NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION – MARCH 2018

PHYSICAL SCIENCES: PAPER II

MARKING GUIDELINES

Time: 3 hours | 200 marks

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QUESTION 1 MULTIPLE CHOICE

1.1 D
1.2 A
1.3 C
1.4 D
1.5 B
1.6 B
1.7 C
1.8 B
1.9 D
1.10 A **[20]**

QUESTION 2 CHEMICAL BONDING

2.1 An ionic bond is *a transfer of electrons and subsequent electrostatic attraction.* (2)

2.2 Any ionic compound (correct formula or name). (1)

2.3 2.3.1 Polar covalent bonds (2)

2.3.2 Non-polar (pure) covalent bonds (2)

2.4 2.4.1 Hydrogen bonds (2)

2.4.2 Dispersion forces
London forces or (weak) van der Waal's forces
or induced dipole forces (2)

2.5 The intermolecular forces in hydrogen fluoride are **stronger** than those in fluorine. **More energy** is needed to overcome the stronger intermolecular forces. (2)

2.6 Silicon dioxide forms a **giant atomic network** or **lattice** where each atom is covalently bonded to **MANY** others. A **lot of energy** is needed to break these many **strong covalent bonds** which results in a high melting point. (Ticks in brackets give marks for either/or) (4)

2.7 2.7.1 m = c.M.V
= 0,2 × 142 × 0,25
= **7,1 g**
OR
n = c.V
n = 0,2 × 0,25
n = 0,05 mol
m = n × M
m = 0,05 × 142
m = **7,1 g** (4)

Award marks for the following skills:
Method (formula)
Molar mass (142 $g.mol^{-1}$)
Conversion of volume to dm^3
Correct answer (7,1 g)

BOTH formulae

2.7.2 **Making a standard solution**

1. Use a scale/balance to accurately **mass out the required amount of solute** onto a watch glass or weighing boat.
2. Transfer the solute into a **volumetric flask**.
3. Re-mass the watch glass or weighing boat to determine exactly how much solute was transferred to the volumetric flask.
4. Add **distilled water** to the flask until approximately half full. (Shake the flask until all of the solute has dissolved.)
5. Add distilled water to **make up the total volume of the solution to the amount required**. The bottom of the meniscus should sit on the line on the neck of the flask.

(Ticks in brackets give marks for either/or) (5)

2.7.3 ion-dipole forces (2)

[28]

QUESTION 3 ENERGY CHANGE AND REACTION RATES

3.1 3.1.1 Heat of reaction (ΔH) *is the net change of chemical potential energy of the system.* (2)

3.1.2 The **activated complex** is *a temporary transition state between the reactants and the products.* (2)

3.2 The colliding particles must have **enough kinetic energy greater than or equal to the activation energy**.
The colliding particles must have the **correct orientation**. (4)

3.3 3.3.1 $Zn + 2HC\ell \longrightarrow ZnC\ell_2 + H_2$
Reactants Products Balanced (state symbols not needed) (3)

3.3.2 Use **powdered** or granulated zinc (increase surface area 1 only)
Use **concentrated** hydrochloric acid (increase [ ] 1 only)
Heat the test-tube of reactants (6)

3.3.3 It interacts with the reactants in such a way that the reaction follows an alternate path of **lower activation energy**. (2)

3.4 3.4.1 C (1)

3.4.2 D (1)

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QUESTION 4 CHEMICAL EQUILIBRIUM

4.1 4.1.1 A closed system is one in which no mass (reactants or products) is transferred into or out of the system. (2)

4.1.2 Dynamic chemical equilibrium is when the forward and reverse reactions continue to take place simultaneously at the same RATE.
OR Dynamic chemical equilibrium is when the RATE of the forward reaction is equal to the RATE of the reverse reaction.
(Omission of the word RATE in either explanation give 0/2.)
OR A steady state system where no observable changes take place but changes occur at the microscopic/molecular level. (2)

