This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

SE01 Exam

09NOV2026

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
You are to answer the questions to this exam on : this exam paper	

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 10 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. The concentration of carbon monoxide in the exhaust gases of a car without a catalytic converter is 0.7 % by volume.
In units of parts per million, this concentration is

☐ **A** 7
☐ **B** 70
☐ **C** 700
☐ **D** 7000

(Total for Question 1 = 1 mark)

2. One of the reactions in the catalytic converter of a car exhaust is

$$2NO(g) + 2CO(g) \rightarrow 2CO_2(g) + N_2(g)$$

400 cm^3 of NO is mixed with 500 cm^3 of CO. What is the **total** volume of gas when the reaction is complete? All gas volumes are measured at the same temperature and pressure.

☒ **A** 600 cm^3
☒ **B** 700 cm^3
☒ **C** 1300 cm^3
☒ **D** The volume cannot be calculated without the molar volume of gas at the appropriate temperature and pressure

(Total for Question 2 = 1 mark)

3. The carbon-carbon bond, C=C, in ethene consists of

☒ **A** two σ bonds.
☒ **B** one π bond
☒ **C** one σ bond and one π bond.
☒ **D** two π bonds.

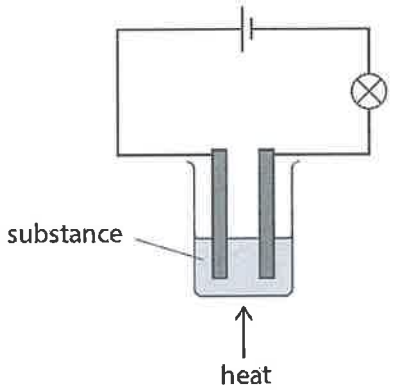
(Total for Question 3 = 1 mark)

4. The terms hazard and risk are used when considering the use of chemical compounds. For a particular characteristic of a pure compound,

☒ **A** hazard is fixed but risk varies.
☒ **B** hazard varies but risk is fixed.
☒ **C** hazard and risk are fixed.
☒ **D** hazard and risk vary.

(Total for Question 4 = 1 mark)

5. Electrical conductivity is investigated using the apparatus shown.



Which substance, **only** when molten, causes the bulb to light?

☒ **A** S
☒ **B** $C_6H_{12}O_6$
☒ **C** Na
☒ **D** NaCl

(Total for Question 5 = 1 mark)

6. Which does **not** indicate the existence of quantum shells in atoms?

☒ **A** the atomic emission spectrum of an element
☒ **B** the direction of electron spin in an atom of an element
☒ **C** the first ionisation energies of successive elements
☒ **D** the successive ionisation energies of electrons in an atom

(Total for Question 6 = 1 mark)

7. Which of these isoelectronic ions has the **largest** ionic radius?

☒ **A** S^{2-}
☒ **B** Cl^-
☒ **C** K^+
☒ **D** Ca^{2+}

(Total for Question 7 = 1 mark)

8. The ionic radii of some ions are shown.

Ion	Li^+	Mg^{2+}	F^-	O^{2-}
Ionic radius/nm	0.060	0.065	0.136	0.140

Which compound has the lowest melting temperature value?

☒ **A** LiF
☒ **B** Li_2O
☒ **C** MgF_2
☒ **D** MgO

(Total for Question 8 = 1 mark)

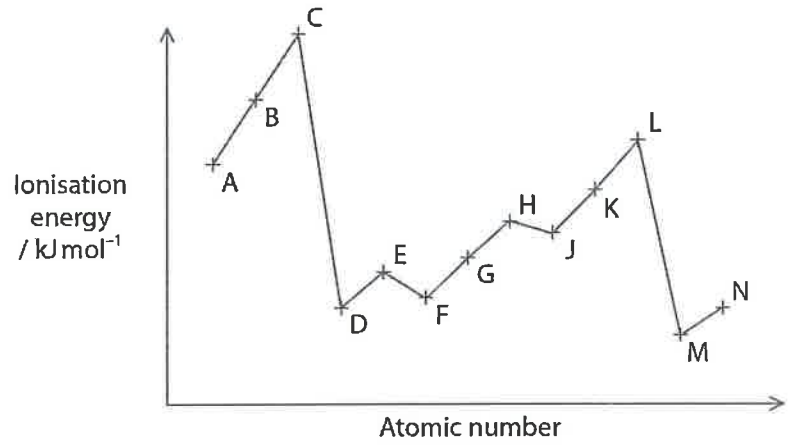
9. Which statement is **not** correct about graphene?

☒ **A** it is an excellent electrical conductor
☒ **B** it can be rolled into a cylinder to form nanotubes
☒ **C** it has a giant structure
☒ **D** it has a multi-layered structure

(Total for Question 9 = 1 mark)

10. The graph shows the first ionisation energies of 13 successive elements in the Periodic Table in order of increasing atomic number.
Trends in first ionisation energies can be used to identify the group to which an element belongs.

The letters are **not** the symbols for the elements.



Which pair of elements belong to Group 2?

- ☒ **A** elements B and K
- ☒ **B** elements C and L
- ☒ **C** elements D and M
- ☒ **D** elements E and N

(Total for Question 10 = 1 mark)

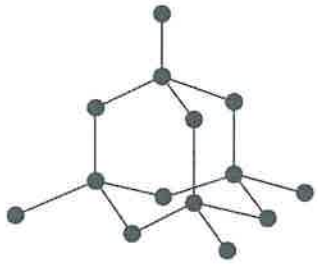
TOTAL FOR SECTION A = 10 MARKS

SECTION B

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

11. This question is about structure of substances.

(a) The structure of diamond is shown.



