



233/2 MS  
CHEMISTRY  
Paper 2  
MARKING SCHEME

*Rm 13*  
*1835*  
*TM-4*

*14*

*Final marking scheme  
for 2021.  
as at 23/3/2021  
on 06/04/2021*

THE KENYA NATIONAL EXAMINATIONS COUNCIL  
Kenya Certificate of Secondary Education

CHEMISTRY

Paper 2

**MARKING SCHEME**  
(CONFIDENTIAL)

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**This marking scheme consists of 10 printed pages.**

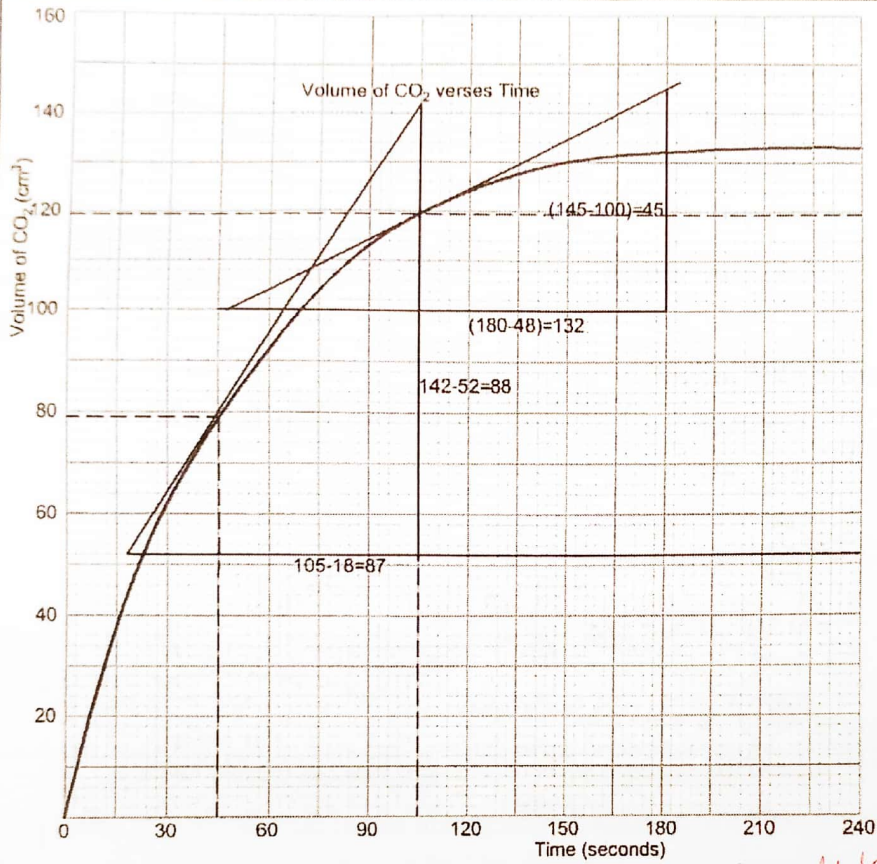
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232/2 MS

1.	(a) (i) Compound <b>A</b> - changes from a crystalline solid to a powder (1) because it loses its water of crystallization (1).	2 marks
	(ii) Compound <b>B</b> - changes from a crystalline solid to a solution (1) because it absorbs water vapour from the atmosphere to an extent of forming a solution / it absorbs water vapour until it dissolves forming a colourless solution (1).	2 marks
b)	<p><math>\text{MgSO}_4 \cdot \text{XH}_2\text{O}</math></p> <p>Mass of anhydrous <math>\text{MgSO}_4</math></p> <p><math>= 26.82 - 25.62 \text{ g}</math></p> <p><math>= 1.20 \text{ g}</math></p> <p>Mass of water <math>= (28.08 - 26.82)\text{g} = 1.26 \text{ g}</math></p> <p><b>(<math>\frac{1}{2}</math> mark for both masses)</b></p> <p style="text-align: center;"><b>OR</b></p> <p>Mass of hydrated sample <math>= (28.08 - 25.62)\text{g} = 2.46 \text{ g}</math></p> <p>Mass of anhydrous salt <math>= 26.82 - 25.62 = 1.20</math></p> <p>Mass of water <math>= (2.46 - 1.20) = 1.26 \text{ g}</math></p> <p>RFM of <math>\text{MgSO}_4 = 24 + 32 + 64 = 120</math></p> <p>RFM of <math>\text{H}_2\text{O} = 18</math></p> <p><b>(<math>\frac{1}{2}</math> mark for both RFMs)</b></p>	<p><math>\frac{1}{2}</math> mark</p> <p><math>\frac{1}{2}</math> mark</p>

