NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2018

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.

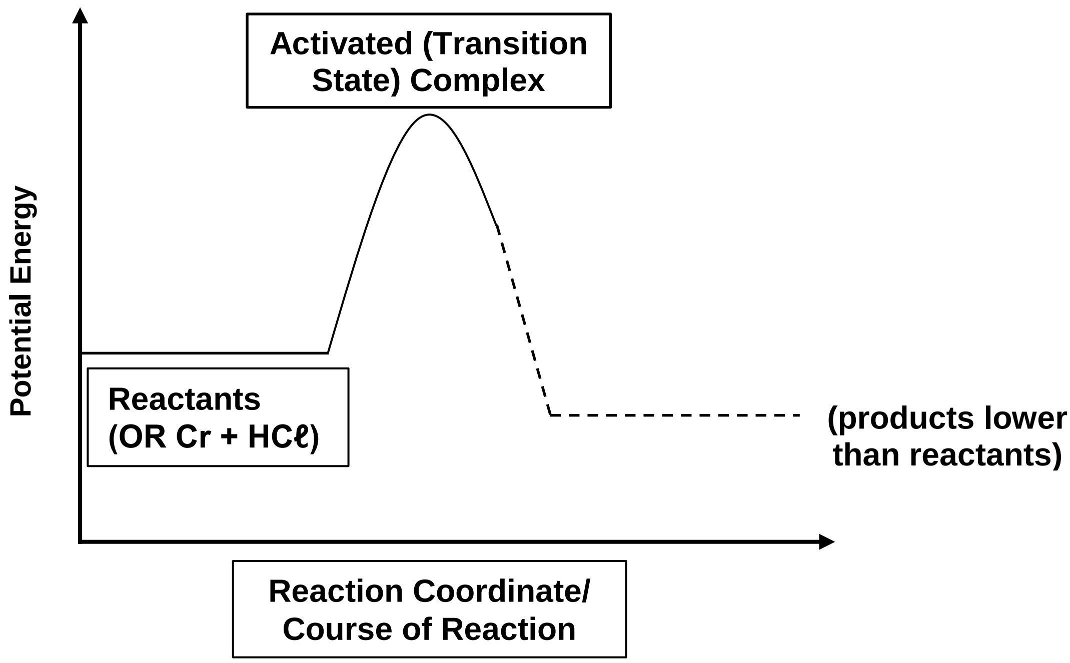
The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there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

QUESTION 1 MULTIPLE CHOICE

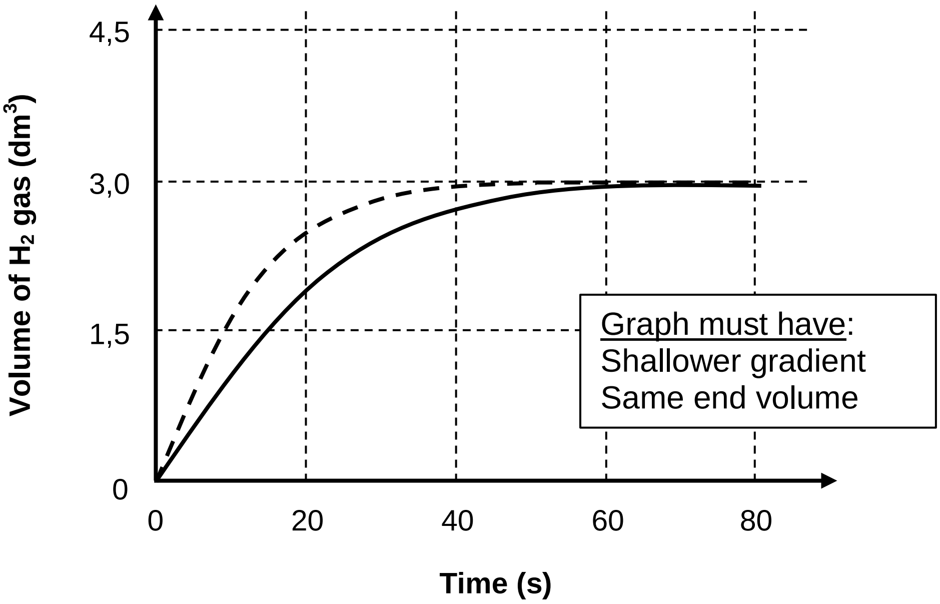
1.1 B
1.2 A
1.3 B
1.4 C
1.5 C
1.6 D
1.7 C
1.8 A
1.9 D
1.10 B

