INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2024

PHYSICAL SCIENCES: PAPER II

MARKING GUIDELINES

Time: 3 hours 200 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1 MULTIPLE CHOICE QUESTIONS

1.1 B

1.2 C

1.3 D

1.4 D

1.5 B

1.6 A

1.7 C

1.8 C

1.9 C

1.10 D

QUESTION 2

2.1 2.1.1 Force of attraction between atoms within a molecule.

2.1.2 Electrons are shared between two non-metal atoms or between two atoms with similar electronegativity.

2.1.3 Non-polar equal sharing of electrons or difference in electro-negativity = 0.

2.1.4 Ionic

2.2 2.2.1 Graphite structure is held together by many strong covalent bonds.
H_2O molecules held together by hydrogen bonding.
Covalent bonds are much stronger.
More energy is needed to overcome/break strong bonds.

2.2.2 Graphite has free electrons that can move around freely.
H_2O does not have free electrons or free ions.

2.3 HBr
Both have dipole-dipole forces.
HBr has greater molar mass (larger molecule) therefore greater electron cloud density.
More energy is required to overcome forces.

QUESTION 3

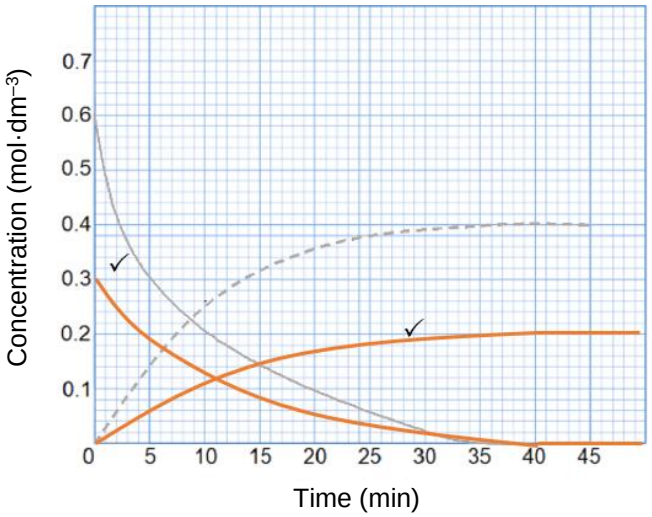
3.1 The change in amount or concentration per unit time of either a reactant or product.

3.2 $$\text{rate} = \frac{-\Delta[\text{reactant}]}{\text{time}}$$
$$= \frac{-(0-0,6)}{35}$$
$$= 0,017 \text{ mol·dm}^{-3}\text{·min}^{-1} \text{ or } 2,86 \text{ mol·dm}^{-3}\text{·s}^{-1}$$

3.3 n = cV
= (0,6)(0,5)
= 0,3 mol

3.4 ΔA : ΔB x = 3 y = 2
0,6 : 0,4 if x = 6 y = 4 (only 1 mark if not simplified)
3 : 2

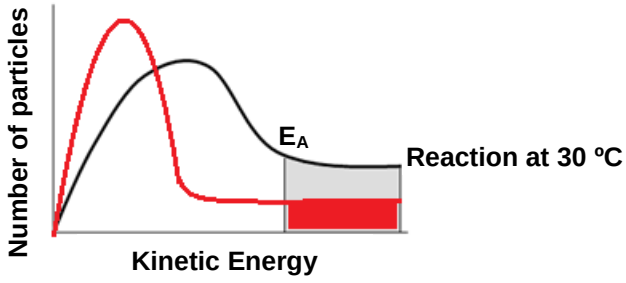
3.5



start at 0,3
end at 0,2
flatten after 35 min
both lines flatten at same time

3.6 Temperature decrease will lower the average kinetic energy of the particles.
Fewer collisions will occur per unit time.
Fewer effective collisions will occur per unit time.
Rate will decrease.

3.7



higher peak
peak shifted to left
smaller shaded area

QUESTION 4

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.

4.2 H^+ ions will react with OH^- ions to form water or OH^- ion decrease according to LCP, the system will try to increase OH^- ions by favouring the forward reaction
more OH^- ions is produced increasing pH.

4.3 $$Kc = \frac{[OH^-][HCO_3^-]}{[CO_3^{2-}]}$$

4.4 $$Kc = \frac{(0,24)(0,32)}{(0,4)}$$
$$= 0,19$$

4.5 Temperature increase

4.6 System will try to decrease the temperature according to LCP by advantaging the endothermic reaction or reaction that consumes heat
the forward reaction is favoured
[product] increases and [reactant] decreases.

First 3 marks can be coe from 4.5

4.7 Higher than no coe

4.8 From first equilibrium:
If CO_3^{2-} decreases, system will try and increase it by favouring the reverse reaction
$[OH^-]$ will decrease and blood will become more acidic.

From second equilibrium:
If $[H^+]$ increases, the system will try to decrease it by favouring the reverse reaction
haemoglobin will release O_2.

QUESTION 5

5.1 5.1.1 Proton donor

5.1.2 A chemical reaction in which an acid and a base react so that neither is in excess.

5.1.3 $CHOOH + NaHCO_3 \rightarrow CHOONa + (H_2O + CO_2)$

5.1.4 Weak ionizes incompletely in an aqueous solution

5.1.5 $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ (–1 if single arrow)
base acid acid base

5.1.6 NaOH is a strong base which forms many ions in solution **or** completely dissociates **or** exothermic reaction produces heat – this could be harmful to the skin.

5.1.7 Vinegar/lemon juice (any weak household acid)

5.2 5.2.1 A solution of known concentration.

