SECTION 2 Microscopic World I

Multiple-Choice Questions

CE90_02

A cation of a certain element has 22 electrons and a mass number of 55. If the charge on the cation is +3, the number of neutrons in the cation is

A. 19
B. 23
C. 25
D. 30

CE90_03

The atomic numbers of element X and element Y are 13 and 16 respectively. The formula of the compound formed between X and Y is likely to be

A. XY_2
B. X_2Y
C. X_2Y_3
D. X_3Y_2

CE90_04

Which of the following combinations concerning the isotopes of an element is correct?

	No. of protons	No. of neutrons	No. of electrons
A.	same	different	same
B.	same	same	different
C.	different	same	different
D.	same	different	different

CE90_25

Bromine has a low melting point because

A. it is a non-metal.
B. it is a member of the halogen family.
C. the atoms in each bromine molecule are bonded together by a covalent bond.
D. the bromine molecules are attracted together by van der Waals' forces.

CE90_26

Dry zinc chloride solid is a non-conductor of electricity because

A. it is a non-electrolyte.
B. it exists as molecules.
C. its ions are not mobile.
D. metallic bonding is not present.

CE91_01

Directions: Questions 1 and 2 refer to the following table.

Element	W	X	Y	Z
Atomic number	4	8	14	20

Which of the following elements are likely to be metals?

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

CE91_02

Directions: Questions 1 and 2 refer to the following table.

Element	W	X	Y	Z
Atomic number	4	8	14	20

The formula of the compound formed between X and Z is likely to be

A. XZ
B. XZ_2
C. X_2Z
D. X_2Z_3

CE91_04

Which of the following groups of ions/atoms has the same number of electrons?

A. K^+, Ca^{2+}
B. Cl^-, S
C. H^+, He
D. O^{2-}, Ar

CE92_02

X and Y are elements. The melting points of their chlorides are given below:

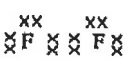
	Melting point (°C)
Chloride of X	772
Chloride of Y	– 68

Which of the following statements is correct?

A. Both X and Y are metals.
B. The chloride of Y is a solid at room temperature.
C. The chloride of X conducts electricity in the solid state.
D. The chloride of Y is a covalent compound.

CE92_03

Which of the following electron diagrams is correct?

A. 
B. 
C. 
D. 

CE92_04

Consider the following table:

Element	W	X	Y	Z
Atomic number	9	10	14	19

Which of the following elements is likely to be an oxidizing agent?

A. W
B. X
C. Y
D. Z

CE92_30

The atomic number and mass number of element E are 8 and 17 respectively. What are the number of protons and neutrons in an atom of E?

	Number of protons	Number of neutrons
A.	8	9
B.	8	17
C.	9	8
D.	9	17

CE92_45

1st statement	2nd statement
Both zinc and molten sodium chloride conduct electricity.	Both zinc and molten sodium chloride contain mobile ions.

CE93_01

Which of the following pairs of atoms/ions has the same number of electrons?

A. Mg^{2+} and F
B. Cl^- and Ne
C. K^+ and O^{2-}
D. Cl^- and S^{2-}

CE93_02

The elements, sodium to chlorine, in the third period of the Periodic Table show a gradual change in properties. Which of the following changes is correct?

A. Their melting points increase.
B. Their ability to gain electrons increases.
C. Their oxides change from acidic to basic.
D. Their chloride change from covalent to ionic.

CE93_23

Which of the following statements about a solution of hydrogen chloride in water is correct?

A. The hydrogen chloride exists as molecules in the solution.
B. The hydrogen chloride is slightly ionized in water.
C. The pH value of the solution is greater than 7.
D. The reaction between the solution and aqueous ammonia is exothermic.

CE94_01

If the atomic number of an element X is 13, the formula of its oxide is

A. XO_2
B. XO_3
C. X_2O_3
D. X_3O_2

CE94_02

Consider the information given in the table below:

Atom	Atomic number	Mass number	No. of neutrons
P	6	14	
Q	7	14	
R		13	7
S		18	10
T	10		10

Which of the following atoms are isotopes?

A. P and Q
B. P and R
C. R and S
D. S and T

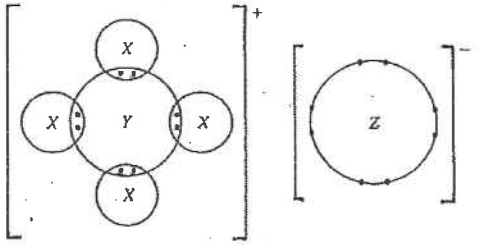
CE94_03

Which of the following molecules has the greatest number of lone pairs of electrons?

A. fluorine
B. hydrogen
C. nitrogen
D. oxygen

CE94_36

X, Y and Z are these different elements. The electronic diagram (showing electrons in the outermost shells only) of the compound formed by X, Y and Z is shown below:



Which of the following statement are correct?

(1) There is one electron in the outermost shell of an atom of X.
(2) There are five electrons in the outermost shell of an atom of Y.
(3) There are eight electrons in the outermost shell of an atom of Z.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE94_46

1st statement	2nd statement
Hydrogen chloride has a lower melting point than sodium chloride.	In each molecule of hydrogen chloride, a hydrogen and a chlorine atom are joined together by a covalent bond.

CE95_01

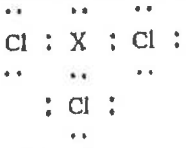
The atomic number of an element X is 18. An atom of X has a mass number of 40.

The atom has

A. 18 protons, 22 neutrons and 18 electrons.
B. 18 protons, 22 neutrons and 22 electrons.
C. 18 protons, 40 neutrons and 18 electrons.
D. 22 protons, 22 neutrons and 18 electrons.

CE95_02

The electronic structure of a compound formed between an element X and chlorine is shown below.



(Only electrons in the outermost shells are shown.)

What would be the formula of the compound formed between X and magnesium?

A. MgX
B. MgX_2
C. Mg_2X_3
D. Mg_3X_2

CE95_03

Which of the following correctly describes the structure of quartz?

A. giant covalent structure
B. giant ionic structure
C. giant metallic structure
D. simple molecular structure

CE95_04

Boron consists of two isotopes. The table below lists the relative abundance of these two isotopes.

Isotope	Relative abundance
$^{10}_{5}B$	19.7%
$^{11}_{5}B$	80.3%

The relative atomic mass of boron (correct to 1 decimal place) is

A. 10.4
B. 10.6
C. 10.8
D. 11.0

CE95_06

Which of the following fertilizers contains the largest percentage by mass of nitrogen?

(Relative atomic masses: H = 1.0, N = 14.0, O = 16.0, Na = 23.0, S = 32.0, Cl = 35.5, K = 39.0)

A. ammonium chloride
B. ammonium sulphate
C. potassium nitrate
D. sodium nitrate

CE95_26

Which of the following elements is a semi-metal?

A. Hg
B. Si
C. C
D. Be

CE95_34

Which of the following particles is/are present in a hydrogen ion?

(1) proton
(2) neutron
(3) electron

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE95_39

Which of the following substances can conduct electricity?

(1) molten zinc chloride
(2) an aqueous solution of magnesium sulphate
(3) a mixture of ethanol and water

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE96_01

Magnesium and calcium have similar chemical properties because

A. their atoms have the same atomic structure.
B. their atoms have the same number of electron shells.
C. their atoms have the same number of electron in their outermost shells.
D. their atoms have the same electronic arrangement.

CE96_02

Which of the following can represent the electronic structure of potassium sulphate?

A. $[K]_2^+ [:\ddot{S}:]^{2-}$
B. $2[K]^+ [:\ddot{S}:]^{2-}$
C. $[K]^{2+} [:\ddot{S}:]^{2-}$
D. $:\ddot{K}:\ \ddot{S}:$

CE96_03

The mass number of atom *X* is 27. *X* forms a cation with a charge of +3. If the number of neutrons in the cation is 14, what is the number of electrons in the *cation*?

A. 10
B. 13
C. 14
D. 17

CE96_39

The atomic number of element *X* is 16. Which of the following statements concerning *X* are correct?

(1) *X* can react with calcium to form an ionic compound.
(2) The oxide of *X* dissolves in water to form an acidic solution.
(3) *X* can conduct electricity in its molten state.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE96_44

Which of the following elements can react together to form a covalent compound?

(1) argon
(2) nitrogen
(3) oxygen
(4) calcium

A. (1) and (2) only
B. (1) and (4) only
C. (2) and (3) only
D. (3) and (4) only

CE96_45

1st statement	2nd statement
The melting point of hydrogen chloride is lower than that of potassium chloride.	Hydrogen chloride is a covalent compound whereas potassium chloride is an ionic compound.

CE96_50

1st statement	2nd statement
Both dry ice and quartz exist in the form of discrete molecules.	Carbon and silicon atoms have the same number of electrons in their outermost shells.

CE97_01

The chemical properties of an element depend on

A. its relative atomic mass.
B. the number of isotopes of the element.
C. the number of electron shells in its atoms.
D. the number of outermost shell electrons in its atoms.

CE97_02

Elements X and Y form a compound having the following electronic structure:

$[:\ddot{\underset{\cdot\cdot}{Y}}:]^-$ $[:\ddot{\underset{\cdot\cdot}{X}}:]^{2+}$ $[:\ddot{\underset{\cdot\cdot}{Y}}:]^-$

(Only outermost shell electrons are shown.)

Which of the following combinations is correct?

	X	Y
A.	Na	S
B.	Mg	Br
C.	Al	Cl
D.	Si	O

CE97_03

Argon exists as a gas at room temperature and pressure because

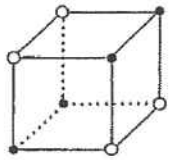
A. argon molecules are monoatomic.
B. argon is chemically inert.
C. the outermost electron shell of an argon atom has an octet structure.
D. the attractive force between argon atoms is weak.

CE97_05

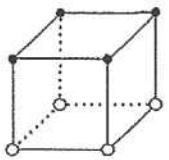
Which of the following diagrams best represents a part of the giant lattice of sodium chloride crystal?

(In these diagrams, ● represents Na^+ ion and ○ represents Cl^- ion)

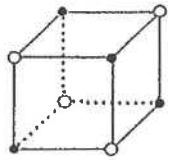
A.



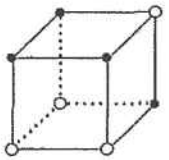
C.



B.



D.



CE97_30

M is an element in the third period of the Periodic Table. M forms a sulphate which has the formula $M_2(SO_4)_3$. The formula of the nitrate of M is

A. MNO_3. B. $M(NO_3)_2$.
C. $M(NO_3)_3$. D. $M_2(NO_3)_3$.

CE98_01

An element X exists as molecules. X has an atomic number of 7 and a molecule of X has a formula X_2. Which of the following can represent the electronic structure of X_2?

A. $:\ddot{\underset{\cdot\cdot}{X}}:\ddot{\underset{\cdot\cdot}{X}}:$ B. $:\dot{\underset{\cdot\cdot}{X}}::\dot{\underset{\cdot\cdot}{X}}:$

C. $:\ddot{\underset{\cdot\cdot}{X}}::\ddot{\underset{\cdot\cdot}{X}}:$ D. $:\underset{\cdot\cdot}{X}\vdots\vdots\underset{\cdot\cdot}{X}:$

CE98_18

Which of the following ions has the same number of protons as the hydroxide ion, OH^- ?

A. O^{2-} B. F^-
C. Na^+ D. Mg^{2+}

CE98_33

Consider the following information:

Substance	Melting point /°C	Electrical conductivity at room temperature	Solubility in water
W	−34	poor	slightly soluble
X	44	poor	insoluble
Y	232	poor	insoluble
Z	782	poor	very soluble

Which of the above substances exists as a simple molecular solid at room temperature?

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

CE98_45

1st statement	2nd statement
Element X (atomic number 11) reacts with element Y (atomic number 16) to form an ionic compound.	Each atom of X loses one electron and each atom of Y accepts two electrons to form a compound with X_2Y.

CE99_05

Consider the information concerning particle *X* and particle *Y* listed below:

Particle	Number of protons	Number of electrons	Number of neutrons
X	16	16	18
Y	16	18	18

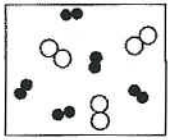
Which of the following statements is correct?

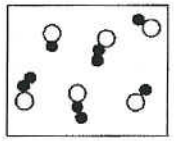
A. *X* and *Y* are atoms of the same element.
B. *X* and *Y* are atoms of different element.
C. *X* is a cation of *Y*.
D. *Y* is an anion of *X*.

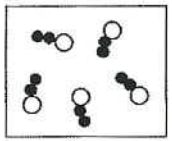
CE99_01

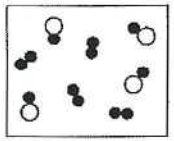
Which of the following diagrams can represent a mixture of two compounds?

(In these diagrams, ● and ○ represent a nitrogen atom and an oxygen atom respectively.)

A. 

B. 

C. 

D. 

CE99_11

The table below shows the ability of four substances *W, X, Y* and *Z* to conduct electricity.

(In the table, √ and × respectively represent 'can conductivity' and 'cannot conduct electricity'.)

Substance	Solid state	Liquid state	Aqueous solution
W	×	√	√
X	×	×	√
Y	×	×	×
Z	√	√	(insoluble in water)

Which of the substances is likely to be zinc chloride?

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

CE99_19

Ionic compound *X* has the formula AB_2, where A and B represent the cation and anion respectively. If both A and B have the same electronic arrangement, X may be

A. potassium sulphide.
B. magnesium fluoride.
C. silicon dioxide.
D. calcium bromide.

CE99_34

Iodine is a solid at room temperature and pressure. Which of the following statement concerning the structure of iodine is/are correct?

(1) Iodine has a giant covalent structure.
(2) Iodine molecules are held together by van der Waals' forces.
(3) Iodine atoms are held together in pairs by covalent bonds.

A. (1) only.
B. (2) only.
C. (1) and (3) only.
D. (2) and (3) only.

CE99_39

Element X has an isotope $^{31}_{15}X$. Which of the following statements is/are correct?

(1) X belongs to V of the Periodic Table.
(2) X can react with oxygen to form an ionic compound.
(3) $^{31}_{15}X$ has 16 neutrons.

A. (1) only.
B. (2) only.
C. (1) and (3) only.
D. (2) and (3) only.

CE99_46

1st statement	2nd statement
Metals have good thermal conductivity.	Metals are composed of giant lattices of positive ions surrounded by valence electrons which are free to move throughout the lattice.

CE00_01

A compound formed from element X and sulphur has the following electronic structure:

(Only electrons in the outermost shells are shown.)

How many electrons are there in the outermost shell of an atom of X?

A. 2
B. 4
C. 6
D. 8

CE00_07

Element X occurs in nature as two isotopes, ^{63}X and ^{65}X. If the relative atomic mass of X is 63.5, what is the relative abundance of the ^{63}X isotope?

A. 25%
B. 60%
C. 75%
D. 90%

CE00_09

The atomic number of element X is 12. X reacts with element Y to form an ionic compound with formula XY_2. To which group of the Periodic Table does Y belong?

A. Group I
B. Group IV
C. Group VI
D. Group VII

CE00_17

The melting point and boiling point of substance X are 321°C and 765°C respectively. In its molten state, X conducts electricity without decomposition. X probably has

A. an ionic structure.
B. a metallic structure.
C. a simple molecular structure.
D. a covalent network structure.

CE00_34

Which of the following statements concerning helium is/are correct?

(1) The outermost electron shell of a helium atom has an octet structure.
(2) Helium is used to fill water weather balloons.
(3) Helium exists as monatomic molecules.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE00_39

X is an element in Group VI of the Periodic Table. X can form X^{2-} ions. Which of the following statements are correct?

(1) The oxidation number of X decrease when X^{2-} ion is formed.
(2) Both X atom and X^{2-} ion have the same number of electron shells.
(3) Both X atom and X^{2-} ion have the same nuclear charge.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE00_42

Which of the following statements concerning carbon, silicon and phosphorus are correct?

(1) Carbon forms numerous compounds with hydrogen and oxygen.
(2) Silicon is used to make computer chips.
(3) Phosphorous is an essential element for plant growth.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE00_46

1st statement	2nd statement
Carbon dioxide and silicon dioxide have similar physical properties.	The atoms of carbon and silicon have the same number of electrons in their outermost shells.

