Q1.

Which is a propagation step in the chlorination of methane?

A $H\bullet + Cl_2 \rightarrow HCl + Cl\bullet$ ⬭

B $Cl\bullet + CH_4 \rightarrow CH_3Cl + H\bullet$ ⬭

C $\bullet CH_3 + Cl\bullet \rightarrow CH_3Cl$ ⬭

D $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$ ⬭

(Total 1 mark)

Q2.

Which statement is **not** correct about the pollutant sulfur dioxide?

A It can be removed from car exhaust gases by a catalytic converter. ⬭

B It can be removed from power station flue gases by reaction with calcium oxide. ⬭

C It can cause respiratory problems. ⬭

D It can cause acid rain. ⬭

(Total 1 mark)

Q3.

Which statement is correct about thermal cracking?

A A pressure between 100 and 200 kPa is used. ⬭

B Aromatic hydrocarbons are the major products. ⬭

C C–C bonds are broken. ⬭

D Zeolite catalysts are used. ⬭

(Total 1 mark)

Q4.

An excess of methane reacts with chlorine in the presence of ultraviolet radiation.

What are the main products of this reaction?

A CCl_4 and H_2 ⬭

B CCl_4 and HCl ⬭

C CH_3Cl and H_2 ⬭

D CH_3Cl and HCl ⬭

(Total 1 mark)

Q5.

This question is about fossil fuels.

(a) The petrol fraction from crude oil contains octane (C_8H_{18}).

Give an equation for the complete combustion of octane.

_____

(1)

(b) The combustion of petrol in car engines produces the pollutant nitrogen monoxide.

Give an equation for a reaction that removes nitrogen monoxide in a catalytic converter.

_____

(1)

(c) Sulfur dioxide is produced in the combustion of fossil fuels. The total emissions of sulfur dioxide in the UK have fallen dramatically since 1970.

Sulfur dioxide is now removed from the flue gases in power stations by reaction with calcium oxide.

$$CaO + SO_2 \rightarrow CaSO_3$$

In 1970, the total UK emissions of sulfur dioxide were 6.49 million tonnes (1 tonne = 1000 kg).

Calculate the mass, in kilograms, of calcium oxide needed to react with this mass of sulfur dioxide.

Give your answer in standard form.

Mass of calcium oxide _____ kg

(2)

(Total 4 marks)

Q6.

Which equation represents a propagation step?

A $\bullet CH_2Cl + Cl\bullet \rightarrow CH_2Cl_2$ ⬭

B $\bullet CH_3 + \bullet CH_3 \rightarrow C_2H_6$ ⬭

C $Cl_2 \rightarrow Cl\bullet + Cl\bullet$ ⬭

D $CH_3Cl + Cl\bullet \rightarrow \bullet CH_2Cl + HCl$ ⬭

(Total 1 mark)

Q7.

Which statement is correct about the fractional distillation of crude oil?

A A zeolite catalyst is used. ⬭

B Each fraction contains a mixture of hydrocarbons. ⬭

C Gaseous fractions are formed by breaking covalent bonds. ⬭

D The fractionating column is hottest at the top. ⬭

(Total 1 mark)

Q8.

Which equation represents a termination step?

A $CH_3CH_2CH_3 + Br\bullet \rightarrow CH_3\dot{C}HCH_3 + HBr$ ⬭

B $ClO\bullet + O_3 \rightarrow Cl\bullet + 2O_2$ ⬭

C $RO\bullet + CH_2 = CH_2 \rightarrow ROCH_2\dot{C}H_2$ ⬭

D $CH_3\dot{C}FCl + Cl\bullet \rightarrow CH_3CFCl_2$ ⬭

(Total 1 mark)

Q9.

When alkanes are burned in an excess of oxygen they produce carbon dioxide and water.

(a) Write an equation for the complete combustion of propane in oxygen.

_____

(1)

(b) An expression can be derived using bond enthalpy data to estimate the enthalpy of combustion ($\Delta_c H$) of an alkane.

