

M1.(a) 34.0

*Penalise precision once*

1

(b) 1.76 mol dm<sup>-3</sup>

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 <sup>12</sup>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 <sup>12</sup>C

**OR**

(Weighted) average mass of all the isotopes  
1/12 mass of one atom of <sup>12</sup>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<sup>2</sup>4s<sup>2</sup> 1
- Can be written in full*  
*Allow subscripts*  
*3d<sup>2</sup> and 4s<sup>2</sup> 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  $\Sigma$  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  $\Sigma$  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<sup>+</sup> = 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

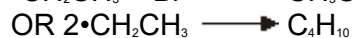
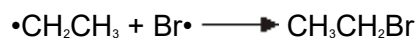
- (iii) Propagation

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

1

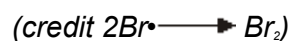
- (iv) Termination

1



*(penalise if radical dot is obviously on CH<sub>3</sub>, but not otherwise)*

*(penalise C<sub>2</sub>H<sub>5</sub>•)*



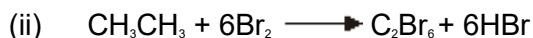
*(ignore "chain" in front of the word termination)*

1

- (b) (i) Fractional distillation OR fractionation

*(credit gas-liquid chromatography, GLC)*

1



*(credit C<sub>2</sub>H<sub>6</sub> for ethane)*

1

(c) Correct structure for  $\text{CF}_2\text{BrCF}_2\text{Br}$  drawn out

*(penalise "F" for fluorine)*

1

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

*(insist on all 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 consequential on part (d)(ii), 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) Average/mean mass of 1 atom (of an element);  
Average mass of 1 atom  $\times$  12.

1

Mass 1/12 atom of  $^{12}\text{C}$ ;  
Mass 1 atom of  $^{12}\text{C}$ .

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;  |   |
| <i>Ignore multiple positive charges.</i>                         |   |
| <i>Candidates do not need to show delocalised electrons.</i>     | 1 |
| (d) Ionic (bonds);   | 1 |
| Minimum 4 ions shown in 2D square arrangement placed Correctly;  |   |
| <i>Do not allow multiple charges on ions.</i>                    | 1 |
| Further 3 ions shown correctly in a cubic lattice;               | 1 |
| Strong (electrostatic) forces/bonds;                             |   |
| <i>If vdw/molecules/covalent mentioned CE = 0 for M4 and M5.</i> | 1 |
| Between <u>+ and – ions</u> ;                                    |   |
| <i>Accept between <u>oppositely charged ions</u>.</i>            | 1 |

[20]