Name: .... **School Year:** ....

School: ....

Answer all questions in the spaces provided.

Please write your answers clearly.

The total marks allocated to the paper are 40 marks (Section A 10 marks, Section B 30 marks)

The time allocated to the paper is 30 minutes.

Scoring: Section A .... / 10 Section B .... / 30 **Total** .... **/ 40**

SECTION A General chemistry knowledge

1. Name the element with the latin name 'plumbum'. (1 mark)

lead...

2. Name the element with a name that means 'light bearer.' (1 mark)

phosphorus ....

3. Four new elements were added to the Periodic Table at the start of 2016.

Give the IUPAC name for any **one** of the elements. (1 mark)

ununtrium / ununpentium / ununseptium / ununoctium (any one, must be spelt correctly) ....

4. Which two elements are the main components of glass? (2 marks)

silicon and oxygen..

5. Write the chemical formula for indium fluoride. (1 mark)

InF_3..

6. State the bond angle in a molecule of methane, CH_4. (1 mark)

109 °/ 109.5 °/ 109° 28' ....

7. Name the process you would use to separate a liquid from an **insoluble** solid. (1 mark)

filtration / filtering / any variation of these..

8. Name the process you would use to separate a liquid from a **soluble** solid. (1 mark)

distillation (ignore mention of fractional or simple)..

9. Which disease is the drug cis-platin used to treat? (1 mark)

cancer...

Total: 10 marks

SECTION B Questions linked to this year's theme of Energy

10. An **endothermic process** is a process that *takes in energy from the surroundings*.

An **exothermic process** is a process that *gives out energy to the surroundings*.

For example respiration is an example of an exothermic process as energy is given out during the process.

State if the following processes are **endothermic** or **exothermic**;

a. evaporation - *endothermic*..

b. photosynthesis - *endothermic* ....

c. thermal decomposition of copper carbonate - *endothermic*...

(3 marks)

11. Car manufacturers are looking at the use of hydrogen as an alternative fuel for powering cars.

a. A fuel cell has been designed that combines hydrogen with oxygen to make a single product.

Write a balanced symbol equation for the reaction. (1 mark)

$2H_2 + O_2 \rightarrow 2H_2O$ ....

b. The fuel cell involves a redox reaction.

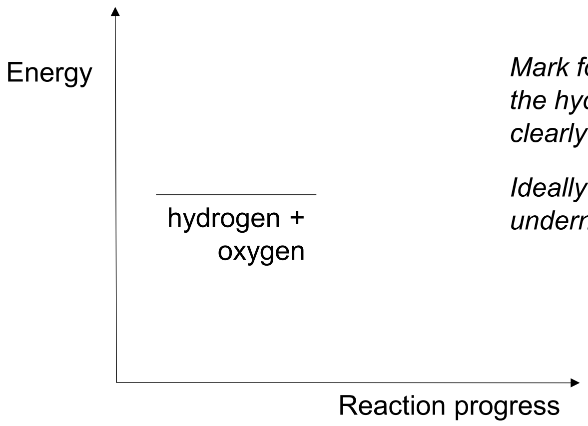
Identify which half equation shows reduction and which half equation shows oxidation occurring. Circle the correct answer for each half equation. e- represents an electron (1 mark)

$O_2 + 4e^- + 2H_2O \rightarrow 4OH^-$ **oxidation** / **<u>reduction</u>**

$2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$ **<u>oxidation</u>** / **reduction**

c. The process gives out energy.

Complete the energy level diagram below for the reaction by indicating a position for the products of the reaction. (1 mark)



Mark for a second line to the right of the hydrogen and oxygen line but clearly <u>lower</u> in energy.

Ideally it should also be labelled underneath with the words water.

12. This question is about jelly babies.

The table below gives some nutritional information taken from the back of a packet of jelly babies.

