



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

CANDIDATE  
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**CHEMISTRY**

**0620/32**

Paper 3 Theory (Core)

**October/November 2016**

**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 an HB pencil for any diagrams or graphs.

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

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 20.

You may lose marks if you do not show your working or if you do not use appropriate units.

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 question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **17** printed pages and **3** blank pages.

2

1 The diagram shows part of the Periodic Table.

H												He					
Li													C	N	O	F	Ne
Na												Al					Ar
K	Ca							Fe		Ni	Cu	Zn					
											Ag						

Answer the following questions using **only** the elements in the diagram. Each element may be used once, more than once or not at all.

(a) Which element

(i) gives a lilac colour in a flame test,

..... [1]

(ii) is a pinkish-brown metal,

..... [1]

(iii) can exist in at least **two** different solid forms,

..... [1]

(iv) has a full outer electron shell containing **two** electrons,

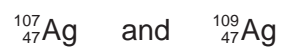
..... [1]

(v) is extracted from hematite?

..... [1]

3

(b) Silver has two naturally occurring isotopes.



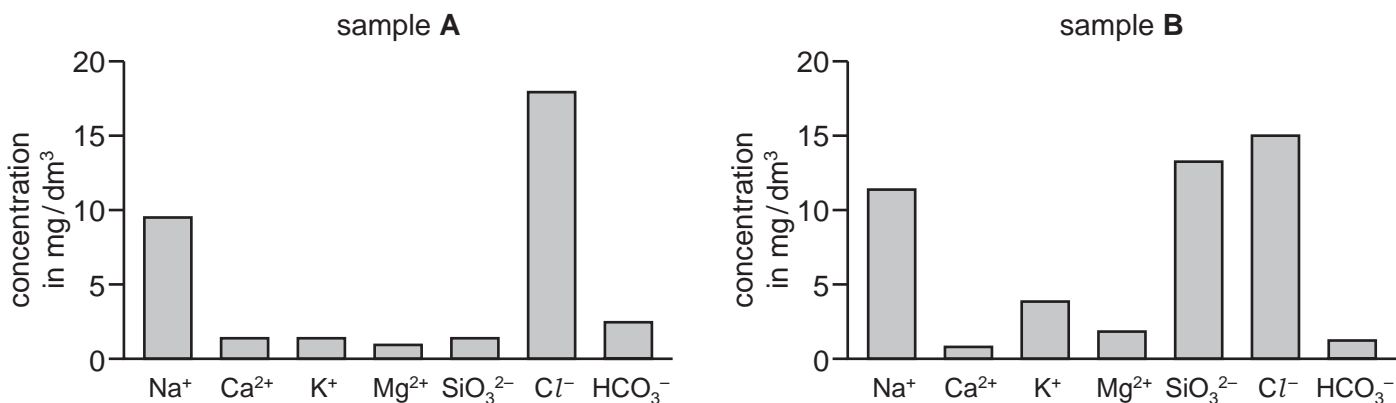
Complete the table to show the number of protons, electrons and neutrons in these **two** isotopes.

	${}_{47}^{107}\text{Ag}$	${}_{47}^{109}\text{Ag}$
number of protons		
number of electrons		
number of neutrons		

[3]

[Total: 8]

2 The bar charts compare the concentrations of ions in two samples of water, sample **A** and sample **B**.



(a) Use the information in the bar charts to answer the following questions.

(i) Describe **two** differences in the composition of sample **A** and sample **B**.

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

(ii) Which positive ion has the lowest concentration in sample **B**?

..... [1]

(iii) Calculate the mass of chloride ions present in 100 cm<sup>3</sup> of sample **B**.  
 Show all your working. [1 dm<sup>3</sup> = 1000 cm<sup>3</sup>]

mass = ..... mg [2]

(b) Describe a test for chloride ions.

test .....

result .....

[2]

5

- (c) River water contains small particles of clay.  
These particles show Brownian motion.

Which **one** of these statements best describes Brownian motion?  
Tick **one** box.

the diffusion of gases

the random movement of particles in a suspension

the downward movement of particles in a suspension

[1]

