NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2020

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

QUESTION 2

2.1 2.1.1 The mass in grams of one mole of that substance.

2.1.2 $n_{O_2} = \frac{m}{M} = \frac{(36,8)}{(32)}$ = 1,15 mol

2.1.3
- $n_{PbS} = n_{O_2} \times \frac{2}{3} = (1,15) \times \frac{2}{3}$ ✓ = 0,76666 mol
- $m_{PbS} = nM = (0,76666)(239)$ = 183,23 g

2.1.4 $\% purity = \frac{pure\,mass}{impure\,mass} \times 100 = \frac{(183,23)}{(800)} \times 100$ = 22,9 %

2.2 Mandy is incorrect
Although SO_3 is not the limiting reagent,
SO_3 can still be used to determine the amount of H_2SO_4 as we can determine the **change** in amount of SO_3

QUESTION 3

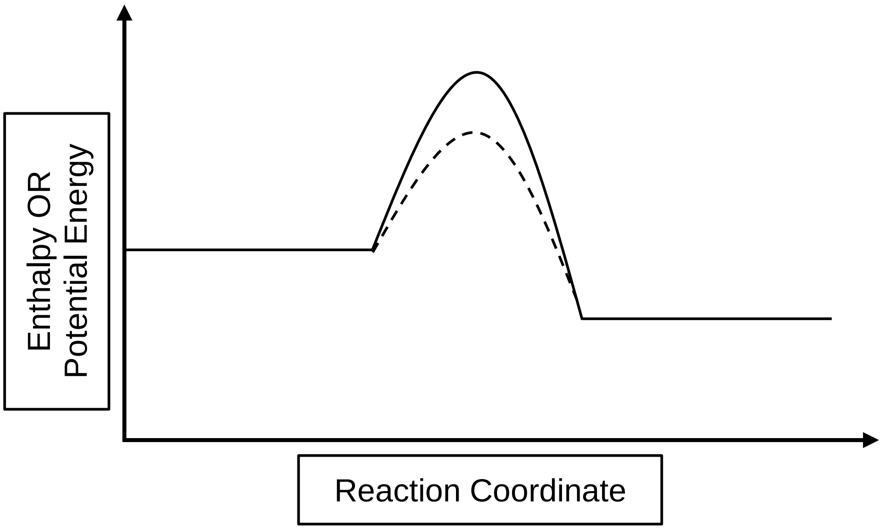
3.1
- Correct orientation
- Sufficient kinetic energy to overcome the activation energy

3.2
- An increase in concentration means that there is a greater number of particles per unit volume
- This causes more collisions (between reacting particles) per unit time
- resulting in more effective (OR successful) collisions per unit time
- increasing the reacting rate

3.3 3.3.1 A high-energy unstable temporary transition state between the reactants and the products.

