higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE

(First paper)

NQF LEVEL 3

(10021003)

21 November 2024 (X-paper)
09:00–12:00

REQUIREMENTS: Graph paper must be supplied

Non-programmable calculators and drawing instruments may be used.

This question paper consists of 14 pages and an information sheet of 3 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
PHYSICAL SCIENCE
NQF LEVEL 3
(First paper)
TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Use only a black or blue pen.
5. Write neatly and legibly.

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SECTION A

QUESTION 1

Answer the following questions by writing only the word(s) next to the question number (1.1–1.5) in the ANSWER BOOK.

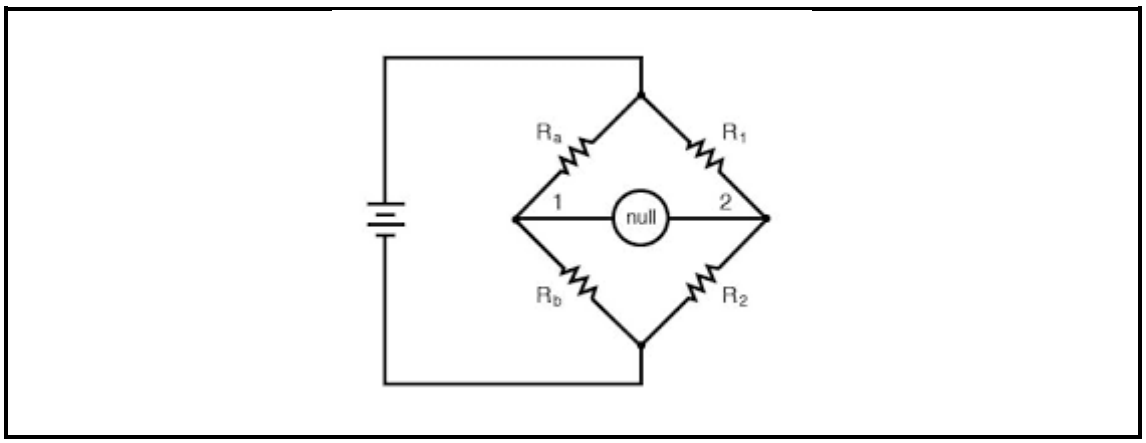
1.1 The fundamental unit representing newtons (N).

1.2 A property of matter that resists a sudden change in the motion/direction of a moving object.

1.3 The property of sound waves described by the frequency of vibration.

1.4 Name of a law that indicates the same amount of matter exists before and after the change, none is created or destroyed.

1.5 What is the name of the circuit represented by the diagram below?



(5 × 1) **[5]**

QUESTION 2

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–G) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	The correct SI unit used to measure volume in physics	A	acceleration
2.2	The quantity that is directly proportional to the net force	B	electrostatic force
2.3	The rate of the change in displacement of an object	C	echo
2.4	A repeated sound caused by the reflection of sound waves from a surface	D	dm^3
2.5	The cause of lightning striking the ground	E	m^3
		F	velocity
		G	distance

(5 × 1) **[5]**

QUESTION 3

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.1–3.5) in the ANSWER BOOK.

3.1 Volt per meter ($V.m^{-1}$) is the standard unit of electric field strength (E).

3.2 The mechanical advantage MA of a screw is defined as the ratio of axial output force F_{out} applied by the shaft on a load to the rotational force F_{in} applied to the rim of the shaft to turn it.

3.3 If two objects are dropped from different heights, their acceleration is the same.

3.4 The distance between a compression and a rarefaction of a longitudinal wave is called a wavelength.

3.5 A solenoid is a coil of wire designed to create a strong magnetic field inside the coil.

(5 × 2) **[10]**

QUESTION 4

Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (4.1–4.5) in the ANSWER BOOK.

4.1 A driver travels on a 100 km.h^{-1} road and passes a speed trap.

At which of the following speeds should the driver be travelling for him/her not to receive a fine for exceeding the speed limit?

A 33,3 m.s^{-1}
B 22,2 m.s^{-1}
C 60 m.s^{-1}
D 0 m.s^{-1}

4.2 The physical quantity represented by the equation $\frac{m\,(v^2-u^2)}{2s}$ is equivalent to …

A change in momentum.
B resultant force.
C momentum.
D energy.

