

## Location Entry Codes

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As part of CIE's continual commitment to maintaining best practice in assessment, CIE uses different variants of some question papers for our most popular assessments with large and widespread candidature. The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions is unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiners' Reports that are available.

<b>Question Paper</b>	<b>Mark Scheme</b>	<b>Principal Examiner's Report</b>
Introduction	Introduction	Introduction
First variant Question Paper	First variant Mark Scheme	First variant Principal Examiner's Report
Second variant Question Paper	Second variant Mark Scheme	Second variant Principal Examiner's Report

### **Who can I contact for further information on these changes?**

Please direct any questions about this to CIE's Customer Services team at:

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The titles for the variant items should correspond with the table above, so that at the top of the first page of the relevant part of the document and on the header, it has the words:

- First variant Question Paper / Mark Scheme / Principal Examiner's Report

or

- Second variant Question Paper / Mark Scheme / Principal Examiner's Report

as appropriate.



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**CHEMISTRY**

**0620/31**

Paper 3 (Extended)

**May/June 2009**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

A copy of the Periodic Table is printed on page 16.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part questions.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
<b>Total</b>	

This document consists of **15** printed pages and **1** blank pages.



1 Some grass is crushed and mixed with the solvent, propanone. The colour pigments are extracted to give a deep green solution.

(a) (i) Draw a labelled diagram to describe how you could show that there is more than one coloured pigment in the green solution.

[3]

(ii) Given a pure sample of chlorophyll, how could you show that the green solution from the grass contained chlorophyll?

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

(b) Explain the role of chlorophyll in green plants.

.....  
.....  
.....  
.....  
.....  
..... [3]

[Total: 8]

- 2 The results of experiments on electrolysis using inert electrodes are given in the table.

Complete the table; the first line has been completed as an example.

For  
Examiner's  
Use

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
..... .....	potassium formed	iodine formed	used up
dilute aqueous sodium chloride	.....	.....	..... .....
aqueous copper(II) sulfate	.....	.....	..... .....
..... .....	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

3 The following is a list of the electron distributions of atoms of unknown elements.

For  
Examiner's  
Use

element	electron distribution
<b>A</b>	2,5
<b>B</b>	2,8,4
<b>C</b>	2,8,8,2
<b>D</b>	2,8,18,8
<b>E</b>	2,8,18,8,1
<b>F</b>	2,8,18,18,7

(a) Choose an element from the list for each of the following descriptions.

- (i) It is a noble gas. ....
- (ii) It is a soft metal with a low density. ....
- (iii) It can form a covalent compound with element **A**. ....
- (iv) It has a giant covalent structure similar to diamond. ....
- (v) It can form a negative ion of the type  $X^{3-}$ . .... [5]

(b) Elements **C** and **F** can form an ionic compound.

- (i) Draw a diagram that shows the formula of this compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.  
Use **o** to represent an electron from an atom of **C**.  
Use **x** to represent an electron from an atom of **F**.

[3]

(ii) Predict **two** properties of this compound.

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

[Total: 10]

- 4 The reactivity series of metals given below contains both familiar and unfamiliar elements. For most of the unfamiliar elements, which are marked \*, their common oxidation states are given.

For  
Examiner's  
Use

* barium	Ba
* lanthanum	La (+3)
magnesium	
zinc	
* chromium	Cr (+2), (+3), (+6)
iron	
copper	
* palladium	(+2)

Choose metal(s) from the above list to answer the following questions.

- (i) Which **two** metals would not react with dilute hydrochloric acid?

..... [2]

- (ii) Which **two** unfamiliar metals (\*) would react with cold water?

..... [2]

- (iii) What is the oxidation state of barium?

..... [1]

- (iv) Name an unfamiliar metal (\*) whose oxide cannot be reduced by carbon.

..... [1]

- (v) Why should you be able to predict that metals such as iron and chromium have more than one oxidation state?

