7 This question is about the thermal decomposition of calcium nitrate.

$$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$$

What volume of gas is produced by the complete decomposition of 0.050 mol of calcium nitrate at room temperature and pressure (r.t.p.)?

[Molar volume of a gas at r.t.p. = 24 $dm^3 mol^{-1}$]

- ☒ **A** 600 cm^3
- ☒ **B** 1.20 dm^3
- ☒ **C** 3.00 dm^3
- ☒ **D** 6.00 dm^3

(Total for Question 7 = 1 mark)

8 Which is the strongest **oxidising** agent in these displacement reactions?

$$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$$

$$Br_2 + 2I^- \rightarrow 2Br^- + I_2$$

- ☒ **A** chlorine
- ☒ **B** bromide ions
- ☒ **C** bromine
- ☒ **D** iodide ions

(Total for Question 8 = 1 mark)

9 The first four ionisation energies of the elements gallium (Ga), indium (In), germanium (Ge) and tin (Sn) are shown.

Which values are the first four ionisation energies of gallium?

- ☒ **A** 557 1821 2705 5200
- ☒ **B** 579 1979 2963 6200
- ☒ **C** 709 1412 2943 3930
- ☒ **D** 762 1537 3302 4411

(Total for Question 9 = 1 mark)

8: Which substance does **not** exist as a giant lattice?

- ☒ **A** silver (Ag)
- ☒ **B** sodium chloride (NaCl)
- ☒ **C** graphite (C)
- ☒ **D** buckminsterfullerene (C_{60})

(Total for Question 8 = 1 mark)

4 Each response gives the atomic numbers of two elements.
Which pair of atomic numbers are those of elements that are in different blocks of the Periodic Table?

- ☒ **A** 5, 9
- ☒ **B** 10, 16
- ☒ **C** 13, 18
- ☒ **D** 16, 20

(Total for Question 4 = 1 mark)

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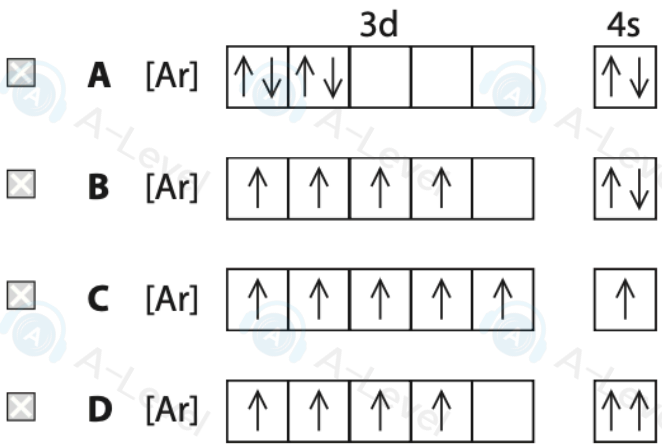
10 Which is the electronic configuration of chromium?



(Total for Question 10 = 1 mark)

5 Four different solutions contain chloride ions.
Three of the solutions contain the same number of moles of chloride ions.

Which solution contains a different number?

- ☒ **A** 15.0 cm^3 of 0.80 mol dm^{-3} hydrochloric acid
- ☒ **B** 10.0 cm^3 of 0.40 mol dm^{-3} iron(III) chloride solution
- ☒ **C** 10.0 cm^3 of 0.90 mol dm^{-3} magnesium chloride solution
- ☒ **D** 20.0 cm^3 of 0.60 mol dm^{-3} sodium chloride solution

(Total for Question 5 = 1 mark)

10 Sulfur has a higher melting temperature than white phosphorus, P_4.

Which is a possible reason for this?

- ☒ **A** sulfur molecules have a greater permanent dipole than phosphorus molecules
- ☒ **B** sulfur has stronger covalent bonds than phosphorus
- ☒ **C** sulfur has a giant covalent structure and phosphorus has a simple molecular structure
- ☒ **D** sulfur molecules have more electrons than phosphorus molecules

(Total for Question 10 = 1 mark)

1: Which row shows the numbers of neutrons and electrons in a bromide ion $^{79}Br^-$?

