



eduresourceza.com

14 SEPTEMBER 2020

MEMO

Question 1: Multiple Choice

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

[10 x 2 = 20 marks]

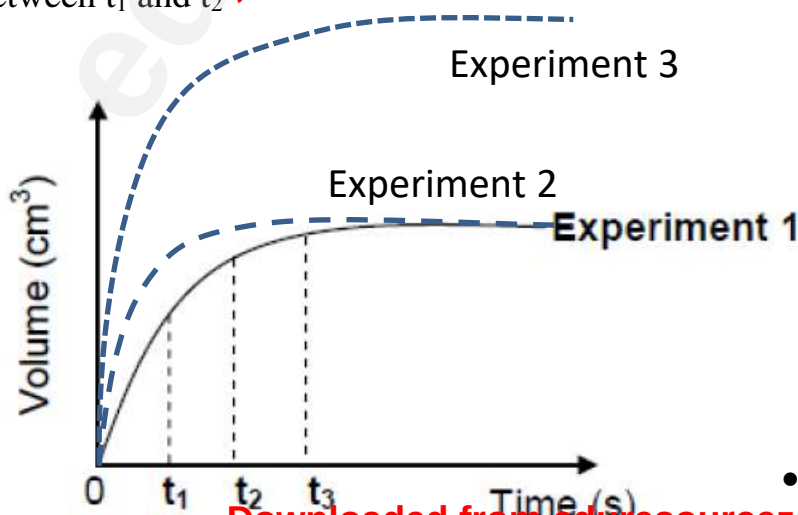
Question 2: Chemical Bonding and Intermolecular Forces

- 2.1 A (weak) force of attraction ✓ between molecules, (ions), or atoms of noble gases ✓. (2)
- 2.2 Intermolecular forces are **between molecules** ✓ and intramolecular bonds are **between atoms within molecules** ✓. (1 mark for intramolecular bonds are stronger than intermolecular forces.) (2)
- 2.3.1 Hydrogen bonds ✓ (1)
- 2.3.2 London forces ✓ (1)
- 2.3.3 Dipole-dipole forces ✓ (1)
- 2.4 A large amount of energy is needed ✓ to break the many ✓ strong ✓ ionic bonds (electrostatic forces) ✓ between the particles of sodium chloride, so the melting point is high. (4)
- 2.5 Iodine has London forces between its molecules ✓. These forces are very weak ✓ and require very little energy to break them ✓, which is why it sublimates. (3)
- 2.6 $2\text{Al} + 3\text{I}_2 \rightarrow 2\text{AlI}_3$ (-1 if doubled) (3)

[17 marks]

Question 3: Rates of Reaction

- 3.1.1 reaction rate ✓ (1)
- 3.1.2 2 of: temperature ✓, surface area of zinc ✓, zinc in excess ✓, size of container ✓ (2)
- 3.2 t_3 ✓ (1)
- 3.3 Between t_1 and t_2 ✓ (1)
- 3.4



Experiment 2:

- Steeper gradient ✓
- Same final volume ✓

Experiment 3:

- Steeper gradient ✓
- Double (higher) final volume ✓

(4)

- 3.5 exothermic ✓ **Downloaded from eduresourceza.com** (1)
- 3.6 The minimum energy required ✓ to start a chemical reaction ✓.
OR
The energy required ✓ to form the activated complex ✓. (2)
- 3.7.1 $E_A = 68 - 25 \checkmark = 43 \text{ kJ.mol}^{-1} \checkmark$ (2)
- 3.7.2 $\Delta H = -86 - 25 \checkmark = -111 \text{ kJ.mol}^{-1} \checkmark$ (0 for 111, unless carry over) (2)
- 3.8 A catalyst lowers the activation energy needed for an effective collision ✓. Therefore more particles will have required energy for effective collisions ✓, thus there will be more effective (correct orientation and $E_k \geq E_a$) collisions per unit time ✓ and therefore a faster reaction rate ✓. (4)

[20 marks]