	MgSO <sub>4</sub>	H <sub>2</sub> O	
Mass (g)	1.20	1.26 <i>to</i>	1 mark
No. of moles	$\frac{1.20}{120} = 0.01$	$\frac{1.26}{18} = 0.07$ <i>(1/2)</i>	
Ratio of moles	$\frac{0.01}{0.01}$	$\frac{0.07}{0.01} = 7$ <i>(1/2)</i>	
	1	7	1 mark
Formula of hydrated salt is MgSO <sub>4</sub> ·7H <sub>2</sub> O (1) <i>✓ 01</i>			
(c)	(i) Hydrogen gas (1) <i>✓ accept correct formula: H<sub>2</sub></i>	(ii) [Zn(OH) <sub>4</sub> ] <sup>2-</sup> (1) <i>✓ - accept Zn(OH)<sub>4</sub><sup>2-</sup> / Zn(OH)<sub>4</sub><sup>2-</sup></i>	4 marks
	(iii) Zinc / Zn (1) <i>✓</i>	Copper / Cu (1) <i>✓</i>	11 marks
2 (a)	Sulphur is obtained from underground sulphur deposits where it is mined using Frasch process <i>or</i> where three concentric pipes are drilled into the sulphur deposits (1/2). Superheated water is pumped through the outer pipe to melt the sulphur deposits (1/2). Hot compressed air is used forced through the inner pipe which pushes the molten sulphur through the middle pipe to the surface (1). <i>Sulphur passed through the middle pipe to the surface</i>		<i>* Diagram can be labelled - 3 marks</i> 2 marks
(b)	Air is cheap source of oxygen gas (1) <i>✓</i> <i>Air is economical - its readily available</i>		1 mark
(c)	(i) M - concentrated sulphuric(VI) acid (1) <i>✓</i>	(ii) N - water (1) <i>✓</i>	2 marks

(d)	<p>(i) Impurities in the gas poisons the catalyst (1)</p> <p>(ii) I. High temperatures <u>increase</u> the rate of the reaction as the particles gain kinetic energy resulting to frequent fruitful collisions (1). <i>successful &amp; effective</i></p> <p>II. Can be <u>recycled</u> to preheat SO<sub>2</sub> and O<sub>2</sub> gases (1). <i>purpose of recycling</i></p>	1 mark
(e)	The formation of SO <sub>3</sub> in chamber 3 occurs when SO <sub>2</sub> and O <sub>2</sub> come into contact with each other on the surface of the catalyst (1). <i>preheat incoming gases</i>	1 mark
(f)	<p>(i) - Metallic structures near the plant are <u>rusted</u> (corroded) (1);</p> <p>- Vegetation near the plant changes from green to yellow or dries <i>/ dies</i></p> <p><i>causes respiratory diseases</i></p> <p><i>up some buildings start corrode out - kills aquatic life</i></p> <p>(ii) Passing the gaseous emissions through alkaline or basic substances such as calcium hydroxide/scrubbing the gas (1). <i>Ca(OH)<sub>2</sub> / NaOH / NaOH</i></p>	2 marks
3	<p>(a) - Colliding particles <u>may not</u> possess / have the necessary kinetic energy (1). <i>needing activation energy</i></p> <p>- Particles may not collide in the right / <del>correct</del> orientation</p> <p>(Any one correct)</p>	11 marks
(b)	(i) Increase in surface area of solid reactants <u>increases</u> the rate of reaction (½) because <u>more particles</u> are exposed to the reaction to the other reactant hence the smaller the size of the particles, the faster the rate of the reaction (1). <i>effective collisions / frequency</i>	1 mark
(b)	(ii) Increase in pressure brings the molecules of gaseous reactants closer to each other (½); this increases number of collisions hence increase in rate of the reaction (½). <i>increased effective collisions</i>	1 mark
<p><i>increase in pressure increases the rate of reaction</i></p> <p><i>brings the molecules closer</i></p> <p><i>reduces volume of the gases</i></p>		

