KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

CURRICULUM GRADE 10 -12 DIRECTORATE

NCS (CAPS)

TEACHER SUPPORT DOCUMENT

GRADE 10

PHYSICAL SCIENCES

SOLUTIONS

2026

PREFACE

This support document serves to assist Physical Sciences learners on how to deal with curriculum gaps and learning losses. It addresses various topics in the Grade 10 curriculum.

Solutions of activities serve as a marking guide on various topics assessed at different cognitive levels in the learner support document. The document prepares learners for informal and formal tasks in Physical Sciences. It covers the following topics:

TERM 1 TOPICS
WAVES, SOUND AND LIGHT • ELECTROMAGNETIC RADIATION
ELECTRICITY AND MAGNETISM • ELECTROSTATICS • ELECTRIC CIRCUITS
TERM 2 TOPICS
ELECTRICITY AND MAGNETISM • ELECTRIC CIRCUITS
MATTER AND MATERIALS • STATES OF MATTER & KMT • THE ATOM • THE PERIODIC TABLE • CHEMICAL BONDING
CHEMICAL CHANGE • PHYSICAL CHANGE AND CHEMICAL CHANGE • REPRESENTING CHEMICAL CHANGE • QUANTITATIVE ASPECTS OF CHEMICAL CHANGE
TERM 3 TOPICS
CHEMICAL CHANGE • QUANTITATIVE ASPECTS OF CHEMICAL CHANGE
MECHANICS • VECTORS & SCALARS • MOTION IN ONE DIMENSION • INSTANTANEOUS SPEED AND VELOCITY • EQUATIONS OF MOTION
TERM 4 TOPICS
MECHANICS • ENERGY

WAVES, SOUND AND LIGHT
ELECTROMAGNETIC RADIATION
QUESTION 1
Multiple choice solutions

1.1 C✓✓ All waves, regardless of their type or medium transmit energy from one point to another (2)

1.2 B✓✓ Point X, maximum point of the pulse above the rest position(crest)
Point Y, minimum point of the pulse below the rest position(trough) (2)

1.3 D✓✓ Frequency is defined as the number of wave pulses that pass a point per second. (2)

1.4 A✓✓ Pitch ∞ frequency
Loudness ∞ amplitude (2)

1.5 C✓✓ Ultrasound uses high frequency sound to create images of the unborn baby (it is the safe choice for monitoring a pregnancy) (2)

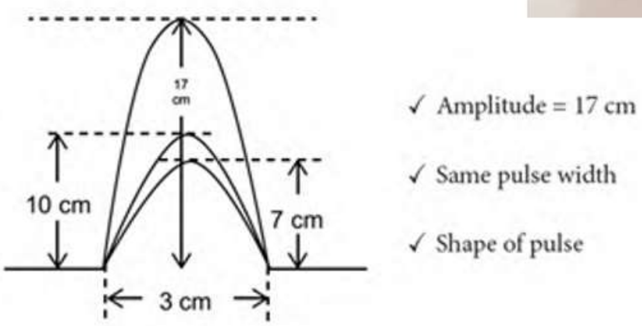
QUESTION 2

2.1 A pulse is a single disturbance in a medium ✓✓ (2)

2.2 Constructive interference ✓✓ (2)

2.3 principle of superposition as the algebraic sum of the amplitudes of two pulses that occupy the same space at the same time.✓✓ (2)

2.4



(3)

2.5 Moves to the left (1)

2.6 V= distance/time (method)✓
= 60/2x60 ✓ (2x60=120 minutes to seconds)
= 0.5 m.s^{-1} ✓ (3)

QUESTION 3

3.1 Transverse wave ✓: a succession of transverse pulse ✓✓ (3)

3.2 A Particles of the medium move perpendicular to the direction of propagation of the wave ✓

B Particles move parallel to the direction of propagation of the wave ✓ (2)

3.3 R: trough ✓
O: Crest ✓
W: wavelength ✓
X: compression ✓ (4)

3.4 3 waves ✓

3.5 *f=number of waves/time taken* ✓
= 3/0.3 ✓
= 10 Hz ✓ (3)

3.6 $T=1/f$
= 1/ 10
=0,1 s ✓ (1)

3.7 period✓ (1)

3.8

3.8.1 points in phase are separated by the whole number multiple of complete wavelength. ✓ (1)

3.8.2 P and O /P and S / S and O ✓ (1)

3.9 The maximum displacement of a particle from its equilibrium position.✓✓ (2)

3.10 Loudness (Volume) (1)

3.11 $c = f\lambda$✓
0.05 = 0.2λ positive marking from 3.5
λ = 0.2 m
X = 200 x 1.5
= 300 mm (3)

QUESTION 4

4.1 transverse wave as a wave in which the particles of the medium vibrate at right angles to the direction of motion of the wave. (2)

4.2 *F=1/T* ✓
= ¼ ✓
= 0.25 Hz ✓ (3)

4.3 $c = f\lambda$✓
0.05 = 0.2λ✓
λ = 0.2 m ✓
X = 200 x 1.5 ✓
= 300 mm ✓ (5)

4.4 3,5x4 = 14 s (1)

