1

(a) <u>Average/mean mass of (1) atom(s) (of an element)</u>

1/12 mass of one atom of ^{12}C

1

If moles and atoms mixes Max = 1

1

OR

<u>(Average) mass of one mole of atoms</u>

1/12 mass of one mole of ^{12}C

OR

<u>(Weighted) average mass of all the isotopes</u>

1/12 mass of one atom of ^{12}C

OR

Average mass of an atom/isotope compared to C-12 on a scale in which an atom of C-12 has a mass of 12

This expression = 2 marks

(b) d block

Allow 3d/D
Other numbers lose M1
Ignore transition metals

1

[Ar] $3d^2 4s^2$

1

Can be written in full
Allow subscripts
$3d^2$ and $4s^2$ can be in either order

27

1

(c) $\frac{(90 \times 9) + (91 \times 2) + (92 \times 3) + (94 \times 3)}{17}$

(= 1550)

1

(or ∑ their abundances)

If one graph reading error lose M1 and allow consequential M2 and M3.
If 2 GR errors penalise M1 and M2 but allow consequential M3
If not 17 or ∑ their abundances lose M2 and M3

1

= 91.2

91.2 = 3 marks provided working shown.

1

Zr/Zirconium

M4 -allow nearest consequential element from M3
accept Zr in any circumstance

1

(d) High energy electrons/bombarded or hit with electrons

accept electron gun

1

knocks out electron(s) (to form ions)

1

Z^+ = 90 deflected most

If not 90 lose M3 and M4
If charge is wrong on 90 isotope lose M3 only
Accept any symbol in place of Z

1

since lowest mass/lowest m/z

Allow lightest

1

(e) (ions hit detector and) cause current/(ions) accept electrons/cause electron flow

QWC

1

bigger current = more of that isotope/current proportional to abundance

Implication that current depends on the number of ions

1

[15]

2 (a) $2s^2\ 2p^6$;

If ignored the $1s^2$ given and written $1s^2 2s^2 2p^6$ mark as correct
Allow capitals and subscripts

1

(b) (i) $Na^+(g) \rightarrow Na^{2+}(g) + e^{(-)}$;

One mark for equation and one mark for state symbols

$Na^+(g) + e^{(-)} \rightarrow Na^{2+}(g) + 2e^{(-)}$;

M2 dependent on M1
Allow $Na^+(g) - e^{(-)} \rightarrow Na(g)$
Allow $X^+(g) \rightarrow X^{2+}(g) + e$ = 1 mark

2

(ii) $Na^{(2+)}$ requires loss of e^- from a 2(p) orbital or 2nd energy level or 2nd shell and $Mg^{(2+)}$ requires loss of e^- from a 3(s) orbital or 3rd energy level or 3rd shell / $Na^{(2+)}$ loses e from a lower (energy) orbital/ or vice versa;

Not from 3p

1

Less shielding (in Na);

Or vice versa for Mg

1

$e^{(-)}$ closer to nucleus/ more attraction (of electron to nucleus) (in Na);

M3 needs to be comparative

1

(iii) Aluminium /Al;

1

(c) Decreases;

If not decreases CE = 0
If blank, mark on

1

Increasing nuclear charge/ increasing number of protons;

1

Electrons in same shell or level/ same shielding/ similar shielding;

1

(d) Answer refers to Na;

Allow converse answers relating to Mg.

Na fewer protons/smaller nuclear charge/ fewer delocalised electrons;

Allow Mg is 2+ and Na is +.
If vdw CE = 0.

1

Na is a bigger ion/ atom;

1

Smaller attraction between nucleus and delocalised electrons;

If mentioned that charge density of Mg^{2+} is greater then allow first 2 marks.
(ie charge / size / attraction).
M3 allow weaker metallic bonding.

1

(e) (Bent) shape showing 2 lone pairs + 2N−H bond pairs;

Atoms must be labelled.
Lone pairs can be with or without lobes.

1

Bent / v shape/ triangular;

Not tetrahedral.
Allow non-linear.
Bent-linear = contradiction.

1

(f) Ne has full sub-levels/ can't get any more electrons in the sub-levels/
Ne has full shells;

Not $2s^2\ 2p^6$ alone.
Not stable electron configuration.

1

[16]

3 (a)

Particle	Relative Charge	Relative mass
Proton	+1	1
Neutron	0	1

1

1

Need +1 for proton

(b) d block/ D block;

Or D or d

1

(c) (i) 74;

Not 74.0

1

(ii) 112;

Not 112.0

1

(d) (i) To accelerate/ make go faster;

1

To deflect/ to bend the beam;

Any order
Not just attract to negative plate

1

(ii) Electromagnet / magnet / electric field /accelerating potential or voltage;

Not electric current
Not electronic field

1

(e) None/ nothing;

If blank mark on.
If incorrect CE = 0

1

Same number of electrons (in outer orbital/shell)/ both have 74 electrons/same electron configuration;

Not just electrons determine chemical properties
Ignore protons and neutrons unless wrong statement.

