Cambridge IGCSE

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

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | | |

**CHEMISTRY** **0620/33**

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 16.
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.



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CAMBRIDGE International Examinations

**1** The diagram shows part of the Periodic Table.

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | H | | | | | | | | | |
| Li | | | | | | | | | | | | C | N | O | F | Ne |
| | | | | | | | | | | | | Si | | | Cl | Ar |
| | | | Ti | | Cr | | | | | Cu | Zn | Ge | | | Br | Kr |
| | | | | | | | | | | | | Sn | | | I | Xe |

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

View solution

**(a)** Which element

**(i)** forms 21% of the air,

..... [1]

**(ii)** reacts with water to form a solution which turns litmus paper from red to blue,

..... [1]

**(iii)** forms ions of type $X^{3+}$ which when tested with aqueous sodium hydroxide produce a green precipitate,

..... [1]

**(iv)** is a red-brown liquid at room temperature and pressure,

..... [1]

**(v)** is a noble gas with only **three** complete electron shells?

..... [1]

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**(b)** The table gives some information about the properties of four metals.

View solution

| metal | density in g / cm$^3$ | relative strength | resistance to corrosion | relative electrical conductivity | melting point / °C |
|---|---|---|---|---|---|
| chromium | 7.2 | 8 | very good | 8 | 1857 |
| copper | 8.9 | 30 | good | 60 | 1283 |
| iron | 7.9 | 21 | poor | 10 | 1535 |
| titanium | 4.5 | 23 | very good | 2 | 1660 |

Which **one** of these metals is most suitable for making the frame of an aircraft?
Explain your answer using information from the table.

.....

.....

.....

..... [3]

[Total: 8]

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**2** A scientist analysed the substances present in a 1 $dm^3$ sample of river water in an agricultural area. The table shows the mass of each ion dissolved in the 1 $dm^3$ sample.

| name of ion | formula of ion | mass / g |
|---|---|---|
| calcium | $Ca^{2+}$ | 1.2 |
| chloride | $Cl^-$ | 0.1 |
| hydrogencarbonate | $HCO_3^-$ | 1.0 |
| magnesium | $Mg^{2+}$ | 0.5 |
| nitrate | $NO_3^-$ | 1.0 |
| sodium | $Na^+$ | |
| | $SO_4^{2-}$ | 0.5 |
| phosphate | $PO_4^{3-}$ | 1.2 |
| | Total | 6.0 |

**(a) (i)** Which negative ion has the highest concentration, in g / $dm^3$, in this sample of water?

View solution

..... [1]

**(ii)** Give the name of the ion with the formula $SO_4^{2-}$.

View solution

..... [1]

**(iii)** Calculate the mass of sodium ions in 1 $dm^3$ of this river water.

View solution

..... [1]

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

View solution

test .....

.....

result .....

[3]

**(c)** The sample of river water also contains insoluble materials such as clay and the remains of dead animals and plants.

View solution

**(i)** What method could be used to separate insoluble materials from river water?

..... [1]

View solution

**(ii)** Some of the remains of dead animals and plants contain food materials.

Which **two** of the following substances are constituents of food?
Tick **two** boxes.

| | |
|---|---|
| alkane | ☐ |
| carbohydrate | ☐ |
| graphite | ☐ |
| protein | ☐ |

[1]

View solution

**(iii)** Particles of clay suspended in river water show Brownian motion.

Describe the movement of these particles.

..... [1]

View solution

**(d)** Most of the nitrate ions in river water come from fertilisers.

**(i)** Explain why farmers use fertilisers.

.....

..... [2]

View solution

**(ii)** Ammonium nitrate is a fertiliser.
Ammonium nitrate reacts with calcium hydroxide.

ammonium nitrate + calcium hydroxide $\rightarrow$ calcium nitrate + ammonia + water

Explain why adding calcium hydroxide to the soil at the same time as nitrate fertilisers results in loss of nitrogen from the soil.

.....

..... [2]

[Total: 13]

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**3** Ethanol can be manufactured by fermentation and from ethene.