QUESTION 5

5.1

5.1.1 Compression as a region of high pressure in a longitudinal wave.✓✓ (2)

5.1.2 $24 \div 2{,}5 = 9{,}6$ cm ✓✓ (2)

5.1.3 1,5s to make 2,5 waves ✓
X s to make 1 wave
X = 0,6 s ✓ (2)

5.2

5.2.1 The sound wave reflects off the hard surface. ✓ (1)

5.2.2 3 s ✓ (1)

5.2.3 $v = \frac{\partial}{t}$

$v = \frac{1000}{3}$ ✓

v = 333.33 $m.s^{-1}$ ✓ (2)

5.2.4 Greater than ✓
Water is denser than air ✓ (2)

QUESTION 6

6.1

6.1.1 $\Delta x = v\Delta t$ ✓
85 = v (0,25) ✓
V = 340 $m.s^{-1}$ ✓ (3)

6.1.2 Positive marking from 6.1.1
v = fλ ✓
340 = (100) λ ✓
λ = 3,40 m ✓ (3)

6.2

6.2.1 Ultrasound refers to sound with a frequency of 20 kHz to 100 kHz ✓✓ (2)

6.2.2 Detecting invisible cracks in the wings of aircraft

Determining the thickness of metals/plastic

Cleaning delicate mechanisms of old-fashioned clocks (any one) ✓ (1)

6.2.3 Ultrasound does not damage the soft tissue of human organs. ✓✓ (2)

QUESTION 7

7.1

7.1.1 Infra-red ✓ (1)

7.1.2 Sun or Gas discharge tube ✓ (1)

7.2 $E = h\frac{C}{\lambda}$ ✓

$E = (6.63 \times 10^{-34})(3 \times 10^{8}/4 \times 10^{-5})$ ✓✓

$E = 4.97 \times 10^{-21}$ (5)

7.3

7.3.1 B ✓ has a highest energy/ frequency than ultraviolet ✓✓ (3)

7.3.2 Type of (electromagnetic) radiation OR
Frequency (of electromagnetic radiation) ✓ (1)

7.3.3 To have an independent variable OR
Fair test OR
Fair investigation ✓✓ (2)

ELECTROSTATICS		
QUESTION 1		
1.1	C ✓✓	(2)
1.2	A ✓✓	(2)
1.3	D ✓✓	(2)
1.4	B ✓✓	(2)
1.5	A ✓✓	(2)
		[10]
LONG QUESTIONS		
QUESTION 2		
2.1	The net charge of an isolated system remains the same ✓✓	(2)
2.2	S ✓ the sphere is negatively charge ✓	(2)
2.3.1	$Q_{new} = \frac{Q_1 + Q_2}{2}$ ✓ $Q_{new} = \frac{2 \times 10^{-9} + (-4 \times 10^{-9})}{2}$ ✓ $Q_{new} = -1 \times 10^{-9} C$ ✓	(3)
2.3.2	**OPTION 1** $\Delta Q = nq_e$ $Q_{final} - Q_{initial} = nq_e$ $-1 \times 10^{-9} - 2 \times 10^{-9} = \text{n} \times 1.6 \times 10^{-19}$ $n = 1.875 \times 10^{10}$ *electrons* **OPTION 2** $\Delta Q = nq_e$ $Q_{final} - Q_{initial} = nq_e$ $-1 \times 10^{-9} - (-4 \times 10^{-9}) = \text{n} \times 1.6 \times 10^{-19}$ $n = 1.875 \times 10^{10}$ *electrons*	(3)
2.4	During contact, electrons are transferred from S to R ✓ The spheres acquire equal charges ✓ Sphere thus repel ✓	(3)
		[13]
QUESTION 3		
3.1	$Q = nq_e$ ✓ $Q = 2 \times 10^{13} \times 1.6 \times 10^{-19}$ $Q = -3.2 \times 10^{-6} C$ ✓	(3)
3.2	The net charge of an isolated system remains constant during any physical process ✓✓	(2)
3.3.1	$Q_{new} = \frac{Q_1 + Q_2}{2}$ ✓ $6.4 \times 10^{-6} = \frac{-3.2 \times 10^{-6} + Q_2}{2}$ ✓	

$Q_{new} = 1.6 \times 10^{-5}\ C$ ✓ (3)

3.3.2

OPTION 1	OPTION 2
$\Delta Q = nq_e$ $Q_{final} - Q_{initial} = nq_e$ $6.4 \times 10^{-6} - 1.6 \times 10^{-5} = n\ 1.6 \times 10^{-19}$ $n = 6 \times 10^{13}$ *electrons*	$\Delta Q = nq_e$ $Q_{final} - Q_{initial} = nq_e$ $6.4 \times 10^{-6} - (3.2 \times 10^{-6}) = \mathrm{n} \times 1.6 \times 10^{-19}$ $n = 6 \times 10^{13}$ *electrons*

(3)

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QUESTION 4

4.1 Neutral object: Has equal amount of both protons and electrons ✓
Charged object: Has either gained or lost electrons. ✓ (2)

4.2 Added to ✓ (1)

4.3 $Q = nq_e$ ✓
$3 \times 10^{-6} = n \times 1.6 \times 10^{-19}$
$n = 1.88 \times 10^{13}$ electrons ✓ (3)

