This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 01
06NOV2023

Do NOT write in this box. Your MARK will be placed here.

Subject :	A Level : Chemistry 1
Class :	11A and 12A
Teacher :	Mrs. Saydeh Nasrallah
Duration :	1 hour

Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

SECTION A

Answer ALL the questions in this section.
You should aim to spend no more than 15 minutes on this section.
For each question, select one answer from A to D and put a cross in the box.
If you change your mind, put a line through ☒ the box and then mark your new answer with a cross. ☒

1. A saturated aqueous calcium hydroxide solution contains $17.3\,g$ in $10.0\,dm^3$ of solution.
Under these conditions the calcium hydroxide is fully dissociated into ions.
What is the concentration of the calcium ions in this solution, in $mol\,dm^{-3}$?

☒ **A** 0.0233
☒ **B** 0.0303
☒ **C** 0.0431
☒ **D** 0.0597

(Total for Question 1 = 1 mark)

2. The first four ionisation energies, in $kJ\,mol^{-1}$, of four elements are shown.
Which element is in Group 3?

☒ **A** 738 1451 7753 10 541
☐ **B** 578 1817 2745 11 578
☐ **C** 789 1577 3232 4356
☐ **D** 1012 1903 2912 4957

(Total for Question 2 = 1 mark)

3. Which is the electronic configuration for the S^{2-} ion?

☒ **A** $1s^2\,2s^2\,2p^6\,3s^2\,3p^2$
☒ **B** $1s^2\,2s^2\,2p^6\,3s^2\,3p^4$
☒ **C** $1s^2\,2s^2\,2p^6\,3p^6$
☒ **D** $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$

(Total for Question 3 = 1 mark)

4. Iodine is a lustrous grey crystalline solid at room temperature.
The formula of the lustrous grey solid is I_2.
Which equation represents the first ionisation energy of iodine?

☐ **A** $I(s) \rightarrow I^+(g) + e^-$
☐ **B** $I_2(s) \rightarrow I_2^+(g) + e^-$
☐ **C** $I(g) \rightarrow I^+(g) + e^-$
☐ **D** $I_2(g) \rightarrow I_2^+(g) + e^-$

(Total for Question 4 = 1 mark)

5. Which list contains only s-block elements?

☒ **A** Li, Na, Mg and Cl
☐ **B** K, Ca, Co and Rb
☐ **C** Mg, Al, Sr and Ba
☐ **D** Be, Rb, Ba and Ra

(Total for Question 5 = 1 mark)

6. What is the number of electrons in the **fourth** quantum shell of bromine?

☐ **A** 2
☒ **B** 7
☐ **C** 17
☐ **D** 18

(Total for Question 6 = 1 mark)

7. What is the percentage by mass of strontium in strontium nitrate, $Sr(NO_3)_2$?

☐ **A** 38.0 %
☐ **B** 41.4 %
☐ **C** 58.6 %
☐ **D** 74.5 %

(Total for Question 7 = 1 mark)

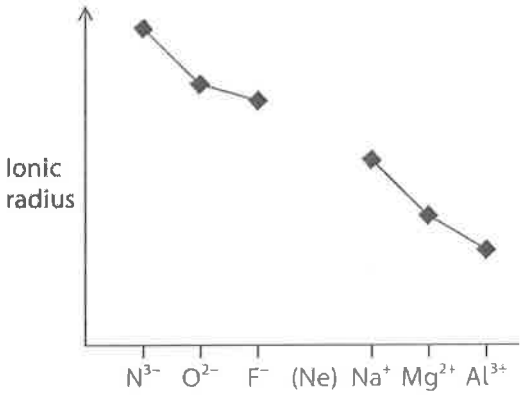
8. The elements sodium and fluorine react together to form the ionic compound sodium fluoride. Select the correct equation for this reaction.

