KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES

COMMON TEST

SEPTEMBER 2022

Stanmorephysics.com

MARKS: **100**

DURATION: **2 hours**

This question paper consists of 8 pages, a data sheet and a periodic table.

INSTRUCTIONS AND INFORMATION

1. Write your name and class (e.g. 10A) in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of 7 questions. Answer ALL questions in the ANSWER BOOK.

3. Number the answers correctly according to the numbering system used in this question paper.

4. Leave ONE line between two sub questions, e.g. between QUESTION 2.1 and QUESTION 2.2.

5. You may use a non-programmable calculator.

6. You may use appropriate mathematical instruments.

7. You are advised to use the attached DATA SHEET and PERIODIC TABLE provided.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your final answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. Write neatly and legibly.

QUESTION 1: MULTUPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A-D) next to the question numbers (1.1 to 1.7) in the ANSWER BOOK, e.g. 1.8   D.

1.1   Which one of the following is equal to 1 Hertz (1Hz)?

     A   1 m.
     B 1 m.s^{-1}
     C   1 s
     D 1 s^{-1} (2)

1.2   A very loud explosion can damage a person's hearing. This provides evidence that sound waves …

     A   can be reflected.
     B   transfer energy.
     C   can travel through a vacuum.
     D   are longitudinal waves.   (2)

1.3   What is the name given to the process by which a solid changes directly into a gas?

     A   Evaporation.
     B   Condensation.
     C   Sublimation.
     D   Freezing.   (2)

1.4   Which ONE of the following combinations shows two elements combining in the same fixed ratio?

     A H_2O and H_2O_2
     B SO_2 and SO_3
     C NO_2 and N_2O_4
     D $FeC\ell_2$ and $FeC\ell_3$ (2)

1.5   What volume (in dm^3) does 1 gram of hydrogen gas occupy at STP?

     A   5,6
     B   11,2
     C   22,4
     D   44,8   (2)

1.6   What will the formula of compound XY be if it consists of 1 mole of X and 1,5 moles of Y?

     A XY_2
     B X_2Y
     C X_3Y_2
     D X_2Y_3 (2)

         Please turn over

1.7 What is the chemical name for $Fe_2(SO_4)_3$?
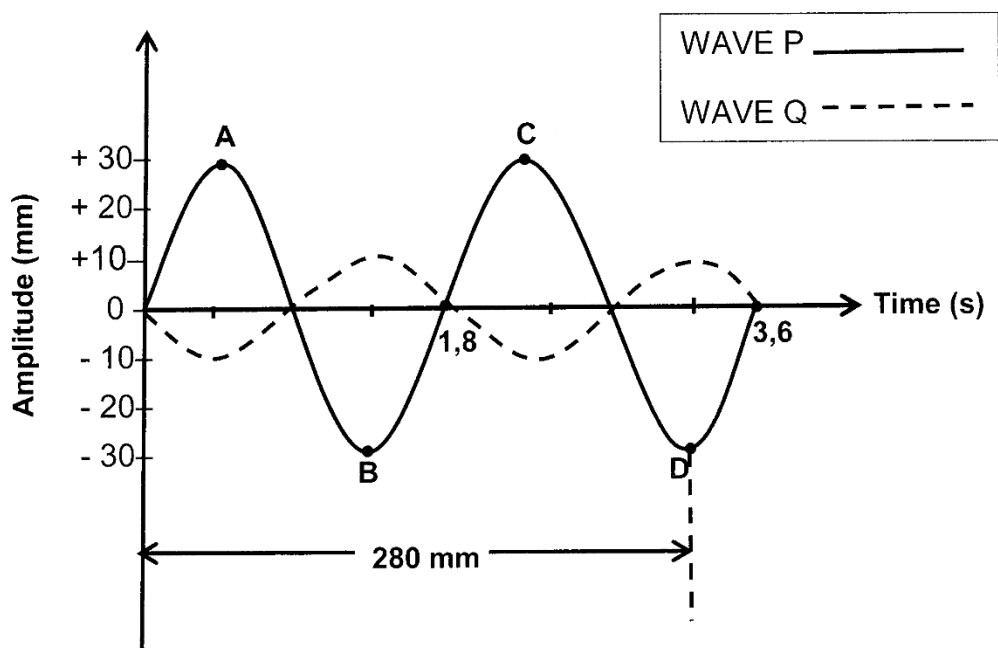
A   Iron (II) sulphite
B   Iron (II) sulphate
C   Iron (III) sulphate
D   Iron (III) sulphite   (2)
                                                                      [14]

