Atoms, Elements and Compounds – 2022 IGCSE

1. June/2022/Paper_11/No.6

Information about the structures of three atoms, X, Y and Z, is shown.

atom	proton number	nucleon number
X	1	1
Y	1	2
Z	1	3

Which statements about atoms X, Y and Z are correct?

1 They are isotopes of the same element.

2 They contain the same number of electrons.

3 They contain the same number of neutrons.

4 They contain one occupied electron shell.

A 1, 2 and 4 **B** 1 and 2 only **C** 3 and 4 **D** 3 only

2. June/2022/Paper_11/No.7

What happens to an atom when it becomes an ion with a charge of +1?

A It gains an electron.

B It gains a proton.

C It loses an electron.

D It loses a proton.

3. June/2022/Paper_12/No.4

X and Y are two different elements.

X and Y have the same number of nucleons.

Which statement about X and Y is correct?

A They have the same physical properties.

B Their atoms have the same number of electrons.

C They are in different groups of the Periodic Table.

D They have different relative masses.

4. June/2022/Paper_12/No.6

Which statement about ions and ionic bonding is correct?

A Caesium atoms gain electrons to form negatively charged caesium ions.

B Ionic bonding involves sharing of pairs of electrons.

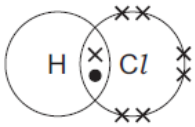
C Potassium ions and chloride ions have the same number of outer-shell electrons.

D Sodium ions have an equal number of protons and electrons.

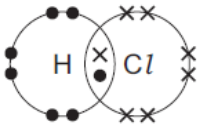
5. June/2022/Paper_12/No.7

Which dot-and-cross diagram shows the arrangement of outer shell electrons in a molecule of hydrogen chloride?

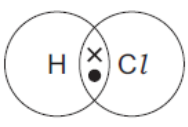
A



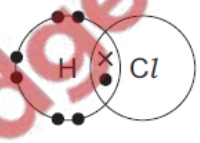
B



C



D



6. June/2022/Paper_12/No.8

Which statement explains why graphite can be used as a lubricant?

A All of the atoms in graphite are carbon.

B Each carbon atom forms three bonds.

C Graphite has a macromolecular structure.

D The layers in graphite can slide over each other.

7. June/2022/Paper_12/No.20

Some statements about gas G are listed.

G is monoatomic.

G is found in clean, dry air.

G is used in lamps.

Which element is G?

A argon

B helium

C nitrogen

D oxygen

8. June/2022/Paper_13/No.6

An atom of an element contains 4 electrons, 4 protons and 6 neutrons.

In which group of the Periodic Table is this element placed?

A Group II

B Group IV

C Group VI

D Group VIII

9. June/2022/Paper_13/No.7

Which row describes an ionic solid?

	soluble in water	conducts electricity when solid	conducts electricity when molten
A	✓	✗	✓
B	✗	✗	✗
C	✓	✗	✗
D	✗	✓	✓

key

✓ = yes

✗ = no

10. June/2022/Paper_13/No.8

Which molecule contains more than one pair of shared electrons?

A chlorine

B hydrogen

C hydrogen chloride

D water

11. June/2022/Paper_21/No.3

The numbers of protons and neutrons and the electronic structures of four particles, W, X, Y and Z, are shown.

	number of protons	number of neutrons	electronic structure
W	8	8	2,8
X	8	10	2,6
Y	8	8	2,6
Z	10	8	2,8

Which particles have the same chemical properties?

A W and Y **B** W and Z **C** X and Y **D** X and Z

12. June/2022/Paper_21/No.5

Metals and ionic compounds have similarities and differences in their structure and properties.