(c)(i)



3 marks

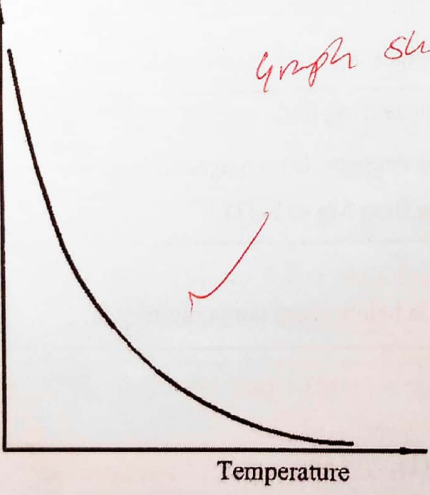
Handwritten notes in red ink:  
-  $\frac{1}{2}$  mark for the scale  
-  $\frac{1}{2}$  mark for the curve  
-  $\frac{1}{2}$  mark for the tangent  
-  $\frac{1}{2}$  mark for the secant

Uniform scale.  
more than have the scale.  
correctly labelled.

Handwritten notes in red ink:  
- correct label 1  
- 9 pts - 1 mark  
- 8 pts - 1/2 mark  
- 7 - 0 mark  
- some marks were blurring most of the 1 mark. Plucking at the end.

**\* Inverted axes - aware a maximum of 2 marks**

(ii)	<p>I. Rate at 45<sup>th</sup> second <i>— tangent must be drawn otherwise penalties</i></p> $\text{Rate} = \frac{\text{Change in Y-axis}}{\text{Change in X-axis}}$ $= \frac{140 - 52}{105 - 18} = \frac{88}{87} \text{ (}\frac{1}{2}\text{)}$ $= 1.011 \text{ cm}^3/\text{sec (}\frac{1}{2}\text{)}$ <p>II. Rate at 105<sup>th</sup> second <i>✓ 1/2</i></p> $\text{Rate} = \frac{145 - 100}{180 - 48} \text{ (}\frac{1}{2}\text{)}$ $= \frac{45}{132}$ $= 0.341 \text{ cm}^3/\text{sec (}\frac{1}{2}\text{)}$	1 mark
(iii)	<p>At 105<sup>th</sup> second the concentration of acid and mass of marble chips is less than at 45<sup>th</sup> second causing reduction in rate of the reaction (1/2). At 45<sup>th</sup> second, the rate is high since concentration of reagents available is high hence the faster the reaction (1/2).</p>	1 mark
(iv)	<p>1 mole = 24,000 cm<sup>3</sup></p> <p>maximum volume of gas produced = 133 cm<sup>3</sup> <i>check on the graph of the student</i></p> $\text{Moles of gas produced} = \frac{133}{24000} = 5.54 \times 10^{-3} \text{ moles of CO}_2 \text{ (}\frac{1}{2}\text{)}$ $\text{Moles of CO}_2 = \text{Moles of CaCO}_3 = 5.54 \times 10^{-3} \text{ (}\frac{1}{2}\text{)}$ $\text{RFM of CaCO}_3 = 40 + 12 + (3 \times 16) = 100 \text{ g}$ <p>1 mole = 100 g</p> $5.54 \times 10^{-3} = ?$ $= \frac{5.54 \times 10^{-3}}{1} \times 100 \text{ (}\frac{1}{2}\text{)}$ <p>0.554 g of marble chips (1/2)</p>	2 marks
<p><i>OR -&gt; <math>\frac{133}{24000} \times 100 = 0.55429</math> ✓</i></p>		11 marks

