1 A major source of energy is the combustion of fossil fuels.

(a) **(i)** Name a solid fossil fuel.

..... [1]

(ii) Name a gaseous fossil fuel.

..... [1]

(b) Petroleum is separated into more useful fractions by fractional distillation.

(i) Name **two** liquid fuels obtained from petroleum.

..... and ..... [2]

(ii) Name **two** other useful products obtained from petroleum that are not used as fuels.

..... and ..... [2]

(iii) Give another mixture of liquids that is separated on an industrial scale by fractional distillation.

..... [1]

[Total: 7]

2 A list of techniques used to separate mixtures is given below.

fractional distillation	**simple distillation**	**crystallization**	**filtration**	**diffusion**

From the list choose the most suitable technique to separate the following.

water from aqueous copper(II) sulphate .....

helium from a mixture of helium and argon .....

copper(II) sulphate from aqueous copper(II) sulphate .....

ethanol from aqueous ethanol .....

barium sulphate from a mixture of water and barium sulphate ..... [5]

[Total: 5]

3 **(a)** Match the following pH values to the solutions given below.

1 **3** **7** **10** **13**

The solutions all have the same concentration.

solution	**pH**
aqueous ammonia, a weak base	.....
dilute hydrochloric acid, a strong acid	.....
aqueous sodium hydroxide, a strong base	.....
aqueous sodium chloride, a salt	.....
dilute ethanoic acid, a weak acid	.....

[5]

(b) Explain why solutions of hydrochloric acid and ethanoic acid with the same concentration, in mol / dm^3, have a different pH.

.....

.....

..... [2]

(c) Measuring pH is one way of distinguishing between a strong acid and a weak acid. Describe another method.

method .....

.....

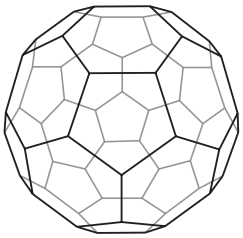
results .....

.....

[2]

[Total: 9]

4 In 1985 the fullerenes were discovered. They are solid forms of the element carbon. The structure of the C_{60} fullerene is given below.



(a) (i) In the C_{60} fullerene, how many other carbon atoms is each carbon atom bonded to?

..... [1]

(ii) Another fullerene has a relative molecular mass of 840.
How many carbon atoms are there in one molecule of this fullerene?

..... [1]

(b) Fullerenes are soluble in liquid hydrocarbons such as octane. The other solid forms of carbon are insoluble.
Describe how you could obtain crystals of fullerenes from soot which is a mixture of fullerenes and other solid forms of carbon.

.....

.....

.....

..... [3]

(c) A mixture of a fullerene and potassium is an excellent conductor of electricity.

(i) Which other form of solid carbon is a good conductor of electricity?

..... [1]

(ii) Explain why metals, such as potassium, are good conductors of electricity.

.....

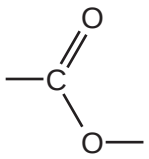
..... [2]

(iii) The mixture of fullerene and potassium has to be stored out of contact with air. There are substances in unpolluted air which will react with potassium.
Name **two** potassium compounds which could be formed when potassium is exposed to air.

..... [2]

[Total: 10]

5 The ester linkage showing all the bonds is drawn as



or more simply it can be written as –COO–.

(a) (i) Give the structural formula of the ester ethyl ethanoate.

[1]

(ii) Deduce the name of the ester formed from methanoic acid and butanol.

..... [1]

(b) (i) Which group of naturally occurring compounds contains the ester linkage?

..... [1]

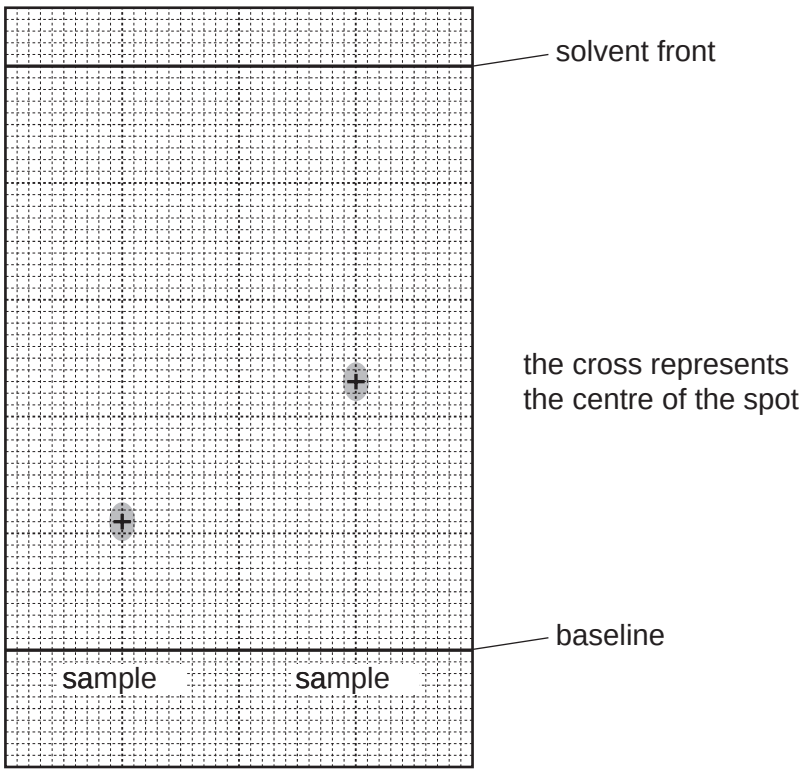
(ii) Draw the structural formula of the polyester formed from the following monomers.

$HOOCC_6H_4COOH$ and $HOCH_2CH_2OH$

You are advised to use the simpler form of the ester linkage.

[3]

(c) Esters can be used as solvents in chromatography. The following shows a chromatogram of plant acids.



An ester was used as the solvent and the chromatogram was sprayed with bromothymol blue.

(i) Suggest why it was necessary to spray the chromatogram.

.....

..... [2]

(ii) Explain what is meant by the R_f value of a sample.

.....

..... [1]

(iii) Calculate the R_f values of the two samples and use the data in the table to identify the plant acids.

plant acid	R_f value
tartaric acid	0.22
citric acid	0.30
oxalic acid	0.36
malic acid	0.46
succinic acid	0.60

sample 1 R_f = ... It is ..... acid.

sample 2 R_f = ... It is ..... acid. [2]

[Total: 11]

6 The ore of aluminium is bauxite which is impure aluminium oxide. Alumina, pure aluminium oxide, is obtained from bauxite.
Aluminium is formed at the cathode when a molten mixture of alumina and cryolite, $Na_3Al F_6$, is electrolysed.

(a) Name **two** products formed at the anode in this electrolysis.

..... [2]

(ii) All the aluminium formed comes from the alumina not the cryolite.
Suggest **two** reasons why the electrolyte must contain cryolite.

.....

..... [2]

(iii) The major impurity in bauxite is iron(III) oxide. Iron(III) oxide is basic, aluminium oxide is amphoteric. Explain how aqueous sodium hydroxide can be used to separate them.

.....

.....

..... [2]

(b) The purification of bauxite uses large amounts of sodium hydroxide.

(i) Describe the chemistry of how sodium hydroxide is made from concentrated aqueous sodium chloride. The description must include at least one ionic equation.

.....

.....

.....

.....

..... [5]

(ii) Making sodium hydroxide from sodium chloride produces two other chemicals. Name these two chemicals and state one use of each chemical.

chemical .....

use .....

chemical .....

use ..... [2]

[Total: 13]