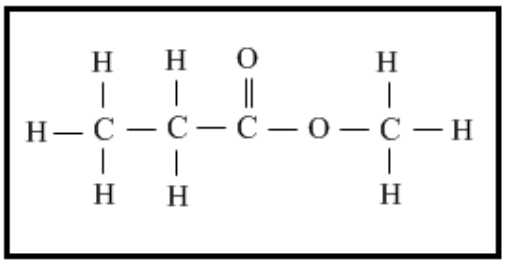
NATIONAL SENIOR CERTIFICATE EXAMINATION
EXEMPLAR 2008

PHYSICAL SCIENCES PAPER II

MARKING GUIDELINES

QUESTION 1

1.1 C_4H_6 ✓ (1)

1.2 $C_2H_5COOCH_3$ ✓  ✓ (2)

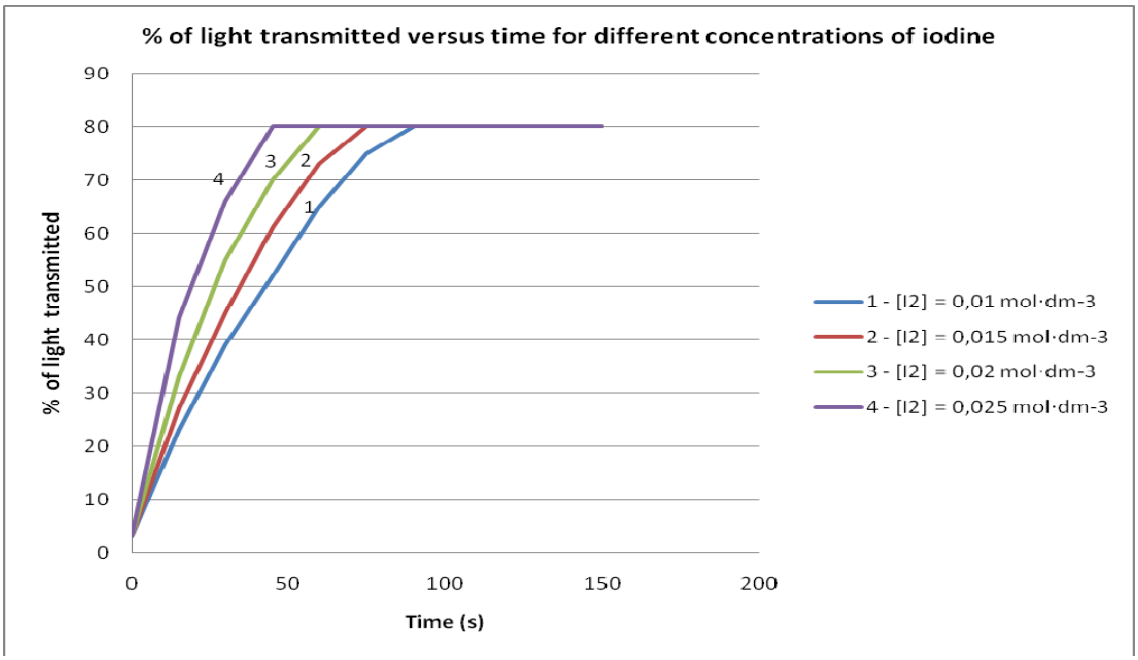
1.3 $C_3H_8 + HC\ell$ ✓ $\rightarrow$ $C_3H_7C\ell + H_2$ ✓ (2)

1.4 A hydrogen atom is substituted with an iodine atom in CH_3COCH_3 ✓ (1)

1.5 Does the concentration of iodine affect the rate of the reaction? ✓ (1)

1.6 If the temperature is changed the reaction rate will be affected. ✓ (1)

1.7 The concentration of propanone. ✓ (1)

1.8 

Appropriate heading ✓, X-axis correctly labelled ✓, Y-axis correctly labelled ✓
Table 1 plotted ✓, Table 2 plotted ✓, Table 3 plotted ✓, Table 4 plotted ✓,
Each graph correctly labelled ✓ (8)