Which row about metals and ionic compounds is correct?

	similarity	difference
A	both contain positive ions	only ionic compounds contain anions
B	both contain positive ions	ionic compounds conduct using a 'sea of electrons'
C	both are malleable	only ionic compounds contain anions
D	both are malleable	ionic compounds conduct using a 'sea of electrons'

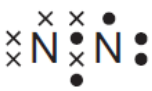
13. June/2022/Paper_21/No.6

Which diagram represents the outer-shell electron arrangement in a nitrogen molecule?

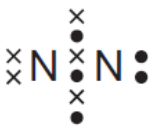
A

B

C



D



14. June/2022/Paper_21/No.20

The electronic structure of element Z is 2,8,1.

Which statements about Z are correct?

1 It is a metal.

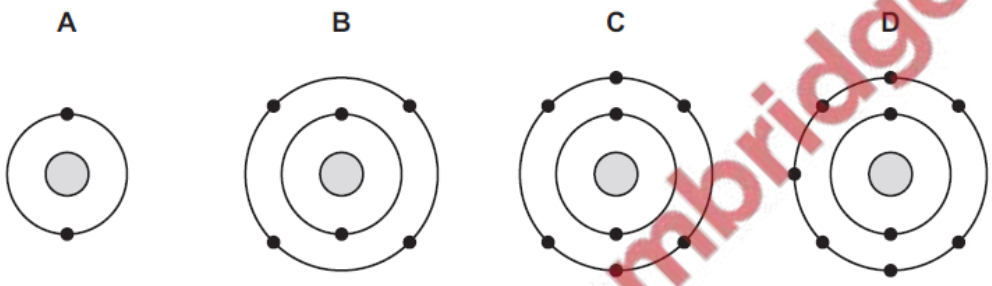
2 It has two outer-shell electrons.

3 It is in Period 3.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only

15. June/2022/Paper_21/No.25

Which diagram represents the arrangement of the outer-shell electrons of a noble gas?



16. June/2022/Paper_22/No.4

X and Y are two different elements.

X and Y have the same number of nucleons.

Which statement about X and Y is correct?

A They have the same physical properties.

B Their atoms have the same number of electrons.

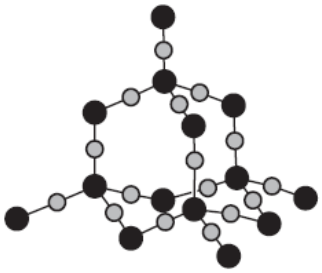
C They are in different groups of the Periodic Table.

D They have different relative masses.

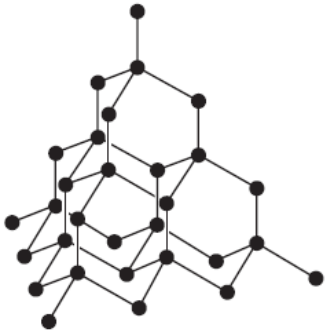
17. June/2022/Paper_22/No.5

The diagrams show the structures of three macromolecules P, Q and R.

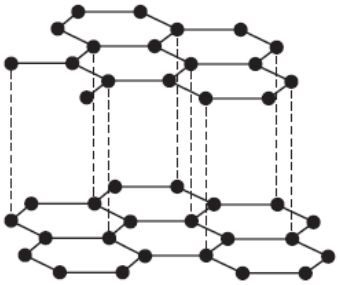
P



Q



R



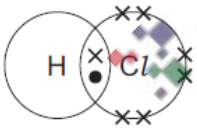
What are P, Q and R?

	P	Q	R
A	diamond	silicon(IV) oxide	graphite
B	graphite	diamond	silicon(IV) oxide
C	silicon(IV) oxide	diamond	graphite
D	silicon(IV) oxide	graphite	diamond

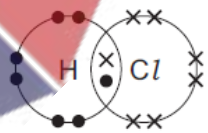
18. June/2022/Paper_22/No.6

Which dot-and-cross diagram shows the arrangement of outer shell electrons in a molecule of hydrogen chloride?