4.3 Which ONE of the statements below is true about sound waves?

A Sound waves can propagate longitudinal or transverse waves depending on the transmitting medium.
B Sound waves can propagate longitudinal or transverse waves depending on the temperature.
C Sound waves are transverse waves, and they propagate perpendicular to the transmitting medium.
D Sound waves are longitudinal waves, and they propagate parallel to the transmitting medium.

4.4 Which ONE statement about electric field lines between parallel plates is true?

A Electric field lines between parallel plates are closer together near the poles.
B Electric field lines between parallel plates move from the negative plate to the positive plate.
C Electric field lines between parallel plates are uniform between the plates.
D Electric field lines between parallel plates move in a circular motion.

4.5 An electric transformer uses … to operate.

A Ohm's law
B Coulomb's law
C electromagnetic induction
D the principle of conservation of charge

(5 × 3) **[15]**

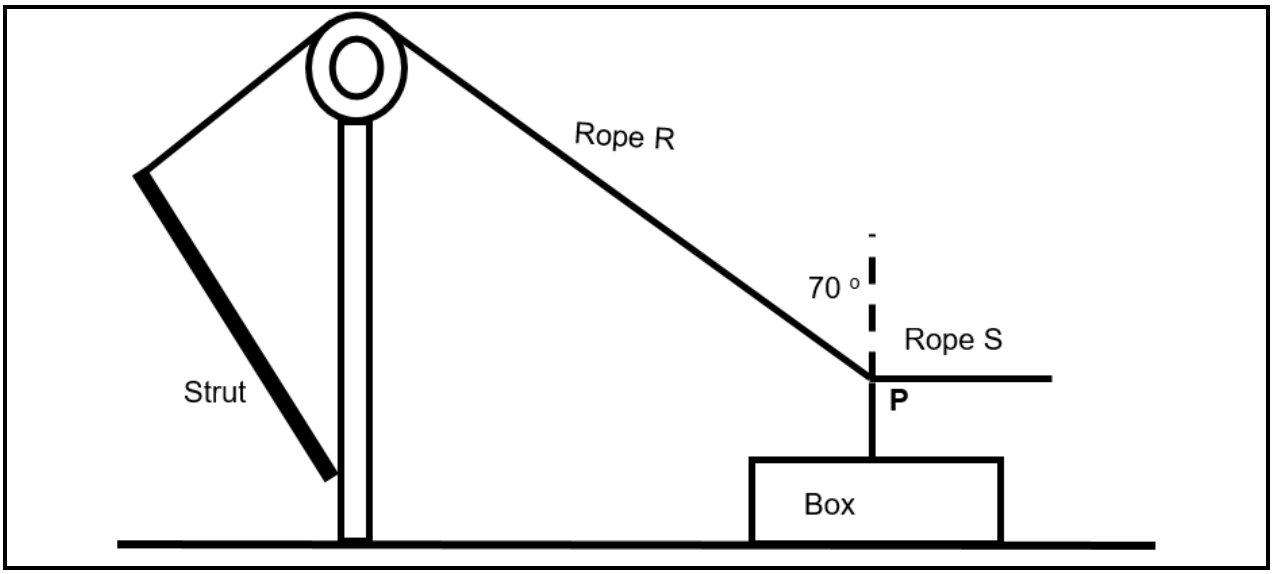
TOTAL SECTION A: 35

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SECTION B

QUESTION 5

A heavy box of mass m, is lifted by means of a rope R which passes over a pulley fixed to a pole. A second rope S, is tied to rope R at point P, exerting a horizontal force and pulling the box to the right. After lifting the box to a certain height, the box is held stationary as shown in the diagram below. Ignore the masses of the ropes. The tension in the rope R is 5 850 N.



5.1 Draw a free body diagram to show all forces acting at point P when point P is at equilibrium. (3)

5.2 By resolving the force exerted by rope R into components, calculate:

5.2.1 The magnitude of a force exerted by rope S (3)

5.2.2 Mass m of the box (4)

5.3 Will the tension in rope R INCREASE, DECREASE or STAY THE SAME if rope S is pulled further to the right (the length of rope R remaining the same)? (1)

5.4 Give the reason for the answer in QUESTION 5.1.3 above. (2)

[13]

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QUESTION 6

A subway train A is traveling at a constant speed of 80 km.h^{-1} when it approaches a slower train B which is 50 m ahead travelling in the same direction at a speed of 25 km.h^{-1}. If the faster train begins decelerating at 2,1 m.s^{-2} while the slower train continues at constant speed, train A will collide with train B.

