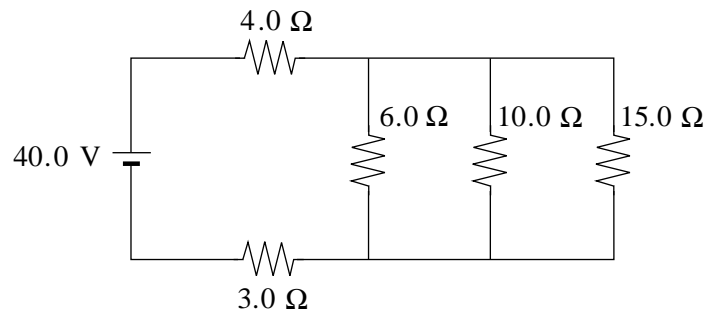


21. What current flows through the $11.0\ \Omega$ resistor?



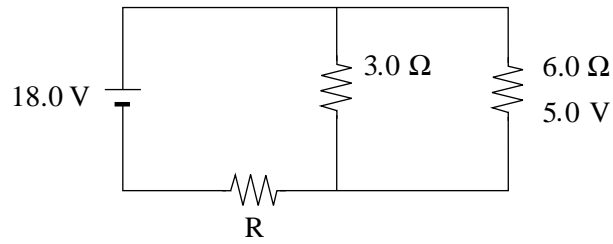
- A. 0.21 A
- B. 0.27 A
- C. 0.93 A
- D. 1.2 A

22. Calculate the current through the $6.0\ \Omega$ resistor in the circuit shown.



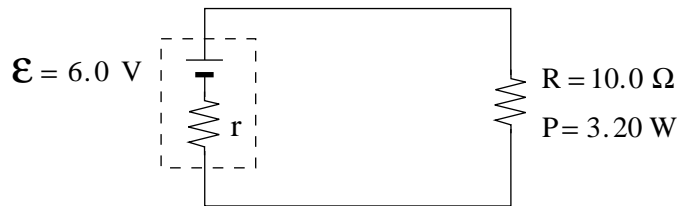
- A. 1.1 A
- B. 2.0 A
- C. 4.0 A
- D. 6.7 A

23. In the following circuit, determine the value of resistor R.



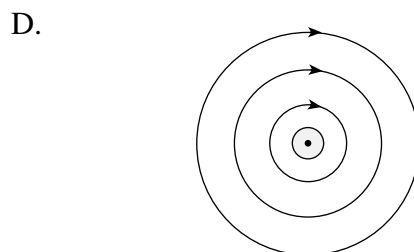
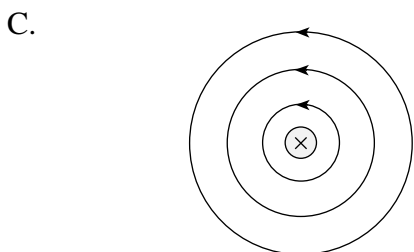
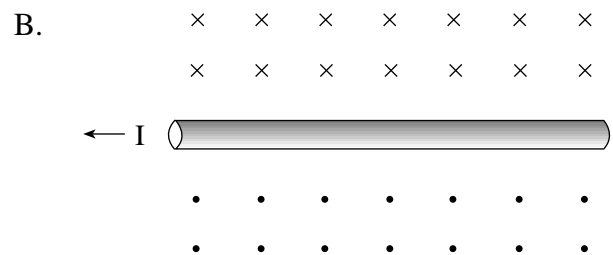
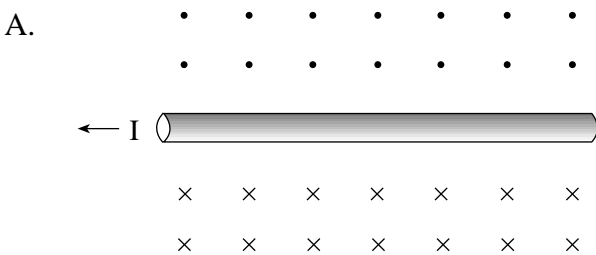
- A. 3.2Ω
- B. 5.2Ω
- C. 9.0Ω
- D. 23Ω

24. A battery provides 3.20 W of power to an external resistance. What power is dissipated as heat by the internal resistance within the battery?