☒ **A** $Na(s) + F(g) \rightarrow NaF(s)$
☒ **B** $2Na(s) + F_2(g) \rightarrow 2NaF(s)$
☒ **C** $Na(s) + F_2(g) \rightarrow NaF_2(s)$
☒ **D** $2Na(s) + F(g) \rightarrow Na_2F(s)$

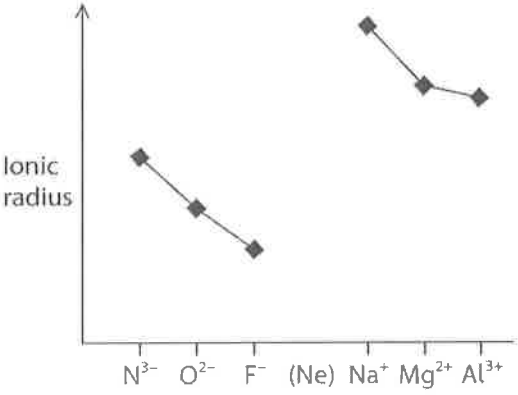
(Total for Question 8 = 1 mark)

9. Which diagram shows the trend in ionic radius for the isoelectronic ions N^{3-} to Al^{3+}?

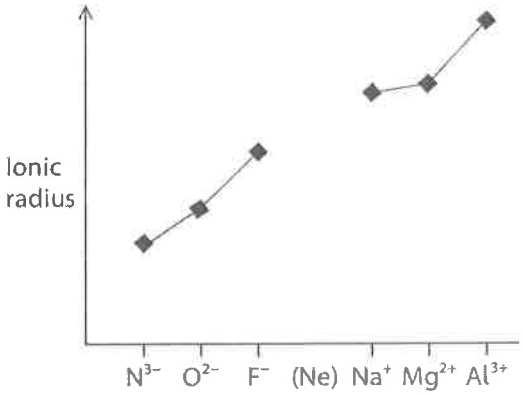
☒ **A**



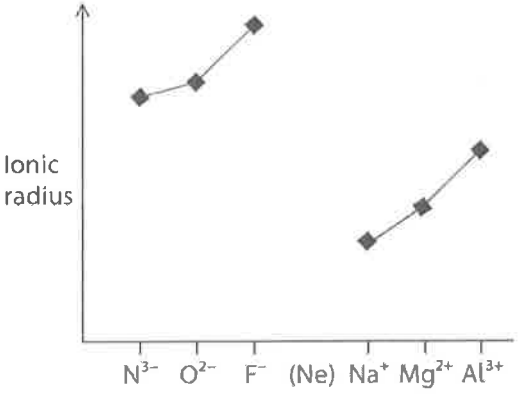
☒ **B**



☐ **C**

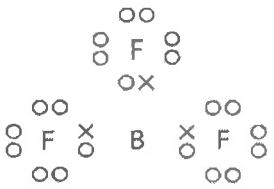


☐ **D**



(Total for Question 9 = 1 mark)

10. The dot-and-cross diagram of BF_3 is



What is the bond angle in BF_3?

- ☐ **A** 90°
- ☐ **B** 107°
- ☐ **C** 109.5°
- ☐ **D** 120°

(Total for Question 10 = 1 mark)

11. $0.15\,mol$ of aluminium is added to $120\,cm^3$ of $1.50\,mol\,dm^{-3}$ hydrochloric acid.

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3\,(aq) + 3H_2(g)$$

The amount of **unused** reactant is

- ☒ **A** 0.06 mol aluminium
- ☐ **B** 0.09 mol aluminium
- ☐ **C** 0.03 mol hydrochloric acid
- ☐ **D** 0.13 mol hydrochloric acid

(Total for Question 11 = 1 mark)

12. 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

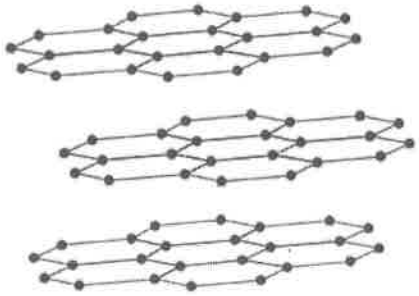
(Total for Question 12 = 1 mark)
TOTAL FOR SECTION A = 12 MARKS

SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

13. Graphite electrodes are used in the extraction of aluminium by the electrolysis of aluminium oxide, Al_2O_3, dissolved in a solvent (molten cryolite) at a temperature of 950°C.