CE01_01

Which of the following ions is responsible for the yellow colour of topaz?

A. Mn^{2+}
B. Mn^{3+}
C. Fe^{2+}
D. Fe^{3+}

[Note: Topaz is a yellow coloured gemstone.]

CE01_07

Which of the following statements concerning water is correct?

A. It reacts with calcium to give a colourless gas.
B. It is a strong electrolyte.
C. It turns anhydrous cobalt(II) chloride from pink to blue.
D. It is immiscible with methanol.

CE01_18

Consider the following information about four substances, W, X, Y and Z:

Substances	Melting point /°C	Electrical conductivity at room temperature
W	–23	poor
X	56	poor
Y	232	good
Z	750	poor

Which substance has a simple molecular structure and is a solid at room temperature?

A. W
B. X
C. Y
D. Z

CE01_20

The table lists some information about two elements, X and Y:

Element	Atomic number	Relative atomic mass
X	12	24.0
Y	9	19.0

The compound formed from X and Y has a formula mass of

A. 43.0
B. 62.0
C. 67.0
D. 81.0

CE01_37

Consider the information listed below:

	Substance	Attraction between particles in substance
(1)	helium	van der Waals' forces
(2)	diamond	covalent bond
(3)	magnesium oxide	ionic bond

Which of the following combination are correct?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_42

Which of the following ions have the same number of electrons as neon atom?

(1) Mg^{2+}
(2) O^{2-}
(3) Cl^{-}

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_49

1st statement	2nd statement
Lithium is the most reactive element in Group I of the Periodic Table.	Among the Group I elements, lithium loses electrons most readily.

CE02_01

The electronic diagram of an atom of element X is shown below:

(Only electrons in the outermost shell are shown.)

The atomic number of X is probably

A. 7
B. 15
C. 17
D. 19

CE02_28

Which of the following substances does not conduct electricity in its solid state but does conduct electricity in its liquid state?

A. lithium chloride
B. phosphorous
C. platinum
D. perspex

CE02_36

Which of the following statements concerning fluorine is/are correct?

(1) It exists as monatomic molecules.
(2) It reacts with hydrogen to form a covalent compound.
(3) It reacts with calcium to form a compound with formula CaF_2.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE02_46

1st statement	2nd statement
Combustion of diamond gives carbon dioxide.	Diamond is a crystalline form of carbon.

CE02_49

1st statement	2nd statement
When iodine sublimes, it absorbs energy.	Energy is required to overcome the attractive force between iodine molecules.

CE03_01

Which of the following pairs of elements in Group I and VII of the Periodic Table would react with each other most vigorously?

	Group I	Group VII
A.	lithium	fluorine
B.	lithium	iodine
C.	potassium	fluorine
D.	potassium	iodine

CE03_12

Gallium (Ga) occurs naturally in two isotopic forms, ^{69}Ga and ^{71}Ga. The table below lists the relative abundance of each isotope.

Isotope	Relative abundance
^{69}Ga	60.2%
^{71}Ga	39.8%

What is the relative atomic mass of gallium?

A. 69.6
B. 69.8
C. 70.0
D. 70.2

CE03_25

An atom of element X has 20 protons while an atom of element Y has 7 electrons. What is the formula of the compound formed from X and Y?

A. XY_2
B. X_2Y_3
C. X_2Y_5
D. X_3Y_2

CE03_46

1st statement	2nd statement
^{35}Cl and ^{37}Cl have the same chemical properties.	The number of electrons in the outermost shell of a ^{35}Cl atom is equal to that of a ^{37}Cl atom.

CE05SP_03

Which of the following substances can conduct electricity in both solid and liquid states?

A. sulphur
B. mercury
C. quartz
D. lead(II) bromide

CE05SP_16

Which of the following natural substances is essentially a single compound?

A. air
B. coal
C. petroleum
D. quartz

CE05SP_31

Caesium (Cs) is a group I element in the Periodic Table and its relative atomic mass is greater than that of potassium. Which of the following statements concerning caesium is INCORRECT?

A. Caesium is a weaker reducing agent than potassium.
B. Caesium reacts violently with water.
C. Caesium is a soft metal.
D. Caesium reacts with oxygen to form an oxide with formula Cs_2O.

CE04_01

How many elements does ammonium dichromate consist of?

A. 2
B. 3
C. 4
D. 5

CE04_02

X, Y and Z are three consecutive elements in the Periodic Table. X forms a stable anion X^-, while Z forms a stable cation Z^+. Which of the following statements about X, Y and Z is correct?

A. X, Y and Z are elements in the same period of the Periodic Table.
B. Both X and Z are electrical conductors under room temperature and pressure.
C. Y reacts with Z readily.
D. X^- and Z^+ have the same electronic arrangement.

CE04_10

Which of the following combinations concerning the properties of gases is INCORRECT?

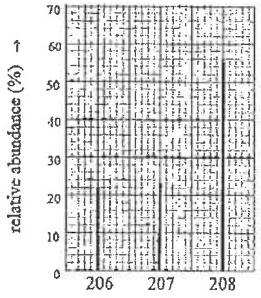
	Gas	*Property*
A.	Ammonia	has an irritating odour
B.	Methane	dissolves readily in water
C.	Carbon monoxide	can burn in air
D.	Nitrogen monoxide	changes from colourless to brown when exposed to air

CE04_23

Element X has three isotopes, ^{206}X, ^{207}X and ^{208}X. The graph below shows the relative abundances of the isotopes.

What is the relative atomic mass of *X*?

A. 206.8 B. 207.0
C. 207.3 D. 207.5



CE04_30

Refer to the melting points and boiling points of four substances at 1 atm pressure as listed in the table below:

Substance	Melting point /°C	Boiling point /°C
argon	−189	−186
bromine	−7	59
chlorine	−101	−35
sulphur dioxide	−75	−10

Which of the following chemical bonds/attractive forces exist(s) in all four substances at 25°C and 1 atm pressure?

(1) van der Waals' forces
(2) ionic bond
(3) covalent bond

A. (1) only B. (2) only
C. (1) and (3) only D. (2) and (3) only

CE04_31

The atomic number of element X is 15. It has only one isotope with a mass number of 31. Which of the following statements concerning X is correct?

A. X forms an oxide which dissolves in water to give an alkaline solution.
B. In the compound formed from X and sodium, X has an oxidation number of −3.
C. X is a gas at room temperature and pressure.
D. There are 15 neutrons in the nucleus of an atom of X.

CE05_03

The table below gives some information about certain components in a sample of liquefied air.

Component	Boiling point /°C
argon	−186
nitrogen	−196
oxygen	−183

In what order are these components distilled out when the sample undergoes fractional distillation?

A. nitrogen, oxygen, argon
B. nitrogen, argon, oxygen
C. oxygen, argon, nitrogen
D. oxygen, nitrogen, argon

CE05_06

Consider the information given in the table below:

Element	Atomic number
w	6
x	17
y	18
z	20

Which of the following pairs of elements would react with each other most readily?

A. w and y B. w and z
C. x and y D. x and z

CE05_07

Which of the following statements concerning van der Waals' forces is correct?

A. They exist in quartz.
B. They exist in limestone.
C. They exist in solid iodine.
D. They exist in solid ammonium nitrate.

CE05_09

Which of the following chlorides has the highest melting point?

A. HCl B. LiCl
C. SCl_2 D. CCl_4

CE05_13

Consider the information given in the table below:

	Particle			
	X	Y	Z	W
No. of protons	8	8	8	10
No. of electrons	10	10	8	10
No. of neutrons	8	10	10	10

Which of the following statements about the particles is correct?

A. W and Z are isotopes.
B. X and Z have the same mass.
C. Y and Z have the same charge.
D. X and W have the same electronic arrangement.

CE05_27

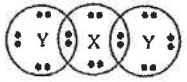
Which of the following properties of sodium chloride is/are evidence(s) to support that ionic bonds are strong?

(1) It is soluble in water.
(2) It has a high melting point.
(3) It can conduct electricity in molten state.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE06_01

The electronic diagram of a compound formed between element X and element Y is shown below:



(Only electrons in the outermost shells are shown.)

Which of the following combinations concerning X and Y is correct?

	X	Y
A.	carbon	oxygen
B.	silicon	oxygen
C.	oxygen	sodium
D.	oxygen	chlorine

CE06_02

Which of the following statements about the Periodic Table is correct?

A. The elements are arranged in order of increasing relative atomic mass.
B. The reactivity of the elements in Group II decreases down the group.
C. The boiling point of the elements in Group VII decreases down the group.
D. All elements in Group 0 exist in gaseous state at room temperature and pressure.

CE06_04

Which of the following combinations concerning the change of physical state of a substance is INCORRECT?

	Change of physical state	Process
A.	liquid to gas	evaporation
B.	liquid to solid	precipitation
C.	solid to gas	sublimation
D.	gas to liquid	condensation

CE06_05

$^{56}_{26}Fe$ is an isotope of iron. Which of the following correctly describes the number of subatomic particles in an Fe^{2+} ion formed from this isotope?

	No. of electrons	No. of neutrons
A.	23	26
B.	23	30
C.	24	26
D.	26	30

CE06_06

Which of the following substance exist(s) in liquid state at room temperature and pressure?

Substance	Melting point /°C	Boiling point /°C
W	–92	7
X	7	81
Y	56	197
Z	–95	69

A. W only
B. X only
C. X and Z only
D. Y and Z only

CE06_14

Element X has two isotopes, ^{39}X and ^{41}X. The table below lists the percentage abundance of the two isotopes:

Isotope	Percentage abundance
^{39}X	93.2
^{41}X	6.8

What is the relative atomic mass of X?

A. 39.0
B. 39.1
C. 40.0
D. 40.9

CE06_24

In which of the following atoms or ions is the outermost shell an octet?

(1) Li^+

(2) Ne

(3) S^{2-}

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE07_03

X is an element in the Periodic Table and X^+ ion has an electronic arrangement of 2, 8, 8. Which of the following statements concerning X is correct?

A. X is a halogen
B. X is a transition element
C. X is a group 0 element
D. X is a period 4 element

CE07_12

Which of the following pairs of elements would form a covalent compound?

A. mercury and neon
B. neon and nitrogen
C. mercury and fluorine
D. fluorine and nitrogen

CE07_13

M is an element in the Periodic Table. M^{2-} ion possesses 45 neutrons and 36 electrons. What is M?

A. Se
B. Kr
C. Sr
D. Rh

CE07_18

Consider the information below:

Solid	Melting point	Electrical conductivity	Solubility in water
W	High	Good	Insoluble
X	High	Non-conducting	Soluble
Y	Low	Non-conducting	Soluble
Z	Very high	Non-conducting	Insoluble

Which of the following solids is likely to be an ionic compound?

A. W
B. X
C. Y
D. Z

CE07_28

1st statement	2nd statement
Molten sulphur is a good conductor of electricity.	Sulphur molecules are mobile in molten sulphur.

CE07_29

1st statement	2nd statement
Isotopes of an element have the same mass.	Isotopes of an element have the same number of protons.

CE07_43

Which of the following bonds or attractive forces exist in ammonium nitrate?

(1) ionic bond

(2) covalent bond

(3) van der Waals' forces

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_02

J and Q are two alkaline earth metals in the Periodic Table. If the atomic number of J is x, then the atomic number of Q could be

A. $x-2$
B. $x+6$
C. $x-10$
D. $x+18$

CE08_18

In which of the following groups of substances there exists a difference in bonding type among the substances?

A. iodine, oxygen, nitrogen
B. chromium, mercury, aluminium
C. methane, ethyl ethanoate, sulphur dioxide
D. potassium chloride, hydrogen chloride, silver chloride

CE08_19

Which of the following statements concerning a water molecule is/are correct?

(1) The number of bonding electrons contributed by each hydrogen atom in the molecule is 2.

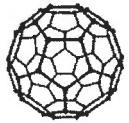
(2) The number of bonding electrons contributed by the oxygen atom in the molecule is 2.

(3) The total number of electrons in the molecule is 8.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE08_46

A certain form of solid carbon is composed of C_{60} molecules. Each C_{60} molecule is formed by 60 carbon atoms bonded together like a football as shown in the diagram below:



Which of the following statements is/are correct?

(1) The molar mass of C_{60} is 12.0 g.
(2) The solid gives carbon dioxide upon complete combustion.
(3) The melting point of the solid is higher than that of diamond.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_01

The electronic arrangements of three chemical species are shown below:

W : 2, 1
X^{2+} : 2, 8
Y^- : 2, 8, 7

Which of the elements W, X and Y are in the same period of the Periodic Table?

A. W and X only
B. W and Y only
C. X and Y only
D. W, X and Y

CE09_07

A colorless aqueous solution of compound Z can conduct electricity and turns blue litmus paper red. It can be deduced that

A. Z must be an ionic compound.
B. Z must contain hydrogen in its chemical formula.
C. Solution of Z must contain more ions than molecules.
D. Solution of Z must contain more H^+ ions than OH^- ions.

CE09_18

Which of the following statements concerning the Periodic Table is/are correct?

(1) Ni is an example of transition elements.
(2) The elements are arranged in increasing order of neutron number.
(3) The lower the element located in each group, the more reactive the element is.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_19

Which of the following substances can exist in the form of simple molecules?

(1) iodine
(2) nylon
(3) dry ice

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_22

A substance has a high melting point and does not conduct electricity when in solid state. It may be

(1) a compound with giant molecules.
(2) an element with giant covalent structure.
(3) A compound with giant ionic structure.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_28

1st statement	2nd statement
Ammonium chloride is an ionic compound.	Ammonium chloride can conduct electricity in aqueous state.

CE10_01

How many electrons and neutrons are there in a doubly charged cation formed from $^{55}_{25}Mn$?

	Number of electrons	Number of neutrons
A.	23	30
B.	23	32
C.	25	28
D.	25	30

CE10_13

Which of the following combinations shows a correct matching of a molecule and its structural formula?

	molecule	structural formula
A.	nitrogen	N=N
B.	helium	He–He
C.	carbon dioxide	O–C–O
D.	hydrogen peroxide	H–O–O–H

CE10_17

Which of the substances listed in the following table has a giant ionic structure?

Substance	Electrical conductivity in solid state	Electrical conductivity in molten state
W	not conducting	not conducting
X	not conducting	conducting
Y	conducting	not conducting
Z	conducting	conducting

A. W
B. X
C. Y
D. Z

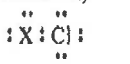
CE11_01

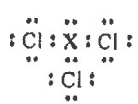
Element Q forms a stable Q^{2+} ion. What may the atomic number of Q be?

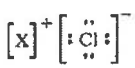
A. 6
B. 11
C. 14
D. 20

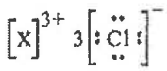
CE11_02

The atomic number of element X is 15. X reacts with chlorine to form a chloride. Which of the following can represent the electronic diagram of the chloride? (Only electrons in the outermost shells are shown.)

A.


B.


C.


D.


CE11_03

Which of the following substances is a single compound?

A. graphite
B. vinegar
C. ethanol
D. Petrol

CE11_31

X, Y and Z are three different elements. X^{2+} ion, Y^- ion and argon atom have the same electronic arrangement. Z belongs to the same period as X and the same group as Y in the Periodic Table. What is Z?

A. Mg
B. Cl
C. Ca
D. Br

AL10(I)_03 (modified)

^{123}I and ^{127}I are two isotopes of iodine. ^{123}I is radioactive with a half-life (time required to reduce by half of its original amount) of 13 hours, while ^{127}I is not radioactive. Which of the following statements about these two isotopes is/are correct?

(1) ^{123}I is chemically more reactive than ^{127}I.
(2) ^{123}I has a greater proton-to-neutron ratio than ^{127}I.
(3) The number of ^{123}I atoms in a sample drops to ¼ of its original value after 26 hours.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE11SP_07

The atomic number of an element X is 18. An atom of X has a mass number of 40. The atom has

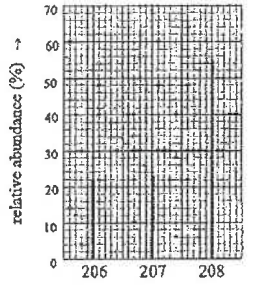
A. 18 protons, 22 neutrons and 18 electrons.
B. 18 protons, 22 neutrons and 22 electrons.
C. 18 protons, 40 neutrons and 18 electrons.
D. 22 protons, 22 neutrons and 18 electrons.

