KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

CURRICULUM GRADE 10 -12 DIRECTORATE

NCS (CAPS)

TEACHER SUPPORT DOCUMENT

GRADE 11

PHYSICAL SCIENCES

SOLUTIONS

2026

DIFFERENT KIND OF FORCES AND NEWTON'S LAWS SOLUTIONS

MCQ SOLUTIONS

QUESTION 1

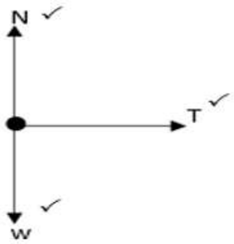
1.1 C (2)

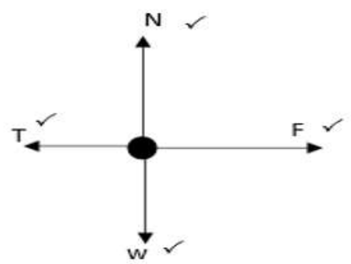
1.2 D (2)

STRUCTURED QUESTIONS SOLUTIONS

QUESTION 1

1.1





(7)

1.2 $F_{net} = ma$

For 0.98kg block

T = ma

T = (0.98)a ……….(1)

For 2kg block

F - T = ma

8 - T = (2)a ……….(2)

Subst. (1) into (2)

8-0.98a = 2a

a = 2.68 m.s^{-2} (7)

1.3 m = 0.98kg block

T = ma

T = (0.98)(2.68)

T = 2.63N (2)

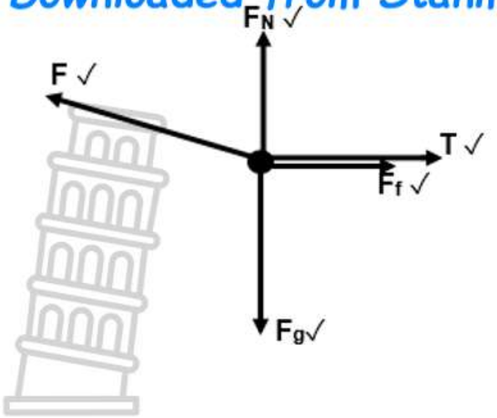
1.4 Stays the same (1)

[17]

QUESTION 2

2.1 The force that opposes the motion of a moving object relative to the surface (2)

2.2



(5)

2.3

2.3.1 $N = Fg - F\sin\theta$

$$N = 25x\,9{,}8 - 250\sin 25° \quad N = 139{,}35\ N$$ (3)

2.3.2 $Fnet = ma$

$Fnet = F\cos\theta - T - f$

$250\cos 25° - T - (0{,}15 \times 139{,}35) = 25a$

$$25a = 205{,}6744468 - T \ldots(1)$$

$Fnet = T - Fg$

$T - 98 = 10a \ldots \ (2)$

Adding the two equations

$35a = 107{,}6744468$

$a = 3{,}08\ m.s^{-2}$

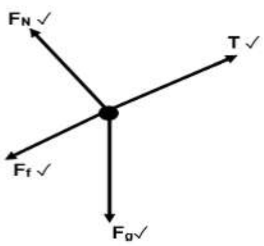
(7)

[17]

QUESTION 3

3.1 When a resultant force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant force and inversely proportional to the mass of the object. (2)

3.2



(4)

3.3.1 $Fnet = ma$

$Fnet = T - Fg_{//} - f$

$T - Fg_{//} - f = ma$

$T - Fg_{//} - f = 0$ (5)

$T - (1,5 \times 9,8 \sin 20°) - 2 = 0$

$T = 7,03\ N$

3.3.2 $F_{net} = ma$

$F_{net} = F - T - Fg_{//} - f$

$F - T - Fg_{//} - f = ma$

$F - T - Fg_{//} - f = 0$

$[24 - 7,03 - (3,2 \times 9,8 \sin 20°) - fk] = 0$

$fk = 6,22425\ N$

$fk = \mu_k N$

$[6,22425 = \mu_k \times 3,2 \text{ x} 9,8 \cos 20°$

$\mu_k = 0,21$ (6)

[17]