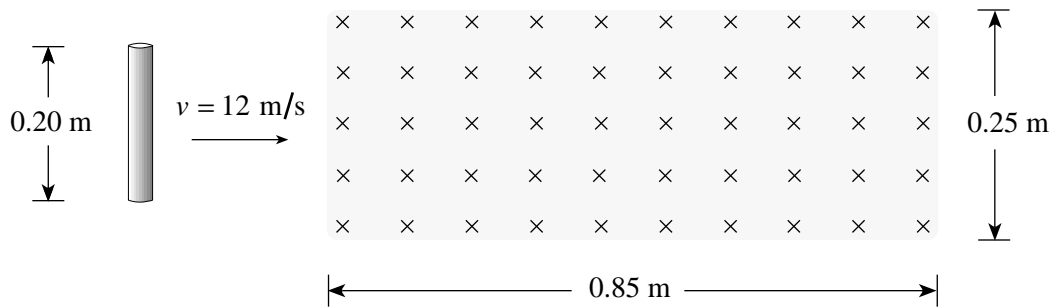


- A. 0.19 W
- B. 3.4 W
- C. 3.6 W
- D. 60 W

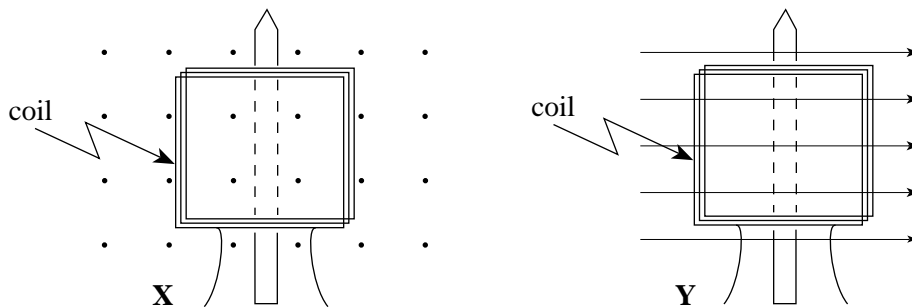
25. Which of the following shows the magnetic field produced by a current carrying conductor?



26. A 0.20 m conductor moves at 12 m/s through the 0.60 T field shown below. Calculate the emf induced in the conductor while passing through the field.



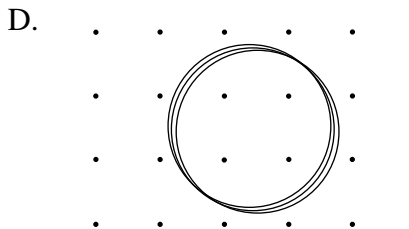
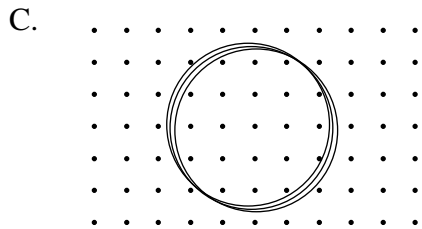
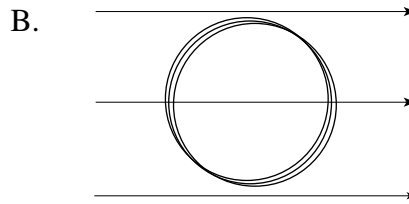
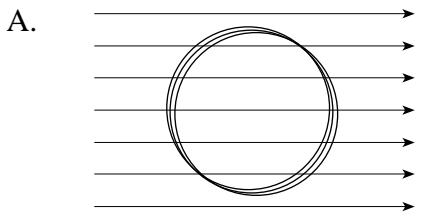
- A. 0 V
 B. 0.13 V
 C. 1.4 V
 D. 1.8 V
27. A coil has 680 turns of wire, a current of 5.6 A, and an area of $2.1 \times 10^{-2} \text{ m}^2$. This coil is placed in a 0.22 T magnetic field in either field-coil orientation X or Y.