DSE11SP_11

Element X has three isotopes, ^{206}X, ^{207}X and ^{208}X. The graph (on the right) shows the relative abundances of the isotopes.

What is the relative atomic mass of X?

A. 206.8
B. 207.0
C. 207.3
D. 207.5



DSE11SP_22

Iodine is a solid at room temperature and pressure. Which of the following statements concerning the structure of iodine is/are correct?

(1) Iodine has a giant covalent structure.
(2) Iodine molecules are held together by van der Waals' forces.
(3) Iodine atoms are held together in pairs by covalent bonds.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE11SP_24

1st statement	2nd statement
Carbon dioxide and silicon dioxide have similar physical properties.	The atoms of carbon and silicon have the same number of electrons in their outermost shells.

DSE11SP_36

1st statement	2nd statement
The reaction of ethanoic acid with ethanol is a neutralization.	Water is one of the products in the reaction of ethanoic acid and ethanol.

DSE12PP_01

Element **X** occurs in nature in two isotopes, ^{69}X and ^{71}X. The table below lists the relative abundance of each isotope:

Isotope	Relative abundance (%)
^{69}X	60.0
^{71}X	40.0

A. 69.6
B. 69.8
C. 70.0
D. 70.2

DSE12PP_03

Which of the following species is NOT an appropriate example for illustrating dative bond formation?

A. NH_3
B. NH_4^+
C. BF_4^-
D. BF_3NH_3

DSE12PP_04

Which of the following statements about silicon dioxide is correct?

A. It consists of discrete molecules.
B. It melts upon heating in a test tube.
C. It is ductile.
D. It is a poor conductor of electricity.

DSE12PP_15

Which of the following statements best describes metallic bonding?

A. It is an attractive force between ions.
B. It is an attractive force between polar chemical species.
C. It is an attractive force between atomic nuclei and bond-pair electrons.
D. It is an attractive force between cations and delocalized electrons.

DSE12PP_18

Barium (Ba) is an element in Group II of the Periodic Table. Which of the following is/are the expected observation(s) when a small piece of barium is added to a trough of water containing a few drops of phenolphthalein?

(1) A colorless gas is liberated.
(2) The piece of barium floats on the water surface.
(3) The resulting solution in the trough is colorless.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12_01

Which of the following substances CANNOT conduct electricity?

A. Pt(s)
B. $PbBr_2(l)$
C. C(graphite)
D. $CH_3CH_2OH(l)$

DSE12_08

Silicon and carbon react to form silicon carbide. The crystal structure of silicon carbide is similar to that of diamond. Silicon carbide is very hard because

A. It has a high melting point.
B. Silicon atoms and carbon atoms form triple bonds.
C. It has a giant network structure with strong covalent bond.
D. Both silicon and carbon atoms have four outermost shell electrons.

DSE12_15

Which of the following statements concerning an ^{131}I and a ^{131}Xe atom is/are correct?

(1) They have the same number of protons.
(2) They have different numbers of neutrons.
(3) They have different numbers of outermost shell electrons.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE13_01

Silicon is an element in Group IV of the Periodic Table. The oxide of silicon has the chemical formula SiO_2. Which of the following statement about silicon and its oxide is correct?

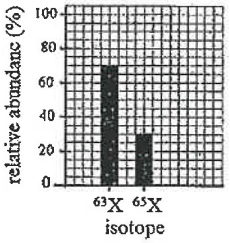
A. Silicon is a good conductor of heat.
B. Silicon exists as simple molecules.
C. SiO_2 is a hard material at room temperature.
D. SiO_2 dissolves in water to give an acidic solution.

DSE13_02

Suppose that element **X** has only two isotopes, ^{63}X and ^{65}X. The graph (on the right) shows the relative abundance of the two isotopes:

Which of the following is the relative atomic mass of X?

A. 63.3
B. 63.5
C. 63.6
D. 64.0



DSE13_04

Scandium (Sc) is a metal. Scandium, in its compounds, exhibits only one oxidation number. The chemical formula of scandium nitrate is $Sc(NO_3)_3$. Which of the following is most likely to be the chemical formula of scandium phosphate?

A. $Sc_2(PO_4)_3$
B. $ScPO_4$
C. $Sc(PO_4)_2$
D. $Sc(PO_4)_3$

DSE13_12

Both radium (Ra) and calcium (Ca) belong to the same group of the Periodic Table. Which of the following statements is INCORRECT?

A. Radium is a good conductor of electricity in the solid state.
B. Radium atoms readily donate electrons to form Ra^{2+} ions.
C. Both radium and calcium become tarnished after exposed to air for some time.
D. Radium is less reactive than calcium.

DSE14_01

Which of the following atoms has the smallest number of neutrons?

A. ^{63}Cu
B. ^{59}Co
C. ^{58}Ni
D. ^{57}Fe

DSE14_02

Which of the following compounds has a giant ionic structure?

A. N_2O_4
B. HNO_3
C. NCl_3
D. NH_4NO_3

DSE15_03

Element **Q** belongs to Group II of the Periodic Table. It combines with element **R** to give an ionic compound with chemical formula Q_3R_2 Which group of the Periodic Table does R belong to?

A. Group III
B. Group V
C. Group VI
D. Group VII

DSE15_15

Which of the following statements concerning 'atom' is correct?

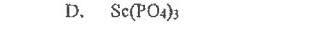
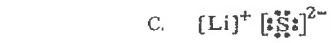
A. All atoms do not carry net charges.
B. Mass is evenly distributed within an atom.
C. All atoms consist of protons, neutrons and electrons.
D. For all elements, atoms of the same element have the same mass number.

DSE15_35

1st statement	2nd statement
The melting point of silicon is higher than that of aluminium.	The number of electrons in a silicon atom is greater than that in an aluminium atom.

DSE16_02

Which of the following is the electron diagram (only electrons in the outermost shell are shown) of lithium sulphide?

A. 
B. 
C. 
D. 

DSE17_01

Elements **X** and **Y** form an ionic compound with chemical formula X_2Y. If the ion of **X** and ion of **Y** have the same electronic arrangement, which of the following may this compound be?

A. Lithium oxide
B. Aluminium oxide
C. Potassium sulphide
D. Magnesium chloride

DSE17_16

Which of the following statements concerning helium is/are correct?

(1) Helium is chemically inert.
(2) Helium exists as diatomic molecules.
(3) The outermost electron shell of a helium atom has an octet structure.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE18_02

Neon exists as a gas at room temperature and pressure because

A. neon is chemically inert.
B. neon molecule are monoatomic.
C. the attractive force between neon atoms is weak.
D. the outermost electron shell of a neon atom has an octet structure.

DSE18_05

Quartz (SiO_2) is harder than dry ice (CO_2) because

A. the atomic size of silicon is larger than that of carbon.
B. a silicon atom has more electrons than a carbon atom has.
C. quartz has a giant network structure, but dry ice consists of discrete molecules.
D. the silicon-oxygen bond in quartz is strong, but the carbon-oxygen bond in dry ice is weak.

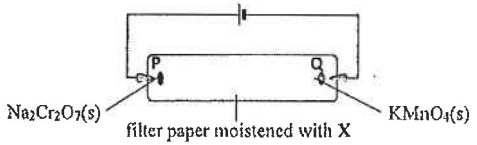
DSE19_01

Which of the following pairs of atomic numbers corresponds to elements with similar chemical properties?

A. 4, 14
B. 8, 18
C. 9, 35
D. 19, 38

DSE19_02

The set-up of an experiment is shown below :



What can be observed after the circuit is closed for a period of time ?

A. If X is dilute H_2SO_4, a purple patch migrates towards P.
B. If X is dilute H_2SO_4, a orange patch migrates towards Q.
C. If X is ethanol, a purple patch migrates towards P
D. If X is ethanol, an orange patch migrates towards X.

DSE19_24

	1st statement	2nd statement
	Mercury has good electrical conductivity at room temperature.	Mercury has delocalized electrons.

DSE2020:

2. Which of the following statements concerning quartz is correct ?

A. Quartz is soluble in hexane.
B. Quartz consists of SiO_2 molecules.
C. Quartz conducts electricity by delocalised electrons.
D. Quartz is hard because it has a giant covalent network structure.

3. What is the mass of oxygen in 24.0 g of $CuSO_4 \cdot 5H_2O(s)$?

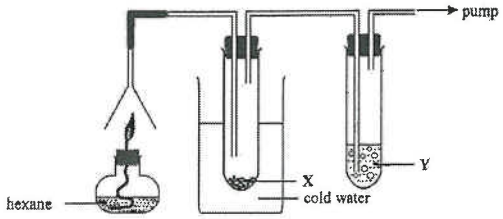
(Relative atomic masses : H = 1.0, O =16.0, S = 32.1, Cu = 63.5)

A. 6.2 g
B. 9.6 g
C. 13.8 g
D. 21.7 g

5. Which of the following statements concerning francium (atomic number = 87) is correct ?

A. Francium has a higher melting point than potassium.
B. Francium forms cations more readily than potassium.
C. Francium is a weaker oxidising agent than potassium.
D. Francium has a fewer number of occupied electron shells than potassium.

14. The set-up below is used to show that hexane (C_6H_{14}) contains carbon and hydrogen. What are X and Y ?



	X	Y
A.	$PbSO_4(s)$	limewater
B.	NaOH(s)	bromine water
C.	anhydrous $CoCl_2(s)$	limewater
D.	anhydrous $CuSO_4(s)$	bromine water

DSE2021:

1. The melting point of a chemical species is 146 °C. It is soluble in water and the solution formed does not conduct electricity. Which of the following structures would this chemical species have ?

A. giant ionic structure
B. giant metallic structure
C. giant covalent structure
D. simple molecular structure

19. The composition by mass of element X in the compound K_2XO_4 is 26.8%. Which of the following statements concerning X is / are correct ?

(Relative atomic masses : O = 16.0, K = 39.1)

(1) X is a transition metal.
(2) X is an element in Group VI of the Periodic Table.
(3) X is an element in the fourth period of the Periodic Table.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

21. Which of the following solids has / have delocalised electrons in its / their structure(s) ?

(1) graphite
(2) silicon
(3) silver

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Structural Questions

CE90_01b

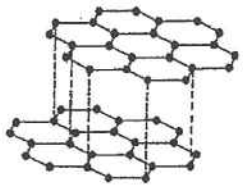


Diagram I : an allotrope of carbon

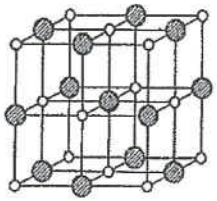


Diagram II : sodium chloride

The two diagrams above represent part of the structure of an allotrope of carbon, and sodium chloride at room temperature.

(i) What type of bonding exists in each of the substances shown above?

(ii) State a condition under which each substance can conduct electricity. Explain your answers.

(iii) Name an allotrope of carbon other than that shown above.

(iv) Which allotrope of carbon is used to
(1) make pencil lead?
(2) cut glass?
Explain your answers with reference to the different arrangements of atoms in these two allotropes.

(v) Do you agree with the statement: 'sodium chloride cannot easily be changed into sodium and chloride?' Explain your answer.

(12 marks)

CE91_01a

The following is a part of the Periodic Table:

	Group							
	I	II	III	IV	V	VI	VII	O
Second period				*a*			*b*	
Third period	*c*		*d*			*e*	*f*	*g*

Referring to the letters indicated in the above table, answer the following questions:

(i) (1) What is the name for the family of elements of which *b* and *f* are members?

(2) In what way are the electronic arrangements of the atoms of elements *b* and *f*
(I) similar to each other?
(II) different from each other?

(ii) Element *d* has a higher melting point than element *c*. Explain.

(iv) Two elements in the above table have allotropes.
(1) Explain the meaning of 'allotropes'.
(2) Suggest what the two elements are.

(v) Element *e* can form compounds with elements *a* and *c* separately.
(1) Draw the electronic structures of these two compounds, showing the outermost electrons ONLY.
(2) Which of these two compounds has a higher melting point? Explain your answer.

(10 marks)

CE92_01b

(iii) Why can metals conduct electricity?

(1 mark)

CE92_03b

Neon, a monatomic gas, occurs naturally as a mixture of three isotopes. The relative abundance of these isotopes is tabulated below:

Isotope	$^{20}_{10}Ne$	$^{21}_{10}Ne$	$^{22}_{10}Ne$
Abundance (%)	90.52	0.31	9.17

(i) State the number of electrons in the outermost shell of a neon atom.

(ii) Explain why neon gas is monatomic.

(iii) What is meant by the term 'isotope'?

(iv) Calculate
(1) the relative atomic mass of neon.

(5 marks)

CE93_02b

Physical properties of substances depend mainly on the types of binding force between their constituent particles.

(i) The melting points of diamond and tetrachloromethane are 3750°C and – 23°C respectively. Draw 3-dimentional diagrams for the structure of diamond and for a tetrachloromethane molecule. Hence explain the difference in their melting points.

(ii) In their solid states, sodium conducts electricity but sodium chloride does not. Explain.

(iii) Explain why tetrachloromethane does not conduct electricity in liquid state.

(7 marks)

CE93_04a

The following table gives some information about W, X, Y and Z which represent particles of some elements. These particles are either atoms or ions.

	Mass number	Atomic number	No. of proton	No. of electron	No. of neutron
W		12		12	12
X			12	10	12
Y	35	17			
Z			17	17	20

(i) In which group of the Periodic Table should W be placed?
Explain your answer.

(ii) (1) What is the relationship between W and X?
(2) Suggest a chemical reaction which can change W into X.

(iii) Molecules of Y and Z are both diatomic.
(1) Draw the electronic structure of a molecule of Y, showing electrons in the outermost shells only.
(2) Do molecules of Y and of Z have the same chemical properties? Explain your answer.

(iv) W can form a compound with Z. Calculate the formula mass of the compound formed.

(6 marks)

CE94_01

The table below lists some information about three metals X, Y and Z.

Metal	X	Y	Z
Atomic number	12	20	

(a) To which group in the Periodic Table does Y belong?

(1 marks)

CE94_07b

The table below lists some physical properties of lead, bromine and lead(II) bromide.

	Lead	Bromine	Lead(II) bromide
Melting point	328°C	−7°C	370°C
Electrical conductivity in the solid state	Conducting	Non-conducting	Non-conducting
Electrical conductivity in the liquid state	Conducting	Non-conducting	

(i) Explain the difference in melting points between bromine and lead(II) bromide.

(ii) Explain the difference in electrical conductivity between lead and lead(II) bromide in the solid state.

(iii) Will lead(II) bromide conduct electricity in the liquid state?
Explain your answer.

(5 marks)

CE95_02

In each of the following groups of substances, there is ONE substance which is different from the others in terms of their properties. In each group, identify the substance which is different from the others and explain your choice.

(a) argon, fluorine, helium, neon

(2 marks)

CE95_04

"When atoms combine, they tend to attain noble gas electronic structures."

Discuss how atoms can attain the noble gas electronic structures. In your answer, you should give suitable examples and the electronic structures of the products formed.

(8 marks)

CE96_07a

The boxes below show some information about two atoms, hydrogen (H) and deuterium (D):

Mass number → 1, Atomic number → 1, **H**

Mass number → 2, Atomic number → 1, **D**

(i) Suggest a term to indicate the relationship between a hydrogen atom and a deuterium atom.

(ii) State the number of neutrons in a deuterium atom.

(iii) Deuterium reacts with oxygen in the same way as hydrogen.

$2D_2(g) + O_2(g) \longrightarrow 2D_2O(l)$ $\quad \Delta H$ is negative

The product of the reaction is known as "heavy water".

(1) Explain why deuterium reacts with oxygen in the same way as hydrogen.
(2) Draw the electronic structure of "heavy water", showing electrons in the outermost shells ONLY.
(3) What is meant by 'ΔH is negative'?
(4) What is the formula mass of 'heavy water'?

(6 marks)

CE98_01

Lithium is a group I element in the Periodic Table. It occurs naturally in two isotopic forms. The relative abundance of the each of these isotopes is shown in the table below:

Isotope	^{6}Li	^{7}Li
Relative abundance (%)	7.4	92.6

(a) What is the meaning of the term 'isotope'?

(b) Calculate the relative atomic mass of lithium.

(3 marks)

CE99_04

With the help of electronic diagrams, describe the formation of magnesium chloride and tetrachloromethane from atoms of relevant elements. State, with explanation, which of the two compounds has a higher melting point.

(9 marks)

CE99_06a

(i) Draw the electronic diagram of water, showing electrons in the outermost shells only.