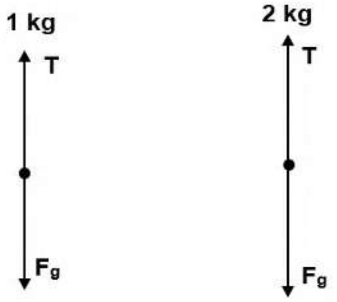
QUESTION 4

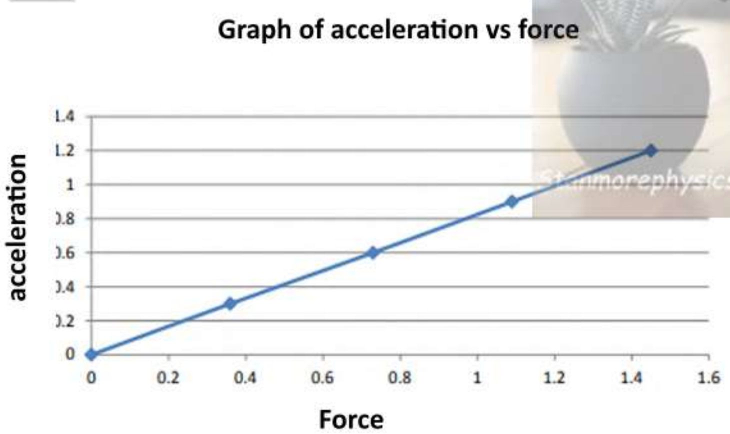
4.1.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the net force and inversely proportional to the mass of the object. ✓✓ (2)

4.1.2 Gradient = $\frac{2,5 - 0}{1,25 - 0}$ = 2 ✓ (3)

4.1.3 Fnet = ½ ✓= 0, 5 N ✓ (2)

4.1.4 The acceleration is inversely proportional to the mass of the object. ✓✓ (2)

4.2.1		(4)
4.2.2	$F_{net} = ma$ $T - Fg = ma$ $T - 1x9,8 = 1a \ \dots (1)$ $Fg - T = ma$ $2x9,8 - T = 2a \dots \ (2)$ $a = 3,37\ m.s^{-2}$	(5)
QUESTION 5		
5.1	Each particle in the universe attracts every other particle with a gravitational force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres. ✓✓	(2)
5.2	weightlessness as the sensation experienced when all contact forces are removed, ✓✓	(2)
5.3	$F = \frac{G\,m_1.m_2}{r^2}$✓ $= \frac{6,67.10^{-11}\ (5,98.10^{24}).(3800)}{[(6,38\ .\ 10^2) + 25.10^6]^2}$ = 1 539, 23 N ✓	(4)
5.4	Greater than. ✓	(4)

	$F = \frac{Gm_1.m_2}{r^2}$ $1539,23 = \frac{6,67.10^{-11}(5,98.10^{24}).(4500)}{R^2}$ ✓ R = 3, 41 x 10^7m Distance above the earth surface: 3, 41x10^7 - 6, 38 x 10^6 ✓ = 2, 78 x 10^7m ✓	
		[12]
QUESTION 6		
6.1	Weight is the gravitational force the Earth exerts on any object on any object on or near its surface. ✓✓	(2)
6.2	F = G$\frac{m1\,m2}{r^2}$ ✓ = 6,67 x10 $^{-11}$ x $\frac{(5{,}98\ x10\ 24)(330\ 000)(5{,}98\ x10\ 24)}{(1{,}38\ x10\ 9\ )2}$ ✓✓ = 4,13 x10^{26} N✓	(4)
6.3	Equal to, ✓ Newton's third law is obeyed. ✓	(2)
		[8]
QUESTION 7		
7.1	What is the relationship between the Net force and the acceleration? ✓ ✓	(2)
7.2.1	Net Force ✓	(1)
7.2.2	Acceleration ✓	
	 **Marking criteria** • **Correct scale ✓** • **Coordinate plotted correctly ✓✓** • **Line best fit ✓**	(4)
7.4	Accept any coordinate from the graph $g = \frac{1.45 - 0.36\ ✓}{1.2 - 0.3\ ✓} = 1.21$ ✓	(3)
7.5	$g = \frac{a}{F} = \frac{1}{m} = \frac{1}{1.21}$ ✓ $= 0.83\ kg$ ✓	(2)
		[13]

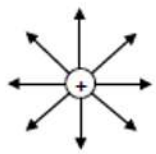
SOLUTIONS ELECTROSTATICS

QUESTION 1

1.1	A ✓✓	(2)
1.2	A ✓✓	(2)
1.3	A ✓✓	(2)
1.4	D ✓✓	(2)
1.5	A ✓✓	(2)
		[10]

QUESTION 2

2.1

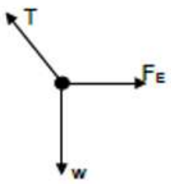


Marking criteria	
Correct shape (straight field lines).	✓
Correct direction away from the charge.	✓✓

(3)

2.2.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes) of the charges and inversely proportional to the square of the distance (r) between them. ✓✓ (2)

2.2.2



w ✓	gravitational force
F_E ✓	Electrostatic force
T ✓	tension

(3)

