2014 O level P2

1 (2014/O/GCSE/P2/01) The following compounds are used in manufacturing chemicals for agriculture.

A. K_3PO_4
B. H_2SO_4
C. NH_3
D. $Ca(OH)_2$
E. NH_4NO_3

Use the letters A, B, C, D and E to answer the following questions.

(a) Which solid compound is added to soil increase the pH?

[1]

(b) Two raw materials are used to make a compound.

1. One of the raw materials is made by cracking hydrocarbons.
2. The other raw material is obtained by fractional distillation of air.

Which compound is manufactured from these two raw materials?

[1]

(c)

(i) Which two compounds can be reacted together to form an ammonium salt?

_____ and _____

[1]

(ii) Give the formula of the salt

[1]

(d) NPK fertilizers are solid fertilizers that contain compounds of nitrogen, phosphorus and potassium. Which two compounds could be mixed to produce an NPK fertilizer?

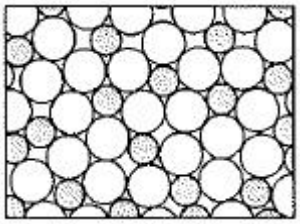
_____ and _____

[1]

2 (2014/O/GCSE/P2/02) Chromium can be used as a protective metal for both steel and pure iron.

(a) Stainless steel is an alloy of iron which contains approximately 20% chromium mixed with iron and some small amounts of other metals.

(i) The diagram show the arrangement of atoms in stainless steel.



Stainless steel is much harder than pure iron. Use ideas about the arrangement of atoms in stainless steel to explain why.

[2]

(b) The chromium in the stainless steel reacts with oxygen in the air to form chromium oxide. The chromium oxide forms a layer on the surface of the stainless steel. This layer stops the iron in the stainless steel from rusting.

(i) The formula for chromium oxide is Cr_2O_3. What is the formula for the chromium ion?

[1]

(ii) Suggest how the layer of chromium oxide stops the iron in the stainless steel from rusting.

[1]

(c) Door handles and trims on some cars are made from iron coated with chromium. Chromium is a more reactive metal than iron.

(i) If the chromium coating is scratched, would you the iron underneath to rust? Explain your answer.

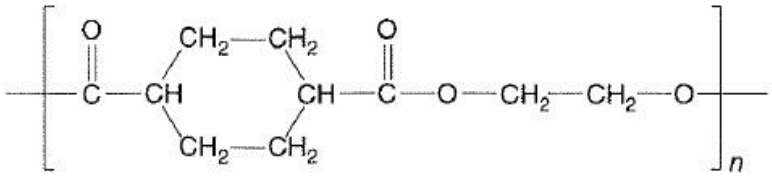
[1]

(ii) Suggest a method that could be used to apply the chromium coating to the iron

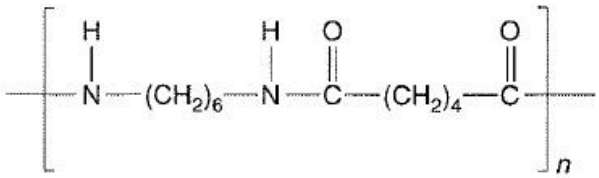
[1]

3 (2014/O/GCSE/P2/03) The diagrams show the structures of some polymers, A, B, C and D

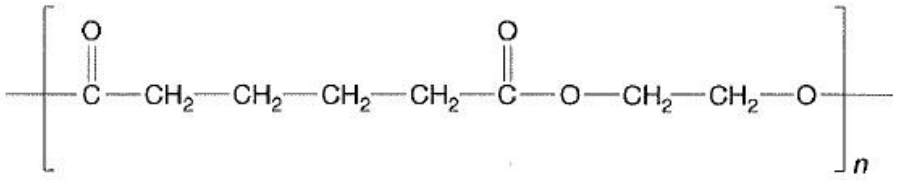
A



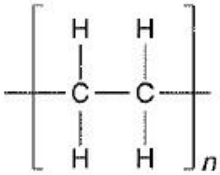
B



C



D



(a) What is the name of the group that links the monomers together in both A and C?

[1]

(b) Name D.

[1]

(c) Draw the structures of the monomers that react to form C.

[2]

(d) A, B, C and D include examples of polymers made by both addition and condensation polymerization reactions. Describe three differences between addition and condensation polymerization reactions.

