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.

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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

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QUESTION 2

2.1 2.1.1 The mass in grams of one mole of that substance. ✓✓ (2)

2.1.2 $n_{O_2} = \frac{m}{M}$ ✓ $= \frac{(36,8)}{(32)}$ ✓ **= 1,15 mol** ✓ (3)

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

2.1.4 $\%purity = \frac{pure\,mass}{impure\,mass} \times 100 = \frac{(183,23)}{(800)} \times 100$ ✓ = **22,9%** ✓ (2)

2.2 Mandy is incorrect ✓
Although SO_3 is not the limiting reagent (OR H_2O is 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 ✓ (OR the mole ratio uses the change in amounts)

If a candidate says the following, mark accordingly:

Vitesh **can** use the SO_3 to determine the amount of sulfuric acid produced (implying Mandy is incorrect) ✓ because the SO_3 **is** the limiting reagent.
OR
Vitesh **can** use the SO_3 to determine the amount of sulfuric acid produced (implying Mandy is incorrect) ✓ because the SO_3 **is not** the limiting reagent. ✓ (3)

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QUESTION 3

3.1
- Correct orientation ✓
- Sufficient kinetic energy to overcome the activation energy ✓ (2)

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. ✓

If a candidate leaves out "per unit time" in both the 2nd and 3rd bullets, then penalise only once. (4)

3.3 3.3.1 A high-energy OR unstable temporary transition state ✓ between the reactants and the products. ✓ (2)

3.3.2 The stability increases OR it becomes more stable. ✓ (1)

3.3.3 y-axis label: potential energy OR enthalpy ✓
x-axis label: reaction coordinate OR course of reaction ✓
Dotted line of lower activation energy but same reactant and product energy ✓ (3)

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

$(12) = \frac{V_f - 0}{(16)}$ ✓✓

$V_f = 192\ \text{cm}^3$ ✓

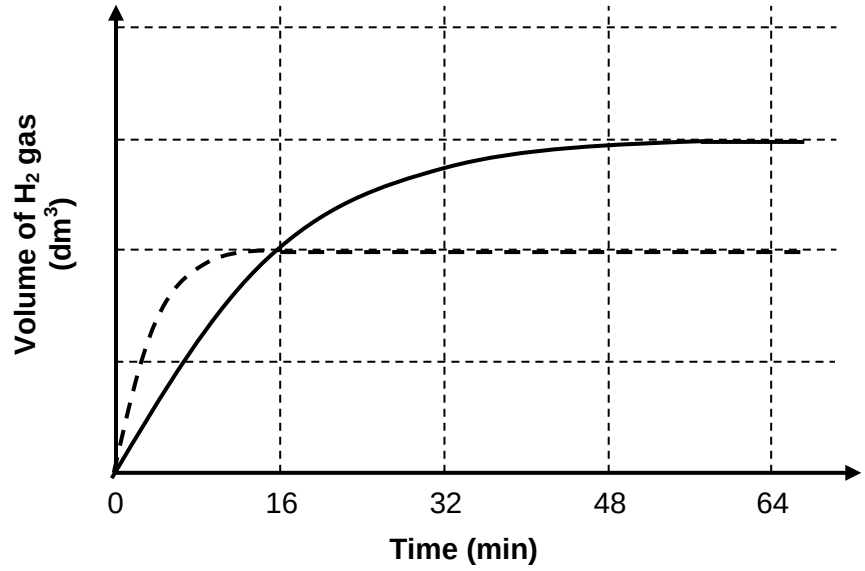
Accept 180 to 192 cm^3 (3)

3.4.2
- $n_{HC\ell} = cV$ ✓ $= (0{,}04)(0{,}4)$ ✓ $= 0{,}016\,\text{mol}$
- $n_{H_2}(\text{theoretical}) = n_{HC\ell} \times \frac{1}{2}$ ✓ $= 0{,}008\ \text{mol}$
- $V_{H_2} = nV_m$ ✓ $= (0{,}008)(26490)$ ✓ $= 211{,}92\ \text{cm}^3$
- $\%\,yield = \frac{actual\ yield}{theoretical\ yield} \times 100 = \frac{(192)}{(211{,}92)} \times 100$ ✓ **= 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%** ✓ (7)

3.4.3



✓ (less steep gradient)
✓ (1,5 times volume) (2)

