2. Atoms, molecules and stoichiometry

2.1 Relative masses of atoms and molecules

Paper 2

Question Paper

1 **(c)** Table 1.2 shows the relative abundances of isotopes in a sample of an alloy containing rhodium and iridium only.

Table 1.2

isotope	relative isotopic mass	relative abundance in alloy
$^{103}_{45}Rh$	102.91	50.00
$^{191}_{77}Ir$	190.96	15.18
$^{193}_{77}Ir$	192.96	34.82

(i) Define relative isotopic mass.

.....

.....

..... [2]

(ii) Use Table 1.2 to calculate the relative atomic mass, A_r, of iridium in the alloy.

Give your answer to **two** decimal places.

relative atomic mass of iridium = ... [2]

2 **(b)** Pelopium was the suggested name for a new element discovered in a mineral.

Pelopium was later found to be a mixture of niobium, Nb, and tantalum, Ta.

Only one naturally occurring isotope exists for each of Nb and Ta.

(i) Complete Table 1.1.

Table 1.1

isotope	relative isotopic mass	number of protons	number of neutrons
$^{93}_{41}$Nb	92.91		
$^{181}_{73}$Ta	180.95		

[2]

(ii) Define relative isotopic mass.

.....

.....

..... [2]

(iii) A sample of pelopium contains 90.9% by mass $^{93}_{41}$Nb and 9.1% by mass $^{181}_{73}$Ta.

Calculate the theoretical relative atomic mass of pelopium based on these data and Table 1.1.

Give your answer to two decimal places.

Show your working.

theoretical relative atomic mass of pelopium = ...

[2]

3 Calcium, magnesium and radium are Group 2 elements. Radium follows the same trends as the other members of Group 2.

(e) A sample of magnesium contains three isotopes, ^{25}Mg, ^{26}Mg and **X**.

The percentage abundance of the three isotopes is shown in Table 1.1.

Table 1.1

isotope of Mg	mass / a.m.u.	percentage abundance / %
X		78.99
^{25}Mg	24.99	10.00
^{26}Mg	25.98	11.01

(i) The relative atomic mass, A_r, is calculated by comparing the average mass of the isotopes of an element to the unified atomic mass unit.

Define the unified atomic mass unit.

..... [1]

(ii) Calculate the mass of **X**. Use data from Table 1.1 and A_r (magnesium) = 24.31 in your calculation. Show your working.

mass of **X** = ...
[2]

(iii) State **one** similarity and **one** difference in the properties of these isotopes of magnesium. Explain your answer.

.....

.....

..... [2]

4 Atoms with nuclei containing an odd number of protons tend to have fewer isotopes than those with an even number of protons.

(a) Gallium has two stable isotopes, ^{69}Ga and ^{71}Ga.

(ii) Define relative atomic mass.

.....

.....

..... [2]

5 Ethanedioic acid, HO_2CCO_2H, has a relative molecular mass of 90.0.

(a) (i) Explain what is meant by the term *relative molecular mass*.

.....

.....

..... [2]

6 A Group 2 metal combines with bromine to form a crystalline solid, **M**Br_2.

Excess aqueous $AgNO_3$ is added to a solution of **M**Br_2 and a precipitate forms. The mixture is filtered. The precipitate is dried and the mass of the precipitate is recorded.

(c) A 0.250 g sample of pure **M**Br_2 contains 8.415×10^{-4} mol **M**Br_2.

Calculate the relative formula mass, M_r, of **M**Br_2. Use this to identify **M**.

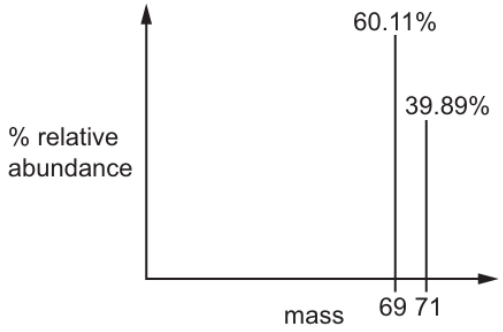
Show your working.

M_r = ...

M = ...
[3]

7 Gallium is an element in Group 13.

A sample of gallium is analysed using a mass spectrometer. The mass spectrum produced is shown.



(a) Explain what is meant by the term *relative atomic mass*.

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..... [2]