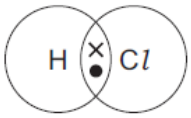
A



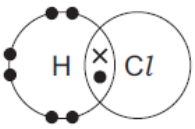
B



C



D



19. June/2022/Paper_22/No.26

The number of protons and the number of neutrons in the atoms of elements X, Y and Z are shown.

	number of protons	number of neutrons
X	6	6
Y	7	6
Z	8	10

Which statement about the elements is correct?

A X and Y are isotopes of the same element.

B Z forms an ion with a +2 charge.

C X and Z react together to form an ionic compound.

D X, Y and Z are non-metals.

20. June/2022/Paper_23/No.3

Which statement describes the properties of both diamond and silicon(IV) oxide?

A They are brittle, with a low melting point, and are insoluble in water.

B They are hard, with a high melting point, and are electrical insulators.

C They are malleable, with a high melting point, and are electrical conductors.

D They are soft, with a low melting point, and are electrical insulators.

21. June/2022/Paper_23/No.5

Particle P has an atomic number of 18, a mass number of 40 and no overall charge.

Particle Q has an atomic number of 19, a mass number of 40 and a single positive charge.

Which statement is correct?

A They are isotopes of the same element.

B They are both ions.

C Q has more neutrons than P.

D They have the same number of electrons in their outer shell.

22. June/2022/Paper_23/No.6

Which statement about the properties of metals is correct?

A Metals are malleable because the layers of positive ions can slide over each other.

B Metals conduct electricity when solid because the positive ions move freely through the metal.

C Metals conduct electricity because there is a strong force of attraction between the positive ions and the delocalised electrons.

D Metals have a high melting point because the positive ions attract each other strongly.

23. June/2022/Paper_31/No.1

(a) A list of symbols and formulae is shown.

CaO
CH_4
C_2H_4
C_2H_6
Cl^-
Cu^{2+}
H_2
He
K^+
N_2
Na^+
SO_2

Answer the following questions using these symbols or formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(i) a compound produced by the thermal decomposition of calcium carbonate

..... [1]

(ii) a positive ion that gives a blue-green colour in a flame test

..... [1]

(iii) an element used as a fuel

..... [1]

(iv) the monomer used to produce poly(ethene)

..... [1]

(v) an ion formed when an atom gains an electron.

..... [1]

(b) Complete the table to show the relative charges of a proton, a neutron and an electron.

type of particle	relative charge
proton	+1
neutron	
electron	

[2]

(c) Choose the two correct statements about nitrogen.
Tick (✓) **two** boxes.

Nitrogen molecules are monoatomic. ☐

All nitrogen atoms have seven protons. ☐

Nitrogen atoms cannot be split into simpler substances by chemical means. ☐

All nitrogen atoms have 14 neutrons. ☐

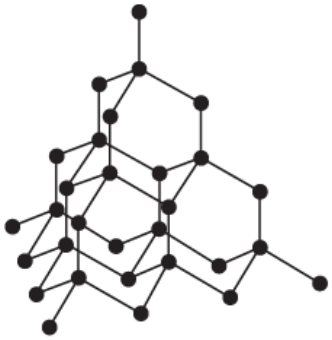
Nitrogen is 21% of clean, dry air. ☐

[2]

[Total: 9]

24. June/2022/Paper_31/No.5(e)

(e) Diamond is a form of carbon.
The structure of diamond is shown.



(i) Choose the word which best describes the structure of diamond.

Draw a circle around your chosen answer.

giant **ionic** **metallic** **simple** [1]

(ii) Name the type of bonding in diamond.

..... [1]

(iii) Give **one** use of diamond.

..... [1]

(iv) Deduce the electronic structure of carbon.

Use the Periodic Table to help you.

..... [1]

25. June/2022/Paper_31/No.7(e)

(e) A compound of zinc has the formula ZnC_4H_{10}.

