INSERT STUDENT I.D. NUMBER (PEN)

STICKER IN THIS SPACE

JUNE 1994

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. 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 .
5. 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 1994 PROVINCIAL
(PHP)

1. _____ (7)	5. _____ (7)
2. _____ (5)	6. _____ (7)
3. _____ (4)	7. _____ (7)
4. _____ (7)	8. _____ (4)

Score **ONLY ONE** of the following optional sections.

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

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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:	Three sections from which **ONE** section **only** must be chosen.	12	12
	Total	**120 marks**	**120 minutes**

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

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

4. An approved scientific calculator is essential for the examination. The calculator **must not** be programmable to process alpha-numeric strings nor should it be capable of processing user-defined functions. It **must not** have the capacity to accept coefficients from either an equation or a system of equations, thereby producing the roots of that equation or system. The calculator **must not** contain a plotter or printer.

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

6. a) Numerical answers to problems must contain correct units.
   b) Numerical answers must be calculated 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. Since partial marks will be awarded for a partial solution, it is important that students provide a clear indication of the steps leading to their answers.

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

8. Students have **two hours** to complete this examination.

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PART A: MULTIPLE-CHOICE QUESTIONS

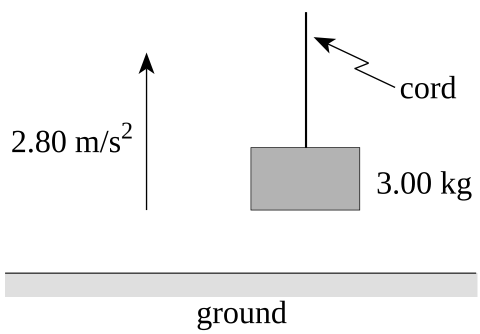
Value: 60 marks (2 marks per question) **Suggested Time: 60 minutes**

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 one of the following **best** describes the motion of a projectile close to the surface of the Earth? (assume no friction)

	VERTICAL ACCELERATION	HORIZONTAL SPEED
A.	constant	constant
B.	constant	changing
C.	changing	constant
D.	changing	changing

2. A 3.00 kg object is being accelerated vertically upwards at 2.80 m/s^2, as shown.

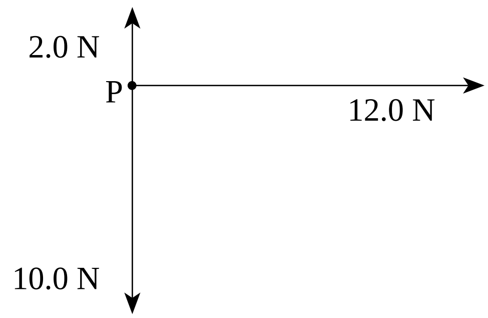


What is the tension in the cord?

A. 8.40 N
B. 21.0 N
C. 29.4 N
D. 37.8 N

OVER

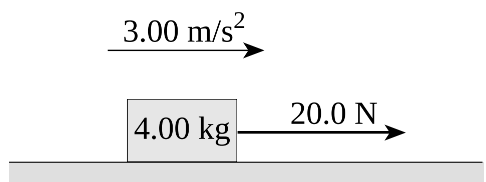
3. Three forces act at point P at the same time, as shown on the force vector diagram below.



What is the magnitude of the resultant force vector?

A. 14.4 N
B. 17.0 N
C. 20.0 N
D. 24.0 N

4. A 4.00 kg block is accelerated along a level surface at 3.00 m/s^2. The applied force is 20.0 N.



What is the coefficient of friction between the block and the surface?

A. 0.20
B. 0.31
C. 0.51
D. 0.67

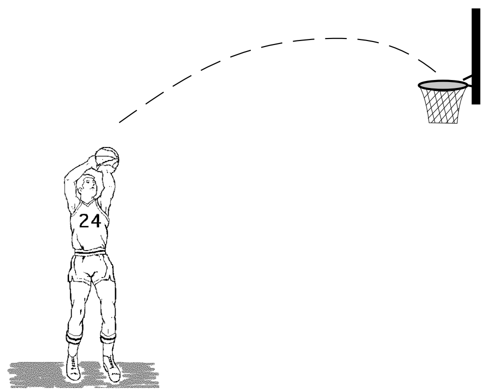
5. A ball is rolled off a horizontal roof at 16 m/s. After leaving the roof, how long will the ball take to reach a speed of 18 m/s?

A. 0.20 s
B. 0.84 s
C. 1.8 s
D. 2.5 s

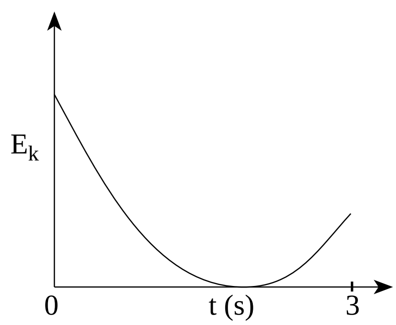
6. A puck sliding on a frictionless table undergoes a change in momentum due to a constant force. Which of the following expressions could be used to determine the change in momentum?

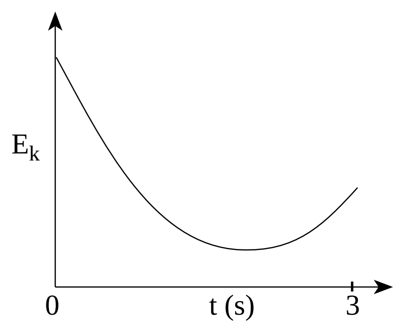
A. $F \times \Delta d$
B. $F \times \Delta t$
C. $F \times \Delta v$
D. $F \times (\Delta v / \Delta t)$

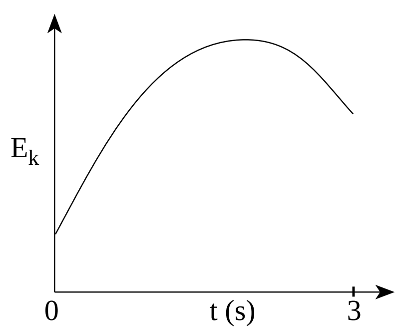
7. A basketball is thrown into the basket, as shown in the diagram below. The ball leaves the player's hand at t= 0 s and reaches the basket at t = 3 s.