4 (a)	Sea water is trapped in a pan, allowed to undergo solar evaporation until solid crystallises out (1), liquor is allowed to drain out (1) and solid left is washed and dried (1).	3 marks
(b)	<p>RFM of NaCl = 23 + 35.5 = 58.5 (½)</p> <p>100g water = 100 cm<sup>3</sup> water</p> <p>36.2 g NaCl in 100 cm<sup>3</sup> = 362 g (½)</p> <p>NaCl in 1000 cm<sup>3</sup></p> <p>∴ Concentration = <math>\frac{\text{g/l}}{\text{RFM}}</math></p> <p><math>= \frac{362}{58.5}</math> (½)</p> <p><math>= 6.2 \text{ mol}^{-1}</math> (½)</p>	2 marks
(c) (i)	Ammonia gas is bubbled/passed through inverted funnel dipped in water in a beaker (1). This is to prevent suck back (½). Ammonia being highly soluble dissolves in the water forming aqueous ammonia (½).	2 marks
(ii)		1 mark
(iii)	Solubility decreases with increase in temperature because the gaseous particles gain energy and escape from the solution (1).	1 mark

CO<sub>2</sub> dissolved in water to form carbon acid. ✓/01  
 Carbon acid reacts with carbonates of magnesium and calcium to form calcium and magnesium salts slowly dissolve in water.

(d)	As water passes through rocks containing minerals of magnesium and calcium such as magnesium carbonate and calcium carbonate (1) magnesium and calcium salts slowly dissolve into the water (1).	2 marks
		<b>11 marks</b>
5(a)	(i) I. metal - Cs (1/2) <i>K</i> II. non-metal - F (1/2) <i>Li</i>	1 mark
	(ii) He <i>Helium</i>	1 mark
(iii)	I. Fractional distillation of liquid air (1). II. Uses of argon <i>Fractional distillation of liquid air</i> - Used to provide inert atmosphere in fluorescent lamps/bulbs (1) <i>- High speed photography</i> - Used in radioactive dating. <i>- Preserve medicine</i> <i>- preservative of camera</i>	1 mark
iv	I. The metallic bonding in lithium is stronger than that in potassium hence more energy required to break the metallic bonds in lithium than potassium during melting (1). <i>used as a respiratory aid in hospitals</i> II. Chlorine and iodine exists as diatomic molecules, mass of I <sub>2</sub> is higher than that of Cl <sub>2</sub> and iodine molecules are bigger than for chlorine. Van der Waals forces are stronger in iodine than in chlorine (1). <i>Intermolecular forces</i>	1 mark
v	Mg <sup>2+</sup> , Na <sup>+</sup> , O <sup>2-</sup> , N <sup>3-</sup> → increasing ionic size (1) <i>Mg<sup>2+</sup>, Na<sup>+</sup>, O<sup>2-</sup>, N<sup>3-</sup></i> Reason: number of protons <u>decrease</u> from magnesium to nitrogen hence nuclear attraction decreases from Mg to N (1). <i>decrease</i>	2 marks
(b)	Substance K (1/2). <i>K</i>	
(i)	Its boiling point of -60°C is below room temperature (1/2).	1 mark
(ii)	I. H - Ions (1). <i>more large</i> II. J - electrons (1). <i>decreased electrons</i>	2 marks
iii	I. H - electrostatic forces (1). <i>ionic bond / electrostatic</i> II. K - weak Van der Waals forces (1). <i>intermolecular forces</i>	2 marks
		<b>13 marks</b>
6	(i) Name	Formula



they are independent.