Describe **two** ways in which this structure can be identified as diamond and **not** graphite.

(2)

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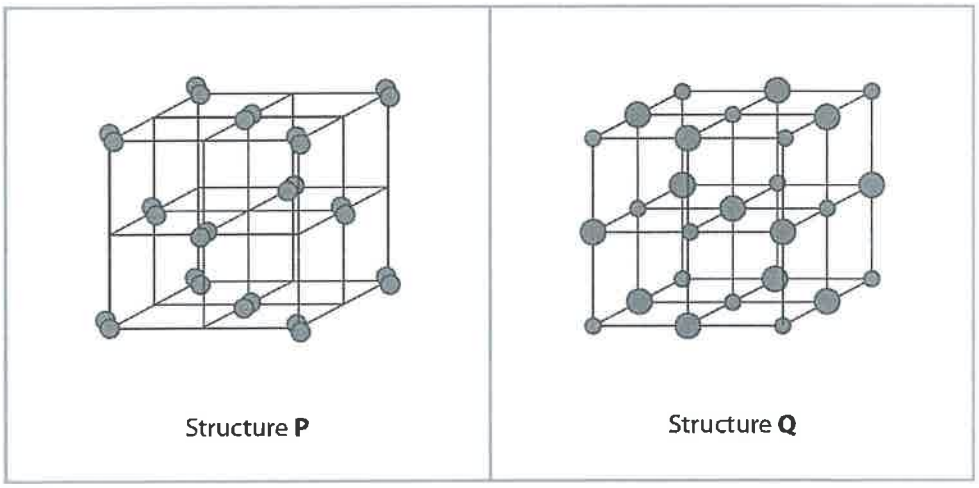
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(b) Two different crystalline structures, **P** and **Q**, are shown.
One structure is iodine, I_2, and the other structure is sodium chloride, NaCl.
Label the **particles** in each structure, using chemical formulae.

(2)



Structure **P**

Structure **Q**

(c) Silver iodide has a theoretical lattice energy of -736 kJ.mol^{-1} but has an experimental lattice energy of -876 kJ.mol^{-1}.
Explain what these data indicate about the bonding of silver iodide.

(2)

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(Total for Question 11 = 6 marks)

12. Ionisation energies provide information about the number of electrons and the arrangement of the electrons in an atom of an element.

(a) A student's definition of first ionisation energy is shown.

> First ionisation energy is the energy released when one mole of gaseous atoms loses one mole of electrons to form one mole of gaseous 1+ ions.

There is **one incorrect** word in the student's definition.
Identify the word, giving the reason why this word is incorrect.

(2)

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(b) Write an equation for the **second** ionisation energy of oxygen. Include state symbols.

(2)

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(c) A sodium atom has 11 protons whereas a potassium atom has 19 protons.
Explain why the first ionisation energy of sodium is greater than that of potassium.

(3)

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(d) The successive ionisation energies for magnesium are given in the table.

Electron number removed	1	2	3	4	5	6	7	8	9	10	11	12
Ionisation energy / $kJ.mol^{-1}$	738	1451	7733	10451	13629	17995	21704	25657	31644	35463	169996	189371
Log (ionisation energy)	2.87	3.16	3.89	4.02	4.13		4.34	4.41	4.50	4.55	5.23	

(i) Complete the table.

(1)

(ii) Give a reason why the logarithm of the ionisation energy, rather than just the ionisation energy, is used to plot a graph.

(1)

