Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Chemistry of our environment

Time allowed: 1 hour 25 minutes

Subject code **0620**

Chemistry

Questions from Paper 3, Paper 4 and Paper 6

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 85

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 85 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 This question is about air and water.

(a) Water needs to be treated to make it safe to drink.

Complete Fig. 7.1 to show the three stages needed in the treatment of domestic water. The second stage has been completed.

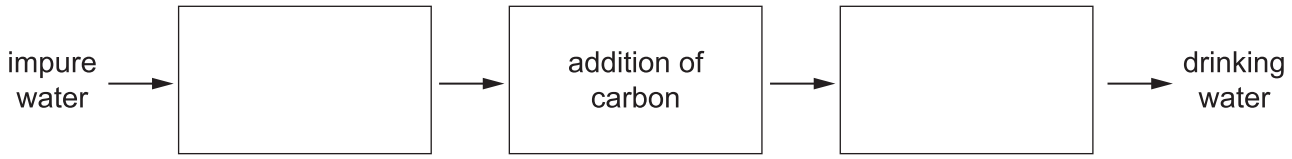


Fig. 7.1

[2]

(b) Describe a chemical test for the presence of water.

test .....

.....

observations .....

.....

[2]

(c) A sample of air contains carbon dioxide and oxides of nitrogen.

State **one** harmful effect of each of these air pollutants.

carbon dioxide .....

oxides of nitrogen .....

[2]

[Total: 6]

Water Click for more variations

Reduced to 77% to fit the page (wider than A4).

1(a)	sedimentation / filtration (1) chlorination / adding chlorine (1)	**2**
1(b)	test: (anhydrous) copper(II) sulfate / (anhydrous) cobalt(II) chloride (1) observations: white to blue / blue to pink (1)	**2**
1(c)	carbon dioxide: global warming / climate change (1) oxides of nitrogen: acid rain / photochemical smog / respiratory problems (1)	**2**

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2 This question is about air and fertilisers.

(a) Air contains nitrogen, oxygen, noble gases and carbon dioxide.

State the percentage of nitrogen in clean, dry air.

..... [1]

(b) Polluted air contains oxides of nitrogen.

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

..... [1]

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

..... [1]

(c) Many fertilisers contain nitrogen and potassium.

(i) Name one **other** element found in most fertilisers.

..... [1]

(ii) Explain why farmers use fertilisers on fields where crops are to be grown.

..... [1]

(iii) Describe a test for potassium ions.

test .....

observations .....

[2]

[Total: 7]

Air, pollution and climate change Click for more variations

Reduced to 77% to fit the page (wider than A4).

2(a)	78 (%)	**1**
2(b)(i)	vehicle engines / high temperature furnaces / lightning	**1**
2(b)(ii)	breathing difficulties / asthma	**1**
2(c)(i)	phosphorus	**1**
2(c)(ii)	to increase crop growth / to replace elements taken from soil by previous crops	**1**
2(c)(iii)	flame test / put potassium (compound) in (non-luminous) flame (1) lilac colour (1)	**2**

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3 **(a)** A list of common air and water pollutants is shown.

methane
nitrates
oxides of nitrogen
particulates
plastics
sewage

Answer the following questions using **only** these pollutants.
Each pollutant may be used once, more than once or not at all.

State which pollutant:

(i) contains harmful microbes that can cause disease

..... [1]

(ii) can be produced by the incomplete combustion of carbon-containing fuels

..... [1]

(iii) is a gas formed from the decomposition of vegetation.

..... [1]

(b) A 250 cm^3 sample of polluted water contains 3.5 mg of particulates.

Calculate the mass of particulates present in 100 cm^3 of this polluted water.

mass of particulates = ... mg [1]

(c) Sulfur dioxide in the atmosphere causes acid rain.

State **one** method of reducing the emissions of sulfur dioxide to the atmosphere.

.....

..... [1]

(d) Sulfur dioxide is a simple molecular compound.

State **two** physical properties of simple molecular compounds.

1 .....

2 .....
[2]

[Total: 7]

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Covalent bonding and simple molecules Click for more variations

3(a)(i)	sewage	**1**
3(a)(ii)	particulates	**1**
3(a)(iii)	methane	**1**
3(b)	1.4 (mg)	**1**
3(c)	low sulfur fuels / flue gas desulfurisation	**1**
3(d)	low melting point / low boiling point (1) poor electrical conductivity / poor thermal conductivity (1)	**2**

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4 This question is about water and air.

(a) Water needs to be treated to make it safe to drink.

Draw a line from each stage in the treatment of domestic water to the reason why it is carried out.

stage	reason
addition of carbon	to kill microbes
sedimentation	to remove tastes and odours
chlorination	to remove solids

[2]

(b) Describe how to test whether a sample of water is pure using melting point.

