NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION – MARCH 2019

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

QUESTION 2 CHEMICAL BONDING

2.1 2.1.1 SiO_2

2.1.2 PH_3

2.1.3 C_6H_{12}

2.1.4 Kr

2.1.5 KBr OR $NH_4C\ell$

2.1.6 $NH_4C\ell$

2.1.7 Pt

2.1.8 H_2O (OR SiO_2)

2.2 2.2.1 A (weak) force of attraction between molecules or atoms of noble gases.

2.2.2
- I_2 has London forces (only)
- H_2O has London forces and hydrogen bonds
- (Although hydrogen bonds are usually stronger than London forces) the London forces in I_2 are stronger than the hydrogen bonds in H_2O
- OR the intermolecular forces in I_2 are stronger than those in H_2O
- due to the larger number of electrons/bigger atoms
- Therefore more energy is needed to separate the particles/ overcome the intermolecular forces in I_2
- Resulting in I_2 having a higher melting point (hence being a solid at room temperature)

2.3 2.3.1 The substance that is dissolved in the solution.

2.3.2 Potassium bromide

2.3.3 Ion-dipole interactions

2.3.4 The intermolecular forces between the ions in KBr and the molecules of C_6H_{12} (ion-induced dipole forces) are much weaker than the ionic forces holding the ions in the KBr crystal lattice.
OR
The London forces in C_6H_{12} are much weaker than the ionic forces holding the ions in the KBr crystal lattice.
OR
The strength of the forces the ions in KBr are not similar to those between the C_6H_{12} molecules.

QUESTION 3 ENERGY CHANGE AND REACTION RATES

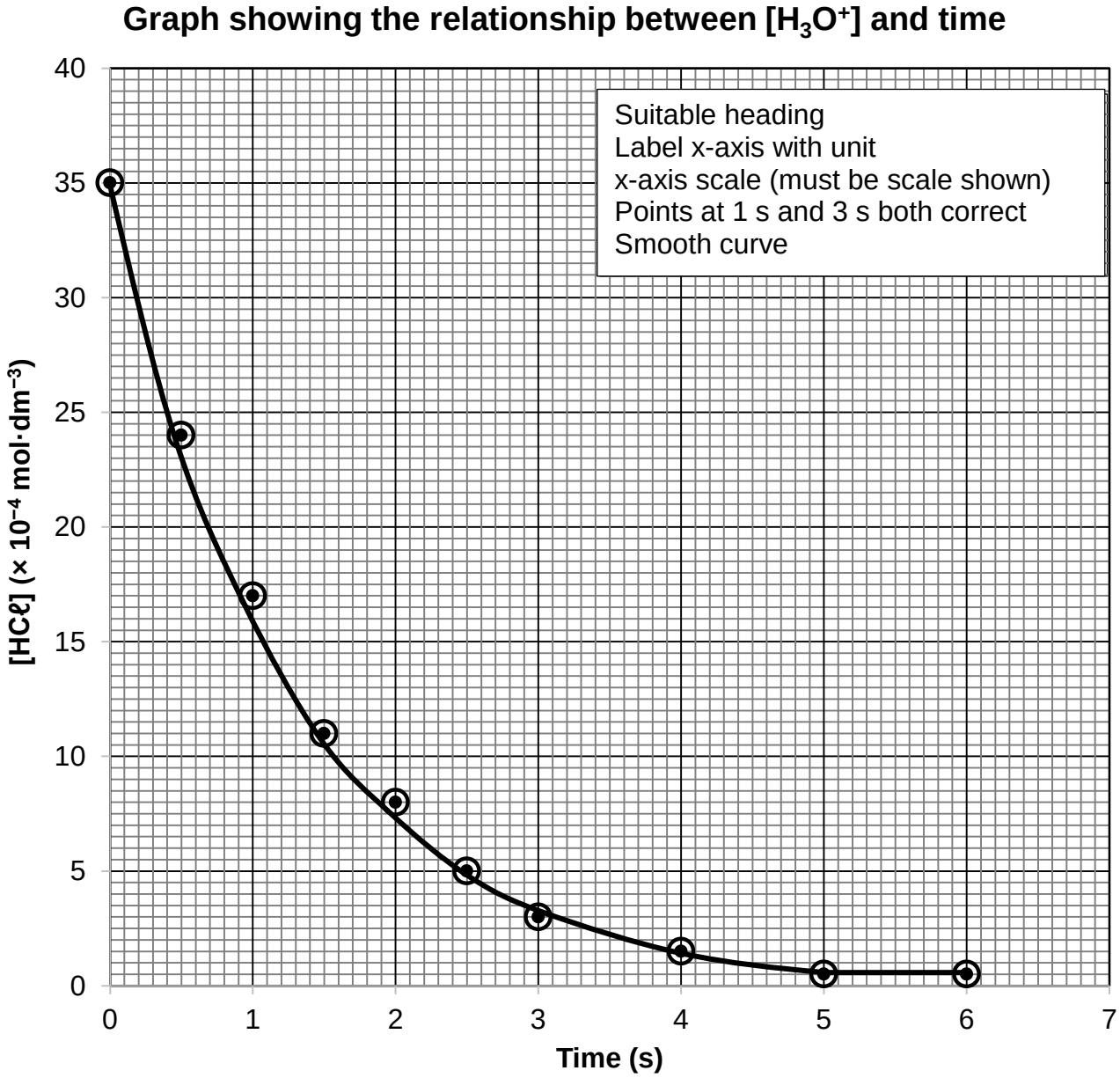
3.1
- The H_3O^+/H^+ ions are being consumed/[HCℓ] is decreasing
- decreasing the concentration of H_3O^+
- The solution becomes less acidic