For an alkane with ***n*** carbon atoms: $\Delta_c H = -(496n + 202)$ kJ mol^{-1}

The enthalpy of combustion of an alkane was calculated to be −6650 kJ mol^{-1} using this expression.

Deduce the molecular formula of this alkane.

Show your working.

Molecular formula of alkane _____

(2)

(c) Suggest **one** reason, other than the use of mean bond enthalpies, why a value for the enthalpy of combustion of a liquid alkane is different from the value obtained using the expression in part (b)

_____

_____

(1)

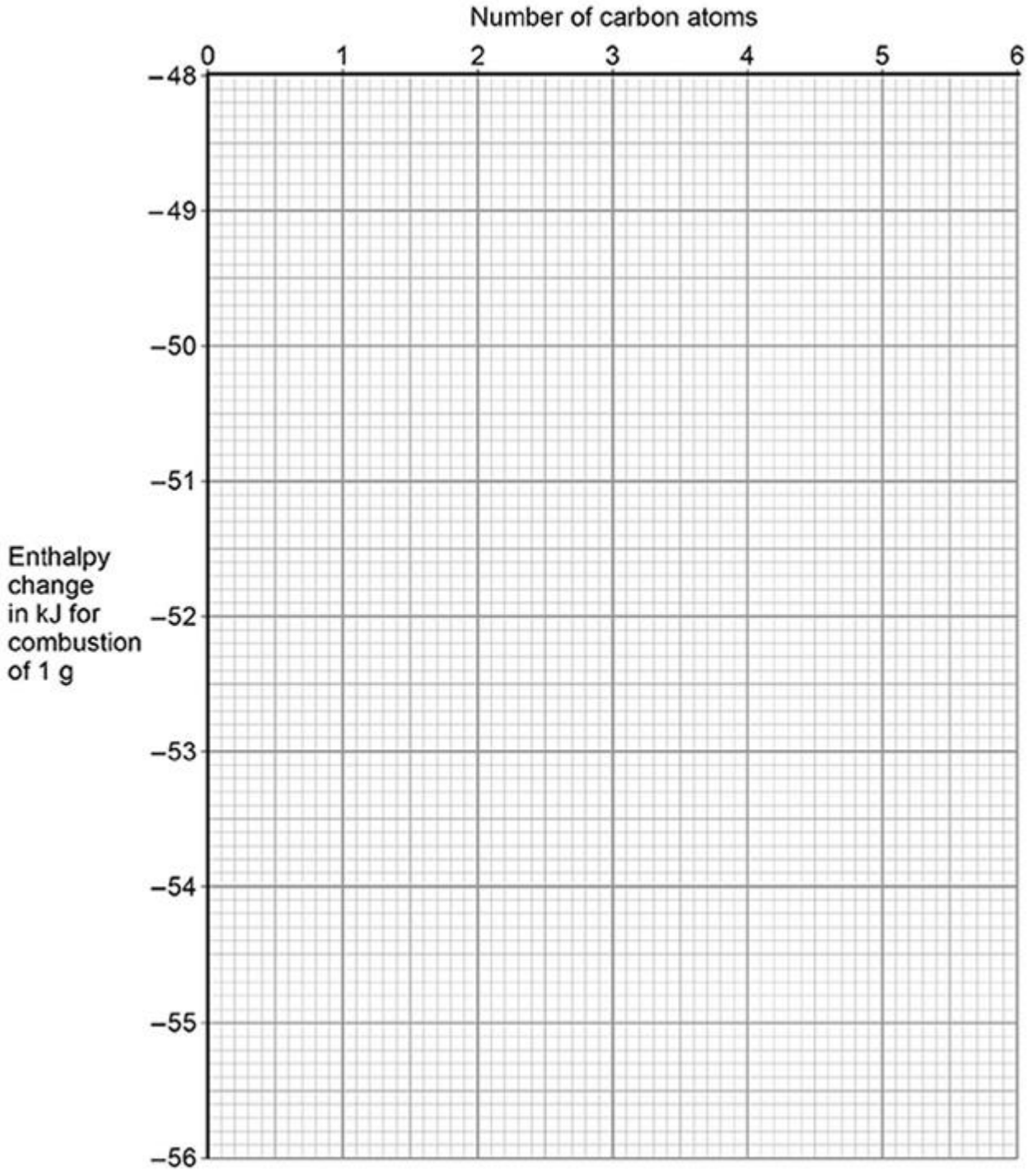
(d) Values of the enthalpy change for combustion of 1 g of some alkanes are shown in the table.