.....

.....

..... [2]

(c) Air may contain sulfur dioxide and particulates.

(i) State **one** harmful effect of each of these air pollutants.

sulfur dioxide .....

particulates .....

[2]

(ii) Describe how flue gas desulfurisation reduces emissions of sulfur dioxide gas.

.....

.....

..... [2]

[Total: 8]

Water Click for more variations

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4(a)	addition of carbon – to remove tastes / odours sedimentation – to remove solids chlorination – to kill microbes all 3 correct = 2 marks 1 correct = 1 mark	**2**
4(b)	**heat** to melting point of the sample and **measure** mp OR **heat** to 0 °C and observe if it's melting	**1**
	pure water melts at 0 °C / has a sharp melting point / if not 0°C then it must be impure. OR impure water melts at a **lower** mp than 0 °C / melts over a range of temperatures OR compare the melting point of the water sample to the mp of pure water.	**1**
4(c)(i)	sulfur dioxide: acid rain (1) particulates: respiratory problems / cancer (1)	**2**
4(c)(ii)	calcium oxide (1) neutralisation (1)	**2**

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5 This question is about water.

(a) The water in rivers often contains pollutants such as acids.

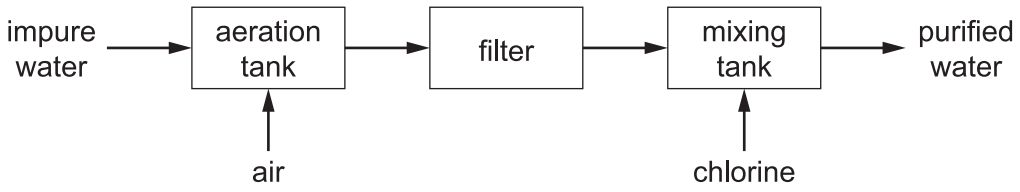
Describe how universal indicator paper can be used to determine the pH value of the water.

.....

.....

..... [2]

(b) The diagram shows some of the stages in water treatment.



(i) Air is blown through the aeration tank.

Name the **two** gases that make up most of the air.

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

(ii) After aeration, the water still contains large insoluble particles.

The filter is made up of fine sand and stones.

Explain how the filter helps purify the water.

.....

.....

..... [2]

(iii) Explain why chlorine is used in water treatment.

..... [1]

(c) Anhydrous cobalt(II) chloride is used to test for water.

State the colour change in this test.

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

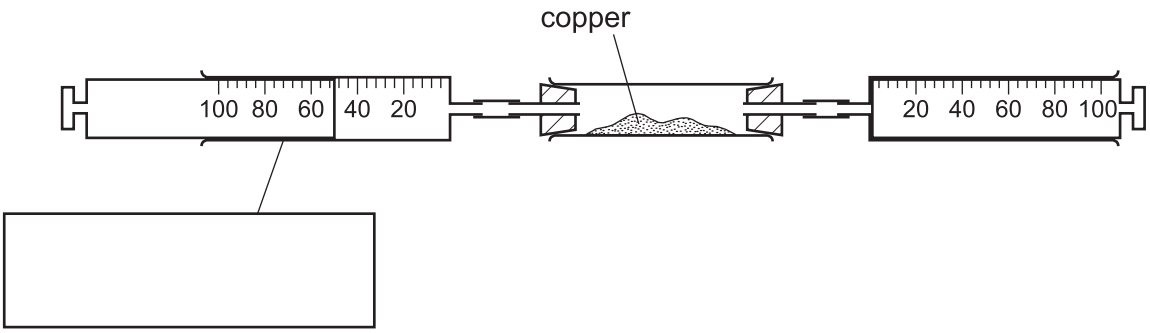
[Total: 9]

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Water Click for more variations

5(a)	dip indicator paper in to water (and record the colour) (1) compare the colour with (universal indicator) colour chart match colour with colour chart (1)	**2**
5(b)(i)	nitrogen (1) oxygen (1)	**2**
5(b)(ii)	large(r) particles cannot get through (the small gaps in) the filter / large(r) particles get trapped in the filter / large(r) particles too big to get through (filter) (1) water passes through (1)	**2**
5(b)(iii)	to kill bacteria / to kill micro-organisms	**1**
5(c)	(from) blue (1) (to) pink (1)	**2**

6 Air is a mixture of gases. The diagram shows the apparatus used to find the percentage of oxygen in air.
50 cm^3 of air were passed backwards and forwards over excess heated copper until there was no further change. The apparatus was left to cool and the volume of gas remaining was 40 cm^3.



(a) Complete the box to name the apparatus. [1]

(b) Use an arrow to indicate where heat is applied. [1]

(c) The colour of the copper changed from ..... to ..... . [2]

(d) From the results, work out the percentage of oxygen in the air.

