



eduresourceza.com



PRELIMINARY EXAMINATION 29 AUGUST 2019

PHYSICAL SCIENCES – PAPER 2 (CHEMISTRY)

Time: 3 hours
Examiner: Durban-50 Cluster (T. Rodrigues)

200 marks
Moderator: S. Pillay

MEMORANDUM

QUESTION 1

- 1.1 B ✓✓
- 1.2 C ✓✓
- 1.3 D ✓✓
- 1.4 C ✓✓
- 1.5 A ✓✓
- 1.6 C ✓✓
- 1.7 A ✓✓
- 1.8 B ✓✓
- 1.9 B ✓✓
- 1.10 D ✓✓

[20]

QUESTION 1

- 2.1 He ✓ because it has the lowest melting point ✓. (2)
- 2.2 CCl_4 ✓ (1)
- 2.3 A bond which occurs between atoms within molecules. ✓✓ (2)
- 2.4 Polar ✓ covalent ✓ bond. (2)
- 2.5 A weak force of attraction between molecules, ions, or atoms of noble gases. ✓✓ (2)
- 2.6 London forces ✓ (1)
- 2.7 Hydrogen bonds ✓ (1)
- 2.8 Nonpolar ✓✓ (2)
- 2.9
- HBr has London forces and dipole-dipole interactions and CCl_4 has London forces only. ✓
 - The London forces in CCl_4 are stronger than those in HBr ✓ due to there being more electrons in CCl_4 , resulting in larger induced dipoles ✓
 - More energy is therefore needed to overcome the intermolecular force and separate the particles in CCl_4 ✓
 - This is why CCl_4 has the higher boiling point (4)

[17]

QUESTION 2

- 3.1 $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$
Left ✓ Right ✓ Balancing ✓ (3)
- 3.2 3.2.1 The net change of chemical potential energy of the system. ✓✓ (2)
- 3.2.2 More energy is released than is absorbed. ✓✓ (2)
- 3.3 The CO_2 escapes ✓ (1)
- 3.4
- 3.4.1 A reaction will only occur if there is an effective collision ✓, i.e. one with the correct orientation ✓ and sufficient kinetic energy to overcome the activation energy ✓. (3)
- 3.4.2
- Using a single lump of calcium carbonate reduces the surface area, resulting in less particles exposed to collisions ✓
 - This means there will be fewer collisions (between reacting particles) per second ✓
 - Thus, there will be fewer effective collisions ✓
 - and a lower reaction rate ✓ (4)
- 3.4.3
- Use a lower temperature ✓
 - Use a lower concentration of HCl ✓ (2)
- 3.4.4
- Apparatus (e.g. gas syringe) ✓
 - Volume of gas ✓
 - Time ✓ (3)
- 3.5 **5,7 g** ✓✓ (2)
- 3.6 $\text{Ave rate} = \frac{\Delta m}{\Delta t}$ ✓
 $\text{Ave rate} = \frac{(6,1)}{(140 \div 60)}$ ✓✓
 $\text{Ave rate} = \mathbf{2,61 \text{ g} \cdot \text{min}^{-1}}$ ✓ (4)
- 3.7 $n = \frac{m}{M}$ ✓ = $\frac{(6,1)}{(44)}$ ✓ = 0,1386 mol
 $V = nV_m$ ✓ = (0,1386)(22,4) ✓ = **3,11 dm³** ✓ (5)
- 3.8 $n_{\text{CaCO}_3} = \frac{m}{M} = \frac{(13,86)}{(100)} = 0,1386 \text{ mol}$ ✓
 $n_{\text{HCl}} = cV = (1,5)(0,25)$ ✓ (conversion) = 0,375 mol ✓
 Working ✓ (4)

[35]