	Per 100 g	**Per 4 sweets (26.4 g)**	**Guideline daily amounts**
Fat **Of which saturates**	$<$ 0.1 g $<$ 0.1 g	$<$ 0.1 g $<$ 0.1 g	70 g 20 g
Carbohydrates **Of which sugars**	78 g 74 g	21 g 20 g	260 g 90 g
Protein	3.5 g	0.9 g	50 g
Salt	0.02 g	$<$ 0.01 g	6 g

a. What percentage of the Guideline Daily Amount of sugar is present in 100 g of jelly babies. (1 mark)

(74 g / 90 g) × 100% = *<u>82 % / 82.2 %</u>* ....

b. Assuming that all the sugar present is in the form of sucrose, $C_{12}H_{22}O_{11}$, write an equation for the complete combustion of the sugar in the jelly babies. (2 marks)

$C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O$ *(1 mark symbols, 1 mark balancing)*...............................

c. If 342 g of sucrose releases 5644 kJ of energy, calculate the amount of energy released by 4 jelly babies. (2 marks)

Sugar in 4 jelly babies = 20 g (1 mark)..

Energy released = (20 / 342) × 5644 kJ = *<u>330.1 kJ / 330 kJ</u>* *(1 mark)*..

....

d. A man needs to consume about 2500 dietary calories (kcal) per day. Given that 1 kJ = 0.239 kcal, how many sweets must a man consume in order to meet his daily calorific requirement? (3 marks)

Correct answer scores all 3 marks..

2500 kcal = (2500 / 0.239) = 10460 kJ (1 mark) ....

10460 kJ / 330.1 kJ per 4 sweets = 31.69 lots of 4 sweets (1 mark) ....

31.69 × 4 sweets = 126.8 / 127 sweets (1 mark) ....

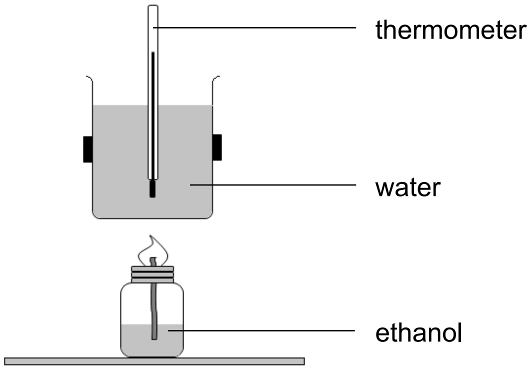
Mark consequentially based on student's answer to part(c) ....

....

13. Many conventional petrol engines will run on ethanol, or mixtures of petrol and ethanol. Much of the petrol sold in the UK at present has 5-10% ethanol added.

a. George uses a simple calorimetry experiment to determine the energy released per gram of ethanol, C_2H_5OH.

He sets up the apparatus as shown in the diagram. He burns some ethanol in a fuel burner and uses the heat energy released to heat up 75 g of water in a copper calorimeter.



He records the temperature of the water before and after heating it with the ethanol.

He records the mass of ethanol burnt by recording the mass of the fuel burner before and after the experiment.

His results are shown in the table below;

Temperature of water at start / °C	18.5
Temperature of water at end / °C	46.2
Mass of fuel burner at start / g	2.36
Mass of fuel burner at end / g	1.84

If 4.2 J of energy is needed to raise the temperature of 1 g of water by 1 °C, calculate;

i. The amount of energy released per gram of ethanol burnt in joules, J. (4 marks)

Temperature change = 27.7 ℃ (1 mark)..

Energy released = 27.7 ℃ × 75 g of water × 4.2 J = 8725.5 J (1 mark)...................................

Mass of fuel burnt = 0.52 g (1 mark)...

Energy released per gram of fuel burnt = 8725.5 J / 0.52 g = <u>16779.8 J / 16780 J</u> (1 mark) ....

....

....

ii. The amount of energy released per mole of ethanol burnt (one mole of a substance has a mass in grams equal to the relative molecular mass for that substance). (2 marks)

Relative molecular mass of ethanol, C_2H_5OH = 46 (1 mark)...

