1)

The equation for the complete combustion of octane is

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

(a) The mass of 10 mol of octane is

(1)

☐ **A** 0.66 kg

☐ **B** 1.14 kg

☐ **C** 2.10 kg

☐ **D** 2.28 kg

(b) The volume of 1 mol of any gas (measured at room temperature and pressure) is 24 dm^3. Hence the volume of oxygen (measured at room temperature and pressure) required for the complete combustion of 10 mol of octane is

(1)

☐ **A** 240 dm^3

☐ **B** 300 dm^3

☐ **C** 3000 dm^3

☐ **D** 6000 dm^3

2 marks)

2)

The enthalpy change for the reaction

$$CH_4(g) \rightarrow C(g) + 4H(g)$$

is +1648 kJ mol^{-1}. Hence the mean bond enthalpy for the C–H bond is

☐ **A** +329.6 kJ mol^{-1}

☐ **B** +412.0 kJ mol^{-1}

☐ **C** +1648 kJ mol^{-1}

☐ **D** +6592 kJ mol^{-1}

1 mark)

3)

Ethane reacts with chlorine when the substances are exposed to UV radiation.

(a) The equation for this reaction is

(1)

☐ **A** $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

☐ **B** $C_2H_6 + Cl_2 \rightarrow C_2H_4Cl_2 + H_2$

☐ **C** $C_2H_6 + Cl_2 \rightarrow 2CH_3Cl$

☐ **D** $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$

(b) The role of the UV radiation in the reaction is to

(1)

☐ **A** break the Cl—Cl bond forming Cl• free radicals.

☐ **B** break the Cl—Cl bond forming Cl^+ and Cl^- ions.

☐ **C** break the C—C bond in ethane forming CH_3• free radicals.

☐ **D** break a C—H bond in ethane forming C_2H_5• free radicals.

(c) The overall reaction between ethane and chlorine is best described as

(1)

☐ **A** addition.

☐ **B** homolytic fission.

☐ **C** heterolytic fission.

☐ **D** substitution.

4)

This question concerns the following compounds

A **B** **C** **D**

Which of these compounds will show geometric (*E–Z* or *cis/trans*) isomerism?

☐ **A**

☐ **B**

☐ **C**

☐ **D**

1 mark)

5)

The correct name for the compound shown below is

☐ **A** 2-methylbut-3-ene

☐ **B** 3-methylbut-2-ene

☐ **C** 3-methylbut-3-ene

☐ **D** 2-methylbut-2-ene

1 mark)

6)

Most compounds of lead are insoluble, an exception being lead(II) nitrate. Therefore a good method of preparing lead(II) sulfate is

☐ **A** adding dilute sulfuric acid to lead metal.

☐ **B** adding concentrated sulfuric acid to lead metal.

☐ **C** adding dilute sulfuric acid to lead(II) nitrate solution.

☐ **D** adding dilute sulfuric acid to solid lead(II) oxide.

1 mark)

7)

Metals usually have high melting temperatures and boiling temperatures because there are

☐ **A** strong attractions between the ions.

☐ **B** strong attractions between the delocalised electrons.

☐ **C** strong attractions between the ions and the delocalised electrons.

☐ **D** strong intermolecular forces.

1 mark)

8)
In 2006, the concentration of carbon dioxide in the atmosphere was 382 ppm. This is equivalent to

☐ **A** 0.00382%

☐ **B** 0.0382%

☐ **C** 0.382%

☐ **D** 3.82%

1 mark)

9)
A hazard that is particularly associated with alkanes is that they are

☐ **A** corrosive.

☐ **B** flammable.

☐ **C** toxic by inhalation.

☐ **D** toxic by skin absorption.