6.1 What is the magnitude of the acceleration of train B before train A collides with it? (1)

6.2 Define the term *acceleration.* (2)

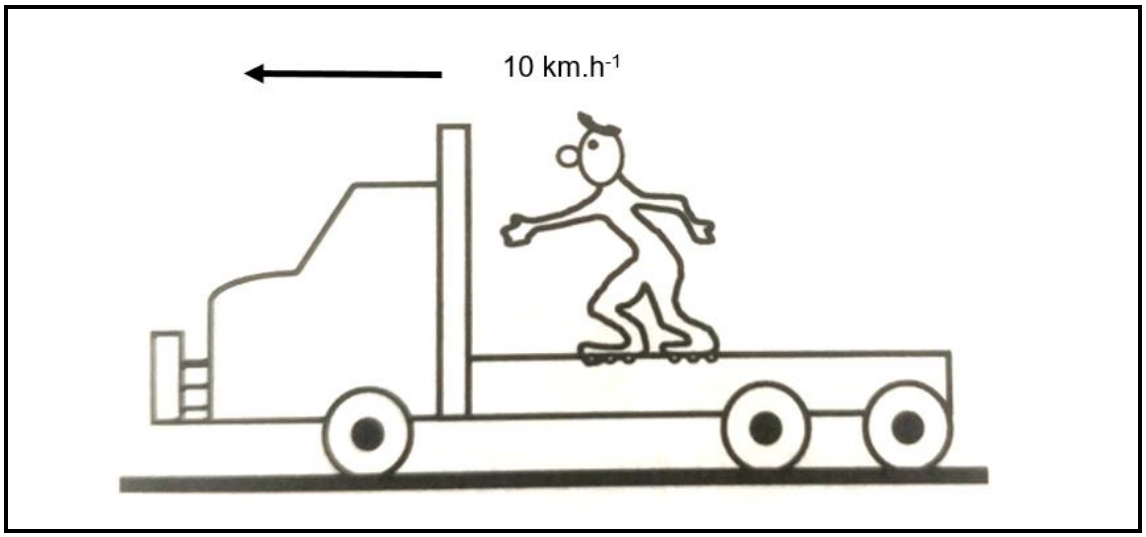
6.3 Calculate the time it will take train A to reach train B. (5)

6.4 Using calculations, verify if the two trains will collide. (4)

[12]

QUESTION 7

7.1 A skater on frictionless roller skates is standing at rest on the back of a truck which is travelling at a constant velocity of 10 km.h^{-1} as shown.



7.1.1 While the truck is moving, in which direction and at what speed must a skater move relative to the truck, in order to be stationary relative to the ground. (2)

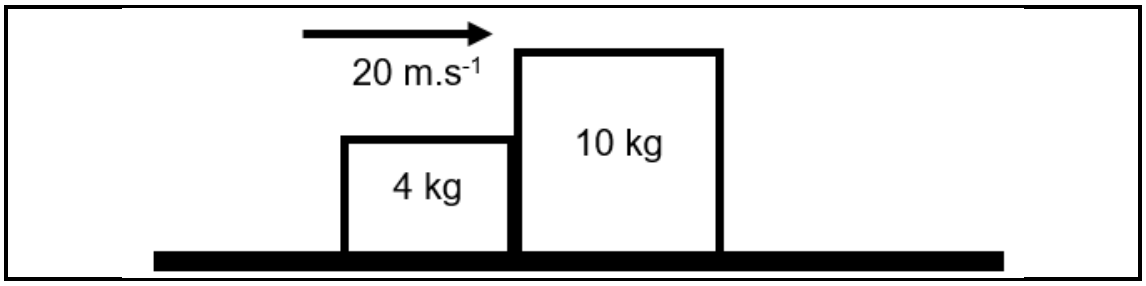
7.1.2 If a skater is initially at rest on the truck, in which direction relative to the truck will a skater be displaced (if at all) if the truck slows down. (2)

7.1.3 Name and state the law that provides an explanation to your answer to QUESTION 7.1.2. (3)

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7.2 Two blocks of 4 kg and10 kg respectively, which are in contact with each other on a frictionless horizontal plane, are moving at 20 $m.s^{-1}$ as shown in the sketch below.