2.2.3

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$F = \frac{9\times10^{9}\times3\times10^{-9}\times6\times10^{-9}}{(0.03)^2} \checkmark$$

$$F = 1.47\times10^{-4}\,N$$

$$w = mg$$

$$= \left(1.5\times10^{-4}\times9.8\right) \checkmark$$

$$= 1.47\times10^{-3}N$$

$\tan\theta = \frac{F_E}{mg}$ $= \frac{1.8\times10^{-4}}{1.47\times10^{-3}}$ ✓ $\theta = 6.98°$ ✓	$T^2 = (F_E)^2 + (F_g)^2$ $= (1.47\times10^{-3})^2 + (1.8\times10^{-4})^2$ $= 1.4781\times10^{-3}N$ $\cos\theta = \frac{1.47\times10^{-3}}{1.481\times10^{-3}}$ ✓ $\theta = 6.98°$ ✓

(5)

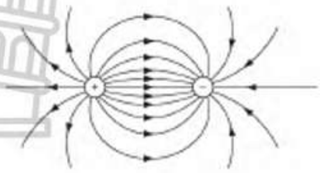
QUESTION 3

3.1 $E = \frac{kQ}{r^2}$ ✓

$E_{net} = \frac{(9 \times 10^9)(3 \times 10^{-6})}{(0.12)^2}$ ✓

E = 5 000 $N \cdot C^{-1}$ ✓ (3)

3.2



Marking criteria	Marks
Correct direction of field lines.	✓
Correct shape of the electric field lines between charges and on the outside of the charges.	✓
No field lines crossing each other. Field lines must touch the charge, but not go inside the charge.	✓

(3)

3.3.1 The magnitude of the electrostatic force exerted by one point charge on another point charge is directly proportional to the product of the magnitudes of their charges and inversely proportional to square of the distance between them. ✓✓ (2)

3.3.2 POSITIVE ✓ (1)

3.3.3 $F_{net} = F_{ST} - F_{PT}$

$F_{net} = \frac{kQ_1Q_2}{r^2} - ✓\frac{kQ_1Q_2}{r^2}$ ✓

2.5×10^{-4} ✓ $= \left\{\frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0.02)^2} - \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0.06)^2}\right\}$ ✓

$Q_T = 6.25 \times 10^{-9}\ C$ ✓ (5)

QUESTION 4

4.1.1

OPTION 1	OPTION 2
$Factor = \frac{1920}{120}$ ✓ $= 16$ OR $Factor = \frac{120}{1920} = \frac{1}{16}$ $Factor\ decreased\ by\ 16.$ ✓ $Factor\ by\ which\ r\ increased = 4$ ✓ $x + 6 = 4x$ ✓ $x = 2\ m$ ✓	$F = \frac{kQ_1Q_2}{r^2}$ ✓ 1920 ✓ $= \frac{(9 \times 10^9)(Q)^2}{(x)^2}$ ✓ $Q^2 = \frac{1920 \times x^2}{9 \times 10^9}$ ……….. (1) $120 = \frac{(9 \times 10^9)(Q)^2}{(x)^2}$ ✓ $Q^2 = \frac{120 \times x^2}{9 \times 10^9}$ ……….. (2) $(1) = (2)$ $x = 2\ m$ ✓

(5)

4.1.2

OPTION 1	OPTION 2
$F = \frac{kQ_1Q_2}{r^2}$ ✓ 1920 ✓ $= \frac{(9 \times 10^9)(Q)^2}{(x)^2}$ ✓ $Q = 9.24 \times 10^{-4} C$ ✓	$F = \frac{kQ_1Q_2}{r^2}$ ✓ 120 ✓ $= \frac{(9 \times 10^9)(Q)^2}{(x)^2}$ ✓ $Q = 9.24 \times 10^{-4} C$ ✓

(4)

4.2.1 $E_{net} = E_1 + E_2$✓

$$E_{net} = \frac{kQ_1}{r^2} + \frac{kQ_2}{r^2}$$

$$E_{net} = \frac{(9 \times 10^9)(9.24 \times 10^{-4})✓}{(2.2)^2} + ✓\frac{(9 \times 10^9)(9.24 \times 10^{-4})✓}{(0.2)^2}$$

$E_{net} = 2.10 \times 10^8$ N•C^{-1} ✓ (5)

4.2.2 $E = \frac{F}{q}$✓

2.10×10^8✓ $= \frac{F}{1.6 \times 10^{-19}}$ ✓

$F = 3.36 \times 10^{-11}\ N$✓ (4)

[17]

QUESTION 5

5.1.1 Inverse of the force is directly proportional to the square distance between the charges ✓ (1)

5.1.2 $gradient = \frac{\Delta \frac{1}{F}}{r^2}$✓

$= \frac{8.0 - 0}{0.6 - 0}$ ✓

$= 13.33\ N^{-1}m^{-2}$

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$Fr^2 = kQ_1Q_2$

$\frac{1}{13.33}$✓ $= (9 \times 10^9)Q^2$✓

$Q = 2.89 \times 10^3\ C$✓ (6)