Name Formula

6/10

(a)	X - Magnesium propoxide (1) $(\text{CH}_3\text{CH}_2\text{CH}_2\text{O})_2\text{Mg}$ (1)	2 marks
(ii)	Name Formula Y - Sodium propanoate (1) $\text{CH}_3\text{CH}_2\text{COONa}$ (1)	2 marks
(b)	(i) Reagents - acidified potassium manganate(VII) $\text{K}_2\text{Cr}_2\text{O}_7$ (1/2) Condition - warm (1/2) (ii) Reagent - catalyst Condition - High temperature (1/2) - High pressure (1/2)	2 marks
(c)	Reagent - Aluminium oxide (1/2) Condition - High temperature (1/2)	1 mark
(d)	(i) dehydration/ elimination (1) (ii) addition polymerization (1)	2 marks
(e)	(i) $\text{CH}_3\text{CHCH}_2 + \text{Br}_2 \rightarrow \text{CH}_3\text{CHBrCH}_2\text{Br}$ (1) (ii) Bromine is decolourised (1)	2 marks 11 marks
7	(a) $\text{HCl}_3(\text{aq}) + 5\text{HCl}(\text{aq}) \rightarrow 3\text{Cl}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$ Oxidation No. of chlorine Chlorine in $\text{HCl}_3$ is reduced from +5 to 0 while chlorine in $\text{HCl}$ is oxidized from -1 to 0 (1)	2 marks
(b)	(i) $\text{PbO}_2(\text{s}) + 2\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + \text{Pb}(\text{s}) \rightarrow 2\text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$ (1) II.	2 marks

Zigzag notes  
Titanium(V) chloride

catalyst  
TiCl4

Accept potassium manganate(VII)

temperature  
340K - 350K

(30 - 40 atmospheres)

phosphoric acid  
Heating

above 150°C  
Si(IV) oxide/SiO2  
temp 30°C

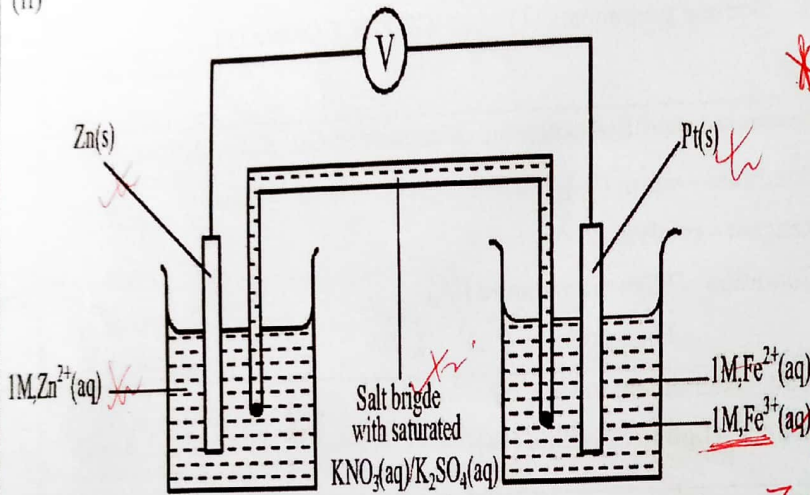
- sand

$E^{\ominus}$  of the cell =  $+1.69 - (-0.36)$   
 =  $+2.05V$

$+1.69 + 0.36$   
 $\rightarrow +2.05V$   
 accept  $2.05V$

Don't penalise on the units at all on that table

(ii)



\* if less are labeled for the name for conc. only

3 marks

\* Fe2+ alone will not score. included to Fe2+

concentration of conventional 1/2 more i.e. Zn being on the left.

(iii) Purple/pink acidified potassium manganate(VII) /  $KMnO_4$  is decolourised (1).  $MnO_4^-$  is reduced to  $Mn^{2+}$  (1) while  $H_2O_2$  is

oxidised to  $O_2$  (1).  $E^{\ominus}$  of the reaction is  $(1.51 - 0.68) = +0.83V$  (1).

- Bubbles of gas / fizzing / effervescence /  $H_2O_2$  is oxidised to  $O_2$

3 marks

\* oxygen produced

(iv) Zinc is more reactive than iron so when coated iron is exposed zinc, it reacts (corrodes) leaving iron intact (1). On the other hand, iron is more reactive than copper, hence it will react (corrode) leaving copper intact (1).

2 marks

12 marks

- copper is less reactive than iron

OK at Zn = -0.76 while that of iron +0.77 V  
 Cu +0.34 while that of iron is +0.77