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METRO CENTRAL
EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: PAPER 2 (CHEMISTRY)
SEPTEMBER 2016 – MARKING GUIDELINE

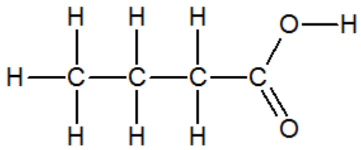
MARKS: 150
TIME: 3 hours

MARKING GUIDELINE

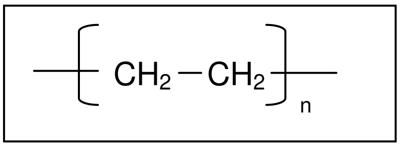
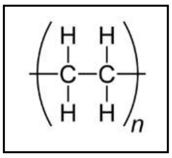
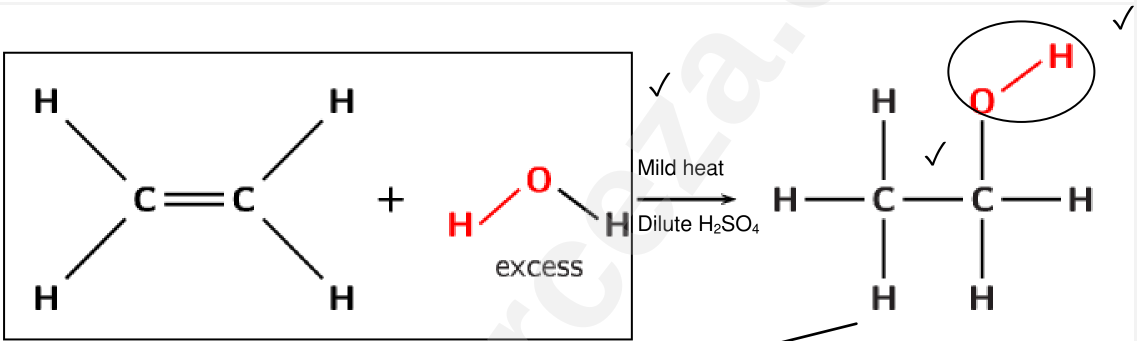
This question MEMO consists of 12 pages.

QUESTION 1

1.1	D ✓✓	(2)
1.2	D ✓✓	(2)
1.3	A ✓✓	(2)
1.4	C ✓✓	(2)
1.5	B ✓✓	(2)
1.6	D ✓✓	(2)
1.7	C ✓✓	(2)
1.8	C ✓✓	(2)
1.9	C ✓✓	(2)
1.10	D ✓✓	(2)
		[20]

QUESTION 2			
2.1.1	There are single bonds between C-atoms✓ / There are no multiple bonds between C atoms in their hydrocarbon chains. ✓ / No double or triple bonds between C atoms✓		(1)
2.1.2	✓ ✓ ✓ (substituents must be in alphabetical order) 3-chloro-3-ethylhexane		(3)
2.1.3	Propanal ✓		(1)
2.1.4	carboxylic acids ✓		(1)
2.1.5	Methanol ✓		(1)
2.1.6	✓ 3C single bonds  carboxylic acid functional group ✓		(2)
2.2.1	Propanoic acid. ✓		(1)
2.2.2	In 100 g there will be 9,81 g H , 58,85g C 31,34g O number of moles: H : $\frac{9,81}{1}$ = 9,81 mole ✓ C : $\frac{58,82}{12}$ = 4,904 moles ✓ O : $\frac{31,37}{16}$ = 1,959 moles ✓ $\frac{9,81}{1,96} : \frac{4,90}{1,96} : \frac{1,96}{1,96}$ 5 : 2,5 : 1 10 : 5 : 2 ✓ Molar mass/Molêre massa: 10(1) + 5(12) + 2(16) = 102 $g\cdot mol^{-1}$ ✓ n = 1 $C_5H_{10}O_2$ ✓		(6) **[16]**