5.2 $F_E = w(\tan\theta)$

$F_E = mg(\tan\theta)$

$F_E = \frac{w}{\tan(90° - \theta)}$

F_E✓ $= (0.012)(9.8)(\tan 9°)$✓

$F_E = 0.0186\ N$

$F_E = \frac{kQ_1Q_2}{r^2}$ ✓

$\left\{0.0186 = \frac{(9 \times 10^9)Q^2}{(0.1)^2}\right\}$ ✓

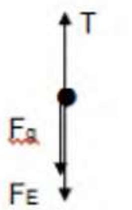
$Q = 1.44 \times 10^{-7}\ C$

$Q_B = 2(1.44 \times 10^{-7})$✓

$Q_B = 2.88 \times 10^{-7}\ C$✓ (6)

QUESTION 6

6.1



F_g / w	Gravitational force	✓
T	Tension	✓

F_E	Electrostatic Force	✓

(3)

6.2
$$F_{net} = 0$$
$$mg + F_E = T$$
$$mg + \frac{kQ_1Q_2}{r^2} ✓ = \mathrm{T}$$
$$(0.007)(9.8)✓ + \frac{(9\times10^9)(32\times10^{-9})(55\times10^{-9})✓}{(1.52)^2✓} = T$$
$$T = 0.137\ N✓$$
(5)

6.3
$$Q_{new} = \frac{Q_1 + Q_2}{2} ✓$$
$$Q_{new} = \frac{(5\times10^{-9}) + (-8\times10^{-9})}{2} ✓$$
$$Q_{new} = -1.5\times10^{-9}\ C✓$$
(3)

6.4.1
$$T_x = (0.07)\cos 60° ✓$$
$$T_x = 0.035\ N✓$$
(2)

6.4.2
$$F = \frac{kQ_1Q_2}{r^2} ✓$$
$$0.035 ✓ = \frac{(9\times10^9)(4.8\times10^{-8})(1.2\times10^{-8})✓}{(r)^2}$$
$$r = 0.012m ✓$$
(4)

[17]

SOLUTIONS ELECTRIC CIRCUITS

QUESTION 1 (MCQ)

1.1 C✓✓ (2)
1.2 A✓✓ (2)
1.3 A✓✓ (2)
1.4 A✓✓ (2)
1.5 B✓✓ (2)
1.6 B✓✓ (2)
1.7 A✓✓ (2)

[14]

STRUCTURED QUESTION

QUESTION 2

2.1.1 The work done per unit charge by the source.✓✓ (2)

2.1.2 15V✓ (1)

2.1.3 When the switch is closed, there is internal resistance✓ which creates lost volts✓. ε = V_{int} + V_{ext}.✓ (3)

2.1.4
$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$= \frac{1}{6} + \frac{1}{12}$$
$$R_P = 4\Omega$$

$$R_{ext} = R_P + R_S$$
$$= 4 + 1$$
$$= 5\Omega$$

$$V_{ext} = IR$$
$$10{,}5 = I(5)$$
$$I = 2{,}1A$$

$$r = \frac{V_{lost}}{I}$$
(4)

$= \frac{4,5}{2,1}$

$= 2,14\Omega$

2.2 $Cost = kWh \times rate$

$= (0,005)(8760)(1,25)$

$= R54,75$ (3)

[13]

QUESTION 3

3.1 The rate at which work is done/dissipated OR energy transferred OR Work done per unit time.✓✓ (2)

3.2.1 $P = VI$

$48 = (32)I$

$I = 1,50A$ (3)

3.2.2 L_1: $P = VI$

$36 = 20I$

$I = 1,80A$

$I_{tot} = 1,5 + 1,8$

$I_{tot} = 3,30A$ (3)

3.2.3 $V_{R1} + V_{L1} = V_{//}$

$V_{R1} + 20 = 32$

$V_{R1} = 12$ V

V = IR ✓

12 ✓= 1,8 R_1 ✓

$R_1 = 6,67\ \Omega$ ✓ (4)

3.2.4 $V_2 = I_{TOT} R_2$

= 3,3(4)

= 13,2 V

$\varepsilon = V_{ext} + Ir$ ✓

= (13,2 + 32) ✓ + 3,3(0,6) ✓

= 47,18 V ✓ (4)

3.3 No✓

$P = \frac{V^2}{R}$

$48 = \frac{32^2}{R}$

$R_{L2} = 21,33\Omega$

ε = I(R + r) ✓

47,18 = I(21,33 + 4 + 0,6) ✓

I = 1,82 A ✓ (5)

[21]