QUESTION 3

4.1 Both the forward and reverse reactions are still occurring ✓ but at equal rates ✓. (2)

4.2 XY_3 was added ✓ (1)

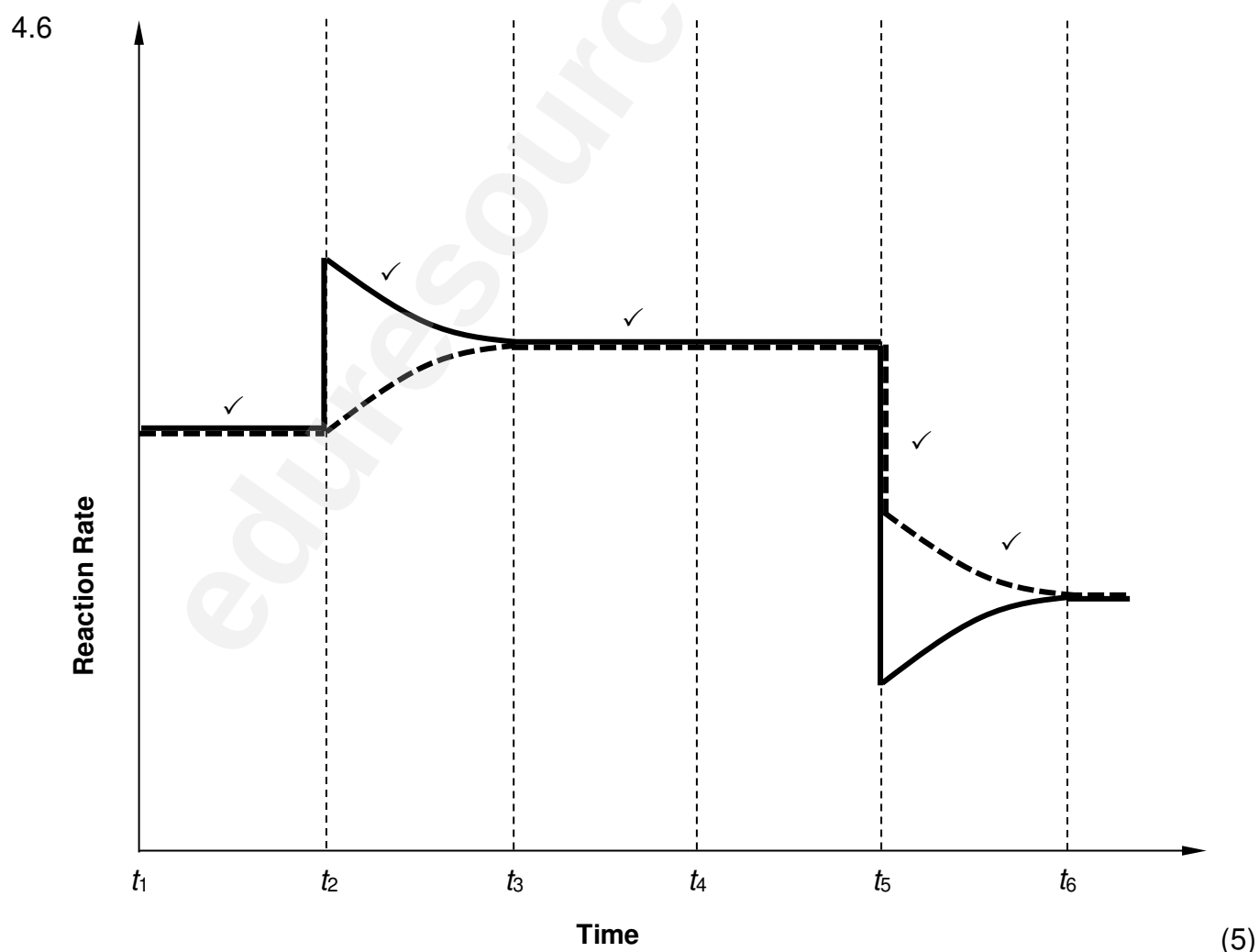
4.3

- Stress: increase in concentration of XY_3
- Le Châtelier's principle predicts the system will counteract the stress by decreasing the concentration of XY_3 (✓)
- Thus, the reverse reaction is initially favoured ✓ as it consumes XY_3 (✓)
- resulting in the amount of XY_3 increasing and X_2 and Y_2 decreasing (as seen in the graph) ✓ (3)