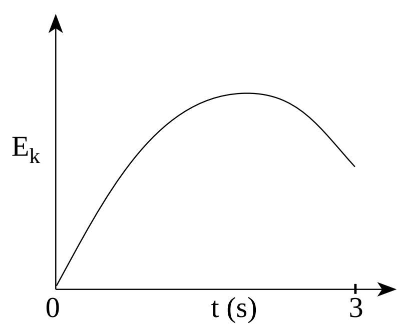


Which of the following graphs **best** represents the ball's kinetic energy E_k as a function of time?

A.


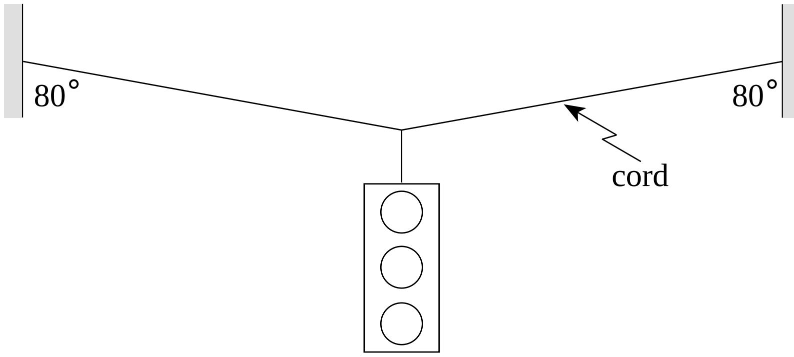
B.


C.


D.


OVER

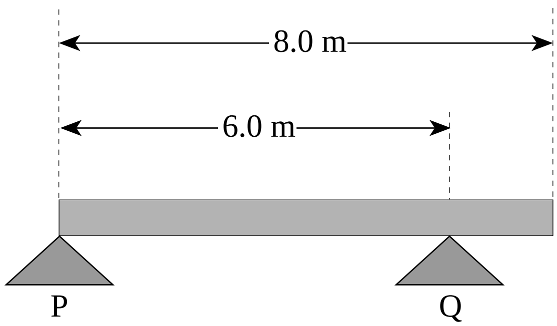
8. A 75 kg traffic light is held stationary midway between two supports, as shown in the diagram below.



What is the tension in the cord?

A. 3.7×10^2 N
B. 7.4×10^2 N
C. 2.1×10^3 N
D. 4.2×10^3 N

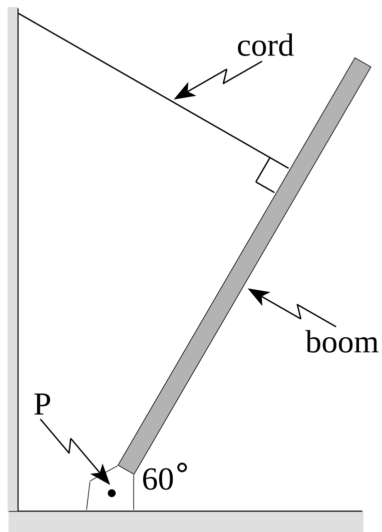
9. A uniform beam of mass 25 kg rests on supports P and Q, as shown in the diagram below.



What force is exerted by support Q on the beam?

A. 1.2×10^2 N
B. 1.6×10^2 N
C. 3.3×10^2 N
D. 4.9×10^2 N

10. A boom hinged at P is held stationary, as shown in the diagram below.



If the tension in the supporting cord, attached three-quarters of the way along the boom from P, is 720 N, what is the weight of the boom?

A. 720 N
B. 1 080 N
C. 1 440 N
D. 2 160 N

11. A child is riding on a merry-go-round which is rotating at a constant rate. Which of the following describes the child's speed, velocity, and magnitude of acceleration?

	SPEED	VELOCITY	MAGNITUDE OF ACCELERATION
A.	constant	constant	constant
B.	constant	changing	constant
C.	changing	constant	changing
D.	changing	changing	changing

12. A satellite is travelling around the Earth in an orbit of radius 4.47×10^7 m. What is the mass of the satellite if it experiences a gravitational force of 3.00×10^3 N?

A. 4.37×10^1 kg
B. 3.06×10^2 kg
C. 2.14×10^3 kg
D. 1.50×10^4 kg

OVER

13. A circular space station of radius 120 m is to be rotated so that its astronauts experience an effect similar to that of a gravitational field. If the field is to be 5.0 m/s^2 at this radius, what should be the period of rotation of the space station?

A. 3.2×10^{-1} s

B. 3.1×10^{1} s

C. 5.1×10^{3} s

D. 8.6×10^{4} s

14. On Earth, the maximum speed without skidding for a car on a level circular curved track of radius 40 m is 15 m/s. This car and track are then transported to another planet for the Indy Galactic 500. The maximum speed without skidding is now 8.4 m/s. What is the value of the acceleration due to gravity on this other planet?

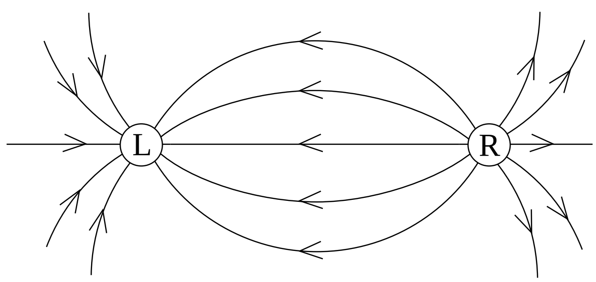
A. 1.8 m/s^2

B. 3.1 m/s^2

C. 4.3 m/s^2

D. 5.5 m/s^2

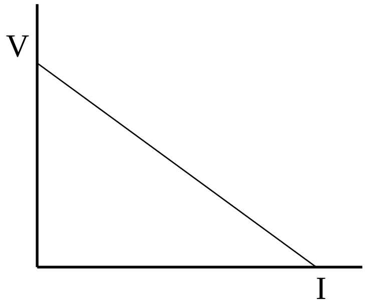
15. The diagram below shows the electric field near two point charges L and R.