QUESTION 2

2.1 The graph below shows two waves **P** and **Q**, that are travelling in the same medium at the same time.

2.1.1 State the Principle of superposition of waves.   (2)

2.1.2 Draw the shape of the resultant wave as the two waves (P and Q) cross at t = 1,35s.
      Indicate the value of the resultant amplitude on your diagram.   (3)

2.1.3 What type of interference is illustrated at t = 1,35s?   (1)

2.1.4 Refer to **wave P** and give TWO reasons why a particle at point A and another particle at point C are in phase.   (2)

2.1.5 Determine the frequency of **wave Q**.   (3)

2.1.6 Calculate the value of the wavelength of **wave Q**.   (3)

2.1.7 Calculate the speed of **wave Q**.   (3)

Please turn over

2.2   A learner uses a slinky spring to demonstrate the movement of a
        LONGITUDINAL WAVE. The slinky spring is fixed to a wall at one end while
        it is held at the other end. He vibrates the spring using his hand.
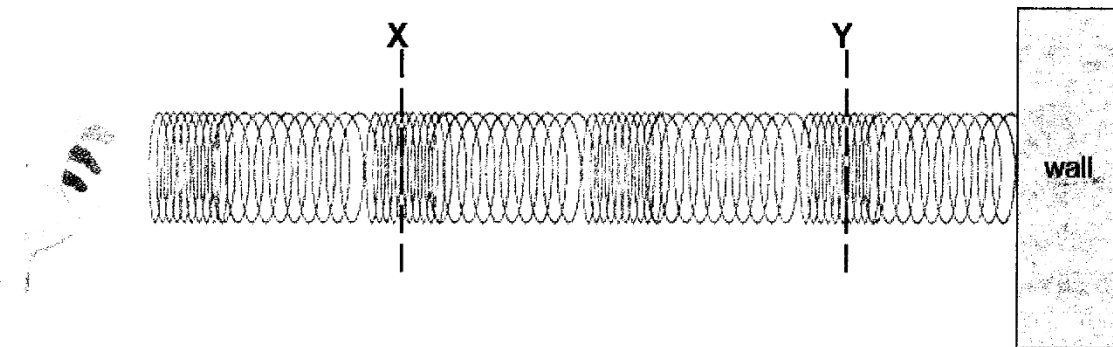
        2.2.1   Describe the hand movement that would be required in order to
                produce the wave pattern in the sketch above. Choose from
                PERPENDICULAR TO or PARALLEL TO the medium.   (1)

        2.2.2   Explain the answer to Question 2.2.1.   (1)

   2.2.3   Calculate the period of the wave if it takes 5 seconds for a disturbance
                to move from position X to position Y.   (3)

        2.2.4   What will happen to the disturbance mentioned in Question 2.2.3
                immediately AFTER striking the wall?
                Choose from MOVES TO THE LEFT, MOVES TO THE RIGHT or STOPS
                MOVING.   (1)
   **[23]**

