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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

$1.1 \quad D \checkmark \checkmark$
$1.2 \mathrm{D} \checkmark \checkmark$
$1.3 \mathrm{~A} \checkmark \checkmark$
$1.4 C \vee \checkmark$
$1.5 B \checkmark \checkmark$
$1.6 \mathrm{D} \checkmark \checkmark$
$1.7 \quad C \checkmark \checkmark$
$1.8 \quad C \checkmark \checkmark$
$1.9 \quad C \checkmark \checkmark$
$1.10 \mathrm{D} \checkmark \checkmark$

## QUESTION 2


#### Abstract

2.1.1 There are single bonds between C -atoms $\checkmark$ / There are no multiple bonds between $C$ atoms in their hydrocarbon chains. $\checkmark /$ No double or triple bonds between C atoms $\checkmark$


2.1.2 3-chloro-3-ethylhexane
2.1.3 Propanal $\sqrt{ }$
2.1.4 carboxylic acids $\checkmark$
2.1.5 Methanol $\sqrt{ }$
$\checkmark$ 3C single bonds
2.1.6

carboxylic acid functional group $\checkmark$
2.2.1 Propanoic acid. $\checkmark$
2.2.2 In 100 g there will be $9,81 \mathrm{~g} \mathrm{H} \quad, 58,85 \mathrm{~g} \mathrm{C} \quad 31,34 \mathrm{~g} \mathrm{O}$
number of moles:
$\mathrm{H}: \frac{9,81}{1}=9,81$ mole $\checkmark$
C: $\frac{58,82}{12}=4,904$ moles $\checkmark$
O: $\frac{31,37}{16}=1,959$ moles $\checkmark$
$\frac{9,81}{1,96}: \frac{4,90}{1,96}: \frac{1,96}{1,96}$
5 : 2,5:1
10 : 5 : $2 \checkmark$
Molar mass/Molêre massa: $10(1)+5(12)+2(16)=102 \mathrm{~g} \cdot \mathrm{~mol}^{-1} \checkmark$ $\mathrm{n}=1$
$\mathrm{C}_{5} \mathrm{H}_{10} \mathrm{O}_{2} \checkmark$

## QUESTION 3

3.1 The temperature at which the vapour pressure of a substance $\sqrt{ }$ equals atmospheric pressure. $\checkmark$
3.2 2-methylpropan-2-ol $\checkmark$
3.3 London force / momentarily dipole forces/ dispersion forces $\checkmark$
3.4.1 In both pentane and 2-methylbutane there are weak London/ dispersion forces present. $\sqrt{ } 2$-methylbutane is more spherical / has a smaller surface area than pentane $\sqrt{ }$ 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. $\checkmark$ therefore a lower boiling point $\checkmark$
3.4.2 2-methylpropan-2-ol have stronger hydrogen bonding between molecules $\checkmark$ 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.
3.5 2-methylpropan-2-ol $\checkmark$
$3.6 \mathrm{n}=\frac{m}{M}$
$\mathrm{M}\left[\mathrm{CO}_{2}\right]=12+2(16)=44$
(a) $\quad \mathrm{CO}_{2}: \quad \mathrm{n}=\frac{34}{44}=0,773 \mathrm{~mol} \checkmark$
(b) $0,773 \mathrm{~mol} \mathrm{CO}_{2}$ is created by $\frac{0,77}{4}=0,193 \mathrm{~mol} \mathrm{C}_{4} \mathrm{H}_{10}$ V
(c) Mass $\mathrm{C}_{4}, \mathrm{H}_{10}: m=\mathrm{n} \times \mathrm{M}$

$$
\begin{aligned}
& =0,193 \times[4(12)+10(1)] \\
& =11,19 \mathrm{~g} \checkmark
\end{aligned}
$$

(d) Percentage purity $=\frac{11,2}{26} \times 100 \checkmark=43,05 \% \checkmark \quad$ [Accept: $--43,09 \%$ ]