Complete the table to calculate the relative molecular mass of ZnC_4H_{10}.

atom	number of atoms	relative atomic mass	
zinc	1	65	$1 \times 65 = 65$
carbon		12	
hydrogen		1	

relative molecular mass = ... [2]

26. June/2022/Paper_32/No.7(d)

(d) A compound of sodium has the formula $Na_2S_2O_3$.

Complete the table to calculate the relative molecular mass of $Na_2S_2O_3$.

atom	number of atoms	relative atomic mass	
sodium	2	23	$2 \times 23 = 46$
sulfur		32	
oxygen		16	

relative molecular mass = ... [2]

27. June/2022/Paper_32/No.1

(a) A list of symbols and formulae is shown.

Br^-
CH_4
CO_2
Cu^{2+}
H_2
K^+
Na^+
N_2
O_2
U

Answer the following questions using these symbols or formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(i) a compound that is a product of respiration

..... [1]

(ii) an ion that gives a lilac colour in a flame test

..... [1]

(iii) a gas which is 21% of clean, dry air

..... [1]

(iv) an element that has a radioactive isotope used as a source of energy

..... [1]

(v) an ion formed when an atom gains an electron.

..... [1]

(b) Complete the table to show the relative masses of a proton, a neutron and an electron.

type of particle	relative mass
proton	1
neutron	
electron	

[2]

(c) Choose the two correct statements about carbon dioxide.
Tick (✓) **two** boxes.

Carbon dioxide is a mixture of two elements.	☐
Carbon dioxide is an acidic oxide.	☐
Carbon dioxide has ionic bonding.	☐
Carbon dioxide has a giant covalent structure.	☐
There are three atoms in a molecule of carbon dioxide.	☐

[2]

[Total: 9]

28. June/2022/Paper_33/No.1

(a) A list of symbols and formulae is shown.

Al_2O_3
C_2H_5OH
CO_2
Fe_2O_3
H_2
He
K^+
Li^+
N_2
Na^+
O^{2-}

Answer the following questions using these symbols or formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(i) an element that is monoatomic

..... [1]

(ii) an ion that gives a red colour in a flame test

..... [1]

(iii) an element that can be used as a fuel

..... [1]

(iv) a gas that contributes to climate change

..... [1]

(v) an ion that is formed when an atom gains electrons.

..... [1]

(b) Complete the table to show the relative charges of a proton, neutron and electron.

type of particle	relative charge
proton	
neutron	0
electron	

[2]

(c) Choose the two correct statements about nitrogen and hydrogen in a mixture.
Tick (✓) **two** boxes.

The nitrogen and hydrogen mixture can be separated by physical means. ☐

The nitrogen and hydrogen mixture is liquid at room temperature. ☐

The atoms of nitrogen and hydrogen in the mixture are chemically combined. ☐

Air is mainly a mixture of nitrogen and hydrogen. ☐

The bonding in both nitrogen and hydrogen molecules is covalent. ☐

[2]

[Total: 9]

29. June/2022/Paper_33/No.7(c)

(c) A compound of lithium has the formula $C_3H_5O_2Li_2$.

Complete the table to calculate the relative molecular mass of $C_3H_5O_2Li_2$.

atom	number of atoms	relative atomic mass	
carbon	3	12	$3 \times 12 = 36$
hydrogen		1	
oxygen		16	
lithium		7	

relative molecular mass = ... [2]

30. June/2022/Paper_41/No.2

(a) Atoms are made of protons, neutrons and electrons. Atoms of the same element are known as isotopes.

(i) Complete the table.

particle	relative charge	relative mass
electron		$\frac{1}{1840}$
neutron		
proton	+1	

[2]

(ii) $^{24}_{12}Mg$ and $^{25}_{12}Mg$ are isotopes of magnesium.

Complete the table to show the numbers of electrons, neutrons and protons in these isotopes of magnesium.

isotope	number of electrons	number of neutrons	number of protons
$^{24}_{12}Mg$			
$^{25}_{12}Mg$			

[2]

(iii) Explain why magnesium ions have a charge of 2+.

