



NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2025

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.

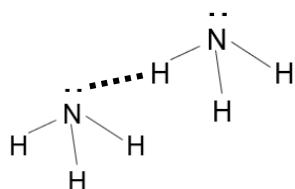
QUESTION 1 MULTIPLE-CHOICE QUESTIONS

- 1.1 D $n = 20/80 = 0,25 \text{ mol SO}_3 \text{ molecules.}$
 $0,25 \times 4 = 1 \text{ mol of atoms}$
- 1.2 A NH_3 is LR, reacts with 0,5 mol O_2 leaving 0,3 mol in excess
Produces 0,4 mol NO and 0,6 mol H_2O
Total at the end = $0,3 + 0,4 + 0,6 = 1,3 \text{ mol}$
- 1.3 B A: +4 and +2 / B: Both +2 / C: +1 and +2 / D: +3 and +6
- 1.4 D acid + base $\therefore$ neutralisation; solid forms $\therefore$ precipitation
- 1.5 B Reverse is favoured to increase X_2
- 1.6 C K_w increases with temperature $\therefore$ $[\text{H}_3\text{O}^+]$ increases and pH decreases. $[\text{OH}^-]$ also increases and is still equal to $[\text{H}_3\text{O}^+]$.
- 1.7 B Two species that differ by the gain/loss of one H^+ .
- 1.8 C Cr is anode, Ni is cathode
Anions (in the cathode half-cell) move into anode electrolyte,
cations (in the anode half-cell) move into the cathode electrolyte.
- 1.9 A In the boiling process, intermolecular forces are overcome to separate particles and change from the liquid to the gaseous phase. No intramolecular bonds are broken and no new substances are formed.
- 1.10 D Same molecular formula, different chain length

QUESTION 2

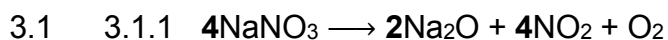
- 2.1 bp of H_2O = 100°C . Then add 50, -50 and -100
- 2.2 period / energy level (of the Group V, VI or VII atom)
- 2.3 H_2Te or PH_3 – atoms have same electronegativity OR $\Delta\text{EN} = 0$
- 2.4 hydrogen bonds
- 2.5 H_2O forms more hydrogen bonds.
- 2.6 F is more electronegative than N so the H-F bond is more polar.
OR F is smaller than N, so the HF molecules can get closer.
- 2.7 2.7.1 ammonia

2.7.2



Draw a 2nd NH_3 molecule.
Show the hydrogen bond between the lone pair of one molecule and an H on the other molecule.

- 2.8 2.8.1 Sb, it is less electronegative than H
- 2.8.2 NH_3 has London forces and H-bonds. SbH_3 has London forces and dipole-dipole forces.
 SbH_3 has a bigger electron cloud / more electrons,
 SbH_3 has larger temporary dipoles,
 SbH_3 has stronger London IMFs.

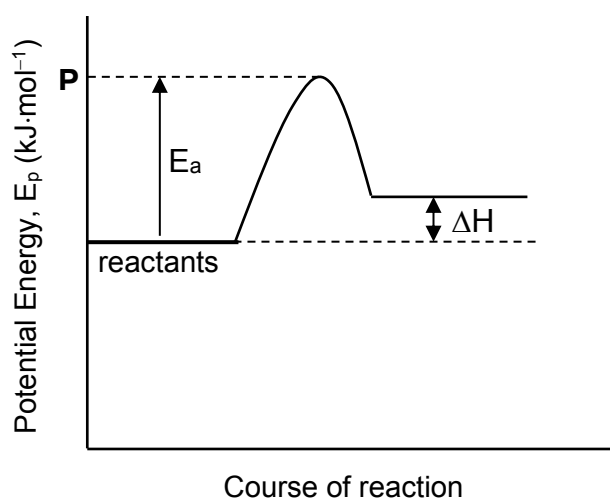
QUESTION 3

3.1.2 endothermic

3.1.3 A high energy unstable transition state between the reactants and the products.

3.1.4 The net change of chemical potential energy of the system.

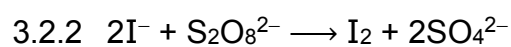
3.1.5 Draw the curve for an endothermic reaction.