Which field-coil orientation would produce a maximum torque, and what is the magnitude of this torque?

	ORIENTATION	TORQUE
A.	X	69 N · m
B.	X	18 N · m
C.	Y	69 N · m
D.	Y	18 N · m

28. Which of the following shows a coil having the largest flux?



29. When the coil of a motor is rotating at maximum speed, the current in the windings is 3.3 A. When the motor is first connected to 120 V, the current in the windings is 12 A. What is the back emf in the coil at maximum speed?

- A. 33 V
- B. 87 V
- C. 110 V
- D. 120 V

30. An ideal transformer has 3 000 turns on its primary winding and 150 turns on its secondary winding. The primary is connected to 120 V ac. If 0.20 A is drawn from the secondary, what is the primary current and the secondary voltage?

	PRIMARY CURRENT	SECONDARY VOLTAGE
A.	4.0 A	2 400 V
B.	4.0 A	6.0 V
C.	0.010 A	2 400 V
D.	0.010 A	6.0 V

**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

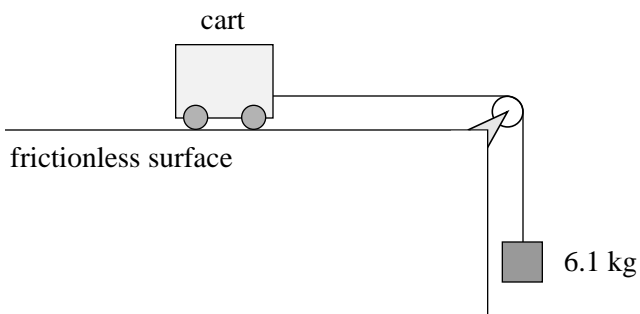
Suggested Time: 48 minutes

INSTRUCTIONS:

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. In the diagram shown, the tension in the cord connecting the hanging mass and cart is 43 N.



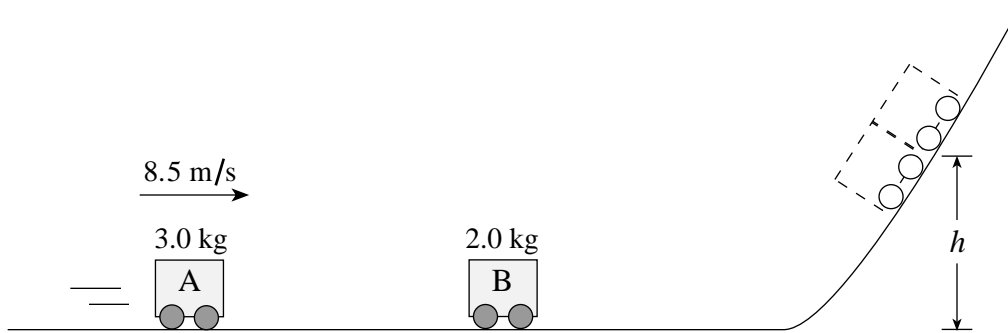
a) Draw and label a free body diagram for the cart and the hanging mass. **(2 marks)**



b) Determine the mass of the cart. **(5 marks)**

<p>ANSWER:</p> <p>b) mass: _____</p>	<p>Score for Question 1:</p> <p>1. _____ (7)</p>
--------------------------------------	--

