Fuels

Total marks : 21

Q1.

Crude oil is found in the Earth's crust.

In January 2015 the United Kingdom produced 850 000 barrels of crude oil per day. 45% of this crude oil was fuel oil.

Calculate the number of barrels of fuel oil present in the 850 000 barrels of crude oil.

Give your answer to two significant figures.

(3)

.....

.....

..... barrels

(Total for question = 3 marks)

Q2.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

(i) Which statement about the members of the alkane homologous series is correct?

(1)

- ☐ **A** they show a trend in chemical properties
- ☐ **B** their boiling point decreases as the molecules get larger
- ☐ **C** the molecular formula of neighbouring compounds differs by CH_3
- ☐ **C** their viscosity increases as the molecules get larger

(ii) Which one of the following hydrocarbons belongs to the same homologous series as octane, C_8H_{18}?

(1)

- ☐ **A** C_4H_6
- ☐ **B** C_4H_8
- ☐ **C** C_4H_{10}
- ☐ **D** C_4H_{12}

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18}.

(3)

.....

.....

(Total for question = 5 marks)

Q3.

The structure of a molecule of ethene is shown in Figure 8.

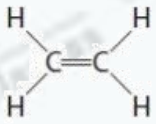


Figure 8

(i) Figure 9 shows the incomplete dot and cross diagram for a molecule of ethene.

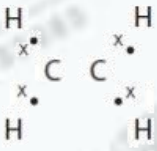


Figure 9

Complete Figure 9 to show the electrons of the C=C double bond.

(1)

(ii) The incomplete combustion of ethene in air produces water as one of the products.

Give the name of another product of the incomplete combustion of ethene.

(1)

.....

(Total for question = 2 marks)

Q4.

Methane is a hydrocarbon fuel.

(i) Complete the word equation for the **complete** combustion of methane in oxygen.

(2)

methane + ... → water + ...

(ii) The **incomplete** combustion of methane can produce carbon and carbon monoxide.

Give the reason why carbon and carbon monoxide are produced in the **incomplete** combustion of methane.

(1)

.....

.....

(Total for question = 3 marks)

Q5.

Crude oil is a complex mixture of substances.

When crude oil is separated into fractions, the amount of each fraction obtained rarely matches the demand for that fraction.

Figure 9 shows the relative amounts of six of the fractions present in a crude oil and the relative demand for each of these fractions.