3.1.6 Correct labels for E_a and ΔH

3.1.7 **P** on y-axis at peak position

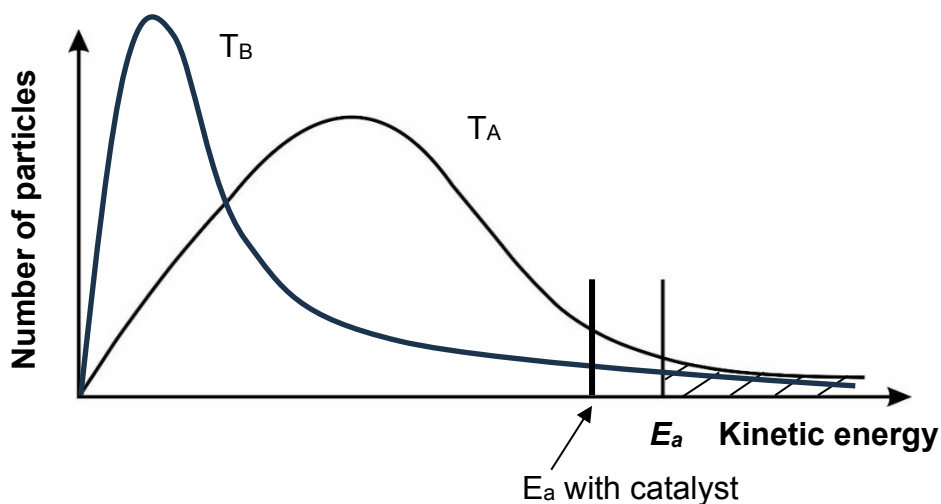
3.2 3.2.1 ... the transfer of electrons



3.2.3 Fe^{3+} or iron(III)

3.3 3.3.1 Maxwell-Boltzmann distribution

3.3.2 Peak is higher and to the left of the original.
Ends below original curve.



3.3.3 E_a line shifts to the left

3.3.4 INCORRECT

EITHER There are more particles with (kinetic energy) $E_k \geq E_a$.
 $\therefore$ there will be more effective collisions per unit time.

OR There are not more particles.
 The particles do not have more E_k / are not moving faster.

QUESTION 4

4.1 4.1.1 Dynamic chemical equilibrium refers to a reversible reaction in which the forward and the reverse reactions are taking place at the same rate, and hence the concentrations of reactants and products are constant.

$$4.1.2 \quad K_c = \frac{[AB_3]}{[B]^3} = \frac{0,1}{[B]^3} = 0,020$$

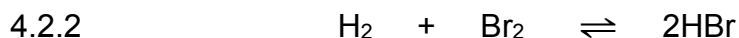
$$[B] = 1,71 \text{ mol}\cdot\text{dm}^{-3}$$

4.1.3 ~~tx~~ $[AB_3]$ was increased OR AB_3 was added
~~ty~~ increase temperature

4.1.4 (a) INCREASED

- (b) (i) There are fewer particles per unit volume.
 There will be fewer collisions per unit time.
 There will be fewer effective collisions per unit time.
Both forward and reverse reaction rates will decrease.
 (The rate of the reverse reaction decreases less than the rate of the forward reaction.)
- (ii) The reverse reaction will be favoured (its rate decreases less) because it creates more moles of gas in order to increase the pressure.

4.2 4.2.1 $K_c = \frac{[HBr]^2}{[Br_2][H_2]}$



Initial mol	0,28	0,28	0
Change	$-x$	$-x$	$+2x$
Eqm mol	$0,28 - x$	$0,28 - x$	$2x$
[eqm]	$\frac{0,28-x}{3}$	$\frac{0,28-x}{3}$	$\frac{2x}{3}$

$$710 = \frac{\left(\frac{2x}{3}\right)^2}{\left(\frac{0,28-x}{3}\right)^2}$$

$$26,65 = \frac{2x}{0,28-x}$$

$x = 0,26$ (If quadratic used, $x = 0,30$ and $0,26$, but $0,30$ is impossible.)