1.9 The reaction reaches completion at the point when the reading on the colorimeter is 80%. ✓ (1)

1.10

Time taken to reach 80% transparency (s)	**Concentration of Iodine ($mol \cdot dm^{-3}$)**	**Rate $\frac{[I_2]}{t}$ (s^{-1})**
90	0,01	0,0001 ✓(row1 correct)
75	0,015	0,0002 ✓(row2 correct)
60	0,02	0,0003 ✓(row3 correct)
45	0,025	0,0006 ✓(row4 correct)

(4)

1.11 The reaction rate increase as the concentration of iodine increases. ✓ (1)

1.12 Higher concentrations of iodine contain more iodine molecules per unit volume. ✓
This increases the number of successful collisions between the iodine molecules and propanone molecules ✓ which results in an increased rate at which the products are formed. ✓ (3)

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QUESTION 2

2.1 Saturated hydrocarbons contain the maximum number of hydrogen atoms that can bond with the number of carbon atoms present. ✓ (1)

2.2.1 The term isomer refers to compounds with the same molecular formula but different structural formulae. ✓ (1)

2.2.2 e.g: $CH_3CH(CH_3)CH_2CH_2CH_2CH_2CH_3$ ✓ 2-methylheptane ✓
(there are a large number of **branched** possibilities) (2)

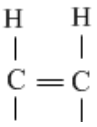
2.3 The boiling point increases as the number of carbon atoms increases. ✓ (1)

2.4 petrol: ±125 ^oC ✓
diesel: ±200 ^oC ✓ (2)

2.5 Larger alkane molecules contain more protons and electrons. ✓
The intermolecular forces between these molecules is therefore greater ✓ so more energy is required to overcome the intermolecular ✓ forces. (3)

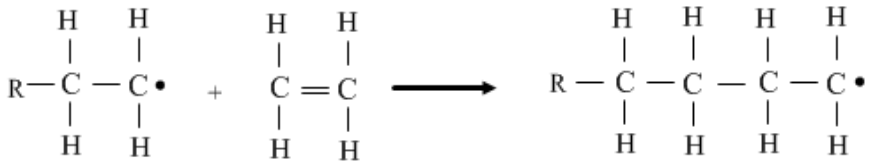
[10]

QUESTION 3A

3.1 

H H ✓ (1)

3.2 A free radical is a molecular fragment with an unpaired electron. ✓ (1)

3.3 

Free Radical ✓ Monomer Longer free radical ✓ (2)

3.4 Two free radicals can combine to form an alkane ✓ or a free radical can remove a hydrogen atom from another free radical to form an alkane and an alkene.✓ (2)

3.5 Thermoplastics are not brittle so they can resist shock.✓
Thermoplastics do not char or break down at higher temperatures.✓ (2)

3.6 LDPE is made up of branched polymer chains which prevents the close arrangement of the molecules. ✓
HDPE is made up of long straight-chain molecules which are able to pack together more closely giving HDPE a higher density and boiling point. ✓ (2)

3.7 Iron is a conductor of electricity, which would result in a short circuit.✓
Iron reacts with sulphuric acid. It will be dissolved by the sulphuric acid.✓ (2)

3.8 3.8.1 PP is the hardest polymer at 20 ^{o}C ✓ or any other suitable hypothesis (1)

3.8.2 Polymers become softer/ harder as their temperature increases/ decreases. ✓ (1)

3.9 3.9.1 The results support my hypothesis as PP got the smallest indentation at 20 ^{o}C. ✓ (1)

3.9.2 The results support my hypothesis as the indentations are deeper at higher temperature. ✓ (1)

3.10 The centre punch must always be dropped from the same height.✓
The polymer samples should all be the same thickness.✓ (2)

3.11 These addition polymers become softer as the temperature increases.✓ (1)

3.12 A car battery is subject to large temperature fluctuations due to engine heat and exposure to different weather conditions.✓ (1)

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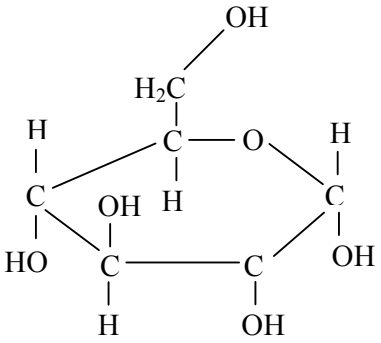
QUESTION 3B

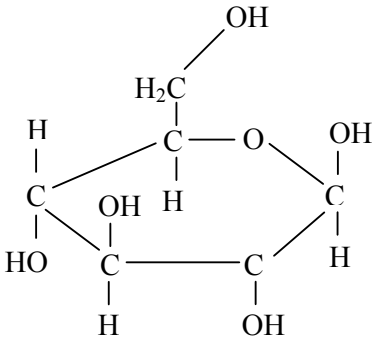
Carbohydrates include sugars and their polymers.