QUESTION 3			
3.1	The temperature at which the vapour pressure of a substance✓ equals atmospheric pressure. ✓		(2)
3.2	2-methylpropan-2-ol ✓		(1)
3.3	London force / momentarily dipole forces/ dispersion forces ✓		(1)
3.4.1	In both pentane and 2-methylbutane there are weak London/ dispersion forces present. ✓ 2-methylbutane is more spherical / has a smaller surface area than pentane✓ and therefore there are fewer/less intermolecular forces between its molecules and the energy required to overcome the intermolecular forces in 2-methylbutane is less than the energy required to overcome the intermolecular forces in pentane. ✓ therefore a lower boiling point ✓		(4)
3.4.2	2-methylpropan-2-ol have stronger hydrogen bonding between molecules ✓ while pentane has weaker London/dispersion forces between its molecules. ✓ Therefore more energy is required to overcome the IMF in 2-methylpropan-2-ol than in pentane. ✓ And the more energy required the higher the boiling point. ✓		(4)
3.5	2-methylpropan-2-ol ✓		(1)
3.6	$n = \frac{m}{M}$ $M[CO_2] = 12 + 2(16) = 44$ (a) CO_2: $n = \frac{34}{44} = 0{,}773$ mol ✓ (b) 0,773 mol CO_2 is created by $\frac{0{,}77}{4} = 0{,}193$ mol C_4H_{10}✓ (c) Mass C_4H_{10}: $m = n \times M$ $= 0{,}193 \times [4(12) + 10(1)]$ $= 11{,}19$ g✓ (d) Percentage purity $= \frac{11{,}2}{26} \times 100$✓ $= 43{,}05$ % ✓ [Accept: -- 43,09%]		(5)
			[18]

QUESTION 4		
4.1	Cracking ✓of alkanes	(1)
4.2.1	Addition polymerization ✓	(1)
4.2.2	polyethene/ polythene/ polyethelene ✓ (any one)	(1)
4.2.3	  ✓ (any one)	(1)
4.3		(3)
4.4	Hydration ✓ +	(1)
4.5	Ethanol ✓	(1)
4.6	Excess of a conc. strong acid (H_2SO_4) ✓ Mild heat ✓	(2)
4.7.1	Substitution ✓ **NOT:** Halogenation/Bromination	(1)
4.7.2	Add NaBr in presence of dilute H_2SO_4 ✓ Mild heat ✓ Add HBr ✓ and mild heat ✓	(2)
4.7.3	Sodium hydroxide ✓ water ✓	(1)
		[15]

QUESTION 5

5.1

Amount of mole Zn available at 0 s: $n = \frac{m}{M}$

$= \frac{0{,}016}{65}$

$= 0{,}00025$ mol ✓ (2,462 x 10^{-4} mol)

Amount of mole Zn available at 12 s: $n = \frac{m}{M}$

$= \frac{0{,}009}{65}$

$= 0{,}00014$ mol ✓ (1,385 x 10^{-4} mol)

Ave Rate = $-\frac{\Delta c}{\Delta t}$ (no mark for formula)

$= \frac{0{,}00014 - 0{,}00025}{12 - 0}$ ✓

= - 9,167 x 10^{-6} mol·s^{-1} ✓ (= - 8,975 x 10^{-6} mol·s^{-1})

Ave Rate = 9,167 x 10^{-6} mol·s^{-1} (= 8,975 x 10^{-6} mol·s^{-1})

$\Delta n = \Delta m/MM$

= (0,009 – 0,016)/ 65 ✓

= - 1,077 x 10^{-4} mol

∴ Average Rate = - $\Delta n/\Delta t$ ✓

= - [-1,077 x 10^{-4} / (12 – 0)] ✓

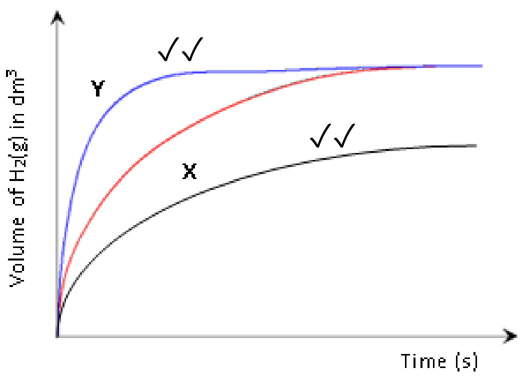
= 8,974 x 10^{-6} mol·s^{-1}. ✓

(4)