4.4.1 When the charged plastic ruler is brought closer to the uncharged pieces of paper, the paper is polarised. ✓The negative charges on the paper are repelled by the negative charges on the ruler. ✓This leaves the side of the paper closest to the ruler positive. ✓ (3)

4.4.2 Photocopier✓ or
Finger printing *or*
Spray painting (1)

[10]

QUESTION 5

5.1.1 Added ✓ (1)

5.1.2 Less than✓, negatively charged ✓/has more electrons than protons/has less protons than electron. ✓ (3)

5.1.3 $Q = nq_e$ ✓
$\mathrm{Q} = 10^{13} \times 1.6 \times 10^{-19}$
$Q = -1.604 \times 10^{-6}\ C$ ✓ (4)

5.2.1 Principle of conservation of charge: The net charge of an isolated system remains constant during any physical process. ✓✓ (2)

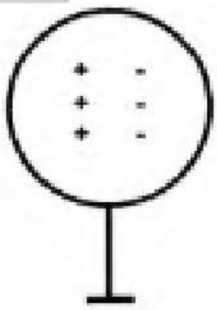
5.2.2 Electrons move from C to B, ✓ until they are evenly distributed. ✓The negative charges from B repel away towards the left while the positive charges migrate towards the right to attract the negative charges from C that have migrated towards the left and the positive charges from C migrate towards the left. ✓ Sphere B is attracted to sphere C because unlike charges attract one another. (3)

5.2.3

OPTION 1	**OPTION 2**
$\Delta Q = nq_e$ $Q_{final} - Q_{initial} = nq_e$ $4 \times 10^{-6} - 6 \times 10^{-5} = \mathrm{n} \times 1.6 \times 10^{-19}$ $n = 1.25 \times 10^{13}$ *electrons*	$\Delta Q = nq_e$ $Q_{final} - Q_{initial} = nq_e$ $4 \times 10^{-6} - 6 \times 10^{-5} = \mathrm{n} \times 1.6 \times 10^{-19}$ $n = 1.25 \times 10^{13}$ *electrons*

(4)

[17]

QUESTION 6		
6.1	Process by which objects are charged by contact/ rubbing ✓✓	(2)
6.2.1	$Q = nq_e$ ✓ $-3.2 \times 10^{-17} = n \times -1.6 \times 10^{-19}$ $n = 200\ electrons$ ✓	(3)
6.2.2	No smallest change that can exist is $1.6 \times 10^{-19}\ C$ ✓	(1)
6.2.3	Principle of Charge Quantization ✓	(1)
6.3.1	Number of electrons equals number of protons ✓✓	(2)
6.3.2	 ✓✓	(2)
6.3.3	Charge Polarisation ✓	(1)
6.3.4	The net charge in an isolated system remains constant during any physical process ✓✓	(2)
6.3.5	$Q_{new} = \frac{Q_1 + Q_2}{2}$ ✓ $Q_{new} = \frac{6.4 \times 10^{-9} + (0)}{2}$ ✓ $Q_{new} = -3.2 \times 10^{-9} C$ ✓	(3)
6.4	B: neutral ✓ C: positive ✓ D: positive ✓ E: negative ✓ F: negative ✓	(5)
		[23]

ELECTRIC CIRCUITS
SOLUTIONS

QUESTION 1

1.1	D	✓✓	(2)
1.2	D	✓✓	(2)
1.3	A	✓✓	(2)
1.4	B	✓✓	(2)
			[8]

STRUCTURED QUESTIONS
QUESTION 2

2.1.1	In series✓	(1)
2.1.2	In parallel✓	(1)
2.1.3	R = V/I✓ R = 4/3 ✓= 1,33 ✓	(3)
2.2.1	Resistance is the ratio of the potential difference across a resistor to the current in the resistor. ✓✓	(2)
2.2.2	$R_T = R_1 + R_2 + R_3 + \ldots$✓ RT = 3+6+7✓ = 16 Ω✓	(3)
		[10]

QUESTION 3

3.1 Emf is the work per unit charge by the source (battery).✓✓

3.2.1 Current✓✓ (1)

3.2.2 Potential difference (1)

3.3.1 Potential difference is the energy transferred per unit electric charge flowing through it.✓✓

3.3.2 I =Q/t✓ (3)

= 6/3 ✓= 2 A✓

3.3.3 V = W/Q✓ (3)

4=W/6✓

W = 24 J ✓

[12]

QUESTION 4

4.1.1 0 V (1)

4.1.2 0 A (1)

4.2.1 $\frac{1}{\mathrm{Rp}} = \frac{1}{\mathrm{R1}} + \frac{1}{\mathrm{R2}}$ ✓ (4)

$\frac{1}{\mathrm{Rp}} = \frac{1}{8} + \frac{1}{8}$ ✓

Rp = 8/2 = 4 Ω

R_T = 4 +8 ✓

R_T = 12 Ω✓

4.2.2 $I_T = V_T/R_T$ (3)

= 24/12 = 2 A ✓

$V_2 = I2R_2$ ✓

= 2 X 8 = 16 V ✓

4.3 $I_2 = I_3$ ✓ (1)

4.4.1 Resistance is directly proportional to the length of the conductor. ✓ (1)

4.4.2 1.4 Ω ✓ (1)