QUESTION 2

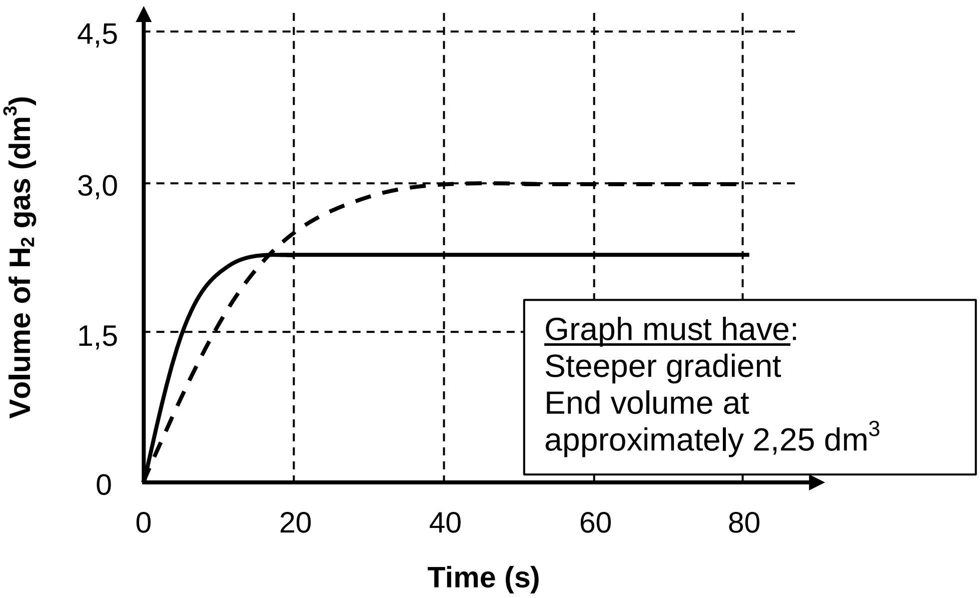
2.1



2.2 2.2.1



2.2.2



2.3
- The reaction could be done using a colorimeter/light meter.
- which would measure the colour intensity of the green solution as a measure of concentration of chromium chloride (Cr^{3+})
- at specific time intervals OR over a period of time.

2.4 2.4.1 $n = \frac{V}{V_m}$

$n = \frac{(3)}{(22,4)}$

n = **0,134 mol**

2.4.2 • $n_{Cr} = \frac{m}{M} = \frac{(6,0)}{(52)} = 0,1154$ mol

• $n_{H_2} = (0,1154) \times \frac{3}{2} = 0,1731$ mol

• % Yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100 = \frac{(0,134)}{(0,1731)} \times 100$

• % Yield = **77,41%**

Alternative:

$V(H_2) = 0,1731 \times 22,4$

$= 3,877\ dm^3$

% Yield = $\frac{3}{3,877} \times 100$

= **77,37%**

2.4.3 Average Rate $= \frac{\Delta V}{\Delta t} = \frac{(3-0)}{(40)} =$ **$0,075\ dm^3 \cdot s^{-1}$**

2.5
- Correct orientation of the colliding reactant particles
- The sum of the kinetic energy (of the reacting particles) is greater than/equal to the activation energy.

2.6
- A higher concentration means that there is a greater number of particles per unit volume.
- This increases the number of collisions that occur per unit time.
- This therefore leads to an increase in the number of effective collisions per unit time,
- leading to a higher reaction rate.

2.7 2.7.1 The sharing of at least one pair of electrons by two atoms.

2.7.2 A measure of the tendency of an atom to attract a bonding pair of electrons.

2.7.3
- The difference in electronegativity between hydrogen and chlorine is greater than zero.
- This results in unequal sharing of electrons, i.e. a polar covalent bond.

QUESTION 3

3.1 5 minutes

3.2 $2SO_3 \rightarrow 2SO_2 + O_2$

3.3 When an external stress (change in pressure, temperature or concentration) is applied to a system in chemical equilibrium, the equilibrium point will change in such a way as to counteract the stress.

