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)   <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^+ = <u>90</u> 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

since lowest mass/lowest m/z
Allow lightest

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

bigger current = more of that isotope/current proportional to abundance
Implication that current depends on the number of ions

[15]

M3.   (a)   (i)   (free–)radical substitution
(both words required for the mark)

(ii)   uv light OR sunlight OR <u>high</u> temperature OR 150 °C to 500 °C
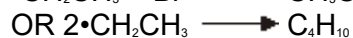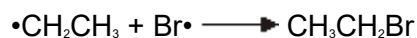
(iii)   Propagation
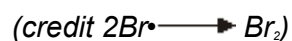*(ignore "chain", "first", "second" in front of the word propagation)*

(iv)   Termination

•CH_2CH_3 + Br• $\longrightarrow$ CH_3CH_2Br
OR 2•CH_2CH_3 $\longrightarrow$ C_4H_{10}
(penalise if radical dot is obviously on CH_3, but not otherwise)
(penalise C_2H_5•)
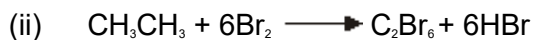*(credit 2Br• $\longrightarrow$ Br_2)*
(ignore "chain" in front of the word termination)

(b)   (i)   <u>Fractional</u> 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) $(57/197.4 \times 100) = 28.9\%$ 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 <u>+ and – ions</u>;
> *Accept between <u>oppositely charged ions</u>.*

1

[20]