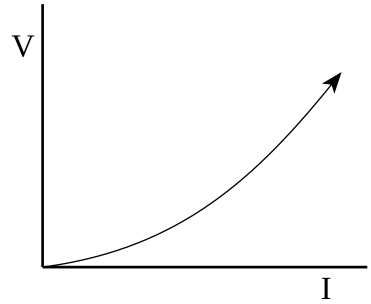


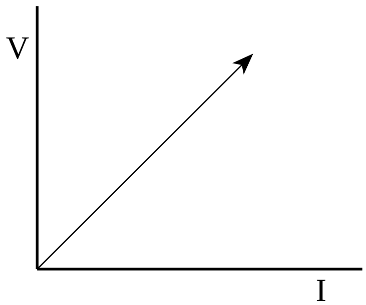
What is the polarity of each charge?

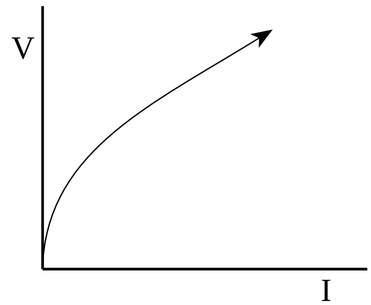
	CHARGE L	CHARGE R
A.	positive	positive
B.	positive	negative
C.	negative	positive
D.	negative	negative

16. The graphs below show potential difference V versus current I for different conductors. Which graph refers to a conductor which obeys Ohm's Law?

A.


B.


C.


D.


17. The electric field 2.0 m from a point charge has a magnitude of 8.0×10^4 N/C. What is the strength of the electric field at a distance of 4.0 m?

A. 2.0×10^4 N/C
B. 4.0×10^4 N/C
C. 1.6×10^5 N/C
D. 3.2×10^5 N/C

18. When a charge is accelerated through a potential difference of 500 V, its kinetic energy increases from 2.0×10^{-5} J to 6.0×10^{-5} J. What is the magnitude of the charge?

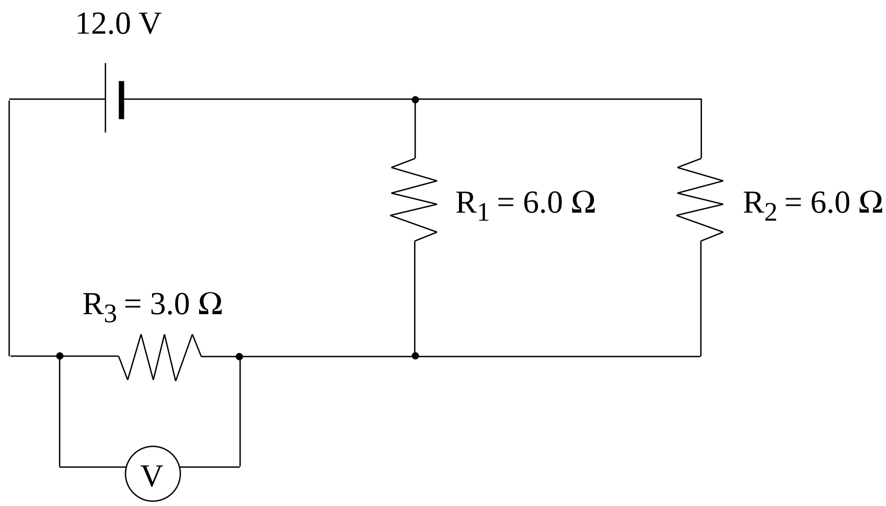
A. 4.0×10^{-8} C
B. 8.0×10^{-8} C
C. 1.2×10^{-7} C
D. 1.6×10^{-7} C

OVER

19. A battery whose emf is 6.0 V is connected to a 2.0 Ω resistor. The voltage drop across the 2.0 Ω resistor is 5.0 V. What is its internal resistance?

A. 0.40 Ω
B. 1.7 Ω
C. 2.4 Ω
D. 2.5 Ω

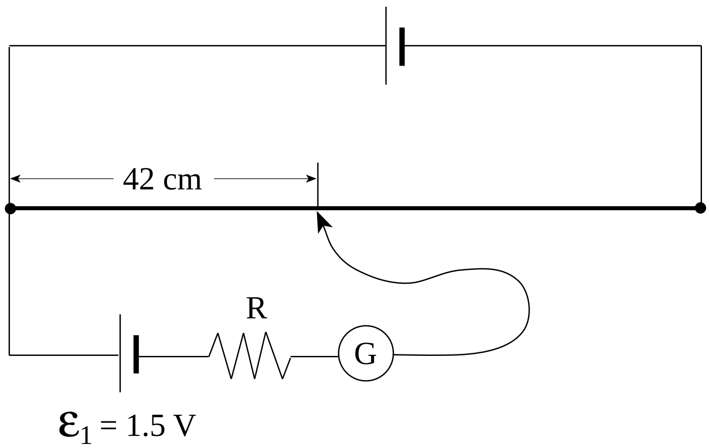
20. A voltmeter is connected across a 3.0 Ω resistor in the circuit shown below.



What is the reading on the voltmeter?

A. 4.0 V
B. 6.0 V
C. 8.0 V
D. 12.0 V

21. The diagram below shows a balanced potentiometer.

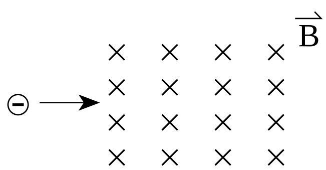


When cell ε_1 is replaced by a new cell, balance is achieved at a distance of 76 cm from the left-hand end. What is the emf of the new cell?

