NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2012

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	A	(2)	1.6	D	(2)
1.2	C	(2)	1.7	D	(2)
1.3	B	(2)	1.8	B	(2)
1.4	C	(2)	1.9	A	(2)
1.5	B or D	(2)	1.10	C	(2)

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QUESTION 2

2.1 2.1.1 The ability of carbon atoms to form chains (or rings). (2)
(Question removed from paper. 2 marks allocated to all learners)

2.1.2 A centre of reactivity in an organic molecule that determines that molecule's chemistry. (2)
A bond, atom or group of atoms that identifies to which Homologous Series a compound belongs and is responsible for the chemical reactivity of that compound

2.1.3 Process whereby monomers are joined together to form a chain. (2)
(increasing chain length /forming a larger chain)

2.2 2.2.1 Pent – 2 – ene (2-Pentene) (2)

2.2.2 2,4 – difluorohexane (absence of dashes – penalise once through question (2)

2.2.3 Propanoic acid (or methyl ethanoate/ethyl methanoate) (2)

2.3 2.3.1 A family/group of organic compounds identified by the same functional group and obey the same general formula. (Will accept any other reasonable answer on discussion at memo meeting.) (2)
(increasing by $–CH_2$ unit)

2.3.2 Butane
- Weak London/van der Waals forces of attraction between molecules.
- Little energy to overcome forces.

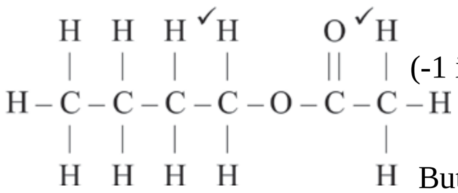
Butanol
- Strong hydrogen bonding forces of attraction between molecules.
- Greater energy needed to overcome forces.

- Identification of types of intermolecular forces in respective molecules .
- Comparison of strength of forces between molecules (4)
- State that more energy required to overcome forces

2.3.3 Butanol and isobutanol both have one – OH group, yet butanol has a longer unbranched chain , thus greater surface area due to larger electron density. Stronger force of attraction between molecules. (3)

2.4 2.4.1 I – addition/hydrochlorination/hydrohalogenation
II – substitution/hydrolysis
III – esterification/elimination/condensation
IV – elimination/dehydration (4)

2.4.2 (a)



(-1 if H's not represented)

Butyl ethanoate

(carry over error – 2 marks for name if wrong ester is drawn (4)

(b) Water (1)

(c)
- Act as catalyst (to speed up reaction).
- To act as dehydrating agent (remove H_2O). (2)

(d)
- Reagent flammable.
- Warm water bath will heat mixture without coming into contact with flame. (2)
- Controls heat to prevent alcohol from vapourising too quickly
- Warm water bath distributes the heat evenly (any two from above)

  also … (safety factor plus any one reason above)

2.4.3 (a) Alkenes (1)

(b) $CH_2 = CH – CH_2 – CH_3$ / $CH_2CHCH_2CH_3$
but-1-ene

$CH_3 – CH = CH – CH_3$ / $CH_3CHCHCH_3$
but-2-ene

$CH_2 = C (CH_3) – CH_3$ / $CH_2C(CH_3)CH_3$
(2) methyl propene (7)

2.4.4 (a) $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$ (2)
(1 mark for O_2 1 mark for balancing)

(b) $n = \frac{m}{M_R}$ $M_R = 56$ g.mol^{-1}

$n = \frac{14}{56}$ Carry over

$n = 0,25$ mol

mole ratio of $C_4H_8 : CO_2 = 1 : 4$

$\therefore$ 1,00 mol of CO_2 produced

$n = \frac{m}{M_R}$

$m = n.M_R$

$= 1,00 \times 44$

$m = 44$ g of CO_2 (4)

(if only the answer is put down showing no working = 1 mark only)

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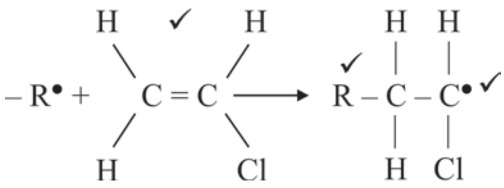
QUESTION 3

3.1 3.1.1 A molecular fragment with an unpaired electron. (2)

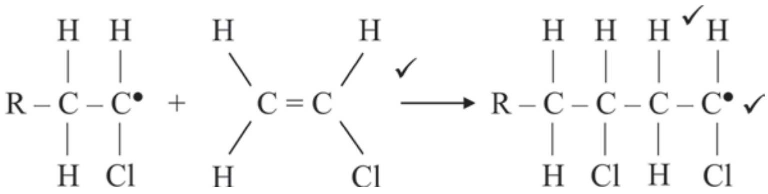
3.1.2 Propagation
Termination (2)