..... % [2]

[Total: 6]

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Air, pollution and climate change Click for more variations

6(a)	(gas) syringe;	1
6(b)	arrow under copper;	1
6(c)	orange / red / brown / pink; to black;	2 1 1
6(d)	volume of oxygen = 10 cm^3; % oxygen = 10/50 × 100 = 20%;	2 1 1

7 Clean dry air contains mainly nitrogen and oxygen.

(a) Name **two** other gases that are in clean dry air.

.....

..... [2]

(b) Air often contains pollutants.

Identify **three** common gaseous pollutants in air and state how each of these pollutants are produced.

pollutant gas 1 .....

how it is produced .....

.....

pollutant gas 2 .....

how it is produced .....

.....

pollutant gas 3 .....

how it is produced .....

.....

[6]

[Total: 8]

Air, pollution and climate change Click for more variations

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7(a)	any 2 from: carbon dioxide; nitrogen; any named noble gas;	**2**
7(b)	any 6 from: carbon monoxide; from incomplete combustion (of carbon-containing fuel); sulfur dioxide; from burning fossil fuels / roasting ores which contain sulphur / volcanoes; oxides of nitrogen; nitrogen reacting with oxygen in car engines / lightning; methane; from anaerobic decomposition / anaerobic decay;	**6**

8 Two important greenhouse gases are methane and carbon dioxide.

(a) Methane is twenty times more effective as a greenhouse gas than carbon dioxide. The methane in the atmosphere comes from both natural and industrial sources.

(i) Describe **two** natural sources of methane.

.....

..... [2]

(ii) Although methane can persist in the atmosphere for up to 15 years, it is eventually removed by oxidation.
What are the products of this oxidation?

..... [2]

(b) How do the processes of respiration, combustion and photosynthesis determine the percentage of carbon dioxide in the atmosphere?

.....

.....

.....

..... [4]

[Total: 8]

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8 **(a)** **(i)** (waste gases) from animals [1]
decaying vegetation / anaerobic decay [1]
accept: decomposition of organic material / natural gas

(ii) carbon dioxide [1]
water [1]

(b) photosynthesis removes carbon dioxide from the atmosphere [1]
both respiration and combustion produce carbon dioxide [1]
any **two** of the following: [2]
plants photosynthesis changes carbon dioxide into carbohydrates
(burning) of fossil fuels / named fuel / petrol / alkanes
respiration by living organisms to obtain energy from
carbon–containing compounds
comment that the balance between these processes determines the percentage of carbon dioxide

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9 **(a)** Coal is a solid fossil fuel.

Name **two** other fossil fuels.

..... [2]

(b) Two of the elements present in a sample of coal are carbon and sulfur.

A sample of coal was heated in the absence of air and the products included water, ammonia and hydrocarbons.

Name **three** other elements present in this sample of coal.

..... [2]

(c) Sulfur, present in coal, is one major cause of acid rain. Sulfur burns to form sulfur dioxide which reacts with rain water to form sulfuric acid.

(i) Describe how the high temperatures in vehicle engines are another cause of acid rain.

.....

.....

..... [3]

(ii) Give **two** harmful effects of acid rain.

.....

..... [2]

(d) In 2010, a large coal-burning power station in the UK was converted to burn both coal and wood.

Explain why the combustion of wood rather than coal can reduce the effect of the emissions from this power station on the level of carbon dioxide in the atmosphere.

.....

.....

.....

..... [3]

[Total: 12]

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9(a)	*Any **two** fossil fuels from:* crude oil / petroleum; natural gas / methane; petrol / gasoline; kerosene / paraffin; diesel (oil) / gas oil; fuel oil; refinery gas / LPG; propane; butane;	**2**	**I** ethane / oil / naphtha / coal / gas **R** coke / bitumen / lubricating oil / wood
9(b)	hydrogen, oxygen, nitrogen; *All three for 2 marks* *two for 1 mark*	**2**	**A** H, O, N **I** H_2, O_2, N_2
9(c)(i)	M1 oxygen and nitrogen (from air) react; M2 oxides of nitrogen **OR** nitrogen oxide(s) are formed; M3 nitrogen oxides formed react with water (to form acid);	**3**	**A** nitrogen combust for M1 **R** M1 if oxygen or nitrogen originate from the fuel **A** named oxide of nitrogen e.g. nitrogen dioxide **A** correct formulae **A** NO_x
9(c)(ii)	*Any **two** from:* M1 lowers pH or acidifies lakes / rivers or kills fish; M2 changes composition of soils or reduces fertility of soil or reduces crop yields deforestation or kills crops / trees / plants / leaves; M3 attacks (limestone) buildings or statues; M4 attacks metal (structures) / bridges;	**3**	**R** 'global warming / greenhouse effect' **R** 'increases pH of lakes so kills fish' for M1 **A** removes nutrients / leaches the soil **A** alternative words for 'attacks' e.g. damages / reacts with / corrode / erode for M3 and M4 **I** rusting but **A** 'enhances rusting' for M4 **I** toxicity to humans
9(d)	*Any **three** from:* M1 wood burns to produce (less) carbon dioxide; M2 trees (wood) take in carbon dioxide; M3 by photosynthesis; M4 wood is carbon neutral fuel;	**3**	

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10 Water is present in the atmosphere, the seas and in ice and snow.

