NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 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.

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

QUESTION 2

2.1 $n = \frac{m}{M}$

$n = \frac{(6,5)}{(27)}$

$n = 0,24$ mol

2.2 For Aℓ to be the limiting reagent, the amount of NaOH needed is:
n (*NaOH needed*) = (0,24) × $\frac{6}{2}$ = 0,72 mol

Amount of NaOH actually present: $n = cV$ = (2,6)(0,4) =1,04 mol

There is (more than) enough NaOH to fully react with the Aℓ

OR

Amount of NaOH present: $n = cV$ = (2,6)(0,4) =1,04 mol

IF NaOH were the limiting reagent, then the amount of Aℓ needed would be:
n(*A*l *needed*) = (1,04) × $\frac{2}{6}$ = 0,347 mol

There is not enough Aℓ to fully react with the NaOH

OR

Amount of NaOH present: $n = cV$ = (2,6)(0,4) =1,04 mol

Mole ratio of (Al) : n(NaOH) = 0,24 : 1,04 = 1 : 4,33

This is greater than the actual mole ratio of 1 : 3

OR

Amount of NaOH present: $n = cV$ = (2,6)(0,4) =1,04 mol
Maximum amount of H_2 produced by Aℓ = 0,24 × $\frac{3}{2}$ = 0,36 mol
Maximum amount of H_2 produced by NaOH = 1,04 × $\frac{3}{6}$ = 0,52 mol

OR

Maximum amount of $Na_3A\ell O_3$ produced by Aℓ = 0,24 × $\frac{3}{2}$ = 0,36 mol
Maximum amount of $Na_3A\ell O_3$ produced by NaOH = 1,04 × $\frac{3}{6}$ = 0,52 mol

NaOH would produce more product (if completely consumed), so must be in excess.

2.3 *Theoretical* $n(Na_3A\ell O_3) = (0,24) \times \frac{2}{2} = 0,24$ mol

actual $n(Na_3A\ell O_3)$ = *theoretical* $n(Na_3A\ell O_3) \times 92\%$

actual $n(Na_3A\ell O_3) = (0,24) \times \frac{92}{100} = 0,2208$ mol

$c = \frac{n}{V} = \frac{(0,2208)}{(0,4)} = 0,55 \text{ mol·dm}^{-3}$

2.4 2.4.1 A reaction that transforms chemical potential energy into thermal energy.

2.4.2 The energy released is greater than the energy absorbed.

2.5 2.5.1 The sum of the kinetic energy (of the reacting particles) is more than the activation energy.

2.5.2
- A decrease in concentration means that there are less (solute) particles per unit volume
- This results in fewer collisions (between reacting particles) per unit time
- Thus, there are fewer effective (or successful) collisions per unit time
- This results in a lower reaction rate

2.6 Remain the same

QUESTION 3

3.1
- As the hydrogen molecules approach each other (get close)
- there is a dispersion of the electrons in each hydrogen molecule
- resulting in induced dipoles forming
- which are then able to attract each other