3.1.3



(3)

3.1.4



(3)

3.1.5 Any 2 possible practical and actual uses of PVC. (each) (4)

- Pipes
- Floor tiles
- Garden furniture
- Bottle top lids

[14]

QUESTION 4

4.1 A prediction of an outcome of an experiment. (2)
A prediction of the relationship between two variables

4.2
- As time of reaction progresses, the rate of loss of mass will decrease.
- As time increases, the rate of the reaction decreases.
- (Accept any hypothesis that is relevant to investigation) (1)
(if in a question or a personalised format = 0 marks)

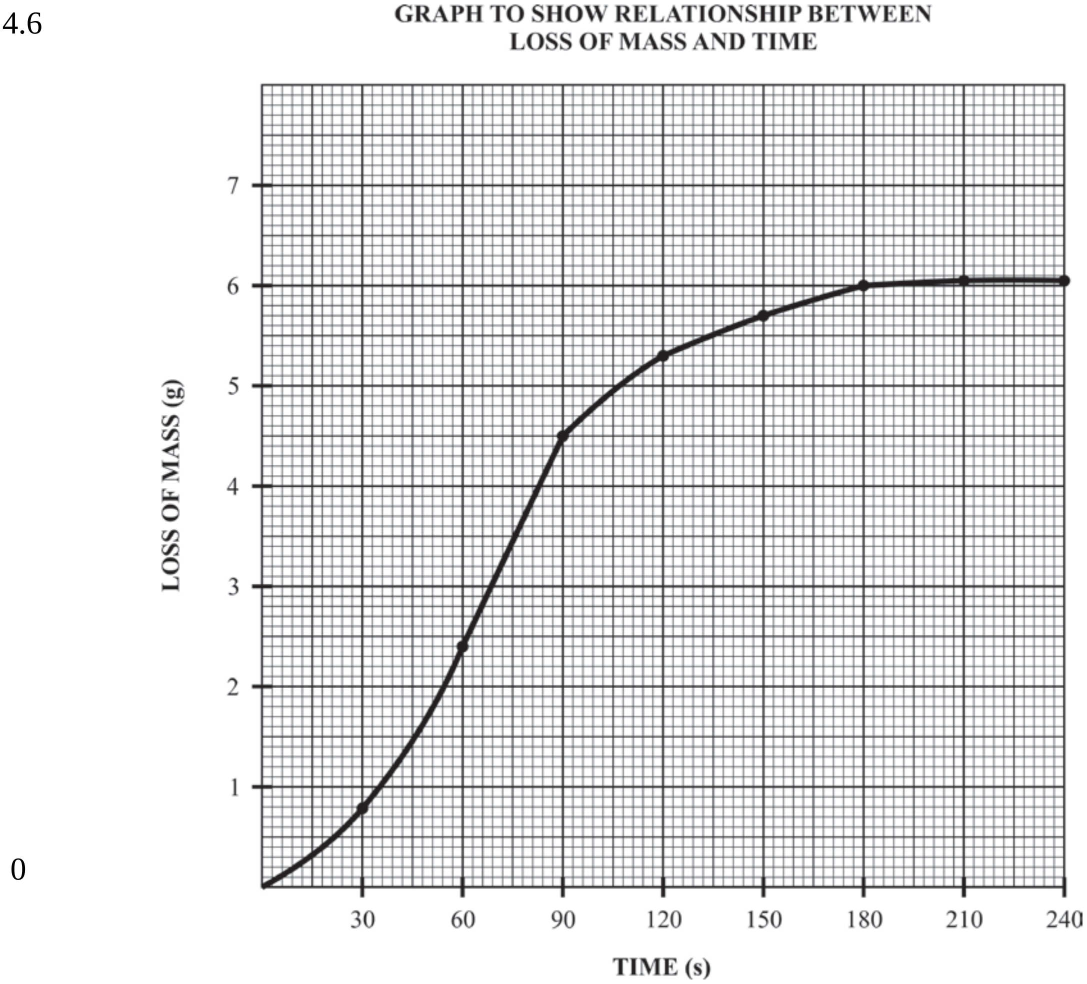
4.3 4.3.1 Independent variable – the variable that is changed or controlled by the experimenter.
Dependent variable – is the outcome variable that is produced as a result of the independent variable/the variable that depends on the change in the independent variable. (4)

4.3.2 Leonard – as the loss of mass is measured against the constant time intervals which are controlled by the experimenter. (2)