(1 mark)

CE00_01

Six compounds are classified into two groups as shown in the table below:

Gas	Solid
Ammonia	Iron(III) oxide
Carbon dioxide	Magnesium oxide
Nitrogen dioxide	Potassium oxide

Reclassify these compounds into two groups according to

(a) one of their physical properties, and

(2 marks)

(b) one of their chemical properties.

(2 marks)

CE00_02

The table below lists some information about four elements, W, X, Y and Z:

Element	Atomic number	Relative atomic mass
W	16	32.1
X	18	39.9
Y	19	39.1
Z	20	40.1

(a) What is the meaning of the term 'relative atomic mass'?

(b) State, with explanation, which of the above elements

(i) should be stored under paraffin oil.

(ii) is used to fill a light bulb.

(6 marks)

CE00_08c

State whether each of the following statements is true or false. Explain your answer in each case.

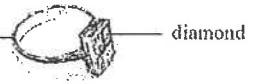
(i) The melting point of sodium chloride is much higher than that of methane because the ionic bonding in sodium chloride is much stronger than the covalent bonding in methane.

Note: methane is a simple molecule.

(2 marks)

CE01_07

(c) The photograph below shows a diamond ring:



(i) Explain why gold and diamond each has a high melting point.

(2 marks)

CE01_08a

A part of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	0
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	Kr
	5								Xe

(i) Across a period, the elements demonstrate a gradual change in some of their physical properties. State ONE such property.

(iv) Xenon (Xe) is a Group 0 element. State, with explanation, what will happen if a balloon filled with xenon is released from the top of a tower.

(2 marks)

CE02_06a

(iii) Explain why molten magnesium chloride can conduct electricity.

(1 mark)

CE02_06b

Magnesium occurs naturally in three isotopic forms. The relative abundance of each isotope is shown in the table below:

Isotope	^{24}Mg	^{25}Mg	^{26}Mg
Relative abundance(%)	78.6	10.1	11.3

(i) State the meaning of the term 'isotopes of an element'.

(ii) Calculate the relative atomic mass of magnesium.

(iii) Is it possible to separate the isotopes of magnesium by chemical means? Explain your answer.

(4 marks)

CE02_08b

Both carbon and silicon are Group IV elements in the Periodic Table.

(i) Draw the electronic diagram of a carbon dioxide molecule, showing electrons in the outermost shells only.

(ii) Explain why carbon dioxide can be used in fire fighting.

(iii) Explain why carbon dioxide is a gas, whereas silicon dioxide is a solid at room temperature and pressure.

(iv) (2) Suggest ONE use of silicon.

(8 marks)

CE03_03

(a) The atomic numbers of sulphur and chlorine are 16 and 17 respectively.
Draw the electronic diagrams of the following atoms:
(i) sulphur atom
(ii) chlorine atom

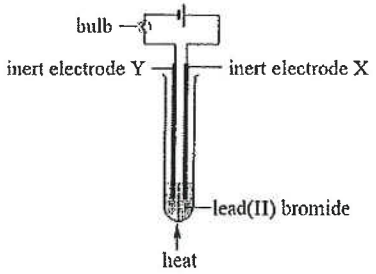
(2 marks)

(b) Chlorine reacts with sulphur to form a compound with relative molecular mass of 135.2. The compound contains 52.5% of chlorine by mass.
(i) Deduce the molecular formula of the compound.
(ii) Draw the electronic diagram of the compound, showing electrons in the outermost shells only.
(Relative atomic masses: S=32.1, Cl=35.5)

(5 marks)

CE03_07a

The set-up shown below is used to investigate the electrical conductivity of lead (II) bromide.



When the lead(II) bromide becomes molten, the bulb lights up.

(iii) State what will happen to the bulb when heating is stopped and the molten lead(II) bromide is allowed to cool down gradually to room temperature.
Explain your answer.

(3 marks)

CE04_05

Na_2O, MgO, SiO_2 and SO_2 are oxides of Period 3 elements in the Periodic Table. Discuss how the melting points of these oxides are related to the bonding and structure.

(9 marks)

CE04_09a

A portion of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	0
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	

(i) Identify ONE semi-metal in the above table.

(ii) Suggest why Group 0 elements seldom form compounds.

(iii) Using aluminium as an example, describe the bonding in metals. Hence, explain why metals are ductile.

(iv) Which metal and non-metal in the above table would react most vigorously with each other?

(v) (1) The atomic number of bromine is 35. The electronic arrangement of a bromine atom can be represented as 2, 8, x, y. What are the values of x and y?

(2) At 5°C, the reaction of bromine with sodium hydroxide solution is similar to that of chlorine with sodium hydroxide solution.
Write a chemical equation for the reaction of bromine with sodium hydroxide solution at this temperature.

(8 marks)

CE05_01

(a) Calcium is an element in Group II of the Periodic Table.

(i) Calcium reacts with nitrogen to form calcium nitride, which is an ionic compound. Draw the electronic diagram of calcium nitride, showing electrons in the *outermost shells* only.

(ii) Suggest a test to show that marble is a calcium-containing substance.

(3 marks)

(b) Strontium (Sr) is another Group II element. It exists in several isotopic forms.

(i) What is the meaning of the term 'isotope'?

(ii) Strontium-90 (^{90}Sr) is a radioactive isotope of strontium, and is one of the dangerous by-products of nuclear fission.
Complete the table below by providing **the relevant information for a ^{90}Sr atom.**

	Number of protons	Number of neutrons
^{90}Sr		

(2 marks)

(c) (i) State the similarity between a calcium atom and a strontium atom in terms of electronic arrangement.

(ii) Children's teeth require a large amount of calcium to grow. Scientists found that in areas where nuclear weapon tests were conducted above the ground, children's teeth contained a higher level of ^{90}Sr.
Suggest a reason for the findings of the scientists.

(2 marks)

CE07_01

A is a compound formed from oxygen and magnesium, while *B* is a compound formed from oxygen and fluorine.

(a) Draw the electronic diagram of *A*, showing electrons in the *outermost shells* only.

(1 mark)

(b) Draw the electronic diagram of *B*, showing electrons in the *outermost shells* only.

(1 mark)

(c) Compare the melting points of *A* and *B*. Explain your answer.

(2 marks)

CE08_01

T, X and Z are three elements in the Periodic Table, with the sum of their atomic numbers equals to 38. Moreover, both T and X are Group VII elements, while the atomic number of T is smaller than that of X.

(a) What are elements T, X and Z?

(1 mark)

(b) Draw the electronic diagram of the compound formed from T and X, showing electrons in the outermost shells only.

(1 mark)

(c) Discuss, with explanation, the electrical conductivity of the compound formed from X and Z with reference to the type and property of the particles in it.

(2 marks)

CE08_02

Boron occurs naturally in two isotopes, ^{10}B and ^{11}B.

(a) What is meant by the term 'isotopes'?

(1 mark)

(b) With reference to the Periodic Table, calculate the percentage abundance of ^{11}B in nature.

(2 marks)

(c) $^{10}BCl_3$ and $^{11}BCl_3$ are compounds formed respectively from the two isotopes of boron with chlorine. $^{10}BCl_3$ reacts with water to give white fumes. State, with explanation, the expected observation when $^{11}BCl_3$ is added to water.

(1 mark)

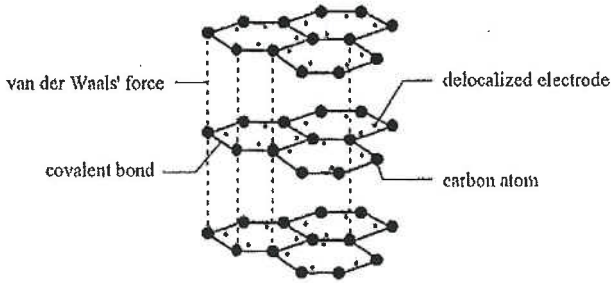
CE09_09

Discuss respectively why electrical conductivity and melting point differ among sodium chloride (NaCl), sodium (Na) and chlorine (Cl_2).

(9 marks)

CE11_03

Graphite is a form of carbon and can be used to make pencil cores and electrodes. There are layers of carbon atoms in the structure of graphite. In each layer, each carbon atom is linked to other carbon atoms by covalent bonds. Moreover, delocalized electrons exist in the layers, while van der Waals' forces exist between the layers as shown in the diagram below:



(a) Answer the following questions according to the information given above.

(i) Explain why the graphite used to make pencil cores can be easily detached to form markings on paper.

(ii) Explain why graphite can be used to make electrodes.

(2 marks)

(b) Lead metal can also be used to draw markings. With reference to the bonding of lead, explain why using lead to make pencil cores is not as good as using graphite.

(2 marks)

(c) Diamond is another form of carbon. With reference to the bonding and structure of diamond, explain why diamond is so hard.

(2 marks)

CE11_08

Write an essay on how the position of an element in the Periodic Table is determined by the electronic arrangement of its atom, and how this position determines the types of chemical bondings the atom might form.

(9 marks)

AL96(I)_01a

(i) Write down the number of neutrons, protons and electrons in one atom of carbon-12, ^{12}C, and ine one atom of carbon-13, ^{13}C.

(1 mark)

(ii) The isotopic mass of ^{12}C is 12.000 atomic mass (a.m.u.). Calculate the mass, in kg, of 1 mol of ^{12}C atoms.

(1 a.m.u. = 1.6605×10^{-27} kg; Avogadro constant, L = 6.0221×10^{23} mol^{-1})

(2 marks)

(iii) The following data were obtained from the mass spectrum of a carbon-containing compound:

Ion	Mass / a.m.u.	Relative intensity
$^{12}C^+$	12.000	100.00
$^{13}C^+$	13.003	1.12

Using the above data, calculate the relative atomic mass of carbon.

(2 marks)

AL98(II)_01 (modified)

(a) Draw the electronic diagram of BF_3.

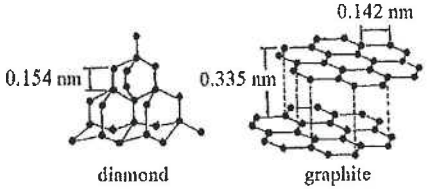
(1 mark)

(b) BF_3 reacts with NH_3 to form an adduct, $BF_3 \cdot NH_3$. Account for the formation of the adduct and draw its electronic diagram.

(3 marks)

AL98(II)_02 (modified)

The structures of two allotropes of carbon, diamond and graphite, are shown below.



(a) Comment on the three different carbon-carbon distances as indicated in the above structure.

(3 marks)

(b) With reference to the above structures, explain why diamond is hard whereas graphite is soft enough to be used as lubricant.

(3 marks)

AL99(I)_01

Account for the statement that "At 298 K and 1 atm pressure, carbon dioxide is a gas whereas silicon dioxide is a solid".

(1.5 marks)

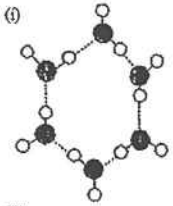
AL00(I)_01

The diagrams below show the arrangement of atoms, ions or molecules in four crystalline substances: graphite, ice, iodine and sodium chloride.

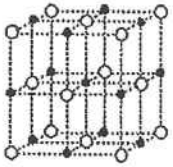
(a) Write the name of the substance of each structure in the space provided.

(b) Label, on the diagrams, the types of interactions that are present in these substances.

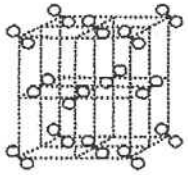
(i)



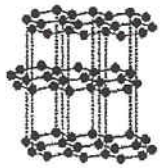
(ii)



(iii)



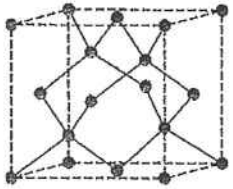
(iv)



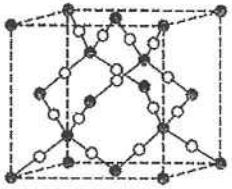
(6 marks)

ASL01(I)_05 (modified)

X is an element in Period 3 of the Periodic Table. The structures of X and one of its oxides are shown below.



● = X



O = oxygen

(a) Suggest, with explanation, what element X is.

(2 marks)

(b) Give one use of X and one use of its oxide.

(2 marks)

(c) (i) Draw the three-dimensional structure of the chloride of X.

(1 mark)

(ii) When the chloride of X is added to water, a white. State the expected observation and write the chemical equation for the reaction involved.

(2 marks)

AL02(I)_03

CO_2 and SiO_2 are oxides of Group IV elements. Account for the fact that CO_2 is a gas while SiO_2 is a high melting solid under room temperature and atmospheric pressure.

(2 marks)

ASL03(I)_07

Carbon, germanium and lead are elements in Group IV of the Periodic Table.

(a) Diamond and graphite are allotropes of carbon.

(i) Draw their three-dimensional structures.

(2 marks)

(ii) With reference to their structure, compare the hardness of diamond and graphite.

(3 marks)

(b) Germanium has the same structure as diamond. Which of these substances has a higher melting point? Explain.

(1 mark)

(c) Suggest why the density of lead (11.3 g cm^{-3}) is much higher than that of germanium (5.3 g cm^{-3})

(2 marks)

ASL04(I)_01 (modified)

(a) Write the electronic arrangement of a copper atom.

(1 mark)

(b) Copper occurs naturally in two isotopic forms, ^{63}Cu and ^{65}Cu. Estimate the relative abundance of each isotope, and show how the answer is obtained.

(2 marks)

(c) Describe the bonding in copper. Hence, explain why copper is an electrical conductor.

(3 marks)

AL04(I)_02

Consider the noble gases, He, Ne, Ar Kr and Xe. Sketch a graph to show the variation of boiling point of these noble gases and account for the variation.

(2 marks)

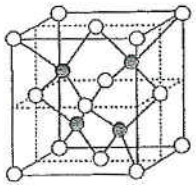
ASL04(I)_06

(a) Explain the following observation:

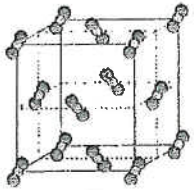
'At 298 K and 1 atm pressure, carbon dioxide is a gas whereas silicon dioxide is a solid.'

(2 marks)

(b) Which of the following diagrams, *X* or *Y*, represents the structure of silicon dioxide in solid state?



X



Y

(1 mark)

(c) With reference to its structure, explain why silicon dioxide can be used as abrasive.

(1 mark)

(d) Dry ice can be used in packaging ice-cream. Suggest TWO advantage of using ice over using ice in packaing ice-cream.

(2 marks)

AL05(I)_01 (modified)

Describe the interaction among the entities in each of the following species:

(a) Argon gas (b) Zinc metal (c) CaF_2 crystal

(4.5 marks)

AL06(I)_01 (modified)

The table below lists the melting points of three oxides of the Period 3 elements:

Oxide	Na_2O	Al_2O_3	SO_2
Melting point / °C	920	2040	−75

Account for the large difference in the melting points of the three oxides

(3 marks)

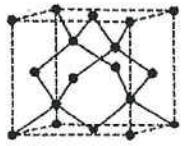
AL06(I)_02 (modified)

Draw a diagram to show the three-dimensional arrangement of carbon atoms in graphite, and indicate the interactions between the carbon atoms.

(2 marks)

ASL06(I)_05

Silicon (Si) and germanium (Ge) normally have the same crystal structure, as shown below:



(a) Identify the type of crystal structure of silicon and germanium.

(1 mark)

(b) Explain which of these two elements has a higher melting point.

(2 marks)

(c) Explain why silicon(IV) oxide has a higher melting point than silicon(IV) chloride in terms of their structures.

(3 marks)

AL08(II)_01

Both sodium and chlorine are elements in Period 3 of the Periodic Table. At room temperature and atmospheric pressure, Na_2O is a solid with a very high melting point whereas Cl_2O is a gas. Account for this difference in property between Na_2O and Cl_2O.

(2 marks)

AL08(II)_04 (modified)

Diamond and graphite show a marked difference in electrical conductivity. Account for their difference in electrical conductivity in terms of bonding and structure.

(3 marks)

ASL08(II)_04 (modified)

Account for the following observations:

The melting point of potassium bromide is lower than that of sodium bromide.

(2 marks)

AL09(I)_03

Selenium (Se) is an element in Group VI of the Periodic Table.

(a) Selenium occurs in nature in six isotopes with the percentage abundance of each isotope given on the right. Calculate the relative atomic mass of selenium.