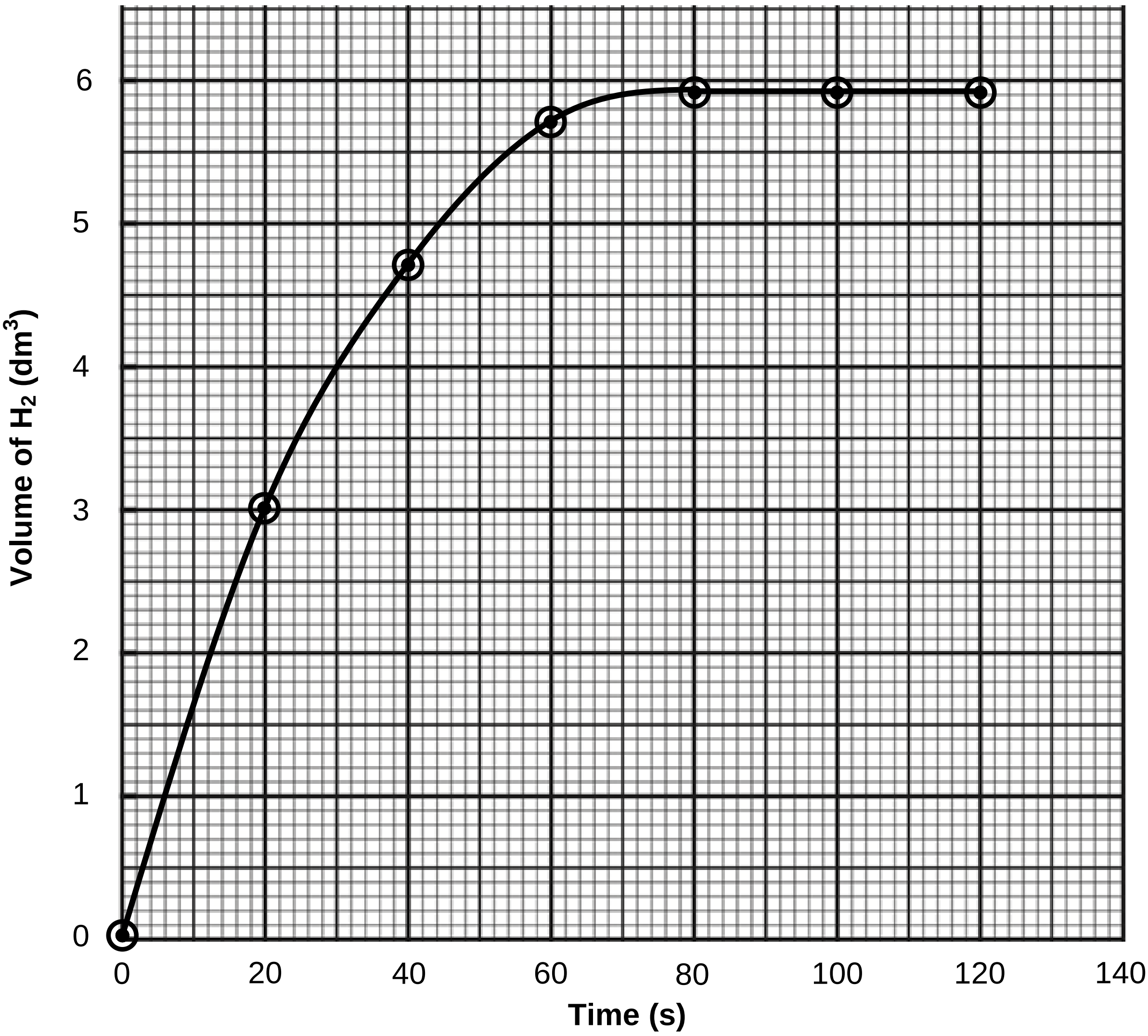
OR

- As a result of the random movement of electrons, a temporary (instantaneous) dipole is set up in one hydrogen molecule
- dispersing the electrons in the other (neighbouring) hydrogen molecule
- resulting in an induced dipole forming
- the two temporary dipoles are then able to attract each other

3.2 3.2.1 80 s

3.2.2 Rate = $\frac{\Delta V}{\Delta t} = \frac{(5,9)}{(80)}$ = 7,38 × 10^{-2} $dm^3 \cdot s^{-1}$

3.2.3 Graph showing relationship between volume (of hydrogen gas) and time



3.3 3S(s) + 6NaOH(aq) → Na_2SO_3(aq) + $2Na_2S$(s) + $3H_2O$(ℓ)

QUESTION 4

4.1 NO_2 was removed (concentration of NO_2 decreased)

4.2
- Stress: decrease in concentration of NO_2
- Le Châtelier's principle predicts the system will respond to counteract the stress and so increase the concentration of NO_2
- Thus, the forward reaction is (initially) favoured as it produces NO_2
- resulting in a decrease in the amount of reactants (NO and O_2) and an increase in the amounts of products (NO_2) as seen in the graph