[12]

QUESTION 5

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

5.2.1

OPTION 1

$R = \frac{V}{I}$ ✓

$= \frac{9}{0,9}$ ✓

= 10 Ω

∴ 10 = 3 + Rx ✓

Rx = 7 Ω ✓

OPTION 2

V_1 = RIT

= 3 x 0,9

2,7V

V_2 = 9 – 2,7

✓

V_2 = 6,3 V

$R = \frac{V}{I}$ ✓

$= \frac{6.3}{0,9}$ ✓

= 7 Ω ✓

(4)

5.2.2

V_1 = IR

= 0,9 x 3 ✓

= 2,7 V ✓ (3)

5.3.1 $\frac{1}{Rp} = \frac{1}{\cancel{R1}} + \frac{1}{\cancel{R2}}$ ✓

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

Rp = 2 Ω ✓

(3)

5.3.2 **Positive marking from QUESTION 5.3.1**

$R_T = Rp + Rx$
$= 2 + 7$ ✓
$= 9\ \Omega$ ✓ (2)

5.3.3
V = IR✓
9 ✓ = I(9)
I = 1A ✓ (3)

5.3.4
OPTION 1

$V_1 = IRp$
$= 1 \times 2$
$= 2\ V$

V = IR
2 ✓ = I (6)
I = 0,33 A

OPTION 2

13 Ω = 216 Ω ✓
1T = 13Ω + 16Ω
1 = 316 Ω ✓
16Ω = 0,33 A ✓ (3)

QUESTION 6

6.1 The opposition to the flow of charge OR die ratio of the potential difference across a resistor to the current in the resistor. ✓✓ **(2)**

6.2
$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{4} + \frac{1}{5}$$
$$R_P = 2{,}22\Omega$$

$$R_T = R_S + R_P = 4 + 2{,}22 = 6{,}22\Omega$$ **(4)**

6.3.1
$$V = \frac{W}{Q} = \frac{120}{10} = 12\,V$$ **(3)**

6.3.2
$$I = \frac{Q}{\Delta t} = \frac{10}{5{,}18} = 1{,}93A$$ **(3)**
[12]

QUESTION 7

7.1.1 **9V✓** **(1)**
7.1.2 **0V✓** **(1)**

7.2
$$R = \frac{V}{I}$$
$$12 = \frac{9}{I}$$
$$I = 0{,}75A$$ **(3)**

7.3
$$I = \frac{Q}{\Delta t}$$
$$0{,}75 = \frac{Q}{6 \times 60}$$
$$Q = 270c$$ **(4)**

7.4.1 **Rate of flow of charge.✓✓** **(2)**

7.4.2
$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{4} + \frac{1}{12}$$
$$R_P = 3\Omega$$

$$R_T = 3 + 8 = 11\Omega$$

$$I = \frac{V}{R} = \frac{9}{11} = 0{,}8182A$$

$$V_2 = IR = 0{,}8182 \times 3 = 2{,}4546\,V$$

$$I = \frac{V}{R} = \frac{2{,}4546}{12} = 0{,}20455A$$ **(6)**
[17]

QUESTION 8

8.1 $R_T = R_1 + R_2 = 4 + 2 = 6\Omega$ **(2)**

8.2 $R = \frac{V}{I}$

$6 = \frac{12}{I}$

$I = 2A$ **(3)**

8.3 $V_1 = IR = 2 \times 4 = 8\,V$ **(3)**

8.4 $V_T = V_1 + V_2$

$12 = 8 + V_2$

$V_2 = 4\,V$ **(2)**

[10]

Matter And Materials Activities Solutions

QUESTION 1 (Multiple Choice QUESTIONs)

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

[18]

QUESTION 2

2.1 Energy needed per mole to remove the first electron from an atom in a gaseous phase. ✓✓ (2)

2.2 The **ionization energy increases** moving from left right across the period. ✓✓ (2)

2.3

2.3.1 Beryllium - $1s^2 2s^2$ ✓ (1)

Boron - $1s^2 2s^2 2p^1$ ✓ (1)

2.3.2 The 2p orbital of Boron is higher in energy and slightly further from the nucleus, requiring less energy to remove. ✓✓ (2)

2.4 False, The ionization energy of noble gases is high because of the **fully-filled** s- and p- orbitals.✓✓ (2)

2.5

2.5.1 Alkali Metals✓ (1)

2.5.2 Reactivity increases down the group.✓ (1)

2.5.3 The ionization energy decreases down the group which leads to the weakening of the attractive force and making it easier to remove the valence electrons. ✓✓ (2)

[14]

QUESTION 3

3.1 The temperature of a liquid at which its vapour pressure equals the Atmospheric(external) pressure.✓✓ (2)

3.2 Thermometer ✓✓ (2)

3.3 To increase the surface area of contact for faster heat transfer.✓✓ (2)

3.4

3.4.1 100 ^{0}C ✓ (1)

3.4.2 Liquid Phase.✓ (1)

3.4.3 Evaporation.✓ (1)

3.4.4 between t_1 and t_2 all solid has melted the heat added increases the temperature and the kinetic energy of the liquid molecules.✓✓ (2)