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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. ✓✓ (2)

4.1.2 NO(g) is added to the container at constant volume.

(a) (More) yellow / less green ✓ (1)

(b)
- Stress: increase in the concentration of NO
- The reverse reaction rate will (suddenly/instantaneously) increase. ✓
- The forward reaction rate will initially remain the same OR the forward reaction rate increases less than the reverse. ✓
- resulting in the reverse reaction (initially) being favoured ✓
- increasing the amount of reactants (NOCℓ) and/or decreasing the amount of products (NO + $C\ell_2$) ✓ (4)

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**. ✓ (2)

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 is in response to a decrease in pressure ✓ (4)

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4.1.5
- NO (nitrogen monoxide) is **polar** (OR has permanent dipoles) ✓
- causing an **attractive force** ✓
- between the **slightly** (delta) **negative side** of one molecule and the **slightly** (delta) **positive side** of another molecule ✓ (3)

4.2 Moles (accept: if concentration is used in the table)

R	C	+	CO_2	⇌	2CO	
I	(3		1,5) ✓		0	
C	−1		−1		+2	✓
E	2		(0,5		2) ✓	
C			(1,25		5)	✓ (÷V)

$K_c = \frac{[CO]^2}{[CO_2]}$ ✓✓ (only 1 mark if carbon is included)

$K_c = \frac{(5)^2}{(1{,}25)}$ ✓(substitution of concentrations – mark NOT awarded if C included)

$K_c = 20$ ✓ (8)

4.3
- Both $C\ell_2$ and CO_2 have London (OR dispersion OR induced-dipole) forces (only) ✓
- $C\ell_2$ has a greater number of electrons OR it is a larger molecule. ✓
- Therefore, $C\ell_2$ forms larger induced dipole ✓
- and thus stronger London forces (OR intermolecular forces). ✓
- More energy is needed to overcome the intermolecular forces (OR separate the particles) in $C\ell_2$ ✓ (5)

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QUESTION 5

5.1 5.1.1 A solution of known concentration. ✓ (1)

5.1.2 $m = cMV$ ✓
$m = (0,25)(56)(0,6)$ ✓✓
$m = 8,4$ **g** ✓ (4)

5.1.3 Lower ✓✓ (2)

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

5.1.5 $F^- + H_2O \rightleftharpoons HF + OH^-$ ✓✓
If no reversible arrow (−1)
- The production of hydroxide ions results in a basic end point ✓ (3)

5.2 5.2.1 Carbonate OR CO_3^{2-} ✓ (1)

5.2.2 A proton acceptor. ✓ (1)

5.2.3 A base that only dissociates/ionises partially ✓ in an aqueous solution ✓. (2)

5.2.4 $NH_3 + H_2O \rightleftharpoons NH_4^+$ ✓ + OH^- ✓
Reversible arrow ✓ (3)
[20]

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QUESTION 6

6.1 A substance that can conduct electricity by forming free ions when molten or dissolved in solution. ✓✓ (2)

6.2 $Au(NO_3)_3$ (OR $AuC\ell_3$) ✓✓ (2)

6.3 X ✓ (1)

6.4 $Au^{3+} + 3e^- \rightarrow Au$ ✓✓
coe from 6.3 – if the answer to Q6.2 is Au, then accept: $X^{2+} + 2e^- \rightarrow X$
(−1) if double arrow is used (2)

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 ✓
∴ **X is Cd** (OR cadmium) ✓
coe from 6.3 for calculation but not conclusion / identification (4)

6.5.2 Gold is too expensive (OR cadmium is very toxic) ✓ (1)

6.6 6.6.1
- Pt electrode ✓
- Solution of H^+ ions (at 1 mol·dm^{-3}) AND/OR H_2 gas (at 1 atm) AND/OR temperature of 25 °C (any two ✓✓)
- All electrode potentials are measured relative to the SHE (which is given a defined electrode potential of 0,00 V) ✓ (4)

6.6.2 $Pt(s) \mid H_2(g) \mid H^+(aq) \parallel Au^{3+}(aq) \mid Au(s)$
Pt ✓
$H_2 \mid H^+$ ✓
$Au^{3+} \mid Au$ ✓
Phases ✓ (4)
[20]