4.4 To prevent any loss of mass out of the flask due to splashing (spitting). (2)
Only allow for CO_2 to escape

4.5 Yes. Changing the timekeeper can change reaction/response times on the stopwatch. (2)
Keeping the variable of time controlled, keep it a fair test

4.6



Description	Mark allocated
Heading	Heading must be specific
Axes labeled with units	(1)
Scale correct on both axes	Half page minimum
Points plotted correctly	• All points plotted correctly (2) • 1 or 2 points plotted incorrectly (1) • More than 2 points plotted incorrectly (0)
Line of best fit	Correct shape between t = 0 and t = 60 (1) Correct shape between t = 60 and t = 240 (1)
Graph drawn on wrong axes = 4 marks (max)	

(7)

4.7 4.7.1 Increasing loss of mass due to:
- HCl being at a high concentration
- temperature in flask increases (exothermic reaction)
- the rate of reaction increases (3)

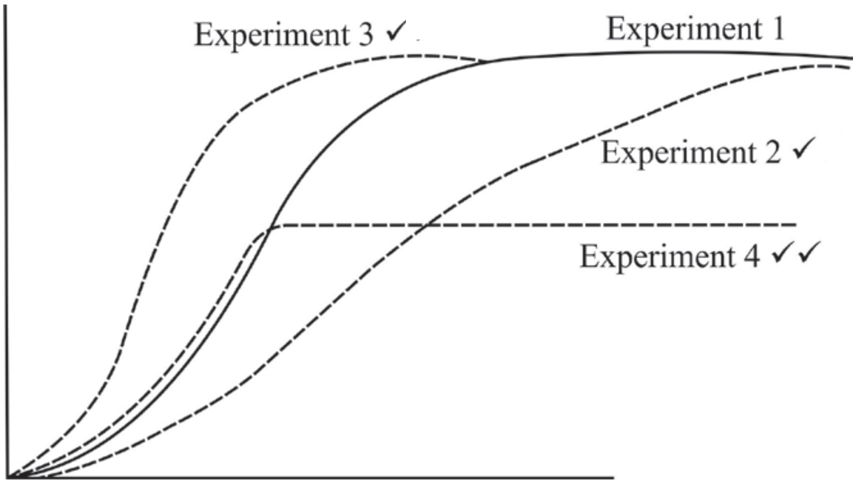
4.7.2 Reactants are being used up, the rate of reaction decreases. (2)

4.7.3 $CaCO_3$ being used up, thus no more product formed. (2)
Reaction has run to completion
reaction is over

4.8 4.8.1 The variable that does not change during the experiment. (2)

4.8.2 2: mass of $CaCO_3$/concentration of HCℓ
4: temperature/concentration of HCℓ (2)

4.8.3



1 mark for correct slope 1 mark for correct finish

(6)
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QUESTION 5

5.1 5.1.1 $0,4\text{mol}$ (no marks for a mass) (2)
(- 1 for no units)

5.1.2 $0,5-0,4$
$=0,1\text{mol}$ (2)
(carry over)

5.2 $C=\dfrac{n}{V}$

$=\dfrac{0,1}{0,4}$ ✓

$=0,25\ \text{mol}\bullet\text{dm}^{-3}$

$C=\dfrac{n}{V}$

$=\dfrac{0,2}{0,4}$

$=0,5\text{mol}\bullet\text{dm}^{-3}$ (3)

no conversion of volume = 1 mark max but check units
penalise only once for incorrect units (-1)
if expressed unit as mol.cm^{-3}

5.3 $K_c=\dfrac{[N_2O_4]}{[NO_2]^2}$ if use round brackets (-1)

$=\dfrac{0,5}{(0,25)^2}$ (carry over)

$K_c=8$ (3)

5.4 5.4.1 The gas mixture will become lighter/less red-brown.
(becomes colourless = 1 mark) (2)

5.4.2
- Decreasing volume will increase the pressure.
- Reaction will tend to favour reaction that reduced pressure, i.e. less number of moles.
- Reaction will thus favour forward reaction producing more N_2O_4.
- More product/N_2O_4(colourless) will reduce the intensity of the mixture colour. (4)

(If answer to Question 5.4.1 is 'darker', explanation in Question 5.4.2 must be consistent with that)(max 3 marks)

[16]

QUESTION 6

6.1 6.1.1 (a) A cell whereby chemical energy is converted into electrical energy. (2)

(b)
- Condition of electrolyte concentration of 1 mol·dm^{-3}.
- Temperature of 25 °C. (2)

(if pressure mentioned , -1 mark)

6.1.2

$$c = \frac{n}{V}$$
$$n = cV$$
$$= 1.0,275$$
$$= 0,275 \text{ mol}$$

$$n = \frac{m}{M_r} \qquad M_r(AgNO_3)$$
$$m = n.M_r \qquad = 108 + 14 + 48$$
$$= 0,275 \times 170 \quad = 170 \text{ g}\bullet\text{mol}^{-1}$$
$$m = 46,75 \text{ g}$$