QUESTION 4

4.1 Ohm's Law✓

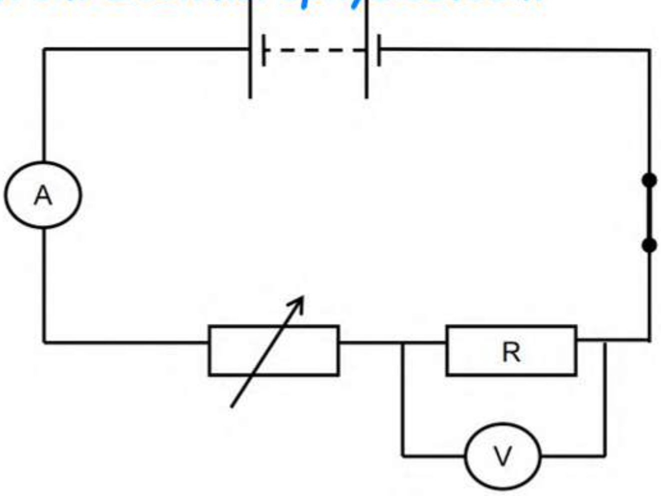
4.2 It allows one to change/vary the current✓ and potential difference aross resistor R.✓ OR to change the portential difference across the resistor.

OR It varies the resistance✓ in the circuit and hence the current.✓ (2)

4.3 Open the switch in the circuit after taking a set of readings to allow the resistor to cool down.✓

OR Do not keep the switch closed for long periods of time. ✓ (1)

4.4



- Rheostat included with correct symbol✓
- Resistor drawn, with voltmeter connected in parallel across the resistor✓
- Ammeter connected in series to resistor✓
- All component correctly connected to enable the verification of Ohm's Law✓ (4)

4.5.1 Directly proportional✓ (1)

4.5.2 Inverse of resistance✓ (1)

4.5.3 0,15A (1)

4.5.4

$$Gradient\left(\frac{1}{R}\right) = \frac{\Delta I}{\Delta V}$$

$$= \frac{0{,}30 - 0}{12 - 0}$$

$$\left(\frac{1}{R}\right)^{-1} = 0{,}025^{-1}$$

$$R = 40\Omega$$

(4)

4.6.1 B✓ (1)

4.6.2 For a constant value of V ,

$I_A > I_B$✓

$\frac{V}{I_A} < \frac{V}{I_B}$

$R_A < R_B$

Therefore the resistor used in graph B has a larger resistance than A.

[18]

QUESTION 5

5.1 The current in a metal is directly proportional to the potential difference across the ends of the conductor, provided the temperature remains constant. ✓✓ (2)

5.2 $\frac{1}{Rp} = \frac{1}{R1} + \frac{1}{R2}$

$\frac{1}{Rp} = \frac{1}{6} + \frac{1}{3}$ ✓

R_p = 2 Ω✓

Effective Resistance = $R_P + R_s$ = 2 + 1 = 3Ω ✓ (3)

5.3.2 $R_p = \frac{V}{I}$ ✓

V= $0.8 \times 2 = 1.6\,V$✓✓

5.3.3 R = $\frac{V}{I}$ ✓ $= 6 = \frac{1.6}{I}$ ✓ I= 0.27 A ✓ (3)

5.4 P = VI ✓

= 2,4 × 0,8 ✓

= 1,92W = 0,00192 KW ✓

W = Pt

= 0,00192 × 48✓

= 0,09216 KWh ✓ (3)

5.5.1 Decrease. ✓ Resistance of circuit increases, from Ohms Law, R is inversely proportional to the current. ✓✓ (5)

5.5.2 Increases ✓ (1)

[20]

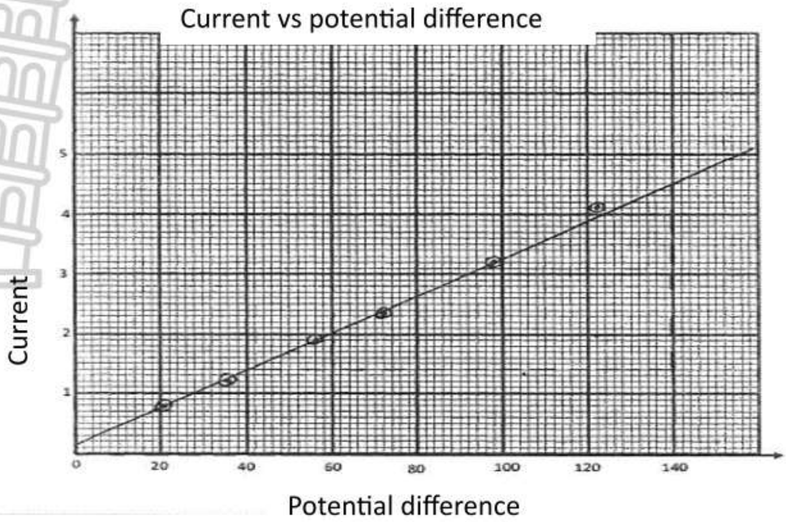
QUESTION 6

6.1 The potential difference across the conductor is directly proportional to the current in the conductor at constant temperature. ✓✓ (2)