[3]

(e) A sample of D contains molecules with an average relative molecular mass of 2800. How many carbon atoms are there in an average molecule of the polymer?

[1]

4 (2014/O/GCSE/P2/04) The alcohols are a homologous series.

The table shows some data about the enthalpy change when 1 mol of 1 of each alcohol are completely combusted.

Name of alcohol	**Formula**	**Enthalpy change of combustion (kJ/mol)**	**Enthalpy change of combustion (kJ/g)**
Methanol	CH_3OH	-715	-22.3
Ethanol	C_2H_5OH	-1371	-29.8
Propanol	C_3H_7OH	-2010	
Butanol	C_4H_9OH	-2673	-36.1

(a) Calculate the enthalpy of combustion when 1 g of propanol burns. Show your working.

[2]

(b) Use ideas about breaking and forming bonds to explain why all of the values in the table are negative

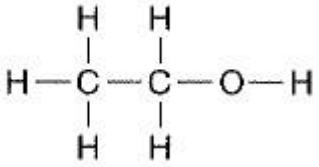
[3]

(c) The enthalpy change of combustion in kJ/mol increases from methanol to butanol. Suggest a reason why.

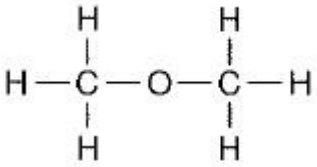
[1]

(d) One characteristic of a homologous series is that properties show a trend. Describe the trends you would expect for three properties of the alcohols as the molecules increase in size. Enthalpy change of combustion must not be one of the properties you choose.

(e) Dimenthylether is an isomer of ethanol.



ethanol



dimethylether

The enthalpy changes of combustion for ethanol and dimenthylether are different.

Isomer	Ethanol C_2H_5OH	Dimenthylether CH_3OCH_3
Enthalpy change of combustion (kJ/mol)	-1371	-1460

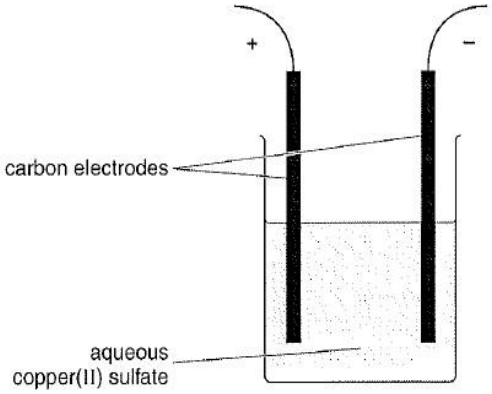
(i) The same products are formed when both isomers are completely combusted. Write equations to show the complete combustion of ethanol and dimenthylether.

[2]

(ii) Suggest why the enthalpy changes of combustion for the two isomers are different.

[2]

5 (2014/O/GCSE/P2/05) A student investigates the amount of copper that forms on the negative electrode during the electrolysis of aqueous copper (II) sulfate. The student uses this apparatus.



(a) Write equations for the reactions that happen at each electrode during the electrolysis. Include state symbols.

At the positive electrode:

At the positive electrode:

[3]

(b) The student measures the mass of the negative electrode at the start He allows the electrolysis to continue for 10 minutes. He dries the electrode, reweighs it and then replaces the electrode to allow the electrolysis to continue for a further 10 minutes. He repeats this process until the mass of the electrode does not change.
The table shows his results.

Total time / min	Mass of electrode / g
0	3.50
10	3.91
20	4.15
30	4.78
40	5.21
50	5.61
60	6.10
70	6.10
80	6.10

(i) What general pattern is show by the results?

[1]

(ii) The student makes an error in recording one of the mass readings. Which result is most likely to be an error? Explain your reasoning.

[2]

(iii) Suggest why the mass does not change after 60 minutes.

[1]

(c) The student repeats the experiment. This time he uses copper electrodes. How would you expect his results for this experiment to differ from his first experiment? Explain your reasoning.

[3]

6 (2014/O/GCSE/P2/06) Naphtha is a fraction of crude oil. The molecules in naphtha are hydrocarbons with between 5 and 12 carbon atoms. Naphtha is processed by cracking in an oil refinery.

(a) Explain why cracking of naphtha is an important process in an oil refinery.