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QUESTION 7

7.1 7.1.1 It is operating at a high temperature OR the electrolyte is molten. ✓
DON'T accept "so that it doesn't melt" (1)

7.1.2
- It is inert ✓
- It is conductive ✓ (2)

7.2 Electrical ✓ to chemical energy ✓ (2)

7.3
- In molten or aqueous state, the ions are free (OR mobile) ✓
- allowing the electrolyte to be conductive ✓ (2)

7.4 7.4.1 Q ✓ (1)

7.4.2 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓
Subtract one mark for use of reversible arrows in either 7.4.2 or 7.4.3 (2)

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

7.4.4 $C\ell^-$ ✓ (1)

7.5 The blue colour of the electrolyte will fade (get lighter) ✓
$Cu^{2+} + 2e^- \rightarrow Cu$ ✓✓ (3)

7.6 Q ✓ and S ✓ (2)

7.7 7.7.1 The reaction would proceed faster ✓ (1)

7.7.2 The reaction of a molecular substance with water to produce ions. ✓✓ (2)

7.7.3 There is an increase in the concentration ✓ of ions. ✓ (2)

7.7.4 Increase ✓✓ (2)
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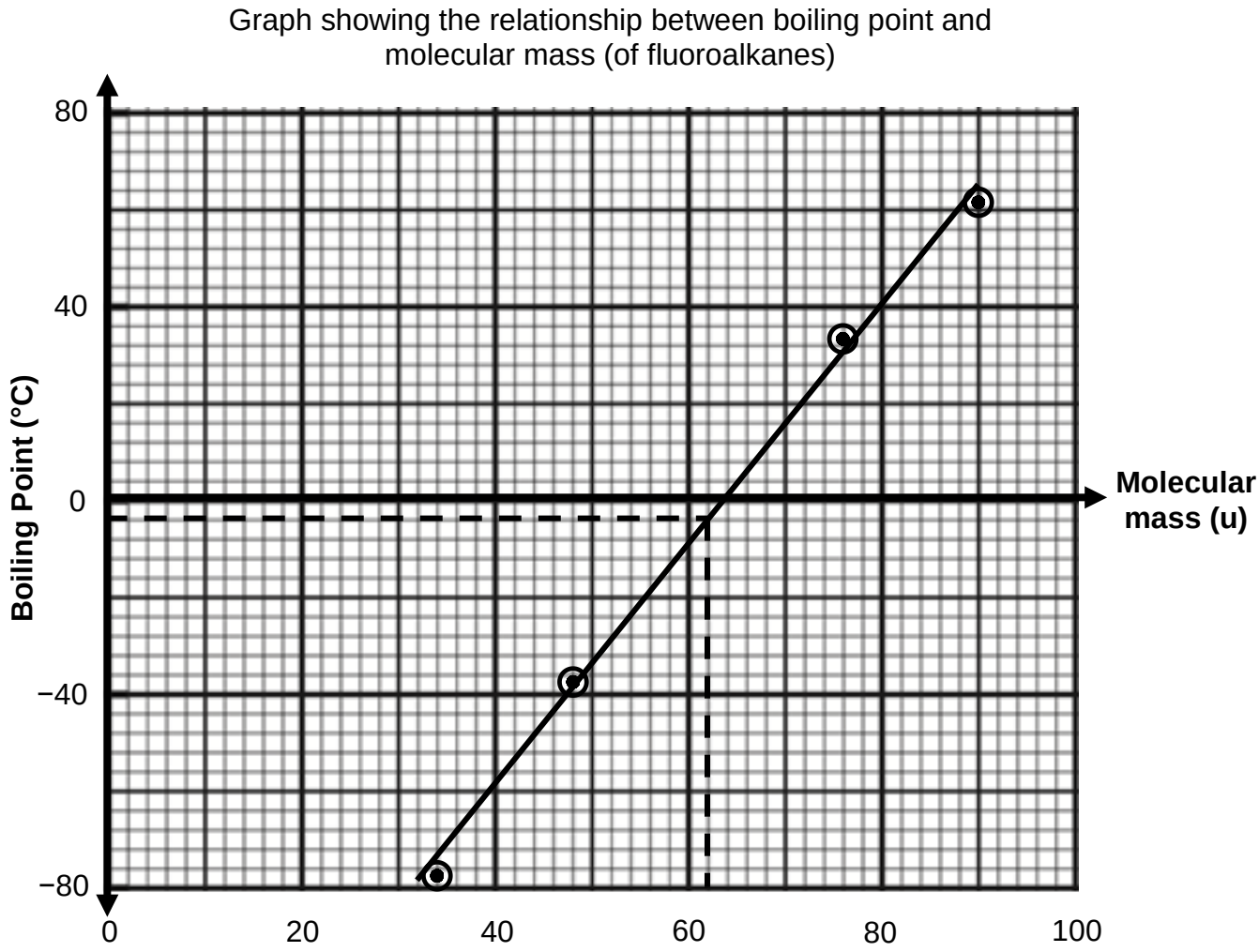
QUESTION 8