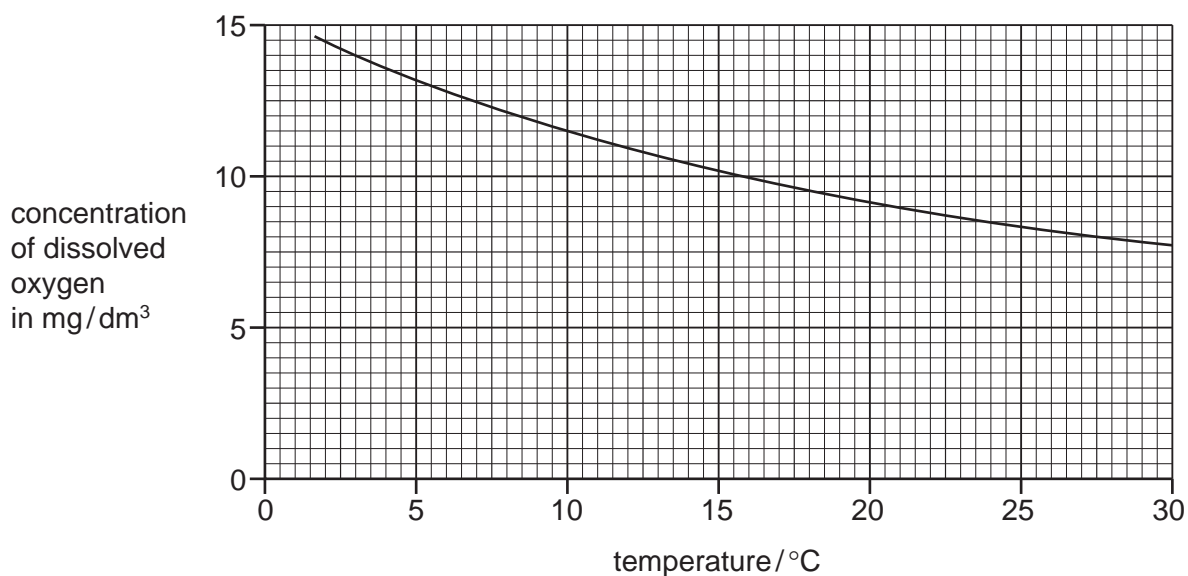
- (d) Silicon in river water comes from silicate rocks. Some of these contain silicon(IV) oxide.

Explain why silicon(IV) oxide is an acidic oxide.

..... [1]

(e) River water contains dissolved oxygen.

The graph shows how the concentration of dissolved oxygen changes with temperature.



(i) Describe how the concentration of dissolved oxygen changes with temperature.

..... [1]

(ii) Determine the concentration of oxygen present in the water at 10 °C.

..... [1]

(iii) Suggest how the rate of corrosion of iron water pipes changes with temperature.  
Explain your answer.

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

(f) Describe how water is treated to make it suitable to drink.

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

(g) Oxides of nitrogen are common pollutants in the air.

(i) State **one** source of oxides of nitrogen in the air.

..... [1]

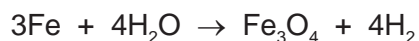
(ii) State **one** adverse effect of oxides of nitrogen on health.

..... [1]

[Total: 16]

3 Iron is a metal.

(a) The equation for the reaction of iron with steam is shown.



Which substance is reduced in this reaction?

Explain your answer.

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

(b) Iron is extracted by heating iron ore with carbon in a blast furnace.

(i) What is the meaning of the term *ore*?

..... [1]

(ii) Air is blown into the blast furnace.

What is the purpose of this air?

..... [1]

(iii) The impurities in the iron ore are removed as slag.

Which **one** of the following is slag?

Tick **one** box.

iron(II) oxide

calcium silicate

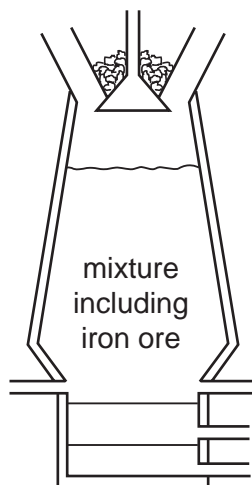
calcium carbonate

coke

[1]

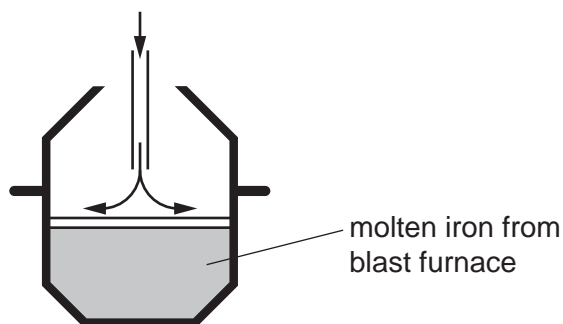
- (iv) Slag is less dense than iron.  
The diagram shows a blast furnace used to extract iron.

On the diagram, write the letter **S** to show where the slag is removed.



[1]

- (c) Iron from the blast furnace contains impurities.  
The diagram shows a converter used to make steel from iron.



