ALEXANDER ROAD HIGH SCHOOL

November 2021 **PHYSICAL SCIENCES ASSESSMENT PAPER 2** 180 MINUTES

CO, JA, MH **GRADE 11 MEMO** TOTAL = 150

1.1 C ✓✓

1.2 C ✓✓

1.3 C ✓✓

1.4 B ✓✓

1.5 D ✓✓

1.6 A ✓✓

1.7 C ✓✓

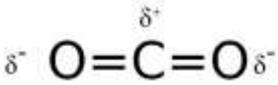
1.8 A ✓✓

1.9 C ✓✓

1.10 A ✓✓

QUESTION 2:

Chemical bonding		
2.1.1	E ✓	(1)
2.1.2	D ✓	(1)
2.1.3	C ✓	(1)
2.1.4	A ✓, N and As are in the same group on the periodic table ✓, thus have the same electron structure ✓	(3)
2.2.1	A and D ✓ ✓	(2)
2.2.2	Ammonium ✓ and hydronium/oxonium ✓	(2)
2.2.3	Covalent: share electrons ✓ from half-filled orbitals ✓ Dative: share electrons ✓ from a full orbital and an empty orbital ✓	(4)

2.3.1	 ✓ ✓	(2)
2.3.2	Polar ✓, ΔEN = 3,5-2,5= 1 ✓ (Oxygen has a higher electronegativity than carbon, bonding electrons are attracted towards oxygen making the oxygen (delta) negative)	(2)
2.3.3	 ✓δ- charge ✓ δ+ charge ✓Couper	(3)
2.4.1	A mutual attraction between two atoms resulting from the simultaneous attraction between their nuclei and the outer electrons ✓ ✓	(2)
2.4.2	A = bond length ✓ B = Bond energy✓	(2)
2.4.3	300✓ J ✓	(2)
2.4.4	3,7 pm ✓ (Accept any value from 3,6-3,8)	(1)
		[28]

QUESTION 3:

IMFs		
3.1.1	Intra – between the atoms in the molecule ✓ Inter – between different molecules of NH3 ✓ (or between 2 ore more molecules)	(2)
3.2.1	covalent (bond) ✓	(1)
3.2.2	H-bonding ✓	(1)
3.3.1	H-bonding ✓	(1)
3.3.2	NH_3 ✓	(1)
3.3.3	<u>Temperature</u> at which liquid changes to gas✓ when the vapour pressure of a substance = the atmospheric pressure ✓	(2)
3.3.4	$NH_3 + H_2O$ ✓ → NH_4OH ✓ OR $NH_3 + H_2O$ ✓ → $NH_4^+ + OH^-$ ✓	(2)
3.3.5	Basic ✓, hydroxide formed ✓	(2)
3.4	HF has H-bonding, HCl has dipole-dipole bonding ✓ H- bonding is stronger ✓ More energy needed to break/overcome the H bonding in HF ✓ Higher temp needed to provide enough energy, ✓ ∴ higher BP	(4)
3.5.1	The BP increases from A to C. ✓✓ OR The BP decreases from C to A.	(2)

3.5.2	All molecule have London forces (or Vd Waals induced dipole-indused dipole)✓ C_3H_8 forces are strongest, since <u>molecule biggest</u> (or greatest surface area)✓ More energy needed to break/overcome the forces in C_3H_8 ✓ (Higher temp needed to provide enough energy, $\therefore$ higher BP)	(3)
		[21]

QUESTION 4:

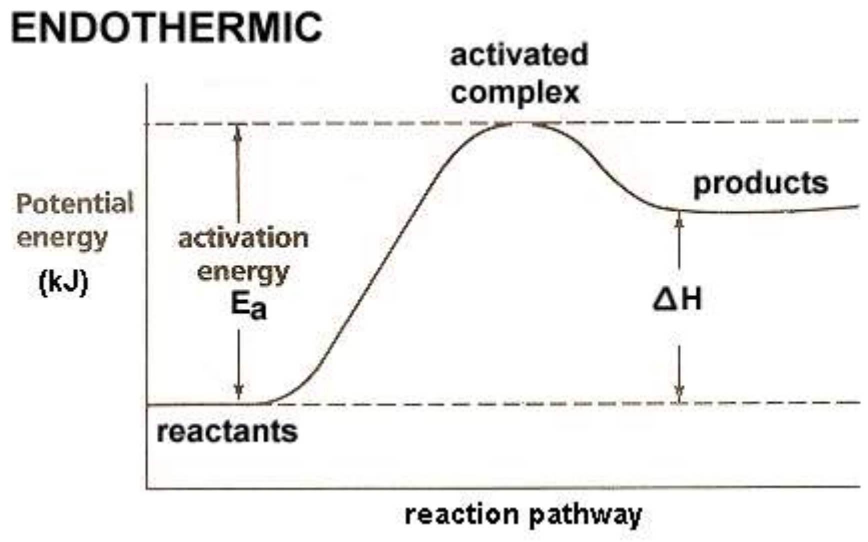
Stoichiometry		
4.1.1	Simplest ratio ✓ between the atoms in the molecule ✓	(2)
4.1.2	n(C) = m/M = 38,8/12 = 3,23 mol n(H) = 16,1 n(N) = 45,1/14 = 3,22 ✓ (for all 3 mole calculations) n(C) : n(H) : n(N) = 3,23 : 16,1 : 3,22 = 1 : 5 : 1 ✓ Empirical: CH_5N ✓ $M(CH_5N)$ = 12 + 5(1) + 14 = 31g.mol^{-1} ✓ $M(CH_5N)$: M (real)=31:93 = 1:3 ✓ Real formula is $C_3H_{15}N_3$ ✓	(6)
4.2.1	$n(Na_2CO_3)$ = m/M ✓ = $^{154}/_{106}$ ✓ = 1,453 mol ✓ n(HCl) = c.v ✓ = 5 x 0,5 ✓ = 2,5 mol ✓ n(HCl) needed to react with 1,453 mol Na_2CO_3 = 1,453 x 2 ✓ = 2,90566 mol ∴ HCl is limiting (only 2,5 mol available)✓ OR $n(Na_2CO_3)$ needed to react with 2,5 mol HCl = 2,5 x ½ ✓ = 1,25 mol ∴ Na_2CO_3 in excess (1,453 mol available) and ∴ HCl is limiting	(8)
4.2.2	$n(CO_2)$ formed = 2,5 x $^1/_2$ ✓ = 1,25 mol (or use 1,25 mol from above) $V(CO_2) = n.V_m$ ✓ = 1,25 x 22,4 ✓ = 28 dm^3 % yield = $^{21}/_{28}$ ✓ x100 = 75% ✓	(5)
		[21]

QUESTION 5:

5.1	The pressure (of an enclosed gas) is inversely proportional to the volume at constant temperature. ✓✓ (2 or 0)
5.2	INCREASE. ✓ The gas particles inside the balloon are in a smaller volume resulting in more collisions (per unit area) with the walls of the balloon. ✓

5.3	$p_1.V_1 = p_2.V_2$ $(101{,}5)(5) = p_2(2)$ ✓ $\therefore p_2 = 253{,}75\ kPa$ ✓ ∴ Yes, the balloon will burst. ✓	
5.4	• Temperature is a measure of the average kinetic energy of the particles. ✓ • At a hotter temperature, the gas particles have more kinetic energy / move around faster. ✓ • This results in more collisions (per unit area) with the walls of the balloon. ✓	
		[10]

QUESTION 6:

6.1	Minimum amount of energy required for a reaction to take place.	(2)
6.2	Endothermic✓ more energy required than released ✓	(2)
6.3	 ✓ Correct shape (products higher than reactants) ✓ Activation energy correctly indicated ✓ △H correctly indicated ✓ activation complex correctly indicated Axes not correctly labelled -1	(4)
6.4	2 x 167 ✓= 334 kJ ✓	(2)
6.5	2 x 251 ✓ = 502 kJ ✓	(2)
		[12]

QUESTION 7:

Acids & Bases maybe include some stoichiometry calculations **MH**		
7.1	Substance which can act as either an acid or a base.	(2)
7.2	HSO_4^-	(1)
7.3	An acid is a proton donor.	(2)
7.4	H_2SO_4 and HSO_4^- ✓✓ H_2O and H_3O^+ ✓✓	(4)
7.5	$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\ H_2O$ Reactants ✓ Products ✓ Balancing ✓	(3)
7.6	Potassium sulphate	(1)
7.7	Neutralisation reaction	(1)
7.8.1	Yellow to red	(2)
7.8.2	$H_2SO_4 + 2\ NH_3 \rightarrow (NH_4)_2SO_4$ 1 : 2 : 1 n = cV ✓ n = 0,1 x 0,05 ✓ n = 0,005 mol n = 0,005 x 0,5 ✓ = 0,0025 c = n/V c = 0,0025/0,025 ✓ c = 0,1 $mol.dm^{-3}$ ✓	(5)
7.8.3	$H_2SO_4 + 2\ NH_3 \rightarrow (NH_4)_2SO_4$ 1 : 2 : 1 n = 0,0025 mol ✓ n = m/M ✓ 0,0025 = m/132 ✓ m = 0,33 g ✓	(4)
		[25]

QUESTION 8:

Redox **MH**		
8.1	Decrease in oxidation number.	(2)
8.2	+6	(1)
8.3	$Cr_2O_7^{2-}$	(1)
8.4	Reducing agent loses electrons.	(2)
8.5	Fe^{2+}	(1)
8.6	weaker	(1)
8.5	$Cr_2O_7^{2-} + 14\,H^+ + 6\,e^- \rightarrow 2\,Cr^{3+} + 7\,H_2O$ ✓ $6\,Fe^{2+} \rightarrow 6\,Fe^{3+} + 6\,e^-$ ✓ x6 ✓ $Cr_2O_7^{2-} + 14\,H^+ + 6\,Fe^{2+} \rightarrow 2\,Cr^{3+} + 7\,H_2O + 6\,Fe^{3+}$ $+ 14\,OH^-$ $+ 14\,OH^-$ ✓ $Cr_2O_7^{2-} + 7\,H_2O + 6\,Fe^{2+} \rightarrow 2\,Cr^{3+} + 14\,OH^- + 6\,Fe^{3+}$ ✓	(5)
		[13]

TOTAL SECTION B = [130]

Formula Sheet

Physical Constants:

Name	Symbol	Value
Acceleration due to gravity	g	$9,8\ m.s^{-2}$
Gravitational constant	G	$6,67 \times 10^{-11}\ N.m^2.kg^{-2}$
Radius of Earth	R_E	$6,38 \times 10^6\ m$
Mass of Earth	M_E	$5,98 \times 10^{24}\ kg$
Speed of light in a vacuum	c	$3,0 \times 10^8\ m.s^{-1}$
Planck's constant	h	$6,63 \times 10^{-34}\ J.s$
Coulomb's constant	k	$9,0 \times 10^9\ N.m^2.C^{-2}$
Charge on electron	e	$-1,6 \times 10^{-19}\ C$
Electron mass	m_e	$9,11 \times 10^{-31}\ kg$
Avogadro's constant	N_A	$6,02 \times 10^{23}\ mol^{-1}$
Molar gas constant	R	$8,31\ J.K^{-1}.mol^{-1}$
Standard pressure	p^θ	$1,013 \times 10^5\ Pa$
Molar gas volume at STP	V_m	$22,4\ dm^3.mol^{-1}$
Standard temperature	T^θ	$273\ K$

Formulae:

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$w = mg$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$p = mv$	$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$
$F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{r^2}$

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$n_i \sin\theta_i = n_r \sin\theta_r$	$n = \frac{c}{v}$

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{F}{q}$
$E = \frac{kQ}{r^2}$	$n = \frac{Q}{e}$

ELECTROMAGNETISM

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$	$\Phi = BA\cos\theta$

ELECTRIC CIRCUITS

$I = \frac{Q}{\Delta t}$	$R = \frac{V}{I}$

$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \cdots$	$R = r_1 + r_2 + r_3 + \cdots$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

CHEMISTRY

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	$pV = nRT$
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or $c = \frac{m}{MV}$