A retarding force (acting in the opposite direction) of 28 N is now applied horizontally to the 10 kg block.



7.2.1 State Newton's Second Law of Motion in words. (2)

Calculate:

7.2.2 The acceleration of the system (3)

7.2.3 The resultant force acting on the 10 kg block (2)

7.2.4 The force that the 4 kg block exerts on the 10 kg block (3)
[17]

QUESTION 8

A man pushes a wheelbarrow up a ramp with a height of 5 m for a distance of 20 m.

8.1 Explain what is meant by the term *mechanical advantage*. (2)

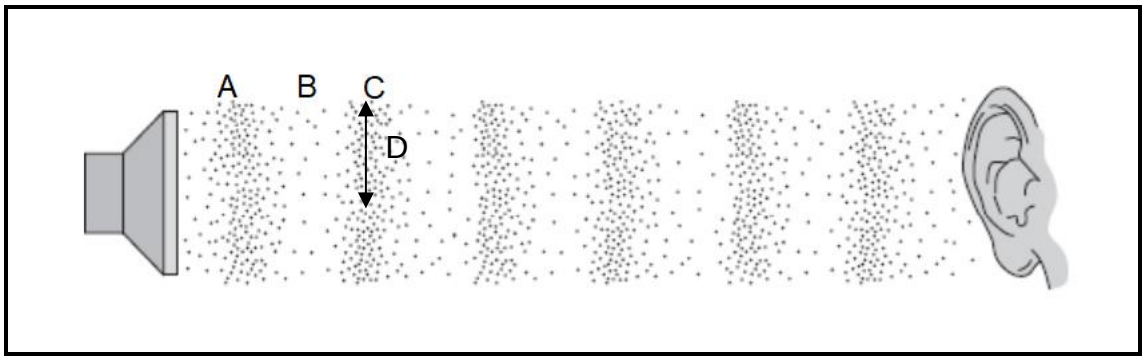
8.2 Calculate the mechanical advantage of the ramp. (3)

8.3 If you are the engineer designing a ramp for a construction site to move a wheelbarrow to enable the work to go faster, would you choose a ramp with a GREATER mechanical advantage or the one with LESS mechanical advantage? (1)

8.4 Explain the answer in QUESTION 8.3. (2)
[8]

QUESTION 9

9.1 The diagram below shows the air particles in a sound wave as the wave travels from a loudspeaker to an ear.



9.1.1 Are sound waves LONGITUDINAL or TRANSVERSE WAVES? (1)

9.1.2 Label the following:

(a) A

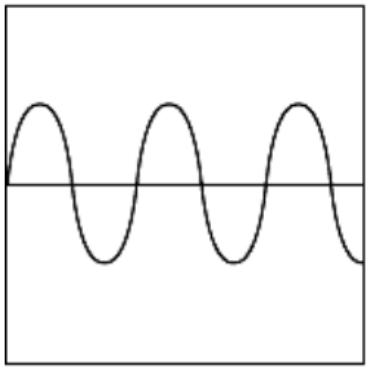
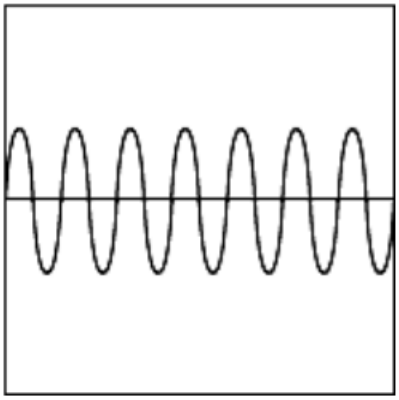
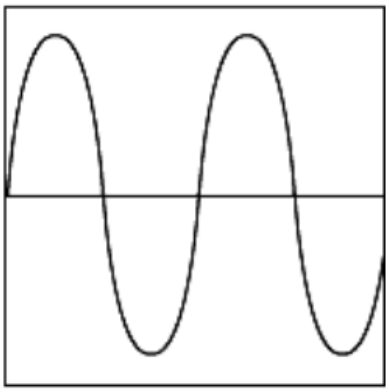
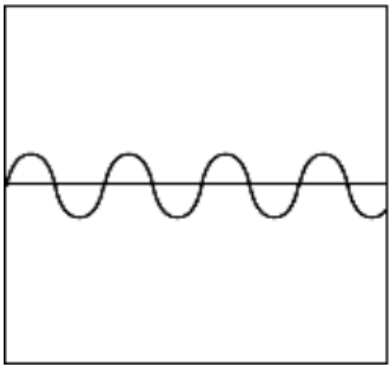
(b) B