(a) Describe a chemical test for water.

test .....

result ..... [2]

(b) State **one** use of water in industry.

..... [1]

(c) Water is a good solvent.
What do you understand by the term *solvent*?

..... [1]

(d) Water vapour in the atmosphere reacts with sulfur dioxide, SO_2, to produce acid rain.

(i) State **one** source of sulfur dioxide.

..... [1]

(ii) State **two** adverse effects of acid rain.

1. .....

2. ..... [2]

(iii) Calculate the relative molecular mass of sulfur dioxide.

[1]

(e) Water from lakes and rivers can be treated to make the water safer to drink.

Describe **two** of the steps in water purification.
For each of these steps, give an explanation of its purpose.

step 1 .....

.....

step 2 .....

..... [4]

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(f) Water is formed when hydrogen burns in air.

(i) State the percentage of oxygen present in the air.

..... [1]

(ii) When 8 g of hydrogen is burned in excess air, 72 g of water is formed.
What mass of hydrogen needs to be burnt to produce 252 g of water?

[1]

[Total: 14]

Water Click for more variations

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10

(a) anhydrous copper sulfate / white copper sulfate [1]
ignore oxidation numbers
turns blue [1]

OR

anhydrous cobalt chloride / blue cobalt chloride (1 mark)
ignore oxidation numbers
turns pink (1 mark)
note second mark is dependent on the first being correct BUT cobalt chloride turns pink = 1 mark

(b) coolant / solvent / hydroelectric power [1]
allow for cooling / to cool
allow specific reactions e.g. making sulfuric acid / making ethanol
allow: for washing or cleaning if specific industrial process mentioned
allow for agriculture / for growing crops (on a large scale) / brewing
ignore for cooking / for drinking / for power (unqualified) / for watering plants / for cooling food

(c) substance OR liquid which dissolves another (substance) /
substance which does the dissolving [1]
ignore it dissolves / it is a liquid / names of solvents

(d) **(i)** burning coal / burning fossil fuels / burning petrol petrol / burning specified fuel (as long as it contains sulfur) / from volcanoes / from heating sulphide ores [1]
ignore burning pure substances e.g. hydrogen, methane / car exhausts
ignore from ores without qualification /

(ii) any two effects (1 mark each) e.g. [2]

- forest death / kills trees / deforestation / destroys trees / damages trees
  ignore kills plants / rots trees / kills crops
- acidification of lakes / acidification of rivers
  ignore acidifies soils
- kills fish / aquatic plants / plant in lakes or rivers
  ignore kills fish or plants in the sea / kills animal (unqualified) / kills plants (unqualified)
- erodes buildings made from limestone / erodes carbonate rocks / damages buildings made from limestone / damages carbonate rocks
  allow destroys building made from limestone / destroys carbonate rocks
  ignore just erosion of buildings or rocks unqualified / dissolves buildings / chemical weathering
- corrosion of metal structures / corrosion of named metal structures e.g. bridges or railings / damages metal structures
  allow erosion of metal structures / damaging metal structures / destroys metal structures / reacts with metals
  ignore dissolves metals
  ignore effects on humans

(iii) 64 (g) [1]

(e) In each of these points, the explanation mark depends on the correct step

filtration or words to that effect [1]

removal of undissolved substances / solids / impurities get trapped / removes insoluble impurities [1]
allow removes dirt
ignore solids which would sediment rapidly or are large e.g. pieces of metal, batteries, twigs

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etc. / removes impurities

chlorination / adding chlorine [1]
allow chlorification

kills bacteria [1]
allow kills microbes / kills germs / disinfection / sterilisation
ignore kills bugs / removes bacteria

allow other stages with correct explanation e.g.
screening (1 mark) removing large objects / removing twigs etc. (1 mark)
sedimentation (1 mark) allowing particles to settle (1 mark)
adding carbon (1 mark) removes tastes / removes smells (1 mark)
flocculation (1 mark) coagulates clay / makes small particles clump together (1 mark)
lime (1 mark) idea of neutralisation or removal of acids (1 mark)

(f) **(i)** 20 (%) allow 19–21 (%) [1]

(ii) 28 (g) [1]

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