.....  
..... [1]

[Total: 7]

5 Insoluble salts are made by precipitation.

(a) A preparation of the insoluble salt calcium fluoride is described below.

To 15 cm<sup>3</sup> of aqueous calcium chloride, 30 cm<sup>3</sup> of aqueous sodium fluoride is added. The concentration of both solutions is 1.00 mol / dm<sup>3</sup>. The mixture is filtered and the precipitate washed with distilled water. Finally, the precipitate is heated in an oven.

(i) Complete the equation.



(ii) Why is the volume of sodium fluoride solution double that of the calcium chloride solution?

.....  
..... [1]

(iii) Why is the mixture washed with distilled water?

.....  
..... [1]

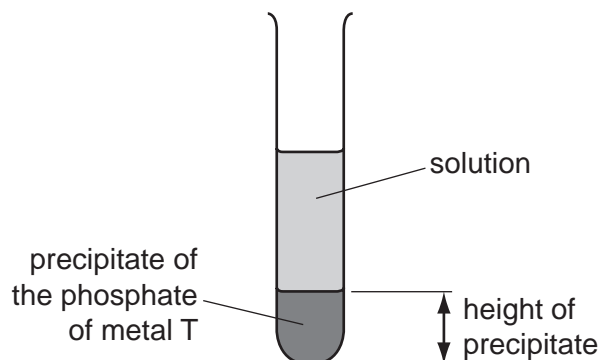
(iv) Why is the solid heated?

.....  
..... [1]

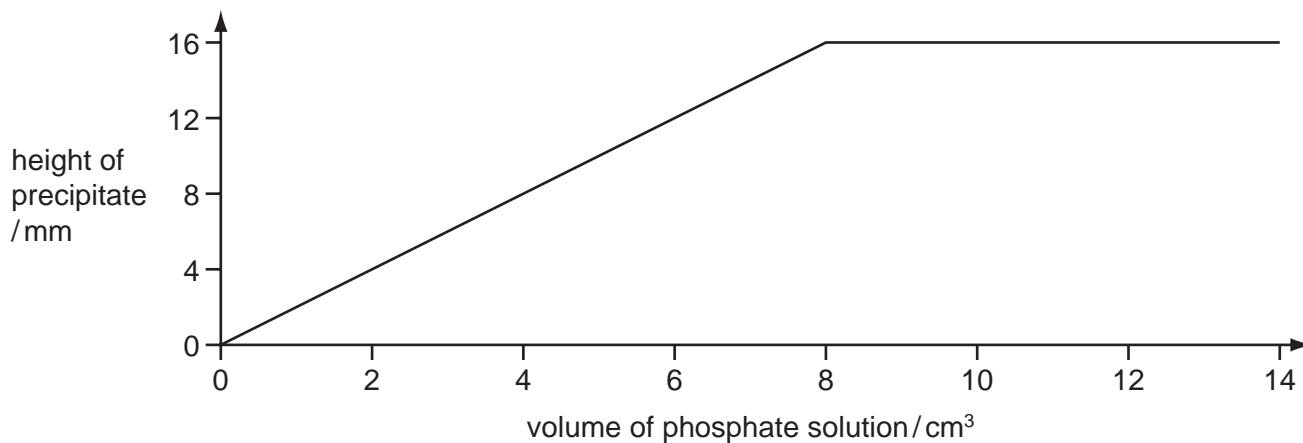
(b) The formulae of insoluble compounds can be found by precipitation reactions.

To  $12.0 \text{ cm}^3$  of an aqueous solution of the nitrate of metal T was added  $2.0 \text{ cm}^3$  of aqueous sodium phosphate,  $\text{Na}_3\text{PO}_4$ . The concentration of both solutions was  $1.00 \text{ mol/dm}^3$ . When the precipitate had settled, its height was measured.

For  
Examiner's  
Use



The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.



What is the formula of the phosphate of metal T? Give your reasoning.

.....

.....