3.4
- Stress: increase in concentration of O_2
- Le Châtelier's principle predicts the system will respond in order to decrease the concentration of O_2
- Therefore, the forward reaction is (initially) favoured as it consumes O_2
- Decreasing the amount of SO_2

3.5 3.5.1 Forward

3.5.2 Exothermic

3.6 3.6.1 All the concentrations decrease (since $c = \frac{n}{v}$ and V has increased).

3.6.2
- From the rate equations we see that the rate of the forward reaction is proportional to cube of concentration (OR forward rate $\alpha \frac{1}{V^3}$) whereas the rate of the reverse reaction is proportional to the square of concentration (OR reverse rate $\alpha \frac{1}{V^2}$) .
- Therefore the change in pressure has a greater effect on the forward reaction rate than the reverse.

QUESTION 4

4.1 Increases

4.2 Reverse

4.3 Turns green

4.4 4.4.1 $K_c = \dfrac{[CuC\ell_4^{2-}]}{[Cu(H_2O)_6^{2+}][C\ell^-]^4}$

4.4.2 **Concentrations:**

Reaction	$Cu(H_2O)_6{}^{2+}$ +	$4C\ell^-$	⇌ $CuC\ell_4{}^{2-}$ +	$6H_2O$
Initial concentration	0	0	2	
Change in concentration	+1,1	+4,4	−1,1	
Equilibrium concentration	1,1	4,4	0,9	

OR

Moles:

Reaction	$Cu(H_2O)_6{}^{2+}$ +	$4C\ell^-$	⇌ $CuC\ell_4{}^{2-}$ +	$6H_2O$
Initial moles	0	0	4	
Change in moles	+2,2	+8,8	−2,2	
Equilibrium moles	2,2	8,8	1,8	
Equilibrium concentration	1,1	4,4	0,9	

Then:

$$K_c = \frac{[CuC\ell_4^{2-}]}{[Cu(H_2O)_6^{2+}][C\ell^-]^4}$$

$$K_c = \frac{(0,9)}{(1,1)(4,4)^4}$$

$K_c = \mathbf{2{,}18 \times 10^{-3}}$

QUESTION 5

5.1 A proton acceptor.

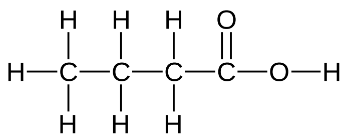
5.2 It dissociates (almost) completely in water/solution.

5.3 KOH (OR LiOH/RbOH/CsOH)

5.4 $NaOH \xrightarrow{H_2O} Na^+ + OH^-$

5.5
- The NaOH solution is more conductive.
- NaOH is strong whilst butanoic acid is weak (OR NaOH dissociates completely, whilst butanoic acid ionises partially)
- It forms a higher concentration of ions in solution (at equal concentrations).

5.6



5.7 methyl propanoate OR ethyl ethanoate OR propyl methanoate

QUESTION 6

6.1 Increases

6.2
$$K_w = [H_3O^+][OH^-]$$
$$(10^{-14}) = (6,31 \times 10^{-5})\ [OH^-]$$
$$[OH^-] = \mathbf{1,58 \times 10^{-10}\ mol \cdot dm^{-3}}$$

6.3 6.3.1 The point where an acid and base have reacted so neither is in excess.

6.3.2 n_{acid} = **0,0165 mol**

6.3.3 $V_{acid} = \frac{n}{c} = \frac{0,0165}{0,21}$

$V_{acid} = 0,07857\ dm^3$

V_{acid} = **78,57 cm^3**

6.4 6.4.1 A reaction with water where water itself is decomposed.

6.4.2 There is an increase in concentration of OH^-.

OR

The production of OH^- ions results in a decrease in the concentration of H_3O^+ (due to the upsetting of the equilibrium involving H_3O^+ and OH^- ions in water)

6.5
- This statement is incorrect
- pH depends on the concentration of hydronium ions (or hydroxide ions)
- which is determined by both strength and concentration of the base

QUESTION 7

7.1 7.1.1 The substance that accepts electrons.

7.1.2
- $C\ell_2$ is a stronger oxidising agent (than Ni^{2+}).
- Therefore $C\ell_2$ is more likely to be reduced and thus accept electrons.

7.2 7.2.1 The electrode where oxidation takes place.