(c) The distance between A and C.

(d) D

(4 × 1) (4)

9.2 Study the diagrams below and answer the questions that follow.

A	B
	
C	**D**
	

Write down only the letter that represents the diagram with the …

9.2.1 loudest sound.

9.2.2 highest pitch.

(2 × 2) (4)

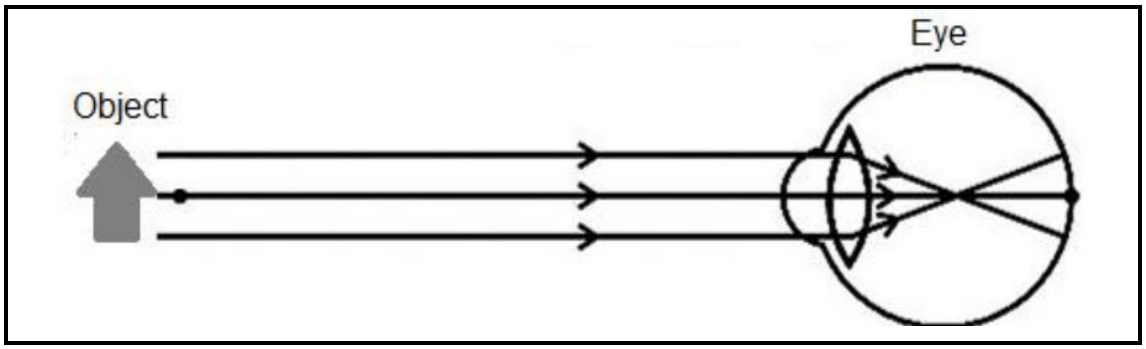
9.3 The lowest frequency of sound the human ear can detect is 20 Hz. The wavelength of a sound wave with a frequency of 20 Hz is 17 metres.

Calculate the speed of a sound wave. (3)

[12]

QUESTION 10

10.1 Some people's eyes are unable to focus on nearby objects, as indicated in the diagram below.

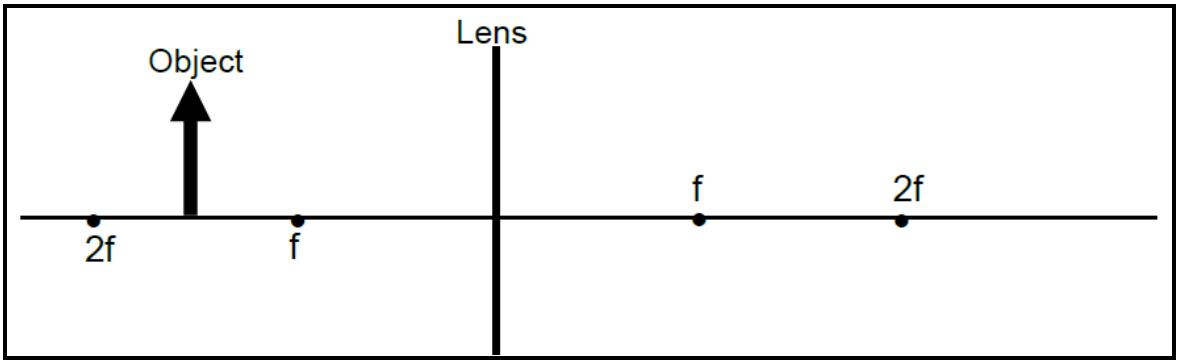


10.1.1 Write down ONE structural difference between a *convex lens* and a *concave lens.* (2)

10.1.2 Write down the name of the eye condition as shown in the diagram above. (1)

10.1.3 Which type of lens can be used to correct the condition named in QUESTION 10.1.2? (1)

10.2 An object is placed between f and 2f of a convex lens as shown below.



10.2.1 Copy the above diagram in your ANSWER BOOK. Use two basic rays to show how the image observed through the lens is formed. (5)