8.1 Dipole-dipole interactions ✓ (1)

8.2 Liquid ✓ (1)

8.3



Suitable title ✓
y-axis label ✓
y-axis scale ✓
Points plotted correctly ✓✓
Straight line of best fit ✓ (6)

8.4 -4 ± 2 °C ✓ (boiling point **must** be negative)
Indication on the graph at a molecular mass of 62 u ✓ (this mark may be awarded independently of the boiling point being correct) (2)

8.5 8.5.1 No ✓ (1)

8.5.2 There is another independent variable (OR it is not a VALID graph OR it is not a FAIR TEST) ✓ because the graph only has data for fluoroalkanes, not chloroalkanes (OR a different halogen / haloalkane was used) ✓ (2)

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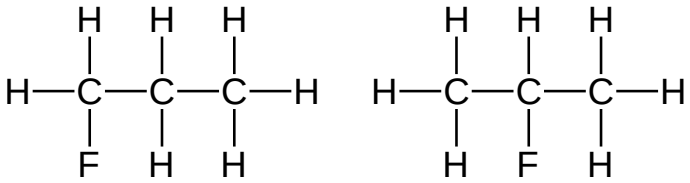
8.6 8.6.1 Compounds having the same molecular formula but different structural formulae. ✓✓ (2)

8.6.2 

Both structures match molecular formula ✓
Fluorine on carbon 1 ✓
Fluorine on carbon 2 ✓ (3)

8.6.3 Positional ✓ (isomers) (1)
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QUESTION 9

9.1 9.1.1 3−ethyl−4,4−difluoroheptane
3−ethyl ✓
4,4−difluoro ✓
hept ✓
ane ✓ (4)

9.1.2 pentane−2,3−diol
pent ✓
ane ✓
2,3−diol ✓ (3)

9.1.3 methyl ✓ hexanoate ✓ (2)

9.2 $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$
C_3H_6 ✓
O_2 ✓
$CO_2 + H_2O$ ✓
Balancing ✓ (4)

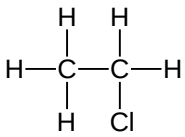
9.3 $CH_3CH_2CH_2CH_3 + Br_2 \rightarrow CH_3CH_2CH_2CH_2Br + HBr$
OR
$CH_3(CH_2)_2CH_3 + Br_2 \rightarrow CH_3(CH_2)_3Br + HBr$
OR
$CH_3—CH_2—CH_2—CH_3 + Br_2 \rightarrow CH_3—CH_2—CH_2—CH_2—Br + HBr$

butane ✓
Br_2 ✓
any bromobutane ✓
HBr ✓ (4)

9.4 9.4.1 Substitution ✓ (1)

9.4.2 C_2H_6O ✓✓ (2)

9.4.3 Hydrohalogenation ✓ (1)

9.4.4  Saturated ✓
One chlorine ✓ (2)

9.4.5 Cracking ✓ (1)

9.4.6 A compound containing only carbon and hydrogen atoms. ✓✓ (2)

9.4.7 Alkenes ✓✓ (2)

9.4.8 • Cracking breaks long-chain alkanes (OR hydrocarbons) into shorter-chain alkanes (OR hydrocarbons) ✓
Any ONE of the following ✓
- The shorter alkanes (OR hydrocarbons) burn better
- The shorter alkanes (OR hydrocarbons) are thus more valuable and expensive fuels
- The shorter alkanes (OR hydrocarbons) are in higher demand (OR demand exceeds supply)
- The alkene byproducts are used in the polymer industry (2)

[30]

Total: 200 marks

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