NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2013

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

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

[10 × 2 = 20]

QUESTION 2

2.1 2.1.1 **Hypothesis** – Catalyst A will decompose hydrogen peroxide faster than Catalyst B.
(Any reasonable answer **as a statement - There must be a relationship between two variables)**

Alternatives : " Catalyst A will produce oxygen faster (at a faster rate) than catalyst B"

2.1.2 **Investigative question** – which of the two catalysts, A or B, will decompose hydrogen peroxide faster?
(Any reasonable answer **as a question**) (4)

1 mark for it in question format
1 mark for correct variables used in the question

2.2 The variable that is changed in a controlled way during the experiment by the experimenter. (2)

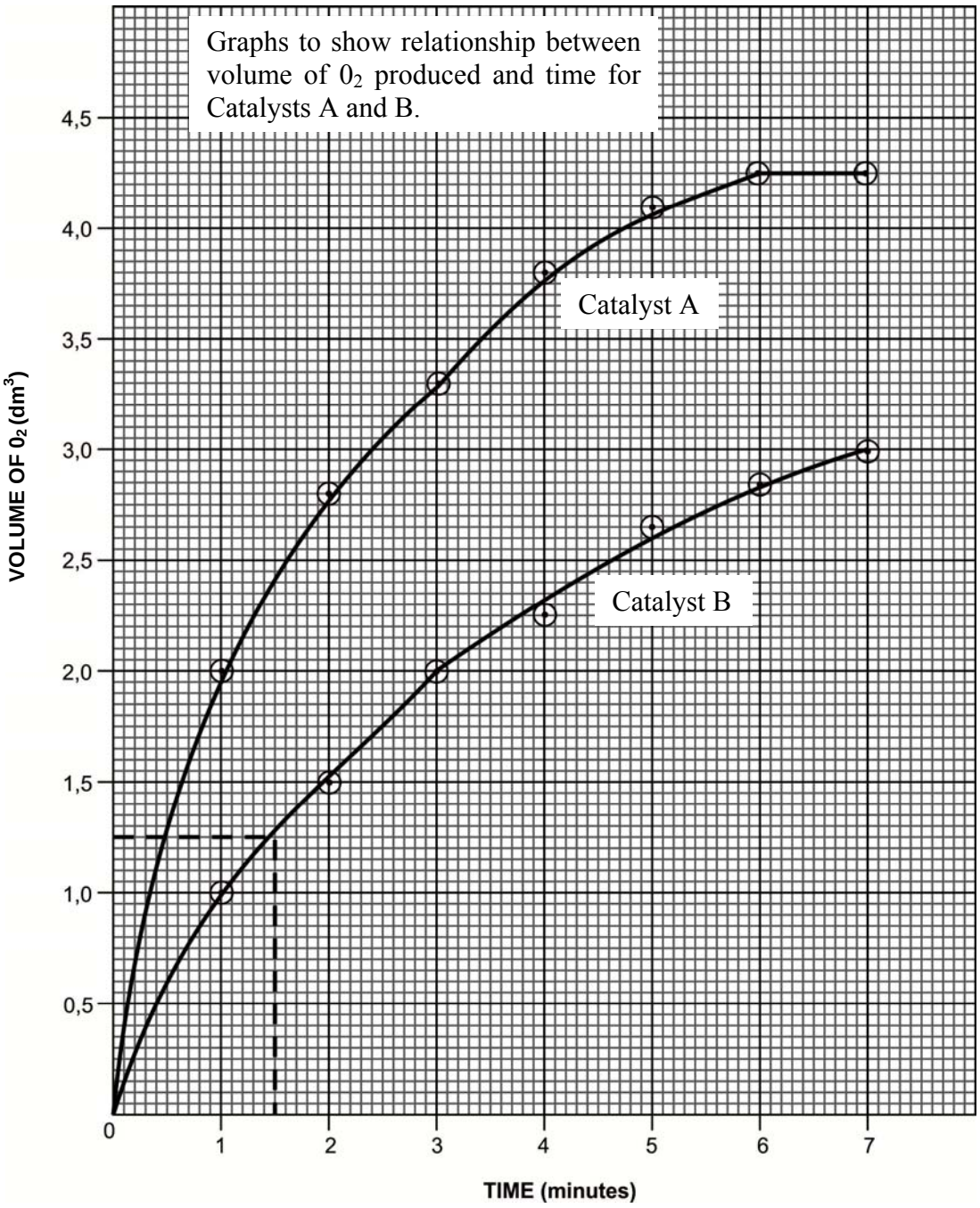
Alternative : A manipulated variable which does not depend on the outcome variable