(a) Explain how the structure and bonding in graphite make it suitable for this application. Refer to the diagram in your answer.



Graphite

(3)

(b) The overall equation for the electrolysis reaction is shown.

$$Al_2O_3 \rightarrow 2Al + 1\frac{1}{2}O_2$$

The oxygen produced reacts with the graphite electrode.

$$C(s) + O_2(g) \rightarrow CO_2(g)$$

(i) Calculate the maximum volume, in dm^3 , of CO_2, measured at r.t.p. which could be produced when 1.00 kg aluminium is extracted using this process.
[The molar volume of a gas is $24.0\,dm^3\,mol^{-1}$ at r.t.p.]

(3)

(ii) Every year in the United Kingdom, about 7.2 billion aluminium cans are recycled. Suggest three ways this recycling reduces energy consumption.

(3)

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(Total for Question 13 = 9 marks)

14. This question is about ionisation energy.

(a) The second ionisation energy of beryllium is more endothermic than the first ionisation energy.

Write an equation for the second ionisation of beryllium. Include state symbols.

(2)

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(b) Explain how the nuclear structure and the electronic structure of the Group 2 elements affect ionisation energies.

Include:

- an explanation of the trend of the first ionisation energies down the group
- a comparison of the first two ionisation energies for an element.

(4)

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(c) A section of a periodic table showing values of first ionisation energy in $kJ\,mol^{-1}$ is shown.

N 1400	O 1310	F 1680
P 1010	S 1000	Cl 1250
As 950	Se 940	Br 1140

(i) Explain why the first ionisation energy of sulfur is lower than that of chlorine.

(2)

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(ii) Explain why the first ionisation energy of sulfur is lower than that of phosphorus.

(2)

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(Total for Question 14 = 10 marks)

15. This question is about sulfur and some of its compounds.

(a) Sulfur is a bright yellow crystalline solid at room temperature.
Sulfur forms rings of 8 sulfur atoms so the formula of the yellow solid is S_8.
Sulfur and diamond are crystalline solids at room temperature.
Explain why diamond has a much higher melting temperature than sulfur.

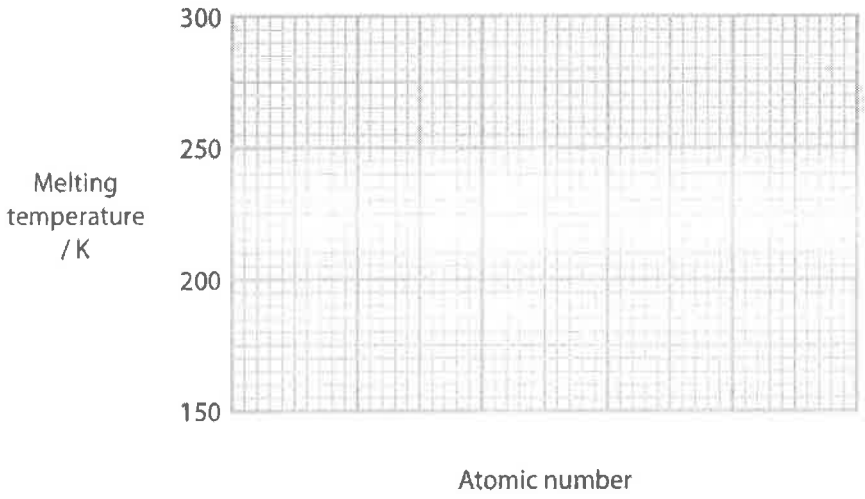
(4)

(b) Sulfur and the other elements in Group 6 form dihydrogen compounds.

Compound	Atomic number of Group 6 element	Melting temperature /K
H_2O	8	273
H_2S	16	To be estimated
H_2Se	34	207
H_2Te	52	224
H_2Po	84	238

(i) Plot a graph of atomic number of the Group 6 element on the x-axis against melting temperature of the dihydrogen compound on the y-axis.

(2)



(ii) Draw a line of best fit through the last three points, and a line through the first point intersecting the previous line at the point of abscissa Z=32 to give an estimate of the melting temperature of H_2S.