(2 marks)

Mass number	% abundance
74	0.9
76	9.0
77	7.6
78	23.5
80	49.8
82	9.2

(b) Selenium dioxide, SeO_2, has a melting point of 315 °C. It does not conduct electricity in both solid and molten state. Deduce the type of bonding and structure of SeO_2.

(2 marks)

AL09(II)_03

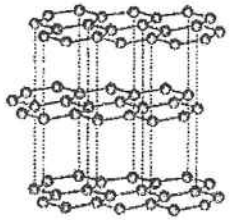
Account for the following:

"Under stress, metals deform but their ionic salts fracture."

(2 marks)

AL12(II)_08

(a) The structure of graphite is shown below:



Describe the bonding and structure of graphite. Hence, explain why graphite is considered a soft material.

(4 marks)

(b) Graphene is a flat monolayer of carbon atom tightly packed into a two-dimensional honeycomb lattice. It is the building block for graphite. Graphene can be isolated from graphite by using adhesive tape.

(i) Suggest why graphene is considered a very strong material.

(1 mark)

(ii) Scientist anticipate that graphene, after appropriate fabrication, can replace steel in making cars. Apart from strength consideration, suggest ONE reason why graphene can be a better material than steel in making cars.

(1 mark)

AL13(II)_05

Calcium and radium are elements in Group II of the Periodic Table.

(a) Would the melting point of radium be higher or lower than that of calcium? Explain.

(2 marks)

(b) Account for the difference in reactivity of Ca(s) and Ra(s) with water.

(2 marks)

(c) Predict, with explanation, the reaction of $RaCl_2(aq)$ with $H_2SO_4(aq)$.

(2 marks)

AL13(II)_08

Both arsenic and bromine are elements in Period 4 of the Periodic Table. They form fluorides with chemical formulae AsF_5 and BrF_5 respectively.

(b) Given: BrF_5 and AsF_5 react according to the following equation:

$$BrF_5 + AsF_5 \rightleftharpoons BrF_4^+ + AsF_6^-$$

Comment on the electrical conductivity of liquid BrF_5 and that of a mixture of BrF_5 and AsF_5. Explain your answer.

(2 marks)

DSE11SP_01

State whether each of the following statements is true or false. Explain your answer in each case.

(a) The melting point of sodium chloride is much higher than that of methane because the ionic bonding in sodium chloride is much stronger than the covalent bonding in methane.

(2 marks)

DSE11SP_07

Complete the table below by

(a) drawing a three-dimensional diagram for the structure of each solid substance, and

(3 marks)

(b) giving an explanation of whether the solid substance is an electrical conductor.

(3 marks)

Solid substance	Three-dimensional diagram for the structure of the solid substance	Explanation of whether the solid substance is an electrical conductor
Diamond		
Graphite		
Caesium chloride		

DSE12PP_03

(a) Nitrogen reacts with magnesium to give magnesium nitride (Mg_3N_2).

(i) Draw the electron diagram of magnesium nitride, showing electrons in the outermost shells only.

(1 mark)

(b) Consider the nitrogen compound NCl_3 .

(i) Draw the electron diagram of NCl_3, showing electrons in the outermost shells only.

(1 mark)

DSE12_01

Neon occurs naturally in three isotopes with the abundance of each isotope shown in the table below:

Isotope	Abundance / %
^{20}Ne	90.48
^{21}Ne	0.27
^{22}Ne	9.25

(a) What is meant by the term 'isotope'?

(1 mark)

(b) Calculate the relative atomic mass of neon.

(2 marks)

(c) Give one daily application of neon.

(1 mark)

(d) Explain why the boiling point of neon is lower than that of oxygen.

(2 marks)

DSE13_01

Water is the most abundant compound on the Earth's surface. It is very important to life on Earth.

(a) Draw the electron diagram for a water molecule, showing *electrons in the outermost shells* only.

(1 mark)

DSE13_02

Both BF_3 and NH_3 exist as simple molecules.

(c) BF_3 reacts with NH_3 to give F_3BNH_3. Describe the bond formation between BF_3 and NH_3.

(2 marks)

DSE13_08

Both caesium (Cs) and sodium (Na) are elements in Group I of the Periodic Table. Caesium reacts with chlorine to form caesium chloride.

(a) Write the chemical equation for the reaction caesium with chlorine.

(1 mark)

(b) Solid caesium chloride has a giant ionic structure.

(i) Draw a diagram to show the structure of caesium chloride.

(1 mark)

(ii) Explain why solid caesium chloride is brittle.

(2 marks)

(c) Predict, with ONE reason, whether sodium or caesium is more reactive towards chloride.

(1 mark)

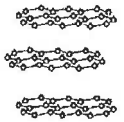
DSE13_13

Lithium, beryllium, carbon (graphite) and nitrogen are elements of the second period of the Periodic Table. Arrange them in increasing order of melting point, and explain the order in terms of structure and bonding.

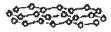
(4 marks + 1 mark)

DSE14_01

Graphite is a form of carbon and has a layer structure. Graphene is an individual single layer of graphite. Their structures are shown below:



graphite



graphene

(a) Thin sheets of graphene can be easily peeled off from graphite using adhesive tape.

(i) Explain why graphene can be easily peeled off.

(1 mark)

(ii) Explain whether graphene can conduct electricity.

(1 mark)

(iii) Draw the electron diagram for a molecule of the compound formed by complete combustion of graphene, showing *electrons in the outermost shells* only.

(1 mark)

(b) Based on the fact that graphene can be easily peeled off from graphite, a student concluded that graphite should have a low melting point due to its layer structure. Explain whether you agree with this conclusion.

(2 marks)

DSE15_01

Argon and chlorine are elements in the same period of the Periodic Table.

(a) Draw the electron diagram for a molecule of argon, showing electrons in *all shells*.

(1 mark)

(b) What is the type of intermolecular force in chlorine gas?

(1 mark)

(c) Complete the table below by stating the natural source and the method of extraction from the source for each element.

Element	Natural source	Method of extraction
Argon		
Chlorine		

(4 marks)

DSE15_10

(a) For each of the oxides below, draw its electron diagram (showing electrons in the outermost shells only), and stat its behavior in water.

(i) Na_2O

(2 marks)

(ii) Cl_2O

(2 marks)

DSE16_01

Refer to the following information of phosphorus (P) and chlorine (Cl).

	P	Cl
Atomic number	15	17
Relative atomic mass	31.0	35.5

(a) State the electronic arrangement of a phosphorus atom.

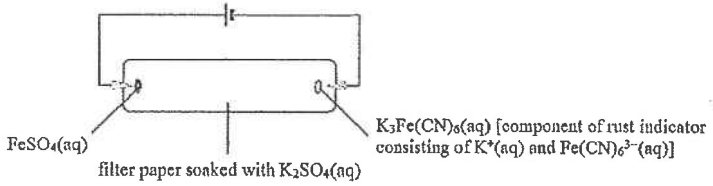
(1 mark)

(b) All chlorine atoms have the same atomic number. Explain why some chlorine atoms have different mass numbers.

(1 mark)

DSE16_02

The set-up of an experiment for studying the movement of ions is shown below.



(a) Explain why the filter paper is soaked with $K_2SO_4(aq)$ instead of water.

(1 mark)

(b) State the color of $FeSO_4(aq)$.

(1 mark)

(c) Explain what would be observed around the middle of the filter paper when the circuit is closed for a period of time.

(2 marks)

(d) The experiment is repeated, but the two poles of the cells have been reversed at the very beginning. Explain what would be observed around the middle of the filter paper when the circuit is closed for a period of time.

(2 marks)

DSE16_04

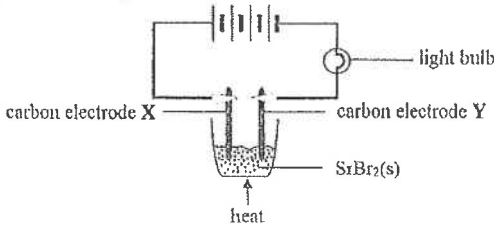
Consider the molecules CO_2, CS_2 and CH_2Br_2.

(c) Suggest why, under room temperature and pressure, CO_2 is a gas but CS_2 is a liquid.

(2 marks)

DSE16_08

Consider the experimental set-up shown below:



(a) In the above experiment, the bulb lights up when the $SrBr_2(s)$ becomes molten.
(Atomic number of Sr = 38)

(i) State the observation at carbon electrode X.

(1 mark)

(ii) Write a half equation for the change that occurs at carbon electrode Y.

(1 mark)

(b) Explain why the experiment should be performed in a fume cupboard.

(1 mark)

DSE17_01

Barium (Ba) is an element in Group II of the Periodic Table. Its chemical properties are similar to those of calcium.

(a) Describe the bonding in barium.

(2 marks)

DSE17_03

Answer the following questions.

(c) Describe the formation of dative covalent bond using H_3O^+ as example.

(3 marks)

DSE17_08

Combustion of petrol increases the concentration of carbon dioxide in the atmosphere, and may contribute to global warming. Combustion of petrol also emits poisonous air pollutants.

(b) Draw the electron diagram for a molecule of carbon dioxide, showing *electrons in the outermost shell* only.

(1 mark)

DSE18_01

Lithium occurs naturally in two isotopes, ^6Li and ^7Li. It can form lithium nitride (Li_3N) when burnt in air.

(a) (i) Calculate the percentage abundance of ^6Li in nature.
(Relative atomic mass: Li = 6.9)

(2 marks)

(ii) Draw the electron diagram for lithium nitride, *showing electrons in the outermost shells only.*

(1 mark)

DSE19_01

The table below shows some information of three atoms:

	Number of protons	Number of electrons	Number of neutrons
Protium	1	1	0
Deuterium	1	1	1
Oxygen	8	8	8

(a) Explain why protium and deuterium are isotopes.

(1 mark)

(b) Deuterium can be represented by D. It reacts with oxygen as shown in the equation below :

$$2D_2 + O_2 \longrightarrow 2D_2O$$

Draw the electron diagram for a D_2O molecule, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

(c) A small piece of sodium metal is placed into liquid D_2O at room conditions.

(i) State TWO expected observations.

(2 marks)

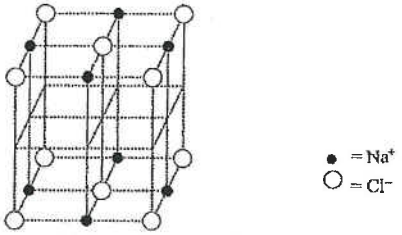
(ii) Write the chemical equation for the reaction involved.

(1 mark)

DSE19_02

Sodium chloride crystal has a giant ionic structure.

(a) The diagram below shows a part of the structure of sodium chloride crystal with some ions missing.



Complete the diagram by using ● as Na^+ ion and ○ as Cl^- ion.

DSE20_01abciii

1. The table below shows some information of elements Y and Z.

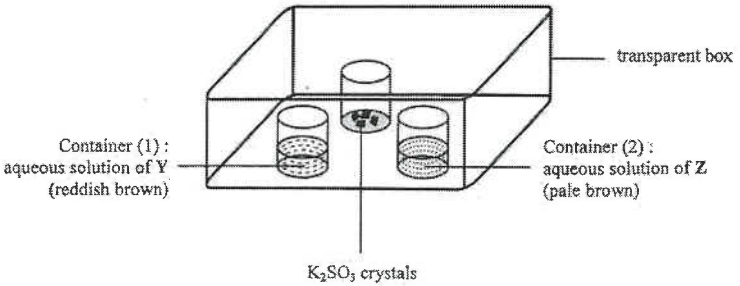
	Y	Z
Atomic number	35	53
Number of occupied electron shells in the atoms	4	5
Number of electrons in the outermost shell in the atoms	7	7

(a) State the electronic arrangement of an atom of Y.

(1 mark)

(b) Draw the electron diagram for a molecule of Z, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(c) An experiment for Y and Z is performed as shown in the set-up below. Dilute hydrochloric acid is added to the K_2SO_3 crystals, then the whole set-up is covered with a lid.



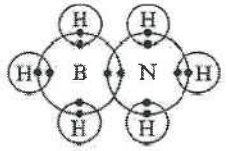
1. (c) (i) K_2SO_3 crystals react with dilute hydrochloric acid to give sulphur dioxide gas. Write a chemical equation for the reaction, showing all state symbols.

(ii) State the expected observation in Container (1) and write an ionic equation for the reaction involved.

(iii) It is expected that the observation in Container (2) is similar to that in Container (1). Suggest a reason for this expectation based on electronic arrangement.

DSE20_03bi,iii

(b) H_3NBH_3 has a structure similar to that of ethane. Its electron diagram is shown below (showing electrons in the outermost shells only).



(i) Which of the H–B, B–N and N–H bonds would be dative covalent bond(s) ? Explain your answer.

(iii) Under suitable conditions, H_3NBH_3 can decompose into boron nitride and hydrogen. The structure of solid boron nitride is similar to that of graphite. Draw the structure of ONE LAYER of solid boron nitride (Note : B and N are in alternate positions).

2022

DSE21_01(a)

(a) Draw the electron diagram for a C_2H_2 molecule, showing ELECTRONS IN THE OUTERMOST SHELLS only.

DSE21_03(a),(b),(c)(i)

3. Silicon occurs naturally in three isotopes with the abundance of each isotope shown in the table below:

Isotope	Abundance / %
^{28}Si	92.20
^{29}Si	x
^{30}Si	y

(a) What is meant by the term 'isotope' ?

(b) Calculate x.
(Relative atomic mass : Si = 28.1)

(c) Silicon dioxide is an oxide of silicon.

(i) Explain why silicon dioxide has a high melting point.

6. Copper(II) phosphate is insoluble in water. What is the number of moles of $Cu^{2+}(aq)$ ions remaining in the solution of the resulting mixture when 0.04 mol of $CuCl_2(aq)$ is mixed with 0.02 mol of $Na_3PO_4(aq)$?

A. 0.00
B. 0.01
C. 0.02
D. 0.03

7. A white solid does NOT dissolve in both water and excess aqueous ammonia. Which of the following m this solid be ?

A. $Pb(NO_3)_2$
B. $Zn(OH)_2$
C. $MgSO_4$
D. $CaCO_3$

10. 6.54 g of zinc granules are added to 100.0 cm^3 of 1.0 M $AgNO_3(aq)$. After the reaction has completed, which of the following statements is correct ?

(Relative atomic masses : Zn = 65.4, Ag = 107.9)

A. Some zinc granules have reacted and no silver ions remain in the solution.
B. All the zinc granules have reacted and no silver ions remain in the solution.
C. All the zinc granules have reacted and some silver ions remain in the solution.
D. The mass of the zinc granules reacted is equal to the mass of the solid product formed.

18. Which of the following pairs of substances, when mixed, would release hydrogen gas ?

(1) copper and concentrated HCl(aq)
(2) iron and $H_2SO_4(aq)$
(3) calcium and NaOH(aq)

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

2022

1. Iodine is a halogen. It can form potassium iodide and hydrogen iodide.

(a) Name the relationship between $^{127}_{53}I$ and $^{129}_{53}I$.

(1 mark)

(b) The electronic arrangement of an iodine atom is 2, 8, x, 18, y. What is x ?

(1 mark)

(c) Draw the electron diagram for potassium iodide, showing ELECTRONS IN THE OUTERMOST SHELLS only.

(1 mark)

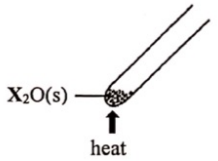
(d) Suggest why an aqueous solution of hydrogen iodide can conduct electricity.

(1 mark)

(e) In terms of bonding and structure, explain whether potassium iodide or hydrogen iodide would have a higher melting point.

(2 marks)

2. The diagram below shows an experimental set-up in which a metal oxide $X_2O(s)$ is decomposed upon strong heating. A silvery metal **X** and a colourless gas **Z** are formed.



(a) State what **Z** is and suggest a test for it.

(2 marks)

(b) When 3.028 g of $X_2O(s)$ is completely decomposed, 2.819 g of metal **X** can be obtained.

