

Eton College King's Scholarship Examination 2016

SCIENCE 2 (Data Analysis)

(30 minutes)

Candidate Number: _____

Remember to write your candidate number on every sheet in the space provided.

You should attempt ALL the questions. Write your answers in the spaces provided.

The maximum mark for each question or part of a question is shown in square brackets.

Calculators are allowed. In questions involving calculations, all your working must be shown.

For examiners' use only.

Total [30]	
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1. An experiment was performed to measure the energy given out by burning different fuels. A quantity of methane was measured and then burned. The flame was used to heat a known volume of water in a copper beaker, the initial and final temperatures of the water being recorded. The experiment was then repeated with a range of fuels as shown in the table below. The amount of fuel (0.01 moles) used in each experiment was chosen to ensure that each portion of fuel contained the same number of molecules.

Fuel	Mass of water (g)	Mass of fuel (g)	Initial temperature of water (°C)	Final temperature of water (°C)	Energy released (kJ)
Methane (CH ₄)	200	0.16	22	29.4	6.2
Ethane (C ₂ H ₆)	200	0.30	22	35.0	10.9
Propane (C ₃ H ₈)	200	0.44	22	40.5	15.5
Butane (C ₄ H ₁₀)	200	0.58	22	38.2	13.5
Pentane (C ₅ H ₁₂)	200	0.72	22	51.4	24.6
Hexane (C ₆ H ₁₄)	200	0.86	22	57.0	

- (a) Why was the mass of fuel burned not kept constant?

_____ [1]

- (b) A book of chemical data suggests that burning 0.16 g of methane should release 8.9 kJ of energy. The values obtained in this experiment for the other fuels are similarly lower than those quoted in the data book. Suggest a reason for the considerable difference between the accepted data book value and the value measured in this experiment.

 _____ [2]

- (c) Name two products formed when methane is burned.

 _____ [2]

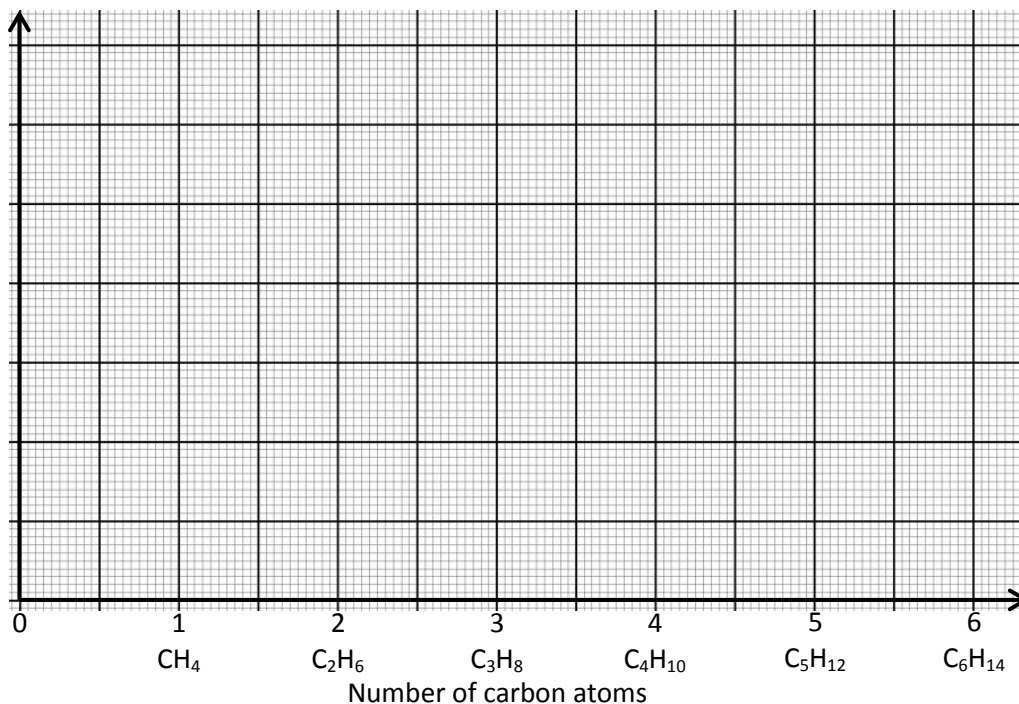
- (d) The energy released by burning the fuel has been calculated using the expression:

$$q = m \times c \times \Delta T$$

Where: q = energy (J)
 m = mass of water (g)
 c = a constant, 4.18
 ΔT = temperature change of water (°C)

Calculate the amount of energy released by burning the sample of hexane in the experiment, giving your answer in kJ. Show your working below, and add your result to the table above. [3]

- (e) Using the graph paper below, draw a suitable scale to show the energy released on the vertical axis and label the axis appropriately. Plot the data for the six different fuels, draw a suitable line of best fit, and identify the anomalous point by circling it. [4]



- (f) The quantity of fuel used in each experiment was carefully checked. The temperature measurements were also all correct. Suggest what else might have caused the anomalous result.