QUESTION 3

3.1   Define the term *echo*.   (2)

3.2   A motorist of a moving car sees an obstacle on the road ahead when he is
        at position 1 as indicated in the diagram below. Position 1 is x metres away
        from the obstacle. He sounds the car hooter while at position 1 and receives
        an echo 3 seconds later at position 2. The distance between position 1 and
        position 2 is 300m.
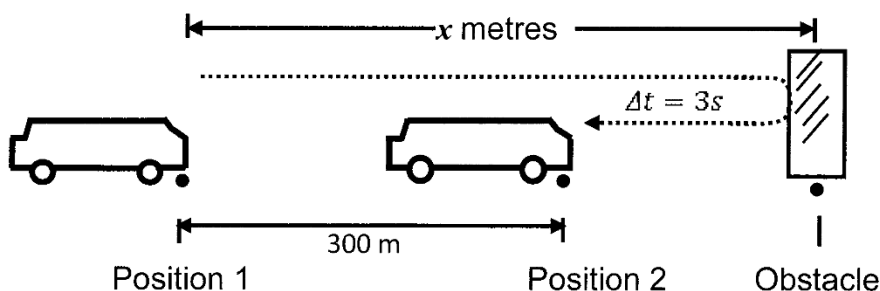
        If the speed of sound in air is 340 m.s⁻¹ SHOW BY CALCULATION
        that the distance between position 2 and the obstacle is 360m.   (5)

3.3 The diagram below shows the waveform produced by a pure sound note.
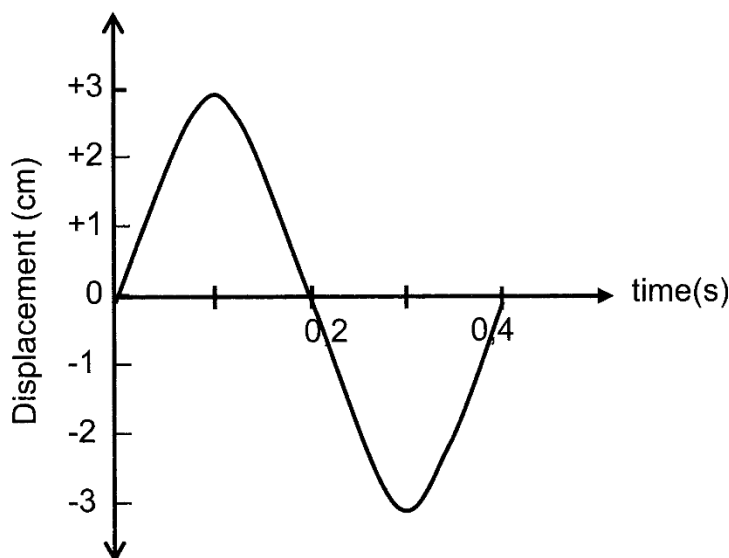
The LOUDNESS of this sound note is now DECREASED to ONE-THIRD of its original value and the PITCH is HALVED.

3.3.1 What is the value (in cm) of the new maximum displacement of particles in the medium? (2)

3.3.2 What is the value (in seconds) of the new period? (2)

3.3.3 Explain the answer to Question 3.3.2. (2)

3.4 What is the frequency range for medical equipment that use ultrasound? (1)

[14]

QUESTION 4

4.1 Study the following physical and chemical processes below. Substances X, Y and Z are either reactants used or products formed during each process.

PROCESS I: Silver nitrate is used in the manufacture of glass mirrors.
$2AgNO_3(s) + Heat \rightarrow 2X + 2NO_2(g) + O_2(g)$
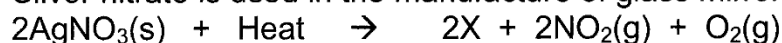
PROCESS II: Carbon monoxide fumes from a motor car engine is released into the atmosphere and forms carbon dioxide.
$CO(g) + Y \rightarrow 2CO_2(g) + Heat$

PROCESS III: A block of ice melts completely.
$H_2O(s) \rightarrow Z$

Write down the:

4.1.1 symbol for substance X (1)

4.1.2   phase in which substance X exists   (1)

4.1.3   formula for substance Y   (1)

4.1.4   name of substance Z   (1)

4.1.5   process that represents a synthesis reaction
        Write down either I, II or III   (1)

4.1.6   process that represents a decomposition reaction.
        Write down either I, II or III.   (1)

4.2   A learner performed two experiments at two different temperatures. One
      experiment was carried out at 30°C and the other at 50°C.
      In both experiments 178,50g of potassium bromide was reacted with 53,50g
      of iron (III) hydroxide to produce potassium hydroxide and iron III bromide.

