Cambridge IGCSE

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

| | | | | | | | | | |
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| CANDIDATE NAME | | | | | | | | | |
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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.

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CAMBRIDGE International Examinations

**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

View solution

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

..... [1]

**(ii)** is a pinkish-brown metal,

View solution

..... [1]

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

View solution

..... [1]

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

View solution

..... [1]

**(v)** is extracted from hematite?

..... [1]

View solution

**(b)** Silver has two naturally occurring isotopes.

View solution

$^{107}_{47}Ag$ and $^{109}_{47}Ag$

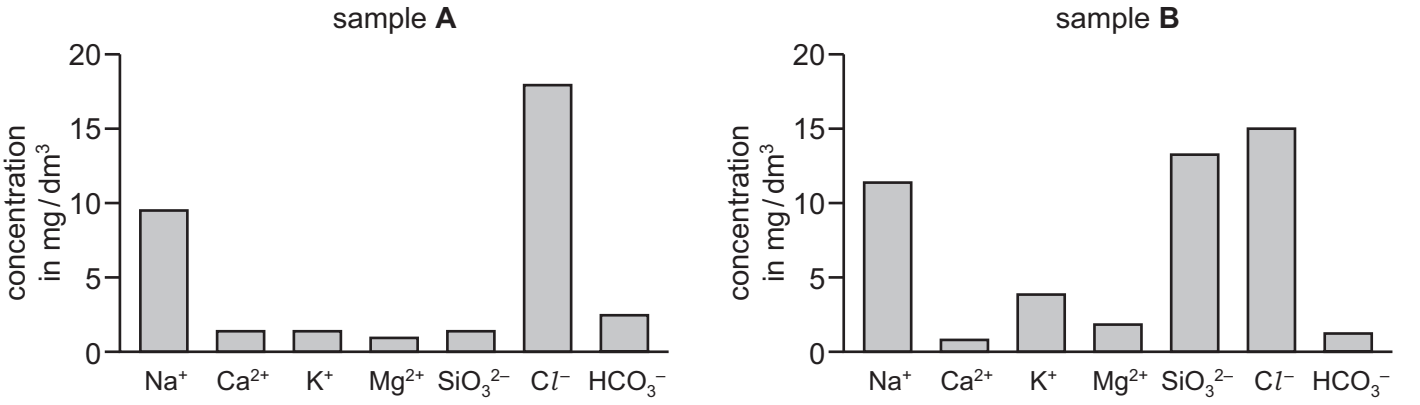
Complete the table to show the number of protons, electrons and neutrons in these **two** isotopes.

| | $^{107}_{47}Ag$ | $^{109}_{47}Ag$ |
|---|---|---|
| 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.

View solution

**(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**?

View solution

..... [1]

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

View solution

mass = ..... mg [2]

**(b)** Describe a test for chloride ions.

View solution

test .....

result .....

[2]

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

View solution

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.