(1)

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(c) Compound **X** is an oxide of sulfur. **X** is found to be 40% by mass in sulfur.

A gaseous sample of $0.318\,g$ of **X** occupied a volume of $132\,cm^3$ at a temperature of $420\,K$ and pressure of $105\,kPa$.

The number of moles of a gas and the volume occupied by it can be found using the ideal gas equation:

$$pV = nRT$$

Calculate the relative molecular mass of **X** and hence its molecular formula.

You must show all your working.

[$R = 8.31\,J\,mol^{-1}\,K^{-1}$]

(5)

(Total for Question 15 = 12 marks)

16. The table shows some information about a selection of elements and compounds.

	Graphene	Graphite	Diamond	Magnesium oxide	Potassium bromide	Iron
Melting temperature /K	>4000	3950	3820	3125	1007	1808
Density /g cm^{-3}	not measured	2.2 to 2.8	3.51	3.58	2.75	7.86
Compressive strength /GPa	not measured	2.3 and 15.3	443	152	15	170

(a) Explain the difference in the melting temperatures of magnesium oxide and potassium bromide.

(3)

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(b) Explain why the electrical conductivity of solid potassium bromide is poor but an aqueous solution of potassium bromide is a good electrical conductor.

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(c) The compressive strength is a measure of the energy required to break some of the bonds within a substance.
Deduce possible reasons why there are two widely different values for the compressive strength of graphite.
Both the values (2.3 and 15.3 GPa) are valid experimental results.

(2)

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(Total for Question 16 = 7 marks)
TOTAL FOR SECTION B = 38 MARKS
TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I fodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
* Actinide series	232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103

SECTION A

Answer ALL the questions in this section.
You should aim to spend no more than 15 minutes on this section.
For each question, select one answer from A to D and put a cross in the box.
If you change your mind, put a line through ☒ the box and then mark your new answer with a cross. ☒

1. A saturated aqueous calcium hydroxide solution contains $17.3\,g$ in $10.0\,dm^3$ of solution. Under these conditions the calcium hydroxide is fully dissociated into ions. What is the concentration of the calcium ions in this solution, in $mol\,dm^{-3}$?

(1) ✓
- ☒ **A** 0.0233
- ☐ **B** 0.0303
- ☐ **C** 0.0431
- ☐ **D** 0.0597

(Total for Question 1 = 1 mark)

2. The first four ionisation energies, in $kJ\,mol^{-1}$, of four elements are shown. Which element is in Group 3?

(1) ✓
- ☐ **A** 738 1451 7753 10 541
- ☒ **B** 578 1817 2745 11 578
- ☐ **C** 789 1577 3232 4356
- ☐ **D** 1012 1903 2912 4957

(Total for Question 2 = 1 mark)

3. Which is the electronic configuration for the S^{2-} ion?

(1) ✓
- ☐ **A** $1s^2\,2s^2\,2p^6\,3s^2\,3p^2$
- ☐ **B** $1s^2\,2s^2\,2p^6\,3s^2\,3p^4$
- ☐ **C** $1s^2\,2s^2\,2p^6\,3p^6$
- ☒ **D** $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$

(Total for Question 3 = 1 mark)

4. Iodine is a lustrous grey crystalline solid at room temperature.
The formula of the lustrous grey solid is I_2.
Which equation represents the first ionisation energy of iodine?

- ☐ **A** $I(s) \rightarrow I^+(g) + e^-$
- ☐ **B** $I_2(s) \rightarrow I_2^+(g) + e^-$
- ☒ **C** $I(g) \rightarrow I^+(g) + e^-$
- ☐ **D** $I_2(g) \rightarrow I_2^+(g) + e^-$

(1) ✓

(Total for Question 4 = 1 mark)

5. Which list contains only s-block elements?

- ☐ **A** Li, Na, Mg and Cl
- ☐ **B** K, Ca, Co and Rb
- ☐ **C** Mg, Al, Sr and Ba
- ☒ **D** Be, Rb, Ba and Ra

(1) ✓

(Total for Question 5 = 1 mark)