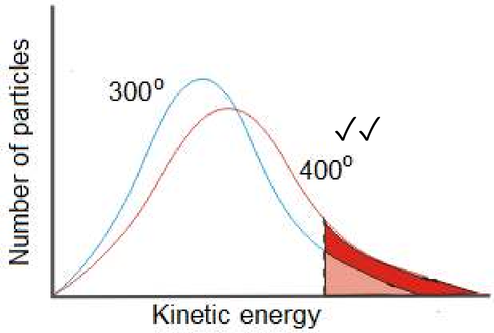
5.2 The HCℓ is used up/depleted / HCℓ is the limiting reactant ✓ (1)

5.3 The rate decreases as time passes. ✓ (1)

5.4.1
5.4.2



(4)

5.5			(2)
5.6	An increase in temperature increases the number of particles having minimum kinetic energy. ✓ Therefore there are more collisions per second/ unit time/ frequency of collision increases More effective collisions per second/ unit time / frequency of effective collision increases ✓ Which increases rate of reaction		(2) **[14]**

QUESTION 6

6.1 It is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction✓✓ and the reactions occur simultaneously.
[2 or 0] (2)

6.2

	N_2	$3\ H_2$	$2\ NH_3$
Initial moles	${}^{33,6}/_{28} = 1,2$ ✓	${}^{24}/_{2} = 12$ ✓	0
Change in moles	- 1	- 3	+ 2
Equilibrium moles	${}^{5,6}/_{28} = 0,2$ ✓	9 ✓	2
Equilibrium conc (= n/V)	${}^{0,2}/_{5} = 0,04$	${}^{9}/_{5} = 1,8$	${}^{2}/_{5} = 0,4$

$\therefore [N_2] = 0,04\ mol \cdot dm^{-3}$ ✓ AND $[H_2] = 1,8\ mol \cdot dm^{-3}$ ✓

mass of N_2 used during the reaction?
33,6 - 5,6 = 28 g
Therefore 1 mol N_2 was used during the reaction. ✓
1 mol N_2 react with three mole H_2
Therefore 6 g H_2 was used during the reaction✓

concentration N_2 at equilibrium: $c = \frac{m}{MV}$
$= \frac{5,6}{28 \times 5}$ ✓
$= 0,04\ mol \cdot dm^{-3}$ ✓

Amount H_2 at equilibrium: $c = \frac{m}{MV}$
$= \frac{24-6}{2 \times 5}$ ✓
$= 1,8\ mol \cdot dm^{-3}$ ✓

(6)

6.3 $K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]}$ ✓
$= {}^{(0,4)2}/_{(0,04)(1,8)3}$ ✓
$= 0,686$ ✓ (3)

6.4 Increases ✓ (1)

6.5 Exothermic ✓ (1)

6.6 When the temperature increases, the K_c value decreases, which means the concentration of the reactants increased and the concentration of the products decreased. ✓ Therefore the reverse reaction was favoured. ✓ An increase of temperature favours the endothermic reaction, ✓ therefore the forward reaction must be exothermic. (3)
[16]

QUESTION 7

7.1	It dissociates completely in water ✓ to produce a high concentration of OH^- ions. ✓		(2)
7.2	(a) $n = \frac{m}{M}$ $= \frac{27}{137 + 2(16+1)}$ $= 0,158$ mol ✓ (b) $Ba(OH)_2 \xrightarrow{H_2O} Ba^{2+}(aq) + 2\,OH^-(aq)$ Therefore 0,158 mol $Ba(OH)_2$ produces 2 x 0,158 = 0,316 mol OH^- ✓ (c) Concentration of hydroxide ions: $c = \frac{n}{V}$ $= {}^{0,316}/_{2}$ $= 0,158\ mol{\cdot}dm^{-3}$ (d) $K_w = [OH^-][H^+]$ ✓ $10^{-14} = [0,158][H^+]$ ✓ $[H^+] = 6,329 \times 10^{-14}\ mol{\cdot}dm^{-3}$ (e) $pH = -\log[H^+]$ ✓ $= -\log[6,329 \times 10^{-14}]$ ✓ $= 13,19$ ✓ OR: Calc: $pOH = -\log[OH^-]$ ✓ $= -\log(0,158)$ ✓ $= 0,801$ ✓ $\therefore pH = 14 - 0,801$ ✓ $= 13,20$ ✓		(7)
7.3	Burette ✓		(1)
7.4	An acid is a proton (H^+-ion) donor. ✓✓ (2 or 0)		(2)
7.5	$Ba(OH)_2 + 2\,HC\ell \rightarrow BaC\ell_2 + 2H_2O$ $n_b = 1$ $n_a = 2$ $c_b = 0,079$ $c_a = 2,5$ $V_b = 2\ dm^3$ $V_a = ?$ 0,158 mol $Ba(OH)_2$ will be neutralized by 0,316 mol $HC\ell$ ✓ $c = \frac{n}{v}$ ✓ $2,5 = \frac{0,316}{V}$ ✓ $V = 0,126\ dm^{-3}$ or $0,13\ dm^{-3}$ ✓. ${}^{CaVa}/_{CbVb} = {}^{na}/_{nb}$ ✓ ✓ ${}^{(2,5)Vb}/_{(0,079)(2)} = {}^{2}/_{1}$ ✓ $V_b = 0,126\ dm^3$ ✓		(4)