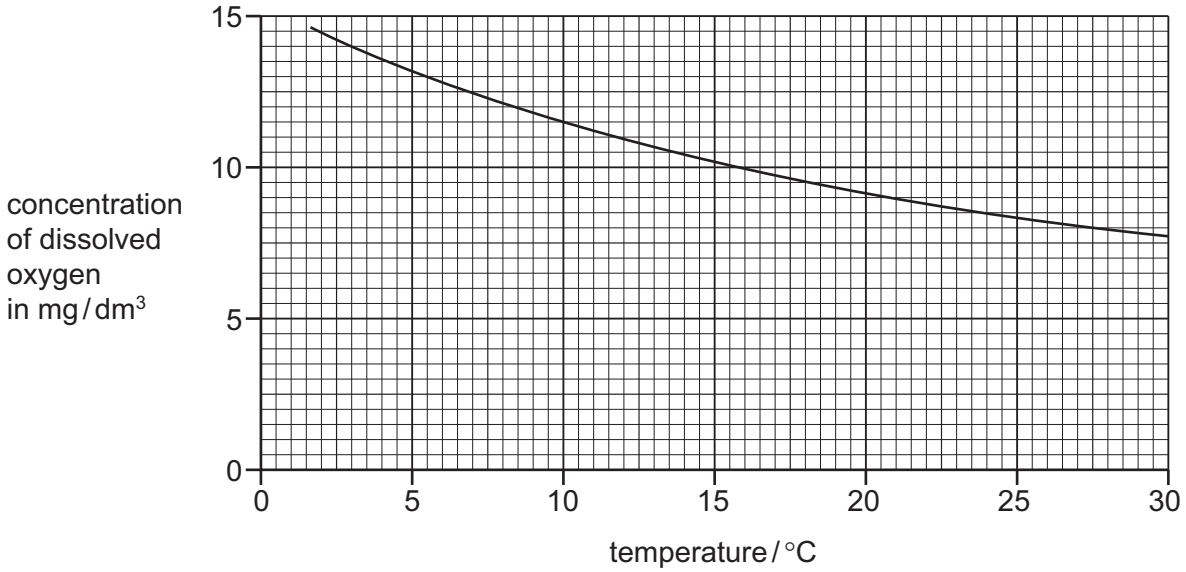
View solution

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.

View solution




**(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.

View solution

..... [1]

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

View solution

.....

..... [1]

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

View solution

.....

..... [2]

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

View solution

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

..... [1]

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

View solution

..... [1]

[Total: 16]

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**3** Iron is a metal.

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

View solution

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

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.

View solution

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

..... [1]

**(ii)** Air is blown into the blast furnace.

View solution

What is the purpose of this air?

..... [1]

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

View solution

Which **one** of the following is slag?
Tick **one** box.

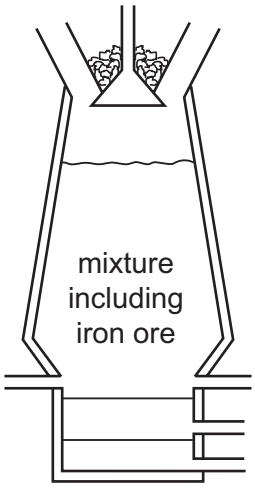
| | |
|---|---|
| iron(II) oxide | ☐ |
| calcium silicate | ☐ |
| calcium carbonate | ☐ |
| coke | ☐ |

[1]

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

View solution

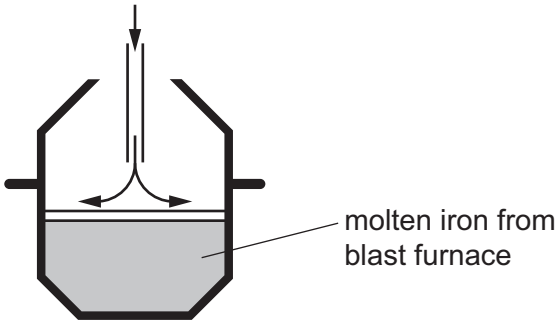
On the diagram, write the letter **S** to show where the slag is removed.




[1]

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

View solution




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 °C.
A chemist prepares a sample of methyl red and finds that it melts over the range 173 °C to 177 °C.

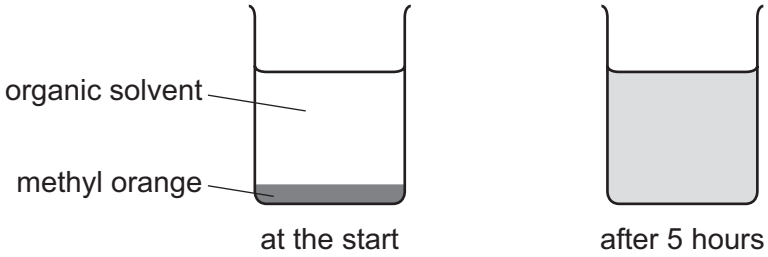
View solution

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.

View solution




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

.....

.....

.....

..... [3]

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

View solution

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.

View solution

**(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.

View solution

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.

View solution

**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.

View solution

$$CaCO_3 \rightarrow \text{.....} + \text{.....}$$

[2]

**(ii)** What type of chemical reaction is this?

View solution

..... [1]

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

View solution

[2]

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

View solution

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

.....

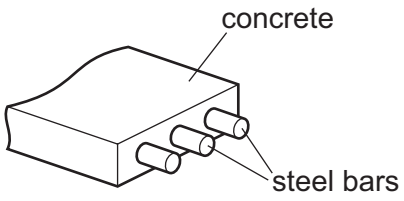
.....

.....

..... [2]

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

View solution




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.

View solution

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*.

View solution

hydrocarbon .....

fraction .....