1 mark)

10)
Complete combustion of 50 cm^3 of a hydrocarbon vapour gave 350 cm^3 of carbon dioxide, both gas volumes being measured at the same temperature and pressure. The formula of the hydrocarbon could be

☐ **A** C_8H_{18}

☐ **B** C_7H_{16}

☐ **C** C_6H_{14}

☐ **D** C_5H_{12}

1 mark)

11)
In an experiment to determine the enthalpy change of combustion of an alcohol, a spirit burner containing the alcohol was weighed, lit and placed under a copper can containing a known volume of water. The temperature rise of the water was measured and the burner re-weighed. The enthalpy change calculated from the results was much less exothermic than the value reported in the literature.

Which of the following factors is **most** likely to be the cause of this error?

☐ **A** Heat loss around the side of the copper can.

☐ **B** The use of a thermometer with a range of 0 – 110 °C rather than 0 – 50 °C.

☐ **C** The use of a measuring cylinder for measuring the water rather than a pipette.

☐ **D** Evaporation of the alcohol during the weighing.

1 mark)

12)
(a) Coral reefs are produced by living organisms and predominantly made up of calcium carbonate. It has been suggested that coral reefs will be damaged by global warming because of the increased acidity of the oceans due to higher concentrations of carbon dioxide.

(i) Write a chemical equation to show how the presence of carbon dioxide in water results in the formation of carbonic acid. State symbols are **not** required.

(1)

(ii) Write the **ionic** equation to show how acids react with carbonates.
State symbols are **not** required.

(2)

(b) One method of determining the proportion of calcium carbonate in a coral is to dissolve a known mass of the coral in excess acid and measure the volume of carbon dioxide formed.

In such an experiment, 1.13 g of coral was dissolved in 25 cm^3 of hydrochloric acid (an excess) in a conical flask. When the reaction was complete, 224 cm^3 of carbon dioxide had been collected over water using a 250 cm^3 measuring cylinder.

(i) Draw a labelled diagram of the apparatus that could be used to carry out this experiment.

(2)

(ii) Suggest how you would mix the acid and the coral to ensure that no carbon dioxide escaped from the apparatus.

(1)

(iii) Calculate the number of moles of carbon dioxide collected in the experiment.

[The molar volume of any gas is 24 000 $cm^3\ mol^{-1}$ at room temperature and pressure.]

(1)

(iv) Complete the equation below for the reaction between calcium carbonate and hydrochloric acid by inserting the missing state symbols.

(1)

$$CaCO_3(\quad) + 2HCl(\quad) \rightarrow CaCl_2(\quad) + H_2O(l) + CO_2(\quad)$$

(v) Calculate the mass of 1 mol of calcium carbonate.

[Assume relative atomic masses: Ca = 40, C = 12, O = 16.]

(1)

(vi) Use your data and the equation in (iv) to calculate the mass of calcium carbonate in the sample and the percentage by mass of calcium carbonate in the coral.
Give your final answer to **three** significant figures.

(2)

(vii) When this experiment is repeated, the results are inconsistent. Suggest a reason for this other than errors in the procedure, measurements or calculations.

(1)

13)

(c) Magnesium chloride may be prepared from magnesium by reaction with chlorine or with hydrochloric acid. Compare these two preparations in terms of the atom economies of the reactions. No calculation is required.

(2)

14)

Alkenes are unsaturated hydrocarbons which, because of their reactivity, are important industrial starting materials. Alkenes for industrial use are obtained by cracking alkanes.

(a) Write the equation for the cracking of decane ($C_{10}H_{22}$) to form 1 molecule of propene as the only alkene.

(1)

(b) The carbon–carbon double bond in alkenes consists of a σ and a π bond.

(i) Explain, using diagrams, the difference between the σ and the π bond in the carbon–carbon double bond of an alkene.

(4)

Diagrams

Explanation

(ii) State the type and mechanism involved in the typical reaction of alkenes.

(1)

*(iii) By considering the strength and structure of the π bond, explain why alkenes are

(c) When propene reacts with hydrogen bromide, there are two possible products.

(i) Draw a displayed formula of each of these products and label the major product.

(2)

(ii) Give the mechanism for the reaction of propene with hydrogen bromide which forms the major product.