Question 4: The Contact Process

- 4.1 When an external stress (change in pressure, temperature or concentration) is applied to a system in dynamic chemical equilibrium ✓, the equilibrium point will change ✓ in such a way as to counteract the stress ✓. (3)
- 4.2.1 Increase ✓ (1)
- 4.2.2 No change ✓ (1)
- 4.2.3 Increase ✓ (1)
- 4.3.1 Stress: High temperature ✓
Response: Reverse reaction favoured ✓, reducing the yield of SO_3 .
Reason: Endothermic reaction favoured ✓ in order to reduce the temperature ✓. (4)
- 4.3.2 Although the yield is low, the high temperature results in a faster ✓ rate of reaction ✓. (Less product produced more quickly.) (2)
- 4.4 $K_C = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} \checkmark \checkmark$ (2)
- 4.5.1 $[\text{SO}_3]^2 = K_C[\text{SO}_2]^2[\text{O}_2] = (160)(0,1)^2(0,4) = 0,64$
 $[\text{SO}_3] = \sqrt{0,64} = 0,8 \text{ mol.dm}^{-3} \checkmark$
 $n(\text{SO}_3) \text{ at equilibrium} = cV = (0,8 \text{ mol.dm}^{-3})(5 \text{ dm}^3) = 4 \text{ mol} \checkmark$
 $n(\text{SO}_3) \text{ produced} = 4 - 0 = 4 \text{ mol} \checkmark$
 $n(\text{SO}_2) \text{ at equilibrium} = cV = (0,1 \text{ mol.dm}^{-3})(5 \text{ dm}^3) = 0,5 \text{ mol} \checkmark$
 $n(\text{SO}_2) \text{ used up} = 4 \times \frac{2}{2} = 4 \text{ mol} \checkmark$
 $n(\text{SO}_2) \text{ initially} = 4 + 0,5 = 4,5 \text{ mol} \checkmark$

	2 SO_2 (g)	+	O_2 (g)	$\rightleftharpoons$	2 SO_3 (g)	
I	4,5 ✓		4		0	4/6 max carry over
C	-4 ✓		-2		+4 ✓	
E	0,5 ✓		2		4 ✓	
[]	0,1		0,4		0,8 ✓	(6)

- 4.5.2 A measure of the extent of a reaction ✓, generally measured by comparing the amount of product against the amount of product that is possible ✓. (2)
- 4.5.3 Theoretical yield $= 4,5 \times \frac{2}{2} = 4,5 \text{ mol} \checkmark$
 $\% \text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100 = \frac{4}{4,5} \times 100 \checkmark = 88,89\% \checkmark$ (3)

[25 marks]

Question 5: Acids and Bases

- 5.1.1 An acid that only ionises partially in aqueous solution. (2)
- 5.1.2 An acid that can donate two (not "more than one") protons / hydrogen ions. (2)
- 5.2 $\text{H}_2\text{SO}_3 + 2 \text{H}_2\text{O} \rightleftharpoons \text{SO}_3^{2-} + 2 \text{H}_3\text{O}^+$ (-1 wrong balancing) (3)
(Give 2 marks for $\text{H}_2\text{SO}_3 + \text{H}_2\text{O} \rightleftharpoons \text{HSO}_3^- + \text{H}_3\text{O}^+$) (2)
- 5.3.1 A solution of known concentration. (2)
- 5.3.2 $m = cMV = (0,2 \text{ mol.dm}^{-3})(56 \text{ g.mol}^{-1})(0,500 \text{ dm}^3) = 5,6 \text{ g}$ (3)
- 5.3.3 Mass of impure sample = $\frac{\text{Mass of pure sample}}{\% \text{ purity}} \times 100 = \frac{5,6}{87,5} \times 100 = 6,4 \text{ g}$ (2 or 0) (2)
- 5.4.1 $2 \text{ KOH} + \text{H}_2\text{SO}_3 \rightarrow \text{K}_2\text{SO}_3 + 2 \text{H}_2\text{O}$ (balancing) (3)
- 5.4.2 $n(\text{KOH}) = cV = (0,2 \text{ mol.dm}^{-3})(0,0309 \text{ dm}^3) = 0,00618 \text{ mol}$ (✓)
 $n(\text{H}_2\text{SO}_3) = 0,00618 \text{ mol} \times \frac{1}{2} = 0,00309 \text{ mol}$ (c/o) (✓)
 $c(\text{H}_2\text{SO}_3) = \frac{n}{V} = \frac{0,00309}{0,025} = 0,124 \text{ mol.dm}^{-3}$ (-1 if not 3 decimal places) (5)
- 5.4.3 (a) Thymol blue (✓) (1)
(b) The titration is between a strong base (KOH) * and a weak acid (H_2SO_3), so the salt produced (K_2SO_3) is basic in solution. The endpoint of the titration will therefore be in the basic range * or "produces more OH-", and thymol blue changes colour in the basic range. (4)
(c) The solution will be yellow in acid initially. As base is added, the H_3O^+ will be neutralized and equilibrium will shift in the forward reaction to replace the H_3O^+ removed. At the neutralization point, the H_3O^+ has been completely neutralized and there will be an equal amount of HIn (yellow) and In^- (blue) in the solution, so the solution will be green at the neutralization point. (4)
- 5.5.1 When the temperature is increased, K_w increases, so the forward reaction is favoured. The forward reaction is therefore endothermic. (3)
- 5.5.2 Increases C/O (1)
- 5.5.3 pH is a measure of H_3O^+ concentration. As the H_3O^+ concentration increases when the temperature increases, the solution becomes more acidic and the pH decreases. (3)