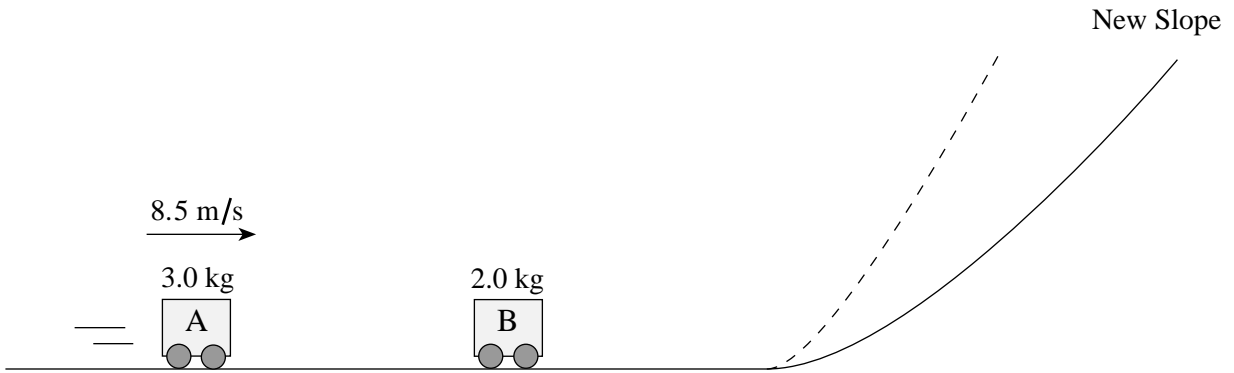
2. A 3.0 kg car A travelling 8.5 m/s on a frictionless track collides and sticks on to a stationary 2.0 kg car B.



- a) The combined cars will reach what height h ?

(5 marks)

b) The steepness of the slope is decreased as shown below.



With this decreased slope, the combined cars will reach (check one response)

(1 mark)

- a lesser height.
- the same height.
- a greater height.

c) Using principles of physics, explain your answer to b).

(3 marks)

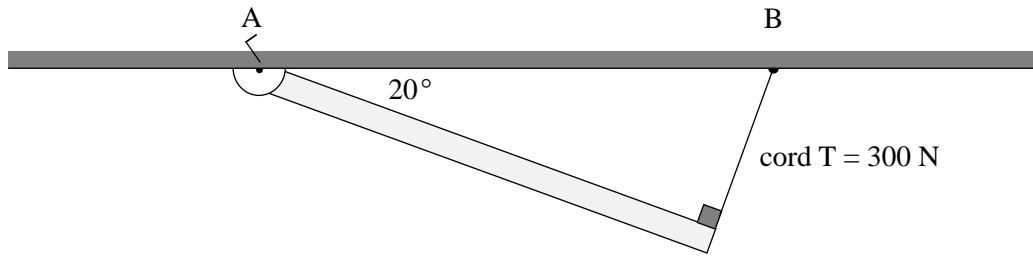
ANSWER:

a) height: _____

Score for
Question 2:

2. _____
(9)

3. A 3.8 m uniform beam is attached to the ceiling with a hinge at A and a cord with a tension of 300 N at B.

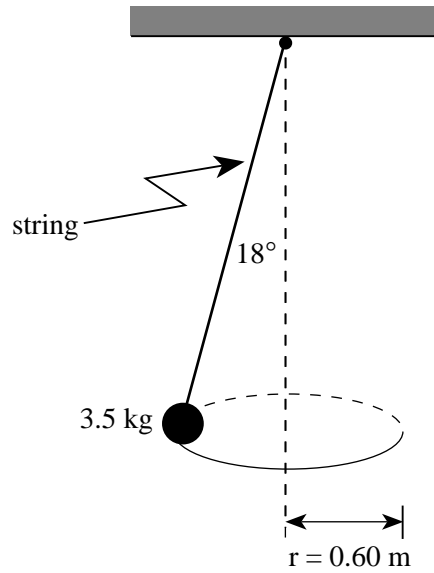


Determine the mass of the beam.

(7 marks)

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

4. A 3.5 kg object is suspended by a string and moves in a horizontal circle of radius 0.60 m. The tension in the string is 36 N.