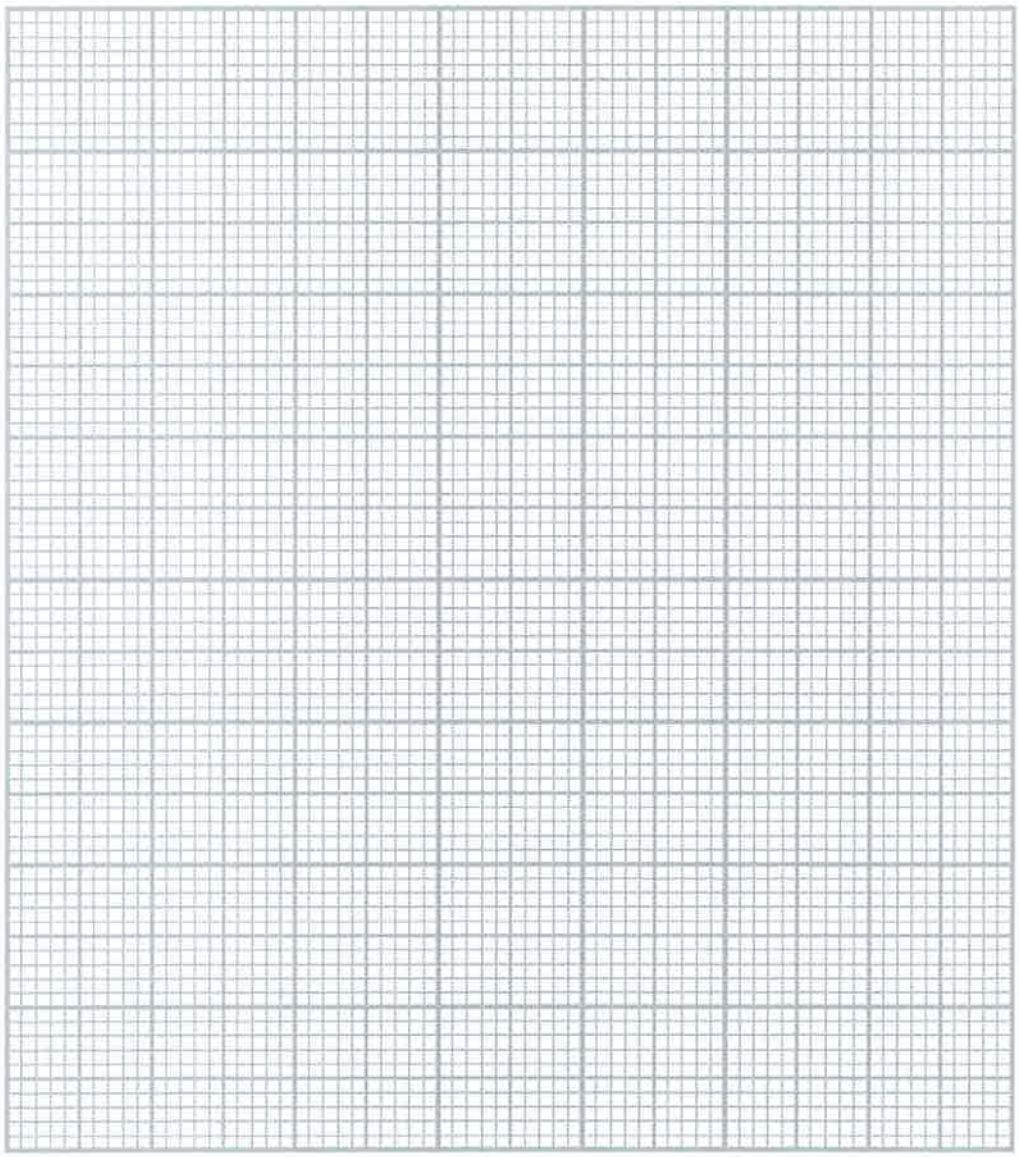
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(iv) Plot the graph of log(ionisation energy) against electron number removed.
Join the individual points using straight lines.

(3)



(v) Identify on the graph, using a circle, the points that represent the removal of the electrons in the **outermost** energy level of magnesium.

(1)

(e) Consider the data given in the table below.

Element	First ionisation energy / kJ.mol^{-1}
Carbon	1086
Nitrogen	1402
Oxygen	.....

(i) Complete the table by estimating a value for the first ionisation energy of oxygen.

(1)

(ii) Explain your choice of the ionisation energy value.

(3)

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(Total for Question 12 = 17 marks)

13. Atoms of silicon contain protons, neutrons and electrons.

(a) Complete the table with the correct data for a proton and a neutron?

(1)

	Proton	Neutron
Relative charge		
Relative mass		

(b)(i) Using the s, p, d notation, give the electronic configuration of silicon.

(1)

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(ii) State the shape of the 2s orbital of a silicon atom.

(1)

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(iii) State the difference between the two subatomic particles in the 2s orbital.

(1)

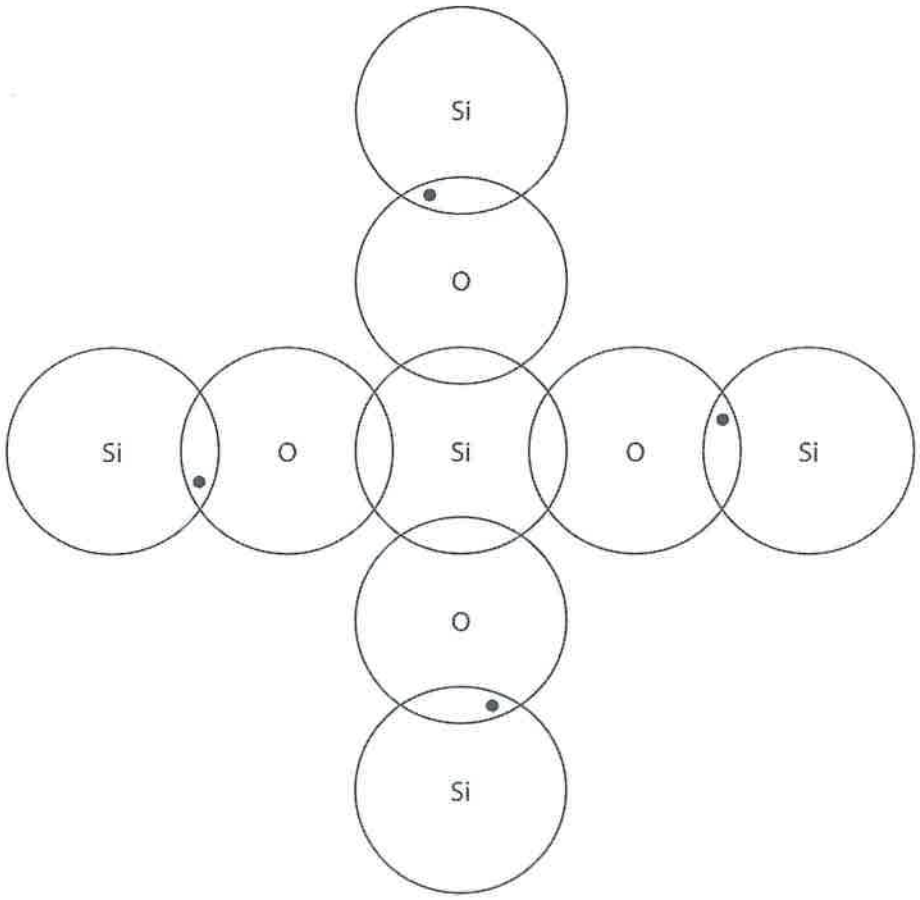
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(c) Silicon has **three** stable isotopes.
A sample of silicon was found to have a relative atomic mass, Ar, of 28.11.
The two isotopes are ^{28}Si and ^{30}Si with their respective abundances 92.2% and 3.1%.
Determine the mass number of the third stable isotope. You **must** show your working.