6. What is the number of electrons in the **fourth** quantum shell of bromine?

- ☐ **A** 2
- ☒ **B** 7
- ☐ **C** 17
- ☐ **D** 18

(1) ✓

(Total for Question 6 = 1 mark)

7. What is the percentage by mass of strontium in strontium nitrate, $Sr(NO_3)_2$?

- ☐ **A** 38.0 %
- ☒ **B** 41.4 %
- ☐ **C** 58.6 %
- ☐ **D** 74.5 %

(1) ✓

(Total for Question 7 = 1 mark)

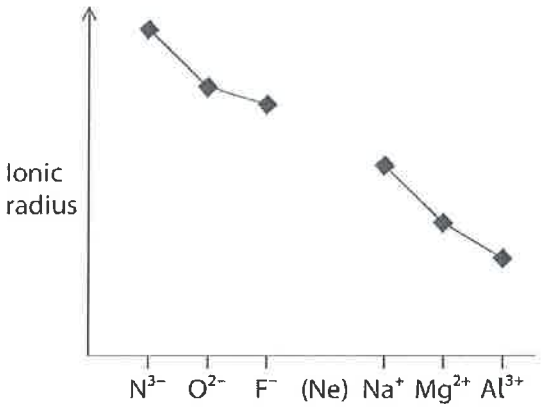
8. The elements sodium and fluorine react together to form the ionic compound sodium fluoride. Select the correct equation for this reaction.

- ☐ **A** $Na(s) + F(g) \rightarrow NaF(s)$
- ☒ **B** $2Na(s) + F_2(g) \rightarrow 2NaF(s)$
- ☐ **C** $Na(s) + F_2(g) \rightarrow NaF_2(s)$
- ☐ **D** $2Na(s) + F(g) \rightarrow Na_2F(s)$

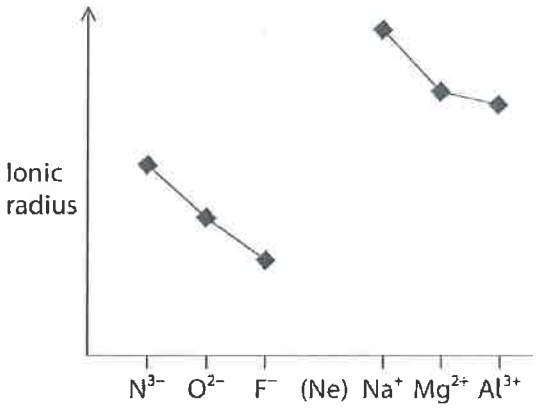
(Total for Question 8 = 1 mark)

9. Which diagram shows the trend in ionic radius for the isoelectronic ions N^{3-} to Al^{3+}?

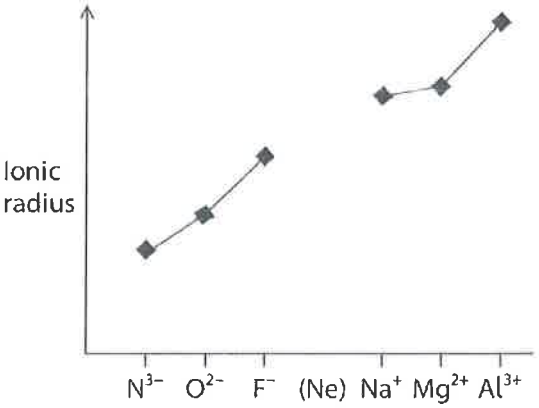
☒ **A**



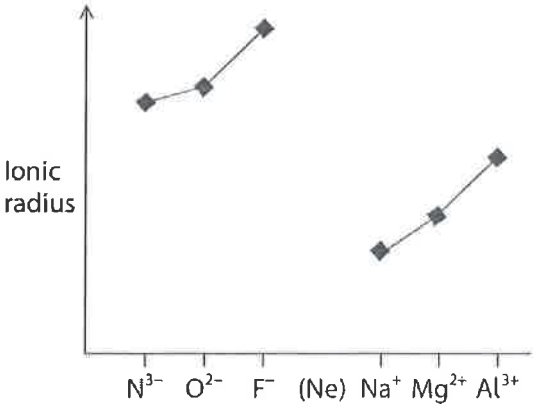
☐ **B**



☐ **C**

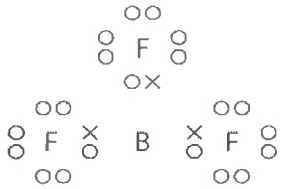


☐ **D**



(Total for Question 9 = 1 mark)

10. The dot-and-cross diagram of BF_3 is



What is the bond angle in BF_3?