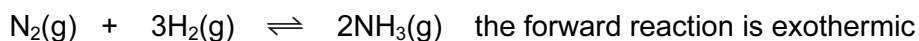
.....

..... [3]

[Total: 8]



6 Ammonia is manufactured by the Haber process.



For  
Examiner's  
Use

(a) (i) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen from .....

[1]

hydrogen from .....

[1]

(ii) Name the catalyst used in this process.

.....

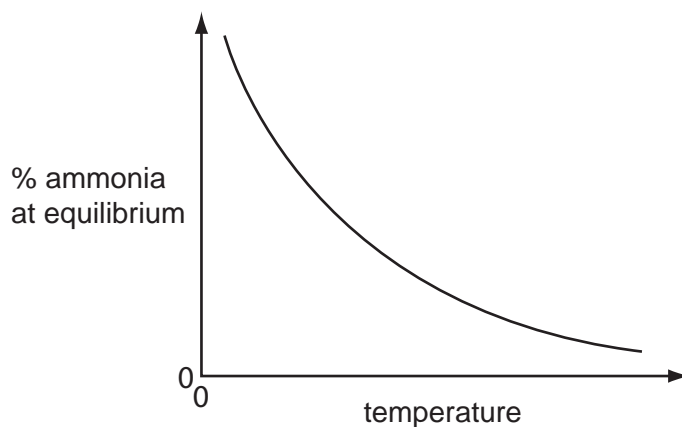
[1]

(iii) What is the most important use of ammonia?

.....

[1]

(b) The following graph shows how the percentage of ammonia in the equilibrium mixture changes with temperature.



(i) Explain the term *equilibrium*.

.....  
 .....  
 .....  
 .....

[2]

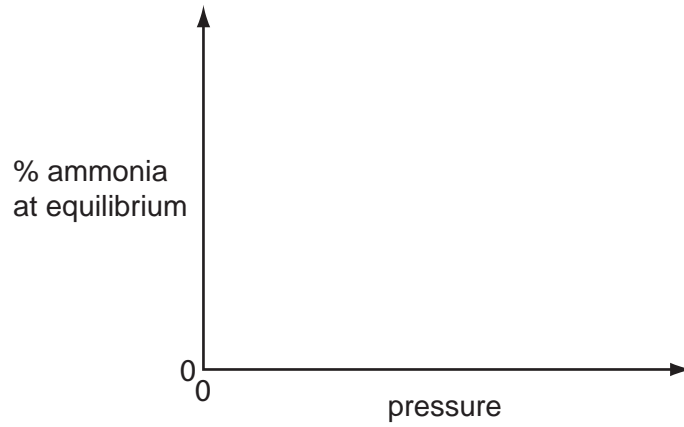
(ii) How does the percentage of ammonia vary with temperature?

.....

[1]

(c) (i) Sketch a graph which shows how the percentage of ammonia in the equilibrium mixture varies with pressure.

*For  
Examiner's  
Use*



[1]

(ii) Explain why the graph has the shape shown.

.....

.....

..... [2]

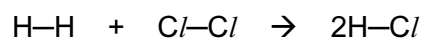
[Total: 10]

7 Hydrogen reacts with the halogens to form hydrogen halides.

(a) Bond energy is the amount of energy, in kJ, that must be supplied (endothermic) to break one mole of a bond.

bond	bond energy in kJ/mol
H—H	+436
Cl—Cl	+242
H—Cl	+431

Use the above data to show that the following reaction is exothermic.



.....  
.....  
.....  
.....  
..... [3]

For  
Examiner's  
Use

(b) They react with water to form acidic solutions.



For  
Examiner's  
Use

(i) Explain why water behaves as a base in both of these reactions.

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

(ii) At equilibrium, only 1% of the hydrogen chloride exists as molecules, the rest has formed ions. In the other equilibrium, 97% of the hydrogen fluoride exists as molecules, only 3% has formed ions.

What does this tell you about the strength of each acid?

