1 This question is about hydrochloric acid.

(a) Dilute hydrochloric acid, HCl(aq), reacts with many metals.

A student observes the reaction of dilute hydrochloric acid with four metals, P, Q, R and S. She uses the same amount of metal in each case.

The table shows her observations.

Metal	Observations
P	very few bubbles produced very slowly
Q	many bubbles produced very quickly
R	many bubbles produced quickly
S	few bubbles produced slowly

(i) Use the information in the table to place the four metals in order of reactivity.

Place the most reactive first.

(2)

most reactive ☐ ☐ ☐ ☐ least reactive

(ii) Give the names of the two products formed when magnesium reacts with dilute hydrochloric acid.

(2)

Product 1 .....

Product 2 .....

(b) Describe a test to show that dilute hydrochloric acid contains chloride ions.

(2)

.....

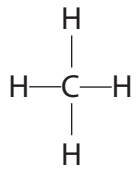
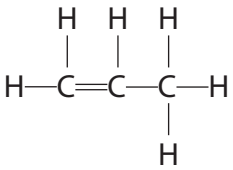
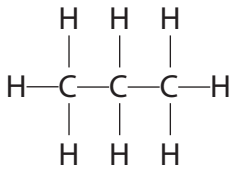
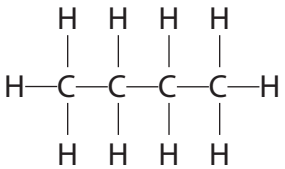
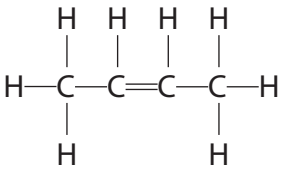
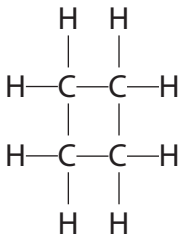
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(Total for Question 1 = 6 marks)

2 The table shows the displayed formulae of some organic compounds.

A 	B 	C 
D 	E 	F 

(a) Explain why all of these compounds are described as hydrocarbons.

(2)

.....

.....

.....

.....

(b) Why are B and E described as unsaturated?

(1)

.....

.....

(c) Which letter represents the first member of the homologous series of alkanes?

(1)

.....

(d) Which letters represent compounds that have the empirical formula CH_2?

(2)

.....

(e) Compound F has the same general formula as an alkene.

Why does F **not** decolourise bromine water?

(1)

.....

.....

(f) One of the compounds in the table reacts with bromine to form G, a compound with the composition by mass C = 22.2%, H = 3.7%, Br = 74.1%.

(i) Show, by calculation, that the empirical formula of G is C_2H_4Br

(3)

(ii) The relative formula mass of G is 216

Deduce the molecular formula of G.

(2)

molecular formula .....

(Total for Question 2 = 12 marks)

3 The production of polymers from crude oil involves several processes, including

- fractional distillation
- cracking
- purification
- polymerisation

(a) Three of the fractions obtained from fractional distillation are fuel oil, gasoline and kerosene.

(i) Identify which of these fractions has the darkest colour.

(1)

.....

(ii) Identify which of these tions has the highest boiling point.

(1)

.....

(iii) Identify which of these fractions contains molecules with the fewest carbon atoms.

(1)

.....

(b) Cracking involves heating some of the fractions to about 650 °C.

(i) Name a catalyst used in industry for cracking.

(1)

.....

(ii) One reaction that occurs in cracking involves the conversion of one molecule of hexadecane into one molecule of octane and two molecules of an alkene.

Complete the equation for this reaction.

(2)

$C_{16}H_{34} \rightarrow C_8H_{18} +$ .....

(iii) Give three reasons why cracking is carried out.

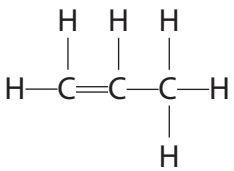
(3)

(c) One of the compounds sometimes present in crude oil has the formula $C_6H_{12}S$

Explain why it is important to remove this compound from a fuel.

(2)

(d) One compound obtained from crude oil is used as a monomer in polymerisation.
It has the displayed formula



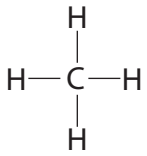
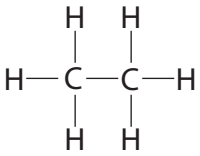
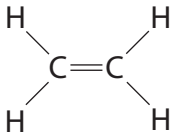
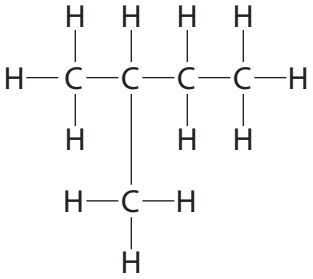
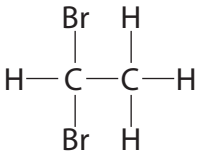
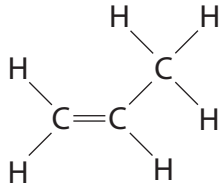
Complete the following structure to show a part of the polymer formed from this monomer.

(2)

—C—C—C—C—

(Total for Question 3 = 13 marks)

4 The table shows the displayed formulae of six organic compounds, P, Q, R, S, T and U.

P 	**Q** 	**R** 
S 	**T** 	**U** 

(a) (i) What is the molecular formula of compound S?

(1)

.....

(ii) What is the empirical formula of compound T?

(1)

.....

(b) (i) Give the letters of two compounds that belong to the homologous series of alkenes.

(1)

..... and .....

(ii) The general formula of this homologous series is

(1)

☒ **A** C_nH_{2n-2}

☒ **B** C_nH_{2n+2}

☒ **C** $C_n + H_{2n}$

☒ **D** C_nH_{2n}

(c) Which of these conversions is an example of an addition reaction?

(1)

☒ **A** compound P → compound Q

☒ **B** compound Q → compound T

☒ **C** compound R → compound Q

☒ **D** compound R → compound U

(d) Complete the table to show the displayed formula and name of the isomer of compound T.

(2)

Displayed formula	
Name	

(e) The equation represents a reaction between compound P and bromine.



(i) Complete the equation to show the displayed formula of the organic product.

(1)

(ii) State the name of this organic product.

(1)

.....

(iii) State the condition used in this reaction.

(1)

.....

(iv) What term is used for this type of reaction?

(1)

- ☒ **A** addition
- ☒ **B** hydration
- ☒ **C** neutralisation
- ☒ **D** substitution

(f) Old refrigerators may contain substances that harm the ozone layer in the atmosphere. Many new refrigerators use 152a, an organic compound that does not harm the ozone layer.

152a has the composition by mass C = 36.4%, H = 6.0% and F = 57.6%.

(i) Calculate the empirical formula of 152a.

(3)

empirical formula .....

(ii) The relative formula mass of 152a is 66

What is its molecular formula?

(1)

molecular formula.....

(Total for Question 4 = 15 marks)