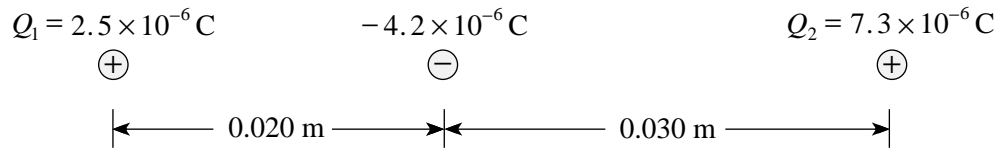


- a) What is the magnitude of the net force on the object? (3 marks)

- b) What is the period of revolution of the object? (4 marks)

ANSWER:	Score for Question 4:
a) force: _____	4. _____
b) period: _____	(7)

5. A -4.2×10^{-6} C charge is placed between two stationary charges, Q_1 and Q_2 , as shown below.



What is the magnitude and direction of the net force on the -4.2×10^{-6} C charge due to the **two** stationary charges? **(7 marks)**

ANSWER: magnitude: _____ direction: _____	Score for Question 5: 5. _____ (7)
---	---

6. Electrons accelerated from rest through a potential difference of 300 V enter a 4.1×10^{-2} T magnetic field at right angles. What is the radius of curvature of the path taken by the electrons?
(7 marks)

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

7. An ideal transformer is connected to a 12 V ac power supply. The light bulb connected to the secondary of the transformer is lit (Figure A). The transformer is then connected to a 12 V dc battery (Figure B).

Figure A

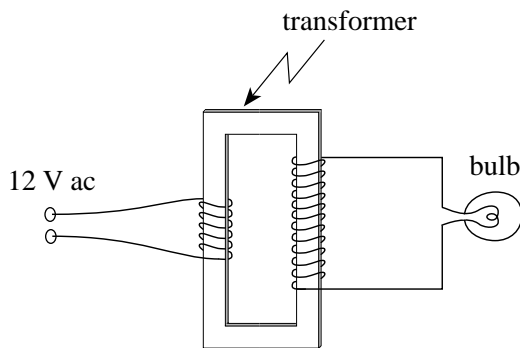
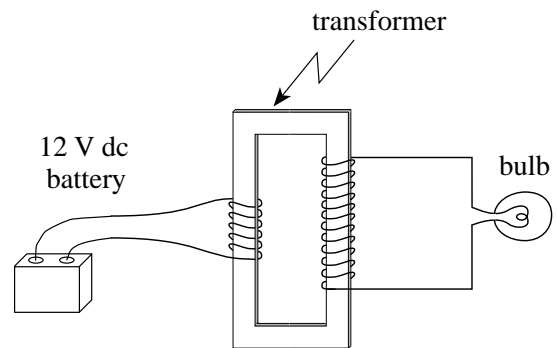


Figure B



- a) The bulb will (check one response)

(1 mark)

- not be lit.
- be dimmer.
- have the same brightness.
- be brighter.

- b) Using principles of physics, explain your answer to a).

(3 marks)

<p>Score for Question 7:</p> <p>7. _____ (4)</p>
--

This is the end of the written-response section.

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. 22 to 24)

or

SECTION II: Fluid Theory (p. 26 to 28)

or

SECTION III: AC Circuitry and Electronics (p. 30 to 32)

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 _____.

OVER

SECTION I: Quantum Mechanics

1. What is the wavelength of a 2.1 eV photon?

(3 marks)

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

SECTION I: Continued

2. What is the de Broglie wavelength of an electron with a kinetic energy of 75 eV? **(4 marks)**

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

OVER

SECTION I: Continued

3. The longest wavelength of light that will emit photoelectrons from a metal surface is 2.4×10^{-7} m. What is the maximum kinetic energy of the electrons emitted by light of wavelength 1.1×10^{-7} m?
(5 marks)

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

END OF SECTION I: Quantum Mechanics

THIS PAGE INTENTIONALLY BLANK

SECTION II: Fluid Theory

1. A piece of styrofoam can withstand a maximum pressure of 2.5×10^3 Pa without being crushed. A 120 kg block is to be placed on the styrofoam. What is the minimum area of the bottom of the block that would prevent crushing the styrofoam? **(3 marks)**

