

First Variant Question Paper



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	
Total	

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
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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
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Use

element	electron distribution
A	2,5
B	2,8,4
C	2,8,8,2
D	2,8,18,8
E	2,8,18,8,1
F	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.

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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 cm³ of aqueous calcium chloride, 30 cm³ of aqueous sodium fluoride is added. The concentration of both solutions is 1.00 mol / dm³. 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?

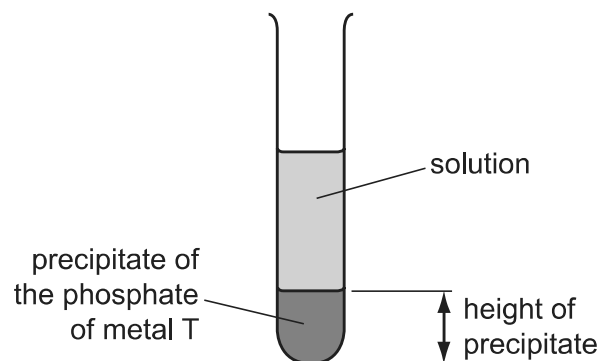
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..... [1]

(iv) Why is the solid heated?

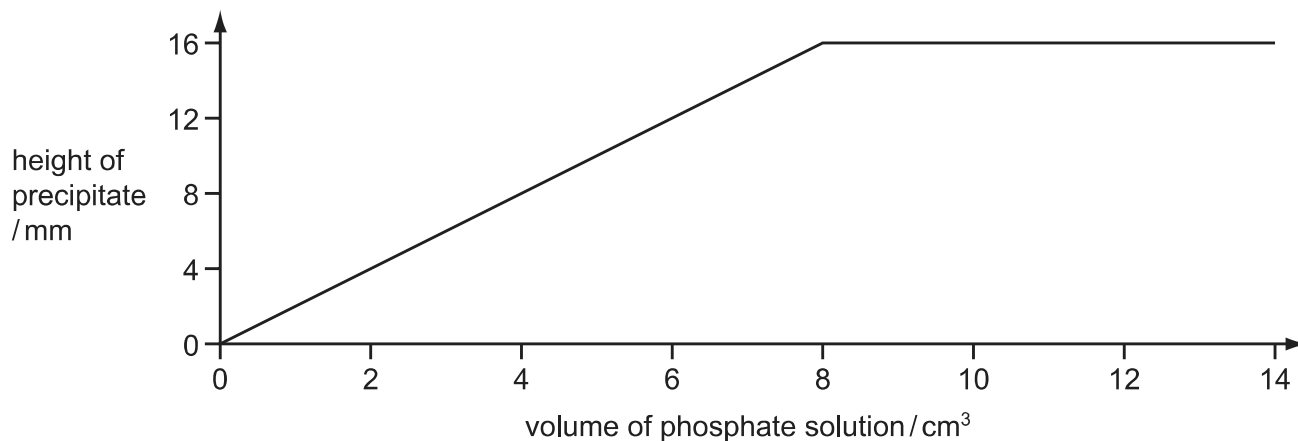
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(b) The formulae of insoluble compounds can be found by precipitation reactions.

To 12.0 cm^3 of an aqueous solution of the nitrate of metal T was added 2.0 cm^3 of aqueous sodium phosphate, Na_3PO_4 . The concentration of both solutions was 1.00 mol/dm^3 . When the precipitate had settled, its height was measured.



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.

.....

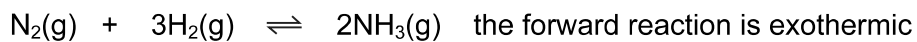
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..... [3]

[Total: 8]

6 Ammonia is manufactured by the Haber process.



For
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(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.

.....

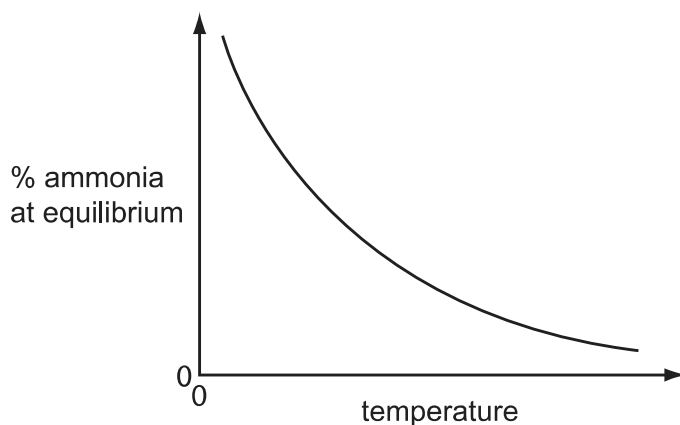
[1]

(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?

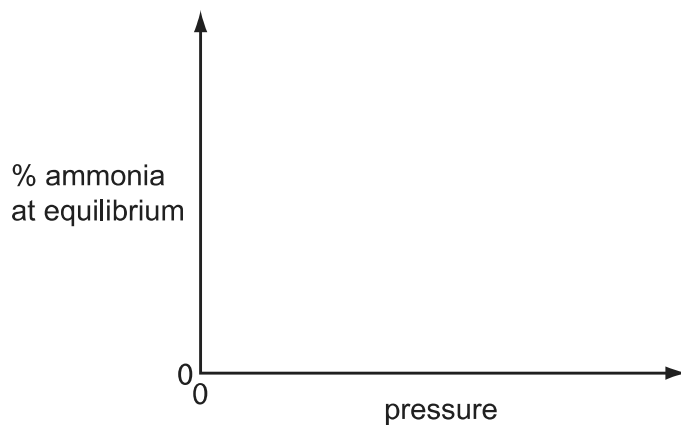
.....