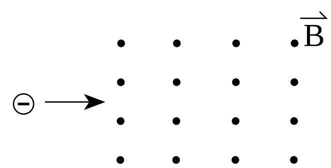
A. 0.83 V
B. 1.5 V
C. 2.1 V
D. 2.7 V

22. In which diagram below would the electron experience **no** magnetic force upon entering the field?

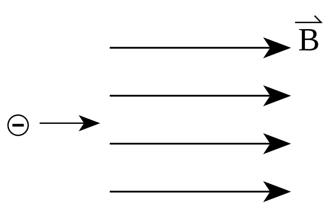
A.



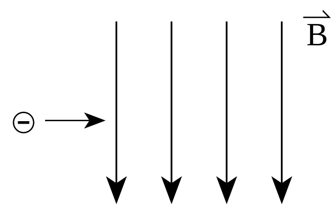
B.



C.



D.

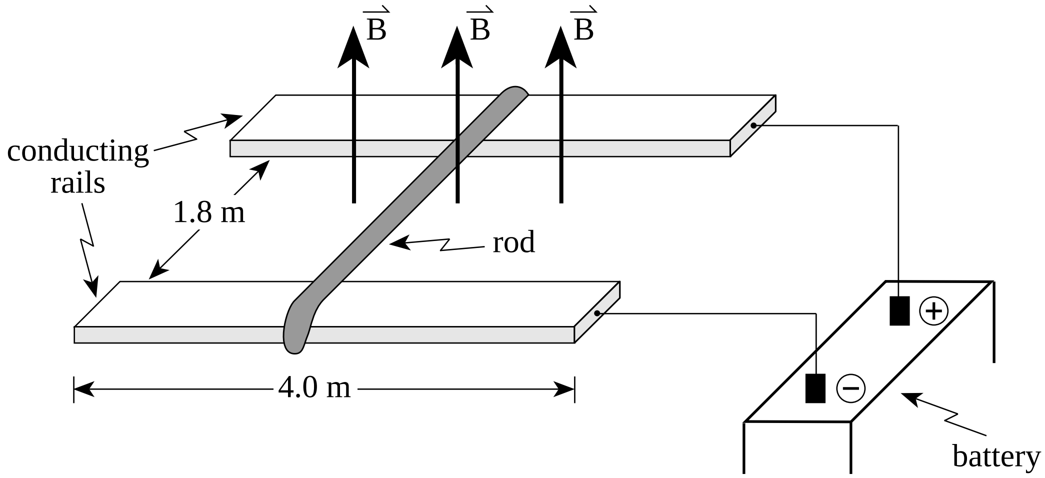


23. Which one of the following **best** describes a step-up transformer? [primary circuit: p; secondarycircuit: s]

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

OVER

24. A metal rod is resting on top of two 4.0 m long conducting rails that are separated by 1.8 m. The force of friction between the rod and the rails is 1.2 N. A magnetic field of 5.2×10^{-2} T is directed upwards, as shown in the diagram below.



How much current must be sent through the rod before the rod begins to move **and** in what direction will the rod move?

	CURRENT	DIRECTION ROD WILL MOVE
A.	5.8 A	Towards the battery
B.	5.8 A	Away from the battery
C.	13 A	Towards the battery
D.	13 A	Away from the battery

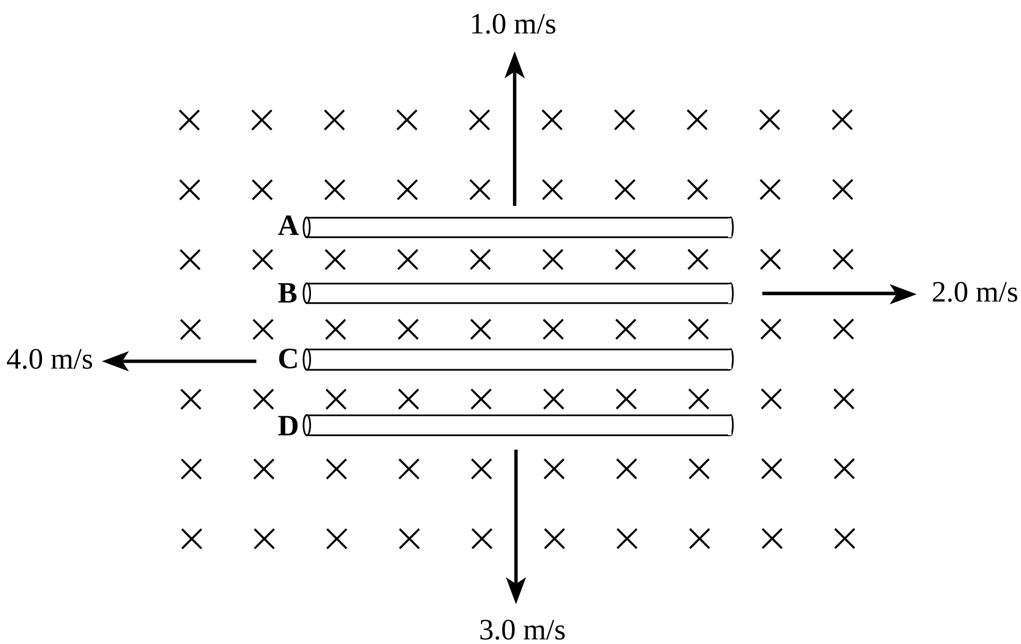
25. Four identical pieces of wire are bent to form four different coils, each containing a different number of loops. Each coil carries 5.0 A of current and is placed in the same magnetic field of 0.2 T. Which of the four coils would experience the greatest maximum torque?

	NUMBER OF LOOPS	AREA OF COIL (m^2)
A.	1	0.18
B.	2	0.045
C.	3	0.020
D.	4	0.011

26. A 0.10 m long solenoid, 3.0×10^{-2} m in diameter, has a total of 550 turns of wire. To produce a 1.2×10^{-2} T magnetic field at the centre of the solenoid, how much current must flow through thewire?

A. 0.26 A
B. 1.7 A
C. 9.5×10^{2} A
D. 1.4×10^{3} A

27. Four conductors of equal length are each moved through a uniform magnetic field in different directions and with different speeds, as shown.