	Number of neutrons	Number of electrons
☒ **A**	44	35
☒ **B**	44	36
☒ **C**	46	35
☒ **D**	46	36

(Total for Question 1 = 1 mark)

14 The formula of phosgene is $COCl_2$.
What is the total number of **atoms** in 9.9 g of phosgene?

[Avogadro constant (L) = 6.02×10^{23} mol^{-1} M_r value: $COCl_2$ = 99.0]

- ☒ **A** 1.51×10^{22}
- ☒ **B** 6.02×10^{22}
- ☒ **C** 1.81×10^{23}
- ☒ **D** 2.41×10^{23}

(Total for Question 14 = 1 mark)

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3 How many oxygen **atoms** are there in 0.0100 mol of H_2SO_4?

[Avogadro constant, $L = 6.020 \times 10^{23}$ mol^{-1}]

- ☒ **A** 6.020×10^{21}
- ☒ **B** 1.204×10^{22}
- ☒ **C** 2.408×10^{22}
- ☒ **D** 4.214×10^{22}

(Total for Question 3 = 1 mark)

11 Which combination of ions would be expected to form the compound with the **highest** melting temperature?

- ☒ **A** Li^+ and Br^-
- ☒ **B** Mg^{2+} and O^{2-}
- ☒ **C** Sr^{2+} and S^{2-}
- ☒ **D** Rb^+ and Cl^-

(Total for Question 11 = 1 mark)

10: Which reaction to produce copper(II) nitrate (M_r = 187.5) has an atom economy of 46.5% by mass?

- ☒ **A** $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
- ☒ **B** $2Cu + Pt(NO_3)_4 \rightarrow 2Cu(NO_3)_2 + Pt$
- ☒ **C** $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$
- ☒ **D** $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$

(Total for Question 10 = 1 mark)

11 A piece of filter paper is soaked in water and attached to a microscope slide.

A few crystals of green copper(II) chromate(VI) are placed in the centre of the filter paper.

The filter paper is connected to a DC supply of 20 V.

What colours are observed on the paper after a few minutes?

☒	**A**	blue	yellow
☒	**B**	green	blue
☒	**C**	yellow	green
☒	**D**	yellow	blue

(Total for Question 11 = 1 mark)

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9 A sample of the element chlorine, Cl_2, was analysed in a mass spectrometer. Chlorine has **two** isotopes.

What is the **total** number of peaks, due to ions with a single positive charge, which could be seen in the mass spectrum?

- ☒ **A** two
- ☒ **B** four
- ☒ **C** five
- ☒ **D** six

(Total for Question 9 = 1 mark)

25 This question is about aluminium and its compounds.

(a) (i) State the shape of a molecule of aluminium trichloride, $AlCl_3$.

(1)

.....

(ii) Aluminium chloride can exist as a dimer formed from two molecules of aluminium trichloride.

Draw a diagram of this dimer, showing the bonding between the two molecules.

(2)

(b) Aluminium trichloride reacts vigorously with water to produce hydrogen chloride and aluminium hydroxide, $Al(OH)_3$.

Write the equation for this reaction.
State symbols are not required.

(1)

(c) Aluminium trichloride also reacts with sodium hydroxide.

$$AlCl_3(g) + 3NaOH(aq) \rightarrow Al(OH)_3(s) + 3NaCl(aq)$$

Calculate the maximum mass of aluminium hydroxide precipitated when excess aluminium trichloride reacts with 150 cm^3 of 1.5 mol dm^{-3} sodium hydroxide.

(3)

(d) (i) Describe the metallic bonding in aluminium.

(3)

(ii) Explain how metallic bonding leads to the properties of electrical conductivity and malleability shown by aluminium.