[38 marks]

Question 6: Lithium-Iodine Battery

- 6.1 $\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$ (1)
- 6.2 $2 \text{Li} + \text{I}_2 \rightarrow 2 \text{Li}^+ + 2 \text{I}^-$ (balancing) (3)
OR
 $2 \text{Li} + \text{I}_2 \rightarrow 2 \text{LiI}$ (balancing) (-1 double arrow) (3)
- 6.3 A substance that accepts electrons. "is reduced" $\frac{1}{2}$ (2)
- 6.4 I_2 or iodine (1)
- 6.5 $\text{emf} = E^\ominus_{\text{cathode}} - E^\ominus_{\text{anode}} = 0,54 - (-3,05) = 3,59 \text{ V}$ (-1 no units) (3)
- 6.6 25°C (1)
- 6.7 Less than (1)
- 6.8 $q = It = (0,005 \text{ A})(86400 \text{ s}) = 432 \text{ C}$ (✓)
 $n(\text{e}^-) = \frac{q}{F} = \frac{432 \text{ C}}{96500 \text{ C/mol}} = 4,48 \times 10^{-3} \text{ mol}$ (c/o) (✓)
 $n(\text{Li}) = 4,48 \times 10^{-3} \times 1/1 = 4,48 \times 10^{-3} \text{ mol}$ (c/o) (✓)
 $m(\text{Li}) = nM = (4,48 \times 10^{-3})(7) = 0,03 \text{ g}$ (7)

Question 7: Electrolysis of Copper(II) Chloride

- 7.1 CuCl_2 ✓✓ (2)
- 7.2 In the solid form the ions are fixed ✓ in a crystal lattice. In solution, the ions are free to move and conduct an electric current ✓. (2)
- 7.3 Electrical energy ✓ to chemical energy ✓. (2)
- 7.4 $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ ✓ (1)
- 7.5 Copper ions ✓ are a better oxidizing agent ✓ than H_2O , so undergo reduction in preference to H_2O ✓ at the cathode. (3)
- 7.6 Water is a stronger reducing agent than Cl^- ✓, so water should oxidise in preference to Cl^- at the anode ✓. However, the high concentration of Cl^- makes its electrode potential more negative and therefore makes it oxidise predominantly ✓. (0 for Cl^- better reducing agent than H_2O) (3)
- 7.7 Chlorine gas is poisonous ✓. (1)
- [14 marks]**

Question 8: Chlor-Alkali Process

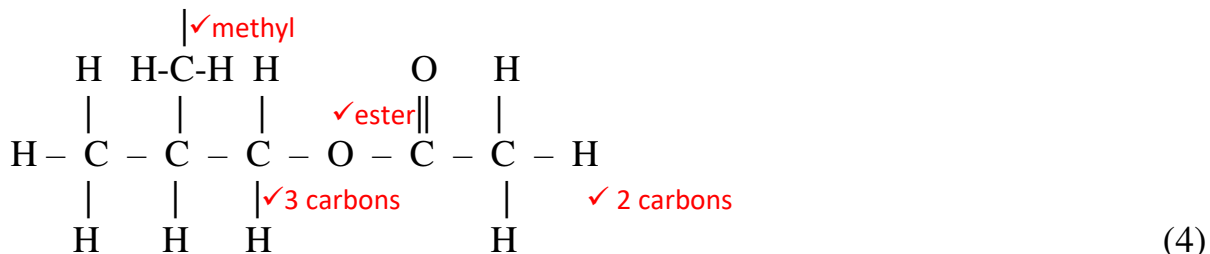
- 8.1 brine ✓ (1)
- 8.2 The difference in water levels creates a pressure gradient ✓, which allows Na^+ ions and unreacted Cl^- ions to migrate to the cathode (and prevents OH^- from passing back to the anode) ✓. (2)
- 8.3 $\text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{OH}^- + \text{H}_2$ ✓✓ (2)
- 8.4 H_2O is a stronger oxidizing agent than Na^+ ions ✓, so it reduces in preference to Na^+ ions at the cathode ✓. (2)
- 8.5 Two of:
Asbestos is toxic ✓.
 NaOH contains unreacted NaCl and needs to be purified ✓.
Not as cost effective ✓.
Greater energy requirement. (2)
- [9 marks]**