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

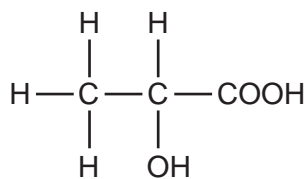
(iii) How would the pH of these two solutions differ?

..... [1]

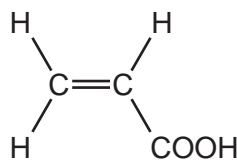
[Total: 8]



(c) When lactic acid is heated, acrylic acid is formed.



lactic acid



acrylic acid

(i) Complete the word equation for the action of heat on lactic acid.

lactic acid → ..... + ..... [1]

(ii) Describe a test that would distinguish between lactic acid and acrylic acid.

*test* .....

*result for lactic acid* .....

*result for acrylic acid* ..... [3]

(iii) Describe a test, other than using an indicator, which would show that both chemicals contain an acid group.

*test* .....

*result* .....

..... [2]

[Total: 13]

For  
Examiner's  
Use

9 Quantities of chemicals, expressed in moles, can be used to find the formula of a compound, to establish an equation and to determine reacting masses.

For  
Examiner's  
Use

(a) A compound contains 72% magnesium and 28% nitrogen. What is its empirical formula?

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

(b) A compound contains only aluminium and carbon. 0.03 moles of this compound reacted with excess water to form 0.12 moles of  $Al(OH)_3$  and 0.09 moles of  $CH_4$ .

Write a balanced equation for this reaction.

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

(c) 0.07 moles of silicon reacts with 25g of bromine.



(i) Which one is the limiting reagent? Explain your choice.

.....  
 .....  
 .....  
 ..... [3]

(ii) How many moles of  $SiBr_4$  are formed?

..... [1]

[Total: 8]





**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																																
I	II	III	IV	V	VI	VII	0																											
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10	27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18																				
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36	85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	101 <b>Ru</b> Ruthenium 44	106 <b>Pd</b> Palladium 46	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54										
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	197 <b>Au</b> Gold 79	198 <b>Hg</b> Mercury 80	201 <b>Pb</b> Lead 82	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89	232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>Np</b> Neptunium 93	241 <b>Am</b> Americium 95	244 <b>Cm</b> Curium 96	247 <b>Bk</b> Berkelium 97	251 <b>Cf</b> Californium 98	252 <b>Es</b> Einsteinium 99	257 <b>Fm</b> Fermium 100	261 <b>Md</b> Mendelevium 101	265 <b>No</b> Nobelium 102	269 <b>Lr</b> Lawrencium 103

\* 58-71 Lanthanoid series  
† 90-103 Actinoid series

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

Key

a	<b>X</b>
b	

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

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CANDIDATE  
NUMBER

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\* 0 5 8 3 1 0 0 1 2 1 \*

**CHEMISTRY**

**0620/32**

Paper 3 (Extended)

**May/June 2009**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

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Answer **all** questions.

A copy of the Periodic Table is printed on page 16.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part questions.

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9	
<b>Total</b>	

This document consists of **15** printed pages and **1** blank page.



1 Some grass is crushed and mixed with the solvent, propanone. The colour pigments are extracted to give a deep green solution.

(a) (i) Draw a labelled diagram to describe how you could show that there is more than one coloured pigment in the green solution.

[3]

(ii) Given a pure sample of chlorophyll, how could you show that the green solution from the grass contained chlorophyll?

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

(b) Explain the role of chlorophyll in green plants.

.....  
.....  
.....  
.....  
.....  
..... [3]

[Total: 8]

- 2 The results of experiments on electrolysis using inert electrodes are given in the table.

Complete the table; the first line has been completed as an example.