1

(f) $\frac{(182 \times 26.4) + (183 \times 14.3) + (184 \times 30.7) + (186 \times 28.6)}{100}$;

If transcription error then
M1 = AE = –1 and mark
M2 consequentially

1

= 183.90; allow range from 183.90 – 184.00;

1

[12]

4 (a) Number of protons in the nucleus

1

(b) They may have different numbers of neutrons

1

(c) (i) Mass spectrometer

1

(ii) $\frac{\text{Mean mass of an atom}}{\text{Mass of 1 atom of } {}^{12}C} \times 12$

2

(iii) $A_r = \frac{\text{sum of relative m/z x rel. abundance}}{\text{Total abundance}}$

1

= (82 × 12 + 83 × 12 + 84 × 50 + 86 × 26)/100 = 84.16

1

(d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$

1

(e) Krypton was thought to be an inert gas
(or has 8 electrons in outer shell)

1

(f) (i) Krypton has more protons than bromine

1

But its outer electrons are in the same shell
(or have similar shielding)

1

(ii) Al electron is in a 3p orbital, magnesium in 3s

1

Energy of 3p is greater than 3s

1

[13]

5 D

[1]

6 B

[1]

7 (a) Proton mass = 1 charge = +1

Electron mass ≤ 1/1800 Or ≤ 5.6×10^{-4} charge = –1

(Do not accept +1 for proton mass or 'g' units)

2

(b) (i) 13

1

(ii) Si

1

Mass number = 28 **and** atomic number = 14

(Do not accept 28.1 or 28.0 or 'Silicon')

5

(c) Mean (average) mass of an atom / all the isotopes
1/12th mass of atom of ^{12}C
Or Mass of 1 mole of atoms of an element **(1)**
1/12th mass of 1 mole of ^{12}C **(1)**
Or Average mass of an atom / all the isotopes **(1)**
relative to the mass of a ^{12}C atom taken as exactly 12 / 12.000 **(1)**

(Penalise 'weight' once only) (Ignore 'average' mass of ^{12}C)
(Do not allow 'mass of average atom')

2

(d) A_r = (24 × 0.735) + (25 × 0.101) + (26 × 0.164) 1 = 24.4 1

(mark M2 conseq on transcription error or incorrect addition of %)

(e) M_r = highest m/z value 1

(NOT 'highest/largest/right-hand' peak)

3

[10]

8

(a) (i) Atoms with the same number of protons / proton number **(1)**

NOT same atomic number

with different numbers of neutrons **(1)**

***NOT** different mass number / fewer neutrons*

(ii) Chemical properties depend on the number or amount of (outer) electrons **(1)** OR, isotopes have the same electron configuration / same number of e^-

(iii) $23/6.023 \times 10^{23}$ **(1)**

CE = 0 if inverted or multiplied

tied to M1 $3.8(2) \times 10^{-23}$ [2-5 sig figs] **(1)**

5

(b) $1s^2\ 2s^2\ 2p^6\ 3s^1$ **(1)**

accept subscripted figures

1

(c) Highest energy e^- / outer e^-s / last e^- in (3)d sub-shell **(1)**

OR d sub-shell being filled / is incomplete
OR highest energy sub-shell is (3)d
NOT transition element / e^- configuration ends at 3d
Q of L

1

(d) $^{15}_{7}N$ N correct symbol **(1)**

allow N^{15}_{7}

Mass number = 15 AND atomic number = 7 **(1)**

2

[9]

9 (a)

Particle	Relative charge	Relative mass	
Proton	+1 **or** 1+	1	**(1)**
Neutron	0 **or** no charge/neutral/zero	1 (not – 1)	**(1)**
Electron	–1 or 1–	1/1800 to 1/2000	**(1)**

or negligible
or zero
or 5.0×10^{-4} to 5.6×10^{-4}

if 'g' in mass column - wrong
penalise once

3

(b) $^{38}_{18}Ar$ **(1)(1)**

Allow numbers before or after Ar

2

(c) *S*: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ **(1)**

Allow upper case letters

S^{2-}: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ **(1)**

If use subscript penalise once

2

(d) *Block*: p **(1)**
Explanation: Highest energy or outer orbital is (3) p

OR outer electron, valency electron in (3) p
NOT 2p etc.

2

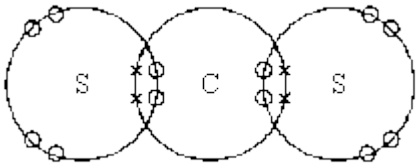
(e) (i) *Bonding in Na_2S*: ionic **(1)**
Bonding in CS_2: covalent **(1)**

ignore other words such as dative / polar / co-ordinate

(ii) Clear indication of electron transfer from Na to S **(1)**
1 e^- from each (of 2) Na atoms or 2 e^- from 2 Na atoms **(1)**

QoL correct English

(iii)



Correct covalent bonds **(1)**
All correct including lone pairs **(1)**

Allow all •s or all ×s
M2 tied to M1
NOT separate e^-s in S• - 2 l p

(iv) $CS_2 + 2H_2O \rightarrow CO_2 + 2H_2S$ **(1)**

Ignore state symbols even if wrong

7

[16]

10 D

[1]