## QUESTION 4

4.1 Cracking $\checkmark$ of alkanes
4.2.1 Addition polymerization $\checkmark$
4.2.2 polyethene/ polythene/ polyethelene $\checkmark$ (any one)
4.2.3

4.3


4.4 Hydration $\checkmark$
4.6 Excess of a conc. strong acid $\left(\mathrm{H}_{2} \mathrm{SO}_{4}\right) \checkmark$
Mild heat $\checkmark$
4.7.1 Substitution $\checkmark$ NOT: Halogenation/Bromination
4.7.2 Add NaBr in presence of dilute $\mathrm{H}_{2} \mathrm{SO}_{4} \checkmark$ Mild heat $\checkmark$

|  | $\checkmark$ |
| :---: | :---: |
| Add | $\checkmark$ |
|  | HBr |
| and mild heat |  |


4.7.3 Sodium hydroxide $\checkmark$

## QUESTION 5

5.1

| Amount of mole Zn available at $0 \mathrm{~s}: n=\frac{m}{M}$ |  |  |
| :---: | :---: | :---: |
| Amount of mole Zn available at 12 s | $\begin{aligned} & \frac{m}{M} \\ & 0,009 \\ & 65 \\ & , 00014 \mathrm{~mol} \end{aligned}$ | $\downarrow$ |
| $\begin{aligned} \text { Ave Rate } & =-\frac{\Delta c}{\Delta t}(\text { no mark for formula }) \\ & =\frac{0,00014-0,00025}{} \end{aligned}$ |  |  |
| $\text { Ave Rate }=9,167 \times 10^{-6} \mathrm{~mol} \cdot \mathrm{~s}^{-1}$ |  | $\left.5 \times 10^{-6} \mathrm{~mol} \cdot \mathrm{~s}^{-1}\right)$ |

$$
\begin{aligned}
\Delta \mathrm{n} & =\Delta \mathrm{m} / \mathrm{MM} \\
& =(0,009-0,016) / 65 \\
& =-1,077 \times 10^{-4} \mathrm{~mol}
\end{aligned}
$$

$\therefore$ Average Rate $=-\Delta n / \Delta t$

$$
\begin{align*}
& =-\left[-1,077 \times 10^{-4} /(12-0)\right] \\
& =8,974 \times 10^{-6} \mathrm{~mol} \cdot \mathrm{~s}^{-1} . \tag{4}
\end{align*}
$$

5.2 The HCl is used up/depleted / HCl is the limiting reactant $\checkmark$
5.3 The rate decreases as time passes. $\checkmark$
5.4.1
5.4.2

(4)

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

## QUESTION 6

6.1 It is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction $\checkmark \checkmark$ and the reactions occur simultaneously.
6.2

|  | $\mathrm{N}_{2}$ |  | $3 \mathrm{H}_{2}$ |
| :--- | :---: | :---: | :---: |
| Initial moles | $33,6 / 28=1,2 \quad \mathrm{NH}_{3}$ |  |  |
| Change in moles | $-\quad 1$ | $-24 / 2=12 \checkmark$ | 0 |
| Equilibrium moles | $5,6 / 28=0,2 \quad$ | 9 | +2 |
| Equilibrium conc $(=\mathrm{n} / \mathrm{V})$ | $0,2 / 5=0,04$ | $9 / 5=1,8$ | 2 |

$\therefore\left[\mathrm{N}_{2}\right]=0,04 \mathrm{~mol} \cdot \mathrm{dm}^{-3} \checkmark \quad$ AND $\quad\left[\mathrm{H}_{2}\right]=1,8 \mathrm{~mol} \cdot \mathrm{dm}^{-3} \checkmark$

6.4 Increases $\sqrt{ }$
6.5 Exothermic $\sqrt{ }$
6.6 When the temperature increases, the $\mathrm{K}_{\mathrm{c}}$ value decreases, which means the concentration of the reactants increased and the concentration of the products decreased. $\checkmark$ Therefore the reverse reaction was favoured. $\checkmark$ An increase of temperature favours the endothermic reaction, $\checkmark$ therefore the forward reaction must be exothermic.

