2. Atoms, molecules and stoichiometry

2.1 Relative masses of atoms and molecules

Paper 3

Marking Scheme

Q1.

(c)	mass of an atom of an isotope	1
	compared to the mass of the unified atomic mass unit (amu) OR on a scale on which a carbon-12 atom has a mass of exactly 12 units OR divided by $\frac{1}{12}$ mass of a carbon-12 atom	1
(c)(ii)	$\frac{190.96\times15.18 + 192.96\times34.82}{50.00}$	1
	= **192.35**	1

Q2.

(b)(i)	<table><tr><th>isotope</th><th>RIM</th><th># protons</th><th># neutrons</th></tr><tr><td>$^{93}_{41}$Nb</td><td>92.91</td><td>• 41</td><td>• 52</td></tr><tr><td>$^{181}_{73}$Ta</td><td>180.95</td><td>• 73</td><td>• 108</td></tr></table>	2

(b)(ii)	**M1** mass of an (atom of an) isotope	1
	M2 relative/compared to (the mass of) the unified atomic mass unit **OR** on a scale in which a carbon-12 atom / isotope has a mass of exactly 12 units OR divided by / compared to $\frac{1}{12}$ of the mass of a carbon-12 atom / isotope Alternative route using mass of 1 mol throughout **M1** mass of one mol of an (atom of an) isotope **M2** relative/compared to $\frac{1}{12}$ of the mass of 1 mol of C-12 atom / isotope **OR** when the mass of one mol C-12 atom / isotope is exactly 12(.000) g	1
(b)(iii)	92.91× 0.909 + 180.95 × 0.091	1
	= 100.92	1

Q3.

(e)(i)	1 / 12 (one twelfth) the mass of a carbon-12 / ^{12}C atom	1
(e)(ii)	**M1** correct expression relating A_r to the mass / % abundance of the three isotopes $24.31 = \boldsymbol{x} \times 0.7899 + 24.99 \times 0.1000 + 25.98 \times 0.1101$ **M2** correct answer to 4 sig figs atomic mass of **X** = 23.99	2
(e)(iii)	**M1** (magnesium isotopes have) identical chemical properties **AND** same electron(ic) arrangement / configuration **M2** different physical properties **AND** different number of neutrons	2

Q4.

(a)(ii)	**M1** (weighted) average / mean mass of the isotopes / average mass of the atom(s) (of an element)	**1**
	M2 compared to (the mass of) the unified atomic mass unit	**1**

Q5.

(a)(i)	**option 1** **M1** the mass of a molecule OR the (weighted) average / (weighted) mean mass of the molecule(s)	**1**
	option 1 and **M2** relative / compared to 1 / 12 (the mass) of **an atom** of carbon–12	**1**
	OR on a scale in which a carbon–12 atom / isotope has a mass of (exactly) 12 (units) **option 2** **M1** mass of one mol of molecules	
	option 2 **M2** relative / compared to 1 / 12 (the mass) of 1 mol of C-12 OR which one mol C-12 (atom / isotope) has a mass of (exactly) 12 g	

Q6.

(c)	**M1** *calculate Mr of* ***M****Br*$_2$ *using 8.415* $\times$ *10*$^{-4}$ *mol* ***M****Br*$_2$ *in 0.250 g* M_r = ... = 297(.1).....	**1**
	M2 *calculate the atomic mass of* ***M*** *using* M_r *calculated in M1* 297.1 – (2 $\times$ 79.9) = 137(.4)	**1**
	M3 *identify group 2 element from* A_r *in M2* Ba / barium	**1**

Q7.

(a)	**EITHER** **M1** (weighted) average/mean mass of the isotope(s)/an atom(s) **M2** relative to 1/12 of the mass (of an atom) of ^{12}C (where an atom of ^{12}C is exactly12). **OR** **M1** mass of one mol of atoms **M2** relative / compared to 1/12 (the mass) of 1 mol of C-12 OR in which one mol C-12 (atom) has a mass of (exactly) 12 g	**2**