(i) Calculate the relative atomic mass of **X**.
(Relative atomic mass : O = 16.0)

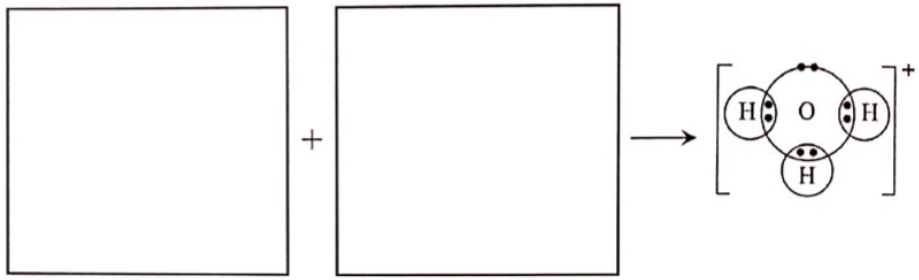
(ii) Suggest what **X** is.

(3 marks)

4. Consider the molecules H_2O, BF_3 and SF_6.

(a) H_2O molecules can form H_3O^+ ions.

(i) In each of the following boxes, draw the electron diagram (showing ELECTRONS IN THE OUTERMOST SHELLS only) for a suitable chemical species to show the formation of a H_3O^+ ion.



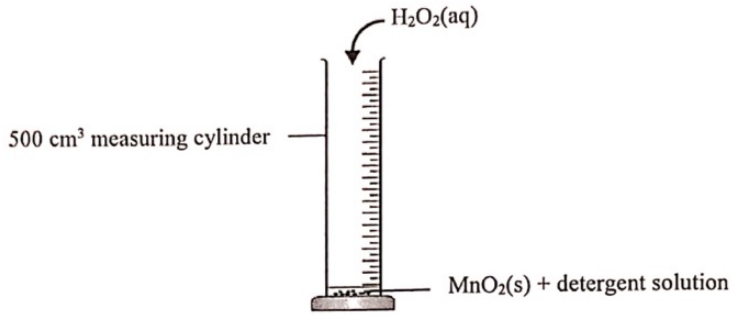
(ii) Describe the formation of dative covalent bond using H_3O^+ as an example.

(3 marks)

(b) Explain whether the boron atom in a BF_3 molecule has an octet structure.

(1 mark)

10. At room conditions, $H_2O_2(aq)$ would decompose into $O_2(g)$ and $H_2O(l)$ very slowly in the absence of $MnO_2(s)$. An experiment was performed as shown in the set-up below :



When 10.0 cm^3 of 3.00 M $H_2O_2(aq)$ was mixed with a small amount of $MnO_2(s)$ and detergent solution at room conditions, $O_2(g)$ started to be released rapidly and foam was produced. The $MnO_2(s)$ remained chemically unchanged at the end of the reaction.

(a) Write a chemical equation for the decomposition of $H_2O_2(aq)$.

(1 mark)

(b) Explain how manganese illustrates a characteristic of transition metals according to the results of this experiment.

(1 mark)

Marking Scheme

MCQ

CE90_02	D	CE90_03	C	_04	A	_25	D
CE90_26	C	CE91_01	B	CE91_02	A	CE92_02	D
CE92_03	C	CE92_04	A	CE92_30	A	CE92_45	C
CE93_01	D	CE93_02	B	CE93_23	D	CE94_01	C
CE94_02	B	CE94_03	A	CE94_36	A	CE94_46	B
CE95_01	A	CE95_02	D	CE95_03	A	CE95_04	C
CE95_06	A	CE95_26	B	CE95_34	A	CE95_39	A
CE96_01	C	CE96_02	B	CE96_03	A	CE96_39	A
CE96_44	C	CE96_45	B	CE96_50	C	CE97_01	D
CE97_02	B	CE97_03	D	CE97_05	B	CE97_30	C
CE98_01	D	CE98_18	B	CE98_33	B	CE98_45	A
CE99_05	D	CE99_01	B	CE99_11	A	CE99_19	B
CE99_34	D	CE99_39	C	CE99_46	A	CE00_01	B
CE00_07	C	CE00_09	D	CE00_17	B	CE00_34	D
CE00_39	D	CE00_42	D	CE00_46	C	CE01_01	D
CE01_07	A	CE01_18	B	CE01_20	B	CE01_37	D
CE01_42	A	CE01_49	D	CE02_01	C	CE02_28	A
CE02_36	D	CE02_46	A	CE02_49	A	CE03_01	C (64%)
CE03_12	B (88%)	CE03_25	D (57%)	CE03_46	B (59%)	CE05SP_03	B (67%)
CE05SP_16	D	CE05SP_31	A (60%)	CE04_01	C (67%)	CE04_02	D (54%)
CE04_10	B (47%)	CE04_23	C (84%)	CE04_30	A (45%)	CE04_31	B (64%)
CE05_03	B (67%)	CE05_06	D (76%)	CE05_07	C (67%)	CE05_09	B (53%)
CE05_13	D (70%)	CE05_27	B (66%)	CE06_01	D (68%)	CE06_02	D (53%)
CE06_04	B (72%)	CE06_05	B (59%)	CE06_06	C (79%)	CE06_14	B (87%)
CE06_24	D (54%)	CE07_03	D (52%)	CE07_12	D (80%)	CE07_13	A (66%)
CE07_18	B (64%)	CE07_28	C (31%)	CE07_29	C (82%)	CE07_43	A (24%)
CE08_02	D (76%)	CE08_18	D (49%)	CE08_19	B (43%)	CE08_46	B (63%)
CE09_01	C (71%)	CE09_07	D (63%)	CE09_18	A (79%)	CE09_19	C (72%)
CE09_22	D (17%)	CE09_28	B (48%)	CE10_01	A (53%)	CE10_13	D (53%)
CE10_17	B (83%)	CE11_01	D (92%)	CE11_02	B (85%)	CE11_03	C (16%)
CE11_31	D (58%)	AL10(I)_03	D	DSE11SP_07	A	DSE11SP_11	C
DSE11SP_22	D	DSE11SP_24	C	DSE11SP_36	C	DSE12PP_01	B
DSE12PP_03	A	DSE12PP_04	D	DSE12PP_15	D	DSE12PP_18	A
DSE12_01	D (71%)	DSE12_08	C (94%)	DSE12_15	D (63%)	DSE13_01	C (70%)
DSE13_02	C (92%)	DSE13_04	B (62%)	DSE13_12	D (80%)	DSE14_01	C (74%)
DSE14_02	D (75%)	DSE15_03	B (73%)	DSE15_15	A (60%)	DSE15_35	B (69%)
DSE16_02	C (88%)	DSE17_01	C (58%)	DSE17_16	A (66%)	DSE18_02	C (70%)
DSE18_05	C (80%)	DSE19_01	C	DSE19_02	A	DSE19_24	A

DSE2020: 2_D, 3_C, 5_B, 14_C

Structural Questions

CE90_01b

(i) carbon: covalent bond/ weak van der Waals' force [½]
sodium chloride: ionic bond [½]

(ii) carbon (graphite): can conduct electricity in solid state. [1]
[Do NOT accept: powder state, molten state and at high temperature]
because of the presence of mobile (delocalized) electrons between the carbon layers. [1]

sodium chloride: can conduct electricity in molten/ liquid state/ in aqueous solution [1]
because the ions become mobile in liquid state [1]

(iii) diamond [1]

(iv) (1) graphite (diagram I) [1]
because the layers of carbon atoms can slide easily [1]
(2) diamond [1]
because the carbon atoms are strongly bonded to form a giant structure [1]

(v) Agree, because it requires a lot of energy to melt NaCl in the laboratory. [1+1]
OR, Disagree, because melting NaCl is easy in industry, followed by electrolysis of molten NaCl to form the elements.
OR, Disagree, because the electrolysis of brine (conc. NaCl) solution using mercury cathode and graphite anode can be carried out.

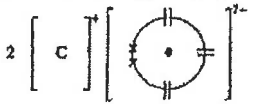
CE91_01a

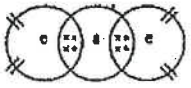
(i) (1) halogen [1]
(2) (I) each has 7 electrons in its outermost shell (or they **have the same number of electrons** in their outermost shells). [1]
(II) *f* and *b* have different numbers of electron shells / *b* occupied 2 electron shells whereas *f* occupied 3 electron shells. [1]

(ii) **because** the metallic bond in element *d* is stronger. [1]

(iv) **(1)** An allotrope is the same element with different structure. [1]
(2) *a* and *e* / carbon and phosphorous. [1]
[Note: allotrope of carbon (diamond and graphite), phosphorous (red phosphorous and yellow phosphorous)]

(v) (1) [1+1]





(2) c_2e has higher melting point because [1]
c_2e has strong ionic bond between ions but ae_2 has weak van der Waals' force between molecules. [1]

CE92_01b

(iii) Metals have delocalized (mobile) electrons for conducting electricity. [1]
[Note: Do not accept free electrons]

CE92_03b

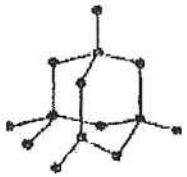
(i) 8 electrons [1]
(ii) Neon has a stable octet structure with 8 outermost shell electrons. [1]
(iii) Isotopes are atoms with same number of protons but different number of neutrons. [1]
(iv) (1) Relative atomic mass of Ne

$$= \frac{20 \times 90.52 + 21 \times 0.31 + 22 \times 9.17}{100}$$ [1]

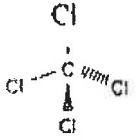
$= 20.19$ [1]

CE93_02b

(i) [1+1]



diamond



tetrachloromethane

Diamond has much higher melting point than CCl_4 because diamond has giant covalent structure with strong covalent bonds between C atoms but [1]
CCl_4 has simple molecular structure with weak van der Waals' force between molecules. [1]

(ii) In solid state, sodium has mobile (delocalized) electrons to conduct electricity but NaCl has ions that are not mobile. [1+1]

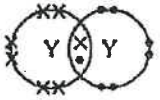
(iii) In liquid state, CCl_4 has no mobile ion or mobile electron. [1]

CE93_04a

(i) Group II [1]
because W has an electronic configuration of (2, 8, 2) that W has <u>two</u> outermost shell electrons. [1]

(ii) (1) X is the cation (or positive ion) of W. [1]
(2) W reacts with HCl(aq) to form chloride of X. [1]

(iii) (1) [1]



(2) Yes. Both Y and Z are isotopes. [1]
OR, Yes. Both Y and Z have the same electronic configuration.

(iv) Formula mass of $WZ_2 = 24 + 37 + 37 = 98$ [1]

CE94_01a

(a) Group II [1]

CE94_07b

(i) Br_2 has a much smaller melting point than $PbBr_2$ because Br_2 has only weak van [1]
der Waals' force between molecules but $PbBr_2$ has strong ionic bond between [1]
ions.

(ii) Lead has mobile electrons for conducting electricity. But solid $PbBr_2$ has ions that [1]
are not mobile. [1]

(iii) Yes, in liquid state, ions in $PbBr_2$ are mobile. [1]

CE95_02a

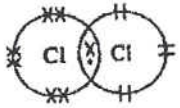
(a) fluorine [1]
fluorine is reactive/ yellow/ coloured gas [1]
OR, others are inert/ unreactive/ stable/ colourless (gases).

CE95_04

Chemical knowledge (5 marks)

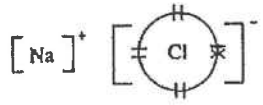
<u>Covalent bond</u>

When atoms of non-metals combine, they tend to share their (valence/ outermost) [1]
electrons to form molecules.
Electronic structure of a molecule, e.g. HCl / Cl_2 etc. [1]



<u>Ionic bond</u>

When metal and non-metal combine, atoms of the metal donate electrons to form [1+1]
positive ions while atoms of the non-metal accept electrons to form negative ions.
Electronic structure of an ionic compound e.g. NaCl etc. [1]



3 marks for presentation

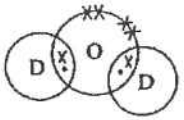
CE96_07a

(i) isotope [1]

(ii) One/ 1 [1]

(iii) (1) H and D have the same electronic structure (or electronic arrangement) [1]

(2) [1]



(3) The reaction is exothermic / gives out heat / release energy [1]

(4) Formula mass of $D_2O = 2 + 2 + 16 = 20$ [1]

CE98_01

(a) Atoms with same atomic number but different mass number. [1]
OR, atoms with the same number of protons but different number of neutrons.

(b) Relative atomic mass $= \frac{6 \times 0.074 + 7 \times 0.926}{100}$ [1]

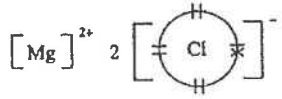
$= 6.93$ [1]

(Also accept 6.9 and 6.929)

CE99_04

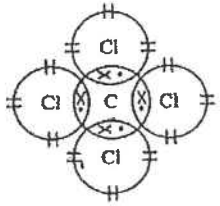
Chemical knowledge

For $MgCl_2$, each magnesium atom loses (two) electeons and each chloride atom accepts [1]
(one) electron to form an ionic compound.



[1]

In CCl_4, the carbon atom shares (a pair of) electrons with (each of the four) chloride [1]
atoms to form a covalent compound.

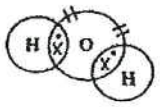


[1]

$MgCl_2$ has higher melting point than CCl_4 because the attraction, weak van der Waals' [1+1]
forces, between molecules of CCl_4 is weak and the attraction between ions, ionic bond,
in $MgCl_2$ is strong.

3 marks for presentation

CE99_06a

(i)  [1]

CE00_01

(a) **Any ONE of the** following:

Substance with colour	Substance without colour (white)
Nitrogen dioxide Iron(III) oxide	Ammonia Carbon dioxide Magnesium oxide Potassium oxide

[1+1]

OR,

Substances with an odour	Substances without an odour
Ammonia Nitrogen dioxide	Carbon dioxide Magnesium oxide Iron(III) oxide Potassium oxide

[1+1]

OR,

Water soluble substances	Water insoluble substances
Ammonia Carbon dioxide Nitrogen dioxide Potassium oxide	Iron(III) oxide Magnesium oxide

[1+1]

(b) Any ONE of the following:

Acidic substances	Basic substances
Carbon dioxide Nitrogen dioxide	Ammonia Iron(III) oxide Magnesium oxide Potassium oxide

[1+1]

OR,

Can be reduced by heating with charcoal	Cannot be reduced by heating with charcoal
Carbon dioxide Nitrogen dioxide Iron(III) oxide	Ammonia Magnesium oxide Potassium oxide

[1+1]

OR,

Can be decomposed by electrolysis	Cannot be decomposed by electrolysis
Magnesium oxide Iron(III) oxide Potassium oxide	Ammonia Carbon dioxide Nitrogen dioxide

[1+1]

OR,

Substances that react with water	Substances not react with water
Ammonia Nitrogen dioxide Carbon dioxide Potassium oxide	Iron(III) oxide Magnesium oxide

[1+1]

CE00_02

(a) Relative atomic mass is the average mass of all isotopes of the element on the $^{12}C(=12.000)$ scale. [1+1]

OR, relative atom mass $= \dfrac{\text{average mass of an atom of the element}}{\frac{1}{12} \times \text{mass of an atom of carbon} - 12}$

(b) (i) Y / potassium (K) [1]

Y is a reactive metal and reacts readily with oxygen / water in air. [1]

(ii) X / argon (Ar) [1]

X is chemically inert / is a noble gas / will not react with hot tungsten filament. [1]

CE00_08c

(i) False.

The high melting point of NaCl is due to the presence of strong ionic acid bond. [1]

The low melting point of CH_4 is not due to the existence of covalent bonding between C and H atoms but due to the weak van der Waals' forces between molecules. [1]

CE01_07c

(i) Gold has strong metallic bond between atoms. [1]

Diamond has a covalent network structure and strong covalent bonds exist between carbon atoms. [1]

CE01_08a

(i) Atomic size (atomic radius) / metallic character. [1]

(iv) The balloon falls to the ground because Xe is much denser than air. [1]

CE02_06a

(iii) Molten magnesium chloride contains mobile ions. [1]

CE02_06b

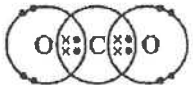
(i) Isotopes are atoms with the same atomic number but different mass number. [1]

OR, the same number of protons but different number of neutrons.

(ii) Relative atomic mass of Mg $= \dfrac{24 \times 78.6 + 25 \times 10.1 + 26 \times 11.3}{100} = 24.3$ [2]

(iii) No, because isotopes of an element have the same chemical properties. [1]
[Note: because isotopes have same electronic arrangement.]