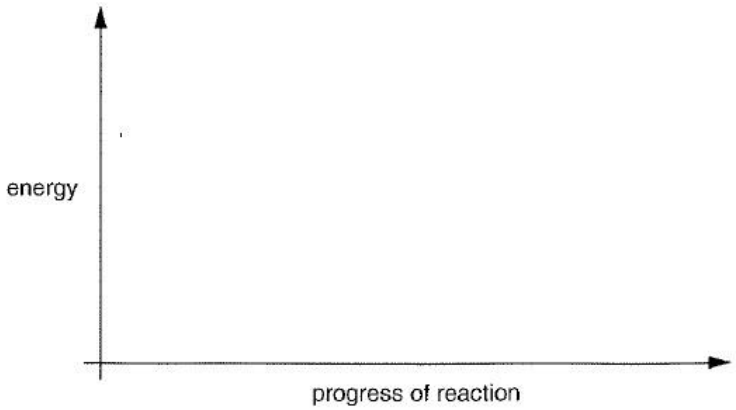
[2]

(b) One of the molecules in naphtha is a saturated hydrocarbon containing 5 carbon atoms. When this molecule is cracked it produces ethane and one other product. Write an equation, showing full structural formulae, for this reaction.

[2]

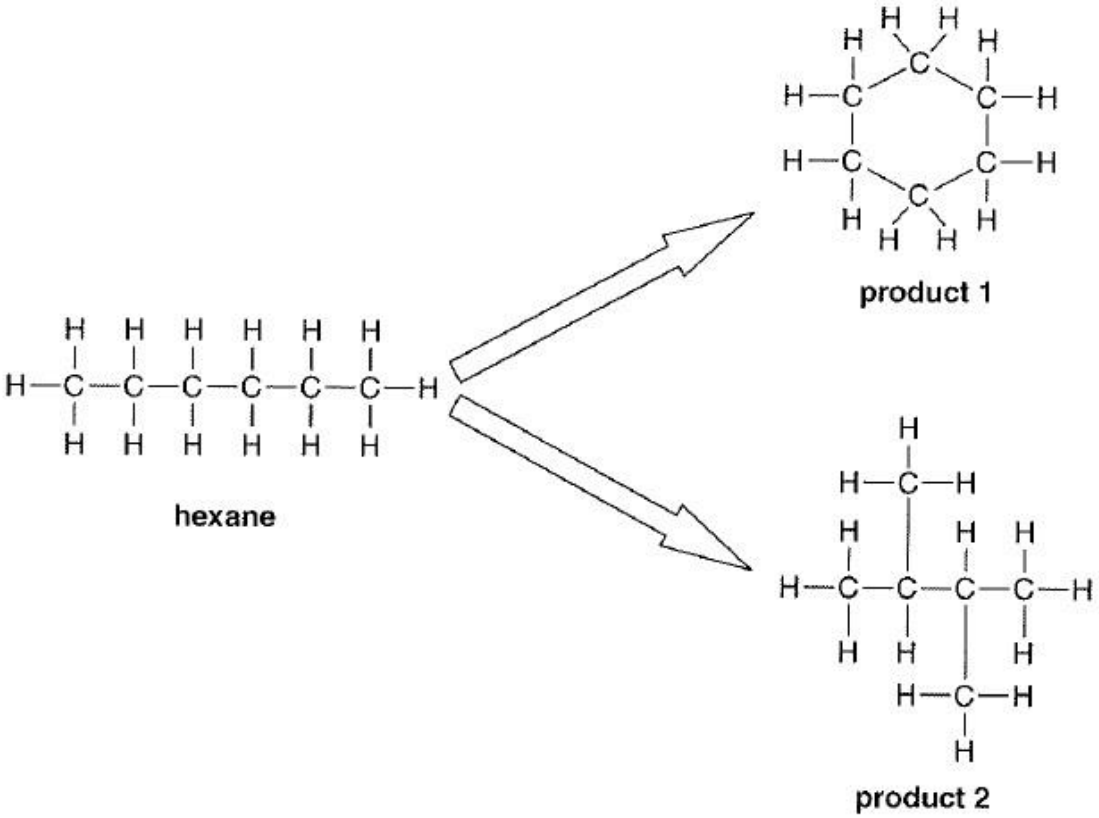
(c) Cracking is an endothermic process that can use catalyst. Draw an energy profile diagram to show the effect of the catalyst on the cracking process.
Your diagram should show and label.