Describe how iron is converted into steel.  
In your answer

- describe the impurities present,
- describe how the impurities are removed,
- include a relevant word equation.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]



4 Methyl orange and methyl red are both dyes which can be used as indicators.

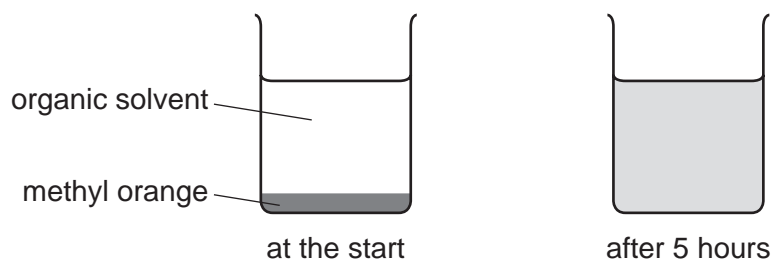
- (a) The actual value for the melting point of methyl red is  $180^{\circ}\text{C}$ .  
A chemist prepares a sample of methyl red and finds that it melts over the range  $173^{\circ}\text{C}$  to  $177^{\circ}\text{C}$ .

Suggest why the melting point of this sample was different from the actual value.

..... [1]

- (b) A concentrated solution of methyl orange was placed at the bottom of a beaker containing an organic solvent.

After 5 hours, the orange colour had spread throughout the solvent.



Use the kinetic particle model of matter to explain this observation.

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

- (c) Methyl orange is used as an indicator.

What colour is methyl orange when placed in dilute sulfuric acid?

..... [1]

(d) Sulfuric acid can be used to prepare copper(II) sulfate from copper(II) oxide.

(i) Complete the general word equation for this reaction.

metal oxide + acid → ..... + .....

[2]

(ii) Sulfuric acid is added to excess copper(II) oxide. The mixture is heated and the unreacted copper(II) oxide is removed.

Suggest how the unreacted copper(II) oxide is removed.

..... [1]

(iii) Put statements **A** to **E** about the preparation of pure dry crystals of copper(II) sulfate from copper(II) sulfate solution in the correct order.

- A** The crystals are filtered off.
- B** The heating is stopped when the point of crystallisation is reached.
- C** The mixture is left to form crystals.
- D** The crystals are dried with filter paper.
- E** The solution is heated gently.

correct order

--	--	--	--	--

[2]

[Total: 10]

- 5 Cement is made by heating clay with limestone. Some of the limestone (calcium carbonate) breaks down to form calcium oxide and a gas which turns limewater milky.

(a) (i) Complete the chemical equation for this reaction.



[2]

(ii) What type of chemical reaction is this?

..... [1]

(iii) Determine the relative formula mass of calcium carbonate. Show all your working.

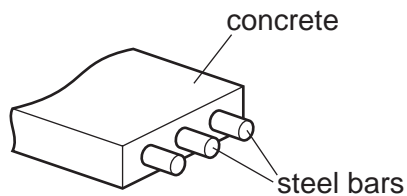
[2]

(b) Concrete is a mixture of cement, sand, water and small stones.  
Calcium carbonate is a compound, but concrete is a mixture.

State **two** differences between a compound and a mixture.

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

- (c) Reinforced concrete contains steel bars within the concrete.



Some properties of concrete and steel are shown in the table.

	relative strength	relative expansion when heated	relative heat conductivity	cost
concrete	60	12	1.5	low
steel	250	12	60.0	high

Use the information in the table to suggest why concrete must be reinforced with steel when it is used to make bridges.

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

- (d) If reinforced concrete becomes cracked, liquids and gases can reach the steel bars. The steel bars rust.

Which **two** substances are needed for steel to rust?

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

[Total: 10]

6 Petroleum can be separated into useful hydrocarbon fractions by fractional distillation.

(a) (i) Explain the term *hydrocarbon fraction*.

hydrocarbon .....

fraction .....

..... [2]

(ii) State **one** use for each of the following hydrocarbon fractions.

naphtha .....

kerosene .....

[2]

(b) Organic compounds can be grouped into different homologous series.

Explain the term *homologous series* by referring to alkenes.

.....

.....

.....

.....

.....

..... [4]

(c) The table shows some information about alkenes.

alkene	formula	density of liquid alkene in g/cm <sup>3</sup>	melting point /°C	boiling point /°C
ethene	C <sub>2</sub> H <sub>4</sub>	0.568	-169	-104
propene	C <sub>3</sub> H <sub>6</sub>	0.610	-185	-47
butene	C <sub>4</sub> H <sub>8</sub>	0.626	-185	-6
pentene	C <sub>5</sub> H <sub>10</sub>	0.640	-165	+30
hexene	C <sub>6</sub> H <sub>12</sub>	0.673	-140	

(i) A student predicts that the density of the liquid alkenes increases as the number of carbon atoms increases.