- ☐ **A** 90°
- ☐ **B** 107°
- ☐ **C** 109.5°
- ☒ **D** 120°

(1) ✓

(Total for Question 10 = 1 mark)

11. $0.15\,mol$ of aluminium is added to $120\,cm^3$ of $1.50\,mol\,dm^{-3}$ hydrochloric acid.

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3\,(aq) + 3H_2(g)$$

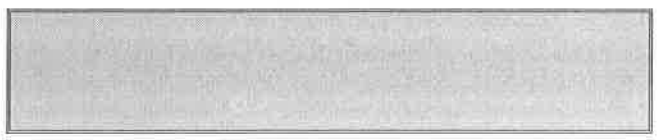
The amount of **unused** reactant is

- ☐ **A** 0.06 mol aluminium
- ☒ **B** 0.09 mol aluminium
- ☐ **C** 0.03 mol hydrochloric acid
- ☐ **D** 0.13 mol hydrochloric acid

(1) ✓

(Total for Question 11 = 1 mark)

12. 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

(1) ✓

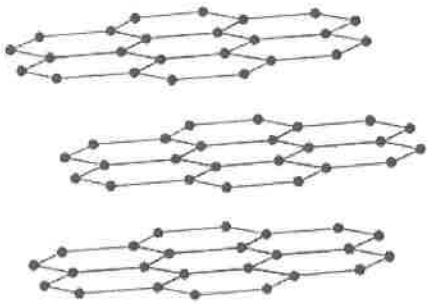
(Total for Question 12 = 1 mark)
TOTAL FOR SECTION A = 12 MARKS

SECTION B

Answer ALL the questions. Write your answers in the spaces provided.

13. Graphite electrodes are used in the extraction of aluminium by the electrolysis of aluminium oxide, Al_2O_3, dissolved in a solvent (molten cryolite) at a temperature of 950°C.

(a) Explain how the structure and bonding in graphite make it suitable for this application. Refer to the diagram in your answer.



Graphite

(3)

Graphite has a giant structure, where atoms are covalently bonded causing it to have high T°m. This allows it to withstand the high temperatures applied in electrolysis.

In graphite, the atoms are bonded to three other atoms leaving one free $\bar{e}$ per atom. These free $\bar{e}$ allow the flow of charge, in electrolysis, wherever a potential difference is applied.

(2)

(1)

(b) The overall equation for the electrolysis reaction is shown.

$$Al_2O_3 \rightarrow 2Al + 1\frac{1}{2}O_2$$

The oxygen produced reacts with the graphite electrode.

$$C(s) + O_2(g) \rightarrow CO_2(g)$$

(i) Calculate the maximum volume, in dm^3, of CO_2, measured at r.t.p. which could be produced when 1.00 kg aluminium is extracted using this process.
[The molar volume of a gas is $24.0\,dm^3\,mol^{-1}$ at r.t.p.]

(3)

Al : O_2

2 : 1.5 ✓ => $n_{O_2} = \frac{3}{4} \cdot n_{(Al)} = \frac{3}{4} \times \frac{1000}{27} = 27.78$ mol ✓ (1)

O_2 : CO_2

1 : 1 => $n_{CO_2} = 27.78$ mol. ✓ (1)

=> $V_{CO_2} = 27.78 \times 24 = 666.67\ dm^3$ ✓ (1)

(ii) Every year in the United Kingdom, about 7.2 billion aluminium cans are recycled.
Suggest three ways this recycling reduces energy consumption.

(3)

Less energy is needed to transport raw material to produce new aluminium ✓ (1)

Less energy is needed to melt cryolite during electrolysis ✓ (1)

Less energy is needed to perform electrolysis. ✓ (1)

(Total for Question 13 = 9 marks)

14. This question is about ionisation energy.

(a) The second ionisation energy of beryllium is more endothermic than the first ionisation energy.