1. Reactants and products.
2. The activation energy for the uncatalysed and catalysed reactions.
3. The enthalpy change of reaction.



[3]

(d) In another process, hexane is passed over a heated catalyst and many products can form. Two of the possible products are shown below.



Are products 1 and 2 isomers of hexane? Explain your reasoning.

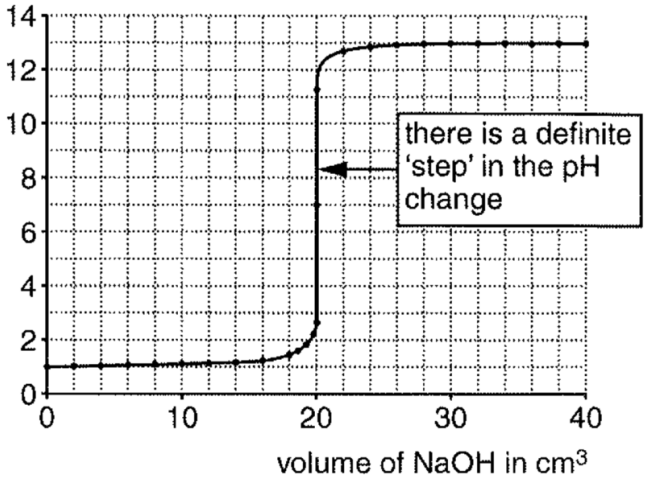
[2]

Section B

7 (2014/O/GCSE/P2/07) pH changes during a titration [N2014/P2/B7]

A pH meter and a data logger are used to monitor the pH changes during a series of titrations. In each titration, 0.1 mol/dm^3 sodium hydroxide, NaOH, is added from a burette into a solution of a different dilute acid. During the titrations the pH does not change smoothly. The data logger gives a graph for each titration.

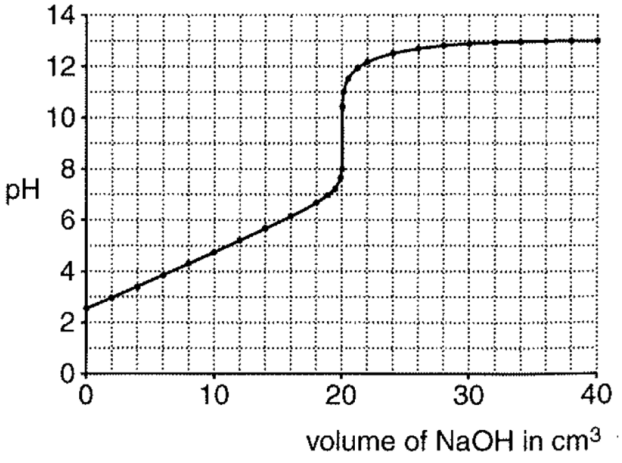
Titration 1:
0.1 mol/dm^3 sodium hydroxide added to 20.0 cm^3 0.1 mol/dm^3 hydrochloric acid (HCl)



Titration 2:
0.1 mol/dm^3 sodium hydroxide added to 20.0 cm^3 0.1 mol/dm^3 ethanoic acid (CH_3COOH)

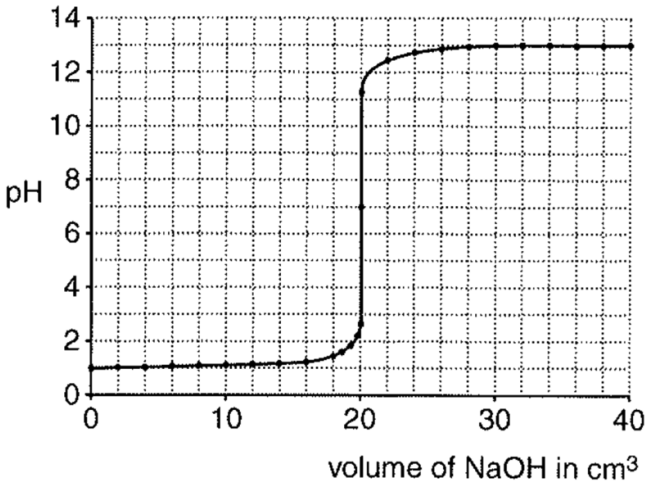
Ethanoic acid is a weak acid.