3.3.2 The stability increases.

3.3.3



3.4 3.4.1 $Average\,Rate = \frac{\Delta V}{\Delta t}$

$(12) = \frac{V_f - 0}{(16)}$

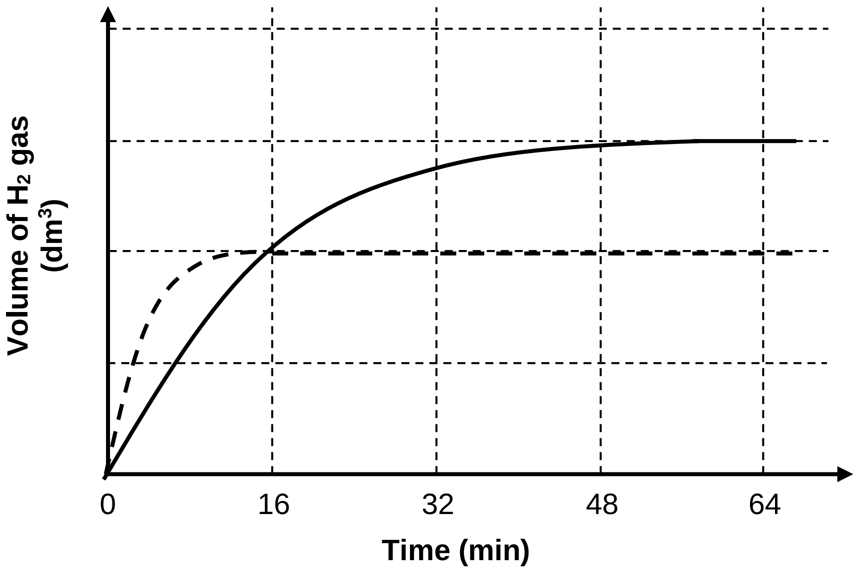
$V_f = 192 \text{ cm}^3$

3.4.2
- $n_{HC\ell} = cV \;\; = (0{,}04)(0{,}4) \;\; = 0{,}016 \text{ mol}$
- $n_{H_2}(\text{theoretical}) = n_{HC\ell} \times \frac{1}{2} = (0{,}016) \times \frac{1}{2} \;\; = 0{,}008 \text{ mol}$
- $V_{H_2} = nV_m \;\; = (0{,}008)(26490) \;\; = 211{,}92 \text{ cm}^3$
- $\%yield = \frac{actual\ yield}{theoretical\ yield} \times 100 = \frac{(192)}{(211{,}92)} \times 100$ = 90,6%

OR

- $n_{H_2}(\text{actual}) = \frac{V}{V_m} \;\; = \frac{(192)}{(26490)} \;\; = 0{,}007248 \text{ mol}$
- $\%yield = \frac{actual\ yield}{theoretical\ yield} \times 100 = \frac{(0{,}007248)}{(0{,}008)} \times 100$ = 90,6 %

3.4.3



QUESTION 4

4.1 4.1.1 One in which mass is conserved inside the system but energy can enter or leave the system freely.

4.1.2

(a) Turns (more) yellow

(b)
- Stress: increase in the concentration of NO
- The reverse reaction rate will suddenly/instantaneously increase but the forward reaction rate will *initially* remain the same
- resulting in the reverse reaction initially being favoured
- increasing the amount of reactants (NOCℓ) and decreasing the amount of products (NO + $Cℓ_2$) as the reaction returns to equilibrium

4.1.3 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.

4.1.4
- A green colour change is caused by the forward reaction being favoured
- The forward reaction produces more gas particles
- Which will increase the pressure
- According to Le Châtelier's principle, this relieves the stress of a decrease in pressure

4.1.5
- NO is polar (NO molecules are permanent dipole)
- causing an attractive force
- between the slightly negative side of one molecule and the slightly positive side of another molecule

4.2 (In this particular case, concentration should not be used in the table as carbon cannot have a concentration and we need to use the carbon to work out the change)

Moles:

Reaction	C(s)	+	CO_2	⇌	2CO
Initial moles	3		1,5		0
Change in moles	−1		−1		+2
Equilibrium moles	2		0,5		2
Concentration			1,25		5

$$K_c = \frac{[CO]^2}{[CO_2]}$$

$$K_c = \frac{(5)^2}{(1,25)}$$

$$K_c = 20$$

4.3
- Both $C\ell_2$ and CO_2 have London only
- $C\ell_2$ has a greater number of electrons
- Therefore, $C\ell_2$ forms larger induced dipoles
- and thus stronger London forces
- More energy is therefore needed to overcome the intermolecular forces and separate the particles in $C\ell_2$

QUESTION 5

5.1 5.1.1 A solution of known concentration.

5.1.2 $m = cMV$
$m = (0,25)(56)(0,6)$
$m = 8,4\ \text{g}$

5.1.3 Decrease

5.1.4 $K_w = [H_3O^+][OH^-]$
$(10^{-14}) = [H_3O^+](6,5 \times 10^{-3})$
$[H_3O^+] = 1,54 \times 10^{-12}\ \text{mol·dm}^{-3}$

5.1.5 $F^- + H_2O \rightleftharpoons HF + OH^-$
F^- is the conjugate base of the weak acid HF and so is also weak itself, but *strong enough* to undergo hydrolysis.
The production of hydroxide ions during hydrolysis results in a basic end point.