5.2.2 $$c = \frac{m}{MV}$$
$$0,5 = \frac{m}{56(0,25)}$$
$$m = 7\ g$$

OR

$n = cV$ (for both formula)
$n = 0,5\ (0,25)$
$n = 0,125$ mol

$$0,125 = \frac{m}{M}$$
$$0,125 = \frac{m}{56}$$
$$m = 7\ g$$

5.2.3 Use a volumetric flask
Dissolve KOH before filling to 250 ml

5.2.4 B

5.2.5 Point where the indicator changes colour or point where all moles of acid has reacted with all moles of base

5.2.6 $\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$

$\frac{c_a(0,0065)}{0,5(0,025)} = \frac{1}{2}$

$Ca = 0,96$ mol·dm^{-3} or by first principles

5.3 $n = \frac{v}{v_m}$

$= \frac{140}{22,4}$

$= 6,25$ mol

$CO_2 : CaCO_3$
1 : 1

$m = nM$
$= 6,25(100)$
$= 625$ g

$\%purity = \frac{625}{700} \times 100$
$= 89,29\%$

QUESTION 6

6.1 6.1.1 A reaction involving the transfer of electrons.

6.1.2 $Cl_2 + 2e^- \rightarrow 2Cl^-$ (–1 if double arrow)

6.1.3 Cl_2 (coe from 6.1.2)

6.1.4 $Mg(s) \mid Mg^{2+}(aq, 1\ mol{\cdot}dm^{-3}) \parallel C\ell_2(g, 1\ atm) \mid C\ell^-(aq, 1\ mol{\cdot}dm^{-3}) \mid Pt(s)$ at 25 °C

both concentrations
gas pressure
temperature

6.1.5 To serve as an electrical conductor between the solution and external circuit.

If only 'To complete the circuit' is given then only award one mark.

6.2 6.2.1 A substance that can conduct electricity due to the presence of free (mobile) ions when molten or dissolved in solution.

6.2.2 To maintain electrical neutrality of the solutions.
To complete the circuit.

6.2.3 Cu

6.2.4 $E_{cell} = E_{cathode} – E_{anode}$
$= 0,34 – (–0,76)$
$= 1,1$ V (no coe)

6.2.5 Decrease

6.2.6 $[Zn^{2+}]$ increases
According to Le Chatelier, the system will try to decrease it
The reverse reaction is favoured.

6.2.7 The reading will decrease.
The voltmeter was reading the emf but now reads the external volts.

OR

Energy is being converted by the internal resistance and so not all.
Energy is delivered to the circuit.

6.2.8 Wider salt bridge
Shorter salt bridge
More conductive solution in salt bridge
Broader/flatter electrodes
(Any 2)

6.3 6.3.1 H_2S:

$$n = \frac{m}{M}$$
$$= \frac{170}{34}$$
$$= 5 \text{ mol}$$

O_2:

$$n = \frac{m}{M}$$
$$= \frac{800}{32}$$
$$= 25 \text{ mol}$$

$H_2S : O_2$
2 : 12
5 : 30 mol needed

30 mol > 25 mol
Not enough O_2 – limiting

6.3.2 $O_2 : SO_2$ (no coe)
12 : 2
25 (coe) : 4,17 mol

$V = nV_m$
$= 4{,}17\ (22{,}4)$
$= 93{,}33\ dm^3$

QUESTION 7

7.1 $Cl^- \rightarrow Cl_2 + 2e^-$ (–1 if double arrow)

7.2 $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ (–1 if double arrow)

7.3 A – Cl_2/chlorine
B – H_2/hydrogen
C – NaOH/sodium hydroxide/caustic soda

7.4 H_2O is a stronger oxidizing agent.

7.5 To prevent negative ions from moving to cathode
- Cl_2 will be contaminated with O_2 (as OH^- ions oxidise at anode).
- NaOH will be contaminated with NaCl.
- Cl_2 and H_2 gasses will react.

(2 marks awarded for any two bullet points)

QUESTION 8

8.1 D

8.2 A series of similar compounds which have the same functional group and have the same general formula, in which each member differs from the previous one by a single CH_2 unit.

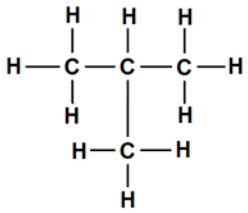
8.3 Carboxylic acids

8.4 Propene + water → propan-1-ol

8.5 Propyl ethanoate

8.6 Compounds having the same molecular formula but different structural formula.

8.7



8.8 $2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$

QUESTION 9

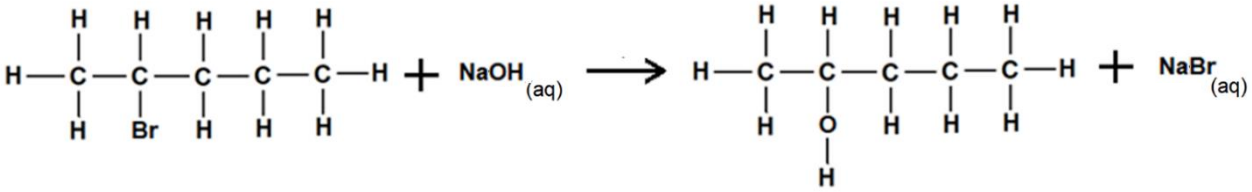
9.1 Addition

9.2 1 – brown colour turns colourless
2 – brown colour remains

9.3 Add heat or UV

9.4 Hydrolysis

9.5



9.6 Elimination

9.7 Pent-1-ene **or** pent-2-ene

9.8 No water or use alcoholic NaOH, or dissolve in ethanol solution.

9.9 Alcohol
Alkenes – London forces
Alcohols – hydrogen bonding
Hydrogen bonds are stronger than London forces
More energy is needed to overcome intermolecular forces

Total: 200 marks