3.1 Photosynthesis. ✓ (1)

3.2



OR



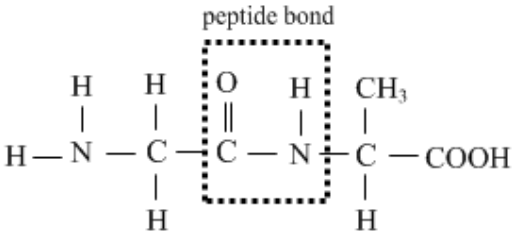
✓ring with correct atoms ✓all other atoms correct (2)

3.3 Cellulose ✓ – the major structural material in plants ✓ **or**
Starch ✓ – stored by plants for use as fuel ✓ (2)

3.4 Amino acids ✓ (1)

3.5 3.5.1 Gycine ✓ and Alanine ✓ (2)

3.5.2



✓✓ structure correct
✓ peptide bond labelled
(3)

3.5.3 Glycine and Alanine would most likely be on the inside ✓of the molecule, because they contain hydrophobic side chains ✓ (-H and $–CH_3$)✓ (3)

3.6 Unit 1 – Phosphate ✓
Unit 2 – Sugar ✓
Unit 3 – Nitrogen base ✓ (3)

3.7 The gene's information is encoded in the specific sequence of the four bases in the DNA which determines the characteristics of the person. ✓
The DNA ensures the genetic information is copied ✓ during cell division and then transmitted ✓ to the messenger RNA. (3)

[20]

QUESTION 4

4.1 Oxidation refers to the loss of electrons ✓ and occurs at the anode ✓ (2)

4.2 The electrolyte is the medium for the movement of ions between the electrodes of the battery ✓ (1)

4.3 The removable cap allows for the addition of electrolyte to the battery✓ (1)

4.4 $Pb(s) + PbO_2(s) + 2SO_4^{2-}(aq) + 4H^+(aq)$ ✓ $\rightarrow$ $2PbSO_4(s) + 2H_2O(\ell)$ ✓ (2)

4.5 $E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ ✓
$= 1,69 - (-0,36)$ ✓
$= 2,05$ V ✓ (3)

4.6 The battery is made up of 3 cells. ✓ $3 \times 2,05 = 6,15$ V ✓ (2)

4.7 A secondary cell is a cell that can be recharged by driving current through it. ✓

The $PbSO_4(s)$ formed on the anode during discharge is converted back to $PbO_2(s)$.✓
The $PbSO_4(s)$ on the cathode is removed and the density of the acid increases.✓ (3)

4.8 In the discharge process $PbSO_4(s)$ is formed on the plates. ✓
Hence the density of the electrolyte decreases as the discharge progresses ✓ and this becomes an indication of the state of the cell. (2)

4.9 Use lead acid batteries are hazardous because they contain lead which is highly toxic to fish, other animals and plants.✓
Lead acid batteries contain sulphuric acid which is corrosive.✓
Lead acid batteries have a plastic casing which contributes to pollution of the environment.✓
The lead acid batteries are collected and processed for lead recovery,✓ which requires less energy than refining the primary ore.✓
The plastic casing (usually PP or HDPE) can be sorted and easily recycled.✓ (6)

4.10 Lead acid batteries are used in cars✓
Leclanche cell used for torches, toys etc✓
Zinc/ air battery used in watches and hearing aids✓
Lithium-Ion battery used in cell phones and laptops✓
Or any other appropriate examples. (4)