7.6	bromothymol blue changes colours when the pH is around 7.✓ This is also the end point for a reaction between a strong acid and a strong base / ✓ Phenolphthalein is an effective indicator for a reaction between a strong base and a weak acid.		(2)
7.7	REMAINS YELLOW ✓		(1) **[19]**

QUESTION 8			
8.1	$A\ell$ ✓		(1)
8.2.1	$A\ell \rightarrow A\ell^{3+} + 3e^-$ ✓✓		(2)
8.2.2	Co^{3+} ✓		(1)
8.3	Decreases ✓		(1)
8.4	$A\ell(s) \mid \overset{✓}{\underset{(1\ mol{\cdot}dm^{-3})}{A\ell^{3+}(aq)}} \parallel \underset{(1\ mol{\cdot}dm^{-3})}{Co^{3+}(aq)} \overset{✓}{\mid} Co^{2+}(aq) \mid Pt(s)$ ✓ • Phase must be indicated. • 1 $mol{\cdot}dm^{-3}$ not necessary accept $A\ell(s) \mid \underset{(1\ mol{\cdot}dm^{-3})}{A\ell^{3+}(aq)} \parallel \underset{(1\ mol{\cdot}dm^{-3})}{Co^{3+}(aq)} \mid Co^{2+}(aq), Pt(s)$ ✓		(3)
8.5	$E^\ominus = E_{reduction} - E_{oxidation}$ ✓ $= 1{,}81 - (-0{,}76)$ ✓ $= 2{,}57\ V$ ✓		(3)
			[11]

 Please turn over

QUESTION 9			
9.1	The chemical process in which electrical energy ✓ is converted to chemical energy ✓ OR The use of electrical energy ✓ to produce a chemical change ✓.		(2)
9.2.1	Chlorine gas/ $C\ell_2$ ✓		(1)
9.2.2	Hydrogen / H_2 ✓		(1)
9.3	H_2O has a stronger oxidizing ability than Na^+ / Na^+ is a weaker oxidizing agent than H_2O ✓✓		(2)
9.4	(a) Amount of mole $C\ell_2$ that formed: $n = \frac{V}{22,4} = \frac{2,24}{22,4}$ $= 0,1$ mol $C\ell_2$ formed. (b) 0,1 mol $C\ell_2$ is formed from 0,2 mol $NaC\ell$✓ Initial amount of $NaC\ell$ available $n = cV = 2,5 \times 0,5$ ✓ $= 1,25$ mol ✓ (c) Amount $NaC\ell$ left in solution after electrolysis: $1,25 - 0,2 = 1,05$ mol ✓		(4) **[10]**

QUESTION 10			
10.1			
10.1.1	Oxygen / O_2 ✓		(1)
10.1.2	Haber process ✓		(1)
10.1.3	H_2SO_4 ✓		(1)
10.1.4	The temperature at which the reaction takes place is approx. 450 °C and water is a vapour.✓ Also the H_2SO_4 that will be formed is a vapour/mist and cannot be collected easily. ✓		(2)
10.2.1	Nitrogen ✓and phosphorous ✓		(2)
10.2.2	Mass of nutrient = $^{35}/_{100}$ x 40 = 14 g ✓ 50% of the fertilizer consist of phosphorous: Mass of phosphorus = 0,5 x 14 = 7 g ✓ $n = \frac{m}{M}$ $= {^7}/_{31}$ ✓ = 0,226 mol ✓		(4)
			[10]
	TOTAL		**150**