3.4.5 A significant increase of the gap between the time intervals will occur and the graph will be less steeper/the slope of the graph will be reduced.✓✓ (2)

[13]

QUESTION 4

4.1.1 18 electrons ✓ (1)

4.1.2 Cl, atomic number is 17 (3)

Sp-notation: $1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^5$ ✓

Aufbau diagram: 3p [↑↓][↑↓][↑]

3s [↑↓]
2p [↑↓][↑↓][↑↓]
2s [↑↓]
1s [↑↓] ✓✓

4.1.3 Ionic bond ✓ (1)
(bond formed between a metal and a non-metal through electron transfer)

4.1.4 (2)
Lewis structure: $[Ca]^{2+} 2[:Cl:]^-$ ✓✓

4.2 Mass of other isotope (x) (6)
Relative atomic mass = (mass$_1$ x %$_1$) + (mass$_2$ x %$_2$) ✓
63.5 = (65 X 0.25) + (x X 0.75) ✓
63.5 = 16.25 + 0.75x
X = 63✓

Abundant isotope is Copper (63). It has 75% abundance thus most abundant
Neutrons in Copper 63
Neutrons = Mass number – Atomic number✓
Neutrons = 63 – 29✓
Neutrons = 34
Therefore 34 neutrons ✓

4.3.1 Magnesium Oxide: MgO ✓✓ (2)
4.3.2 Ammonium dichromate: $(NH_4)_2Cr_2O_7$ ✓✓ (2)
4.4 $Cu(NO_3)_2$: Copper(II)nitrate ✓✓ (2)
[17]

QUESTION 5

5.1 Magnesium + Oxygen → Magnesium oxide ✓✓ ✓ (3)
5.2 MgO ✓✓ (2)
5.3 $3s^2$ ✓✓ (2)
5.4 $2s^2 2p^4$ ✓✓ (2)
5.5 Mg^{2+} ✓ (1)
5.6 O^{2-} ✓ (1)
[11]

PHYSICAL AND CHEMICAL CHANGE: SOLUTIONS

QUESTION 1

1.1 C No new substances are formed, (2)
1.2 D Release of a gas indicates that a chemical change is occurring. During a chemical change there is always a change in temperature (2)
1.3 D (2)
1.4 B The law of constant composition states that atoms of elements combine in fixed ratios to produce a specific compound. Note that it is not a mass ratio in which elements combine. The last statement is correct, but it is not the law of constant composition. (2)
1.5 A The number of molecules being conserved is not what occurs in a chemical change (2)

[10]

QUESTION 2

2.1 Physical change ✓ (1)
2.1.1 No new substances are formed ✓✓ (2)
2.1.2 The number of atoms molecules and mass is conserved ✓ (1)
2.1.3 Physical change ✓ (1)
2.1.4 Chemical change ✓ (1)
2.1.5 New substances formed ✓ (1)

2.2 By the law of conservation of mass, the total mass of reactants and products must be the same.✓ So,

Reactants = Products (3)

X + 16,5 = 23,5 + 10 ✓

X = 17,0 g✓

2.3.1 a. Reactants:

NH_3 : m = 4(14 + 1 X 3)
= 68 ✓

O2: m = 5(2 x 16)
= 160 ✓

Total reactants = 228 ✓

Products:

NO: m = 4(14 + 16)
= 120 ✓

H2O: m = 6(2 X 1 + 16)
= 108 ✓

Total products = 228 ✓

∴ reactants = products ✓ (7)

2.3.2 a. Reactants: N = 4 atoms✓
H = 4 X 3 = 12 atoms✓
O = 5 X 2 = 10 atoms✓

Products: N = 4 X 1 = 4 atoms✓
O = 4 X 1 + 6 X 1 = 10 atoms✓
H = 6 X 2 = 12 atoms✓

Number of atoms of each element is the same in reactants and products.

∴ conserved. ✓ (7)

2.4 The number of molecules of each substance is not conserved in a chemical change because the molecules of the reactants each break up✓ when they react and form different molecules in the products✓. The number of molecules may increase or decrease.✓ (3)

[24]

QUESTION 3

3.1.1 In solid sulphur, the molecules are held in place in a crystal lattice by intermolecular forces. ✓ When the sulphur melts, the molecules become disordered✓ because the intermolecular forces can no longer keep them in the crystal lattice arrangement. ✓ (3)

3.1.2 In liquid sulphur there are still intermolecular forces in place ✓so the molecules are not totally free to move. ✓When the sulphur absorbs more energy, the intermolecular forces are broken completely ✓and the sulphur molecules are totally free to move.✓ (4)

QUANTITATIVE ASPECTS

Solutions

QUESTION 1

1.1 B (2)

1.2 B (2)

1.3 A (2)

1.4 A (2)

1.5 C (2)

[10]

QUESTION 2

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

2.1.2. $n(Mg_3N_2) = \frac{m}{M}$

$= \frac{10}{24 \times 3 + 14 \times 2} = 0,1 \text{ mol}$ ✓

(3)

2.2.1. $Mg_3N_2 : HCl$

1 : 6 ✓

$n(HCl) = 0,6 \text{ mol}$

$c(HCl) = \frac{n}{V}$

$= \frac{0,6}{1,2}$

$= 0,5 \text{ mol·dm}^3$ ✓ (4)