DO NOT ACCEPT – variable that is controlled in the experiment

2.3 This is the variable that is being measured in the experiment. (2)

Can accept : volume of oxygen produced is dependent on the efficiency of the catalyst

2.4



Description	Mark allocated
Heading	**Full description between at least two variables** (1)
Axes labelled with units	(1)
Scale correct on both axes	(Half page) (1)
Points plotted correctly	• All points plotted correctly for both (2) • Points incorrect (1 – 2) (1) • More than 2 points incorrect (0)
Line of best fit	Correct smooth shape for both graphs (2) **Do not accept "dot to dot"** **Must check that line of best fit for catalyst A joins the last two points or -1**

(7)

If axes are swapped around – max 4 out of 7

2.5 Rate = gradient

$$= \frac{\Delta \text{volume}}{\Delta \text{time}}$$

$$= \frac{1,25 - 0}{1,5 - 0}$$

Rate = $\underline{0,83\ dm^3 \cdot min^{-1}}$ (3)

2.6 4,2 dm^3

- Same number of moles (amount) of H_2O_2 (g) being converted to O_2 (g) – only slower. (3)
- **Alternative – same amount of reactant used in both experiments**

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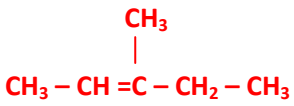
QUESTION 3

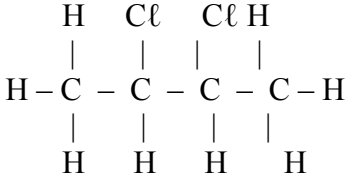
3.1 3.1.1 These are carbon based side branches attached to the main carbon chain. (hydrocarbon side branches obeying the general formula (C_nH_{2n+1})) (2)

3.1.2 Organic compounds consisting of C and H atoms only and have only single bonds to the C atoms in the chain. (All four bonds to the C in chain singularly occupied) (2)

3.2 3.2.1 $CH_3\ CHC(CH_3)\ CH_2\ CH_3$ (2)



3.2.3



1 mark for Cl in correct position

1 mark for correct chain and structure (2)

3.3 3.3.1 B **If B with another letter …… 1 mark only** (2)

3.3.2 D and G (2)

3.3.3 A, E and F (any two) (2)

If other letters used , mark only the first two

3.3.4 Haloalkanes (alkyl halides) **halogenoalkanes** (1)

3.3.5 $CH_3CH_2CH_2CH_2CH_3$ Pentane
$CH_3C(CH_3)_2CH_3$ 2,2 – dimethylpropane (4)

3.3.6 E – Has – OH which causes hydrogen bonding intermolecular forces between molecules

A – Is polar causing dipole – dipole intermolecular forces between molecules which are not as strong as hydrogen bonds. (4)

1 mark : E has H- bonding intermolecular forces
1 mark : A has dipole-dipole/van der Waals/Keesom IM forces
1 mark : stating that H-bonding stronger than dipole-dipole
1 mark : more energy needed to overcome IM forces between molecules E

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QUESTION 4

4.1 4.1.1 I Substitution **bromination halogenation**
II Elimination **dehydration**
III Esterification/Elimination
IV Combustion (4)

4.1.2 (a) Propyl ethanoate (2)
(b) Ethanoic acid (2)
(c) Acting as a dehydrating agent the concentrated form must be used to allow rapid dehydration**(must have no water present to be more effective)** to produce the ester, thus speeding up the reaction giving it catalytic properties as well. **If dilute , water already present thus will not be as effective and reduce the rate at which reaction takes place** (4)

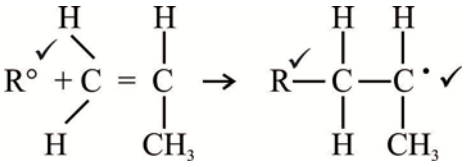
(d) Pentanoic acid (2)

4.2 4.2.1 This is a single **(small)** molecular unit that is repeated throughout the polymer structure (2)

4.2.2 Addition (1)

4.2.3 Initiation
Propagation
Termination (3)

4.2.4



(3)

4.2.5 Advantage – strong and durable, thus can last over long periods of time.
- **Can be recycled**
- **unreactive with oxygen and water**

Disadvantage – will not decompose naturally, thus a pollutant.
- weakened by UV rays (2)