[1]

9

- (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.

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Use

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.



.....

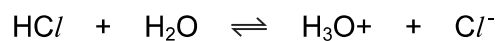
.....

.....

.....

..... [3]

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



For
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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?

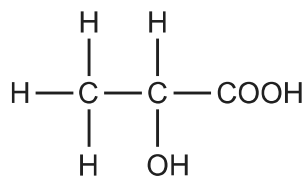
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(iii) How would the pH of these two solutions differ?

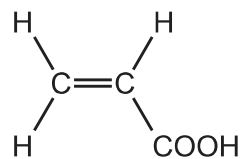
..... [1]

[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
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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]

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DATA SHEET
The Periodic Table of the Elements

		Group																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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3 Li Lithium	4 Be Beryllium	5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon	11 B Boron	12 C Carbon	13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon	19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton	37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon	55 Cs Caesium	56 Ba Barium	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium	72 Fr Francium	73 Ra Radium	74 Ac Actinium	75 Th Thorium	76 Pa Protactinium	77 U Uranium	78 Np Neptunium	79 Pu Plutonium	80 Am Americium	81 Cm Curium	82 Bk Berkelium	83 Fm Fermium	84 Md Mendelevium	85 No Nobelium	86 Lr Lawrencium	87 Fr Francium	88 Ra Radium	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium	104 Fr Francium	105 Ra Radium	106 Ac Actinium	107 Th Thorium	108 Pa Protactinium	109 U Uranium	110 Np Neptunium	111 Pu Plutonium	112 Am Americium	113 Cm Curium	114 Bk Berkelium	115 Fm Fermium	116 Md Mendelevium	117 No Nobelium	118 Lr Lawrencium	119 Fr Francium	120 Ra Radium	121 Ac Actinium	122 Th Thorium	123 Pa Protactinium	124 U Uranium	125 Np Neptunium	126 Pu Plutonium	127 Am Americium	128 Cm Curium	129 Bk Berkelium	130 Fm Fermium	131 Md Mendelevium	132 No Nobelium	133 Lr Lawrencium	134 Fr Francium	135 Ra 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Neptunium	441 Pu Plutonium	442 Am Americium	443 Cm Curium	444 Bk Berkelium	445 Fm Fermium	446 Md Mendelevium	447 No Nobelium	448 Lr Lawrencium	449 Fr Francium	450 Ra Radium	451 Ac Actinium	452 Th Thorium	453 Pa Protactinium	454 U Uranium	455 Np Neptunium	456 Pu Plutonium	457 Am Americium	458 Cm Curium	459 Bk Berkelium	460 Fm Fermium	461 Md Mendelevium	462 No Nobelium	463 Lr Lawrencium	464 Fr Francium	465 Ra Radium	466 Ac Actinium	467 Th Thorium	468 Pa Protactinium	469 U Uranium	470 Np Neptunium	471 Pu Plutonium	472 Am Americium	473 Cm Curium	474 Bk Berkelium	475 Fm Fermium	476 Md Mendelevium	477 No Nobelium	478 Lr Lawrencium	479 Fr Francium	480 Ra Radium	481 Ac Actinium	482 Th Thorium	483 Pa Protactinium	484 U Uranium	485 Np Neptunium	486 Pu Plutonium	487 Am Americium	488 Cm Curium	489 Bk Berkelium	490 Fm Fermium	491 Md Mendelevium	492 No Nobelium	493 Lr Lawrencium	494 Fr Francium	495 Ra Radium	496 Ac Actinium	497 Th Thorium	498 Pa Protactinium	499 U Uranium	500 Np Neptunium	501 Pu Plutonium	502 Am Americium	503 Cm Curium	504 Bk Berkelium	505 Fm Fermium	506 Md Mendelevium	507 No Nobelium	508 Lr Lawrencium	509 Fr Francium	510 Ra Radium	511 Ac Actinium	512 Th Thorium	513 Pa Protactinium	514 U Uranium	515 Np Neptunium	516 Pu Plutonium	517 Am Americium	518 Cm Curium	519 Bk Berkelium	520 Fm Fermium	521 Md Mendelevium	522 No Nobelium	523 Lr Lawrencium	524 Fr Francium	525 Ra Radium	526 Ac Actinium	527 Th Thorium	528 Pa Protactinium	529 U Uranium	530 Np Neptunium	531 Pu Plutonium	532 Am Americium	533 Cm Curium	534 Bk Berkelium	535 Fm Fermium	536 Md Mendelevium	537 No Nobelium	538 Lr Lawrencium	539 Fr Francium	540 Ra Radium	541 Ac Actinium	542 Th Thorium	543 Pa Protactinium	544 U Uranium	545 Np Neptunium	546 Pu Plutonium	547 Am Americium	548 Cm Curium	549 Bk Berkelium	550 Fm Fermium	551 Md Mendelevium	552 No Nobelium	553 Lr Lawrencium	554 Fr Francium	555 Ra Radium	556 Ac Actinium	557 Th Thorium	558 Pa Protactinium	559 U <