2.2.2. $Mg_3N_2 : NH_3$

1 : 2 ✓

$n(NH_3) = 0,2 \text{ mol}$

$n(NH_3) = \frac{V}{V_m}$

$0,2 = \frac{V}{22,4}$

$V(H_2) = 4,48 \text{ dm}^3$ ✓ (4)

2.2.3. $Mg_3N_2 : MgCl_2$

1 : 3 ✓

$n(MgCl_2) = 0,3 \text{ mol}$

$n(MgCl_2) = \frac{N}{N_A}$

$0,3 = \frac{N}{6,02 \times 10^{23}}$

$N(MgCl_2) = 1,806 \times 10^{23}$ formula units

$N(Cl^-) = \underline{2 \times}$ ✓ $1,806 \times 10^{23}$

$= 3,612 \times 10^{23}$ ions✓ (5)

[18]

QUESTION 3

3.1 The mass of one mole of substance. ✓✓ (2)

3.2.1 $n(Fe_2O_3) = \frac{m}{M}$ ✓

$n(Fe_2O_3) = \frac{1200}{160}$ ✓

$= 7{,}5$ mol ✓

(3)

3.2.2 $Fe_2O_3 : Fe_3O_4$

3 : 2 ✓

$n(Fe_3O_4) = 5$ mol

$n(Fe_3O_4) = \frac{N}{N_A}$ ✓

$5 = \frac{N}{6{,}02 \times 10^{23}}$ ✓

$N(Fe_3O_4) = 3{,}01 \times 10^{24}$ Fe_3O_4 molecules ✓

(4)

3.2.3 $Fe_2O_3 : CO$

3 : 1 ✓

$n(CO) = 2{,}5$ mol

$n(CO) = \frac{V}{V_m}$ ✓

$2.5 = \frac{V}{22.4}$ ✓

$V(CO) = 56$ dm^3 ✓

(4)

3.2.4 $n = \frac{Mr\ Fe}{Mr\ Fe2O3} = \frac{56 \times 2}{160} = 70\ \%$

(2)

[15]

QUESTION 4

4.1.1 The simplest whole-number ratio✓ of atoms in a compound ✓

(2)

4.1.2. Consider 100g

Element	mass (g)	$n = \frac{m}{M}$	Simplest Ratio		Simplest Ratio (Modified)	
C	48,65	$\frac{48{,}65}{12} = 4{,}05$ ✓	$\frac{4{,}05}{2{,}7} = 1{,}5$	✓ (all simplest ratios)	1,5 x 2 = 3	✓ (all modified simplest ratios)
H	8,11	$\frac{8{,}11}{1} = 8.11$ ✓	$\frac{8{,}11}{2{,}7} = 3$		3 x 2 = 6	
O	43,24	$\frac{43{,}24}{16} = 2{,}7$ ✓	$\frac{2{,}7}{2.7} = 1$		1x 2 = 2	

Empirical Formula: $C_3H_6O_2$ ✓

(6)

4.2. $m(O) = 10 – 4{,}21 – 1{,}89 = 3{,}9$ g ✓

Element	mass (g)	$n = \frac{m}{M}$	Simplest Ratio	
Na	4,21	$\frac{4{,}21}{23} = 0{,}18$ ✓	$\frac{0{,}18}{0{,}06} = 3$	✓ (Obtaining all simplest ratios)
P	1,89	$\frac{1{,}89}{31} = 0{,}06$ ✓	$\frac{0{,}06}{0{,}06} = 1$	
O	3,9	$\frac{3{,}9}{16} = 0{,}24$ ✓	$\frac{0{,}24}{0{,}06} = 4$	

Empirical Formula: Na_3PO_4 ✓

(6)

4.3.1. $c = \frac{m}{MV}$

$0,5 = \frac{15,75}{M(0,25)}$

$M(H_2C_2O_4.\mathbf{x}H_2O) = 126\ g.mol^{-1}$ ✓ (3)

4.3.2. $M(H_2C_2O_4.\mathbf{x}H_2O) = M(H_2C_2O_4) + \mathbf{x}M(H_2O)$

126 ✓ $= \underline{2 + 2x12 + 4x16 + \mathbf{x}(18)}$ ✓

$\mathbf{x} = 2$ ✓

(3)

[20]

QUESTION 5

5.1 $\%\ yield = \frac{actual\ yield}{theoretical\ yield} \times 100$

$75 = \frac{80}{theoretical\ yield} \times 100$

$m(PbI_2)_{theoretical} = 106,67\ g$

$n(PbI_2) = \frac{m}{M}$

$= \frac{106,67}{461}$

$n(PbI_2) = 0,23\ mol$

$KI : PbI_2$

2 : 1 ✓

$n(KI) = 0,46\ mol$

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

$0,46 = \frac{m}{166}$ ✓

$m(KI) = 76,36\ g$ ✓

(6)

5.2. $CH_4 : H_2$

1 : 3✓

H_2 (Theoretical) = 41.4 ×3 ✓=124.2 dm^3 ✓

$Percentage\ yield = \frac{Actual\ yield}{Theoretical\ yield} \times 100$ ✓

$= \frac{55.89}{124.2} \times 100$✓

=45 %✓

(6)