4.3 The same

4.4 $$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$$

4.5 $$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$$

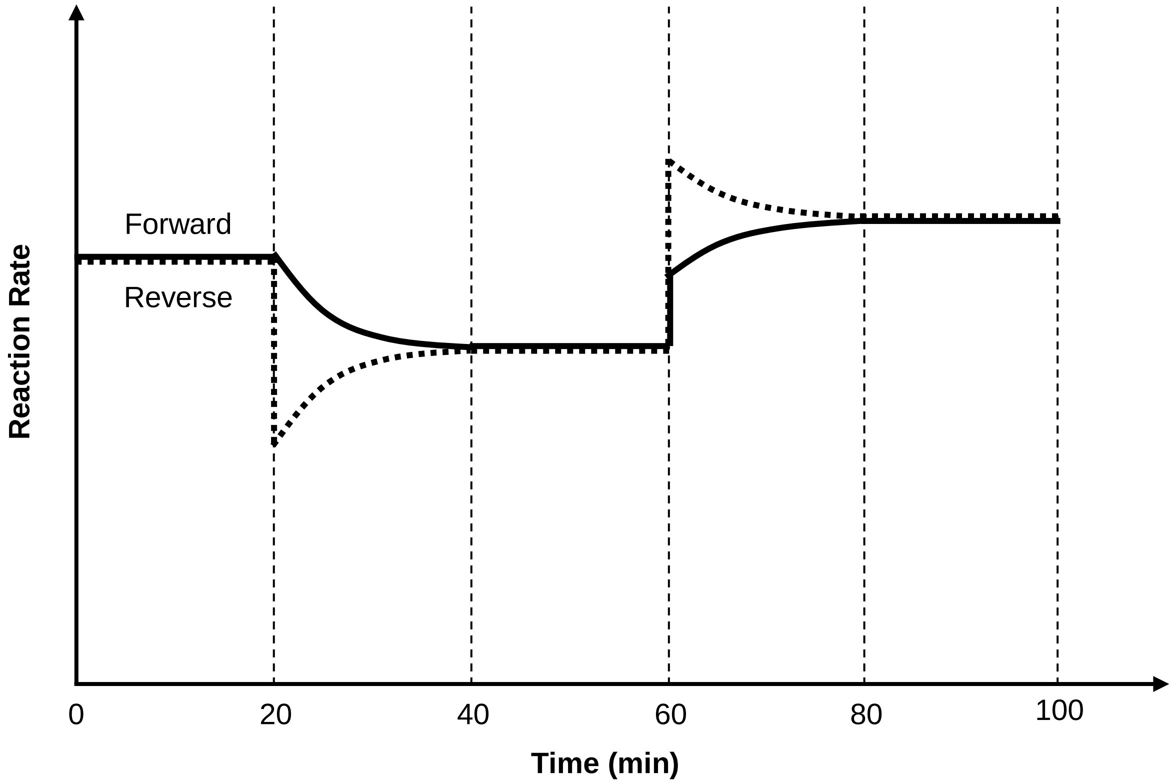
$$(256) = \frac{[\mathrm{NO_2}]^2}{\left(\frac{3}{3}\right)^2 \quad \left(\frac{5}{3}\right)}$$

$$[NO_2] = 20{,}6559$$

$$n(NO_2) = cV = (20{,}6559)(3) = \mathbf{61{,}97\,mol}$$

4.6
- Stress: increase in temperature
- Le Châtelier's principle predicts the system will respond to counteract the stress and so decrease the temperature
- Thus, the endothermic reaction is favoured as it consumes heat
- From the graph, we see that there is an increase in the amount of reactants (NO and O_2) and a decrease in the amount of products (NO_2)
- Thus, the reverse reaction has been favoured
- Therefore, the reverse reaction is endothermic