Energy released per mole = 16779.8 J/g × 46 = <u>771871 / 771870 J</u> (1 mark)...........................

[Mark consequentially on student's answer to part(i)] ....

....

b. A theoretical value for the energy released during the combustion of ethanol can be calculated by looking at the bonds made and broken during the reaction.

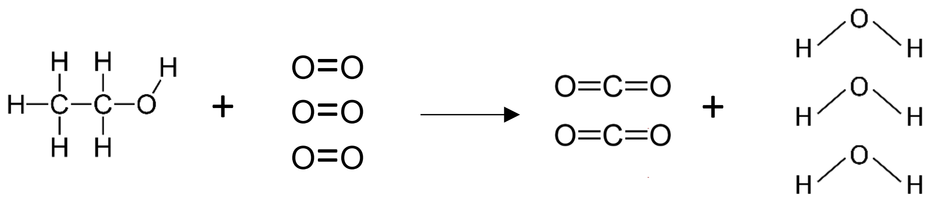
Energy must be supplied to break bonds – so bond breaking is an endothermic process.

Energy is released when new bonds are formed – so bond formation is an exothermic process.

By comparing the energy required to break bonds in the reactants with the energy released when the bonds in the products are formed it is possible to calculate the overall energy change in a reaction.

The equation for the complete combustion of ethanol is shown below;

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$



i. Complete the table by showing the number of each type of bond broken when the reactants are turned into individual atoms during the reaction. (1 mark)

Bonds broken	Number	Bonds made	Number
C–H	.........*5*.........	C=O	4
C–C	.........*1*.........	H-O	6
C–O	.........*1*.........		
O–H	.........*1*.........		
O=O	.........*3*.........	*(all correct for 1 mark)*	

ii. The energy required to make or break a bond is given by the bond enthalpy of that bond.

The bond enthalpies of the bonds involved in this reaction are shown in the table.

Bond	Bond enthalpy / kJ per mole
C–H	413
C–C	347
C–O	335
O–H	464
O=O	498
C=O	804
H–O	464

Use the table of bond enthalpies given to calculate;

- The energy needed to break all the bonds in the reactants (2 marks)

  (5 × 413) + (1 × 347) + (1 × 335) + (1 × 464) + (3 × 498) = 4705 kJ/mol ....

  (1 mark for working; 1 mark for answer) ....

  (correct final answer on own scores both marks)..

- The energy needed to break all the bonds in the products. (1 mark)

  (4 × 804) + (6 × 464) = 6000 kJ/mol...

....

- The overall energy change for the reaction.
  Indicate if the reaction is endothermic or exothermic. (2 marks)

  Overall energy change = 4705 – 6000 = -1295 or 1295 kJ/mol (1 mark) ....

  Reaction is exothermic (1 mark)..

  ....

c. How does the theoretical value you calculated in part (b) compare to the experimental value obtained from the results in part (a). Explain any differences. (2 marks)

Experimental value is smaller / Theoretical value is larger (1 mark)..

Some discussion of heat loss / inaccuracy of the practical experiment (1 mark) ....

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d. An alternative way to calculate a theoretical value for the energy change for the combustion of ethanol is to look at the energy required to form each of the reactants and products from their elements.

Use the energy changes for forming each of the reactants and products from their elements, given below, to calculate the energy change for the complete combustion of ethanol. (2 marks)

$C + 3H_2 + 1/2O_2 \rightarrow C_2H_5OH$	Energy change = -147 kJ/mol
$C + O_2 \rightarrow CO_2$	Energy change = -394 kJ/mol
$H_2 + 1/2O_2 \rightarrow H_2O$	Energy change = -242 kJ/mol

....

Energy to make reactants = -147 kJ/mol...

Energy to make products = (2 × -394) + (3 × -242) = -1514 kJ/mol (1 mark for this number)...........

Overall energy change = -1514 - -147 = <u>-1367 kJ/mol</u> (1 mark) ....

(Correct final answer with no working scores only 1 mark)...

....

Total: 30 marks