5.3 $m(H_2)_{actual} = 0,8 \times m(H_2)_{theoretical}$

$1,2 = 0,8 \times m(H_2)_{theoretical}$ ✓

$m(H_2)_{theoretical} = 1,5\ g$

$n(H_2) = \frac{m}{M}$✓

$n(H_2) = \frac{1,5}{2}$ ✓

$n(H_2) = 0,75\ mol$

$Mg : H_2$

1 : 1 ✓

$n(Mg) = 0,75\ mol$

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

$0,75 = \frac{m}{24}$✓

$m(Mg) = 18\ g$ ✓

(6)

[18]

QUESTION 6

6.1 $C(H_2SO_4) = \frac{n}{V}$✓

$0,75 = \frac{n}{0,4}$ ✓

$n(H_2SO_4) = 0,3\ mol$

(6)

Y : H_2SO_4
2 : 1 ✓
n(Y) = 0,6 mol

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

$0,6 = \frac{13,8}{M}$

M(Y) = 23 $g.mol^{-1}$
Y is Sodium ✓

6.2. $C_3H_8 : CO_2$
1 : 3 ✓
$V(CO_2) = 15\ dm^3$
$C_3H_8 : H_2O$
1 : 4 ✓
$V(H_2O) = 20\ dm^3$
V (end) = 15 + 20 ✓
= 35 dm^3 ✓

(4)

6.3 $V(CO_2) = 12\ dm^3$ ✓
$C_3H_8 : CO_2$
1 : 3 ✓
$V(C_3H_8) = 4\ dm^3$

$n(C_3H_8) = \frac{V}{V_m}$

$= \frac{4}{22,4}$ ✓

= 0,18 mol

$n(C_3H_8) = \frac{m}{M}$

$0,18 = \frac{m}{44}$

$m(C_3H_8) = 7,92$ g ✓

(5)

[15]

QUESTION 7

7.1 $Gradient = \frac{120 - 0}{40 - 0} = 3$ (2)

7.2 The volume /mole ratio✓ between hydrogen and methane✓ (2)

7.3 $V(H_2) = 72 \times 3$
$= 216 cm^3$✓ (2)

7.4 $CO : H_2$
1 : 3
$V(H_2) = \frac{3}{4} \times 420$✓
y = 315✓
x = 315 ÷3✓
= 105✓

(4)

[10]

SOLUTIONS: VECTORS AND SCALARS

QUESTION 1

1.1 C✓✓ (2)

1.2 B✓✓ (2)

1.3 D✓✓ (2)

QUESTION 2

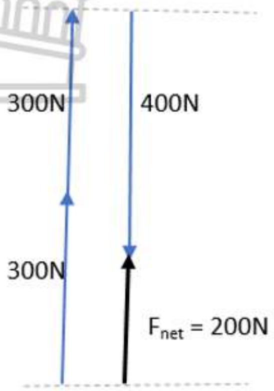
2.1.1 Resultant vector is the single vector that has the same effect as two or more vectors acting together. ✓✓ (2)

2.1.2 Fnet = $F_1 + F_2 + F_3$✓
= 100 + (-15) +(-80) ✓
= 5N to the right✓ (3)

2.1.3 RIGHT✓ (1)

2.2.1 Vector quantities have both magnitude and direction✓✓ (2)

2.2.2



(1 mark for each force drawn correctly) (3)

2.3.1 Distance = 80 + 60 ✓
= 140 m ✓ (2)

2.3.2 Upward positive:
Displacement = +80 + (-60)
= 20 m ✓ upwards
Upward negative:
Displacement = -80 + 60
= 20 m ✓ upwards (2)

[15]

SOLUTIONS – MOTION IN ONE DIMENSION

QUESTION 1

1.1 B✓✓ (2)

1.2 A✓✓ (2)

1.3 B✓✓ (2)

[6]

QUESTION 2

2.1 50 m east ✓✓ (2)

2.2 Distance = 50+50+90+40 = 230 m ✓
speed= $\frac{distance}{time}$ ✓
= $\frac{230}{30}$ ✓
= 7,67 m.s-1 ✓ (4)

2.3.1 speed= $\frac{distance}{time}$ ✓
6.67 = $\frac{90+90+100}{time}$ ✓
time = 41,98 m.s-1 ✓ (3)

2.3.2 v=$\frac{\Delta x}{\Delta t}$ ✓
v=$\frac{100}{41,98}$ ✓
v= 2.38 m.s-1 west ✓ (3)

[12]

QUESTION 3

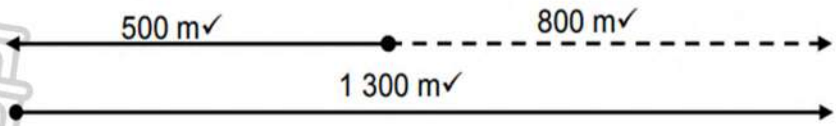
3.1 The total distance travelled per total time. (2)

3.2 Average speed= $\frac{distance\ travelled}{time\ taken}$ (4)

$= \frac{(500 + 800)}{(30 \times 60)}$

=0,72 m.s-1

3.3



(3)

