NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2024

PHYSICAL SCIENCES: PAPER II

MARKING GUIDELINES

Time: 3 hours | 200 marks

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QUESTION 1 MULTIPLE-CHOICE QUESTIONS

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

QUESTION 2

2.1 2.1.1 $SiO_2 + \mathbf{4}HF \rightarrow SiF_4 + \mathbf{2}H_2O$ LHS RHS

2.1.2 Giant structure – a lot of energy is needed to break the many, strong covalent bonds.

2.1.3 Both molecules (are non-polar and) have only London forces.
$SiC\ell_4$ has a larger electron cloud / more electrons.
It will have larger temporary dipoles.
More energy is needed to overcome the stronger intermolecular forces
OR $SiC\ell_4$ will have a higher boiling point.

2.2 2.2.1 molecules

2.2.2 London / induced dipole / dispersion forces

2.3 2.3.1 (a) NaF

(b) ReF_7

(c) Na

2.3.2 Covalent – shared
Ionic – transferred
Metallic – delocalised / free / mobile

2.4 2.4.1 (a) hydrogen bonds

(b) dipole-dipole forces

2.4.2 The difference in EN is greater for HF,
therefore the HF molecule is more polar.
F is smaller than Cℓ,
so the HF molecules can get closer to each other.
NOT "H-bonds are stronger than dipole-dipole forces"

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QUESTION 3

3.1 $MgCO_3 + 2HC\ell \rightarrow MgC\ell_2 + (CO_2 + H_2O)$ reac prod bal
Double arrow -1

3.2 Collect the (CO_2) gas using a gas syringe or by downward displacement of water using a filled inverted burette or measuring cylinder.
Measure the volume of gas produced
as a function of time.

OR
Use a balance
to measure the mass / mass loss of the reaction vessel as a function of time due to the escaping (CO_2) gas / measure the mass of (CO_2) gas that escapes as a function of time.

OR
Use a pH electrode
to measure the change (increase) in pH as the concentration of the $HC\ell$ changes (decreases)
as a function of time.

OR
Use a thermometer
to measure the (change in) temperature
as a function of time.

Equipment used quantity measured vs time.

3.3 No
More than one variable is changing
OR All independent variables are changing / there is no control variable.
OR It is unclear which factor is causing the change in the rate.

3.4 An increase in temperature causes the reaction rate to increase.

3.5 The crushed tablet has a greater surface area.
There will be more collisions per unit time between reacting particles.
There will be more effective collisions per unit time.
The reaction rate in Exp 2 is higher.

3.6 3.6.1 The minimum energy required to start a chemical reaction.
OR
The energy required to form the activated complex.

3.6.2 (Represents) the number / fraction of particles
with $E_k \geq E_a$ OR with enough kinetic energy to react.

3.6.3 Exp. 3 has a higher concentration of acid.
Curve should be same shape but above original.
Same peak position.

QUESTION 4

4.1 Mass is conserved inside the system **OR** reactants and products cannot leave the system (but energy can enter or leave the system freely).

4.2 silver phosphate **OR** silver(I) phosphate

4.3 4.3.1 dissociation

4.3.2 low

4.4 $K_c = [Ag^+]^3[PO_4^{3-}]$

4.5 $Ag_3PO_4(s) \rightleftharpoons 3Ag^+(aq) + PO_4^{3-}(aq)$

[Initial]	**0**	**0**
[Change]	$+3x$	$+x$
[Equil]	$3x$	x

$K_c = (3x)^3(x)$
$= 27x^4$
$= 8{,}9 \times 10^{-17}$

Solve: $x = 4{,}26 \times 10^{-5}$ mol·dm^{-3} (given)

OR

Substitute: $27(4{,}26 \times 10^{-5})^4 = 8{,}9 \times 10^{-17}$

4.6 $n = cV$
$= 4{,}26 \times 10^{-5} \times 0{,}2$
$= 8{,}52 \times 10^{-6}$ mol PO_4^{3-} ions
$n_{total} = 4 \times 8{,}52 \times 10^{-6}$
$= 3{,}41 \times 10^{-5}$ mol
$N = n_{total}N_A$
$= 3{,}41 \times 10^{-5} \times 6{,}02 \times 10^{23}$
$= 2{,}05 \times 10^{19}$

4.7 4.7.1 increase

4.7.2 decrease

4.7.3 remain the same

4.8 The forward endothermic reaction is favoured to decrease the temperature

4.9 The solution is saturated.

OR

No more Ag_3PO_4 can dissolve.

QUESTION 5

5.1 An acid that only ionises partially in aqueous solution.

5.2 succinic acid
Has the lowest K_a

5.3 5.3.1 A substance that can act as either an acid or a base.

5.3.2 $C_2O_4^{2-}$

5.3.3 basic
$C_2O_4^{2-} + H_2O \rightleftharpoons HC_2O_4^{-} + OH^{-}$

5.4 5.4.1 burette

5.4.2 pipette

5.5 Equivalence point: (point) where neither reactant is in excess.
Endpoint: (point) where the indicator changes colour.