.....

[2]

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

View solution

naphtha .....

kerosene .....

[2]

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

View solution

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

.....

.....

.....

.....

.....

..... [4]

**(c)** The table shows some information about alkenes.

View solution

| alkene | formula | density of liquid alkene in g / cm$^3$ | melting point / °C | boiling point / °C |
|---|---|---|---|---|
| ethene | $C_2H_4$ | 0.568 | –169 | –104 |
| propene | $C_3H_6$ | 0.610 | –185 | –47 |
| butene | $C_4H_8$ | 0.626 | –185 | –6 |
| pentene | $C_5H_{10}$ | 0.640 | –165 | +30 |
| hexene | $C_6H_{12}$ | 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.

View solution

[1]

**(e)** Alkenes are manufactured by cracking.
When tetradecane, $C_{14}H_{30}$, is cracked the products are ethene, an alkene with four carbon atoms and an alkane.

View solution

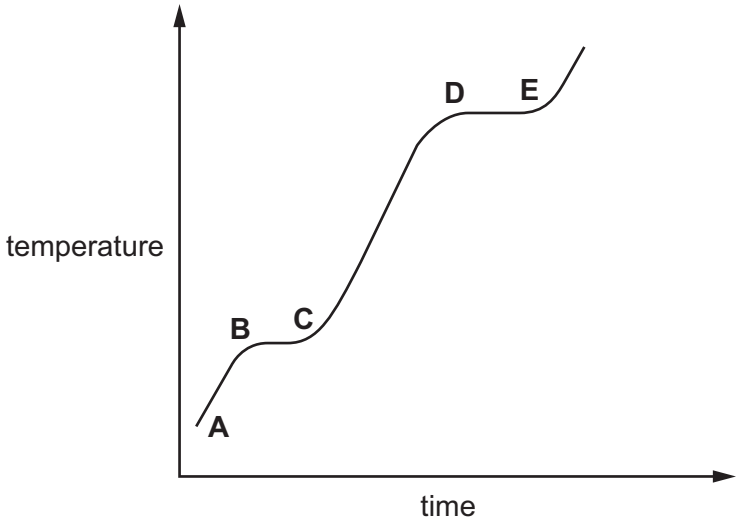
Complete the chemical equation for this reaction.

$$C_{14}H_{30} \rightarrow C_2H_4 + \text{.....} + \text{.....}$$

[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.

View solution

..... [1]

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

View solution

| | |
|---|---|
| **A–B** | ☐ |
| **B–C** | ☐ |
| **C–D** | ☐ |
| **D–E** | ☐ |

[1]

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

View solution

.....

.....

..... [2]

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

View solution

arrangement .....

motion .....

[2]

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

View solution

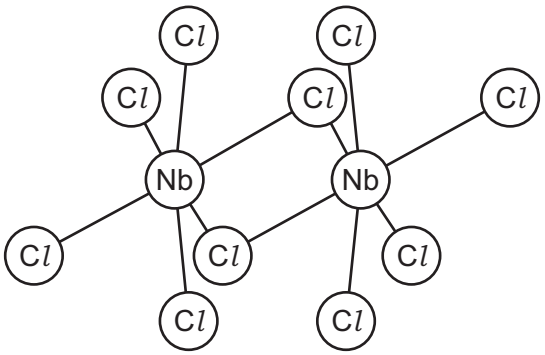
**(i)** Describe **two** properties of niobium which are different from sodium.

.....

..... [2]

View solution

**(ii)** The structure of niobium chloride is shown.




Determine the formula of niobium chloride.

..... [1]

View solution

**(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 H hydrogen 1 | | | | | | | | | | 2 He helium 4 |
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium – | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57–71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium – | 85 At astatine – | 86 Rn radon – |
| 87 Fr francium – | 88 Ra radium – | 89–103 actinoids | 104 Rf rutherfordium – | 105 Db dubnium – | 106 Sg seaborgium – | 107 Bh bohrium – | 108 Hs hassium – | 109 Mt meitnerium – | 110 Ds darmstadtium – | 111 Rg roentgenium – | 112 Cn copernicium – | | 114 Fl flerovium – | | 116 Lv livermorium – | | |

**Key**

atomic number
atomic symbol
name
relative atomic mass

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 $dm^3$ at room temperature and pressure (r.t.p.).