4.2.6 1. Will clog landfill sites
2. Unsightly
3. Release hazardous gases into environment if burnt (CO_2 and CO)

Any two (4)
- **danger to animals**
- **unsightly litter**

QUESTION 5

5.1 In an isolated (closed) chemical system the rate of the forward reaction will equal the rate of the reverse reaction. (3)

Alternative : forward and reverse reaction continue to take place at equal rates

5.2

H_2	I_2
$n = \frac{m}{M}$	$n = \frac{m}{M}$
$= \frac{3,5}{2}$	$= \frac{635}{254}$
$= 1,75$ mol	$= 2,5$ mol

(4)

5.3 $2,5 - 1,45$ **carry over error**
$= 1,05$ mol (2)

5.4 5.4.1 $H_2 : I_2$
$1 : 1$ **can use H_2 : HI ratio of 1 : 2 to get 1,05mol**
$\therefore$ $1,05 : 1,05$
$n = 1,05$ mol of H_2 used (2)

5.4.2 H_2 left : $1,75 - 1,05$ **carry over error**
$= 0,7$ mol (2)

5.5

H_2	I_2	HI
$c = \frac{n}{v}$ **carry over error**	$c = \frac{n}{v}$	$c = \frac{n}{v}$
$= \frac{0,7}{1,5}$	$= \frac{1,45}{1,5}$	$= \frac{2,1}{1,5}$
$= 0,466$ mol·dm^{-3}	$= 0,966$ mol·dm^{-3}	$= 1,4$ mol·dm^{-3}

(4)

5.6 $K_c = \frac{[HI]^2}{[H_2][I_2]}$ **carry over error if K_c used correctly with incorrect values from above**

$= \frac{(1,4)^2}{(0,466)(0,966)}$

$K_c = 4,35$ (3)

5.7
- Increase in temperature will cause forward reaction to be favoured.
- Will increase amount of HI and decrease the amount of H_2 and I_2.
- Kc will thus increase. (3)

Alternative : Increase in temp will cause endothermic reaction to be favoured

5.8
- Increasing volume will decrease pressure in the system.
- Total molar volumes of both reactant and product the same.
- Change in pressure will thus have no effect on equilibrium hence statement is inaccurate. (3)

Alternative : rate of both forward and reverse reactions will decrease

rate of reverse reaction will decrease but rate of forward reaction will decrease equally

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QUESTION 6

6.1 6.1.1 Temperature 25 °C **298 K**
Concentration of electrolyte = 1 mol·dm^{-3}
Pressure of H_2 gas = 1 atmosphere (101,3 kPa) **(1,013 x 10^5 Pa)** (3)

6.1.2 It is used as the reference electrode to which all other half cell potentials are compared. (2)

6.1.3 (a)
- Platinum
- It is an inert **(unreactive)** metal and will not become electrochemically involved in the reaction. (2)

(b) Fe/Fe^{2+} has E^{θ} = –0,44 V
Meaning Fe is a stronger reducing agent than **(Fe has a more negative reduction potential)** H_2 thus hydrogen electrode will be the cathode (3)

6.1.4 **Anode** – oxidation of metal electrode **increases cation concentration**.
Cathode – reduction of cations in electrolyte **reduces cation concentration**.
Salt bridge will act as an 'ion pump' by moving anions and cations from salt bridge into half cells to balance out ionic charges. (3)
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QUESTION 7

7.1 Alumina (1)

7.2
- Lowers melting point. **lowers the working temperature of the cell**
- Less energy needs to be consumed.
- Less demand on power grid means less coal burned (less CO_2/SO_2 emissions) (3)

7.3 Cathode : $A\ell^{3+} + 3e^- \longrightarrow A\ell$ **- 1 mark if double arrows used** (2)

7.4 O_2 reacts with the carbon electrodes to form CO_2. (2)
Accept : C + O_2 ~~CO_2~~

7.5 7.5.1 Energy = 17 000 × 3 600 000

$$= \frac{6{,}12 \times 10^{10}\ J}{1\ 000\ 000}$$

= 61 200 MJ (3)

7.5.2 (a) $n = \frac{m}{M_R}$ **- 1 mark for no conversion to grams**

$$= \frac{225\ 000}{12}$$

= 18 750 mol of C (3)

(b) $2A\ell_2O_3 + 3C \longrightarrow 4A\ell + 3CO_2$

C : Al

3 : 4

18 750 : n

n = 25 000 mol.