(2)

(d) Quartz is a naturally occurring form of the compound silicon dioxide (SiO_2).
Complete the dot-and-cross diagram for a section of the structure of quartz.
Show **only** the outer electrons for the **central** silicon atom and its **four** surrounding oxygen atoms.
Use dots (•) for the silicon electrons and crosses (×) for the oxygen electrons.

(2)



(e) State **one** similarity and **one** difference between the definitions of the relative atomic mass and the relative isotopic mass of an element.

(2)

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(Total for Question 13 = 10 marks)

14. The compound copper(II) glycinate, $Cu(H_2NCH_2COO)_2$, forms when glycine, H_2NCH_2COOH, is added to copper(II) ethanoate, $Cu(CH_3COO)_2$.

The solid is soluble in hot aqueous ethanol but insoluble when the solvent is cold.

Part of the experimental procedure is shown.

Procedure

A sample of copper(II) ethanoate monohydrate, $Cu(CH_3COO)_2 \cdot H_2O$, was added to a beaker and dissolved in about 15 cm^3 of deionised water.

In a separate beaker, a known mass of glycine, H_2NCH_2COOH, was dissolved in about 15 cm^3 of deionised water.

The two solutions were warmed and then mixed together.

(a) Describe the next experimental steps required to produce a dry sample of the hydrated copper(II) glycinate compound.

(3)

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(b) 1.62 g of copper(II) ethanoate monohydrate, $Cu(CH_3COO)_2 \cdot H_2O$, which was in **excess**, was mixed with 1.17 g of glycine, H_2NCH_2COOH.

1.46 g of hydrated copper(II) glycinate, $Cu(H_2NCH_2COO)_2 \cdot H_2O$, was produced.

The equation for this reaction is shown.

$$Cu(CH_3COO)_2 \cdot H_2O + 2H_2NCH_2COOH \rightarrow Cu(H_2NCH_2COO)_2 \cdot H_2O + 2CH_3COOH$$

Calculate the percentage yield by mass of the hydrated copper(II) glycinate.

(4)

(Total for Question 14 = 7 marks)
TOTAL FOR SECTION B = 40 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									(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 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 10 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. The concentration of carbon monoxide in the exhaust gases of a car without a catalytic converter is 0.7 % by volume.
In units of parts per million, this concentration is

- ☐ **A** 7
- ☐ **B** 70
- ☐ **C** 700
- ☒ **D** 7000

(1) ✓

(Total for Question 1 = 1 mark)

2. One of the reactions in the catalytic converter of a car exhaust is

$$2NO(g) + 2CO(g) \rightarrow 2CO_2(g) + N_2(g)$$

400 cm^3 of NO is mixed with 500 cm^3 of CO. What is the **total** volume of gas when the reaction is complete? All gas volumes are measured at the same temperature and pressure.

- ☐ **A** 600 cm^3
- ☒ **B** 700 cm^3
- ☐ **C** 1300 cm^3
- ☐ **D** The volume cannot be calculated without the molar volume of gas at the appropriate temperature and pressure

(1) ✓

(Total for Question 2 = 1 mark)

3. The carbon-carbon bond, C=C, in ethene consists of

- ☐ **A** two σ bonds.
- ☐ **B** one π bond
- ☒ **C** one σ bond and one π bond.
- ☐ **D** two π bonds.

(1) ✓

(Total for Question 3 = 1 mark)

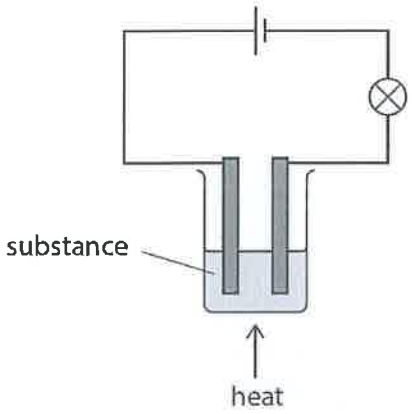
4. The terms hazard and risk are used when considering the use of chemical compounds.
For a particular characteristic of a pure compound,

(1) ✓

- ☒ **A** hazard is fixed but risk varies.
- ☐ **B** hazard varies but risk is fixed.
- ☐ **C** hazard and risk are fixed.
- ☐ **D** hazard and risk vary.

(Total for Question 4 = 1 mark)

5. Electrical conductivity is investigated using the apparatus shown.



Which substance, **only** when molten, causes the bulb to light?