CE02_08b

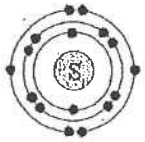
(i)  [1]

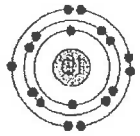
(ii) Carbon dioxide is denser than air. [1]
It can exclude air from the fuel / can blanket the fire from air. [1]

(iii) Silicon dioxide has a covalent network structure. [1]
Attraction between CO_2 molecules is weak van der Waals' forces. [1]

(iv) (1) $SiO_2 + C \longrightarrow Si + CO_2$ [1]
OR, $SiO_2 + 2C \longrightarrow Si + 2CO$
(2) Making computer chips / electronic parts / alloy / semi-conductors [1]

CE03_03

(a) (i)  [1]

(ii)  [1]

[From HKEAA:
The question asked for the electronic diagrams of a sulphur atom and a chlorine atom. Many candidates drew electronic diagrams which showed only electrons in the outermost shells. Such answers were considered as incomplete and were not accepted.]

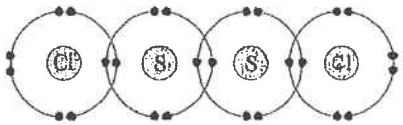
CE03_03

(b) (i)

	S	Cl
Mass / g	$135.2 - 70.98 = 64.22$	$135.2 \times 0.525 = 70.98$
Number of mole	$\frac{64.22}{32.1} = 2$	$\frac{70.98}{35.5} = 2$
Mole ratio	2	2

[1+1]

Molecular formula: S_2Cl_2 [1]

(ii)  [1]

CE03_07a

(iii) The light bulb gradually goes out. [1]
At lower temperatures, movement of ions slows down. Therefore, a smaller current flows through the external circuit and the light became dimmer. [1]
When molten lead(II) bromide becomes solid, there is no translational motion of ions. Thus no current flows through the external circuit and the light went out. [1]
[From HKEAA:
Few candidates were able to describe the gradual dimming of the light bulb as an observation of the experiment. Some candidates failed to provide an explanation for the observation in terms of the slowing down in the motion of the ions.]

CE04_05

Chemical knowledge (6 marks)
Na_2O and MgO are ionic compounds. The cations and anions pack together to form a giant ionic structure/ lattice/ crystal. [1]
The atraction between cations and anions in Na_2O and MgO is strong ionic bond/ strong electrostatic attraction exists between cations and anions. [1]
$\therefore$ Na_2O and MgO have high melting points.
SiO_2 has a covalent network structure/ giant covalent structure. [1]
Melting of SiO_2 requires the breaking of strong covalent bonds between atoms. [1]
$\therefore$ SiO_2 has a high melting point,
SO_2 has a simple molecular structure. [1]
Intermolecular attraction is weak van der Waals' forces/ dipole-dipole attraction, [1]
$\therefore$ SO_2 has a low melting point / exists as a gas at room temperature and pressure.
Effective communication [3]

CE04_09a

(i) Boron (B) / Silicon (Si) [1]
(ii) Atoms of Group 0 elements have an octet (duplet) structure in the outermost shell/ have completely filled outermost shells. [1]
(accept equivalent answers.)
(iii) Metals can be considered as making up of positive ions and a 'sea' of delocalised electrons. The attraction between the positive ions/ metallic ions and the delocalised electrons holds the particles together (metallic bond). [1]
Metallic bond is non-directional. Layers of atoms can easily slide over each another.
$\therefore$ metals have high ductility. [1]
(iv) Potassium and fluorine / K and F [1]

(v) (1) $y = 7$ [1]

$x = 18$ [1]

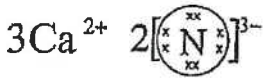
(2) $Br_2 + OH^- \longrightarrow BrO^- + Br^- + H_2O$ [1]

OR, $Br_2 + 2NaOH \longrightarrow NaOBr + NaBr + H_2O$

[Note: we know that $Cl_2 + 2NaOH \longrightarrow NaOCl + NaCl + H_2O$

Just replace Cl by Br]

CE05_01

(a) (i)  [1]

(ii) Flame test [1]

Calcium compounds give a brick-red flame. [1]

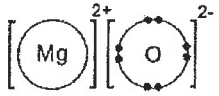
(b) (i) Isotopes are atoms of the same element with same proton number but different neutron numbers. [1]

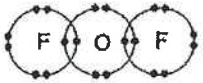
(ii) Protons = 38, neutrons = 52 [1]

(c) (i) They have the same number of electrons in their outermost shells. [1]

(ii) Sr has similar chemical properties as Ca does, thus can replace some of the Ca required. [1]

CE07_01

(a)  [1]

(b)  [1]

(c) Melting point of A is higher than that of B.

Ions of A are linked by strong ionic bonds / electrostatic force forming giant crystal lattice. [1]

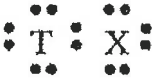
Molecules of B are attracted by weak van der Waals' forces / intermolecular forces. [1]

CE08_01

(a) T: fluorine / F [1]

X: chlorine / Cl

Z: magnesium / Mg

(b)  [1]

(c) The compound contains ions. It conducts electricity in molten/ aqueous state because the ions in it are mobile. It does not conduct electricity in solid state because the ions in it are not mobile. [1+1]

CE08_02

(a) Isotopes are atoms of the same element / atomic number / proton number that have different mass numbers / neutron numbers. [1]

(b) Let the percentage abundance of ^{11}B be X%.

$11(X) + 10(100 - X) = 10.8(100)$

$X = 80$

The percentage abundance of ^{11}B is 80%. [2]

(c) Giving out white fumes because chemical properties of isotopes are the same. [1]

CE09_09

Chemical knowledge

Electrical conductivity

a. Sodium can conduct electricity because there are delocalised electrons. [1]

b. Chlorine cannot conduct electricity because of no delocalised electrons and no mobile ions. [1]

c. Sodium chloride can conduct electricity in aqueous / molten state because there are mobile ions. [1]

Melting point

d. Chlorine has low melting point because weak intermolecular forces / weak van der Waals' forces / weak forces between molecules. [1]

e. Sodium has high melting point because strong metallic bonds / strong electrostatic forces between delocalised electrons and sodium ions. [1]

f. Sodium chloride has high melting point because strong ionic bonds / strong electrostatic forces between sodium ions and chloride ions. [1]

Effective communication [3]

CE11_03

(a) (i) The van der Waals' forces between layers are weak. [1]

(ii) The delocalised electrons can conduct electricity. [1]

(b) Lead atoms are held by metallic bonds. [1]

The metallic bonds are strong, so lead metal tears off less readily than graphite. [1]

(c) Diamond has a giant covalent structure. [1]

There are strong covalent bonds between atoms in diamond. [1]

CE11_08

Chemical knowledge

<u>The position of atom in the Periodic Table</u>

- Total number of electron shells equals to the period number. [1]
- Total number of outermost shell electrons equals to the group number. [1]

[1]

The types of chemical bondings

- Group I to III atoms may form ionic bonds with Group IV to VII atoms. / Group I to III atoms lose electrons to form ionic bonds. / Group IV to VII atoms gain electrons to form ionic bonds. [1] [1]
- Group I to III atoms may form metallic bonds within their elements.
- Group IV to VII atoms may form covalent bonds within their elements or with other Group IV to VII atoms. [1]
- Group 0/ VIII atoms or noble gases normally do not form any chemical bonds. [3]

Effective communication

AL96(I)_01a

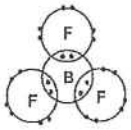
(i) ^{12}C 6n, 6p, $6e^-$ [½]
^{13}C 7n, 6p, $6e^-$ [½]

(ii) mass of 1 mole of $^{12}C = 12.000 \times 1.6605 \times 10^{-27} \times 6.0221 \times 10^{23}$ [1]
$= 0.0120$ kg [1]
(Accept answers which could round off to 0.012)

(iii) $\text{relative atomic mass} = \dfrac{12.000 \times 100 + 13.003 \times 1.12}{100 + 1.12} = 12.001$ [2]
(Accept answers which could round off to 12.01)

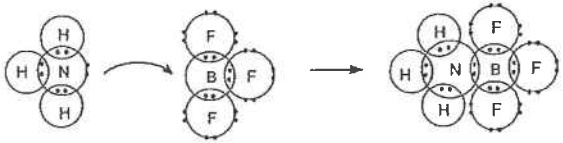
AL98(II)_01 (modified)

(a)



[1]

(b) The vacant site on the electron shell of B atom in BF_3 can accept the lone pair of [1]
electron on N atom in NH_3 to form a dative bond. [1]



[1]

AL98(II)_02 (modified)

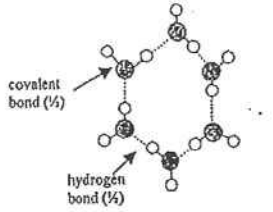
(a) In diamond, the C atoms are held by **C–C single covalent bonds**, whereas in graphite [½]
the interaction between C atoms within the same layer is **covalent bond with multiple bond character**. In graphite, the attraction between the layers of C atoms is **van der Waals' forces**. [½]
The stronger interaction will lead to a shorter C–C distance [1]
Therefore the C–C distances are:
Between layers of graphite > between C atoms in diamond > within layers of graphite [½]

(b) In diamond, the **C–C bonds are strong**. The strong directional character of [½]
covalent bond restricts the relative motion between C atoms. ∴ Diamond is hard. [1]
In graphite, the C atoms are held in **layer structure**. The **weak attraction force** [½]
between layers allows the layers to slip over each other. [1]
∴ graphite is soft and can be used as lubricant

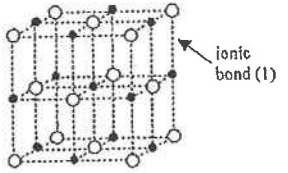
AL99(I)_01

CO_2 has a **simple molecular structure**, while SiO_2 has a **giant covalent structure**. [1]
The covalent bond between Si and O in SiO_2 is much stronger than the van der Waals' [½]
forces between CO_2 molecules. ∴ SiO_2 is a high melting point solid whereas CO_2 is a gas.

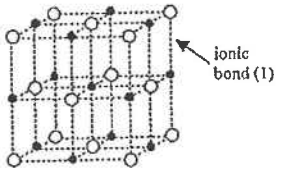
AL00(I)_01



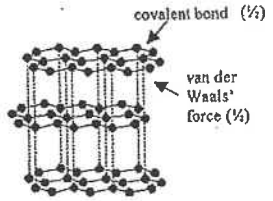
Ice (hydrogen bond)



Sodium chloride [2]



Iodine



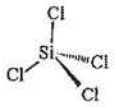
Graphite [2] [1]

ASL01(I)_05 (modified)

(a) Silicon [1]
Since element X forms covalent bonds with other 4 X atoms tetrhedrally to give a giant [1]
covalent structure.

(b) X: to make a semi-conductor [1]
Oxide of X: to make a glass [1]

(c) (i)



[1]

(ii) $SiCl_4(l) + 2H_2O(l) \longrightarrow SiO_2(s) + 4HCl(g)$ [1]

$SiCl_4(l)$ hydrolyzes in water to give white fume, $HCl(g)$. [1]

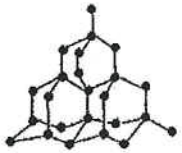
AL02(I)_03

CO_2 exists as simple molecules / has simple molecular structure and the intermolecular attraction is van der Waals' forces. [½]

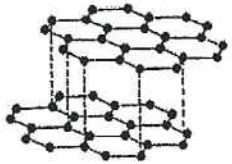
SiO_2 has a giant covalent network structure. Attraction between CO_2 molecules is weak, but attraction between Si and O atoms in $SiO_2(s)$ is strong. [½]

ASL03(I)_07

(a) (i)



diamond



graphite

[2]

(ii) **In diamond, the C–C bonds are strong. The strong directional character of covalent bond restricts the relative motion between C atoms. ∴ Diamond is harder.** [1] [½]

In graphite, the C atoms are held in layer structure. The weak attraction force between layers allows the layers to slip over each other. ∴ Graphite is soft material. [1] [½]

(b) Diamond has a higher boiling point. [1]

As the carbon atom is smaller than germanium atom, and hence C–C bonds are stronger than Ge–Ge bonds [1]

(c) The atomic mass of Pb is much higher than Ge, and Pb adopts a close-packing pattern in its lattice. [1] [1]

ASL04(I)_01 (modified)

(a) 2, 8, 17, 2 [1]

(b) Let x be the fractional abundance of ^{63}Cu

$63.5 = 63(x) + 65(1 - x)$

$x = 0.75$

% abundance of $^{63}Cu = 75$ [1]

% abundance of $^{65}Cu = 25$ [1]

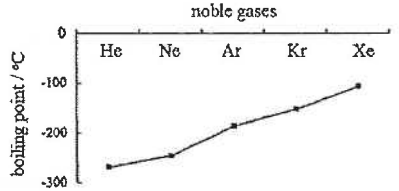
(c) Copper metal can be considered as making up of a lattice of cations and a 'sea' of delocalized electrons. [1]

The attraction between the cations and the 'sea' of delocalized electrons is responsible for the metallic bond. [1]

The deolocalized electrons can move under the influence of an electric field. [1]

∴ Cu is an electrical conductor.

AL04(I)_02



[1]

The intermolecular attraction between noble gas molecules is van der Waals' forces. [½]

The strength of van der Waals' forces increases with the number of electrons / atomic size of the noble gas. ∴ The boiling point of noble gas increases as the group is descended. [½]

ASL04(I)_06

(a) At 298 K and 1 atm pressure, CO_2 exists as simple molecules while SiO_2 exists as a giant covalent network. [½] [½]

In the lattice of SiO_2, atoms do not have translational motion. In carbon dioxide, as the intermolecular attraction between CO_2 is weak, molecules of CO_2 can have free random motion. [½] [½]

∴ CO_2 is a gas while SiO_2 is a solid.

(b) *X* [1]

(c) The strong covalent bonds in SiO_2 prevent the atoms from translational motion. [1]

SiO_2 is hard and strong.

(d) Dry ice can produce a very low temperature (–78 °C). [1]

Dry ice sublimes and no messy liquid (as in the case of ice) is produced. [1]

AL05(I)_01 (modified)

(a) Van der Waals' forces [For reference only] [½]

Owing to electron movement, uneven distribution of electron induces the polarity (instantaneous dipole) in molecules of Ar. The instantaneous polarity in a molecule attracts electrons of a neighboring molecule leading to the formation of an induced polarity (induced dipole).

Van der Waals' forces are resulted from the attraction of the instantaneous dipole and induced dipole. [1]

(b) Metallic bond [½]

In metal, the outermost shell electrons of a metal atom are weakly attracted by the nucleus. Metallic bond is resulted from the **electrostatic attraction between the metallic cations and the delocalized electron.** [Do not accept Zn 'atoms' or 'nuclei' instead of 'cation"] [1]

(c) Ionic bond [½]

Ca atoms donate electrons to F atoms, and Ca^{2+} and F^- ions are formed.

The strong electrostatic attraction between Ca^{2+} and F^- **holds the ions in a regular three dimensional structure.** [1]

AL06(I)_01 (modified)

$Na_2O(s)$ and $Al_2O_3(s)$ are ionic compounds. $SO_2(g)$ is a covalent compound and it exists as simple molecule. The attraction between $SO_2(g)$ molecule is weak van der Waals' forces. [1] [1]

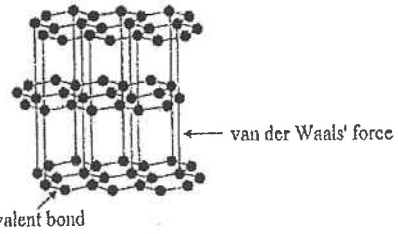
∴ $SO_2(g)$ has a very low melting point.