Write an equation for the second ionisation of beryllium. Include state symbols.

(2)

$Be^{+}(g) \longrightarrow Be^{2+}(g) + e^{-}$ ✓ (2)

(b) Explain how the nuclear structure and the electronic structure of the Group 2 elements affect ionisation energies.

Include:
- an explanation of the trend of the first ionisation energies down the group
- a comparison of the first two ionisation energies for an element.

(4)

Going down the group, the nuclear charge increases yet, the ē cloud also increases in size causing more shielding which will result in a decrease in the attraction between the nucleus and the outer ē. As a result, the values of the first I.E decrease going from Be down to Ba. ✓✓ (2)

The ē configuration of group II elements ends with s^2. After the removal of the first ē, two factors change for the remaining ē on the s-sublevel which lead to an increase in the 2nd I.E values.

These 2 factors are:

- greater effective nuclear charge
- no repulsion from ē outer s-sublevel ē. ✓✓ (2)

(c) A section of a periodic table showing values of first ionisation energy in $kJ\,mol^{-1}$ is shown.

N 1400	O 1310	F 1680
P 1010	S 1000	Cl 1250
As 950	Se 940	Br 1140

(i) Explain why the first ionisation energy of sulfur is lower than that of chlorine.

(2)

Both chlorine and sulfur have equal number (1) of energy levels in their e^- cloud (1). Yet, chlorine has a greater nuclear charge compared to that of sulfur which explains the higher 1st I.E value for chlorine compared to that of sulfur. (1)

(ii) Explain why the first ionisation energy of sulfur is lower than that of phosphorus.

(2)

S: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ P: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

Although the nuclear charge of S is greater than that of P yet, (1) the repulsion between the $2e^-$ occupying the 3p orbital favours the removal of the 1st e^- in S compared to no repulsion in P. (1)

(Total for Question 14 = 10 marks)

15. This question is about sulfur and some of its compounds.

(a) Sulfur is a bright yellow crystalline solid at room temperature.
Sulfur forms rings of 8 sulfur atoms so the formula of the yellow solid is S_8.
Sulfur and diamond are crystalline solids at room temperature.
Explain why diamond has a much higher melting temperature than sulfur.

(4)

Diamond has a giant covalent structure where the particles (atoms) are covalently bonded ✓ (1)
The covalent bonds are strong attractions which require huge amount of energy to be overcome explaining diamond's high melting point ✓ (1)

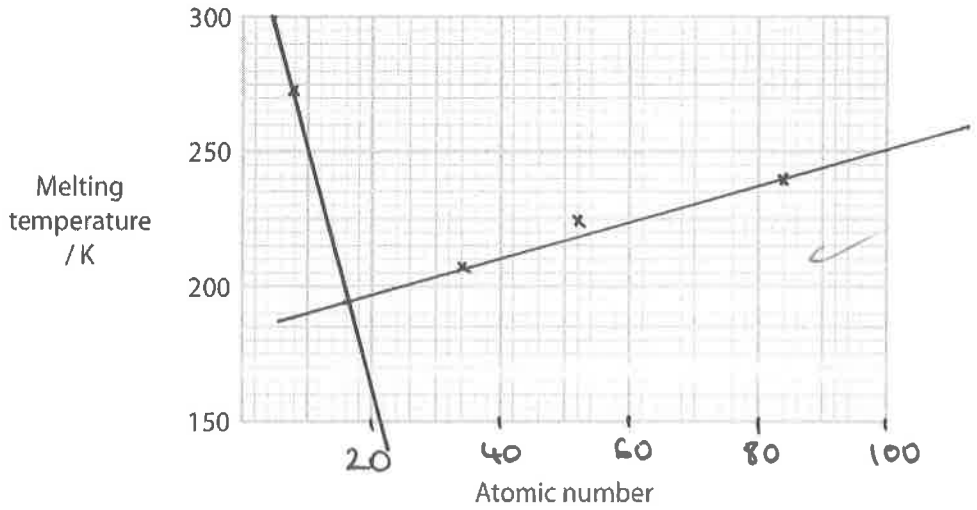
Sulfur has a simple molecular structure, where the particles (molecules) are weakly attracted via intermolecular attractions ✓ (1) These forces require low amount of energy to be broken, which explains sulfur's low melting temperature. ✓ (1)

(b) Sulfur and the other elements in Group 6 form dihydrogen compounds.

