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Marking Guidelines

Question 1

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

(20 marks)

Question 2

- 2.1 Measure of the tendency of an atom to attract a bonding pair of electrons. ✓✓
- 2.2.1 Polar✓ covalent✓ bond
- 2.2.2 The more electronegative Cl atom(3) bears the partial negative charge, while the less electronegative H atom(2,1) ✓bears the partial positive charge, leading to the formation of a dipole. ✓
- 2.3. (a) Weak force of attraction✓ between molecules, ions or atoms of noble gases ✓
- (b) dipole-dipole attraction. ✓
- 2.4 The dipole-dipole✓ attractions between HCl molecules are sufficient to cause them to “stick together” to form a liquid, whereas the relatively weaker dispersion/Londons’ forces✓ between nonpolar F₂ molecules are not, and so this substance is gaseous at this temperature. The higher normal boiling point of HCl compared to F₂ is due to the greater strength of dipole-dipole attractions between HCl molecules, ✓ compared to the attractions between nonpolar F₂ molecules(more energy is needed to overcome the stronger forces). ✓
- 2.5 (a) HCl and H₂O are both polar molecules, ✓while CCl₄ is a non polar molecule (like dissolves like). ✓
- (b) dipole-dipole forces.✓
- 2.6.1 Large amounts of energy✓ are needed to overcome the many strong electrostatic forces of attraction✓ between the cations and anions in the lattice structure. (or to break the many strong ionic bonds).
- 2.6.2 MgO. ✓ The charge of the ions are bigger than that of NaCl. ✓

(21 marks)

Question 3

- 3.1 The rate of reaction increase with increase in temperature. ✓✓
- 3.2.1 Sulphur dioxide✓
- 3.2.2 Sulphur✓
- 3.3 Concentration of reactants (HCl and Na₂S₂O₃). ✓
- 3.4 Turbidity(measure time taken for the cross to disappear due to precipitate).✓✓
- 3.5.1 Minimum energy ✓required to start a chemical reaction✓ or the energy required ✓to form the activated complex. ✓
- 3.5.2 T₂. At a higher temperature the average kinetic energy of the reactant particles increases, hence frequency of collisions increases. T₂ corresponds with more particles having E_K ≥ E_A and shows that more molecules have enough energy to be involved in effective collisions.
- 3.6.1 Reaction rate✓
- 3.6.2 The reaction rate✓ increases with increase in temperature. ✓
- 3.7.1 Measure of the extent of a reaction, ✓generally measured by comparing the amount of product against the amount of product that is possible. ✓
- 3.7.2 Na₂S₂O₃(aq) + 2HCl(aq) → 2NaCl(aq) + S(s) + H₂O(l) + SO₂(g)
 $n_{\text{(HCl)}} = cv = (2)(0,005) \checkmark = 0,01 \text{ mol} \checkmark$
 $2 n_{\text{(HCl)}} = 1 n_{\text{(S)}}$
 $n_{\text{(S)}} = 0,005 \text{ mol}$
 $n = \frac{m}{M}$
 $0,005 = \frac{m}{32}$
 $m_{\text{(s)}} = 0,16 \text{ g} \checkmark$
 Percentage Yield = $\frac{0,12}{0,16} \times 100 \checkmark = 75\% \checkmark$

(23 marks)

Question 4

- 4.1.1 2NO(g) → N₂(g) + O₂(g) ✓
- 4.1.2 The system is in equilibrium ✓ because the rates of the forward and reverse reactions are equal. ✓
- 4.1.3 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. ✓✓

- 4.1.4 (a) Decreased. ✓
 (b) The rates of both the forward and the reverse reactions decrease ✓, but the rate of the reverse reaction decreases more. ✓ The rate of the endothermic reaction will always decrease the more when a reaction mixture is cooled. Thus the reverse reaction is endothermic. That means that the forward reaction must be exothermic and was favoured by the decrease in temperature. ✓

- (c) Increases. ✓
 Since $K_c = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]}$ and the forward reaction is favoured ✓ which causes an increase in $[\text{NO}]$, the value of K_c increases. ✓

- 4.1.5 (a) Increased. ✓ The pressure is probably caused by a volume decrease. This results in the concentrations ($c = \frac{n}{V}$) of the reactants, as well as the products, to increase ✓, which in turn causes an equal increase in the forward and reverse reaction rates. ✓
 (b) The amount (n) of reactants and products does not change, ✓ since 2 moles of gaseous reactant molecules $\rightleftharpoons$ 2 moles of gaseous product molecules. ✓