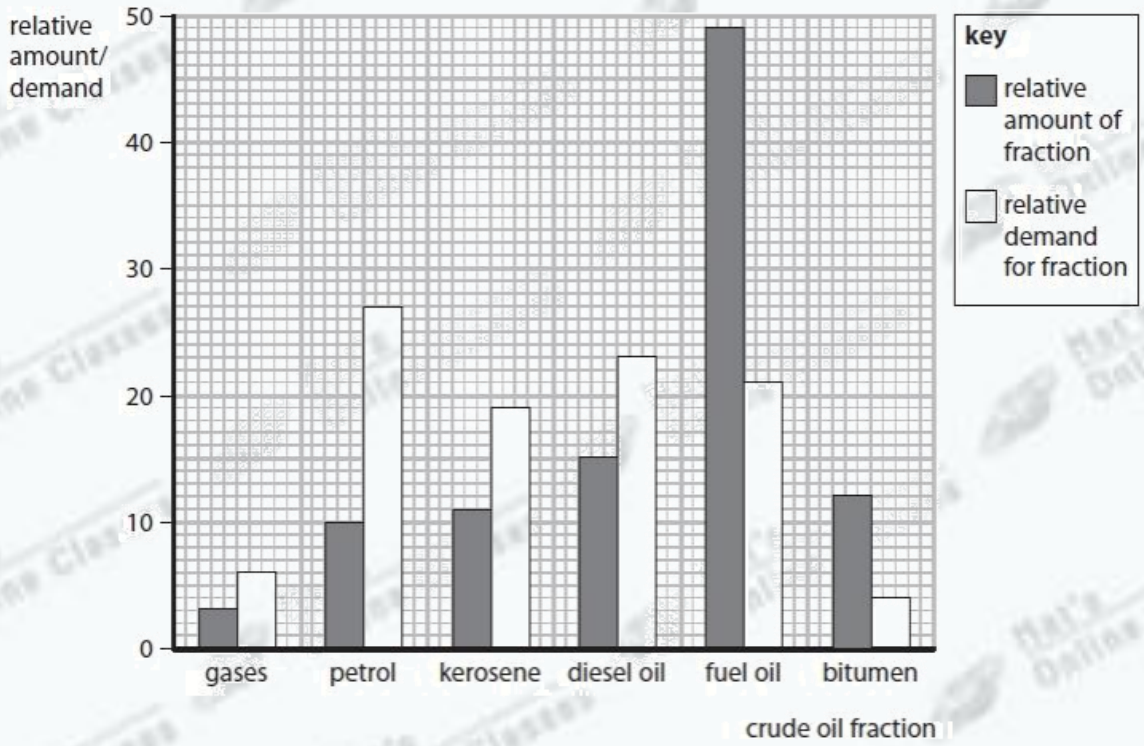


Figure 9

Cracking is used to match the relative amount of a fraction of crude oil to the demand for that fraction.

(i) Use the information in Figure 9 to give the name of the fraction that is most likely to need to be cracked.

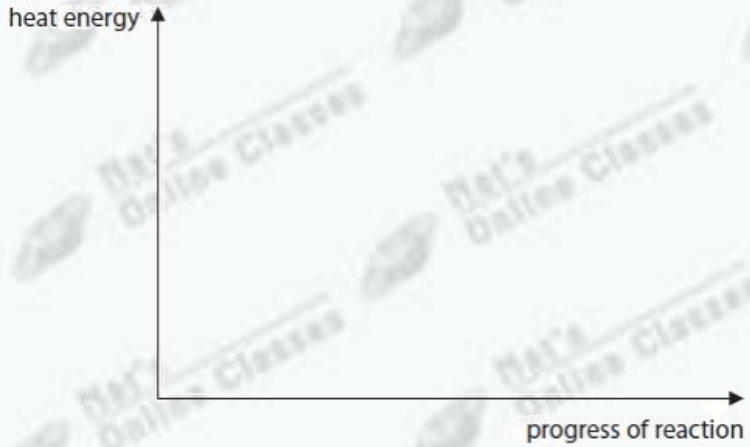
(1)

.....

(ii) In a cracking reaction, reactants are heated to form products.
This reaction is endothermic.

On the axes provided, draw the reaction profile of this reaction.
Label the energy of the reactants, the energy of the products and the activation energy of the reaction.

(3)



(iii) Dodecane, $C_{12}H_{26}$, can be cracked to form useful products.

Complete the equation for the cracking of dodecane by filling in the formula of the single molecule needed to balance the equation.

(1)

$C_{12}H_{26} \rightarrow$ ..... $+ 3C_2H_4$

(Total for question = 5 marks)

Q6.

Cracking involves the breaking down of large hydrocarbon molecules into smaller hydrocarbon molecules.

(i) Octane, C_8H_{18}, can be cracked to produce one molecule of ethene, C_2H_4, and one molecule of C_xH_{14}.

$$C_8H_{18} \rightarrow C_2H_4 + C_xH_{14}$$

Determine the value of x in the molecule of C_xH_{14}.

(1)

x = ...

(ii) Dodecane is a large hydrocarbon molecule.

When one molecule of dodecane is cracked the products are one molecule of octane and one molecule of butene.

dodecane → octane + butene

Calculate the maximum mass of octane that could be produced when 340 g of dodecane is cracked in this reaction.
(relative formula masses: dodecane = 170, octane = 114)

(2)

.....