- ☒ **A** S
- ☒ **B** $C_6H_{12}O_6$
- ☒ **C** Na
- ☒ **D** NaCl

(1) ✓

(Total for Question 5 = 1 mark)

6. Which does **not** indicate the existence of quantum shells in atoms?

(1) ✓

- ☒ **A** the atomic emission spectrum of an element
- ☒ **B** the direction of electron spin in an atom of an element
- ☒ **C** the first ionisation energies of successive elements
- ☒ **D** the successive ionisation energies of electrons in an atom

(Total for Question 6 = 1 mark)

7. Which of these isoelectronic ions has the **largest** ionic radius?

(1) ✓

- ☒ **A** S^{2-}
- ☒ **B** Cl^-
- ☒ **C** K^+
- ☒ **D** Ca^{2+}

(Total for Question 7 = 1 mark)

8. The ionic radii of some ions are shown.

Ion	Li^+	Mg^{2+}	F^-	O^{2-}
Ionic radius/nm	0.060	0.065	0.136	0.140

Which compound has the lowest melting temperature value?

(1) ✓

- ☒ **A** LiF
- ☒ **B** Li_2O
- ☒ **C** MgF_2
- ☒ **D** MgO

(Total for Question 8 = 1 mark)

9. Which statement is **not** correct about graphene?

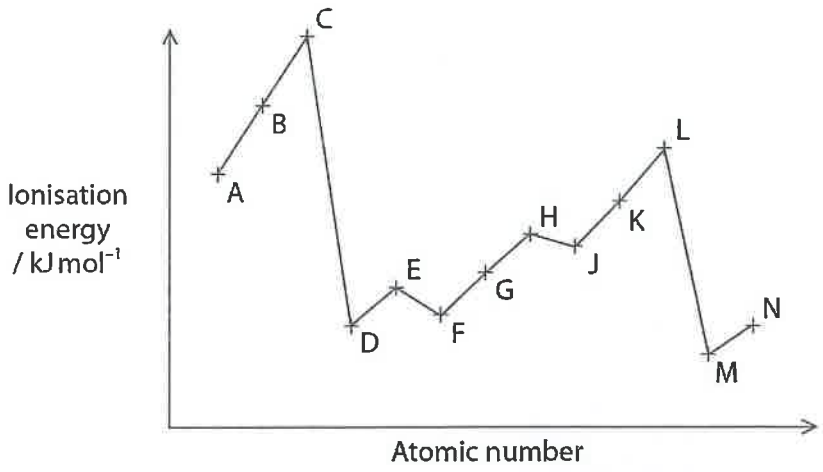
- ☒ **A** it is an excellent electrical conductor
- ☒ **B** it can be rolled into a cylinder to form nanotubes
- ☒ **C** it has a giant structure
- ☒ **D** it has a multi-layered structure

(1) ✓

(Total for Question 9 = 1 mark)

10. The graph shows the first ionisation energies of 13 successive elements in the Periodic Table in order of increasing atomic number.
Trends in first ionisation energies can be used to identify the group to which an element belongs.

The letters are **not** the symbols for the elements.



Which pair of elements belong to Group 2?

- ☒ **A** elements B and K
- ☒ **B** elements C and L
- ☒ **C** elements D and M
- ☒ **D** elements E and N

(Total for Question 10 = 1 mark)

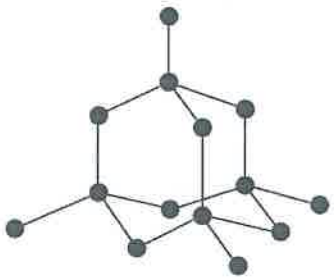
TOTAL FOR SECTION A = 10 MARKS

SECTION B

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

11. This question is about structure of substances.

(a) The structure of diamond is shown.



Describe **two** ways in which this structure can be identified as diamond and **not** graphite.

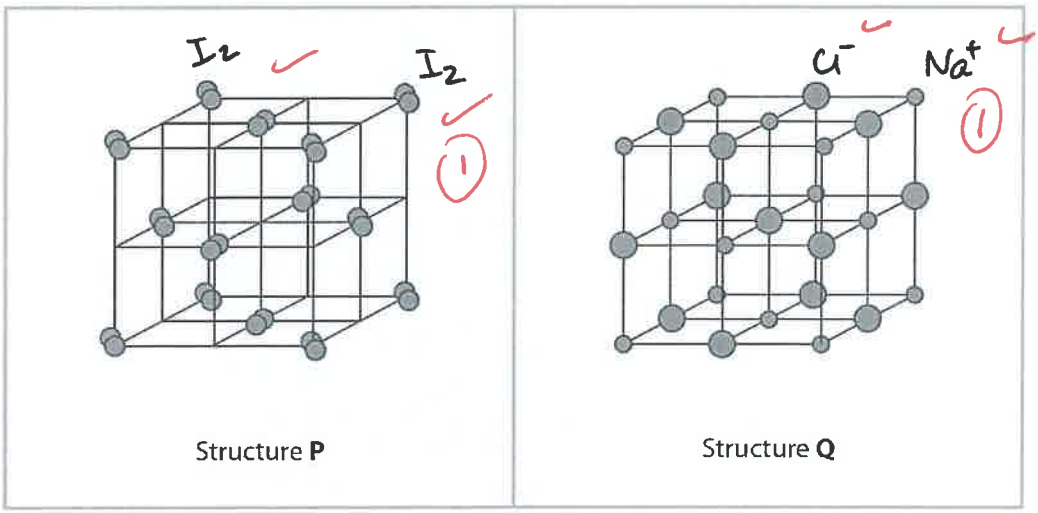
(2)

1 Each carbon atom is bound to 4 other carbon atoms while in graphite each atom is bound to 3 only. (1)

2 It's a tetrahedral structure, unlike graphite which is made of hexagonal sheets of carbon. (1)

(b) Two different crystalline structures, **P** and **Q**, are shown.
One structure is iodine, I_2, and the other structure is sodium chloride, NaCl.
Label the **particles** in each structure, using chemical formulae.