6.2.1 Resistance / Temperature of the resistor✓ (1)

6.2.2 Do not keep the circuit on for long periods of time. ✓ (1)

6.3



suitable scale used on X and Y axes	✓
X and Y axes correctly labelled	✓
correct plotting of points	✓✓
best fit curve drawn joining points	✓

(5)

6.4 Gradiant (1/R) = $\frac{\Delta I}{\Delta V}$ ✓

= $\frac{4.5-1.4}{140-40}$ ✓✓

=0.031Ω✓ (4)

6.5 Inverse of resistance/ $\frac{1}{R}$ ✓ (1)

6.6 $\frac{1}{R}$= 0,031 (2)

R =32,26 Ω ✓✓ **[16]**

QUESTION 7

7.1.1 $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}$ $\frac{1}{R}=\frac{1}{6}+\frac{1}{3}$ $R_P=2\Omega$✓ (3)

7.1.2 $R=\frac{V}{I}$ $2=\frac{6}{I}$ $\mathrm{I}=3\mathrm{A}$ (3)

7.1.3 $I=\frac{1}{3}\times 3$ $\mathrm{I}=1\mathrm{A}$ (3)

7.1.4 $P=I^2R$ $\mathrm{P}=1^2\times 4$ $\mathrm{P}=4\mathrm{W}$ (3)

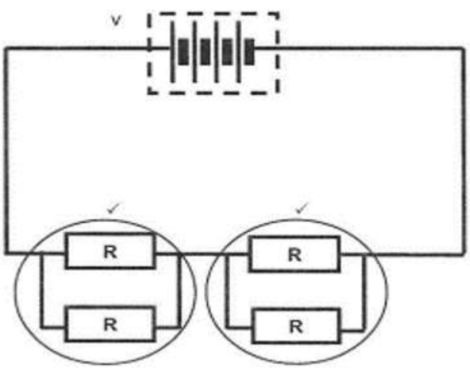
7.2 6V✓ (1)

7.3 $W=P\Delta t$ $\mathrm{W}=1.5\times 4$ $\mathrm{W}=6\mathrm{kWh}$ $\mathrm{Cost}=6\times 2.05$ $\mathrm{Cost}=\mathrm{R}12.30$ (4)

[17]

QUESTION 8

8.1



(2)

8.2 $\frac{1}{R_p}=\frac{1}{R}+\frac{1}{R}$ $R_P=\frac{1}{2}R$ $R_{TOTAL}=\frac{1}{2}R+\frac{1}{2}R$ $=\mathrm{R}$ (3)

8.3 $\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R} = \frac{1}{6} + \frac{1}{3}$ $R_P = 2$ $R_T = R_P + R_S$ $2 + 4 = 6$ (3)

8.3.1 $I_1 = I_2$ $\frac{V}{R}$ $= \frac{4}{2} = 2A$ (3)

8.3.2 $I_2 = I_2$ $\frac{V}{R} = \frac{4}{2}$ $= 2A$ (3)

8.3.3 $V_6 = (2+6)2 = 6V$ $\mathrm{I} = \frac{V}{R} = \frac{6}{6}$ $= 1\mathrm{A}$

$I = I + I = 2 + 1 = 3A$ (5)

8.3.4 V = I × R OR Emf = $V_P + V_{4\Omega}$
= 3 × 6 = 6 + (3)(4) (3)
= 18 V = 18 V

8.4.1 Decreases (1)

8.4.2 When switch S is opened, the total resistance in the circuit increases and the current strength decreases. (2)

[25]

QUESTION 9

9.1 The potential difference across a conductor is directly proportional to the current (2)

9.2.1 More resistors in parallel effective resistance will decrease (2)

9.3.1 $R = \frac{V}{I}$ $\frac{4.8}{2.4}$ $= 2\Omega$ (3)

9.3.2 $R_{TOTAL} = 3 + 2 = 5$ $V_{EMF} = IR = (2.4)(5) = 12\mathrm{V}$ (4)

9.4 The rate at which work is done/dissipated OR energy transferred OR Work done per unit time.✓✓ (2)

9.5 $P = \frac{V^2}{R}$

$= \frac{6^2}{6}$

$= 6W$ (4)

9.6 INCREASES✓ (1)

9.7 The current through the lightbulb increases✓. Current is directly proportional to the brightness of a lightbulb.✓ (2)

QUESTION 10

10.1.1 Slope constant $\text{slope} = \frac{1}{R}$ $\mathrm{R} = \frac{8}{0,4} = 20$ (3)

10.1.2 Not ohmic slope is not constant (2)

10.2.1 $I_T = I_Y + I_R = 0,1 + 0,2 = 0,3\ \mathrm{A}$ (3)

10.2.2 For 8 V the total current of both resistors is 0,5 + 0,4 = 0,9A $R = \frac{V}{I} = \frac{8}{0,9} = 8,9\Omega$ (3)

10.2.3 $W = VIt = 8 \times 0,4 \times 20 = 64\mathrm{J}$ (4)