View solution

**(a)** Describe the manufacture of ethanol by fermentation **and** from ethene.
In your answer include

- the essential conditions required for each reaction,
- **one** or more relevant word equations.

.....

.....

.....

.....

.....

..... [5]

View solution

**(b)** The table shows some properties of different alcohols.

| alcohol | formula | melting point / °C | boiling point / °C | relative viscosity |
|---|---|---|---|---|
| methanol | $CH_4O$ | –94 | 65 | 0.54 |
| ethanol | $C_2H_6O$ | –117 | 79 | 1.08 |
| propanol | $C_3H_8O$ | –126 | 98 | 1.94 |
| butanol | $C_4H_{10}O$ | –89 | 117 | 2.54 |
| pentanol | $C_5H_{12}O$ | –79 | | 3.47 |

**(i)** Deduce the state of methanol at room temperature.
Explain your answer.

.....

..... [2]

**(ii)** Predict the boiling point of pentanol.

View solution

..... [1]

**(iii)** Describe how the relative viscosity changes with the number of carbon atoms in the alcohol.

..... [1]

View solution

**(c) (i)** Draw the structure of ethanol. Show all of the atoms and all of the bonds.

View solution

[2]

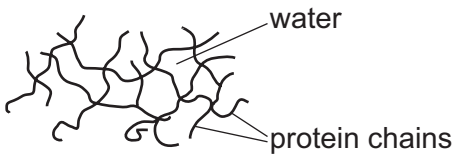
**(ii)** Give **one** major use of ethanol.

..... [1]

[Total: 12]

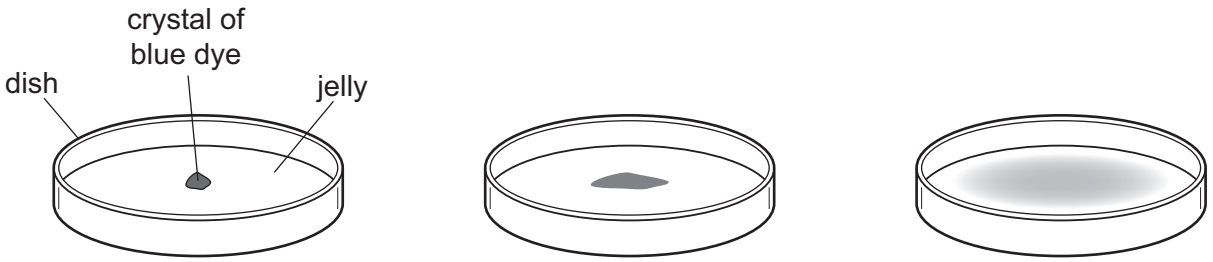
View solution

**4** Jelly is a mixture of water and protein chains.




View solution

**(a)** A crystal of blue dye was placed on top of some jelly.
After 30 minutes some of the blue colour could be seen in the jelly.
After 1 day the blue colour had spread out further into the jelly.




Use the kinetic particle model of matter to explain these observations.

.....

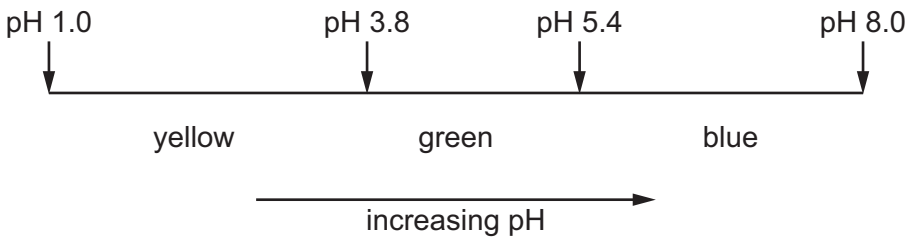
.....

.....