Compound	Atomic number of Group 6 element	Melting temperature /K
H_2O	8	273
H_2S	16	To be estimated
H_2Se	34	207
H_2Te	52	224
H_2Po	84	238

(i) Plot a graph of atomic number of the Group 6 element on the x-axis against melting temperature of the dihydrogen compound on the y-axis.

(2)



correct points (1)

lines (1)

(ii) Draw a line of best fit through the last three points, and a line through the first point intersecting the previous line at the point of abscissa Z=32 to give an estimate of the melting temperature of H_2S.

(1)

195 K ✓ (1)

(c) Compound **X** is an oxide of sulfur. **X** is found to be 40% by mass in sulfur.
A gaseous sample of $0.318\,g$ of **X** occupied a volume of $132\,cm^3$ at a temperature of $420\,K$ and pressure of $105\,kPa$.
The number of moles of a gas and the volume occupied by it can be found using the ideal gas equation:

$$pV = nRT$$

Calculate the relative molecular mass of **X** and hence its molecular formula.
You must show all your working.
[$R = 8.31\,J\,mol^{-1}\,K^{-1}$]

(5)

$$n_{(X)} = \frac{p.V}{RT} = \frac{105 \times 10^{3} \times 132 \times 10^{-6}}{8.31 \times 420} = 0.00397 \text{ mol}$$

$$M_{(X)} = \frac{0.318}{0.00397} = 80.1 \text{ g.mol}^{-1}$$

in 100 g:

S	O
40 g	60 g
32.1	16
1.25	3.75
1.25	1.25
1	3

$\Rightarrow$ E.F : $(SO_3)_n$

$$n = \frac{80.1}{32.1 + 3 \times 16} = 1 \Rightarrow \text{M.F is } SO_3.$$

(Total for Question 15 = 12 marks)

16. The table shows some information about a selection of elements and compounds.

	Graphene	Graphite	Diamond	Magnesium oxide	Potassium bromide	Iron
Melting temperature /K	> 4000	3950	3820	3125	1007	1808
Density /g cm^{-3}	not measured	2.2 to 2.8	3.51	3.58	2.75	7.86
Compressive strength /GPa	not measured	2.3 and 15.3	443	152	15	170

(a) Explain the difference in the melting temperatures of magnesium oxide and potassium bromide.

(3)

• The ionic radii increase down the group

=> I.R (Mg^{2+}) < I.R (K^+) and I.R (O^{2-}) < I.R (Br^-) (1)

• $q_{(Mg^{2+})} \times q_{(O^{2-})} > q_{(K^+)} \times q_{(Br^-)}$ (1)

and L.E = $k \frac{q_1 q_2}{d^2}$ => L.E(MgO) is more exothermic than L.E(KBr) (1)

=> T°m (MgO) > T°m (KBr)

(b) Explain why the electrical conductivity of solid potassium bromide is poor but an aqueous solution of potassium bromide is a good electrical conductor.

(2)

In solid state, the ions are in fixed position (vertices of the cube) (1) unlike in aqueous state where they become hydrated and mobile (1). Hence, they can carry a charge whenever a potential difference is applied

(c) The compressive strength is a measure of the energy required to break some of the bonds within a substance.
Deduce possible reasons why there are two widely different values for the compressive strength of graphite.
Both the values (2.3 and 15.3 GPa) are valid experimental results.

(2)

There are 2 different types of attractions to be broken:
- covalent bonds between atoms within each layer ✓ (1)
- weak attraction between consecutive layers. ✓ (1)

(Total for Question 16 = 7 marks)
TOTAL FOR SECTION B = 38 MARKS
TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds damstactium 110	[272] Rg roentgenium 111							

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
* Actinide series	232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103