Describe whether the data in the table support this prediction.

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

(ii) Predict the boiling point of hexene.

..... [1]

(iii) Deduce the state of pentene at -60 °C.  
 Explain your answer.

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

(d) Draw the structure of ethene. Show all of the atoms and all of the bonds.

[1]

(e) Alkenes are manufactured by cracking.

When tetradecane, C<sub>14</sub>H<sub>30</sub>, is cracked the products are ethene, an alkene with four carbon atoms and an alkane.

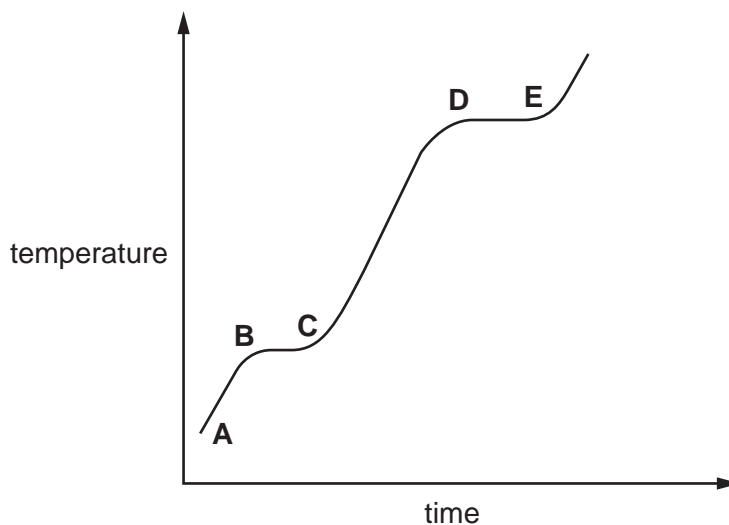
Complete the chemical equation for this reaction.



[2]

[Total: 15]

7 The graph shows how the temperature of sodium changes when it is heated at a constant rate in an atmosphere of argon.



(a) Suggest why the sodium is heated in argon and **not** in air.

..... [1]

(b) Which part of the graph above represents the boiling point of sodium?  
Tick **one** box.

- A-B
- B-C
- C-D
- D-E

[1]

(c) (i) Describe **two** differences in the general properties of a liquid and a gas.

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

(ii) Describe the arrangement and motion of the particles in a liquid.

arrangement .....

motion .....

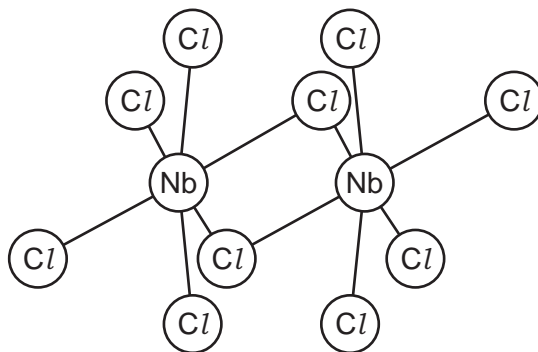
[2]

(d) Niobium is a transition element. Sodium is an element in Group I of the Periodic Table.

(i) Describe **two** properties of niobium which are different from sodium.

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

(ii) The structure of niobium chloride is shown.



Determine the formula of niobium chloride.

..... [1]

(iii) Niobium chloride is a covalent molecule.

Predict **two** physical properties of niobium chloride.

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

[Total: 11]



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The Periodic Table of Elements

		Group							
I	II	III	IV	V	VI	VII	VIII		
1	2	3	4	5	6	7	8	9	10
H hydrogen 1	He helium 4	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20		
<p><b>Key</b></p> <p>atomic number atomic symbol name relative atomic mass</p>									
3	4	5	6	7	8	9	10		
Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20		
11	12	13	14	15	16	17	18		
Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40		
19	20	21	22	23	24	25	26	27	28
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59
37	38	39	40	41	42	43	44	45	46
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106
55	56	57–71	72	73	74	75	76	77	78
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195
87	88	89–103	104	105	106	107	108	109	110
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —
81	82	83	84	85	86	87	88	89	90
Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —	Fr francium —	Ra radium —	Ac actinium —	Th thorium —
91	92	93	94	95	96	97	98	99	100
Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —
101	102	103	104	105	106	107	108	109	110
Md mendelevium —	No nobelium —	Lr lawrencium —	103	104	105	106	107	108	109
109	110	111	112	113	114	115	116	117	118
111	112	113	114	115	116	117	118	119	120
Rg roentgenium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Mc moscovium —	Lv livermorium —	Ts tennessine —	Og oganeson —	119	120

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	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 —

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