..... [3]

**(b)** The diagram shows the colour changes of the indicator bromocresol green at different pH values.

View solution



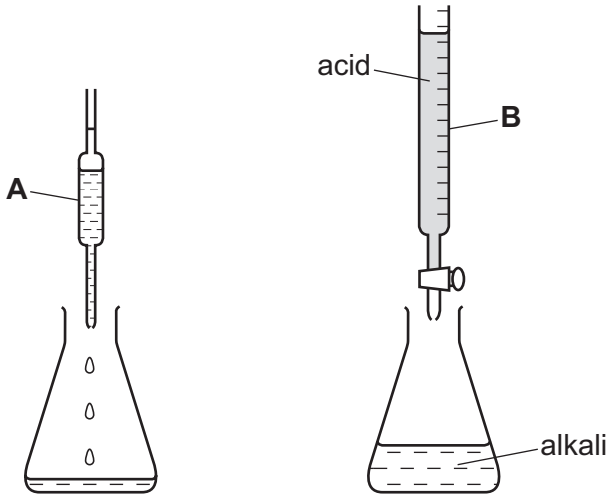

Predict the colour of bromocresol green

in pure water, .....

in a strongly acidic solution. .....
[2]

**(c)** The concentration of an alkali can be found by titrating it with an acid using the apparatus shown.

View solution




**(i)** State the names of the pieces of glassware labelled **A** and **B**.

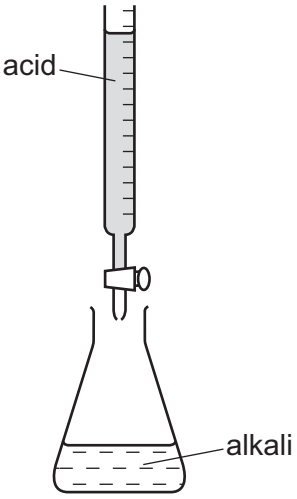
**A** .....

**B** .....

[2]

**(ii)** Describe how you would carry out a titration using the apparatus shown.

View solution




.....

.....

.....

.....

.....

..... [3]

[Total: 10]

**5** Lime (calcium oxide) is made by heating limestone (calcium carbonate).

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

View solution

**(a) (i)** Is this reaction exothermic or endothermic?
Explain your answer.

.....

..... [1]

View solution

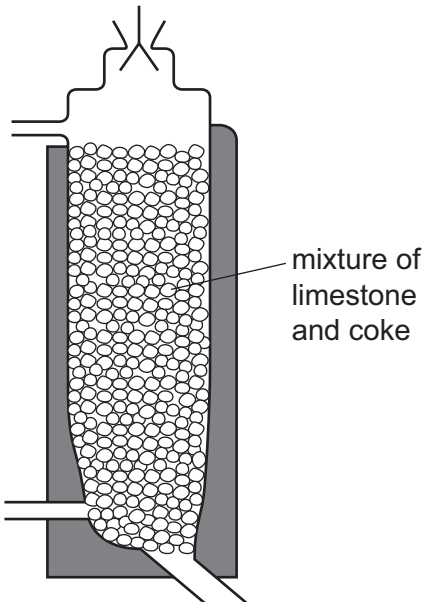
**(ii)** The reaction is reversible.

What information in the equation shows that this reaction is reversible?

..... [1]

View solution

**(b)** The diagram shows a furnace for making lime.




**(i)** On the diagram, write

- the letter **C** to show where the waste gases exit the furnace,
- the letter **L** to show where the lime is removed from the furnace.

[2]

View solution

**(ii)** Suggest a reason for adding coke (carbon) to the furnace.

..... [1]

View solution

**(c)** Explain why farmers use lime to treat acidic soils.

.....

..... [2]

**(d)** Limestone is used to manufacture cement. The limestone is mixed with clay and heated to 1500 °C. It is then mixed with calcium sulfate and crushed.

View solution

**(i)** Describe the test for sulfate ions.

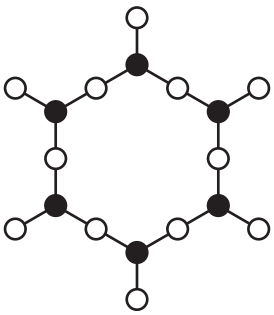
test .....

result .....