.....

.....

.....

.....

.....

mass of octane = ... g

(Total for question = 3 marks)

Mark schemes :

Q1.

Question Number	Answer	Additional guidance	Mark
	380 000 with or without working scores 3 382 500 with or without working scores 2 OR $\frac{45}{100}$ (1) = (0.45) (0.45) x 850 000 (1) = (382 500) = 380 000 (1) OR $\frac{850\,000}{100}$ (1) (= 8500) (8500) x 45 (1) (= 382 500) 380 000 (1) OR 4x10% = 340 000 **and** 1x5% = 42 500 (1) 340 000 + 42 500 (= 382 500) (1) 380 000 (1)	allow ECF throughout (answers based on 55%) 470 000 scores 2 467 500 scores 1 allow alternative chunking methods that add to 45% The clear rounding of any worked out final answer (using data provided) to 2 sig figs scores 1	**(3)** AO 2 1

Q2.

Question number	Answer	Mark
(i)	**D** their viscosity increases as the molecules get larger is the only correct answer **A**, **B**, **C** are incorrect statements	(1) AO1 1

Question number	Answer	Mark
(ii)	**C** C_4H_{10} is the only correct answer **A**, **B** and **D** are not alkanes	(1) AO2 1

Question number	Answer	Additional guidance	Mark
(iii)	$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$ LHS formulae → (1) → RHS formulae (1) balancing correct formulae (1)	allow multiples including halves ignore any state symbols	(3) AO2 1

Q3.

Question number	Answer	Additional guidance	Mark
(i)	4 electrons shown between the 2 carbon atoms	electrons may be shown as dots, crosses or as a mixture	(1)
(ii)	carbon monoxide / carbon / soot	allow CO / C ignore carbon dioxide	(1)

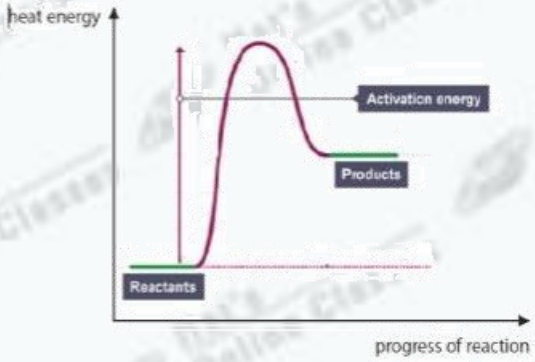
Q4.

Question number	Answer	Additional guidance	Mark
(i)	methane + oxygen (1) → water + carbon dioxide (1)	ignore symbols reject other substances on either side for that mark	(2)

Question number	Answer	Additional guidance	Mark
(ii)	limited supply of oxygen	ignore air	(1)

Q5.

Question Number	Answer	Mark
(i)	fuel oil	(1) AO 3 2a

Question Number	Answer	Additional guidance	Mark
(ii)	• reactant(s) and product(s) labelled in their correct positions (1) • activation energy labelled (1) • energy of reactants lower than energy of products (1)	example of diagram  ignore arrow heads allow unlabelled diagram of an endothermic reaction showing the basic outline shape if exothermic reaction profile shown, allow (1) for reactants and products in correct position and (1) for correct labelling of activation energy	(3) AO 1 1

Question Number	Answer	Additional guidance	Mark
(iii)	C_6H_{14}		(1) AO 2 1

Q6.

Question number	Answer	Mark
(i)	x = 6	(1)

Question number	Answer	Additional guidance	Mark
(ii)	allow 2 for correct answer with or without working 170 (g) dodecane forms 114 (g) octane 1 (g) dodecane forms $\frac{114}{170}$ (g) octane (1) 340 (g) dodecane forms $\frac{114}{170}$ x 340 (1) (= 228(g))	OR $\frac{340}{170}$ (1) (= 2) 2 x 114 (1) (= 228 (g))	(2)