4.2.1	1 NO ₂ : 1 NO : 1 N ₂ O : 1 O ₂			
I	0,06	0,29	0,18	0,38✓
C	+0,06	+0,06	-0,06	-0,06✓
E	0,12	0,35	0,12	0,32✓
c	0,12	0,35	0,12	0,32✓

$$K_c = \frac{[\text{N}_2\text{O}] \cdot [\text{O}_2]}{[\text{NO}_2] \cdot [\text{NO}]}$$

$$= \frac{0,12 \cdot 0,32}{0,12 \cdot 0,35}$$

$$= 0,91✓$$

- 4.2.2 $\text{NO}_2(\text{g}) + \text{NO}(\text{g}) + \text{Energy} \rightleftharpoons \text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g})$
 $\Delta [\text{NO}_2] = [\text{NO}_2]_{\text{final}} - [\text{NO}_2]_{\text{initial}} = (0,12 - 0,06) = 0,06 \text{ mol NO}_2 \text{ is formed. } ✓$ but NO_2 is the product of the reverse reaction ✓ the reverse reaction was favoured.

- 4.2.3 Temperature. ✓ K_c was initially 3,93 (given) now it is 0,91. If the K_c value changed, the temperature must have changed ✓

(28 marks)

Question 5

- 5.1 An acid that ionises completely✓ in an aqueous solution. ✓
- 5.2 $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{Cl}^- + \text{H}_3\text{O}^+$ ✓. HCl is a strong acid ionises completely in water to produce a high concentration of H_3O^+ ions. ✓ The more H_3O^+ ions present, the more acidic✓ the solution therefore pH decreases.
- 5.3.1 (a) A solution of known✓ concentration. ✓
 (b) $n = m/M = 21,2/106✓ = 0,2\text{mol}$
 $c = n/v = 0,2/0,5✓ = 0,4\text{mol.dm}^{-3}✓$
- 5.3.2 $\text{Na}_2\text{CO}_3 + 2\text{H}[\text{NO}_2] \text{Cl} \rightarrow 2\text{NaCl}✓ + \text{H}_2\text{O} ✓ + \text{CO}_2✓$ ✓(+1 for balancing)
- 5.3.3 A substance in which the hydrogen of an acid ✓has been replaced by a cation. Sodium chloride✓
- 5.4.1 Both acids react with Na_2CO_3 to produce a gas/bubbles✓
 HCl produces a more vigorous reaction as it is a stronger acid. ✓
- 5.4.2 HCl is a stronger acid ✓and therefore ionises more completely and therefore produces a larger concentration of ions. ✓ The more free ions in solution, the better the conductivity of the solution. ✓
- 5.4.3 $K_w = [\text{H}_3\text{O}^+] [\text{OH}^-] = 1 \times 10^{-14}✓$
 $0,01✓ \times [\text{OH}^-] = 1 \times 10^{-14}$
 $[\text{OH}^-] = 1 \times 10^{-12}\text{mol.dm}^{-3}✓✓$
- (27 marks)

Question 6

- 6.1 Galvanic✓
- 6.2 HCl ✓and $\text{ZnSO}_4✓$ (or any other suitable electrolyte).
- 6.3 A salt bridge is connected ✓
- 6.3 HCl and ZnSO_4
- 6.4 0V ✓
- 6.5 $\text{Zn(s)} \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{e}^- ✓$
- 6.6 $\text{Pt(s)}/\text{H}_2(\text{g}, 1\text{atm})/\text{H}^+(\text{aq}, 1\text{mol.dm}^{-3})//\text{Zn}^{2+}(\text{aq}, 1\text{mol.dm}^{-3})/\text{Zn(s)}$ @25°C
- ✓ ✓ ✓ ✓ ✓

- 6.7.1 Mg. ✓ Mg is oxidised ✓
- 6.7.2 $E^0_{\text{cell}} = E^0_{\text{cathode}} - E^0_{\text{anode}} \checkmark = 0,76 - (-2,36) \checkmark = 1,6 \text{ V} \checkmark$
- 6.7.3 As the cell functions, the concentration of zinc ions (reactants) decreases ✓ relative to the standard conditions and the concentration of magnesium ions (products) increases relative to standard conditions. ✓ The reverse reaction starts opposing the forward reaction causing the emf to decrease relative to standard conditions. ✓

(20 marks)