4.2 4.2.1 NO EFFECT (1)

4.2.2 NO EFFECT (1)

4.3 Stress: Increase temperature (add heat).
Response: **Favour reverse** reaction
Reason: Reverse reaction is **endothermic** therefore **absorbs heat** (decreases temperature) and relieves the stress.
Yield of Fe: **Decreases**. (4)

4.4 4.4.1 $K_c = \frac{[CO_2]^3}{[CO]^3}$ (–1 for use of round brackets) (2)

4.4.2 **Fe_2O_3** $n = \frac{m}{M}$ $= \frac{800}{160}$ = **5 mol** (Fe_2O_3 initially)

CO_2 $n = \frac{V}{V_m}$ $= \frac{215,04}{22,4}$ = **9,6 mol**

MOLE table **$Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(s) + 3CO_2(g)$**

*Mole ratio	1	3	2	3	
Moles at start	**5**	**18**	0	0	
*Moles used/formed	(3,2	9,6)	6,4	9,6	
Moles at equilibrium	(1,8	8,4)	6,4	**9,6**	÷ 10
Conc. at equilibrium ($mol \cdot dm^{-3}$) (c = n/V) (V = 10 dm^3)		0,84		0,96	

$$K_c = \frac{(0,96)^3}{(0,84)^3}$$
$$= \mathbf{1,49}$$

Award marks for the following skills:
Applying mol ratio to get mols of Fe (6,4) at eqm
Applying mol ratio to get mols of reactants used
Subtraction to get mols of reactants at eqm
Divide mol at eqm by volume (10 dm^3) for gases ONLY
Substitution of conc at eqm into K_c (expression as given in Question 4.4.1)
Correct answer (1,49)

(10)

4.5 4.5.1 NO EFFECT (1)

4.5.2 INCREASES (1)

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QUESTION 5 EQUILIBRIUM GRAPH

5.1 5.1.1 Equal (1)

5.1.2 Forward faster than reverse (1)

5.2 Decrease in volume of container/increase in pressure (1)

5.3 **Stress:** Gas A_2 was removed from reaction vessel.
Response: Reverse reaction favoured
Reason: AB_2 breaks down in the reverse reaction in order to increase $[A_2]$ and relieve stress. (3)

5.4 The slopes/gradients of each line would be steeper or equilibrium would be reached sooner.

The graph would level out at the same number of moles (as without a catalyst) in each case. (2)

[8]

QUESTION 6 TITRATION

6.1 It is the point where an acid and base have reacted so neither is in excess **OR** where **equivalent** (NOT same or equal) number of moles of acid and base have reacted. (2)

6.2 The neutralisation of the **strong base** (KOH) by the **strong acid** (H_2SO_4) produced a **neutral salt** (K_2SO_4). (3)

6.3 n = c.V (method)
= 0,04 × 0,024 (conversion cm^3 to dm^3)
= **$9,6 \times 10^{-4}$ mol H_2SO_4** (0,00096 mol)

Mol ratio: H_2SO_4 : KOH
1 : 2
$9,6 \times 10^{-4}$: $1,92 \times 10^{-3}$ (applying correct mol ratio)

Conc. of KOH c = n/V

$$= \frac{1,92 \times 10^{-3}}{0,05} \text{ (divide by volume)}$$

= **0,038 mol·dm^{-3}** (5)

6.4 Before the equivalence point KOH was in excess (pH>7) after the equivalence point the KOH was neutralised and H_2SO_4 was in excess (pH<7). (2)

6.5 Bromothymol blue. The equivalence point of the titration falls within the pH range of the indicator. (2)

[14]

QUESTION 7 ACIDS AND BASES

7.1 7.1.1 $HNO_2 + H_2O \rightleftharpoons NO_2^- + H_3O^+$
Reactants
Products (2)

7.1.2 Nitrous acid. It is a stronger acid (as shown by higher K_a) therefore it would ionise more or it would have a higher concentration of free ions. (No marks for HCℓO.) (3)