$$[HBr] = 2(0,26)/3 = 0,17 \text{ mol}\cdot\text{dm}^{-3}$$

$$[H_2] = [Br_2] = (0,28 - 0,26) / 3$$

$$= 0,0067 \text{ mol}\cdot\text{dm}^{-3}$$

OR

	H_2	+	Br_2	$\rightleftharpoons$	$2HBr$
Initial conc	$0,28/3$		$0,28/3$		0
Change	$-x$		$-x$		$+2x$
Eqm conc	$0,0933 - x$		$0,0933 - x$		$2x$

$$710 = \frac{(2x)^2}{(0,0933-x)^2} \therefore 26,65 = \frac{2x}{0,0933-x} \therefore x = 0,0868$$

$$[HBr] = 2 \times 0,0868 = 0,17 \text{ mol}\cdot\text{dm}^{-3}$$

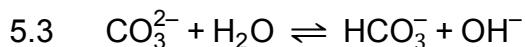
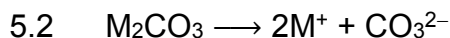
$$[H_2] = [Br_2] = 0,0933 - 0,0868 = 0,0065 \text{ mol}\cdot\text{dm}^{-3}$$

- Use x in correct ratio ✓
- $\div 3$ ✓
- Sub eqm concs into K_c expression ✓
- Solve for x ✓
- Conc of HBr ✓
- Conc of H_2 and Br_2 ✓

- $\div 3$ ✓
- Use x in correct ratio ✓
- Sub eqm concs into K_c expression ✓
- Solve for x ✓
- Conc of HBr ✓
- Conc of H_2 and Br_2 ✓

QUESTION 5

5.1 A substance in which the hydrogen of an acid has been replaced by a cation.



5.4

Volume of 0,102 mol·dm ⁻³ HCl(cm ³)			
Titration	1	2	3
Initial reading	24,20	0,20	0,40
Final reading	47,40	23,50	23,65
Volume added	23,20	23,30	23,25
Average volume for the experiment			23,25

5.5 A solution of known concentration

5.6 methyl orange

5.7

$$\begin{aligned}
 n(HCl) &= cV \\
 &= 0,102 \times 0,02325 \\
 &= 2,3715 \times 10^{-3} \text{ mol} \\
 n(M_2CO_3) &= 2,3715 \times 10^{-3} / 2 \\
 &= 1,18575 \times 10^{-3} \text{ mol} \\
 c(M_2CO_3) &= n / V \\
 &= 1,18575 \times 10^{-3} / 0,025 \\
 &= 0,0474 \text{ mol·dm}^{-3} \text{ (answer given)}
 \end{aligned}$$

OR USE: $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$

$$\begin{aligned}
 \frac{0,102 \times 23,25}{c_b \times 25} &= \frac{2}{1} \\
 c(M_2CO_3) &= 0,0474 \text{ mol·dm}^{-3} \text{ (answer given)}
 \end{aligned}$$

5.8

$$\begin{aligned}
 c &= m / MV \\
 M &= m / cV \\
 &= 1,31 / (0,0474 \times 0,2) \\
 &= 138,19 \text{ g·mol}^{-1} \text{ (answer given)}
 \end{aligned}$$

OR

$$\begin{aligned}
 n &= cV \\
 &= 0,0474 \times 0,2 \\
 &= 9,48 \times 10^{-3} \text{ mol} \\
 M &= m / n \\
 &= 1,31 / 9,48 \times 10^{-3} \\
 &= 138,19 \text{ g·mol}^{-1}
 \end{aligned}$$

5.9 $[138 - (12+48)] / 2 = 39 \therefore \mathbf{M}$ is K or potassium

QUESTION 6

6.2 chlorine OR Cl_2

6.3 6.3.1 An electrochemical cell that converts the chemical energy of spontaneous redox reactions into electrical energy.



$$\begin{aligned} 6.3.3 \quad E_{\text{cell}}^{\theta} &= E_{\text{cathode}}^{\theta} - E_{\text{anode}}^{\theta} \\ &= 1,36 - 1,09 \\ &= 0,27 \text{ V} \end{aligned}$$

6.3.4 Any one of:
increase pressure of $\text{Cl}_2(\text{g})$
increase $[\text{Cl}_2]$
increase $[\text{Br}^-]$
decrease $[\text{Cl}^-]$
decrease $[\text{Br}_2]$
decrease temperature

6.4 6.4.1 NO ✓

6.4.2 Bromine(Br_2) is a weaker oxidising agent than chlorine (Cl_2) therefore will not oxidise chloride (Cl^-) to chlorine (Cl_2).