The shape of the graph is different from titration 1.



Titration 3:

0.1 mol/dm^3 sodium hydroxide added to 20.0 cm^3 unknown concentration of dilute sulfuric acid (H_2SO_4)



Sulfuric acid is a strong acid. The ionisation of sulfuric acid can be shown by two equations

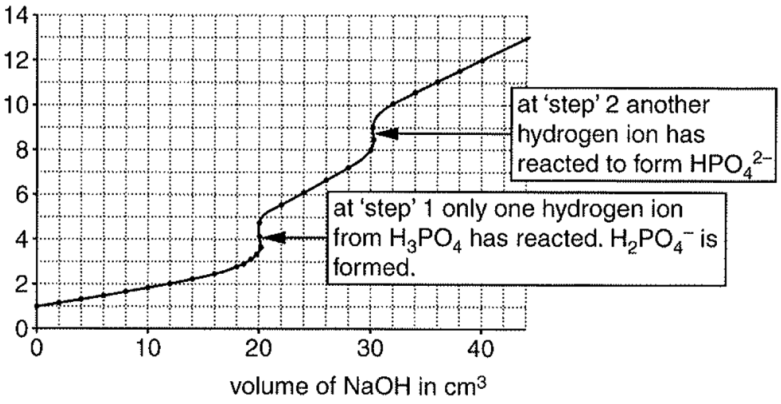
1. $H_2SO_4 \rightarrow H^+ + HSO_4^-$
2. $HSO_4^- \rightarrow H^+ + SO_4^{2-}$

H_2SO_4 and HSO_4^- are both strong acids. Therefore they are both neutralised at the same point in the titration, which means that there is still only a single 'step' on the graph.

Titration 4:

0.1 mol/dm^3 sodium hydroxide added to 20.0 cm^3 unknown concentration of dilute phosphoric acid (H_3PO_4)

The graph for phosphoric acid has two 'steps'



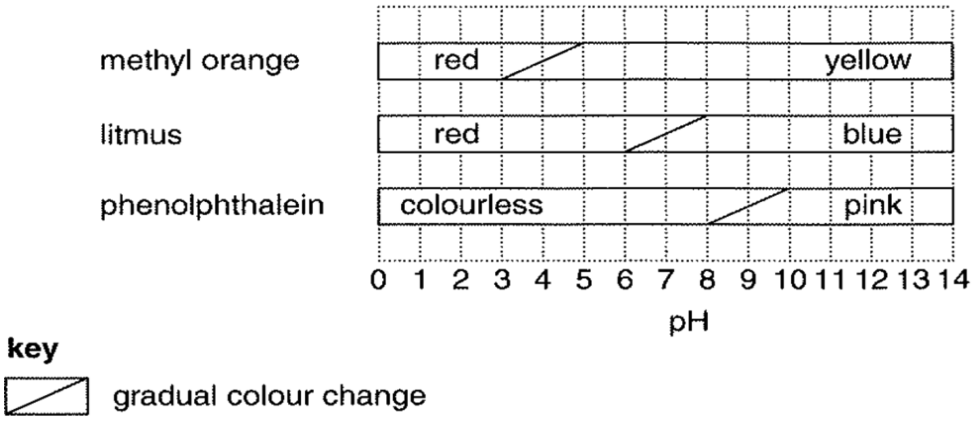
There appear to be three hydrogen atoms in phosphoric acid that may ionise. In practice, only the first two hydrogen atoms form ions. At the end of the titration, HPO_4^{2-} ions are left.

Endpoints and indicators

An indicator can also be used to see when a 'step' happens in the pH change.

The endpoint of each titration happens when the indicator changes colour.

The diagram shows the colours of some indicators at different pH values. In between the colours, most indicators change colour gradually over a range of pH values.



The best indicator for a titration gives a distinct colour change when a 'step' occurs.

For a titration between a strong acid and a strong alkali, every indicator in the diagram would give an accurate titration volume.

(a) The information does not give the concentration of sulfuric acid used in titration 3. What is the concentration? Explain your reasoning in words or by means of a calculation.

[2]

(b) Hydrochloric acid is a strong acid; ethanoic acid is a weak acid.