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

SECTION II: Continued

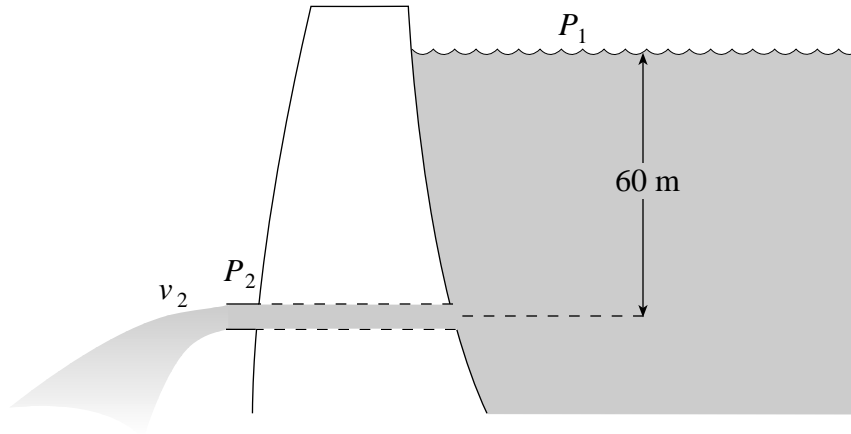
2. A weather balloon has a total weight of 18 N when it is inflated to a volume of 6.0 m^3 . What maximum equipment load (in Newtons) can it lift? **(4 marks)**

ANSWER:	Score for Question 2:
maximum equipment load: _____	12. <u> </u> (4)

OVER

SECTION II: Continued

3. The outlet of a fresh water dam is 60 m below the surface as shown. The atmospheric pressure at the outlet P_2 is 760 Pa **greater** than at the surface P_1 .



What is the speed of the water v_2 at the outlet?

(5 marks)

ANSWER:

speed: _____

Score for
Question 3:

13. _____
(5)

END OF SECTION II: Fluid Theory

THIS PAGE INTENTIONALLY BLANK

SECTION III: AC Circuitry and Electronics

1. A 12 V battery is connected to a capacitor. If 4.2×10^{-4} C of charge flows from the battery to fully charge this capacitor, what is the value of the capacitor? **(3 marks)**

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

SECTION III: Continued

2. A transistor circuit has a current gain of 430. When the base current is $6.00 \mu\text{A}$ the collector current is 1.15 mA . What is the collector current when the base current is $7.50 \mu\text{A}$? **(4 marks)**

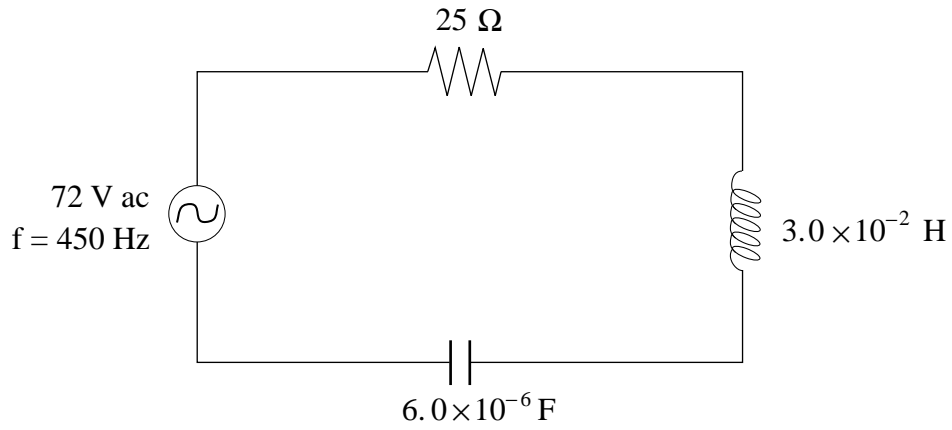
ANSWER:	Score for Question 2:
collector current: _____	15. _____ (4)

OVER

SECTION III: Continued

3. What is the current in the circuit shown below?

(5 marks)



ANSWER:

current: _____

Score for
Question 3:

16. _____
(5)