7.2.2 Ni OR nickel

7.3 Pt OR platinum

7.4 Ni | Ni^{2+}(1 mol·dm^{-3}) || $C\ell_2$(1 atm) | $C\ell^-$(1 mol·dm^{-3}) | Pt at 25 °C

7.5 7.5.1 $Ni \rightarrow Ni^{2+} + 2e^-$

7.5.2
- The Ni electrode corrodes (loses mass).
- The green colour of the Ni^{2+} electrolyte intensifies.

7.5.3 To complete the circuit.

7.5.4
- Ni^{2+} ions are being produced in this half-cell.
- Anions enter the electrolyte from the salt bridge.
- and Ni^{2+} cations exit the electrolyte into the salt bridge.

7.6 Increases

QUESTION 8

8.1 It is light.

8.2 It protects itself from corrosion.

8.3 Anode

8.4 $A\ell^{3+} + 3e^- \rightarrow A\ell$

8.5 8.5.1
- Less energy (OR electricity) is used to melt the electrolyte.
- This saves money (cost is less).

8.5.2
- The cryolite is also electrolysed/decomposed.
- This produces perfluorocarbons (PFCs) which are greenhouse gases

8.6
- O_2 is produced at the anode.
- This reacts with the carbon electrode (to produce CO_2), causing the electrode to corrode (OR the carbon anode is continually oxidised)
- $C + O_2 \rightarrow CO_2$ OR $2O^{2-} + C \rightarrow CO_2 + 4e^-$

8.7 In order to melt aluminium oxide,
- Many
- Strong
- ionic (electrostatic) forces/bonds need to be broken/overcome,
- which requires much energy to separate the ions from the crystal lattice.

8.8 8.8.1 $A\ell C\ell_3 + 3\,Na \rightarrow A\ell + 3\,NaC\ell$

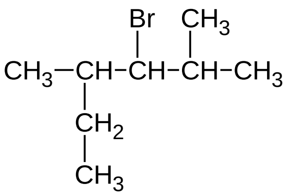
8.8.2
- $n_{Na} = 3 \times n_{A\ell} = 3 \times (7,56) = 22,68$ mol
- $m_{Na} = nM = (22,68)(23) = 521,64$ g

QUESTION 9

9.1 9.1.1 3−bromo−2,4−dimethylhexane

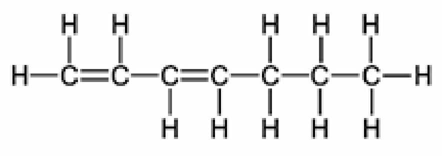
9.1.2 $CH_3CH_2CH(CH_3)CHBrCH(CH_3)CH_3$

OR



9.2 9.2.1 Alkenes

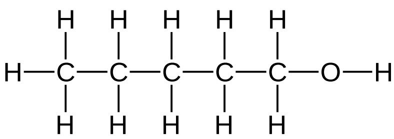
9.2.2



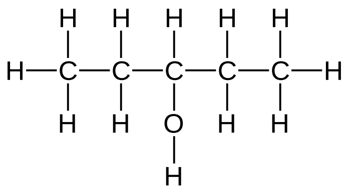
9.3 9.3.1 Hydroxyl group

9.3.2 Molecules with the same molecular formula but different positions of their same functional group OR same substituents.

9.3.3 Any one of the following:



OR



9.4 9.4.1 A weak force of attraction between molecules or between atoms of noble gases.

9.4.2
- Compound **B** has London forces (only)
- Compound **C** has hydrogen bonding
- Hydrogen bonds are stronger than London forces (OR compound **C** has stronger intermolecular forces)
- It is more difficult for the particles in compound **C** to flow past one another
- resulting in compound **C** having a higher viscosity

9.5 $C_7H_{12} + 10O_2 \rightarrow 7CO_2 + 6H_2O$

QUESTION 10

10.1 A compound/molecule containing only carbon and hydrogen atoms.

10.2 Pentane

10.3 10.3.1 Substitution

10.3.2 Addition

10.3.3 Condensation

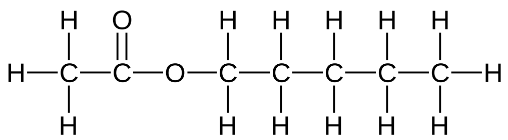
10.4 Hydrohalogenation

10.5 Pent−1−ene

10.6 Unsaturated

10.7 Pentan−1−ol

10.8



10.9 2

Total: 200 marks