.....

..... [1]

(b) Mg^{2+} ions have the electronic structure 2,8.

Give the formula of the following particles which have the same electronic structure as Mg^{2+} ions.

- a cation (positive ion)

.....

- an anion (negative ion)

.....

- an atom

.....

[3]

[Total: 8]

31. June/2022/Paper_41/No.3(a ,b)

This question is about sodium and compounds of sodium.

(a) (i) Describe the bonding in a metallic element such as sodium.

You may include a diagram as part of your answer.

.....

.....

..... [3]

(ii) Describe how solid sodium conducts electricity.

..... [1]

(b) Some properties of sodium chloride are shown:

- melting point of 801 °C
- non-conductor of electricity when solid
- conductor of electricity when molten
- soluble in water.

(i) Name the type of bonding in sodium chloride.

..... [1]

(ii) Explain why sodium chloride conducts electricity when molten.

.....

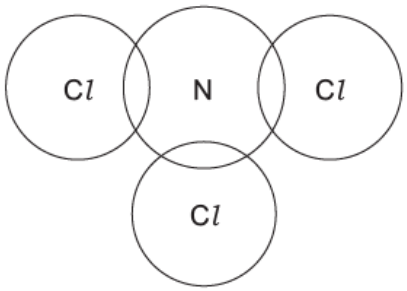
..... [1]

32. June/2022/Paper_42/No.4(c _e)

(c) Nitrogen trichloride, NCl_3, is a covalent compound.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NCl_3.

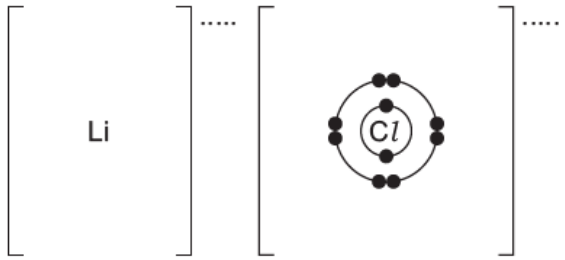
Show outer electrons only.



[3]

(d) Lithium chloride, LiC*l*, is an ionic compound.

Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in lithium chloride.



[3]

(e) Explain, in terms of attractive forces between particles, why LiC*l* is a solid at room temperature but N$C l_3$ is a liquid with a relatively low boiling point.

.....

.....

..... [3]

33. June/2022/Paper_43/No.2

(a) $^{32}_{16}S$ and $^{33}_{16}S$ are isotopes of sulfur.

Use your knowledge of protons, neutrons and electrons to answer the following questions.

(i) Describe how these isotopes of sulfur are the same and how they are different.

same .....

.....

different .....

.....

[3]

(ii) Explain why each of these isotopes have an overall charge of zero.

.....

..... [1]

(iii) Explain why both isotopes have the same chemical properties.

.....

..... [1]

(b) Sulfide ions, S^{2-}, have the electronic structure 2,8,8.

(i) Explain why sulfide ions have a charge of 2–.

.....

..... [1]

(ii) Give the formula of:

- an anion which has the same electronic structure as S^{2-}

.....

- a cation which has the same electronic structure as S^{2-}.

.....

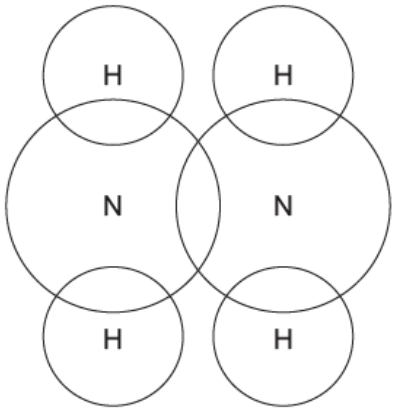
[2]

[Total: 8]

34. June/2022/Paper_43/No.3(d)

(d) Hydrazine, N_2H_4, is another compound that contains nitrogen and hydrogen.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrazine. Show outer electrons only.