4.4 The same ✓ (1)

4.5

- Stress: decrease in temperature
- Le Châtelier's principle predicts the system will counteract this stress by increasing the temperature (✓)
- favouring the exothermic reaction ✓ as it produces heat (✓)
- An increase in the amount of reactants means that the reverse reaction was favoured ✓
- meaning the reverse reaction is exothermic and the forward reaction is endothermic ✓ (4)



4.7

4.7.1 $K_c = \frac{[XY_3]^2}{[X_2][Y_2]^3} \checkmark \checkmark$ (2)

4.7.2 Moles:

R	X ₂	+	3Y ₂	⇌	2XY ₃
I	5		5		0
C	(-0,6		-1,8) ✓		+1,2 ✓
E	(4,4		3,2) ✓		1,2 ✓
C	0,88		0,64		0,24

✓(÷ 2)

$$K_c = \frac{[XY_3]^2}{[X_2][Y_2]^3}$$

$$K_c = \frac{(0,24)^2}{(0,88)(0,64)^3} \checkmark$$

$$K_c = 0,25 \checkmark$$

(7)
[25]

QUESTION 4

- 5.1 Hydrolysis ✓ (1)
- 5.2 Basic ✓✓ (2)
- 5.3
- 5.3.1 A proton acceptor. ✓ (1)
- 5.3.2
- HCO_3^- ✓
 - At the same concentration, the stronger base will ionize to a greater extent ✓
 - resulting in NH_3 producing a higher concentration of OH^- ions (and therefore a lower concentration of H_3O^+ ions) ✓ (3)
- 5.3.3 $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{OH}^-$
Left ✓ right ✓ (2)
- 5.3.4 H_2CO_3 ✓ (1)
- 5.3.5 $K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]}$ ✓✓ (2)
- 5.4 $K_w = [\text{H}_3\text{O}^+][\text{OH}^-]$ ✓
 $(10^{-14}) = [\text{H}_3\text{O}^+](2 \times 0,38)$ ✓✓
 $[\text{H}_3\text{O}^+] = 1,32 \times 10^{-14} \text{ mol} \cdot \text{dm}^{-3}$ ✓ (4)

[16]

QUESTION 5

- 6.1 Chemical energy to electrical energy ✓✓ (2)
- 6.2 A substance that can conduct electricity by forming free ions when molten or dissolved in solution. ✓✓ (2)
- 6.3 AgNO_3 ✓ (1)
- 6.4 A substance that accepts electrons. ✓ (1)
- 6.5 Ag^+ ✓ (1)
- 6.6 $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ ✓✓ (2)
- 6.7 The electrode ✓ at which oxidation occurs ✓. (2)
- 6.8 Cd ✓ (1)
- 6.9
- Maintains electrical neutrality ✓
 - Completes the circuit ✓
- (2)
- 6.10
- In the cadmium half-cell, Cd^{2+} ions are being produced ✓
 - To counter this production of positive charge, anions exit the salt bridge into the electrolyte ✓
 - and cations enter the salt bridge from the electrolyte ✓
- (3)
- 6.11
- $$E_{\text{cell}}^0 = E_{\text{cathode}}^0 - E_{\text{anode}}^0 \quad \checkmark$$
- $$E_{\text{cell}}^0 = (+0,80) - (-0,40) \quad \checkmark$$
- $$E_{\text{cell}}^0 = +1,20 \text{ V} \quad \checkmark$$
- (3)
- 6.12 Decreases ✓✓ (2)
- 6.13 Silver metal will deposit onto the cathode (gains mass) ✓✓ (2)

[24]