	methane	**ethane**	**propane**	**butane**	**pentane**
Enthalpy change in kJ for combustion of 1 g	−55.6	−52.0		−49.6	−48.7

Plot the enthalpy change for the combustion of 1 g against the number of carbon atoms in the alkanes in the table.

Draw a best fit line and use this to estimate the enthalpy change for combustion of 1 g of propane.

Write your answer in the table.


Number of carbon atoms
0
1
2
3
4
5
6
−48
−49
−50
−51
−52
−53
−54
−55
−56
Enthalpy change in kJ for combustion of 1 g

(3)

(e) Isooctane (2,2,4-trimethylpentane) is an important component of petrol used in cars.

When isooctane is burned, the enthalpy change is −47.8 kJ g^{-1}

Isooctane is a liquid at room temperature with a density of 0.692 g cm^{-3}

Calculate the heat energy released, in kJ, when 1.00 dm^3 of isooctane burns in excess oxygen.

Give your answer to the appropriate number of significant figures.

Heat energy released _____ kJ

(2)

(Total 9 marks)

Q10.

Which equation is a propagation step in the conversion of trichloromethane into tetrachloromethane by reaction with chlorine in the presence of ultraviolet light?

A $CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$ ⬭

B $\bullet CCl_3 + \bullet Cl \longrightarrow CCl_4$ ⬭

C $CHCl_3 + \bullet Cl \longrightarrow CCl_4 + \bullet H$ ⬭

D $\bullet CCl_3 + Cl_2 \longrightarrow CCl_4 + \bullet Cl$ ⬭

(Total 1 mark)

Q11.

The table shows possible conditions and products for the cracking of alkanes.

Which row is correct?

	Type of cracking	Conditions	Products	
A	Thermal	High pressure High temperature	Mainly alkanes	⬭
B	Thermal	Slight pressure High temperature	Mainly alkenes	⬭
C	Catalytic	Slight pressure High temperature	Mainly branched alkanes and aromatics	⬭
D	Catalytic	High pressure High temperature	Mainly branched alkanes and aromatics	⬭

(Total 1 mark)

Q12.

Which catalyst is used in the catalytic cracking of alkanes?

A Concentrated phosphoric acid ⬭

B Iron ⬭

C Nickel ⬭

D Zeolite ⬭

(Total 1 mark)

Q13.

Which correctly represents an incomplete combustion of pentane?

A $C_5H_{12} + 8O_2 \longrightarrow 5CO_2 + 6H_2O$ ○

B $C_5H_{12} + 8O_2 \longrightarrow 4CO + CO_2 + 6H_2O$ ○

C $C_5H_{12} + 6O_2 \longrightarrow 4CO + CO_2 + 6H_2O$ ○

D $C_5H_{12} + 5O_2 \longrightarrow 4CO + CO_2 + 4H_2O + 2H_2$ ○

(Total 1 mark)

Q14.

Which species is produced in a propagation step during the reaction of propane with an excess of chlorine in the presence of UV light?

A $H\bullet$ ○

B C_3H_5Cl ○

C $C_3H_6CL_2$ ○

D C_6H_{14} ○

(Total 1 mark)

Q15.

Which of these substances does **not** contribute to the greenhouse effect?

A Unburned hydrocarbons. ○

B Carbon dioxide. ○

C Water vapour. ○

D Nitrogen. ○

(Total 1 mark)

Q16.

Which molecule is **not** produced when ethane reacts with bromine in the presence of ultraviolet light?

A $C_2H_4Br_2$ ⬭

B HBr ⬭

C H_2 ⬭

D C_4H_{10} ⬭

(Total 1 mark)