[2]

35. March/2022/Paper_11/No.6

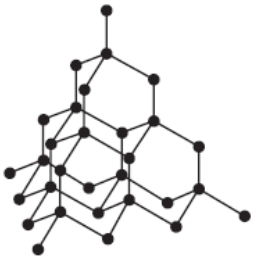
Matter exists as elements, compounds and mixtures.

Which row identifies an element, a compound and a mixture?

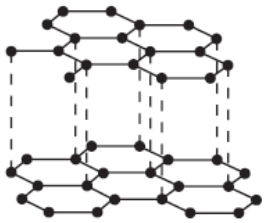
	element	compound	mixture
A	calcium	potassium carbonate	sodium chloride
B	brass	sodium chloride	air
C	calcium	sodium chloride	brass
D	sodium chloride	water	potassium carbonate

36. March/2022/Paper_11/No.7

Which pair of statements about diamond and graphite is correct?



diamond



graphite

A Diamond and graphite are both pure carbon. They are both macromolecules.

B Diamond and graphite can both be used as electrodes. Graphite is also used as a lubricant.

C Diamond has covalent bonds. Graphite has ionic bonds.

D Diamond is hard with a high melting point. Graphite is soft with a low melting point.

37. March/2022/Paper_11/No.8

An isotope of chromium is represented by $^{52}_{24}Cr$.

Which statement about an atom of this isotope of chromium is correct?

A It contains 24 electrons.

B It contains 24 neutrons.

C It contains 28 protons.

D It contains 52 neutrons.

38. March/2022/Paper_11/No.9

Sodium is in Group I of the Periodic Table and chlorine is in Group VII.

Which row describes what happens when sodium bonds ionically with chlorine?

	sodium atoms	ion formed	chlorine atoms	ion formed
A	gain an electron	Na^-	lose an electron	Cl^+
B	gain an electron	Na^+	lose an electron	Cl^-
C	lose an electron	Na^-	gain an electron	Cl^+
D	lose an electron	Na^+	gain an electron	Cl^-

39. March/2022/Paper_11/No.10

Caesium fluoride is an ionic compound.

Which statements about caesium fluoride are correct?

1 It conducts electricity when solid.

2 It has a high melting point.

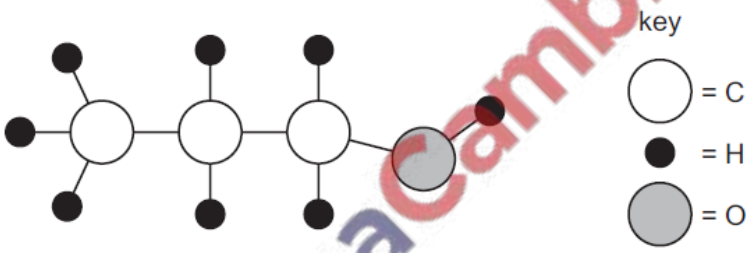
3 It is soluble in water.

4 It is highly volatile.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

40. March/2022/Paper_11/No.11

The structure of a molecule of a compound is shown.



What is the formula of this compound?

A C_3H_7O **B** C_3H_8O **C** C_8H_3O **D** C_8HO_3

41. March/2022/Paper_22/No.3

Which statement explains why isotopes of the same element have the same chemical properties?

A They have the same electronic structure.

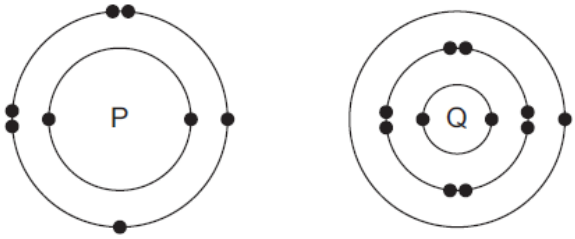
B They have the same relative mass.