(i) What is the difference between a strong acid and a weak acid?

[1]

(ii) Identify 2 differences between the pH graphs for titration 1 & titration 2.

[2]

(c)

(i) Write equations to show how phosphoric acid produces the hydrogen ions involved in the two 'steps' on the pH graph in titration 4.

'step' 1

'step' 2

[2]

(ii) Give the formula for the salt formed at the end of titration 4.

[1]

(d)

(i) Explain why any of the indicators in the diagram can be used to give an accurate titration volume when strong acids are titrated with dilute sodium hydroxide.

[2]

(ii) Explain why methyl orange would not be suitable to use when titrating ethanoic acid with dilute sodium hydroxide.

[2]

(iii) Suggest the best indicator to use when titrating ethanoic acid with dilute sodium hydroxide.

[1]

8 (2014/O/GCSE/P2/08) Diamond and graphite have some similarities and some differences between their bonding and structures.

(a) Describe the similarities and differences between the bonding and structures in diamond and graphite

[4]

(b) When graphite is heated in air, it reacts with oxygen to produce carbon dioxide. The table shows some differences between the properties of graphite and carbon dioxide.

	Graphite	Carbon dioxide
Melting point and boiling point	Both above 3000°C	Both below 0°C
Solubility in water	Insoluble	Dissolves to form an acidic solution
Electrical conductivity	Good	Does not conduct

Explain why graphite and carbon dioxide have different properties.

[4]

EITHER

9 (2014/O/GCSE/P2/09) Phosphorus tribromide, PBr_3, is a covalently bonded compound.

It is used as a catalyst for making chemical compounds for medicines

It has to be handled and stored carefully because it is very toxic and it reacts very vigorously with water.

(a) Draw a 'dot-and-cross' diagram to show the bonding in phosphorus tribromide. Show outer electrons only.

[2]

(b) When phosphorus tribromide reacts with water, it forms phosphorus acid, H_3PO_3 and hydrogen bromide, HBr. Write a balanced equation for this reaction.

[1]

(c) One way of making phosphorus tribromide is to react phosphorus with bromine.

$$P + 3Br \rightarrow 2PBr_3$$

(i) Bromine has an oxidation state of -1 in phosphorus tribromide. How does the oxidation state of phosphorus change during the reaction?

[1]

(ii) Calculate the mass of bromine that reacts to make 54.2 g of phosphorus tribromide.

[3]

(d) Chlorine also reacts with phosphorus.

$$2P + 3C/_2 \leftrightarrow 2PC/_3$$

(i) When the same number of moles of phosphorus is reacted with both bromine and chlorine, the rates for the two reactions are different. How would you expect the rates to differ? Explain your reasoning.

[2]

(ii) In practice, when phosphorus reacts with chlorine, the yield of phosphorus trichloride is never 100%. Suggest a reason why.

[1]

OR

10 (2014/O/GCSE/P2/10) The radii of atoms and ions can be measured.

The tables show some information about atomic radii and ionic radii of some Group I and Group VII elements.

Element	Number of shells of electrons in atom	Atomic radius/pm	Number of shells of electrons in + 1 ion	Ionic radius /pm
Lithium	2	152		68
Sodium	3	185		98
Potassium	4	227		133

Element	Number of shells of electrons in atom	Atomic radius/pm	Number of shells of electrons in - 1 ion	Ionic radius /pm
Fluorine	2	71		133
Chlorine	3	99		181
Bromine	4	115		196

(1 000 000 000 000 pm = 1 m)

(a) Complete the table to show the number shells of electrons in the ions of Group I and Group VII elements.

[2]

(b) Describe the trend in atomic radii for Group I and use the data to explain this trend.

[2]

(c)

(i) Describe the change in the radius when a lithium atom forms a lithium ion.

[1]

(ii) Suggest why the radius of a lithium atom changes in this way when it forms a lithium ion.

[1]

(iii) Draw diagrams to show the arrangement of electrons in a lithium and a lithium ion to support your answer in ii.

[2]

(d) Strontium is in Group II.The table below shows the atomic radius of a strontium atom.

Element	Atomic radius /pm
Strontium	215

Predict the ionic radius of strontium.
Explain your reasoning.

Prediction _____pm

Reasoning

_____

[2]