While the four conductors are being moved through the field, in which conductor will the largest potential difference be induced?

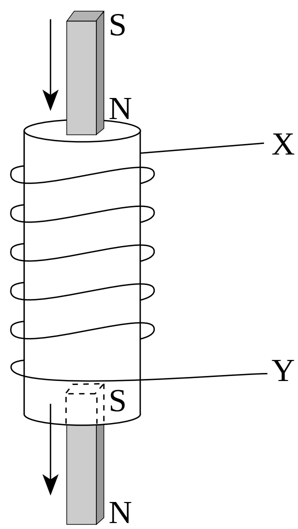
A. Conductor A
B. Conductor B
C. Conductor C
D. Conductor D

OVER

28. A 75-turn square coil of wire, 0.12 m on a side, is in a 4.5×10^{-2} T magnetic field. The field is perpendicular to the coil. If the coil of wire is removed from the field in 0.10 s, what average emf is induced in the coil?

A. 6.5×10^{-3} V
B. 1.2×10^{-1} V
C. 2.4×10^{-1} V
D. 4.9×10^{-1} V

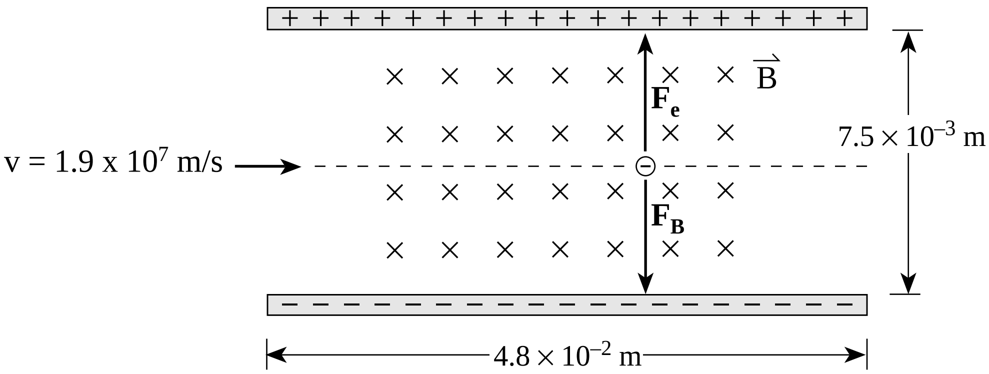
29. A bar magnet is dropped through a solenoid, as shown.



What is the direction of the induced current in the solenoid as the magnet enters the top (i) and as the magnet leaves the bottom (ii)?

	(i) ENTERS TOP	(ii) LEAVES BOTTOM
A.	From X to Y	From X to Y
B.	From X to Y	From Y to X
C.	From Y to X	From Y to X
D.	From Y to X	From X to Y

30. In the situation below, an electron is moving at 1.9×10^7 m/s through crossed electric and magnetic fields. When the electric force is equal to the magnetic force, as shown, the electron will travel in a straight line.



If the magnetic field strength is 5.2×10^{-3} T, what must be the potential difference between the plates for the electron to continue in a straight line?

A. 1.9×10^{-7} V
B. 3.9×10^{-5} V
C. 7.4×10^{2} V
D. 4.7×10^{3} V

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

OVER

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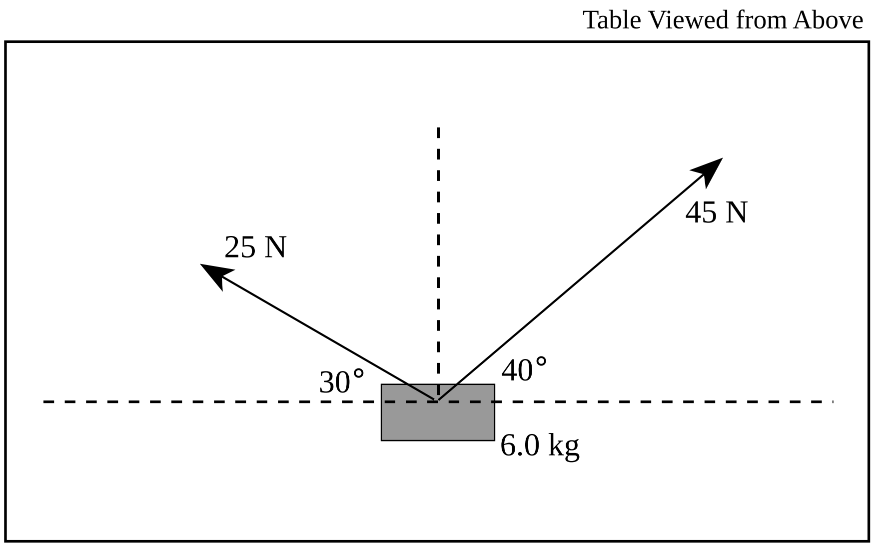
PART B: PROBLEMS

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

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

OVER

1. A 6.0 kg block is held at rest on a horizontal, frictionless air table. Two forces are pulling on this block in the directions shown in the diagram below.



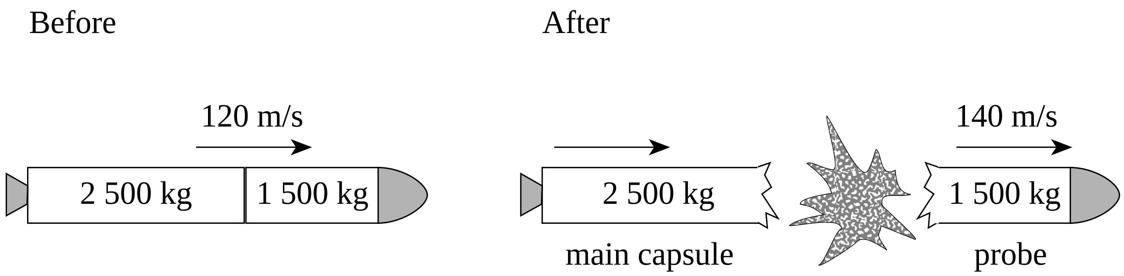
What will be the magnitude of the acceleration on the 6.0 kg block at the moment it is released?