5.6 $n(\text{NaOH}) = cV$
$= 0{,}102 \times 0{,}0235$
$= 2{,}397 \times 10^{-3}$ mol
$n(H_2A) = 2{,}397 \times 10^{-3} / 2$
$= 1{,}1985 \times 10^{-3}$ mol
$c(H_2A) = n / V$
$= 1{,}1985 \times 10^{-3} / 0{,}025$
$= 0{,}0479$ mol·dm^{-3}

OR USE: $$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$$

$$\frac{c_a \times 25}{0{,}102 \times 23{,}5} = \frac{1}{2}$$

$c(H_2A) = 0{,}0479$ mol·dm^{-3}

5.7 $c = m / MV$
$M = m / cV$
$= 1 / (0{,}0479 \times 0{,}2)$
$= 104{,}4$ g·mol^{-1}
$\therefore$ malonic acid

OR

$n = cV$
$= 0{,}0479 \times 0{,}2$
$= 9{,}58 \times 10^{-3}$ mol
$M = m / n$
$= 1 / 9{,}58 \times 10^{-3}$
$= 104{,}4$ g·mol^{-1}
$\therefore$ malonic acid

5.8 5.8.1 The colour changes from colourless to pink.

5.8.2 At the endpoint, there will be more OH^-
Hence $[H_3O^+]$ decreases
The forward reaction is favoured to produce H_3O^+
Therefore, more In^- forms

QUESTION 6

6.1 Mn is not part of the half-cell reaction / a different half-cell reaction would occur.

6.2 (Pt) electrode B / the positive electrode / the electrode in Half-cell Q.

6.3 permanganate (ion)

6.4 6.4.1 $H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$ ×5

6.4.2 $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ×2

6.4.3 $5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 5O_2 + 2Mn^{2+} + 8H_2O$
LHS RHS BAL

6.5 $E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$
$= 1,51 - 0,68$
$= 0,83$ V

6.6 TWO OF:
Use a shorter salt bridge.
Use a wider salt bridge.
Use a more conductive salt bridge.
Use electrodes with a larger surface area.

6.7 He put Pt first instead of last (on the outside).
He used phase separators (|), not commas (,) to separate (aq) substances.
He used the balancing number (8).

6.8 $C\ell^-$ can / will be oxidised by MnO_4^- (to form $C\ell_2$)
SO_4^{2-} will not.

QUESTION 7

7.1 Electrolytic

7.2 negative

7.3 $H_2 + (2)OH^-$

7.4 $c = m / MV$
$= 55 / (203,3 \times 0,1)$
$= 2,71\ mol{\cdot}dm^{-3}$
$[C\ell^-] = 2 \times 2,71 = 5,42\ mol{\cdot}dm^{-3}$

OR

$n = m / M$
$= 55 / 203,3$
$= 0,271\ mol$
$c = n / V$
$= 0,271 / 0,1$
$= 2,71\ mol{\cdot}dm^{-3}$
$[C\ell^-] = 2 \times 2,71 = 5,42\ mol{\cdot}dm^{-3}$

7.5 **P** $C\ell_2$

R $O_2 + (4)H^+$

7.6 When the concentration of $MgC\ell_2$ is 1 $mol{\cdot}dm^{-3}$
H_2O is a stronger reducing agent than $C\ell^-$
therefore H_2O is oxidised to O_2 at **R**.
When the concentration of $C\ell^-$ is high (cell **X**)
the rate of oxidation of $C\ell^-$ increases
OR $C\ell^-$ is a stronger reducing agent than water
and more $C\ell_2$ forms at **P**.

7.7 7.7.1 A substance that can conduct electricity due to the presence of free (mobile) ions when molten or dissolved in solution.

7.7.2 $MgC\ell_2$ is an ionic compound – it has a high melting point.

7.7.3 **T** $C\ell_2$ OR chlorine

U Mg OR magnesium

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QUESTION 8

8.1 **A:** C_4H_{10}

8.2 8.2.1 **B:** 1-chlorobutane (one word)

8.2.2 **C:** ethanol (one word)

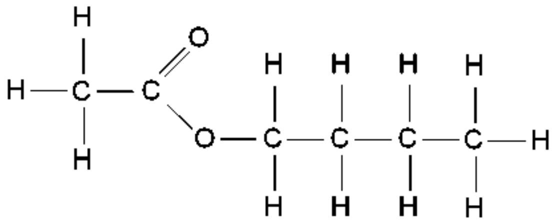
8.2.3 **D:** butyl ethanoate

8.3 A series of similar compounds which have the same functional group and general formula, in which each member differs from the previous one by a single CH_2 unit.

8.4 8.4.1 **C:** alcohol

8.4.2 **D:** ester

8.5 **D:**



8.6 ethene

8.7 8.7.1 **P:** elimination

8.7.2 **Q** substitution

8.8 8.8.1 **R:** hydration

8.8.2 **S:** hydrolysis

8.9 8.9.1 Condition **II**

8.9.2 (a) dehydrohalogenation

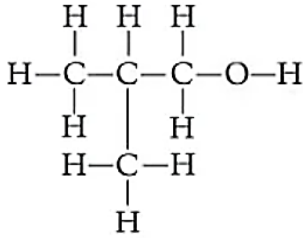
(b) but-1-ene

8.9.3 To prevent (volatile / low bp) compounds from escaping.

8.10 8.10.1 reaction will be slow

8.10.2 R

8.11 8.11.1



8.11.2 butan-2-ol

8.12 3-ethyl-3-methylpentane

8.13 octane

Total: 200 marks

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