OR

$$c = \frac{m}{M_r \bullet V}$$
$$m = c \bullet M_r \bullet V$$
$$= 1 \quad \times 170 \quad \times 0,275$$
$$= 46,75 \text{ g}$$

(4)

6.1.3 E^θ cell = E^θ cathode – E^θ anode
= 0,80 – (0,34)
= 0,46 V
Nothing – light bulb will not light up (3)

6.1.4
- To join/link $\frac{1}{2}$ cells together to form a circuit.
- To maintain neutrality in the half cells. (2)

6.1.5 Oxidation: $Cu \rightarrow Cu^{2+} + 2e^-$
Reduction : $Ag^+ + e^- \rightarrow Ag$
$Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$ (–1 for any errors) (3)

6.2 $Cr^{3+} + 3e^- \rightarrow Cr$ Thus 0,01 mol of Cr deposited will require 0,03 mol of electrons

METHOD 1
Total charge required to deposit
Cr = 0,03 × 96 500
= 2 895 C

Thus Q = IΔt

$$\Delta t = \frac{Q}{I} = \frac{2895}{0,8} = 3\ 618,75 \text{ s}$$

METHOD 2
OR $N_e = n \times N_A = 0,03 \times \underline{\mathbf{6,02 \times 10^{23}}}$
$= 1,806 \times 10^{22}$
$Q = 1,806 \times 10^{22} \times 1,6 \times 10^{-19}$
$= 2\ 889,60$ C

Thus $\Delta t = \frac{Q}{I} = \frac{2889,60}{0,8} = 3\ 612$ s (6)

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QUESTION 7

7.1 A concentrated solution of sodium chloride (2)
Saline solution
(salt solution = 1 mark
NaCl = 1 mark)
Seawater = 0 marks

7.2
- it is an ion selective membrane (if they say 'only permits ...', can get 2 marks as implies ion selective)
- Na^+ ions can now pass through it. (3)

7.3 $Na^+ + e^- \rightleftharpoons Na$

$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$

- H_2O is a stronger oxidising agent than Na^+ ions.
- Thus H_2O will be reduced in preference to Na^+. (3)

(can get 1 mark if just puts down the correct H_2O equation)

7.4

Chlorine	NaOH
• Water purification • Bleach • Production of PVC (impact)	• Soap + detergents • Drain cleaner • Production of paper (impact)

(4)

[12]

QUESTION 8

8.1 It is able to be recharged. (2)

8.2 Oxidation: $Pb + SO_4^{2-} \rightarrow PbSO_4$
Reduction: $PbO_2 + SO_4^{2-} + 4H^+ \rightarrow PbSO_4 + 2H_2O$

$Pb + PbO_2 + 2SO_4^{2-} + 4H^+ \rightarrow 2PbSO_4 + 2H_2O$
$(2H_2SO_4)$
(–1 for any error) (3)

8.3
- Conc. of H_2SO_4 will decrease.
- H_2SO_4 is being used up in the reaction to react with Pb to produce $PbSO_4$. (3)

8.4
- Conc. of H_2SO_4 will increase.
- Pb will be produced and plate at the negative electrode.
- PbO_2 is produced at the positive electrode.

Any 2 (2)

8.5 E^θ cell = E^θ cathode – E^θ anode
= 1,69 – (–0,36)
= 2,05V

Total = 6 × 2,05
= 12,3V (3)

8.6 Closer the plates – the less the internal resistance of the cell. (2)

8.7 8.7.1 The ability of a charged battery to deliver a specific amount of electrical charge./The total charge a battery can deliver. (2)

8.7.2 $V = \frac{W}{Q}$

$W = VQ$ and $Q = I\Delta t$ = 22,5 x ((60 x 60) x 2)

$= 12.\ 162\ 000$ $= 162\ 000\ C$

$W = 1\ 944\ 000\ J$

$\left(1,94 \times 10^6\ J\right)$

Can also use W = V. I . Δt

(4)

8.7.3 Total energy $= 1\ 944\ 000\ J$ and rate of transfer $= 21$ J per second

Thus time taken $= \frac{1\ 944\ 000}{21}$

$= 925\ 710\ s$

$\Delta t = 25$ hours 43 minutes (4)

8.8 **Negative effects**
- Toxicity of Pb poisons environment.
- Non-biodegradable casings (plastic).
- Sulphuric acid hazardous

Minimise
- Recycle the Pb and the plastic casings. (6)

[31]

Total: 200 marks