3.2 3.2.1 The net change of chemical potential energy of the system.

3.2.2
- The reaction is exothermic
- resulting in the temperature initially increasing (therefore more particles will have the necessary energy to overcome the activation energy)

3.2.3
- As time proceeds, the lump of lithium becomes smaller, decreasing the surface area of the lithium
- Fewer particles are exposed to collisions resulting in fewer collisions per second (between the lithium and acid particles)
- This results in fewer effective collisions per second
- Leading to a decreasing reaction rate.

3.3

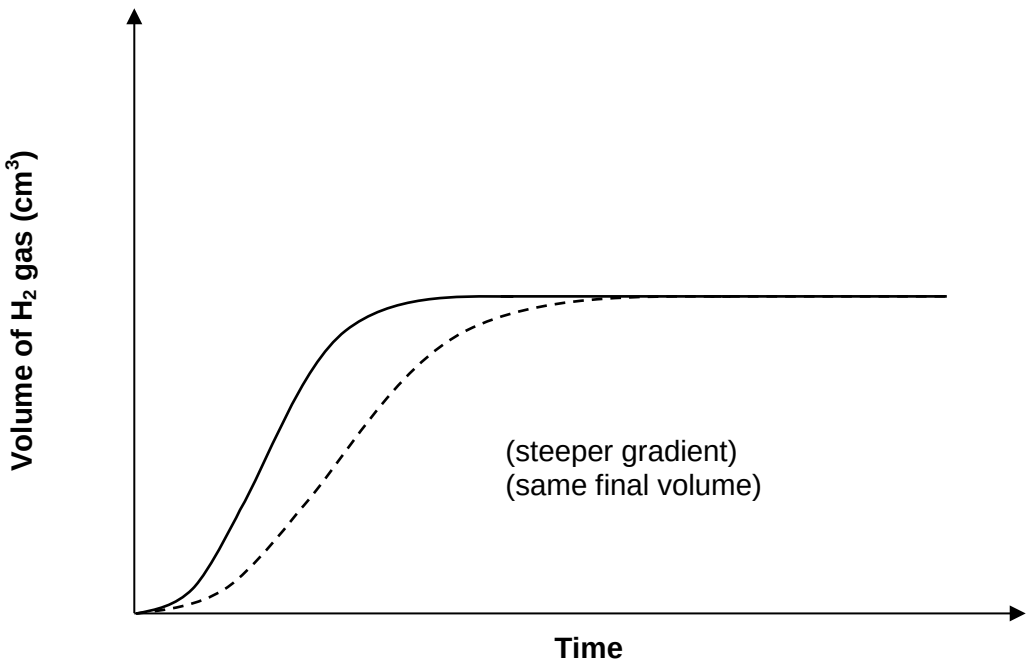


3.4 **2,5** (± 0,1 from their graph) **× 10^{-4} mol·dm^{-3}** (c.o.e from graph)