[15]

QUESTION 11

11.1 Potential difference across conductor is directly propotional to current (2)

11.2 $P = \frac{V^2}{R}$ $13.5 = \frac{18^2}{R}$ $\mathrm{R} = 24$ (3)

11.3 $R = \frac{V}{I}$ $12 = \frac{18}{I}$ $I = 1.5A$ $24 = \frac{18}{I}$ $I = 0,75$ $I_{TOTAL} = 1.5 + 0.75 = 2.25A$ (5)

11.4 It is the opposition of flow of charge inside the battery (2)

11.5 $V_{10} = IR$ $V = 2.25 \times 10$ $\mathrm{V} = 22.5\ \mathrm{V}$ (3)

11.6 $EMF = I(R + r)$ $45.9 = (2.25)(8 + 10 + \mathrm{r})$ $\mathrm{r} = 2.4\Omega$ (5)

11.7 INCREASE (1)

[21]

SOLUTIONS FOR QUANTITATIVE ASPECTS OF CHEMICAL CHANGE

QUESTION 1

1.1 D ✓✓ (2)
1.2 A ✓✓ (2)
1.3 C ✓✓ (2)
1.4 B ✓✓ (2)
1.5 B ✓✓ (2)
[10]

QUESTION 2

2.1 The number of moles of solute per cubic decimetre of solution. ✓✓ (2)

2.2.1
$$n(Al) = \frac{m}{M}$$
$$= \frac{5}{27}$$
$= 0{,}19$ mol ✓ (3)

2.2.2 Al : H_2SO_4
2 : 3 ✓
$n(H_2SO_4) = 0{,}285$ mol
$$c(H_2SO_4) = \frac{n}{V}$$
$$0{,}1 = \frac{0{,}285}{V}$$
$V(H_2SO_4) = 2{,}85\ dm^3$ ✓ (4)

2.2.3 Al : H_2 OR H_2SO_4 : H_2
2 : 3 ✓ 3 : 3 (or 1:1) ✓

$n(H_2) = 0{,}285$ mol
$$n(H_2) = \frac{V}{V_m}$$
$$0{,}285 = \frac{V}{22{,}4}$$
$V(H_2) = 6{,}38\ dm^3$ ✓ (4)
[13]

QUESTION 3

3.1

Element	mass (g)	$n = \frac{m}{M}$	Simplest Ratio		Simplest Ratio (Modified)	
C	60	$\frac{60}{12} = 5$	$\frac{5}{2{,}22} = 2{,}25$		2,25 x 4 = 9	
H	4,48	$\frac{4{,}48}{1} = 4{,}48$	$\frac{4{,}48}{2{,}22} = 2$	✓	2 x 4 = 8	✓
O	35,52	$\frac{35{,}52}{16} = 2{,}22$	$\frac{2{,}22}{2{,}22} = 1$		1 x 4 = 4	

Empirical formula: $C_9H_8O_4$ ✓ (6)

3.2
$$\frac{540}{180} = 3$$

Molecular formula: $C_{27}H_{24}O_{12}$ ✓ (2)
[8]

QUESTION 4

4.1
$$\text{Mass of C} = \frac{12}{44} \times 1{,}74 = 0{,}475\ g$$
$$\text{Mass of H} = \frac{2}{18} \times 0{,}70 = 0{,}078\ g$$
$$\text{Mass of O} = 15 - (0{,}475 + 0{,}078) = 0{,}947\ g$$

Element	$n=\frac{m}{M}$	Simplest Ratio	Modified Simplest Ratio
C	$\frac{0,475}{12}=0,04$	$\frac{0,04}{0,04}=1$	1 x 2 = 2
H	$\frac{0,078}{1}=0,078$	$\frac{0,078}{0,04}=1,95\approx 2$	2 x 2 = 4
O	$\frac{0,947}{16}=0,059$	$\frac{0,059}{0,04}=1,48\ \approx 1,5$	1,5 x 2 = 3

Empirical formula: $C_2H_4O_3$ ✓ (7)

4.2 Molecular formula: $C_6H_{12}O_9$ ✓✓ (2)

[9]

QUESTION 5

5.1 $M\ (C_{12}H_{22}O_{11}) = 12(12) + 22(1) + 11(16)$

$= 144 + 22 + 176$

$= 342\ g.mol^{-1}$ ✓

$\% C = \frac{144}{342} \times 100 = 42,11\%$ ✓

(2)

5.2.1 $\frac{M}{M+71} \times 100 = 44,1$ ✓ OR $\frac{71}{M+71} \times 100 = 55,9$ ✓

$M = 56\ g \cdot mol^{-1}$ ✓

(4)

5.2.2 $\frac{x(35,5)}{56 + x(35,5)} = \frac{65,5}{100}$ ✓

$x = 3$ ✓

(4)

[10]