(2)



(c) Silver iodide has a theoretical lattice energy of –736 $kJ.mol^{-1}$ but has an experimental lattice energy of –876 $kJ.mol^{-1}$.
Explain what these data indicate about the bonding of silver iodide.

(2)

Silver ions have relatively high charge density and iodide ions are considered to be large anions which are easily polarised by Ag^+ ions.
As a result, silver iodide has a covalent character which explains the difference in L.E values.

(Total for Question 11 = 6 marks)

12. Ionisation energies provide information about the number of electrons and the arrangement of the electrons in an atom of an element.

(a) A student's definition of first ionisation energy is shown.

> First ionisation energy is the energy released when one mole of gaseous atoms loses one mole of electrons to form one mole of gaseous 1+ ions.

There is **one incorrect** word in the student's definition.
Identify the word, giving the reason why this word is incorrect.

(2)

the incorrect word is "released" (1)
the attraction between the e⁻ and the nucleus is broken which requires energy and not release energy. (1)

(b) Write an equation for the **second** ionisation energy of oxygen. Include state symbols.

(2)

$O^{+}_{(g)} + e^{-} \longrightarrow O^{2+}_{(g)} + 2e^{-}$ (1) (1) 2nd I.E

(c) A sodium atom has 11 protons whereas a potassium atom has 19 protons.
Explain why the first ionisation energy of sodium is greater than that of potassium.

(3)

Although the nuclear charge of potassium (1) is greater than that of sodium, yet the shielding effect in sodium is smaller than that found in potassium so is the atomic radius (1)
As a result, the attraction between the nucleus & the outer e⁻ in sodium is greater than that in potassium, (1) which explains the trend in I.E between potassium & sodium.

(d) The successive ionisation energies for magnesium are given in the table.

Electron number removed	1	2	3	4	5	6	7	8	9	10	11	12
Ionisation energy / kJ.mol^{-1}	738	1451	7733	10451	13629	17995	21704	25657	31644	35463	169996	189371
Log (ionisation energy)	2.87	3.16	3.89	4.02	4.13	4.26	4.34	4.41	4.50	4.55	5.23	5.28

(1)

(i) Complete the table.

(1)

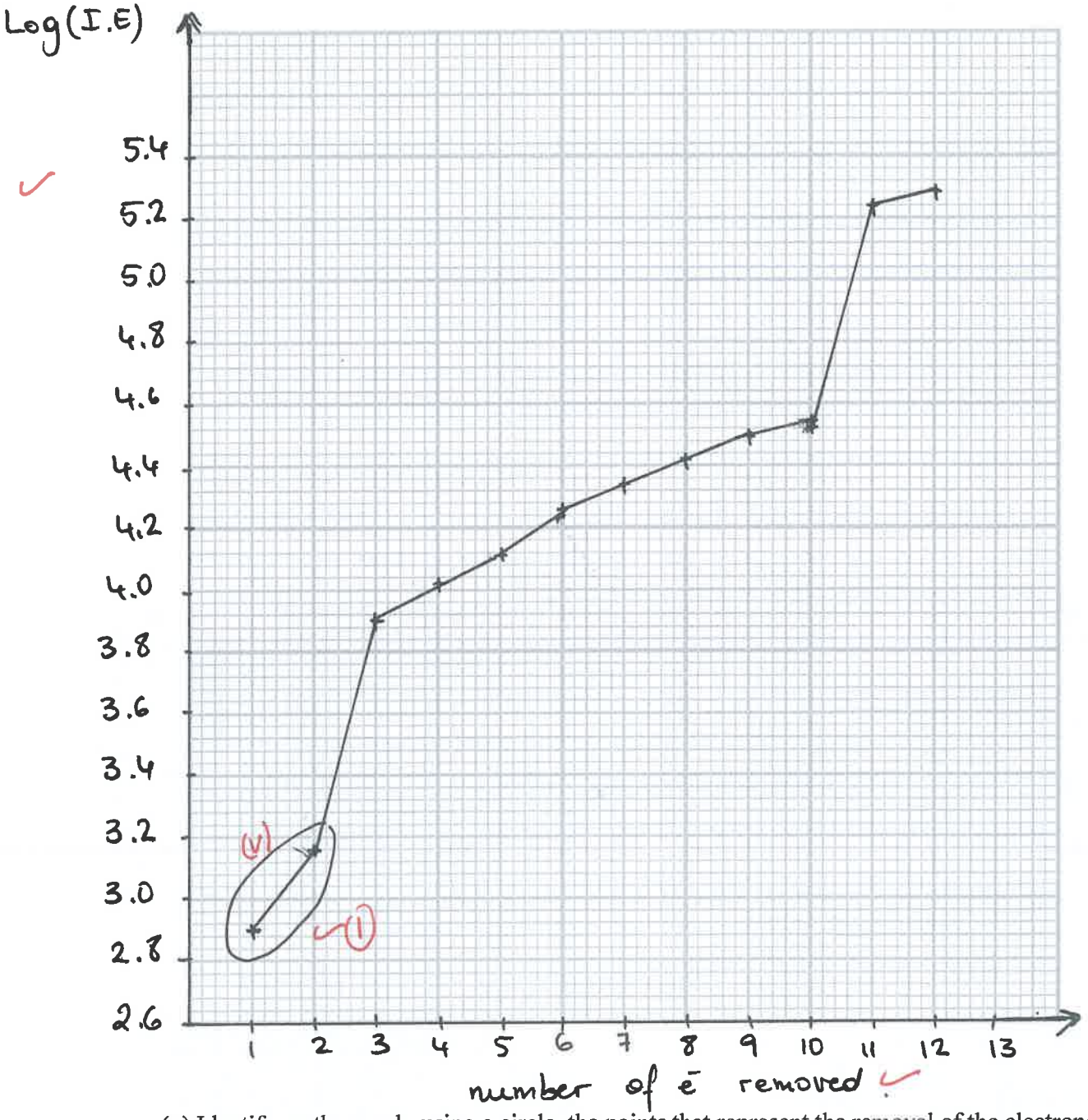
(ii) Give a reason why the logarithm of the ionisation energy, rather than just the ionisation energy, is used to plot a graph.