7.2 7.2.1 $2HC\ell + MgCO_3 \longrightarrow MgC\ell_2 + CO_2 + H_2O$ **OR**
$2HC\ell + MgCO_3 \longrightarrow MgC\ell_2 + H_2CO_3$
Reactants
Products
Balanced (3)

7.2.2 $6HNO_3 + A\ell_2O_3 \longrightarrow 2A\ell(NO_3)_3 + 3H_2O$
Reactants
Products
Balanced (3)

7.3 7.3.1 Hydrochloric acid ($HC\ell$)
Ammonia solution (NH_3) or ammonium hydroxide (NH_4OH) (2)

7.3.2 Less than 7 (1)
[14]

QUESTION 8 GALVANIC CELLS

8.1 **Temperature** = 298 K or 25 °C;
Pressure of gas = 1 atm or $1,01 \times 10^5$ Pa;
Concentration of electrolyte = 1 $mol \cdot dm^{-3}$ (3)

8.2 X^{3+} (1)

8.3 $3H_2 + 2X^{3+} \longrightarrow 2X + 6H^+$
Products Reactants Balanced (3)

8.4 8.4.1 Remains the same (1)

8.4.2 Increases (1)

8.4.3 Remains the same (1)

8.5 Y (1)

8.6 The negative sign indicates **electrons will NOT flow spontaneously from hydrogen to metal Y**. **Metal Y is a stronger reducing agent than H_2** therefore metal Y is more readily oxidised and ACTS as the anode (even though the hydrogen electrode was CONNECTED as the anode.) (3)

8.7 8.7.1 $Y|Y^{2+}||X^{3+}|X$
Anode Salt bridge Cathode (3)

8.7.2 **Cell R:** $E^o_{Cell\ R} = E^o_P - E^o_Q$
$= 0,61 - (-2,14)$
$=$ **2,75 V** (3)
[20]

QUESTION 9 ELECTROLYTIC CELL

9.1 Oxidation is loss of electrons (2)

9.2 9.2.1 cobalt or nickel or zinc (1)

9.2.2 Impurities that are **stronger reducing agents** or that have **less positive/more negative E^o** than copper will be oxidised. (2)
(Apply negative marking principle. No marks for Question 9.2.2 if Question 9.2.1 is wrong.)

9.2.3 They fall to the bottom of the cell (beaker) as sludge, which can be filtered off. (1)

9.3 $Cu^{2+} + 2e^- \rightarrow Cu$ (–1 for double arrow) (2)

9.4 Loss in mass = (435 – 265) = **170 g**

Gain in mass at cathode = (283 – 156) = 127 g
Percentage of Cu present in material oxidised from impure lump $= \frac{127}{170}$
= **74,71 %** (4)

9.5 The $A\ell^{3+}$ ions formed by oxidation of the impure anode would not be reduced at the cathode (pure Aℓ strip).
H_2O is a stronger oxidising agent than $A\ell^{3+}$ ions ∴ H_2O is preferentially reduced at the cathode. (3)
[15]

QUESTION 10 ORGANIC CHEMISTRY (1)

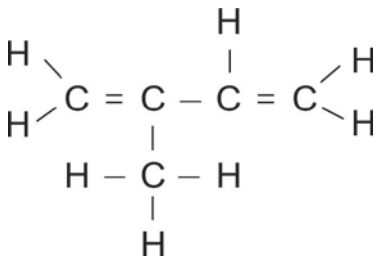
10.1 10.1.1 B (1)

10.1.2 A and F (2)

10.1.3 C and H (must have both, no part marks) (2)

10.2 alcohol (1)