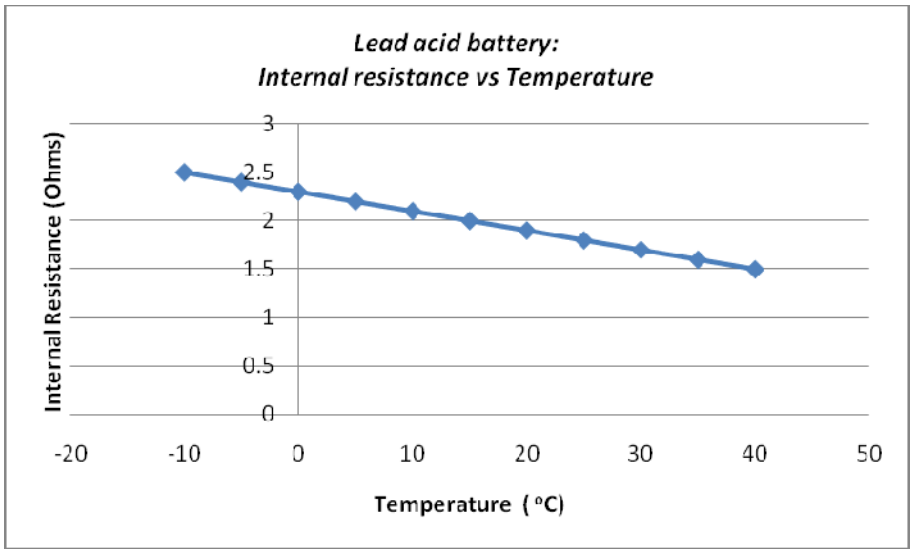
[26]

QUESTION 5

5.1 The internal resistance of the battery increases ✓as the temperature is increased ✓
or
The internal resistance of the battery decreases ✓as the temperature is increased ✓ (2)

5.2 Independent variable: temperature. ✓ (1)

5.3



✓ appropriate heading, ✓ independent variable on X-axis, ✓ X-axis labelled with unit, ✓ Y-axis labelled with unit, ✓✓ points correctly plotted with trend line. (6)

5.4 Between -10 °C and 40 °C ✓the internal resistance of the lead acid battery decreases (linearly) as the temperature increases. ✓ (2)

5.5 As the temperature decreases in colder weather the internal resistance of the battery becomes greater ✓ resulting in a decrease in the current delivered by the battery. ✓ (2)

5.6 The surface area of the electrodes. ✓
The concentration of the sulphuric acid electrolyte. ✓ (2)

5.7 5.7.1 $Q = It$ ✓
$= 25 \times 100 \times 60$
$= 150\ 000$ C ✓ (2)

5.7.2 $W = VQ$ ✓
$= 12 \times 150\ 000$
$= 1\ 800\ 000$ J ✓ (2)

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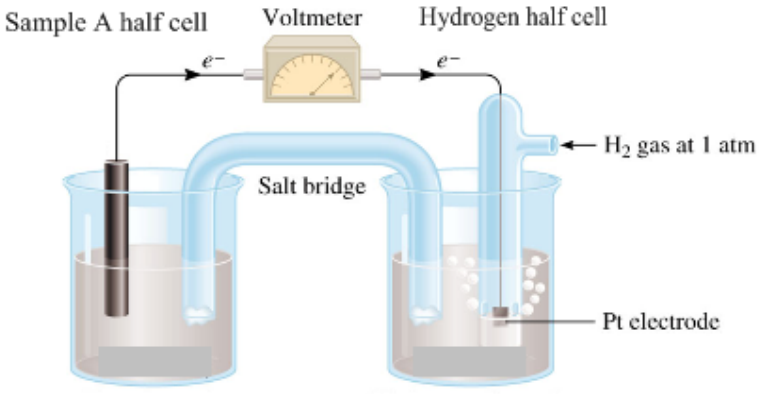
QUESTION 6

6.1



✓ half cells labelled correctly
✓ salt bridge correctly labelled with cotton wool in ends
✓✓ apparatus and connecting wires correctly arranged relative to each other (4)

6.2 Measure the pressure of $H_2(g)$ to ensure it is at 1 atm. ✓
Measure the concentrations of the electrolytes to ensure they are 1 mol.dm^{-3}. ✓
Measure the temperature to ensure it is 25 ^{o}C. ✓ (3)

6.3 Sample A is made of magnesium. ✓ (1)

6.4 ✓ A clear choice is made for either a diesel generator or a UPS
✓✓ The choice is justified financially in terms of initial outlay versus running cost.
✓✓✓✓ The negative environmental impact of diesel as a fuel and the dwindling reserves is outlined as a reason for not choosing the diesel generator
OR
Ways to reduce pollution and make use of alternative means such as biodiesel to address the weakness in your choice of the generator.