C They have the same nucleon number.

D They have the same proton number.

42. March/2022/Paper_22/No.4

The electronic structures of atoms P and Q are shown.



P and Q form an ionic compound.

What is the formula of the compound?

A PQ **B** P_2Q **C** P_2Q_3 **D** PQ_2

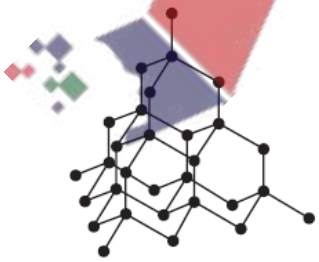
43. March/2022/Paper_22/No.6

Which row explains why copper is a good conductor of electricity at room temperature?

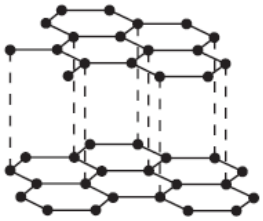
	copper ions move freely	electrons move freely
A	no	no
B	no	yes
C	yes	no
D	yes	yes

44. March/2022/Paper_22/No.7

Which pair of statements about diamond and graphite is correct?



diamond



graphite

A Diamond and graphite are both pure carbon. They are both macromolecules.

B Diamond and graphite can both be used as electrodes. Graphite is also used as a lubricant.

C Diamond has covalent bonds. Graphite has ionic bonds.

D Diamond is hard with a high melting point. Graphite is soft with a low melting point.

45. March/2022/Paper_22/No.8

Sodium nitride contains the nitride ion, N^{3-}.

Sodium nitride is unstable and decomposes into its elements.

What is the equation for the decomposition of sodium nitride?

A $2NaN_3 \rightarrow 2Na + 3N_2$

B $2Na_3N \rightarrow 6Na + N_2$

C $2NaN_3 \rightarrow Na_2 + 3N_2$

D $2Na_3N \rightarrow 6Na + 2N$

46. March/2022/Paper_22/No.10

Caesium fluoride is an ionic compound.

Which statements about caesium fluoride are correct?

1 It conducts electricity when solid.

2 It has a high melting point.

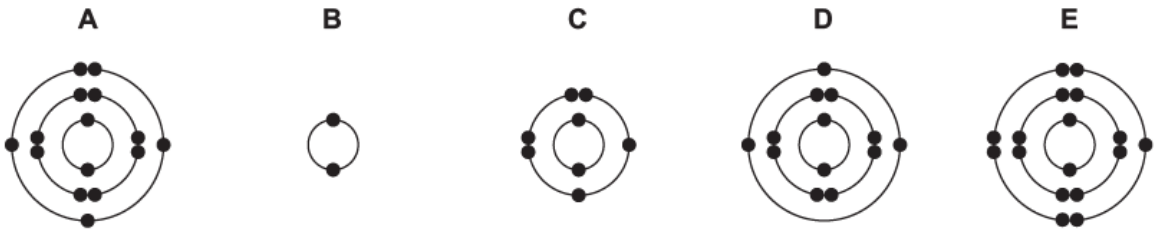
3 It is soluble in water.

4 It is highly volatile.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

47. March/2022/Paper_32/No.1

(a) The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these electronic structures.
Each electronic structure may be used once, more than once or not at all.

State which electronic structure, **A**, **B**, **C**, **D** or **E**, represents:

(i) an atom in Group V of the Periodic Table

..... [1]

(ii) an atom which contains only two shells of electrons

..... [1]

(iii) an atom that forms a stable ion with a charge of 2–

..... [1]

(iv) an atom of an element that exists as a monoatomic gas

..... [1]

(v) an atom of the metal that is extracted from bauxite.

..... [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the uranium atom and rubidium ion shown.