QUESTION 6

6.1 $c = \frac{m}{MV}$

$0,326 = \frac{1,826}{M(0,1)}$

$M(XOH) = 56\ g \cdot mol^{-1}$

$M(X) + 16 + 1 = 56$ ✓

$M(X) = 39\ g \cdot mol^{-1}$

XOH is potassium hydroxide ✓ (5)

6.2 $n\ (NO_3^-) = C \times V$

$= 0,15 \times 0,25$ ✓

$= 0,0375$ mol

$n\ (H_2O) = 4(0,0375)$ ✓

$= 0,15$ mol

∴ mass of $Ca(NO_3)_2 \cdot 4H_2O$ used $= 0,0375(164)$ ✓ $+ 0,15(18)$ ✓

$= 8,85$ g ✓ (5)

[10]

QUESTION 7

7.1 $n = \frac{m}{M}$

$n = \frac{34,5}{16}$ ✓

$n = 2,16$ mol CH_4

$n = \frac{V}{V_m}$

$n = \frac{69,3}{22,4}$ ✓

$n = 3,09$ mol O_2

OPTION 1

$CH_4 : O_2$

1 : 2

2,16 : 4,32 mol ✓

OPTION 2

$CH_4 : O_2$

1 : 2

1,55 : 3,09 mol ✓

O_2 is the limiting reagent ✓ (4)

7.2 $O_2 : CO_2$

2 : 1

3,09 : 1,55 dm^3 ✓

Amount of CH_4 left over = 2,16 − 1,55 ✓

= 0,61 mol

Total number of moles of gas = 0,61 + 1,55 ✓

= 2,16 mol ✓ (4)

7.3 $n = \frac{m}{M}$

$1,55 = \frac{m}{44}$ ✓

m = 68,2 g

% yield = $\frac{\text{Actual yield}}{\text{Theoretical yield}}$ x 100 ✓

= $\frac{58,05}{68,2}$ x 100 ✓ = 85,11 % ✓

(3)

[11]

QUESTION 8

$n(CO_2) = \frac{V}{V_m}$

$= \frac{0,65}{22,4}$

= 0,029 mol

$n(CaCO_3) = n(CO_2)$ ✓

= 0,029 mol

$n(CaCO_3) = \frac{m}{M}$

$0,029 = \frac{m}{100}$

$m(CaCO_3)$ = 2,9 g

$\% \text{ Purity} = \frac{\text{Pure mass}}{\text{Impure mass}} \times 100$

$\% \text{ Purity} = \frac{2,9}{3,5} \times 100$

= 82,86%✓ (6)

QUESTION 9

9.1 No more carbon dioxide is produced. / The reaction has ended / All the $CaCO_3$ has reacted. ✓ (1)

9.2 $n = \frac{V}{V_m}$ ✓

$= \frac{500}{24000}$ ✓

= 0,0208 mol ✓ (3)

9.3 $n_i = cV$ = 0,5 x 0,3✓

= 0,15 mol

$n_{reacted}$ = 2 x 0,0208✓

= 0,0416 mol

$n_{excess} = n_i - n_{reacted}$

= 0,15 – 0,0416✓✓

= 0,1084 mol

$c = \frac{n}{V}$✓

= 0,1084 ✓ (7)

0,6

= 0,361 $mol.dm^{-3}$ ✓

[11]

QUESTION 10

10.1 Calcium carbonate/$CaCO_3$ ✓✓ (2)

10.2.1 $n(CaCO_3)\text{reacted} = \frac{1}{2} \times n(HCl)$ ✓

$$= \frac{1}{2} \times \frac{m}{M}$$

$$= \frac{1}{2} \times \frac{(20 - 12,7)}{36,5}$$

$$= 0,1 \text{ mol}$$

$$n(CaCO_3) = \frac{m}{M}$$

$$0,1 = \frac{m}{100}$$

$m(CaCO_3) = 10$ g

$$\%\ \text{Purity} = \frac{\text{Pure mass}}{\text{Impure mass}} \times 100$$

$$\%\ \text{Purity} = \frac{10}{12,5} \times 100$$

= 80% ✓ (7)

10.2.2 $n(CO_2)\text{produced} = n(CaCO_3)$ ✓

= 0,1 mol

$$n(CO_2) = \frac{V}{V_m}$$

$$0,1 = \frac{V}{22,4}$$

$V = 2,24$ dm^3 (4)

10.3 $n(H_2O) = \frac{m}{M}$

$$= \frac{12,6}{18}$$

= 0,7 mol

$n(CaCO_3) = n(H_2O)$

= 0,7 mol

$$n(CaCO_3) = \frac{m}{M}$$

$$0,7 = \frac{m}{100}$$

$m(CaCO_3) = 70$ g

$$70 = \frac{80}{100} \times \mathbf{X}$$

X = 87,5 g (5)

[18]