[2]

**(ii)** Concrete is a mixture of cement, silicates and water. Part of the structure of a silicate is shown.

View solution



key

● = silicon atom

○ = oxygen atom

Deduce the formula for this silicate.

..... [1]

**(e)** Concrete contains small amounts of calcium oxide.
This can react with rainwater to form calcium hydroxide.

View solution

**(i)** Calcium hydroxide is strongly alkaline.

What is the most likely pH of a strongly alkaline solution?
Draw a ring around the correct answer.

pH 2 pH 6 pH 7 pH 12

[1]

**(ii)** The calcium hydroxide on the surface of a piece of concrete reacts with carbon dioxide in the air.

View solution

Complete the chemical equation for this reaction.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + .....$$

[1]

**(iii)** Limewater is an aqueous solution of calcium hydroxide. A teacher left an open beaker of limewater in the laboratory.
After a week, the solution in the beaker was pH 7 and a white precipitate was observed.

Use the information in **(e)(i)** and **(e)(ii)** to help you explain these observations.

View solution

.....

.....

.....

.....

.....

..... [3]

[Total: 15]

**6** The Periodic Table is a method of classifying elements.

**(a) (i)** In what order are the elements arranged in the Periodic Table?

View solution

..... [1]

**(ii)** How does the character of the elements change from left to right across a period?

..... [1]

**(iii)** Describe **two** trends in the properties of the elements going down Group I.

.....

.....

..... [2]

**(b)** The halogens are a group of elements with diatomic molecules.

View solution

**(i)** Chlorine reacts with an aqueous solution of sodium iodide.

$$Cl_2 + 2NaI \rightarrow I_2 + 2NaCl$$

What colour change would be observed in the solution?

from ..... to ..... [2]

**(ii)** Astatine, $At_2$, is a halogen.

View solution

Suggest why astatine does **not** react with aqueous potassium iodide.

..... [1]

**(c)** Chlorine reacts with hydrogen to form hydrogen chloride.

View solution

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

$$Cl_2 + \text{.....} \rightarrow \text{.....}HCl$$

[2]

**(ii)** Draw a diagram to show the electronic structure of a molecule of hydrogen chloride. Show only the outer shell electrons.

View solution

[2]

**(iii)** Hydrochloric acid reacts with lithium hydroxide.

View solution

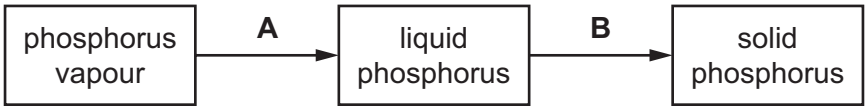
Complete the word equation for this reaction.

| | | | | | | |
|---|---|---|---|---|---|---|
| hydrochloric acid | + | lithium hydroxide | → | | + | |

[2]

[Total: 13]

**7** The diagram shows the changes of state when phosphorus is cooled slowly to room temperature.




**(a)** Give the names of the changes of state labelled **A** and **B**.

View solution

**A** .....

**B** .....

[2]

**(b)** Describe the arrangement and motion of the particles in solid phosphorus.

View solution

arrangement .....

motion .....

[2]

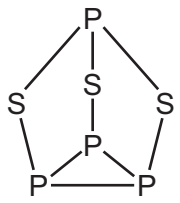
**(c)** Is phosphorus(V) oxide an acidic oxide or basic oxide?
Explain your answer.

View solution

..... [1]

**(d)** Phosphorus sulfide is a covalent molecule.

View solution




Predict **two** properties of phosphorus sulfide.

.....

..... [2]

**(e)** Many metal ores contain sulfides.
When zinc sulfide is heated in air the following reaction takes place.

View solution

zinc sulfide + oxygen → zinc oxide + sulfur dioxide

Explain why this reaction may be harmful to the environment.

.....

..... [2]

[Total: 9]

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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.).