Question 7

- 7.1.1 The process in which electricity is used to bring about a chemical change / decompose / break compounds into components ✓✓ or A process in which electrical energy is converted to chemical energy. ✓✓
- 7.1.2 P. ✓ P is the positive electrode /anode ✓ or Oxidation takes place at the positive electrode/anode✓
- 7.1.3 $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s}) \checkmark \checkmark$
- 7.1.4 Pt and Ag are both weaker reducing agents ✓ (than copper) and will not be ✓oxidised ✓ or Cu is a stronger reducing agent (than Pt and Ag) and will be oxidised ✓✓
- 7.1.5 The rate at which copper is oxidised at the anode, ✓ is equal to the rate at which copper ions are reduced at the cathode. ✓
- 7.1.6 Contains platinum and silver that are valuable/expensive metals ✓
- 7.1.7 $q = It = 12 \times 1800 = 21600\text{C} \checkmark \checkmark$
 $n(\text{electrons}) = 21600/96500 = 0,224\text{mol} \checkmark \checkmark$
 $n(\text{Cu}) = 0,112\text{mol}$
 $m = Nm = 0.112 \times 63,5 = 7,11\text{g} \checkmark \checkmark$
- 7.2.1 NaCl✓
- 7.2.2 Y✓
- 7.2.3 $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^- \checkmark \checkmark$
- 7.2.4 The membrane prevents chloride ions from moving to the cathode, only ✓allows positive ions through. ✓✓

(23 marks)

Question 8

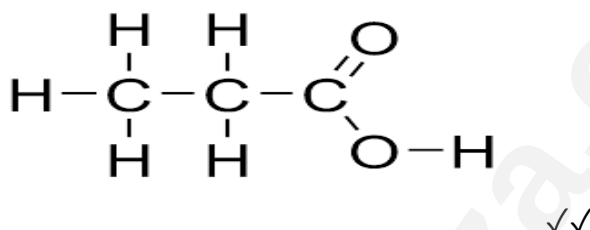
8.1.1 Compounds containing only carbon and hydrogen atoms✓✓and all of the bonds between carbon atoms are single bonds. ✓

8.1.2 (a) Haloalkane✓

(b) carboxyl group✓

(c) ethanol ✓and methanoic acid ✓

8.1.3 (a)



(b) $\text{CH}_2(\text{Cl})\text{CH}(\text{CH}_3)\text{CH}_3$ ✓✓

(c) C_6H_{14} ✓✓

8.1.4 Compounds having the same molecular formula✓ but different structural formula. ✓✓

8.1.5 (a) chain isomers✓

(b) functional isomers✓

8.1.6 C. ✓ It is a straight chain haloalkane and occupies a larger surface area(more points of contact)and have more and collectively stronger Londons and dipole-dipole interactions. ✓More energy is needed to overcome the stronger forces thus C has a higher boiling point than D, ✓

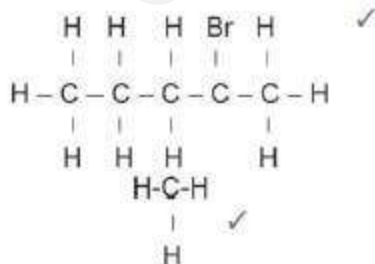
8.2.1 Elimination ✓

8.2.2 I- hydration ✓ II- hydrohalogention ✓

8.2.3 Butan-2-ol ✓✓

8.2.4 H_2SO_4 ✓

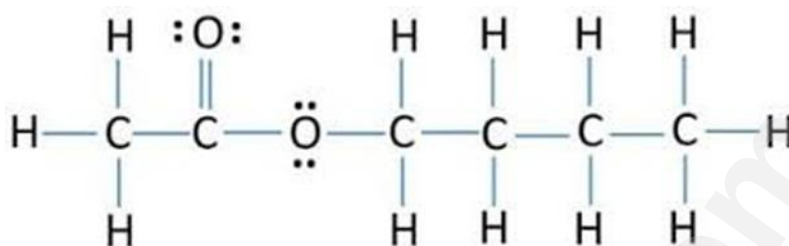
8.2.5 2-bromo-2-methylpentane



8.2.6 Alkene ✓

8.3 (a) The reaction would take longer and it would also not produce water. ✓✓

(b) butyl ethanoate ✓



✓✓

(c) Alcohols are flammable, therefore use a water bath when heating the mixture. ✓ (or any other suitable answer).

(38 marks)