## QUESTION 7

7.1 It dissociates completely in water $\checkmark$ to produce a high concentration of $\mathrm{OH}^{-}$ions.
7.2 (a) $\mathrm{n}=\frac{m}{M}$

$$
\begin{aligned}
& =\frac{27}{137+2(16+1)} \\
& =0,158 \mathrm{~mol}
\end{aligned}
$$

(b) $\mathrm{Ba}(\mathrm{OH})_{2} \xrightarrow{\mathrm{H}_{2} \mathrm{O}} \mathrm{Ba}^{2+}(\mathrm{aq})+2 \mathrm{OH}^{-}(\mathrm{aq})$

Therefore $0,158 \mathrm{~mol} \mathrm{Ba}(\mathrm{OH})_{2}$ produces $2 \times 0,158=0,316 \mathrm{~mol} \mathrm{OH}^{-} \checkmark$
(c) Concentration of hydroxide ions:

$$
\begin{aligned}
c & =\frac{n}{V} \\
& =0,316 / 2 \\
& =0,158 \mathrm{~mol} \cdot \mathrm{dm}^{-3}
\end{aligned}
$$

(d)

$$
\begin{aligned}
& \mathrm{K}_{\mathrm{w}}=\left[\mathrm{OH}^{-}\right]\left[\mathrm{H}^{+}\right] \checkmark \\
& 10^{-14}=[0,158]\left[\mathrm{H}^{+}\right] \checkmark \\
& {\left[\mathrm{H}^{+}\right]=6,329 \times 10^{-14} \mathrm{~mol} \cdot \mathrm{dm}^{-3}} \\
& \text { (e) } \mathrm{pH}=-\log \left[\mathrm{H}^{+}\right] \quad \checkmark \\
& =-\log \left[6,329 \times 10^{-14}\right] \checkmark \\
& =13,19 \mathrm{~V}
\end{aligned}
$$

$$
\begin{aligned}
& \text { OR: } \\
& \begin{aligned}
\text { Calc: } \mathrm{pOH} & =-\log [\mathrm{OH}] \\
& =-\log (0,158) \\
& =0,801 \quad \checkmark \\
\therefore \mathrm{pH}= & 14
\end{aligned} \\
& \begin{aligned}
& -0,801 \quad \checkmark \\
= & 13,20 \checkmark
\end{aligned}
\end{aligned}
$$

### 7.3 Burette $\sqrt{ }$

7.4 An acid is a proton ( $\mathrm{H}^{+}$-ion) donor. $\checkmark \checkmark$ (2 or 0 )
$7.5 \mathrm{Ba}(\mathrm{OH})_{2}+2 \mathrm{HCl} \longrightarrow \mathrm{BaCl}_{2}+2 \mathrm{H}_{2} \mathrm{O}$

$$
\begin{array}{ll}
\mathrm{n}_{\mathrm{b}}=1 & \mathrm{n}_{\mathrm{a}}=2 \\
\mathrm{c}_{\mathrm{b}}=0,079 & \mathrm{c}_{\mathrm{a}}=2,5 \\
\mathrm{~V}_{\mathrm{b}}=2 \mathrm{dm}^{3} & \mathrm{~V}_{\mathrm{a}}=?
\end{array}
$$

$0,158 \mathrm{~mol} \mathrm{Ba}(\mathrm{OH})_{2}$ will be neutralized by $0,316 \mathrm{~mol} \mathrm{HCl}$,
$\mathrm{C}=\frac{n}{v} \mathrm{~V}$
$2,5=\frac{0,316}{V} V$
$V=0,126 \mathrm{dm}^{-3}$ or $0,13 \mathrm{dm}^{-3} \checkmark$.

$$
\begin{gather*}
\text { CaVa }^{\text {CbVb }} \\
\checkmark \\
\checkmark \text { na/nb }  \tag{4}\\
(2,5) \mathrm{Vb} /(0,079)(2)=2 / 1 \quad \checkmark \\
V_{\mathrm{b}}=0,126 \mathrm{dm}^{3}
\end{gather*}
$$

7.6 bromothymol blue changes colours when the pH is around $7 . \checkmark$ This is also the end point for a reaction between a strong acid and a strong base $/ \checkmark$ Phenolphthalein is an effective indicator for a reaction between a strong base and a weak acid.