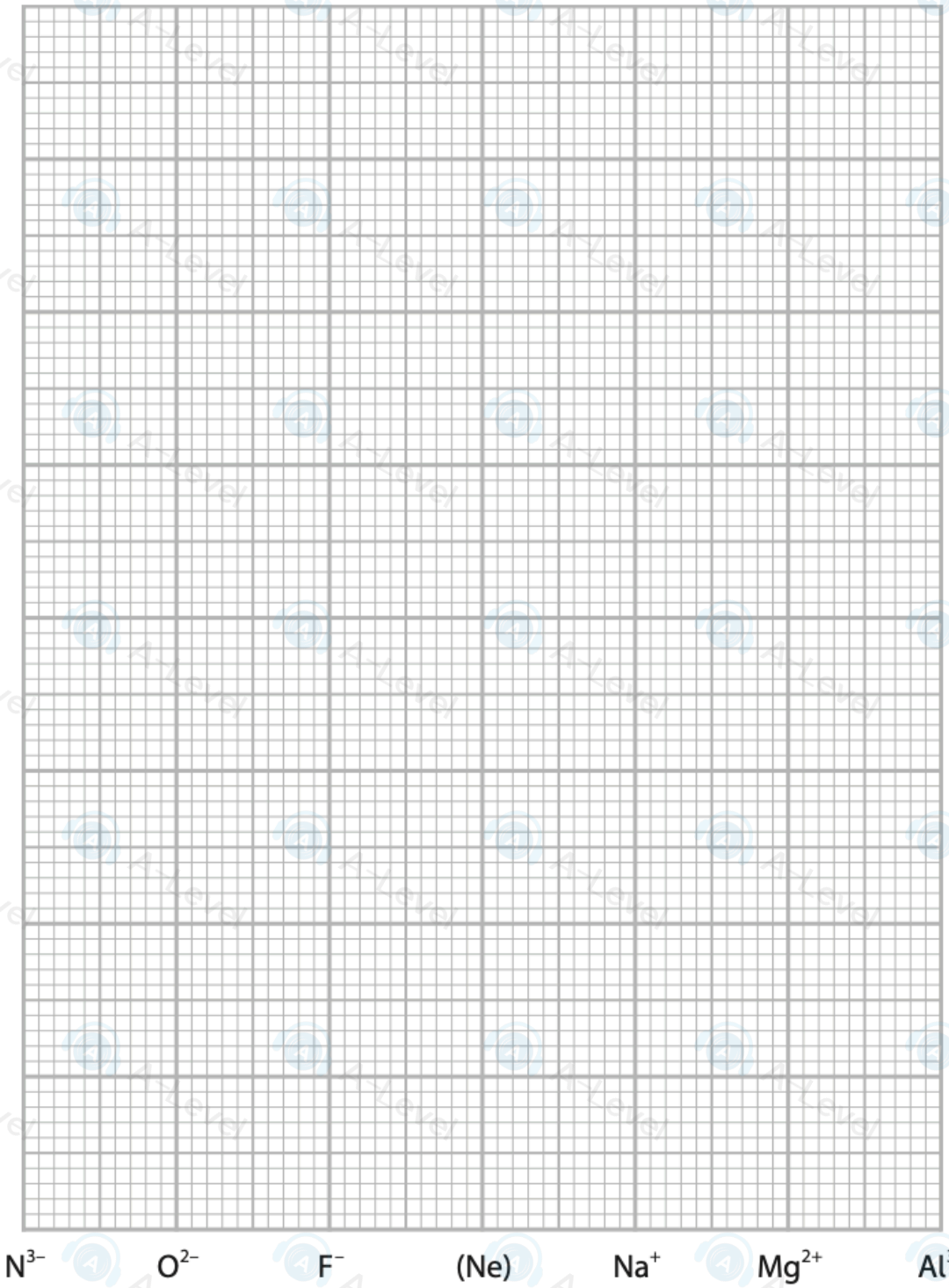
(2)

24 The radii of ions of some successive elements in the Periodic Table are shown.

Ion	N^{3-}	O^{2-}	F^-	Na^+	Mg^{2+}	Al^{3+}
Ionic radius / pm	171	140	133	102		54

(a) (i) Plot a graph of the data.

(2)



(ii) Predict the radius of the magnesium ion using a straight line of best fit on your graph.

(2)

(iii) Explain the trend in the ionic radii from the nitride ion to the aluminium ion.

(3)

(b) Sodium and fluorine react to form a compound.

(i) State the structure and bonding of sodium fluoride.

(1)

(ii) Explain how the electrical conductivity of sodium fluoride provides evidence for the existence of ions.

(3)

(iii) Explain why the fluoride ion is difficult to polarise.

(2)

(Total for Question 24 = 13 marks)

23 Samples of germanium consist of five isotopes, four of which are stable.
The fifth isotope, germanium-76, is radioactive but with a very long half-life.

This means that the isotopic composition is almost constant.
The table shows data for four of the isotopes.

Atom	^{70}Ge	^{73}Ge	^{74}Ge	^{76}Ge
Mass number	70	73	74	76
Abundance / %	20.5	7.8	36.5	7.8

(a) (i) Calculate the mass number of the fifth isotope of germanium.
The relative atomic mass of germanium is 72.6.

You must show your working.

(3)

(ii) Give the main reason why the answer in (a)(i) should not be quoted to more than 2 significant figures.

(1)

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