10.2.2 Write down the name for letter f. (1)

10.2.3 Is the image formed through the lens REAL or VIRTUAL? (1)

[11]

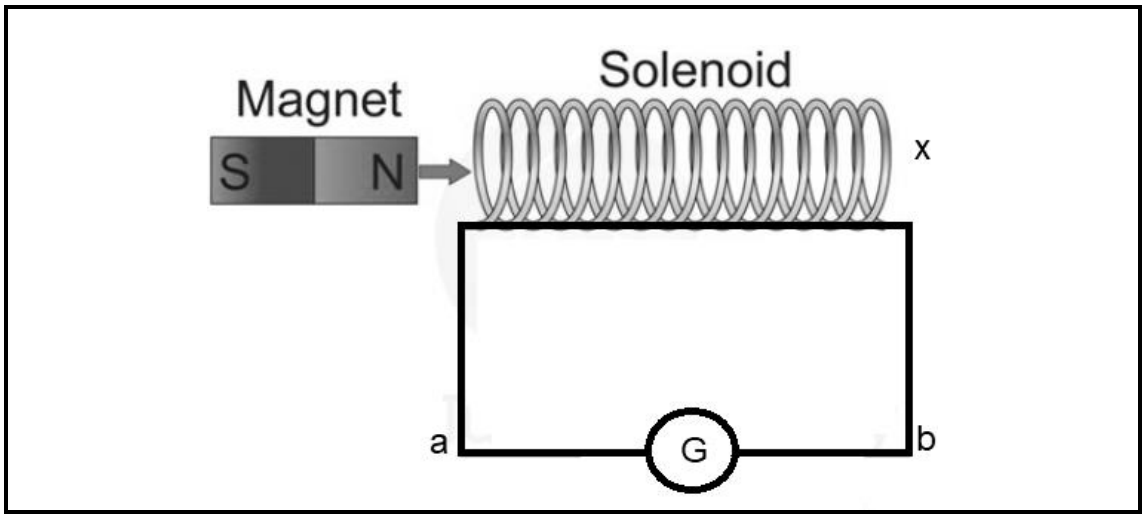
QUESTION 11

A changing magnetic field induces an emf in a conductor

11.1 State Faraday's Law in words. (2)

11.2 The North pole of a bar magnet is pushed into a solenoid as shown in the diagram below.

Write down the NAME of the law/rule use to determine the direction of magnetic field and induced current in a solenoid.



(1)

11.3 In which direction will the induced current flow? Write down only "a to b" or "b to a". (1)

11.4 Explain why an emf is induced in the coil as the magnet enters it. (2)

11.5 Will the emf be induced when the magnet is entirely inside the coils? (1)

11.5.1 Explain the answer in QUESTION 11.5. (2)

11.5.2 What is the polarity of the magnetic field of the solenoid a **x**? (1)

[10]

QUESTION 12

12.1 Two oppositely charged plates A (negatively charged) and B (positively charged) are 100 mm apart in a vacuum and have a potential difference of 2 000 V across them. An electric charge N of -3×10^{-8} C moves freely from plate A to plate B.