QUESTION 7

7.1 $n(\text{Cu}) = m/M$
 $= 1000 / 63,5$
 $= 15,75 \text{ mol}$
 $n(\text{Cu}_2\text{S}) = 15,75 / 2 \text{ from (ii)}$
 $= 7,87 \text{ mol}$
 $n(\text{CuFeS}_2) = 7,87 \times 2$
 $= 15,75 \text{ mol from (i)}$
 $m(\text{CuFeS}_2) = nM$
 $= 15,75 \times 183,5$
 $= 2889,76 \text{ g}$
 $\% \text{CuFeS}_2 = 2889,76 / 3000 \times 100$
 $= 96,33\%$

7.2 copper(I) sulfide

7.3 7.3.1 SiO_2

7.3.2 SO_2

7.3.3 $\text{Cu}_2\text{S} / \text{CuFeS}_2 / \text{FeSiO}_3$

7.3.4 O_2

7.4 electrorefining

7.5 to be a good conductor of electricity

7.6 PURE COPPER

7.7 Co is a stronger reducing agent than Cu
Au is a weaker reducing agent than Cu
Co will be oxidised, but Au will not

7.8 Cu^{2+} is a stronger oxidising agent than Co^{2+}
Hence, only Cu^{2+} will be reduced
OR Co^{2+} is a weaker OA than $\text{Cu}^{2+} \therefore$ will not be reduced

7.9 7.9.1 DECREASE

7.9.2 Only Cu^{2+} is being reduced at the cathode.
At the anode, Cu and other impurity atoms (Co) are being oxidised.
Therefore, in the same time interval, more Cu^{2+} reacts than is produced.

7.10 7.10.1 $n(e^-) = q/F$
 $= 19,3 \times 10^3 / 96500 = 0,2 \text{ mol}$
OR $N(e^-) = q/q_{e^-}$
 $= 19,3 \times 10^3 / 1,6 \times 10^{-19}$
 $= 1,20625 \times 10^{23} e^-$
 $n(e^-) = N / N_A$
 $= 1,20625 \times 10^{23} / 6,02 \times 10^{23}$
 $= 0,2 \text{ mol}$

7.10.2 $n(\text{Cu}) = 0,2 / 2 = 0,1 \text{ mol}$
 $m(\text{Cu}) = nM$
 $= 0,1 \times 63,5 = 6,35 \text{ g}$

QUESTION 8

8.1 8.1.1 Compounds having the same molecular formula but different structural formulae.

8.1.2 positional

8.2 8.2.1 ester

8.2.2 alkane

8.2.3 alcohol

8.3 8.3.1 substitution

8.3.2 elimination

8.3.3 reflux(ing)

8.4 8.4.1 H₂O and CO₂

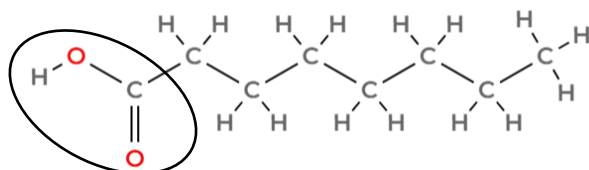
8.4.2 Br₂

8.5 8.5.1 2-bromo-1-iodobutane

8.5.2 5-ethyl-3,6-dimethylocta-2,4-diene

8.6 8.6.1 propyl pentanoate

8.6.2 Structural formula (show all bonds) of an 8-C carboxylic acid
Octanoic acid is one example of many:



-COOH group
all correct

8.6.3 circle -CO₂H group

NAME: carboxyl

8.6.4 Q 8.6.2

8.6.5 The isomers will have similar strength London forces.
The isomer in 8.6.1 (ester) also has dipole-dipole forces.
The isomer in 8.6.2 (carboxylic acid) also has hydrogen bonds.
Hydrogen bonds are stronger than dipole-dipole forces.

8.7 8.7.1 CH₃F

8.7.2 The compounds have the same number of electrons (18).

8.8 8.8.1 CH₃(CH₂)₅OH → CH₃(CH₂)₃CH=CH₂ + H₂O

8.8.2 C₁₄H₃₀ → C₅H₁₂ + 3C₃H₆

Total: 200 marks