$m = n.M_R$

$= 25\ 000 \times 27$

$= 6{,}75 \times 10^5$ g

$$\frac{6{,}75 \times 10^5}{(1\ 000 \times 1\ 000)}$$

M = 0,675 tonnes of Al (4)

Alternative
C : Al
3 : 4
36g.mol^{-1} : 108g.mol^{-1}
225 000 : x

X = 6,75 x 10^5 g
X = 0,675 tonnes

7.6 (i) As bauxite is imported, ports offer easy transport to smelter.

(ii) Aluminium is exported – again ports offer easy transport to ships. (lower/minimal transport costs) (2)

Accept : reduction of pollution due to minimal transport

QUESTION 8

8.1 Primary cell – non rechargeable
Secondary cell – rechargeable (2)

8.2 Cd will act as anode – has a more negative E^{θ} value hence Cd is a better reducing agent and will favour oxidation.
NiO(OH) will act as cathode – has more positive E^{θ} value, hence NiO(OH) is a better oxidising agent – favour reduction. (4)

1 each for correct identification of cathode and anode
2 marks for correct reasoning on one or the other

8.3 $Cd + 2NiO(OH) + 2H_2O \longrightarrow Cd(OH)_2 + 2Ni(OH)_2$ **-1 for any double arrows**
(–1 for any error) (2)

8.4 Ni – Cd cell converts chemical energy to electrical energy. (2)
Accept : cell has a positive emf

8.5 8.5.1 The total amountof charge that a cell is able to deliver. (2)

Alternative : the ability of a battery to deliver a specific amount of current (electricity)over a specific amount of time

8.5.2 $V = \frac{W}{Q}$

$\therefore Q = \frac{W}{V}$

$= \frac{256\ 250}{1,25}$

$= \underline{205\ 000\ C}$

$Q = It$

$\therefore I = \frac{Q}{t}$

$= \frac{205\ 000}{100\ 800}$

$\underline{I = 2,03A}$ (4)

8.6 1. Made from toxic substances (heavy metals).

2. Expensive to produce thus to sell.

(Any two reasonable answers) (2)

Accept : can explode
Loose capacity fast
Relatively low cell capacity
Poor "memory"

[18]

QUESTION 9

9.1 Brine (1)

9.2 Asbestos (1)

9.3 Electrical energy to chemical energy. (2)

9.4 9.4.1 $2C\ell^- \longrightarrow C\ell_2 + 2e^-$ **-1 for double arrows over whole question** (2)

9.4.2 $2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$ (2)

9.4.3 $2C\ell^- + 2H_2O \longrightarrow C\ell_2 + H_2 + 2OH^-$ (2)

$2NaCl + 2H_2O \longrightarrow Cl_2 + H_2 + 2NaOH$

9.5 Creates a pressure gradient which allows Na^+ ions and unreacted $C\ell^-$ ions to migrate into cathode compartment. (3)

Prevents OH^- ions from flowing back into the anode compartment

9.6 Na^+ is a much weaker oxidising agent than H_2O. (2)

H_2O is a stronger oxidising agent than Na^+

9.7 9.7.1 **Fluoro polymer** – is ion selective thus will only allow Na^+ ions to migrate into cathode compartment.
Asbestos – non-ion selective (2)

9.7.2
- Asbestos is toxic to humans causing disease (asbestosis).
- Asbestos is carcinogenic causing cancer. (4)
- **(accept answers which may come from the Table used in Q9.8)**

9.8 Membrane cell
- Highest purity of NaOH produced.
- Least amount of H_2O used.
- Less energy consumed.

} any two (3)

9.9 $n = \frac{V}{Vo}$

$= \frac{11\,000}{22,4}$

$= 491,1$ mol of $C\ell_2$

$2C\ell^- \longrightarrow C\ell_2 + 2e^-$

1 : 2

$\therefore n_{e^-} = 491,1 \times 2$

$= 982,2$ mol of e^-

Amount of change for 1 mol e^- = 96 500 C·mol^{-1}

$\therefore Q = 96\,500 \times 982,2$

$= 94\,782\,300$ C

$Q = It$

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

$= \frac{94\,782\,300}{63\,000}$

$\underline{I = 1\,504,39\ A}$

OR

$Q = 982,2 \times 6,02 \times 10^{23} \times 1,6 \times 10^{-19}$

$Q = 94\,605\,504$ C

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

$= \frac{94\,605\,504}{63\,000}$

$I = \underline{1\,501,76\ A}$ (6)

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Total: 200 marks