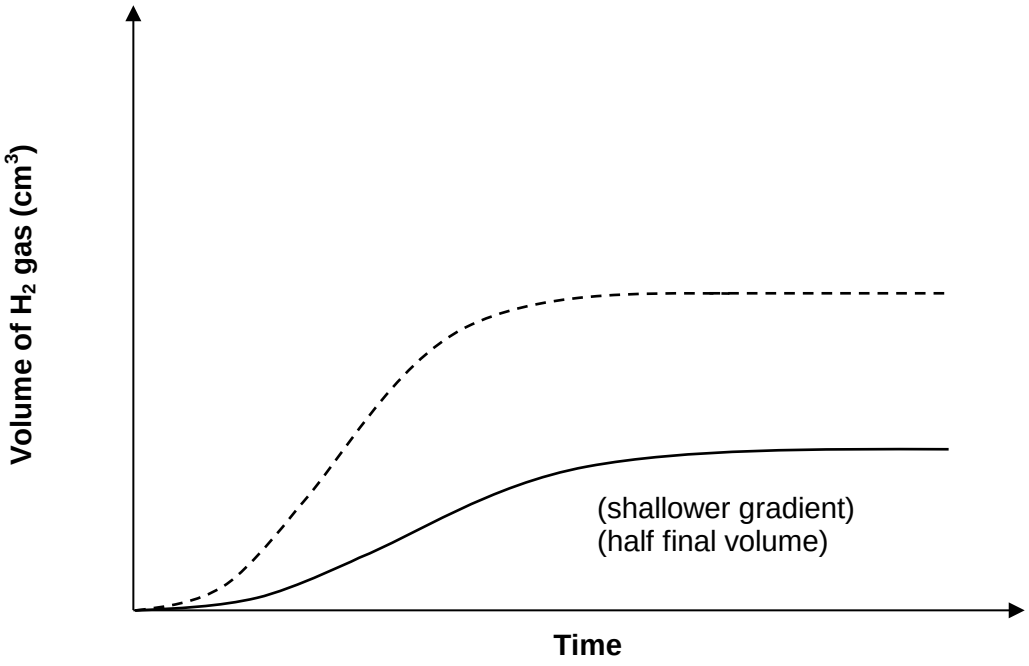
3.5 3.5.1

- $n(Li) = \frac{m}{M} = \frac{(1,8)}{(7)} = 0,2571$ mol
- $n(H_2) = (0,2571) \times \frac{1}{2} = 0,1286$ mol
- $V(H_2) = nV_m = (0,1286)(22,4) = 2,88$ dm^3 2 880 **cm^3**

3.5.2


Volume of H_2 gas (cm^3)
(steeper gradient)
(same final volume)
Time

3.5.3


Volume of H_2 gas (cm^3)
(shallower gradient)
(half final volume)
Time

QUESTION 4 CHEMICAL EQUILIBRIUM

4.1 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**.

4.2
- Stress: increase in pressure
- Le Châtelier's principle predicts the system will respond in order to decrease the pressure
- Thus, the reverse reaction is initially favoured
- as it produces fewer moles of gas
- increasing the amount of ozone

4.3 4.3.1 Reverse

4.3.2 Exothermic

4.3.3 Decrease

4.4
- The addition of a suitable catalyst increases both reaction rates equally
- Therefore, the equilibrium amount of oxygen remains the same

4.5 *Concentrations:*

Reaction	O_3	+	NO	⇌	O_2	+	NO_2
Initial	0,6		0,9		0,73		0,55
Change	−0,54		−0,54		+0,54		+0,54
Equilibrium	0,06		0,36		1,27		1,09

OR

Moles:

Reaction	O_3	+	NO	⇌	O_2	+	NO_2
Initial	1,2		1,8		1,46		1,10
Change	−1,08		−1,08		+1,08		+1,08
Equilibrium	0,12		0,72		2,54		2,18
Concentrations	0,06		0,36		1,27		1,09

$$K_c = \frac{[O_2][NO_2]}{[O_3][NO]}$$

$$K_c = \frac{[1,27][1,09]}{[0,06][0,36]}$$ (substitution of concentrations)

K_c = **64,09** (Range of values accepted: 64,0 – 64,2)

4.6 4.6.1 Increase

4.6.2 No effect

4.6.3 Increase

4.6.4 Decrease

QUESTION 5 ACIDS AND BASES

5.1 5.1.1 A proton acceptor.