For  
Examiner's  
Use

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
..... .....	lithium formed	chlorine formed	used up
dilute aqueous sodium chloride	.....	.....	..... .....
aqueous copper(II) sulfate	.....	.....	..... .....
..... .....	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

3 The following is a list of the electron distributions of atoms of unknown elements.

For  
Examiner's  
Use

element	electron distribution
<b>A</b>	2,6
<b>B</b>	2,8,4
<b>C</b>	2,8,8,2
<b>D</b>	2,8,18,8
<b>E</b>	2,8,18,8,1
<b>F</b>	2,8,18,18,7

(a) Choose an element from the list for each of the following descriptions.

(i) It is a noble gas. ....

(ii) It is a soft metal with a low density. ....

(iii) It can form a covalent compound with element **A**. ....

(iv) It has a giant covalent structure similar to diamond. ....

(v) It is a diatomic gas with molecules of the type  $X_2$ . .... [5]

(b) Elements **C** and **A** can form an ionic compound.

(i) Draw a diagram that shows the formula of this compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use **o** to represent an electron from an atom of **C**.

Use **x** to represent an electron from an atom of **A**.

[3]

(ii) Predict **two** properties of this compound.

.....

.....

..... [2]

[Total: 10]

- 4 The reactivity series of metals given below contains both familiar and unfamiliar elements. For most of the unfamiliar elements, which are marked \*, their common oxidation states are given.

For  
Examiner's  
Use

* barium	Ba
* lanthanum	La (+3)
magnesium	
zinc	
* chromium	Cr (+2), (+3), (+6)
iron	
copper	
* palladium	(+2)

Choose metal(s) from the above list to answer the following questions.

- (i) Which **two** metals would not react with dilute hydrochloric acid?

..... [2]

- (ii) Which **two** unfamiliar metals (\*) would react with cold water?

..... [2]

- (iii) What is the oxidation state of barium?

..... [1]

- (iv) Name an unfamiliar metal (\*) whose oxide cannot be reduced by carbon.

..... [1]

- (v) Why should you be able to predict that metals such as iron and chromium have more than one oxidation state?

.....  
..... [1]

[Total: 7]

5 Insoluble salts are made by precipitation.

For  
Examiner's  
Use

(a) A preparation of the insoluble salt iron fluoride is described below.

To 15 cm<sup>3</sup> of aqueous iron(III) chloride, 45 cm<sup>3</sup> of aqueous sodium fluoride is added. The concentration of both solutions is 1.00 mol / dm<sup>3</sup>. The mixture is filtered and the precipitate washed with distilled water. Finally, the precipitate is heated in an oven.

(i) Complete the equation.



(ii) Why is the volume of sodium fluoride solution three times that of the iron(III) chloride solution?

.....  
..... [1]

(iii) Why is the mixture washed with distilled water?

.....  
..... [1]

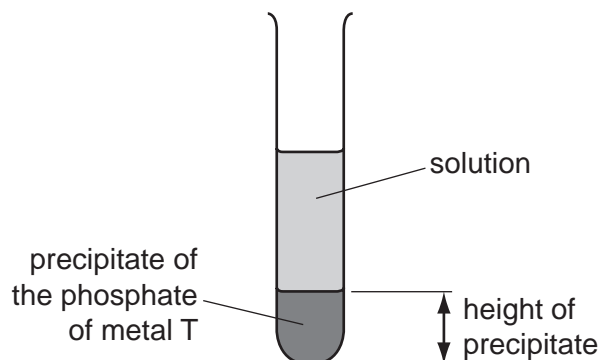
(iv) Why is the solid heated?