Question 9: Organic Chemistry

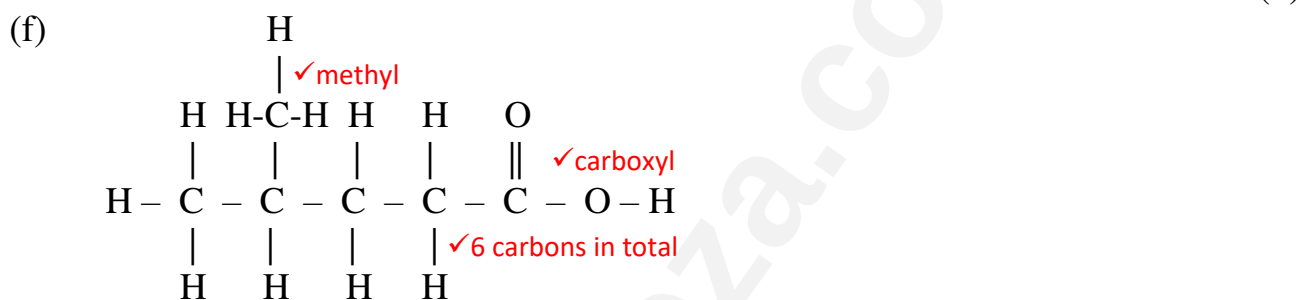
- 9.1.1 A series of similar compounds which have the same functional group and the same general formula ✓, in which each member differs from the previous one by a single CH_2 unit ✓. (2)
- 9.1.2 butanoic ✓ acid ✓ (2)
- 9.1.3 $\text{CH}_3\text{CH}_2\text{COOH}$ ✓ or $\text{CH}_3\text{-CH}_2\text{-COOH}$ (2)
- 9.1.4 All four compounds have similar hydrogen bonds between their molecules ✓.
As the chain length increases, the contact surface area of the molecule increases ✓.
More London forces can form between the molecules ✓.
More energy is needed to break the London forces, so the boiling points increase ✓.
OR NOT "bonds"
All four compounds have similar hydrogen bonds between their molecules ✓.
As the molecular mass increases, the electron density / number of electrons increases ✓.
The London forces between the molecules are stronger ✓.
More energy is needed to break the London forces, so the boiling points increase ✓. (4)

9.1.5 (a)

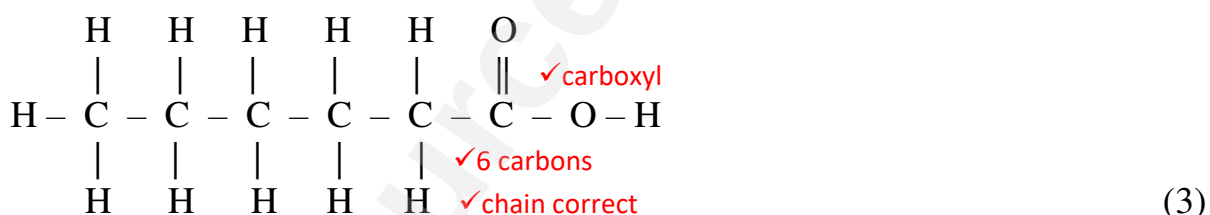
Downloaded from eduresourceza.com



- (b) 2-methylpropan-2-ol OR 2-methylpropan-1-ol (4)
- (c) catalyst, dehydrating agent. (2)
- (d) Compounds having the same molecular formula but different structural formulae. (2)
- (e) butyl ethanoate OR 1-methylpropyl ethanoate OR 2,2-dimethyl ethanoate (2)



OR



- 9.2.1 (a) substitution OR hydrolysis, hydration (1)
- (b) dilute (1)
- (c) NaCl (1)
- 9.2.2 (a) dehydration (elimination) (2)
- (b) A compound containing carbon and hydrogen atoms only, in which there is at least one double and/or triple bond between carbon atoms. (3)
- (c) CH₂CH₂ OR CH₂-CH₂ (2)
- (d) Reaction with Br₂. If the solution changes colour from brown to colourless immediately then an addition reaction has occurred and the compound is unsaturated. (3)

[38 marks]

[TOTAL = 200 MARKS]