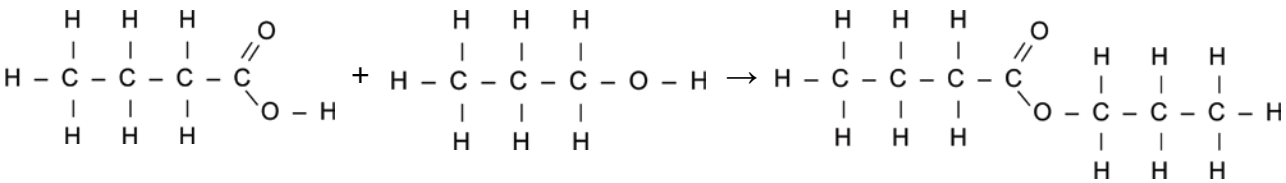
10.3 4 carbons in longest chain
Methyl on C_2
Double bond between C_1 & C_2 and between C_3 & C_4
Correct number of H's attached to each C



(4)

10.4 2-bromo-3-ethylhexane 2-bromo 3-ethylhexane (4)

10.5

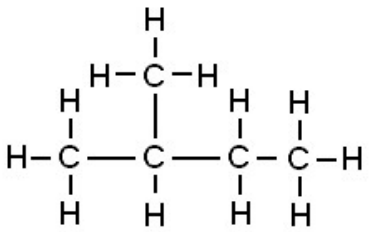
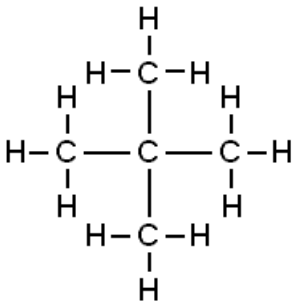


Ester linkage correct
Rest of structure correct

+
H_2O

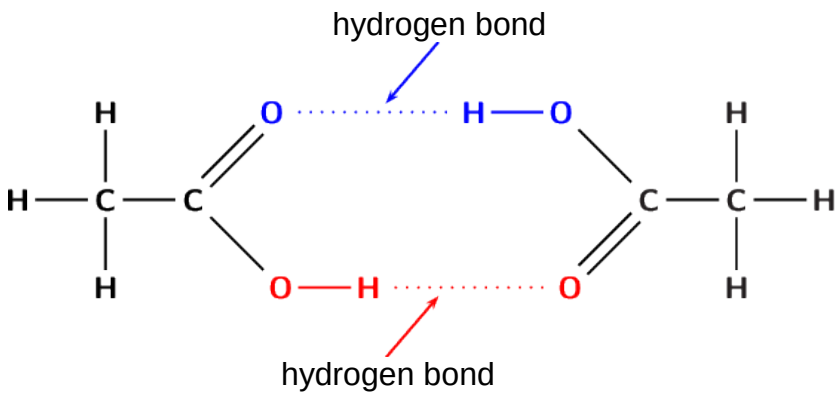
(5)

10.6 ONE of the following:

Structural formula (2 marks each)	**IUPAC name** (2 marks each)
	2-methylbutane (2 is redundant: don't penalise if missing)
	2,2-dimethylpropane (2,2- is redundant: don't penalise if missing)

(4)

10.7 Ethanoic acid is able to form **TWO hydrogen bonds** with another ethanoic acid molecule (to form a dimer).
Propan-1-ol can only form **ONE** hydrogen bond with another propan-1-ol molecule.
TWO hydrogen bonds per molecule are collectively **stronger** than ONE.
More energy is needed to overcome two H-bonds compared with one H-bond, therefore, ethanoic acid has a higher boiling point. (4)



[Source: <https://www.everythingmaths.co.za/science/grade-12>]

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QUESTION 11 ORGANIC CHEMISTRY (2)

11.1 X = methanol Y = hex-1-ene Z = ethanoic acid (3)

11.2 $CH_2CHCH_3 + Br_2 \longrightarrow CH_2BrCHBrCH_3$
Each reactant Product (3)

11.3 $CH_3CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CHCH_2 + H_2O$
Reactant both Products (3)
[9]

Total: 200 marks

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