4.7



4.8 A bond that occurs between atoms within molecules.

4.9 Nonpolar (pure) covalent

QUESTION 5

5.1 It dissociates completely.

5.2 A solution of known concentration.

5.3 $n = cV$
$n = (0,12)(0,4)$
$n = 0,048$ mol

5.4 Endothermic as the value of K_w is greater than 10^{-14}.

5.5 $K_w = [H_3O^+][OH^-]$
$(1,44 \times 10^{-14}) = [H_3O^+](0,24)$
$[H_3O^+] = 6 \times 10^{-14}$ mol·dm^{-3}

5.6 Weak

5.7 ZF_2

5.8 The reaction of an ion with water.

5.9 $F^- + H_2O \rightleftharpoons HF + OH^-$

5.10 Alizarin yellow

QUESTION 6

6.1 Salt bridge

6.2 Any TWO of the following:
Temperature of 25 °C
1 mol·dm^{-3} concentration of Sn^{2+} solution
1 mol·dm^{-3} concentration of Sn^{4+} solution

6.3 Any ONE of the following:
It is inert
It is solid
It is conductive

6.4 The electrode where reduction takes place.

6.5 Pt

6.6 $Sn^{4+} + 2e^{-} \rightarrow Sn^{2+}$

6.7 A substance that donates electrons.

6.8 Zn

6.9 $E^{0}_{cell} = E^{0}_{cathode} - E^{0}_{anode}$

$E^{0}_{cell} = (+0,15) - (-0,76)$

$E^{0}_{cell} = 0,91\ V$

6.10 Decreases

6.11 6.11.1 Electroplating

6.11.2 Cathode

6.11.3
- Ag^{+} is a much stronger oxidising agent than water
- meaning Ag^{+} will be reduced predominantly

6.11.4 Silver

6.11.5
- Electrode X is a metal with positive kernels and delocalised electrons
- These delocalised electrons are free to move and thus conduct electricity

6.11.6 $Q = It$

$Q = (3,2)(6 \times 3600)$

$Q = 69\ 120$ C

6.11.7 $n_{e^-} = \frac{Q}{F}$

$n_{e^-} = \frac{(69120)}{(96500)}$

$n_{e^-} = 0{,}72$ mol

6.11.8
- $n_{Ag} = n_{e^-} = 0{,}72$ mol
- $m_{Ag} = nM = (0{,}72)(108) = 77{,}76$ g

QUESTION 7

7.1 A concentrated aqueous solution of sodium chloride (NaCℓ).

7.2 Q

7.3 7.3.1 $2C\ell^- \rightarrow C\ell_2 + 2e^-$

7.3.2
- H_2O has a more negative electrode potential than $C\ell^-$ (OR H_2O is a stronger reducing agent than $C\ell^-$)
- Therefore, H_2O would be more likely to be oxidised under standard conditions
- However, the high concentration of $C\ell^-$ ions increases the rate of its oxidation (OR makes its electrode potential more negative), making the oxidation of $C\ell^-$ predominant

7.3.3 Oxygen / O_2

7.4
- A membrane does not allow $C\ell^-$ ions to pass through and so the NaOH solution will NOT be contaminated with $C\ell^-$/NaCℓ.

  OR
- A diaphragm does allow $C\ell^-$ ions to pass through and so the NaOH solution will be contaminated with $C\ell^-$/NaCℓ.