.....  
..... [1]

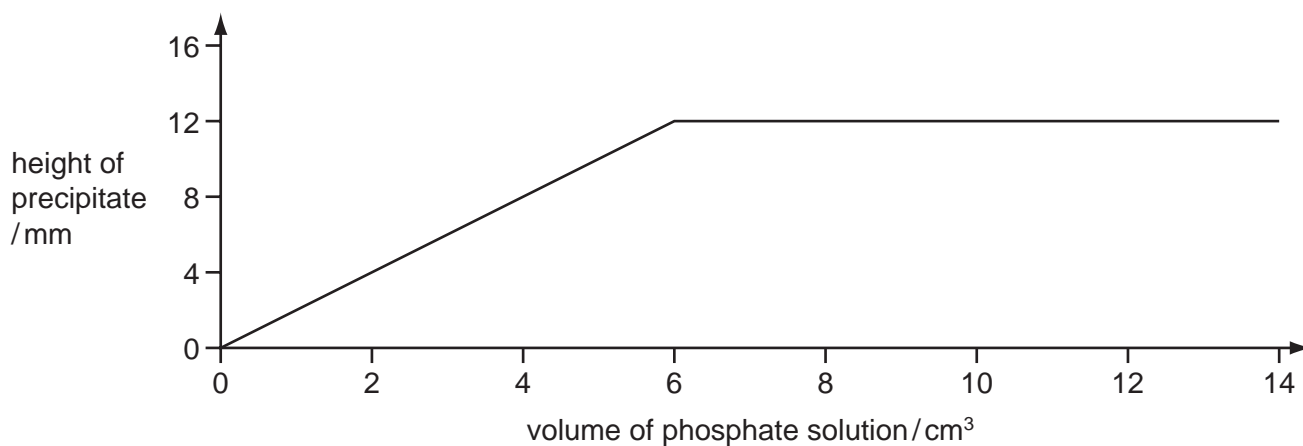
(b) The formulae of insoluble compounds can be found by precipitation reactions.

To  $18.0 \text{ cm}^3$  of an aqueous solution of the nitrate of metal T was added  $2.0 \text{ cm}^3$  of aqueous sodium phosphate,  $\text{Na}_3\text{PO}_4$ . The concentration of both solutions was  $1.00 \text{ mol/dm}^3$ . When the precipitate had settled, its height was measured.

For  
Examiner's  
Use



The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.



What is the formula of the phosphate of metal T? Give your reasoning.

.....

.....

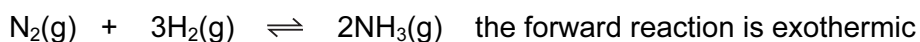
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..... [3]

[Total: 8]



6 Ammonia is manufactured by the Haber process.



For  
Examiner's  
Use

(a) (i) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen from .....

[1]

hydrogen from .....

[1]

(ii) Name the catalyst used in this process.

.....

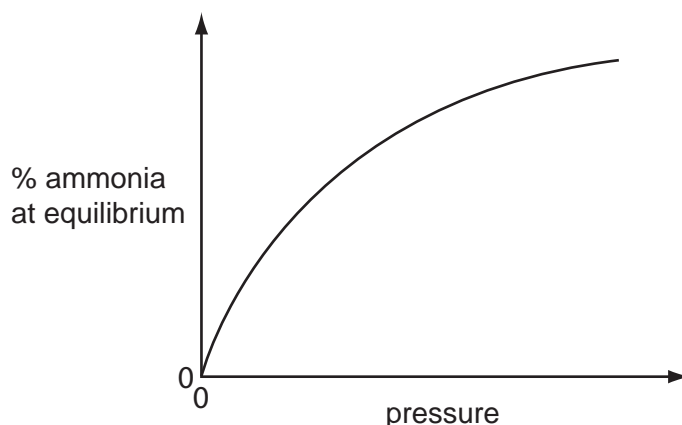
[1]

(iii) What is the most important use of ammonia?

.....

[1]

(b) The following graph shows how the percentage of ammonia in the equilibrium mixture changes with pressure.



(i) Explain the term *equilibrium*.

.....  
 .....  
 .....  
 .....