(7marks)

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

OVER

2. A 4 000 kg space vehicle consists of a 2 500 kg main capsule and a 1 500 kg probe. The space vehicle is travelling at 120 m/s when an explosion occurs between the capsule and the probe. As a result, the probe moves forward at 140 m/s, as shown in the diagram below.



a) (i) What is the speed of the main capsule after the explosion? **(3 marks)**

(ii) What is the magnitude of the impulse given to the probe? **(2 marks)**

ANSWERS:	Score for Question 2a:
speed: ______________________	
impulse: ______________________	2. ____ (5)

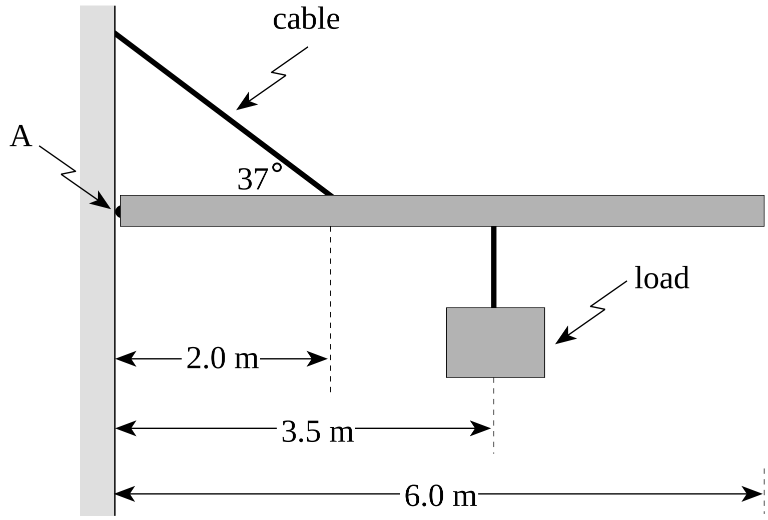
b) Define *impulse* and briefly explain why the impulse on the probe is equal in magnitude to the impulse on the main capsule. **(4 marks)**

Score for Question 2b:

3. ______
(4)

OVER

3. A uniform beam 6.0 m long, and with a mass of 75 kg, is hinged at A. The supporting cable keeps the beam horizontal.



If the maximum tension the cable can withstand is 2.4×10^3 N, what is the maximum mass of the load? **(7 marks)**

ANSWER:	Score for Question 3:
maximum mass: ______________________	4. _____ (7)

OVER

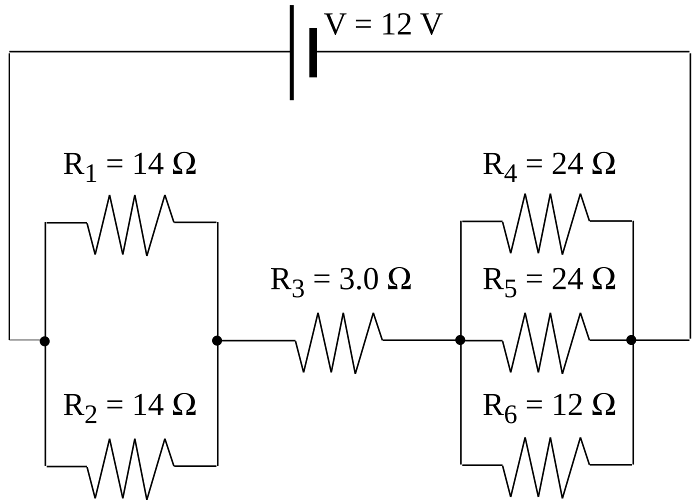
4. A 900 kg satellite which is travelling at 8 600 m/s around a planet of mass 8.1×10^{25} kg has an orbital radius of 7.3×10^{7} m. What is the total orbital energy of this satellite relative to infinity?

(7 marks)

ANSWER:	Score for Question 4:
total orbital energy: ____________________	5. _____ (7)

OVER

5. What is the power dissipated by the 3.0 Ω resistor in the circuit below? **(7 marks)**



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

OVER

6. A motor is connected to 117 V and draws a current of 32.5 A when it first starts up. At its normal operating speed, the motor draws a current of 4.20 A.

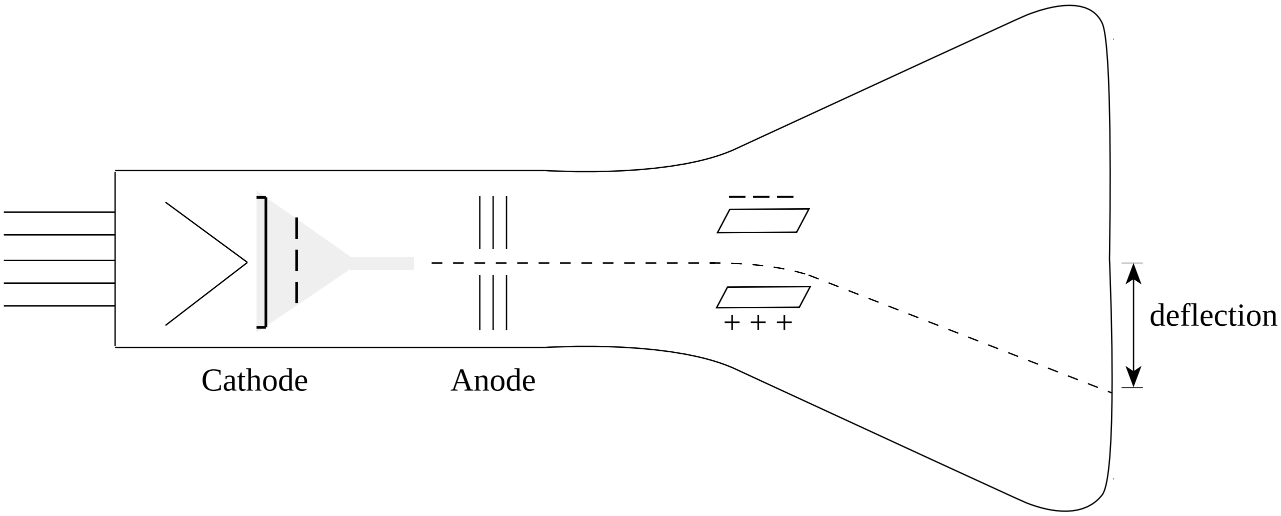
   a) What is the resistance of the armature coil? **(3 marks)**

b) What is the back emf developed at normal operating speed? **(4 marks)**

ANSWERS:	Score for Question 6:
resistance: ____________________ back emf: ____________________	7. _____ (7)

OVER

7. In a cathode-ray tube, electrons are accelerated from the cathode towards the anode by an accelerating voltage V_a. After passing through the anode, the electrons are deflected by the two oppositely-charged parallel plates.