5.2 5.2.1 Carbonate OR CO_3^{2-}

5.2.2 A proton acceptor.

5.2.3 A base that only dissociates/ionises partially in an aqueous solution.

5.2.4 $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

QUESTION 6

6.1 A substance that can conduct electricity by forming free ions when molten or dissolved in solution.

6.2 $Au(NO_3)_3$ OR $AuC\ell_3$

6.3 X

6.4 $Au^{3+} + 3e^- \rightarrow Au$

6.5 6.5.1 $E^0_{cell} = E^0_{cathode} - E^0_{anode}$

$(1{,}82) = (1{,}42) - E^0_{anode}$

$E^0_{anode} = -0{,}4$ V

$\therefore$ X is Cd (OR cadmium)

6.5.2 Gold is too expensive

6.6 6.6.1
- Pt electrode
- Solution of H^+ ions at a concentration 1 mol·dm^{-3}
- H_2 gas at a pressure of 1 atm
- Temperature of 25 °C
- All electrode potentials are measured relative to the SHE, which is given a defined electrode potential of 0,00 V

6.6.2 Pt(s) | H_2(g) | H^+(aq) || Au^{3+}(aq) | Au(s)

QUESTION 7

7.1 7.1.1 Because the electrolyte is molten, the cell is operating at a high temperature.

7.1.2
- It is inert
- It is conductive

7.2 Electrical energy to chemical energy.

7.3
- In molten or aqueous state, the ions are free/mobile
- allowing the electrolyte to be conductive

7.4 7.4.1 Q

7.4.2 $2C\ell^- \rightarrow C\ell_2 + 2e^-$

7.4.3 $Cu^{2+} + 2e^- \rightarrow Cu$

7.4.4 $C\ell^-$

7.5 The blue colour of the electrolyte will fade
$Cu^{2+} + 2e^- \rightarrow Cu$

7.6 Q and S

7.7 7.7.1 The reaction would proceed faster.