5.1.2 A base that dissociates (almost) completely in solution.

5.1.3

$m = cMV$	**OR**	$n = cV$	$m = nM$ (both equations)
$m = (0{,}1)(122)(0{,}25)$		$n = (0{,}1)(0{,}25)$	$m = (0{,}025)(122)$
$\boldsymbol{m} = 3{,}05$ **g**		$n = 0{,}025$ mol	$\boldsymbol{m} = 3{,}05$ **g**

5.1.4 **0,2 mol·dm^{-3}** (only 1 mark given for 0,1 mol·dm^{-3} – this shows understanding that the base is strong)

5.1.5 $K_w = [H_3O^+][OH^-]$

$(10^{-14}) = [H_3O^+](0{,}2)$ {coe from 5.1.4}

$[H_3O^+] = 5 \times 10^{-14}$ mol · dm^{-3}

5.2 5.2.1 To see the colour change (of the indicator) clearly

5.2.2 $Sr_3(PO_4)_2$

5.2.3 $3Sr(OH)_2 + 2H_3PO_4 \rightarrow Sr_3(PO_4)_2 + 3H_2O$ left right balancing {coe from 5.2.2}

5.2.4 $n = cV$

$n = (0{,}17)(0{,}01)$

$n = 0{,}0017$ **mol**

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

5.2.6
- $n(acid) = 0{,}0017$ mol (coe from 5.2.4)
- $n(base) = (0{,}0017) \times \frac{3}{2} = 0{,}00255$ mol (coe mole ratio from 5.2.3)
- $V(base) = \frac{n}{c} = \frac{(0{,}00255)}{(0{,}1)} = 2{,}55 \times 10^{-2}$ **dm^3**

5.3 5.3.1 Acid

5.3.2 Weak

5.3.3 Colourless

5.3.4
- Stress: increase in concentration of H_3O^+ ions
- Le Châtelier's principle predicts the system will respond in order to decrease the concentration of H_3O^+ ions
- Thus, the reverse reaction is favoured
- as it consumes H_3O^+ ions
- Increasing the amount (concentration) of HIn and decreasing the amount (concentration) of In^-
- Resulting in the colourless solution

QUESTION 6 ELECTROCHEMISTRY

6.1 Platinum (1 mark only for Sn^{4+})

6.2 $E^0_{cell} = E^0_{cathode} - E^0_{anode}$

$E^0_{cell} = (+0{,}15) - (-0{,}28)$

$E^0_{cell} = 0{,}43$ **V**

6.3
- It completes the circuit
- and maintains electrical neutrality.

6.4 Co(s) | Co^{2+}(aq) || Sn^{4+}(aq), Sn^{2+}(aq) | Pt(s)

6.5 6.5.1 $Co \rightarrow Co^{2+} + 2e^-$

6.5.2 Decrease

6.5.3 $n = \frac{m}{M}$

$n = \frac{(8{,}85)}{(59)}$

$n = 0{,}15$ **mol**

6.5.4 $\Delta t = \frac{Q}{I}$

$\Delta t = \frac{(28\,950)}{(4{,}43)}$

$\Delta t = 6\,534{,}99$ **s**

6.5.5 Shorter/wider/more conductive salt bridge
OR use a more concentrated Sn^{4+} solution
OR use higher surface area electrodes

QUESTION 7 ELECTROCHEMISTRY

7.1 Electrolytic

7.2 The electrode where oxidation takes place.

7.3 P

7.4 The pure copper deposited would then have to be removed from the graphite (extra separation step)

7.5 (Pure) copper

7.6 It increases the conductivity of the solution (**OR** increases the rate of the reaction)

7.7 $Cu^{2+} + 2e^{-} \rightarrow Cu$

7.8 7.8.1
- Although Zn is oxidised at the anode to form Zn^{2+}
- Zn^{2+} is a much weaker oxidising agent than the Cu^{2+} in the solution
- And so it is not reduced at the cathode