If the accelerating voltage V_a is increased, will the deflection increase, decrease, or remain the same? Using principles of physics, explain your answer. **(4 marks)**

___

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___

Score for Question 7:
8. ______ (4)

PART C: ELECTED TOPICS

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

INSTRUCTIONS

1. Choose **ONLY ONE** section from the three sections in this part of the examination.

   SECTION I: Quantum Physics (p. 30 to 32)

   OR

   SECTION II: Fluid Theory (p. 33 to 35)

   OR

   SECTION III: AC Circuitry and Electronics (p. 36 to 39)

2. If you answer questions in more than one section, only the answers in the first section chosen willbe 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 clearindication of the steps leading to your answer.

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

I have selected SECTION __________.

SECTION I: Quantum Physics

1. What is the de Broglie wavelength of a proton travelling at 5.0×10^7 m/s? **(3 marks)**

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

2. a) What is the energy of a photon of light with a frequency of 5.0×10^{16} Hz? **(2 marks)**

b) Through what potential difference must electrons be accelerated to have the same amount of energy as that of the above photon? **(2 marks)**

ANSWERS:	Score for Question 2:
energy: ______________________	
potential difference: ______________	10. _____ (4)

OVER

3. What is the wavelength of photons emitted when electrons in the n = 5 energy level drop to the n = 2 energy level in hydrogen atoms? **(5 marks)**

ANSWER:	Score for Question 3:
wavelength: __________________________	11. _____ (5)

END OF SECTION I: Quantum Physics

SECTION II: Fluid Theory

1. A fire hose of area $4.0 \times 10^{-4}\ \text{m}^2$ is connected to a fire hydrant. Water enters the hydrant at a speed of 3.5 m/s through an underground pipe of area $5.6 \times 10^{-3}\ \text{m}^2$. What is the speed of the water in the fire hose? **(3 marks)**

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

OVER

2. Very fine dust particles are suspended in air at a temperature of $22°$ C. If the rms speed of the dust particles is 4.5×10^{-3} m/s, what is their average mass? **(4 marks)**

ANSWER:	Score for Question 2:
average mass: ______________________	13. _____ (4)

3. The Goodyear airship contains 5 400 m^3 of helium having a density of 0.179 kg/m^3. The solid parts of the airship have a weight of 5.10×10^4 N. How much extra weight can the airship carry in equilibrium if the density of air is 1.29 kg/m^3? **(5 marks)**

ANSWER:	Score for Question 3:
extra weight: ________________________	14. _____ (5)

END OF SECTION II: Fluid Theory

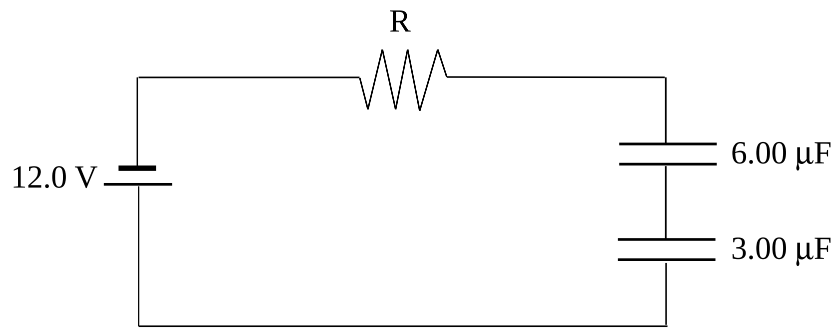
OVER

SECTION III: AC Circuitry and Electronics

1. A coil has an inductance of 0.420 H. Determine the inductive reactance of the coil if 120 V_{rms} at 50.0 Hz is applied to it. **(3 marks)**

ANSWER:	Score for Question 1:
inductive reactance: ____________________	15. _____ (3)

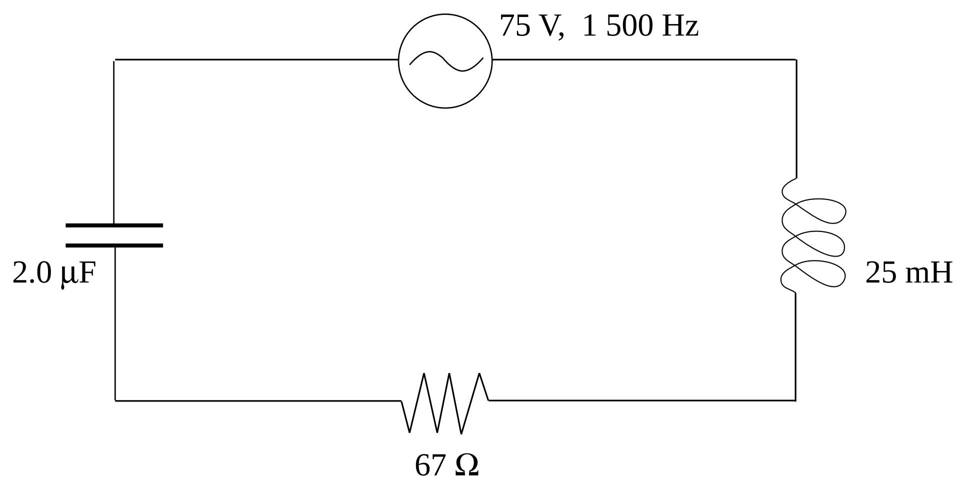
2. Calculate the maximum charge that can be stored in the 6.00 μF capacitor shown below. **(4 marks)**