EXPERIMENT	TEMPERATURE (°C)	MASS OF POTASSIUM HYDROXIDE FORMED (grams)	MASS OF IRON (III) BROMIDE FORMED (grams)
1	30	84	(i)
2	50	84	(ii)

4.2.1   Write down a balanced equation for the reaction between potassium
        bromide and iron (III) hydroxide.   (3)

4.2.2   Write down the value of (i).   (1)

4.2.3   How will the mass (ii) formed in experiment 2 compare to the mass (i)
        formed in experiment 1?
        Choose from MORE THAN (i), LESS THAN (i) or THE SAME AS (i).   (1)

4.2.4   Explain the answer to Question 4.2.3 by referring to a relevant law in
        chemistry.   (3)
                                                                          [14]

QUESTION 5

5.1   Define the mole in terms of Avogadro's *number of particles.*   (2)

5.2   Determine the number of oxygen atoms in 9,8g of H_2SO_4.   (5)

5.3   The percentage hydrogen in a 34g sample of H_2O_2 is found to be 5,88%.

      5.3.1   How will the percentage hydrogen be affected if the mass of the H_2O_2
              sample is increased from 34g to 68g?
              Choose from INCREASES, DECREASES or REMAINS THE SAME.   (1)

      5.3.2   NAME the law that was applied in Question 5.3.1.   (1)

5.4 A learner prepares a solution of NaOH of concentration 0,22 mol.dm^{-3}.
She does this by dissolving 4,4g of NaOH in distilled water.

    5.4.1 Define the term *concentration*. (2)

    5.4.2 Determine the volume of the solution required to prepare the 0,22 mol.dm^{-3}
solution. (4)

                        [15]

QUESTION 6

A learner analysed a 100g sample of hydrated aluminium chloride ($A\ell C\ell_3 \cdot nH_2O$) and found that 44,72g of the sample was composed of water.

6.1 Define the term *water of crystallization*. (2)

6.2 Determine the value of **n** in the $A\ell C\ell_3 \cdot nH_2O$. (5)

6.3 Determine the percentage hydrogen in the 100g sample. (3)

                        [10]

QUESTION 7

Ammonium chloride reacts with calcium hydroxide according to the following balanced equation.

$$2NH_4C\ell(s) \; + \; Ca(OH)_2(s) \;\; \longrightarrow \;\; 2NH_3(g) \; + \; CaC\ell_2(s) \; + \; 2H_2O(\ell)$$

If 5,60g of $Ca(OH)_2$ is used up completely in this reaction, calculate:

7.1 the number of moles of $NH_4C\ell$ required for the reaction (3)

7.2 the volume of NH_3 gas formed at STP (4)

7.3 the percentage yield of NH_3 gas if 2,90 dm^3 of NH_3 is actually produced (3)

                        [10]

                TOTAL MARKS: **100**

PHYSICAL CONSTANTS: PHYSICS

NAME	SYMBOL	VALUE
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8 \text{ m·s}^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vacuum*	c	$3,0 \times 10^8 \text{ m·s}^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34} \text{ J·s}$

FORMULAE: WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \dfrac{1}{f}$
$v = \dfrac{\Delta x}{\Delta t}$	$E = hf$
$c = f\lambda$	$E = h\dfrac{c}{\lambda}$

PHYSICAL CONSTANTS: CHEMISTRY

NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$
Molar gas volume at STP	V_m	$22,4 \text{ dm}^3\text{·mol}^{-1}$
Standard temperature	T^θ	273 K
Standard pressure	p^θ	$1,013 \times 10^5 \text{ Pa}$