(3)

(iii) Explain, by referring to the mechanism, why the major product is formed.

(2)

(d) The polymer poly(propene) is manufactured from propene.

(i) Write an equation for the polymerization, drawing the displayed formula of the repeat unit of poly(propene).

(3)

(ii) UV radiation causes poly(propene) to degrade. Suggest one advantage and one disadvantage of this.

(2)

Advantage .....

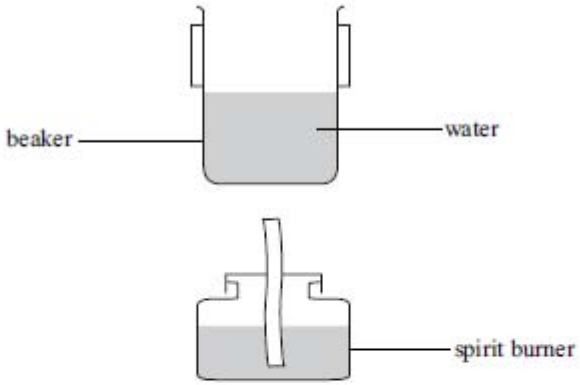
.....

Disadvantage .....

.....

15)

The enthalpy change of combustion of ethanol was determined using the apparatus shown in the diagram below. In the experiment, the temperature increase of the water in the beaker is measured when a known mass of the ethanol is burned.



(a) The results of the experiment are summarised in the table below.

Mass of water in the beaker	250.00 g
Mass of spirit burner + contents (initial)	63.21 g
Mass of spirit burner + contents (final)	62.47 g
Temperature of water (initial)	21.0 °C
Temperature of water (final)	31.5 °C

(i) Calculate the heat energy produced by the combustion of the alcohol using the equation

heat energy produced (J) = mass of water × 4.18 × temperature change

(1)

(ii) Calculate the number of moles of ethanol burned in this experiment (the formula of ethanol is C_2H_5OH).

(3)

(iii) Use the equation below to calculate the enthalpy change of combustion of ethanol in kJ mol^{-1}. Give the value an appropriate sign.

ΔH = heat energy produced ÷ number of moles

(2)

(b) The data book value for the enthalpy change of combustion of ethanol is –1370 kJ mol^{-1}.

(i) Calculate the percentage error in the value calculated in (a)(iii) in comparison with the data book value.

(1)

(ii) List **three** ways in which the design of the experiment causes the results to be so different from the data book value. (You should be specific but detailed explanations are not required.)

(3)

(iii) Use the data book values for enthalpy changes of combustion given in the table below to calculate the enthalpy change of formation of ethanol.

(3)

Substance	Enthalpy change of combustion / kJ mol^{-1}
C(s, graphite)	–394
$H_2(g)$	–286
$C_2H_5OH(l)$	–1370

16)

Sulfamic acid is a white solid used by plumbers as a limescale remover.

(a) Sulfamic acid contains 14.42% by mass of nitrogen, 3.09% hydrogen and 33.06% sulfur. The remainder is oxygen.

(i) Calculate the empirical formula of sulfamic acid.

(3)

(ii) The molar mass of sulfamic acid is 97.1 g mol^{-1}. Use this information to deduce the molecular formula of sulfamic acid.

(1)

(b) A solution of sulfamic acid contains hydrogen ions. The hydrogen ions react with magnesium to produce hydrogen gas. In an experiment, a solution containing 5.5×10^{-3} moles of sulfamic acid was reacted with excess magnesium. The volume of hydrogen produced was 66 cm^3, measured at room temperature and pressure.

(i) Draw a labelled diagram of the apparatus you would use to carry out this experiment, showing how you would collect the hydrogen produced and measure its volume.

(2)

(ii) Calculate the number of moles of hydrogen, H_2, produced in this reaction.

[The molar volume of a gas is 24 $dm^3 mol^{-1}$ at room temperature and pressure]

(1)

(iii) Show that the data confirms that each mole of sulfamic acid produces one mole of hydrogen ions in solution.

(2)