7.8.2
- The Au is not oxidised at the anode
- but falls off the anode (to form the anode sludge)

7.8.3 $\left(\% \ purity = \frac{pure\,mass}{impure\,mass} \times 100\right)$

$$\% \ purity = \frac{(32{,}55)}{(33)} \times 100$$

$$\% \ purity = 98{,}64 \ \%$$

7.9 7.9.1 Zn

7.9.2 Any **metal above Cu** on the SEP table

7.9.3
- The [metal above] is a stronger reducing agent than Cu
- therefore it is more likely to be oxidized (hence the Cu^{2+} is reduced) OR it is able to reduce copper ions to copper metal

QUESTION 8 ORGANIC CHEMISTRY

8.1 8.1.1 An atom or group of atoms that form the centre of chemical activity in the molecule.

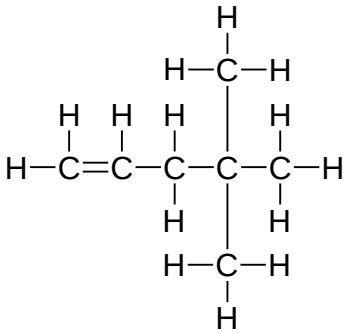
8.1.2 Hydroxyl (group)

8.1.3 4,4−dimethylpentan−1−ol
4,4
dimethyl
pentan
1−ol

8.2 8.2.1 (A series of similar compounds which have) the same functional group and have the same general formula, in which each member differs from the previous one by a single CH_2 unit.

8.2.2 Alkenes

8.2.3



Double bond in correct place
Rest of structure correct

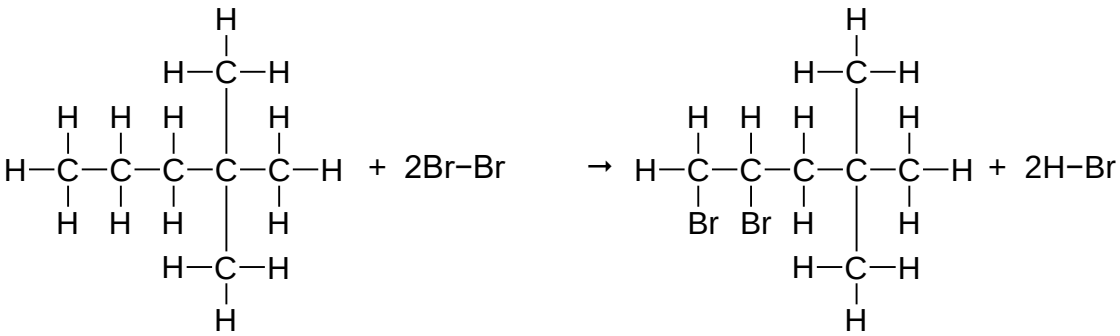
8.3 8.3.1 Halogenation/bromination

8.3.2 $CH_2CHCH_2C(CH_3)_2CH_3 + Br_2 \rightarrow CH_2BrCHBrCH_2C(CH_3)_2CH_3$

8.4 8.4.1 Elimination (dehydration)

8.4.2 Esters

8.5



{Inorganic compounds do not have to be structural, i.e. Br_2 and HBr will be accepted}

8.6 $2C_7H_{16}O + 21O_2 \rightarrow 14CO_2 + 16H_2O$ (products) (balancing)

8.7 $CH_2{=}CH{-}CH_2{-}CH_2{-}CH_2{-}CH_2{-}CH_3$

OR

$CH_2CHCH_2CH_2CH_2CH_2CH_3$

OR

$CH_2CH(CH_2)_4CH_3$

8.8 8.8.1 Addition (hydrogenation)

8.8.2 Alkanes

8.8.3 It speeds up the reaction (**OR** it provides an alternative pathway of lower activation energy **OR** it lowers the activation energy **OR** it breaks the bond between the hydrogen atoms in H_2)

Total: 200 marks

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