FORMULAE: CHEMISTRY

$n = \dfrac{m}{M}$	$c = \dfrac{n}{V}$ or $c = \dfrac{m}{MV}$	$n = \dfrac{V}{V_m}$	$n = \dfrac{N}{N_A}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/SLEUTEL

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit →

29
1,9 **Cu**
63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 **H** 1																	2 **He** 4
3 1,0 **Li** 7	4 1,5 **Be** 9											5 2,0 **B** 11	6 2,5 **C** 12	7 3,0 **N** 14	8 3,5 **O** 16	9 4,0 **F** 19	10 **Ne** 20
11 0,9 **Na** 23	12 1,2 **Mg** 24											13 1,5 **Aℓ** 27	14 1,8 **Si** 28	15 2,1 **P** 31	16 2,5 **S** 32	17 3,0 **Cℓ** 35,5	18 **Ar** 40
19 0,8 **K** 39	20 1,0 **Ca** 40	21 1,3 **Sc** 45	22 1,5 **Ti** 48	23 1,6 **V** 51	24 1,6 **Cr** 52	25 1,5 **Mn** 55	26 1,8 **Fe** 56	27 1,8 **Co** 59	28 1,8 **Ni** 59	29 1,9 **Cu** 63,5	30 1,6 **Zn** 65	31 1,6 **Ga** 70	32 1,8 **Ge** 73	33 2,0 **As** 75	34 2,4 **Se** 79	35 2,8 **Br** 80	36 **Kr** 84
37 0,8 **Rb** 86	38 1,0 **Sr** 88	39 1,2 **Y** 89	40 1,4 **Zr** 91	41 **Nb** 92	42 1,8 **Mo** 96	43 1,9 **Tc** 101	44 2,2 **Ru** 101	45 2,2 **Rh** 103	46 2,2 **Pd** 106	47 1,9 **Ag** 108	48 1,7 **Cd** 112	49 1,7 **In** 115	50 1,8 **Sn** 119	51 1,9 **Sb** 122	52 2,1 **Te** 128	53 2,5 **I** 127	54 **Xe** 131
55 0,7 **Cs** 133	56 0,9 **Ba** 137	57 **La** 139	72 1,6 **Hf** 179	73 **Ta** 181	74 **W** 184	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 201	81 1,8 **Tℓ** 204	82 1,8 **Pb** 207	83 1,9 **Bi** 209	84 2,0 **Po**	85 2,5 **At**	86 **Rn**
87 0,7 **Fr**	88 0,9 **Ra** 226	89 **Ac**															

58 **Ce** 140	59 **Pr** 141	60 **Nd** 144	61 **Pm**	62 **Sm** 150	63 **Eu** 152	64 **Gd** 157	65 **Tb** 159	66 **Dy** 163	67 **Ho** 165	68 **Er** 167	69 **Tm** 169	70 **Yb** 173	71 **Lu** 175
90 **Th** 232	91 **Pa**	92 **U** 238	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lr**

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MARKING GUIDELINE

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MARKS: 100

TIME: 2 hours

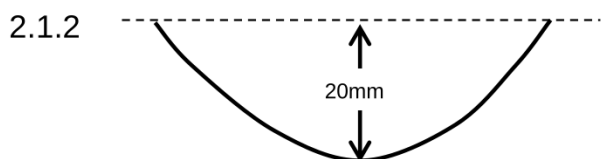**This marking guideline consists of 8 pages.**

QUESTION 1: MULTIPLE- CHOICE

1.1   D ✓✓   (2)

1.2   B ✓✓   (2)

1.3   C ✓✓   (2)

1.4   C ✓✓   (2)

1.5   B ✓✓   (2)

1.6   D ✓✓   (2)

1.7   C ✓✓   (2)

                                                                                              [14]

QUESTION 2

2.1.1   • when two waves occupy the same space at the same time✓
         • the resultant displacement is the algebraic sum of the two waves ✓   (2)

2.1.2

• ✓✓ for shape (trough)
• ✓ 20mm correctly indicated

20mm   (3)