QUESTION 6

- 7.1 Cathode ✓ (1)
- 7.2 Positive ✓ (1)
- 7.3
- 7.3.1 $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr}$ ✓✓ (2)
- 7.3.2
- Although Cr^{3+} is a stronger oxidising agent than H_2O , it is not significantly so
 - However, the concentration of Cr^{3+} is high, increasing the rate of its reduction ✓
 - meaning Cr^{3+} is predominantly reduced ✓ (2)
- 7.3.3
- $n_{\text{Cr}} = \frac{m}{M} = \frac{(0,95)}{(52)} \checkmark = 0,018269 \text{ mol}$
 - $n_{\text{e}^-} = (0,018269) \times \frac{3}{1} \checkmark = 0,054808 \text{ mol}$
 - $Q = nF = (0,054808)(96500) \checkmark = 5288,9423 \text{ C}$
 - $I = \frac{Q}{t} = \frac{(5288,9423)}{(10 \times 60)} \checkmark\checkmark = \mathbf{8,81 \text{ A}} \checkmark$ (6)
- 7.3.4 Use a larger current. ✓ (1)
- 7.3.5 Iron cannot be reduced. ✓✓ (2)
- 7.4 $\text{Cr} \rightarrow \text{Cr}^{3+} + 3\text{e}^-$ ✓✓ (2)
- 7.5
- The chromium strip will corrode ✓
 - The green colour of the electrolyte will intensify around the anode. ✓ (2)
- 7.6 Any valid use, e.g. extraction of aluminium. ✓ (1)

[20]

QUESTION 8

- 8.1 A series of similar compounds which have the same functional group and have the same general formula, in which each member differs from the previous one by a single CH_2 unit. ✓✓ (2)
- 8.2 Esters ✓ (1)
- 8.3 An atom or a group of atoms that form the centre of chemical activity in the molecule. ✓✓ (2)
- 8.4 Carboxyl group ✓ (1)
- 8.5 $\text{C}_n\text{H}_{2n+2}\text{O}$ ✓ (1)
- 8.6 Ethanol ✓✓ (2)
- 8.7
- Dehydrating agent ✓
 - Acid catalyst ✓
- (2)
- 8.8 Structural formulae correct for:
Ethanol ✓ + Hexanoic acid ✓✓ → Ester ✓✓ + H_2O ✓ (6)
- 8.9 Organic reagents are flammable. ✓ (1)
- 8.10 A compound having the same molecular formula but different structural formulae (as another compound). ✓✓ (2)
- 8.11 Octanoic acid ✓ (2)
- 8.12 $\text{C}_8\text{H}_{16}\text{O}_2 + 11\text{O}_2 \rightarrow 8\text{CO}_2 + 8\text{H}_2\text{O}$
Left ✓ Right ✓ Balancing ✓ (3)

[25]

QUESTION 9

9.1

9.1.1 Addition ✓ (1)

9.1.2 Substitution ✓ (1)

9.1.3 Elimination ✓ (1)

9.2

9.2.1 H_3PO_4 ✓ (1)

9.2.2

$$\begin{array}{c}
 \text{H} & \text{H} & \text{H} \\
 | & | & | \\
 \text{H}-\text{C}- & \text{C}- & \text{C}-\text{H} \\
 | & | & | \\
 \text{H} & \text{O} & \text{H} \\
 & | & \\
 & \text{H} &
 \end{array}$$

✓✓ OR

$$\begin{array}{c}
 \text{H} & \text{H} & \text{H} \\
 | & | & | \\
 \text{H}-\text{C}- & \text{C}- & \text{C}-\text{H} \\
 | & | & | \\
 \text{H} & \text{H} & \text{O} \\
 & & | \\
 & & \text{H}
 \end{array}$$

(2)

9.3

9.3.1 Hydrogenation ✓ (1)

9.3.2 CH_3CHCH_2 ✓ + H_2 ✓ $\xrightarrow{\text{Pt} / \Delta}$ $\text{CH}_3\text{CH}_2\text{CH}_3$ ✓ (4)

9.4

9.4.1 Dilute ✓ aqueous ✓ potassium hydroxide ✓ (3)

9.4.2 $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ ✓✓
OR
 $\text{CH}_3\text{CHClCH}_3$ (2)

9.4.3 London forces, dipole-dipole interactions, hydrogen bonds ✓✓ (2)

[18]

Total: 200 Marks