[1]

- (g) Use your graph to find the amount of energy which would be released by burning a 0.01 moles of hydrogen, H_2 . Explain your answer, and show your working on the graph.

[2]

- (h) (i) The fuels used in the experiment are all *alkanes*. Work out the formula of the alkane molecule which has 8 carbon atoms.

[1]

- (ii) Use your graph to calculate how much energy would be released by burning 0.01 moles of the alkane molecule which has 8 carbon atoms. Show your working.

_____ kJ

[2]

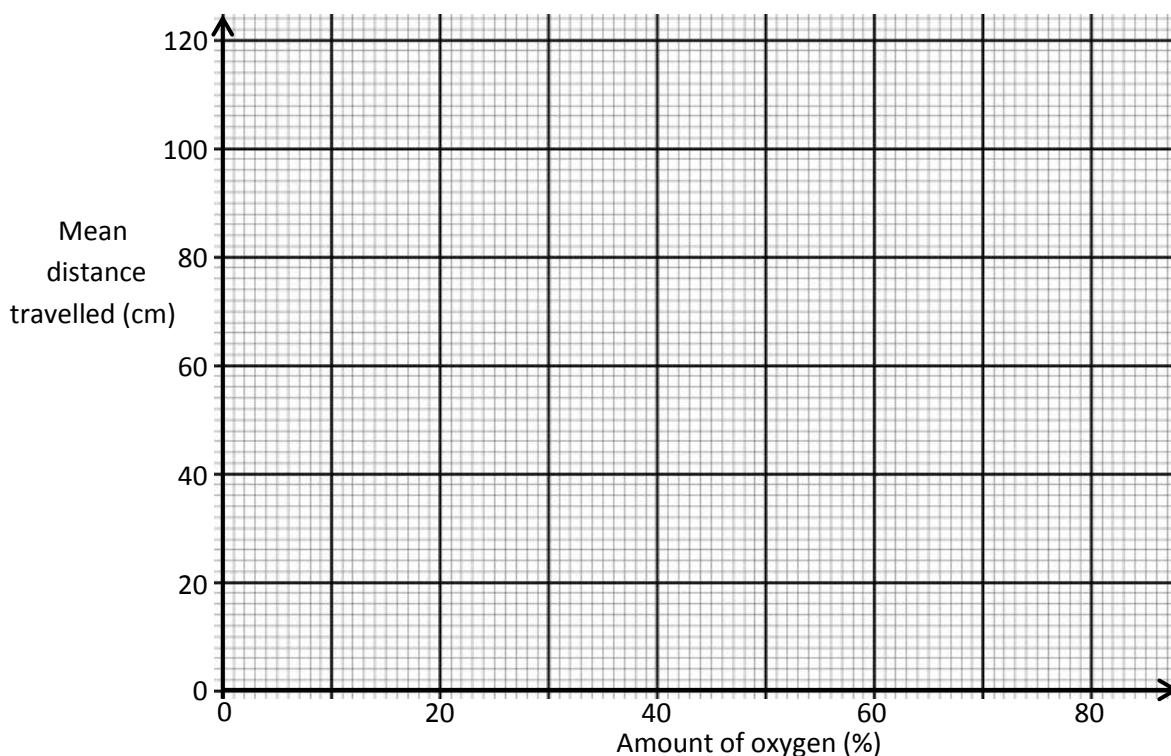
2. Hydrogen can be used as a fuel to power rockets. The hydrogen burns, reacting explosively with oxygen, to form water vapour.

An experiment was carried out using a plastic bottle containing a mixture of hydrogen and oxygen as a model rocket. The mixture was ignited by a spark and the distance travelled by the bottle rocket was measured. The procedure was repeated three times for each mixture.

Amount of oxygen (%)	Distance travelled (cm)			
	1	2	3	Mean
10	34	32	30	32
15	55	56	56	56
20	67	68	70	
25	87	84	83	85
45	104	92	93	93
50	85	84	84	84
60	73	71	81	
70	49	51	49	50
80	36	36	36	36

(a) Calculate the two missing means, dealing appropriately with any anomalous data. Put your answers into the table, giving the values to the nearest cm. [2]

(b) Complete the graph by plotting the mean data from the table, and drawing two suitable lines of best fit. [4]



- (c) (i) Use your graph to find the % of oxygen in the hydrogen-oxygen mixture which would give the maximum distance of travel for the rocket. Show your working on the graph.

_____ % oxygen
[1]

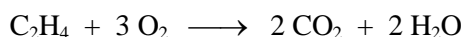
- (ii) Explain why this ratio of hydrogen to oxygen gives the maximum distance of travel.

[2]

- (d) Suggest how far the rocket would travel if it were filled with 100% oxygen. Explain your answer.

[1]

- (e) A mixture of ethene (C₂H₄) and oxygen can also be used to fuel a bottle rocket. The chemical equation for the combustion of ethene is:



Use this equation to suggest the percentage of oxygen in the mixture which would give the maximum distance of travel for the rocket. Explain your answer.

[2]

[End of paper]

SCIENCE 2 CANDIDATE NUMBER _____