### 7.7 REMAINS YELLOW $\checkmark$

## QUESTION 8

8.1 Al $\sqrt{ }$
8.2.1 $A l \rightarrow A l^{3+}+3 e^{-} \checkmark \checkmark$
8.2.2 $\mathrm{Co}^{3+}$ V
8.3 Decreases $\checkmark$


- Phase must be indicated.
- $1 \mathrm{~mol} \cdot \mathrm{dm}^{-3}$ not necessary
accept $\mathrm{Al}(\mathrm{s})\left|\underset{\left(1 \mathrm{~mol}^{2} \cdot \mathrm{dm}^{3}\right)}{\mathrm{Al}^{3+}} \| \underset{\left(1 \mathrm{~mol}^{2} \cdot \mathrm{dm}^{3}\right)}{\mathrm{Co}^{3+}}{ }_{(\mathrm{aq})}\right| \mathrm{Co}^{2+}(\mathrm{aq}), \mathrm{Pt}(\mathrm{s}) \checkmark$
8.5 $\quad E^{\ominus}=E_{\text {reduction }}-E_{\text {oxidation }} \checkmark$
$=1,81-(-0,76) \checkmark$
$=2,57 \vee \checkmark$


## QUESTION 9

9.1 The chemical process in which electrical energy $\checkmark$ is converted to chemical energy $\checkmark$

OR
The use of electrical energy $\checkmark$ to produce a chemical change $\checkmark$.
9.2.1 Chlorine gas/ $\mathrm{Cl}_{2}$
9.2.2 Hydrogen / $\mathrm{H}_{2} \checkmark$

9.3 $\quad \mathrm{H}_{2} \mathrm{O}$ has a stronger oxidizing ability than $\mathrm{Na}^{+}$/
$\mathrm{Na}^{+}$is a weaker oxidizing agent than $\mathrm{H}_{2} \mathrm{O}$
9.4 (a) Amount of mole $\mathrm{Cl}_{2}$ that formed:

$$
\begin{aligned}
\mathrm{n} & =\frac{V}{22,4}=\frac{2.24}{22,4} \\
& =0,1 \mathrm{~mol} \mathrm{Cl} \\
2 & \text { formed. }
\end{aligned}
$$

(b) $0,1 \mathrm{~mol} \mathrm{Cl}_{2}$ is formed from $0,2 \mathrm{~mol} \mathrm{NaCl} \checkmark$

Initial amount of NaCl available

$$
\mathrm{n}=\mathrm{cV}=2,5 \times 0,5 \checkmark=1,25 \mathrm{~mol} \checkmark
$$

(c) Amount NaCl left in solution after electrolysis: 1,25-0,2=1,05 mol $\checkmark$

## QUESTION 10

10.1
10.1.1 Oxygen / $\mathrm{O}_{2} \checkmark$
10.1.2 Haber process $\checkmark$
10.1.3 $\mathrm{H}_{2} \mathrm{SO}_{4} \checkmark$
10.1.4 The temperature at which the reaction takes place is approx. $450^{\circ} \mathrm{C}$ and water is a vapour. $\checkmark$ Also the $\mathrm{H}_{2} \mathrm{SO}_{4}$ that will be formed is a vapour/mist and cannot be collected easily. $\checkmark$
10.2.1 Nitrogen $\checkmark$ and phosphorous $\checkmark$
10.2.2 Mass of nutrient $={ }^{35} / 100 \times 40=14 \mathrm{~g}$
$50 \%$ of the fertilizer consist of phosphorous:
Mass of phosphorus $=0,5 \times 14=7 \mathrm{~g} \checkmark$
$\mathrm{n}=\frac{\mathrm{m}}{\mathrm{M}}$
$={ }^{7} / 31 \mathrm{~V}$
$=0,226 \mathrm{~mol} \checkmark$