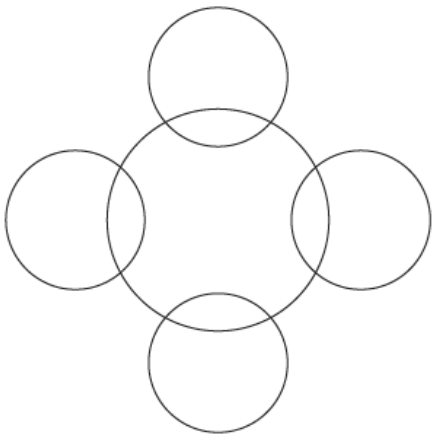
	number of electrons	number of neutrons	number of protons
$^{235}_{92}U$	92		
$^{87}_{37}Rb^{+}$		50	

[3]

[Total: 8]

48. March/2022/Paper_32/No.2(b)

(b) Complete the diagram to show the electronic structure in a methane molecule.
Show only the outer shell electrons.



[1]

49. March/2022/Paper_42/No.2(a _ c)

A student adds excess large pieces of magnesium carbonate, $MgCO_3$, to dilute hydrochloric acid, HCl, and measures the volume of carbon dioxide gas, CO_2, given off.

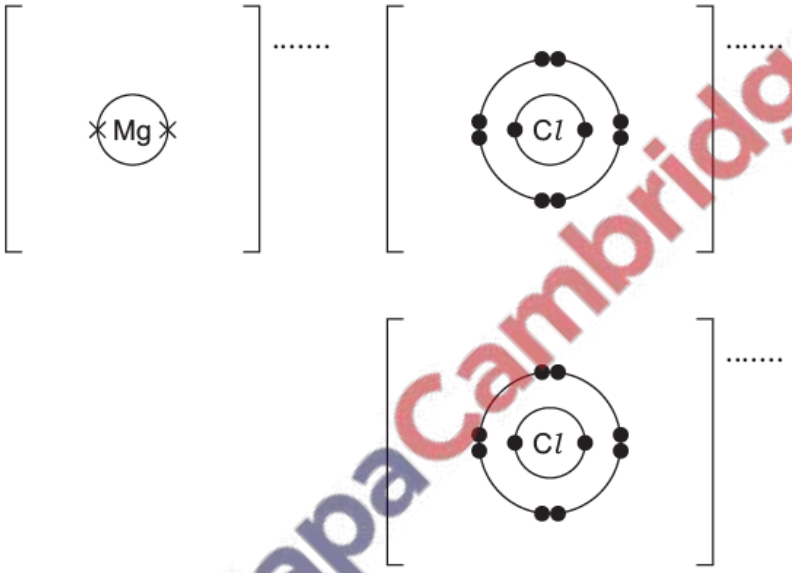
(a) Add the missing state symbols to the chemical equation for the reaction.

$$MgCO_3 \text{ .....} + 2HCl \text{.....} \rightarrow MgCl_2(aq) + H_2O \text{ .....} + CO_2 \text{ .....}$$ [1]

(b) Complete the dot-and-cross diagram to show the electron arrangement of the ions in magnesium chloride.

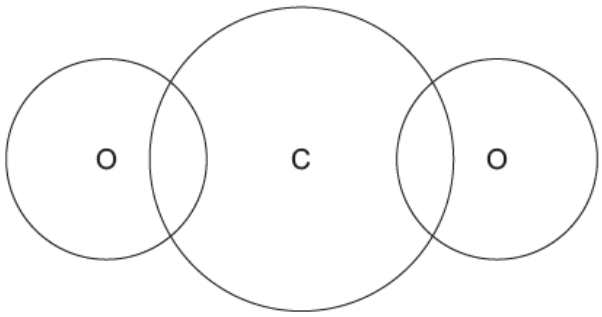
The inner shells have been drawn.

Give the charges on the ions.



[3]

(c) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of carbon dioxide.
Show outer shell electrons only.



[2]