✓✓✓✓ The negative environmental impact of lead, acid and plastic on the environment is outlined as a reason for not choosing the UPS
OR
Ways to address these concerns by recycling the plastic and recovering the lead. (11)

[19]

QUESTION 7

7.1 Galvanic cell: chemical energy is converted to electrical energy. ✓
Electrolytic cell: electrical energy is converted to chemical energy. ✓ (2)

7.2 7.2.1 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓ (1)

7.2.2 $2H2O + 2e(\rightarrow H2 + 2OH^-$ ✓ (1)

7.3 $E\theta cell = E\theta cathode - E\theta anode$
$= -0,83 – (1,36)$ ✓
$= -2,19$ V ✓
The negative value for E^{θ}_{cell} indicates that the reaction is not spontaneous. ✓ (3)

7.4 Chlorine gas: making PVC or another appropriate use ✓
Hydrogen gas: making ammonia or another appropriate use ✓
Sodium hydroxide: making soap or another appropriate use ✓ (3)

7.5 The mercury cathode process results in losses of mercury into the environment which are problematic as mercury is highly toxic to all forms of life. ✓
The diaphragm cell uses asbestos which is harmful to humans causing cancer of the respiratory tract and lungs. ✓ (2)

[12]

QUESTION 8A

The initial equilibrium of the system was disturbed after 5 minutes by **adding ammonia gas**.

8.1 To offset the stress✓, some ammonia reacts to produce nitrogen and hydrogen until a new equilibrium is established.✓ (2)

8.2 10 minutes. ✓ (1)

8.3 $K_C = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓ ✓ (2)

8.4 $K_C = \frac{[NH_3]^2}{[N_2][H_2]^3}$ (2)
$= \frac{7^2}{3 \times 15^2}$ ✓
$= 4,84 \times 10^{-3}$ ✓

8.5 $K_C = 4,84 \times 10^{-3}$ ✓during the first 5 minutes, since only a change in temperature can cause a change in the value of K_C. ✓ (2)

8.6 NH_4NO_3 ✓ (1)

8.7 $\%\,\text{N in } NH_4NO_3 = \frac{28}{80} \times 100$ ✓

$= 35\%$ ✓ (2)

8.8 Positive impacts: fertilizer has made it possible to large food crops on the same soil year after year to sustain a growing world population. ✓✓
Negative impacts: Fertilizers leach from the soil contaminating ground water and eventually resulting in the process of eutrophication in dams and lakes. ✓✓ (4)

8.9 Avoid over fertilizing ✓and balance the use of high soluble, quick release fertilizers with slower acting substances such as urea. ✓ (2)

[18]

QUESTION 8B

8.1 Coal. ✓ (1)

8.2 C ✓, H_2O ✓ and O_2 ✓ (3)

8.3 $4CO + 9H_2$ ✓ $\rightarrow C_4H_{10} + 4H_2O$ ✓ (2)

8.4 8.4.1 Fractional distillation. ✓ (1)

8.4.2 Different hydrocarbons have different boiling points,✓ so they can be collected from different fractions of the distillation column.✓ (2)

8.5 8.5.1 Ethene is the monomer used in the production of polyethylene. ✓ (1)

8.5.2 Propene. ✓ (1)

8.6 8.6.1 Sulphur is an impurity in the coal. ✓ (1)

8.6.2 $H_2S(g)$ will poison the catalyst in the SAS reactor. ✓ (1)

8.6.3 $SO_2(g) + 2H_2S(g) \rightarrow 3S(s) + 2H_2O(\ell)$ ✓

The $H_2S(g)$ is made to react with $SO_2(g)$ to form sulphur ✓, a solid, which can then be easily removed. ✓ (3)

8.6.4 Hydrogen sulphide is poisonous gas.✓
Employees who in close proximity to this gas should wear gas masks. ✓ (2)

[18]

TOTAL FOR THIS PAPER: 150 MARKS