7.7.2 The reaction of a molecular substance with water to produce ions.

7.7.3 There is an increase in the concentration of ions.

7.7.4 Increase

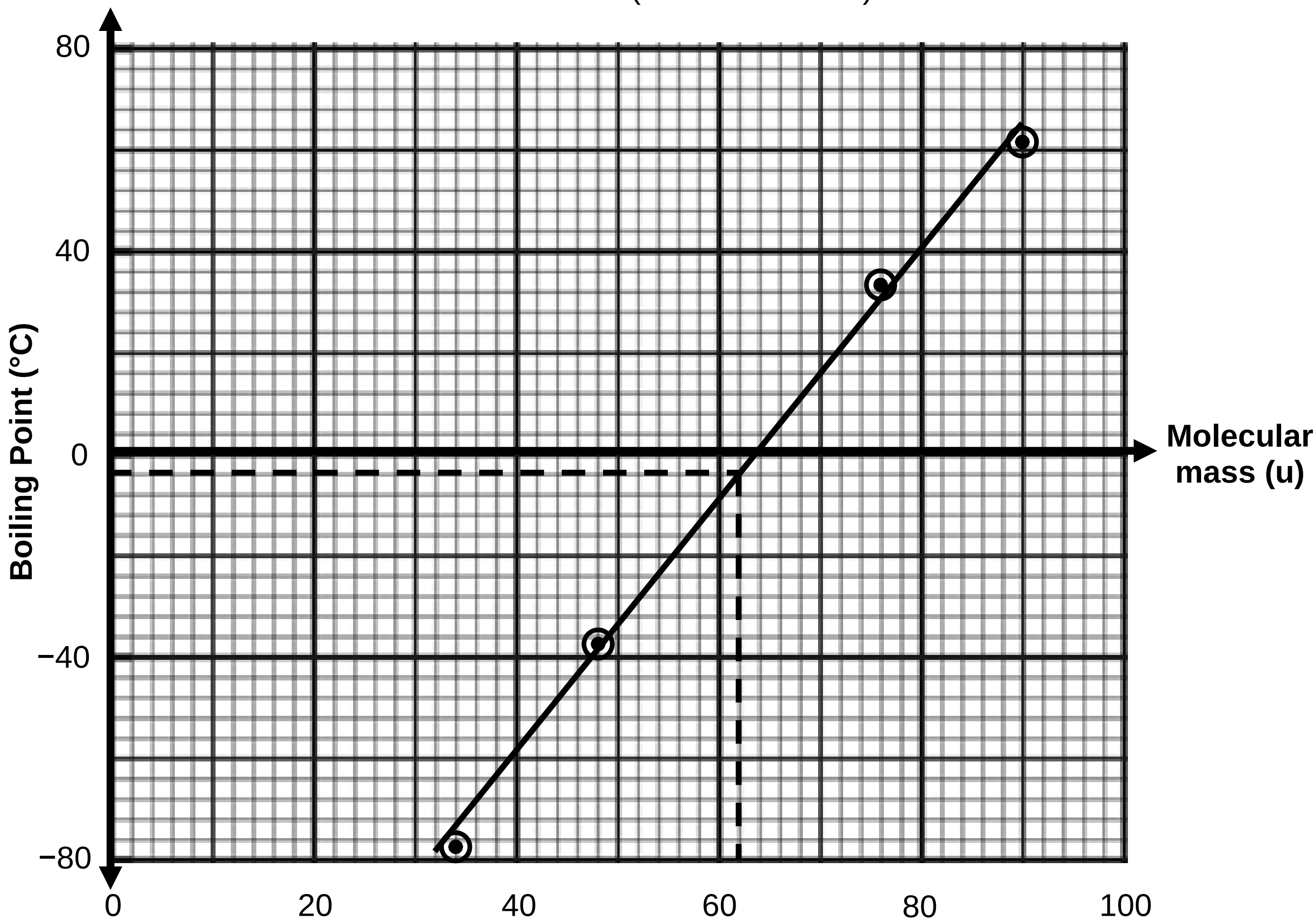
QUESTION 8

8.1 Dipole-dipole interactions

8.2 Liquid

8.3

Graph showing the relationship between boiling point and molecular mass (of fluoroalkanes)



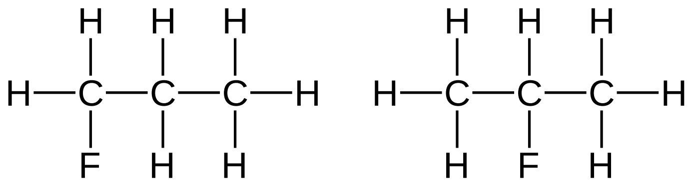
8.4 −4 ± 2 °C

8.5 8.5.1 No

8.5.2 In addition to the molecular mass, there is another independent variable (OR all other variables have not been fixed / controlled)
This is because the graph only has data for fluoroalkanes, not chloroalkanes (a different haloalkane was used).

8.6 8.6.1 Compounds having the same molecular formula but different structural formulae.

8.6.2



8.6.3 Positional isomers

QUESTION 9

9.1 9.1.1 4−ethyl−3,3−difluoroheptane

9.1.2 pentane−2,3−diol

9.1.3 methyl hexanoate

9.2 $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$

9.3 $CH_3CH_2CH_2CH_3 + Br_2 \rightarrow CH_3CH_2CH_2CH_2Br + HBr$

OR

$CH_3(CH_2)_2CH_3 + Br_2 \rightarrow CH_3(CH_2)_3Br + HBr$

OR

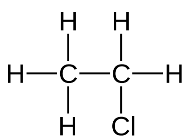
$CH_3—CH_2—CH_2—CH_3 + Br_2 \rightarrow CH_3—CH_2—CH_2—CH_2—Br + HBr$

9.4 9.4.1 Substitution

9.4.2 C_2H_6O

9.4.3 Hydrohalogenation

9.4.4



9.4.5 Cracking

9.4.6 A compound containing only carbon and hydrogen atoms.

9.4.7 Alkenes

9.4.8
- Cracking breaks long-chain alkanes into shorter-chain alkanes
- The shorter alkanes burn better and are thus more useful/ valuable as fuels

Total: 200 marks