The charge : radio ratio of Al^{3+} is greater than that of Na^+ / Al^{3+} has a higher charge density than Na^+. ∴ $Al_2O_3(s)$ has a **much stronger ionic bond** than $Na_2O(s)$. ∴ m.p. of $Al_2O_3(s)$ > m.p. of $Na_2O(s)$ [½] [½]

[Remark: strength of ionic bond increases with the increasing charge of cations and anions AND decreases with the increasing ionic radii of the ions]

AL06(I)_02 (modified)

Diagram + labels of interatomic attractions:



[2]

ASL06(I)_05

(a) Giant covalent structure [1]

(b) Silicon would have a higher melting point than germanium. [1]

Si–Si bond is stronger than Ge–Ge bond. [1]

(c) Silicon (IV) oxide has a giant covalent structure. Silicon(IV) chloride has a simple molecular structure. [1]

Large amount of energy is required to break down numerous Si–O covalent bonds in silicon(IV) oxide during melting. [1]

Small amount of energy is sufficient to overcome weak van der Waals' forces between silicon(IV) chloride molecules. [1]

AL08(II)_01

Na_2O is an ionic solid in giant ionic structure. The strong attraction between the cations and anions makes it a high melting point solid. [1]

Cl_2O exists as simple molecules. The intermolecular attraction is weak van der Waals' force. It is much weaker than ionic bond in Na_2O. [1]

AL08(II)_04 (modified)

Diamond is a covalent crystal. All carbon atoms covalently bonded to each other and give a single bond. **The electrons are localized.** ∴ Diamond is a poor conductor / insulator of electricity. [½] [½]

In graphite, each carbon atom is covalently bonded to only three other carbon atoms in its layer, and one outer electron of each carbon atom is "free". These "free" electrons are **delocalized and moved in the direction of an electric field.** ∴ Graphite is an electrical conductor. [½] [½] [1]

ASL08(II)_04 (modified)

The size of K^+ is larger than that of Na^+. / Na^+ has a higher charge-to-radii ratio than that of K^+. [1]

For the same anion Br^-, the large the cation, the weaker is the electronic attraction between the cations and anions. [1]

∴ KBr(s) has a lower melting point.

AL09(I)_03

(a) $$\text{R.A.M.} = \frac{74 \times 0.9 + 76 \times 9.0 + 77 \times 7.6 + 78 \times 23.5 + 80 \times 49.8 + 82 \times 9.2}{100}$$ [1]

$= 79.1$ [1]

(b) The high m.p. indicates that SeO_2 is unlikely to have a simple molecular structure. [½]

Its melting point is not very high. ∴ it does not exist as covalent crystal. [½]

It does not conduct electricity in molten state. ∴ It cannot be giant ionic structure. [½]

SeO_2 has a macromolecular structure / consists of polymers of $(SeO_2)_n$ [½]

AL09(II)_03

In metals, the metal cations are surrounded by delocalized valence electrons. The attraction between the cations and electrons (metallic bond) is non-directional. If a stress is applied, the layers of metal cations will slide over one another without breaking of metallic bonds. [1]

In ionic compounds, the cations and anions occupy specific positions in the lattice. When an ionic crystal is subjected to a stress, a slight dislocation in the structure brings similar charged ions together, causing repulsion. [1]

AL12(II)_08 (modified)

(a) 3 out of 4 outermost electrons of each C atom form a C-C bond with another 3 carbon atoms on the same plane. [1]

The remaining outermost electron of each C atom is delocalized. [1]

The attraction between atoms within a layer is strong covalent bond, while that between layers is weak van der Waals' forces. [1]

Graphite is soft because the layers can slide over one another easily. [1]

(b) (i) The C atoms in graphene are bonded by strong covalent bond. [1]

(ii) Any ONE of the following: [1]

- Graphene has a smaller density.
- Graphene is not easily corroded / chemically inert.

AL13(II)_05

(a) m.p. of Ca > m.p. of Ra

For metals in the same group of the Periodic Table, their metallic bond strength depends on their atomic radius (or atomic size). [1]

Ra has a larger atomic size than Ca. ∴ metallic bond in Ca is stronger than that in Ra. [1]

(b) Ra is more reactive than Ca towards water. ($H_2(g)$ is formed.) [1]

$M(s) + 2H_2O(l) \longrightarrow M(OH)_2(aq) + H_2(g)$

Ra has a larger size and is more ready to donate its outermost electrons. [1]

(c) A white precipitate of $RaSO_4(s)$ will be formed. [1]

The solubility of sulphate(VI) of Group II elements decreases as the group is decended. As both $SrSO_4(s)$ and $BaSO_4(aq)$ are insoluble in water, it is likely that $RbSO_4(s)$ is also insoluble. [1]

AL13(II)_08

(b) $BrF_5(l)$ contains only molecules and no delocalized electrons or mobile ions. It cannot conduct electricity. [1]

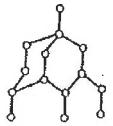
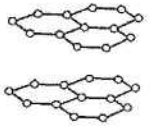
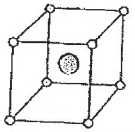
A mixture of BrF_5 and AsF_5 contains BrF_4^+ and AsF_6^- ions. These ions have translational motion in an applied electric field. Thus, the mixture can conduct electricity. [1]

DSE11SP_01

(a) False. The high melting point of NaCl is due to the strong electrostatic attraction between ions (sodium ions and chloride ion) / the presence of strong ionic bonds. [1]

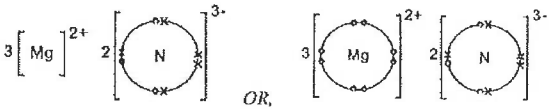
The low melting point of CH_4 is not due to the existence of covalent bond between C and H atoms, but due to the weak van der Waals' forces between the molecules / weak intermolecular forces. [1]

DSE11SP_07

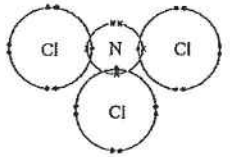
Solid substance	Three-dimensional diagram for the structure of the solid substance	Explanation of whether the solid substance is an electrical conductor
Diamond		Insulator because no delocalized electrons [2]
Graphite		Conductor because delocalized electrons are present [2]
Caesium chloride		Insulator because no mobile ions [2]

DSE12PP_03

(a) (i) [1]



(b) (ii) [1]



DSE12_01

(a) **Atoms with the same number of protons but different numbers of neutrons.** [1]

OR, Atoms with the same atomic number but different mass numbers.

(b) $20\times0.9048 + 21\times0.0027 + 22\times0.00925 = 20.19$ [1]

(c) Gas for filling luminous advertisement tubes / neon tubes / neon signs / neon light. [1]

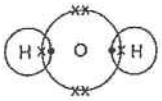
(NOT accept fluorescent tubes)

(d) Neon is monoatomic whereas oxygen is diatomic. O_2 molecule has larger molecular size than Ne molecule. (NOT accept larger molecular mass) [1]

Thus stronger van der Waals' force / strong intermolecular force among O_2 molecules. [1]

(NOT Accept VDW force)

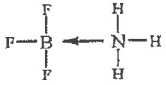
DSE13_01

(a)  [1]

DSE13_02

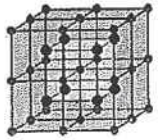
(c) In BF_3, there are three (bond) electron pairs / there is a vacant site / 6 electrons only / electron deficient in the outermost shell of the B atom. [1]

By accepting the lone pair of electrons from the nitrogen atom of NH_3 / forming dative bond with N, boron attains the stable electronic configuration of neon (a noble gas). [1]



DSE13_08

(a) $2Cs + Cl_2 \longrightarrow 2CsCl$ [1]

(b) (i)  [1]

(The drawing should be either show the correct labels for Cs^+ and Cl^-, or show clearly there are two types of ions in the lattice with correct relative positions.)

(ii) CsCl contains **Cs^+ / cations** and **Cl^- / anions**. In CsCl, ions are **strongly held by ionic bond.** [1]

Relative movement of the ions can **bring ions of the same charge close to each other, and will result in repulsion.** ∴ CsCl(s) is brittle. [1]

(c) Cs(s) is more reactive than Na(s). The **relativity of Group I metal increases down the group.** [1]

OR, The electron in the outermost shell (valence electron) of Cs is weakly bounded by the nucleus as compared with that of Na.

OR, Cs atom loses its outermost shell electron more easily than Na atom.

OR, Cs atom loses it electron more easily than Na atom because Cs has more electron shells than Na / the size of Cs atom is larger than that of Na / the atomic radius of Cs is larger than that of Na.

OR, Both Cs and Na are Grop I metals, and the size of Cs atom is larger than that of Na.

DSE13_13

Nitrogen < lithium < beryllium < carbon (graphite) [1]

N_2 has the lowest melting point as it has a **simple molecular structure**, weak **van der Waals' forces / intermolecular forces** need to be overcome. [1]

Both Li and Be have **metallic structure, metallic bond in Li is weaker than that in Be.** [1]

∴ Li < Be in melting points.

C has the highest melting point as it has a giant covalent structure, large amount of energy is needed to **break strong covalent bonds between atoms** in melting. [1]

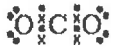
[1]

Effective communication

DSE14_01

(a) (i) Layers of graphite are held together by **van der Waals' forces / weak intermolecular forces only.** [1]

(ii) Yes, graphene has **delocalized electrons** / electrons in graphene are not localized / mobile electrons / electrons will flow. [1]

(iii)  [1]

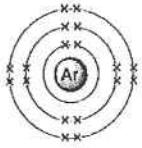
(Accept any symbols of electrons, ignore shape)

Not accepted: Showing electrons in the inner shells.

(b) No. Graphene layers are made up of a **giant covalent structure.** [1]

A large amount of energy is needed during melting to destroy the large amount of **strong covalent bonds between atoms.** [1]

DSE15_01

(a)  [1]

(b) Van der Waals' forces [1]

(c)

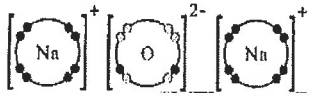
Element	Natural source	Method of extraction
Argon	Atmosphere / air	**Fractional distillation of liquefied air** (NOT accept "distillation")
Chlorine	Rock salt / sea water / ocean NOT accept "lake", "river", "salt water", etc.	Electrolysis of sea water

[2]

[2]

DSE15_10

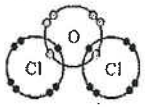
(a) (i)



[1]

It gives an alkaline / a base solution / NaOH / sodium hydroxide [1]

(ii)



[1]

It gives an acidic solution / HOCl / hypochlorous acid [1]

DSE16_01

(a) 2,8, 5 [1]

(b) Chlorine exists as isotopes. / There are chlorine atoms with same number of protons but different number of neutrons. / All chlorine atoms have 17 protons. Some chlorine atoms have 18 neutrons and some have 20. [1]

DSE16_02

(a) To increase the electrical conductivity of the filter paper / To increase the number of mobile ions / To provide mobile ions / $K_2SO_4(aq)$ is an electrolyte [1]
(Also accept: Allow ions to pass through / $K_2SO_4(aq)$ acts as a salt bridge)
(Not accept: To complete the circuit)

(b) pale green / green / light green [1]

(c) (Dark) Blue color appears around the middle of the filter paper. [1]
$Fe^{2+}(aq)$ ions move towards negative pole / move to the right and $Fe(CN)_6^{3-}(aq)$ ions move towards positive pole / move to the left (forming a blue compound). [1]

(d) The color around the middle of the filter paper remains unchanged / white / colorless. [1]
$Fe^{2+}(aq)$ ions and $Fe(CN)_6^{3-}(aq)$ ions do not migrate towards each other. [1]
OR, $Fe^{2+}(aq)$ ions and $Fe(CN)_6^{3-}(aq)$ ions move to opposite sides.
OR, $K^+(aq)$ and $SO_4^{2-}(aq)$ migrate towards each other but do not form colored compounds.

DSE16_04

(c) The intermolecular forces between CS_2, CO_2 molecules are van der Waals' forces. [1]
As CS_2 has greater molecular size than CO_2, the van der Waals' forces between CS_2 molecules are stronger than those between CO_2 molecules. [1]

DSE16_08

(a) (i) Reddish brown gas observed. [1]
Do not accept reddish brown liquid.

(ii) $Sr^{2+} + 2e^- \longrightarrow Sr$ [1]

(b) Bromine gas formed is toxic / poisonous. / Bromine is toxic. / A toxic gas is formed. [1]
Do not accept answers like "irritant", "harmful".

DSE17_01

(a) The metallic bond / electrostatic attraction between delocalized electrons / sea of electrons and metal ions / barium ions / Ba^{2+}. [1] [1]
(Not accept: free electrons / electrons / outermost electrons)
(Or diagram with correct labels)
(For diagram:
(1) The barium ions should be labelled as "Ba^{2+}"
(2) Clearly indicates sea of electrons, or delocalized electrons between metal ions.
(3) Clearly indicate metallic bond / electrostatic attraction between sea of electrons / delocalized electrons and metal ions)

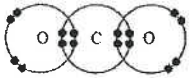
DSE17_03

(c) The O atom in H_2O has lone pairs of electrons. [1]
H^+ does not have electrons in its outermost shell. [1]
Dative covalent bond formed between the O atom in H_2O and H^+ by sharing electron pair. [1]
(Also accept graphical answer as below:)

dative covalent bond

DSE17_08

(b)



[1]

DSE18_01

(a) (i) $6x + 7(1 - x) = 6.9$ [1]
$x = 0.1 = 10\%$ (Accept answer without unit) (Accept 0.1, 10, 10.0) [1]

(ii)

[1]

The electron diagram should have brackets

DSE19_01

(a) Protium and deuterium have same number of protons but different number of neutrons. [1]

OR, Protium and deuterium have same atomic number but different mass number.

(b) [1]

(c) (i) Any TWO of the following [2]

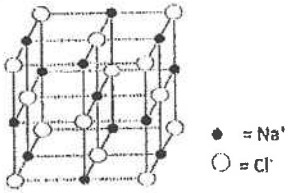
- (Colourless) gas evolves.
- Sodium metal dissolves.
- Sodium drags / moves on the surface of $D_2O(l)$.
- Sparks are observed / flame is observed / sodium burns.
- Heat evolves.
- White fume evolves.
- Hissing sound is heard.
- Sodium melts to (silvery) ball.

(ii) $2Na + 2D_2O \longrightarrow 2NaOD + D_2$ [1]

(State symbols not required) (Ignore incorrect state symbols)

DSE19_02

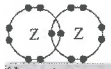
(a) [1]



DSE20_01

1. (a) 2, 8, 18, 7 1

(b) 1



(Accept answer with correct inner shell electrons)
(Not accept answer with incorrect inner shell electrons, if inner shell electrons are drawn)

(c) (i) $K_2SO_3(s) + 2HCl(aq) \rightarrow 2KCl(aq) + H_2O(l) + SO_2(g)$ / 2
$K_2SO_3(s) + 2H^+(aq) \rightarrow 2K^+(aq) + H_2O(l) + SO_2(g)$
Correct states (1 mark)
Balanced equation (1 mark)
(No mark if the chemical species shown in the equation are incorrect)

(ii) (Reddish brown / brown) changes to colourless. / The solution changes to colourless. 1
(Not accept incorrect initial colour. Not accept pale brown)
$Br_2 + SO_2 + 2H_2O \rightarrow 2Br^- + SO_4^{2-} + 4H^+$ 1
(State symbols not required) (Ignore incorrect state symbols)
OR $Y_2 + SO_2 + 2H_2O \rightarrow 2Y^- + SO_4^{2-} + 4H^+$

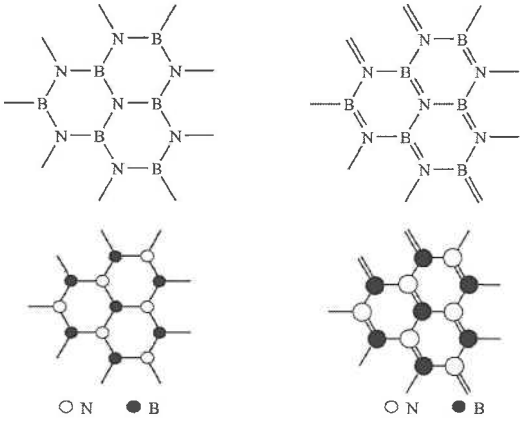
(iii) Y and Z have the same number of electrons / seven electrons in the outermost shells, hence similar chemical properties (leading to similar observation). 1
(Not accept "Same chemical properties")

DSE20_03

(b) (i) • B–N is the dative covalent bond. 1
• The lone electron pair on nitrogen atom of NH_3 is donated to form a dative covalent bond with the boron atom of BH_3. 1

(ii) • Both are van der Waals' forces between their respective molecules. 1
• As H_3NBH_3 is polar but ethane is not, the van der Waals' forces between H_3NBH_3 molecules are stronger than those between ethane molecules. 1
(Only the 2nd mark will be given if the candidate answered in terms of "intermolecular forces" instead of van der Waals' forces)
(2nd mark not accept comparison of molecular size)

(iii) 2



(1 mark for showing the fused hexagonal structure, need to show at least 2 fused rings)
(1 mark for showing alternating N and B atoms)
(Ignore the double bonds in the structure)