2.1.3   Destructive✓   (1)

2.1.4   • same displacement from the rest position✓
         • both moving in the same direction at the same time ✓   (2)

2.1.5
$$f = \frac{1}{T} \qquad ✓$$
$$= \frac{1}{1,8} \qquad ✓$$
$$= 0,56\, Hz \quad ✓$$
                                                                                              (3)

2.1.6   1,75 wavelengths✓ = 280 mm✓
         1 wavelength = 160mm ✓ OR   0,16m   (3)

2.1.7   POSITIVE MARKING FROM 2.1.5 AND 2.1.6
         v = f x λ ✓
             = 0,56 x 0,16✓
             = 0,09 m.s^{-1}✓
                                                                                              (3)

2.2

2.2.1   PARALLEL TO ✓   (1)

2.2.2   To ensure that <u>particles of the medium</u> vibrate <u>along the medium</u> ✓
           OR do not vibrate perpendicular medium of the wave   (1)

2.2.3

$2 \, waves: 5s$ ✓

$1 \, wave: x$ ✓

$x = \dfrac{5}{2}$

$= 2{,}55 \text{ s}$ ✓

(3)

2.2.4   MOVES TO THE LEFT ✓   (1)
[23]

QUESTION 3

3.1   A sound wave that is reflected off a surface ✓✓   (2)

3.2   **<u>OPTION 1</u>:**
The distance covered in 3 s = ($2x -$ 300)m

$v = \dfrac{D}{\Delta t}$ ✓

$340 = \dfrac{2x - 300}{3}$ ✓ ✓

$x = 660 \, m$

$dis \tan ce = \left(660 - 300\right)$ ✓

$= 360 \, m$

<u>OPTION 2</u>:
Δt for sound to travel from position 1 to position 2:

$v = \dfrac{D}{\Delta t}$ ✓

$340 = \dfrac{300}{\Delta t}$ ✓

$\Delta t = 0{,}882 \text{ s}$

Δt for sound to travel from position 2 to obstacle = $\dfrac{3 - 0{,}882}{2} = 1{,}059 \text{ s}$ ✓

Distance = vΔt = 340 x 1,059   ✓

= 360 m   (5)

<u>OPTION 3:</u>
Distance covered= 300 + 2d ✓

$v = \dfrac{D}{\Delta t}$ ✓

$340 = \dfrac{(300 + 2d)}{3}$ ✓ ✓

$D = 360 \, m$ ✓

3.3.1   1 (cm)✓ ✓   (2)

3.3.2   0,8(s) ✓✓   (2)

3.3.3   • pitch is <u>inversely proportional</u> to period ✓
         • therefore when the <u>pitch is halved</u> then the <u>period will double</u> ✓   (2)

3.4   <u>20 000 – 100 000 Hz</u> ✓   (1)
                                                                                            [14]

QUESTION 4

4.1.1   Ag ✓   (1)

4.1.2   Solid ✓   (1)

4.1.3 O_2 ✓   (1)

4.1.4   Water ✓ or dihydrogen oxide   (1)

4.1.5   II ✓   (1)

4.1.6   I ✓   (1)

4.2.1 $3KBr + Fe(OH)_3 \rightarrow 3 KOH + FeBr_3$
         • ✓ for reactants
         • ✓ for products
         • ✓ for Balanced Equation   (3)

4.2.2   148 g✓   (1)

4.2.3   REMAIN THE SAME ✓   (1)

4.2.4   • According to the <u>law of conservation of mass</u> ✓
         • The total mass of the reactants must equal the total
           mass of the products. ✓✓   (3)
                                                                                          [14]

QUESTION 5

5.1.
- one mole of any substance ✓
- contains 6,02 x 10²³ particles ✓ (2)