END OF SECTION III: AC Circuitry and Electronics

END OF EXAMINATION

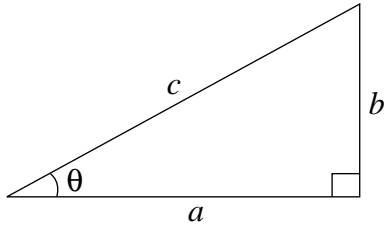
DATA TABLE

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	$h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$ $h = 4.14 \times 10^{-15} \text{ eV} \cdot \text{s}$
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.**

TRIGONOMETRIC AND OTHER EQUATIONS

For Right-angled Triangles:

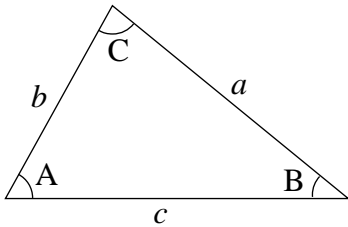


$$a^2 + b^2 = c^2$$

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

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

For All Triangles:



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

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

$$\text{Sine Law: } \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

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

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:

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

EQUATIONS

Note: Vector quantities have not been indicated.

1. Kinematics: (for constant acceleration)

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

$$d = v_0t + \frac{1}{2}at^2$$

2. Dynamics:

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

3. Mechanical Energy and Momentum:

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

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

4. Equilibrium:

$$\tau = Fd$$

5. Circular Motion and Gravitation:

$$a_c = \frac{v^2}{r} = \frac{4\pi^2r}{T^2} \qquad F = G\frac{m_1m_2}{r^2}$$

$$E_p = -G\frac{m_1m_2}{r} \qquad r^3 \propto T^2$$

6. Electrostatics:

$$F = k\frac{Q_1Q_2}{r^2} \qquad E = \frac{V}{d} \qquad V = \frac{kQ}{r}$$

$$E_p = k\frac{Q_1Q_2}{r} \qquad F = QE \qquad V = \frac{\Delta E_p}{Q}$$

7. Circuitry:

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

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

EQUATIONS (continued)

8. Electromagnetism:

$$\begin{array}{lll}
 F = IlB & B = \frac{\mu_0 I}{2\pi d} & \tau = NIAB \\
 F = QvB & B = \mu_0 nI \left(\text{where } n = \frac{N}{l} \right) & \Phi = BA \\
 \mathcal{E} = -N \frac{\Delta\Phi}{\Delta t} & \mathcal{E} = Blv & \frac{V_s}{V_p} = \frac{N_s}{N_p}
 \end{array}$$

9. Quantum Mechanics: (Section I)

$$\begin{array}{lll}
 E = hf & c = f\lambda & E_n = (-13.6eV) \frac{Z^2}{n^2} \\
 E_{k_{\max}} = hf - W_0 & \lambda = \frac{h}{p} &
 \end{array}$$

10. Fluid Theory: (Section II)

$$\begin{array}{lll}
 \rho = \frac{m}{V} & PV = NkT & PV = \frac{1}{3} Nmv^2 \\
 F = \rho Vg & P = \frac{F}{A} & P = P_G + P_a \\
 PV = nRT & P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant} & E_k = \frac{3}{2}kT \\
 & Av = \text{constant} &
 \end{array}$$

11. AC Circuits and Electronics: (Section III)

$$\begin{array}{lll}
 Q = CV & E_p = \frac{1}{2} CV^2 & \tau = RC \\
 X_C = \frac{1}{2\pi fC} & Z = \sqrt{R^2 + (X_L - X_C)^2} & X_L = 2\pi fL \\
 f_0 = \frac{1}{2\pi\sqrt{LC}} & \beta \text{ (current gain)} = \frac{\Delta I_C}{\Delta I_B} & A_f = \frac{A}{1 - \beta A} \\
 & & \text{(where } \beta = \text{ feedback ratio)}
 \end{array}$$

ROUGH WORK FOR MULTIPLE-CHOICE

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

ROUGH WORK FOR MULTIPLE-CHOICE