M1. (a) (i) Average/mean mass of 1 atom (of an element);
Average mass of 1 atom × 12.

1

Mass 1/12 atom of ^{12}C;
Mass 1 atom of ^{12}C.
QWC.

1

(ii) Other isotope = 46.0%;

1

$$107.9 = \frac{(54 \times 107.1) + (46 \times ?)}{100};$$
M2 whole expression.

1

108.8;
Answer 108.8 (3 marks).
Answer min 1 d.p..

1

Same electronic configuration/ same number of electrons (in outer shell)/ both have 47 electrons;
Ignore protons and neutrons unless incorrect.
Not just electrons determine chemical properties.

1

(b) Ionisation;

1

high energy electrons fired at sample;
Allow electron gun /blasted with electrons.

1

Acceleration;

1

With electric field/accelerating potential/potential difference;
Allow by negative plate.

1

Deflection;

1

With electromagnet/ magnet/ magnetic field;
M2 dependent on M1.

M4 dependent on M3.
M6 dependent on M5.

1

(c) (Silver) metallic (bonding);

Vdw/molecules CE=0.

1

Regular arrangement of same sized particles;

1

+ charge in each ion;

Ignore multiple positive charges.
Candidates do not need to show delocalised electrons.

1

(d) Ionic (bonds);

1

Minimum 4 ions shown in 2D square arrangement placed Correctly;

Do not allow multiple charges on ions.

1

Further 3 ions shown correctly in a cubic lattice;

1

Strong (electrostatic) forces/bonds;

If vdw/molecules/covalent mentioned CE = 0 for M4 and M5.

1

Between + and – ions;

Accept between oppositely charged ions.

1

[20]

M2. (a) NaCl is ionic

1

cubic lattice

1

ions placed correctly

1

electrostatic attraction between ions

1

Covalent bonds between atoms in water

1

Hydrogen bonding between water molecules

1

Tetrahedral representation showing two covalent and two hydrogen bonds

1

2 hydrogen bonds per molecule

1

Attraction between ions in sodium chloride is very strong

1

Covalent bonds in ice are very strong

1

Hydrogen bonds between water molecules in ice are much weaker

1

Consequently, less energy is required to break the hydrogen bonds in ice to form separate water molecules than to break the ionic bonds in sodium chloride and make separate ions

1

(b)

Mark Range	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question **Descriptor** an answer will be expected to meet most of the criteria in the level descriptor
3	– claims supported by an appropriate range of evidence – good use of information or ideas about chemistry, going beyond those given in the question – argument well structured with minimal repetition or irrelevant points – accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2	– claims partially supported by evidence – good use of information or ideas about chemistry given in the question but limited beyond this – the argument shows some attempt at structure – the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	– valid points but not clearly linked to an argument structure

	– limited use of information or ideas about chemistry – unstructured – errors in spelling, punctuation and grammar or lack of fluency

4 bonding electron pairs **1**

and one lone pair **1**

repel as far apart as possible QWC **1**

lone pair - bond pair repulsion > bp—bp QWC **1**

pushes S-F bonds closer together **1**

shape is trigonal bipyramidal with lone pair either axial or equatorial QWC **1**

angles <90 **1**

and < 120 **1**

[20]

M3. **M1** macromolecule = <u>a giant/massive/huge</u> molecule/lattice/structure with <u>covalent</u> bonding

(in words, not diagram)

(not just 'very large')

(not 'molecules bonded together'/reference to ions)

1

M2 **White**: IMF = van der Waals'

1

M3 which are weak

(tied to 'IMF' or van der Waals' in M2)

(if H-bonding or dipole-dipole, treat as CE, M2 = M3 = 0)

1

M4 **Red**: (covalent) bonds must be <u>broken/overcome</u>

(not weakened / loosened)

1

M5 (covalent) bonds are strong [tied to M4]
Or there are many (covalent) bonds

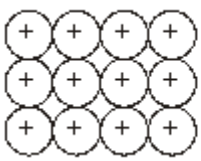
Or much energy is required to.

1

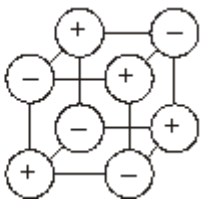
- If wrong bonding quoted, e.g. ionic bonding in white phosphorus or an IMF in red phosphorus, award no marks for that allotrope.
- In order for marks to be awarded for red phosphorus, the bonding must be stated to be covalent. One reference to covalent bonding is sufficient; the rest may be inferred as shown above. Thus, failure to refer to covalent bonding anywhere would result in the loss of M1, M4 and M5,
- Mark M1 independently. Allow the criteria for this mark to be earned elsewhere, but do not treat errors in the red allotrope description as contradictions of M1.

[5]

M4. (a)



(1)



(1)

[Diagrams must be complete and accurate]

2

(b) (i) Attraction /electrostatic forces/bonds/attractions between (positive) ions/lattice and delocalised/free electrons/sea of electrons.

[Not metallic bonding]

[Not just 'forces']

1

(ii) Electrostatic attractions/forces between ions or attractions between (oppositely charged) ions/ Na^+ & Cl^-

[Not ionic bonding]

1

(iii) (Here) the ionic bonding in NaCl is stronger/requires more energy to break than the metallic bonding in Na

QoL Accept 'bonding/forces of attraction in NaCl is stronger than in Na'

[If IMF/molecules/van der Waals'/dipole–dipole mentioned in parts(i) or (ii), then CE = 0 for parts (i) and/or(ii) and CE = 0 for part(iii)]

1

(c) Comparison:
Sodium conducts **and** sodium chloride does NOT conduct

Allow 'only Na conducts'

Accept 'Na conducts, NaCl only conducts when molten'

[Do not accept sodium conducts better than sodium chloride etc.]

1

Explanation:
(Delocalised) electrons flow though the metal

1

Allow e^- move/carry current/are charge carriers/transfer charge.

[Not 'electrons carry electricity']

[Not 'NaCl has no free charged particles']

Ions can't move in solid salt

1

(d) Layers can slide over each other – idea that ions/atoms/particles move

[Not molecules]

[Not layers separate]

1

(e) (i)

Na	Cl	O
$\frac{21.6}{23}$	$\frac{33.3}{35.5}$	$\frac{45.1}{16}$

1

0.9(39)	0.9(38)	2.8(2)
Hence: 1	1	3

Accept backwards calculation, i.e. from formula to % composition, and also accept route via M_r to 23; 35.5; 48, and then to 1:1:3

[If % values incorrectly copied, allow M1 only]

[If any wrong A_r values/atomic numbers used = CE = 0]

1

(ii) $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$

1

[12]