3.4 Average speed= $\frac{distance\ travelled}{time\ taken}$

$0.72 = \frac{(500 + 500 + 1300)}{time\ taken}$

t= 3194,44s (4)

[12]

QUESTION 4

4.1 The difference in position in space. ✓✓ (2)

4.2 12 m ✓west ✓ or -12 m ✓✓ (2)

4.3

$$v = \frac{\Delta x}{\Delta t}$$
$$= \frac{5}{30} ✓✓$$
$$= 0{,}17\ m \cdot s^{-1} ✓ \text{ west } ✓$$

(4)

4.4

$speed = \frac{distance}{time}$ ✓

$(0{,}17)(2)$ ✓ $= \frac{12}{t}$ ✓

$0{,}34 = \frac{12}{t}$

$t = 35{,}29\ s$ ✓ (4)

4.5

$$a = \frac{\Delta v}{\Delta t} ✓$$
$$= \frac{v_f - v_i}{t_f - t_i}$$
$$= \frac{5-3}{0{,}8-0} ✓$$
$$a = 2{,}5 \text{ ms-2 } ✓ \text{ east } ✓$$

(4)

[16]

SOLUTIONS (INSTANTANEOUS VELOCITY AND INSTANTANEOUS SPEED)

QUESTION 1

1.1 C ✓✓

1.2 A ✓✓

1.3 C ✓✓

1.4 B ✓✓

[8]

QUESTION 2

2.1 Is displacement (change in position) divided by very small time interval. ✓✓ (2)

2.2 From C to D:

The car turns around/moves south/moves in opposite direction/moves with velocity that increases from 0 m·s-1 to 6 m·s-1. ✓

at an increased velocity/constant acceleration. ✓

From point D to E:

The car travels at a constant velocity south. ✓ (3)

2.3.1 $A = L \times B$

$= 20 \times 2$ ✓

$= 20m$

$A = \frac{1}{2} b \times h$

$= \frac{1}{2}(4)(40)$ ✓

$= 20m$ (4)

Total distance = 20m + 20m ✓

= 40m ✓

2.3.2 $m = \frac{\Delta v}{\Delta t}$

$= \frac{0 - 10}{6 - 2}$ ✓✓

$= -2.5$

$a = 2.5 m.s^{-2}$ south ✓✓ (4)

2.4 Smaller than ✓ (1)

2.5 Slope of the graph at B – C is steeper than C – D ✓ (1)

2.6 North ✓ (1)

[16]

QUESTION 3

3.1 Magnitude of instantaneous velocity or the velocity at a specific moment ✓✓ (2)

3.2.1 The car start from rest and velocity increases to 10 m.s^{-1} in 20 seconds

Constant positive acceleration or uniformly accelerated motion ✓✓ (2)

3.2.2 Velocity is constant (uniformly) ✓

Acceleration is zero ✓ (2)

3.2.3 Car has stopped. Acceleration is zero ✓✓ (2)

[8]

SOLUTIONS – EQUATIONS OF MOTION

QUESTION 1

1.1 Car A

$\Delta x = v_i\Delta t + ½ a\Delta t^2$ ✓

$500 = 0\Delta t + ½(1,2)\Delta t^2$ ✓

$\Delta t = 28,87$ s ✓

Car B

$\Delta x = v_i\Delta t + ½ a\Delta t^2$

$500 = 27,78\Delta t + ½(0)\Delta t^2$ ✓

$\Delta t = 18$ s ✓

Car B will reach the robot 2 first ✓ (6)

1.2 $v_f = v_i + a\Delta t$ ✓

$v_f = 0 + 1,2(28,87)$ ✓

$v_f = 34,64$ m.s^{-1} East ✓✓ (4)

[10]

QUESTION 2

2.1 $v_f = v_i + a\Delta t$ ✓

$0 = 25 + a(5)$ ✓

$a = -5$

$a = 5$ m.s^{-2} west ✓ (3)

2.2 VAN

$\Delta x = v_i\Delta t + ½ a\Delta t^2$ ✓

$\Delta x = 25(5) + ½(-5)(5)^2$ ✓

$\Delta x = 62,50$ m

CAR

$\Delta x = v_i\Delta t + ½ a\Delta t^2$

$\Delta x = 25(5) + ½(0)(5)^2$ ✓

$\Delta x = 125$ m

125 – 62.50 – 5 ✓ = 57.5m ✓ (5)

[8]

QUESTION 3

31. The rate of change of velocity ✓✓ (2)

3.2.1 $v_f = v_i + a\Delta t$ ✓ (3)

$0 = 15 + (-4,5)\Delta t$ ✓

$\Delta t = 3,33s$ ✓

3.2.2 $v_f^2 = v_i^2 + 2a\Delta x$ ✓

$(0)2 = (15)2 + 2(-4,5)\Delta x$ ✓

$\Delta x = 25\ m$ ✓ (3)

3.3 $v_f^2 = v_i^2 + 2a\Delta x$ ✓

$(0)2 = (30)2 + 2(-4,5)\Delta x$ ✓

$\Delta x = 100\ m$ ✓

Car B has a larger stopping distance (100 m > 25 m) ✓ (4)

3.4 The greater/larger the speed, the larger the stopping distance if acceleration is constant. ✓✓

(2)

[14]