12.1.1 Draw a diagram to show the pattern of electric field between parallel plates. (3)

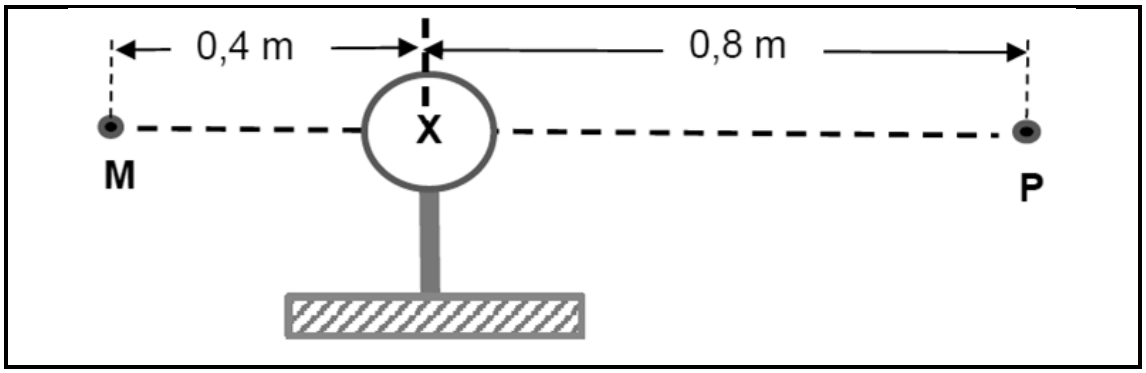
12.1.2 Calculate the magnitude of the electrostatic force experienced by the charge as it moves between the plates. (5)

12.2 A capacitor also operates on the principle of parallel plates.

12.2.1 Define the term *capacitor*. (2)

12.2.2 What is the name of the material placed between the plates of a capacitor? (1)

12.3 The diagram below shows a metal sphere X of negligible mass on an insulated stand in a vacuum. 3,125 x 10^{10} electrons have been removed from the sphere.



12.3.1 Describe an electric field. (2)

12.3.2 Calculate the net charge on the sphere. (3)

12.3.3 Calculate the electric field at point P. (3)

12.3.4 How does the magnitude of the electric field at point M compare with the value calculated in QUESTION 12.3.3? Write down only GREATER THAN, EQUAL to or SMALLER THAN. (1)

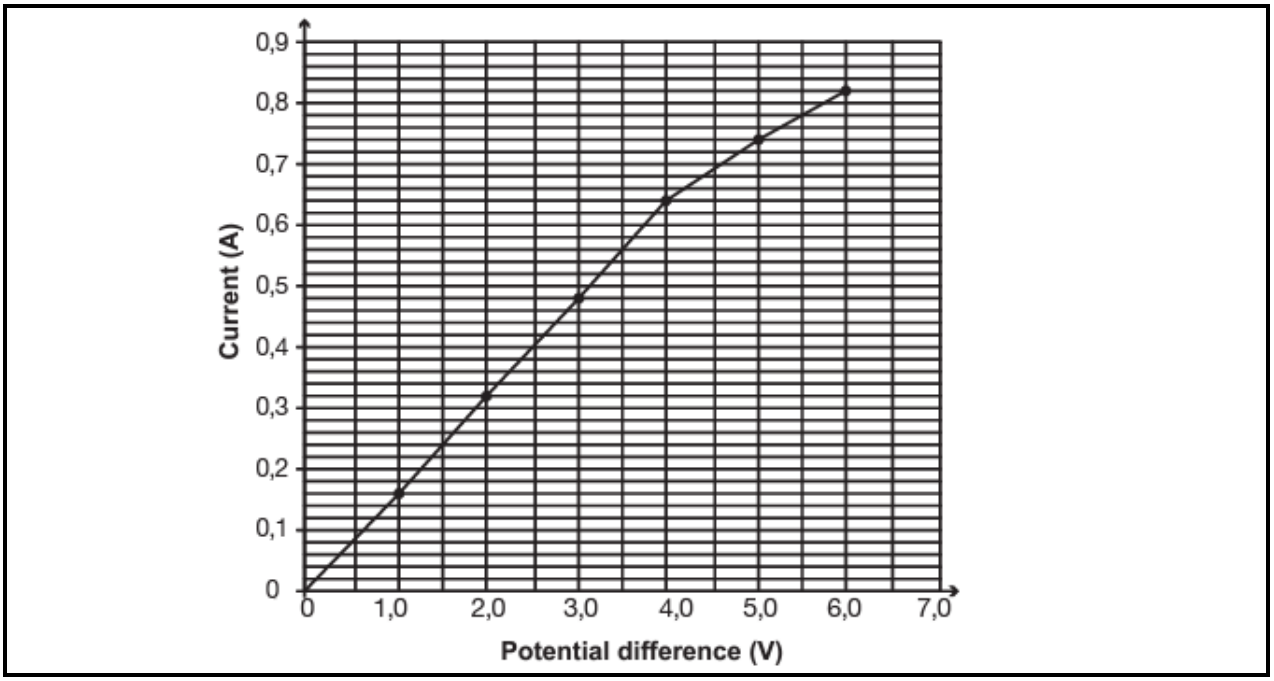
12.3.5 Write down the reason for the answer in QUESTION 12.3.4. (2)

[22]

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QUESTION 13

Learners conduct an investigation to verify Ohm's Law. They measure the current through a conducting wire for different potential differences across its ends. The results obtained are shown in the graph below.