ANSWER:	Score for Question 2:
maximum charge: ____________________	16. _____ (4)

OVER

3. What is the voltage drop across the inductor in the LCR circuit shown in the diagram below, when the applied voltage is 75 V_{rms} at a frequency of 1 500 Hz? **(5 marks)**



ANSWER:	Score for Question 3:
voltage drop: ____________________	17. _____ (5)

END OF SECTION III: AC Circuitry and Electronics

END OF EXAMINATION

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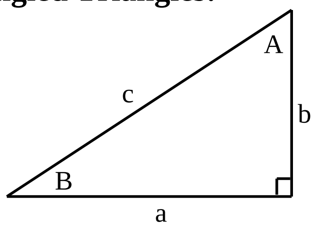
DATA TABLE

Pi	π	= 3.14
Gravitational constant	G	= 6.67×10^{-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		= 6.38×10^{6} m
radius of orbit about Sun		= 1.50×10^{11} m
period of rotation		= 8.61×10^{4} s
period of revolution about Sun		= 3.16×10^{7} s
mass		= 5.98×10^{24} kg
Moon		
radius		= 1.74×10^{6} m
radius of orbit about Earth		= 3.84×10^{8} m
period of rotation		= 2.36×10^{6} s
period of revolution about Earth		= 2.36×10^{6} s
mass		= 7.35×10^{22} kg
Sun		
mass		= 1.98×10^{30} kg
Constant in Coulomb's Law	k	= 9.00×10^{9} N•m^2/C^2
Elementary charge	e	= 1.60×10^{-19} C
Mass of electron	m_e	= 9.11×10^{-31} kg
Mass of proton	m_p	= 1.67×10^{-27} kg
Mass of neutron	m_n	= 1.68×10^{-27} kg
Permeability of free space	μ_o	= $4\pi \times 10^{-7}$ T• m/A
Planck's constant	h	= 6.63×10^{-34} J•s
	h	= 4.14×10^{-15} eV•s
Speed of light	c	= 3.00×10^{8} m/s
Rydberg's constant	R	= 1.097×10^{7} m^{-1}
Unified atomic mass unit	u	= 1.66×10^{-27} kg
Boltzmann's constant	k	= 1.38×10^{-23} J/K
Gas constant	R	= 8.31 J/mol•K
Density of water		= 1.00×10^{3} kg/m^3
Density of air		= 1.29 kg/m^3
Standard atmospheric pressure		= 1.01×10^{5} Pa
Volume of one mole of gas at STP		= 22.4 L (2.24×10^{-2} m^3)
Avogadro's number	N	= 6.02×10^{23} particles/mol
Absolute zero		= –273 ˚C

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

For Right-angled Triangles:

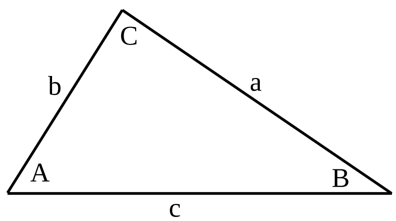


$$a^2 + b^2 = c^2$$

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

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

For All Triangles:



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

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

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

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

Circle:

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

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

Sphere:

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

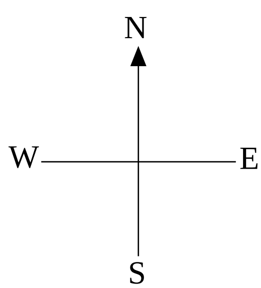
$$\text{Volume} = \frac{4}{3}\pi r^3$$

Prefixes:

giga $(G) = 10^9$
mega $(M) = 10^6$
kilo $(k) = 10^3$
centi $(c) = 10^{-2}$

milli $(m) = 10^{-3}$
micro $(\mu) = 10^{-6}$
nano $(n) = 10^{-9}$
pico $(p) = 10^{-12}$

Relative Compass Directions:



Quadratic Equation:

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

EQUATIONS

1. Vector Kinematics: (for constant acceleration)

$$\vec{v} = \vec{v}_0 + \vec{a}t \qquad \vec{v}_{av} = \frac{v + v_0}{2} \qquad v^2 = {v_0}^2 + 2ad$$

$$\vec{d} = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

2. Vector Dynamics:

$$F_f = \mu F_N \qquad \vec{F}_{net} = m\vec{a}$$

3. Mechanical Energy and Vector Momentum:

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

$$P = \frac{W}{\Delta t} \qquad \vec{p} = m\vec{v} \qquad \Delta\vec{p} = \vec{F}_{net}\Delta t$$

4. Equilibrium:

$$\tau = Fd$$

5. Circular Motion and Gravitation:

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

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

6. Electrostatics:

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

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

7. Circuitry:

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

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8. Electromagnetism:

$F = BIl$ $\quad B = \frac{\mu_0 I}{2\pi d}$ $\quad \tau = NIAB$

$F = QvB$ $\quad B = \mu_0 \frac{N}{l} I$ $\quad \Phi = BA$

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$ $\quad B = \mu_0 nI \left(\text{where } n = \frac{N}{l}\right)$ $\quad \frac{V_s}{V_p} = \frac{N_s}{N_p}$

$\varepsilon = Blv$

9. Quantum Mechanics: (Section I)

$E(\text{energy}) = hf$ $\quad c = f\lambda$ $\quad W_0 = hf_0$

$E_{k_{max}} = hf - W_0$ $\quad \lambda = \frac{h}{p}$ $\quad E_n = (-13.6eV)\frac{Z^2}{n^2}$

10. Fluid Theory: (Section II)

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

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

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

$Av = \text{constant}$

11. AC Circuits and Electronics: (Section III)

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

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

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

(where $\beta =$ feedback ratio)

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ROUGH WORK FOR MULTIPLE-CHOICE