[2]

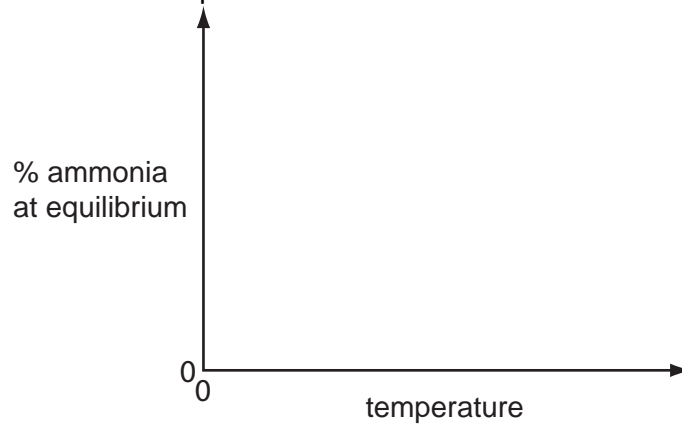
(ii) How does the percentage of ammonia vary with pressure?

.....

[1]

- (c) (i) Sketch a graph which shows how the percentage of ammonia in the equilibrium mixture varies with temperature.

For  
Examiner's  
Use



[1]

- (ii) Explain why the graph has the shape shown.

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

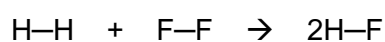
[Total: 10]

7 Hydrogen reacts with the halogens to form hydrogen halides.

(a) Bond energy is the amount of energy, in kJ, that must be supplied (endothermic) to break one mole of a bond.

bond	bond energy in kJ/mol
H—H	+436
F—F	+158
H—F	+562

Use the above data to show that the following reaction is exothermic.



.....

.....

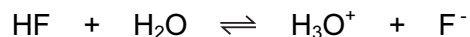
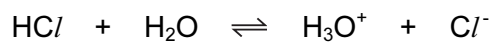
.....

.....

..... [3]

For  
Examiner's  
Use

(b) They react with water to form acidic solutions.



For  
Examiner's  
Use

(i) Explain why water behaves as a base in both of these reactions.

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

(ii) At equilibrium, only 1% of the hydrogen chloride exists as molecules, the rest has formed ions. In the other equilibrium, 97% of the hydrogen fluoride exists as molecules, only 3% has formed ions.

What does this tell you about the strength of each acid?

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

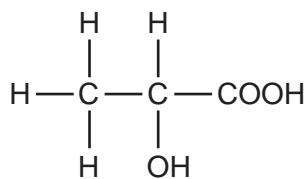
(iii) How would the pH of these two solutions differ?

..... [1]

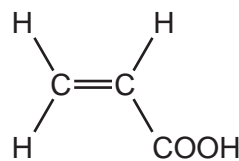
[Total: 8]



(c) When lactic acid is heated, acrylic acid is formed.



lactic acid



acrylic acid

(i) Complete the word equation for the action of heat on lactic acid.

lactic acid → ..... + ..... [1]

(ii) Describe a test that would distinguish between lactic acid and acrylic acid.

*test* .....

*result for lactic acid* .....

*result for acrylic acid* ..... [3]

(iii) Describe a test, other than using an indicator, which would show that both chemicals contain an acid group.

*test* .....

*result* .....

..... [2]

[Total: 13]

For  
Examiner's  
Use

9 Quantities of chemicals, expressed in moles, can be used to find the formula of a compound, to establish an equation and to determine reacting masses.

For  
Examiner's  
Use

(a) A compound contains 72% magnesium and 28% nitrogen. What is its empirical formula?

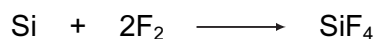
.....  
 .....  
 .....  
 ..... [2]

(b) A compound contains only aluminium and carbon. 0.03 moles of this compound reacted with excess water to form 0.12 moles of  $Al(OH)_3$  and 0.09 moles of  $CH_4$ .

Write a balanced equation for this reaction.

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

(c) 0.08 moles of silicon reacts with 7.2 g of fluorine.



(i) Which one is the limiting reagent? Explain your choice.

.....  
 .....  
 .....  
 ..... [3]

(ii) How many moles of  $SiF_4$  are formed?

..... [1]

[Total: 8]

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