13.1 Which ONE of the measured quantities is the dependent variable?

HINT: The graph deviates from Ohm's Law at some point. (1)

13.2 State Ohms Law in words. (2)

13.3 Write down the coordinates of the plotted point on the graph beyond which Ohm's Law is not obeyed (2)

13.4 Give a possible reason for the deviation from Ohm's Law as shown in the graph. Assume that all measurements are correct. (2)

13.5 Calculate the gradient of the graph for the section where Ohm's Law is obeyed. Use this to calculate the resistance of the conducting wire. (3)

[10]

TOTAL SECTION B: 115
GRAND TOTAL: 150

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INFORMATION SHEETS

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8\ m.s^{-2}$
Speed of light in a vacuum	c	$3,0 \times 10^{8}\ m.s^{-1}$
Planck's constant	h	$6,63 \times 10^{9}\ J.s$
Coulomb's constant	k	$9,0 \times 10^{9}\ N.m^{2}.C^{-2}$
Charge of an electron	e	$-1,6 \times 10^{-19}\ C$
Electron mass	m_e	$9 \times 10^{-31}\ kg$
Permittivity of free space	ε_0	$8,85 \times 10^{-12}\ F.m^{-1}$

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TABLE 2: FORMULAE

MECHANICS

$v = u + at$ OR $vf = vi + g\Delta$	$p = mv$ $Fnet\Delta t = \Delta p$ $Fnet\Delta t = m(vf - vi)$ $\sum \boldsymbol{p}i = \sum \boldsymbol{p}f$ $\mathbf{F}_{net} = \frac{\Delta p}{\Delta t}$
$v^2 = u^2 + 2as$ OR $Vf2 = vi2 + 2g\Delta y$ OR $Vf2 = vi2 + 2a\Delta x$	$MA = \frac{load}{effort}$
$S = ut + \frac{1}{2}at^2$ OR $\Delta y = vit + ½\, g\Delta t2$ OR $\Delta x = vit + ½\, a\Delta t2$ $\Delta x = \frac{(vi + vf)}{2}t$	$VR = \frac{S_E}{S_R}$
$F = ma$ $Fg = mg$ $W = mg$	$W = F\ x\ \Delta y\ \ OR\ W = F\ x\ \Delta x$ $W = F\Delta x cos\theta$
$\tau = \perp F.s$	$Efficiency = \frac{MA}{VR}$ OR $Efficiency = \frac{E\ (output)}{E\ (input)}\ x\ 100$
$Ek = \frac{1}{2}mv^2$	$R^2 = X^2 + Y^2$
$Ep = mgh$	$F_x = FCos\theta$
$v = \frac{s}{t}$	$Fy = FSin\theta$

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WAVES, SOUND AND LIGHT

$V = f\lambda$
$T = \frac{1}{f}$
$f_L = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s$
$E = hf$ or/*of* $E = h\frac{c}{\lambda}$

MAGNETISM AND ELECTRICITY

$F = \frac{kQ_1Q_2}{r^2}$	$R_T = R_1 + R_2 + R_3 \ldots$
$E = \frac{kQ}{r^2}$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots$
$C = \frac{\kappa \varepsilon_o A}{d}$	$Q = It$
$C = \frac{Q}{V}$	$V = IR$
$E = \frac{V}{d}$	$V = \frac{W}{Q}$
$E = \frac{F}{q}$	$Emf = I(R + r)$ $Emf = IR + Ir$
$\frac{V_P}{V_S} = \frac{N_P}{N_S}$	$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_1}{I_2}$ $\frac{V_P}{V_S} = \frac{N_P}{N_S}$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

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