7.5 7.5.1 H_2

7.5.2 Increase the surface area

7.6
- Both chorine and hydrogen have London forces only
- Chlorine has more electrons
- producing larger temporary dipoles
- Therefore, chlorine has stronger London forces
- resulting in more energy required to overcome the intermolecular forces and separate the particles in chlorine
- thus, chlorine has a higher boiling point

QUESTION 8

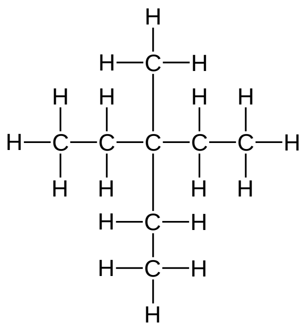
8.1 A series of similar compounds that have the same functional group and have the same general formula, in which each member differs from the previous one by a single CH_2 unit.

8.2 C_nH_{2n+2}

8.3 Alkenes

8.4 Saturated

8.5



8.6 Double carbon-carbon bond

8.7 3−methylhexa−1,3−diene

8.8 Alkanes

QUESTION 9

9.1 9.1.1 Substitution

9.1.2 Addition

9.2 9.2.1 Dehydrohalogenation

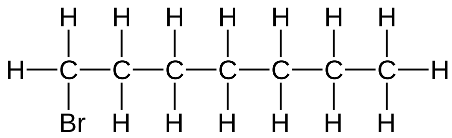
9.2.2 Hydration

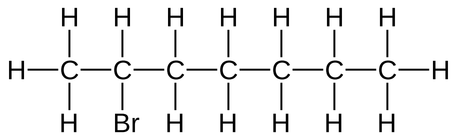
9.3 Heptan−2−ol

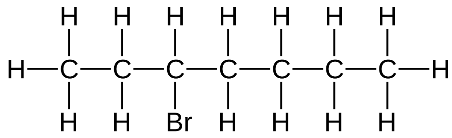
9.4 9.4.1 C_7H_{16}

9.4.2 C_3H_6

9.5 Any one of the following:

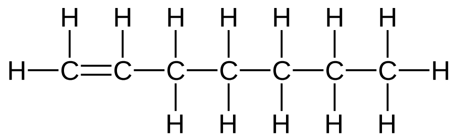




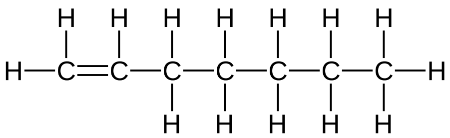


9.6 This question is marked in relation to Q9.5.

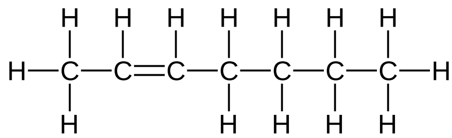
If Q9.5 is 1−bromoheptane, then:



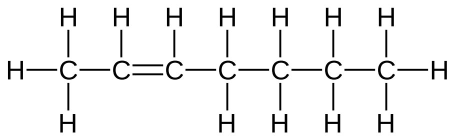
If Q9.5 is 2−bromoheptane, then:



OR



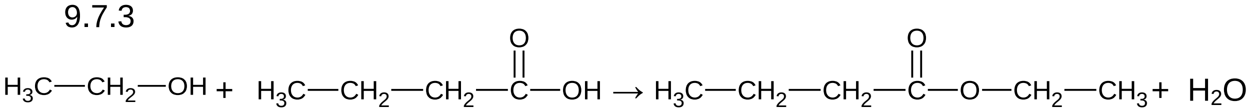
If Q9.5 is 3−bromoheptane, then:



9.7 9.7.1 $C_2H_6O + 3O_2 \rightarrow 2CO_2 + 3H_2O$

9.7.2
- The alcohol/carboxylic acid/ester is flammable
- The water bath allows for gentle heating

9.7.3



OR

$CH_3CH_2OH + CH_3CH_2CH_2COOH \rightarrow CH_3CH_2CH_2COOCH_2CH_3 + H_2O$

OR

$CH_3CH_2OH + CH_3(CH_2)_2COOH \rightarrow CH_3(CH_2)_2COOCH_2CH_3 + H_2O$

9.7.4 Ethyl butanoate

9.7.5
- Dehydrating agent
- (Acid) catalyst

Total: 200 marks