(1)

The use of log (I.E) to plot a graph reduces the range of values (1)

(iv) Plot the graph of log(ionisation energy) against electron number removed.
Join the individual points using straight lines.

(3)



(v) Identify on the graph, using a circle, the points that represent the removal of the electrons in the **outermost** energy level of magnesium.

(1)

labels of axes : 1 pt correct plotting : 1 pt
proper scale : 1 pt

(e) Consider the data given in the table below.

Element	First ionisation energy / kJ.mol^{-1}
Carbon	1086
Nitrogen	1402
Oxygen	....1315.... ✓ (1)

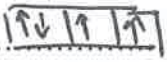
(i) Complete the table by estimating a value for the first ionisation energy of oxygen.

(1)

(ii) Explain your choice of the ionisation energy value.

(3)

*N: $1s^2\ 2s^2\ 2p^3$ O: $1s^2\ 2s^2\ 2p^4$ (1)

 ✓  ✓

Although the nuclear charge ✓ of oxygen is greater than that of nitrogen and the fact that its A.R is less than that of nitrogen, yet, the repulsion between the pair of e^- on $2p_x$ orbital ✓ favours the removal of the 1st e^- ✓ (1) (1)

This explains the slight drop in I.E values. ✓

(Total for Question 12 = 17 marks)

13. Atoms of silicon contain protons, neutrons and electrons.

(a) Complete the table with the correct data for a proton and a neutron?

(1)

	Proton	Neutron
Relative charge	+1	0
Relative mass	1	1

(1)

(b)(i) Using the s, p, d notation, give the electronic configuration of silicon.

(1)

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ ✓ (1)

(ii) State the shape of the 2s orbital of a silicon atom.

(1)

sphere ✓ (1)

(iii) State the difference between the two subatomic particles in the 2s orbital.

(1)

they have opposit spins ✓ (1)

(c) Silicon has **three** stable isotopes.
A sample of silicon was found to have a relative atomic mass, Ar, of 28.11.
The two isotopes are ^{28}Si and ^{30}Si with their respective abundances 92.2% and 3.1%.
Determine the mass number of the third stable isotope. You **must** show your working.

(2)

% abundance of the 3rd isotope :

$100 - (92.2 + 3.1) = 4.7\%$ ✓ (1)

Let x be the mass number of the 3rd isotope:

$$28.11 = \frac{92.2 \times 28 + 3.1 \times 30 + 4.7x}{100}$$ ✓

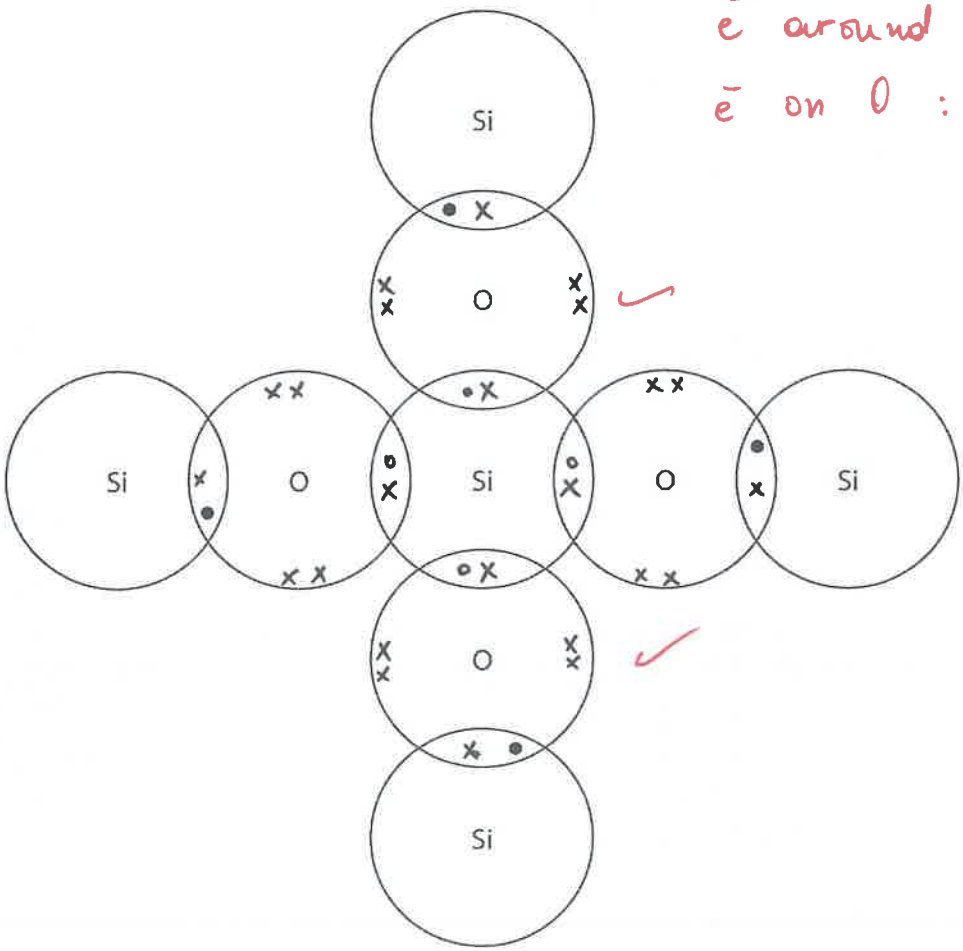
$$\Rightarrow x = \frac{28.11 \times 100 - 92.2 \times 28 - 3.1 \times 30}{4.7}$$ ✓

$\Rightarrow x = 29$ ✓ (1)

(d) Quartz is a naturally occurring form of the compound silicon dioxide (SiO_2).
Complete the dot-and-cross diagram for a section of the structure of quartz.
Show **only** the outer electrons for the **central** silicon atom and its **four** surrounding oxygen atoms.
Use dots (•) for the silicon electrons and crosses (×) for the oxygen electrons.

(2)

ē around Si : (1)
ē on O : (1)



(e) State **one** similarity and **one** difference between the definitions of the relative atomic mass and the relative isotopic mass of an element.

(2)

* They are both compared to C-12 isotope. (1)
* The relative atomic mass is a weighted average mass while the relative isotopic is the mass of one individual atom (1)

(Total for Question 13 = 10 marks)

14. The compound copper(II) glycinate, $Cu(H_2NCH_2COO)_2$, forms when glycine, H_2NCH_2COOH, is added to copper(II) ethanoate, $Cu(CH_3COO)_2$.

The solid is soluble in hot aqueous ethanol but insoluble when the solvent is cold.

Part of the experimental procedure is shown.

Procedure

A sample of copper(II) ethanoate monohydrate, $Cu(CH_3COO)_2 \cdot H_2O$, was added to a beaker and dissolved in about 15 cm^3 of deionised water.

In a separate beaker, a known mass of glycine, H_2NCH_2COOH, was dissolved in about 15 cm^3 of deionised water.

The two solutions were warmed and then mixed together.

(a) Describe the next experimental steps required to produce a dry sample of the hydrated copper(II) glycinate compound.

(3)

* Heat the mixture until the point of crystallisation which is detected when tiny crystals deposit on a glass rod. (1)
* Transfer the solution into a large basin and allow to evaporate
* Filter the solution + crystals using a buchner funnel and a filter paper (1)
* Collect the crystals off the filter paper, rinse them cold ethanol.
* Dab with filter paper & allow to dry in a dessicator (1)

(b) 1.62 g of copper(II) ethanoate monohydrate, $Cu(CH_3COO)_2 \cdot H_2O$, which was in **excess**, was mixed with 1.17 g of glycine, H_2NCH_2COOH.

1.46 g of hydrated copper(II) glycinate, $Cu(H_2NCH_2COO)_2 \cdot H_2O$, was produced.

The equation for this reaction is shown.

$$Cu(CH_3COO)_2 \cdot H_2O + 2H_2NCH_2COOH \rightarrow Cu(H_2NCH_2COO)_2 \cdot H_2O + 2CH_3COOH$$

Calculate the percentage yield by mass of the hydrated copper(II) glycinate.

$M_{glycine} = 75\ g.mol^{-1}$ $M_{Cu(H_2NCH_2COO)_2.H_2O} = 229.5\ g.mol^{-1}$ (4)

$n_{glycine} = \frac{1.17}{75} = 1.56 \times 10^{-2}$ mol ✓ (1)

H_2NCH_2COOH : $Cu(H_2NCH_2COO)_2.H_2O$ ✓ (1)

2 : 1

$\Rightarrow n_{Cu(H_2NCH_2COO)_2.H_2O} = \frac{1.56 \times 10^{-2}}{2} = 0.78 \times 10^{-2}$ mol ✓

$\Rightarrow m_{(theoretical)} = 0.78 \times 10^{-2} \times 229.5 = 1.79\ g$ ✓ (1)

(Total for Question 14 = 7 marks)
TOTAL FOR SECTION B = 40 MARKS
TOTAL FOR PAPER = 50 MARKS

$\Rightarrow$ % yield $= \frac{1.46}{1.79} \times 100$ ✓

(1)

% yield = 81.6% ✓ or 82%

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									(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 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