5.2 $$\frac{m}{n} = \frac{N}{N_A} \quad ✓$$

$$\frac{9,8}{98} ✓ = \frac{N}{6,02 \times 10^{23}} \quad ✓$$

$$N = 6,02 \times 10^{22} \underline{molecules\,of\,H_2SO_4}$$

$= 4 \times 6,02 \times 10^{22}$ atoms of oxygen ✓

$= 2,41 \times 10^{23}$ atoms ✓

OR

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

$$= \frac{9,8}{98} \quad ✓$$

✓ for BOTH $n = \frac{m}{M}$ and $n = \frac{m}{M}$

$$= 0,1\, mol$$

$$n = \frac{N}{N_A} \quad ✓$$

$$0,1 = \frac{N}{6,02 \times 10^{23}} \quad ✓ \; ✓$$

$$N = 6,02 \times 10^{22} \underline{molecules\,of\,H_2SO_4}$$

$= 4 \times 6,02 \times 10^{22}$ atoms of oxygen ✓

$= 2,41 \times 10^{23}$ atoms ✓ (5)

5.3.1 REMAINS THE SAME ✓ (1)

5.3.2 The law of constant composition ✓ (1)

5.4.1
- The number of moles of dissolved solute ✓
- Per dm³ of solution ✓ (2)

5.4.2

$$c = \frac{m}{MV} \quad \checkmark$$

$$0,22 = \frac{4,4}{40 \times V} \quad \checkmark$$

$$V = 0,5\,dm^3 \quad \checkmark$$

OR

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

$$= \frac{4,4}{40} \quad \checkmark$$

$$= 0,11\,mol.$$

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

$$0,22 = \frac{0,11}{V} \quad \checkmark$$

$$V = 0,5\,dm^3 \quad \checkmark$$

$\checkmark$ for BOTH $n = \dfrac{m}{M}$ and $c = \dfrac{n}{V}$

(4)
[15]

QUESTION 6

6.1
- The amount of water molecules which is present $\checkmark$
- In one formula unit of salt $\checkmark$

(2)

6.2

$$For\, H_2O : n = \frac{m}{M}$$

$$= \frac{44,72}{18} \quad \checkmark$$

$$= 2,48\,mol \cdot$$

$$for\, AlCl_3 : n = \frac{55,28}{133,50} \quad \checkmark$$

$$= 0,41\,mol$$

$$Ratio\, of\, AlCl_3 : H_2O$$

$$= 0,41 : 2,48 \quad \checkmark$$

$$= \frac{0,41}{0,41} : \frac{2,48}{0,41} \quad \checkmark$$

$$= 1 \qquad : 6$$

$$Therefore\, n_{H_2O} = 6 \quad \checkmark$$

(5)

6.3 **POSITIVE MARKING FROM QUESTION 6.2**

$$\%H = \frac{6(1\times2)}{27+(35,5\times3)+6(18)}\times100$$

$$=\frac{12\ \checkmark}{241,50\ \checkmark}\times100$$

$$=4,97\%\ \checkmark$$ (3)

[10]

QUESTION 7

7.1
$$For\ Ca(OH)_2: n=\frac{m}{M}$$

$$=\frac{5,6}{74}\ \checkmark$$

$$=0,08\,mol\ \checkmark$$

$$NH_4Cl:Ca(OH)_2$$

$$=\quad 2:1$$

$$Therefore\ n_{NH_4CL}=0,16\,mol\ \checkmark$$ (3)

7.2 POSITIVE MARKING FROM 7.1

$$NH_4Cl:NH_3$$
$$=2:2$$
$$=\ 1:1$$

$$For\ NH_3: n\frac{V}{Vm}\ \checkmark$$
$$0,16=\frac{V}{22,4}\ \checkmark$$
$$V=3,58\,dm^3\ \checkmark$$ (4)

7.3 **POSITIVE MARKING FROM QUESTION 7.2**

$$\% \, yield = \frac{actual \; yield}{theoritical \; yield} \times 100 \; \checkmark$$

$$= \frac{2,90}{3,58} \times 100 \; \checkmark$$

$$= 80,92\% \; \checkmark$$

(3)
[10]

TOTAL MARKS: 100