M1.(a) 34.0

Penalise precision once

1

(b) 1.76 mol dm^{-3}

1

(c) answer to (b) divided by 0.05

35(.3) on correct figures

1

Shows working

Correct answer only scores this mark

Lose this mark if any units are given for the factor

1

[4]

##

(a) Average/mean mass of (1) atom(s) (of an element)
1/12 mass of one atom of ^{12}C

1

If moles and atoms mixes Max = 1

1

OR

(Average) mass of one mole of atoms
1/12 mass of one mole of ^{12}C

OR

(Weighted) average mass of all the isotopes
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]

M3. (a) (i) (free–)radical substitution

(both words required for the mark)

1

(ii) uv light OR sunlight OR high temperature OR 150 °C to 500 °C

1

(iii) Propagation

(ignore "chain", "first", "second" in front of the word propagation)

1

(iv) Termination

1

$\bullet CH_2CH_3 + Br\bullet \longrightarrow CH_3CH_2Br$

OR $2\bullet CH_2CH_3 \longrightarrow C_4H_{10}$

(penalise if radical dot is obviously on CH_3, but not otherwise)

(penalise $C_2H_5\bullet$)

(credit $2Br\bullet \longrightarrow Br_2$)

(ignore "chain" in front of the word termination)

1

(b) (i) Fractional distillation OR fractionation

(credit gas–liquid chromatography, GLC)

1

(ii) $CH_3CH_3 + 6Br_2 \longrightarrow C_2Br_6 + 6HBr$

(credit C_2H_6 for ethane)

1

(c) Correct structure for CF_2BrCF_2Br drawn out

(penalise "Fl" for fluorine)

1

(d) (i) 2–bromo–2–chloro–1,1,1–trifluoroethane
OR 1–bromo–1–chloro–2,2,2–trifluoroethane

(insist on <u>all</u> numbers, but do not penalise failure to use alphabet)

(accept "flourine" and "cloro" in this instance)

1

(ii) 197.4 only

(ignore units)

1

(iii) (57/197.4 × 100) = 28.9% OR 28.88%

(credit the correct answer independently in part (d)(iii), even if (d)(ii) is blank or incorrectly calculated, but mark <u>consequential on part (d)(ii),</u> if part (d)(ii) is incorrectly calculated, accepting answers to 3sf or 4sf only)

(penalise 29% if it appears alone, but not if it follows a correct answer)

(do not insist on the % sign being given)

(the percentage sign is not essential here, but penalise the use of units e.g. grams)

1

[11]

M4. (a) (i) <u>Average/mean mass of 1 atom (of an element)</u>;

<u>Average mass of 1 atom × 12.</u>

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]