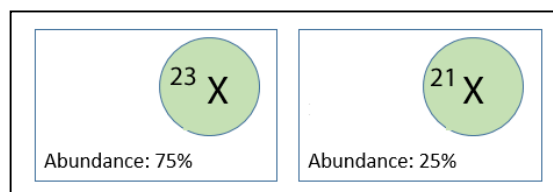


- 1) An amount of 0.35 mol of H_2SO_4 contains:
- 0.35 mol of hydrogen atoms,
 - 2.45 mol of atoms,
 - 2.45 mol of H_2SO_4 molecules,
 - 0.70 mol of sulphur atoms.
- 2) Carbon dioxide (CO_2) has a molar mass of 44.0 grams/mol. An amount of 1.81×10^{24} molecules of CO_2 :
- has a mass 44.0 grams,
 - contains 1.81×10^{24} oxygen atoms,
 - contains 3 mol of oxygen atoms,
 - has a mass of 132 grams.
- 3) A pure sample of HNO_3 is weighed at 6.50 grams. This sample of HNO_3 most likely contains:
- 1 mol of hydrogen atoms,
 - 1.40 grams of nitrogen atoms,
 - 4.80 grams of oxygen atoms,
 - close to 0.3 mol of oxygen atoms.
- 4) What is the percentage composition, by mass, of KClO_3 .
- 39.2 % Oxygen : 31.9 % Potassium : 28.9 % Chlorine
 - 25.2 % Oxygen : 35.9 % Potassium : 39.9 % Chlorine
 - 39.2 % Potassium: 31.9 % Oxygen : 28.9 % Chlorine
 - None of the above represent the percentage composition, by mass, of KClO_3 .
- 5) An element "X" has two isotopes of atomic mass 23 and 21. The percentage abundance of each isotope is shown on the right. The relative atomic mass of X, in atomic mass units, is:
- slightly less than 21,
 - just over 23,
 - 22.5,
 - 22.0.



The list of properties below relates to questions 8 -10.

- i. Relatively high melting temperatures
- ii. High electrical conductivity in the solid state.
- iii. High electrical conductivity in the liquid state.
- iv. High electrical conductivity in the aqueous state.
- v. Malleable.
- vi. Can be soluble in water.

8) What properties are shared between ionic substances and metallic?

- a. i and iii only
- b. ii, iii and v only
- c. ii and iii only
- d. i, vi and iii only

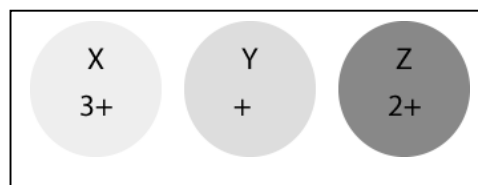
9) A substance formed when a metal and non-metal react chemically may have the following properties:

- a. i, and vi.
- b. iii, iv and vi.
- c. i, iii, iv and vi.
- d. i, iii and vi.

10) Non-directional forces of attraction enable:

- a. ionic substances to exhibit properties i and vi.
- b. metals to exhibit property v only.
- c. metals to exhibit properties ii and vi.
- d. ionic substances to exhibit property iii only.

11) The diagram shows the charge and the size of three different stable ions of metals in the same period of the periodic table. Which statement is most likely correct?



- a. Metal X is most likely to have the highest melting temperature.
- b. Metal Z will most likely react with chlorine to form a compound with the formula Z_3Cl_2
- c. Metal Y will most likely have the highest structural strength and conductivity.
- d. Metal X will be the most reactive.

12) Iron is mixed with a small amount of carbon to form an:

- a. ionic substance that is lustrous and not brittle,
- b. ionic substance that can conduct electricity in the solid state,
- c. alloy that has properties of both carbon and iron so that it can burn in a furnace to produce CO_2 and H_2O ,
- d. alloy that has different properties to pure iron.

Section B

1. NutraSweet is an artificial sweetener with the following percentage composition, by mass.
57.14% C, 6.16% H, 9.52% N, and 27.18% O.

a. Calculate the empirical formula of NutraSweet

4 marks

Step 1 Assume 100g of sample and convert all percentages into mass (grams) 1 mark

57.14 g C, 6.16 g H, 9.52 g N, and 27.18 g O.

Step 2 Convert mass to mol 1 mark

4.76 C : 6.16 H : 0.68 N : 1.70 O

Step 3 Find simplest ratio 1 mark

7 C : 9 H : 1 N : 2.5 O

Step 4 Multiply to remove fractions 1 mark

$C_{14}H_{18}N_2O_5$

b. Find the molar mass of NutraSweet, in grams/mol, if an amount of 0.25 mol of this substance has a mass of 73.6 grams.

2 marks

Step 1 Express the formula $F_m = \text{mass} / \text{mol}$

$\Rightarrow F_m = 73.6 / 0.25 = 294.4 \text{ g/mol}$

1 mark correct formula

1 mark for correct calculation

c. Find the molecular formula of NutraSweet.

3 marks

Consequential marks are given here for the use of the molar mass given in b) and the empirical formula given in a)

$\Rightarrow x = \text{molar mass} / \text{empirical mass.}$

1 mark for correct empirical mass

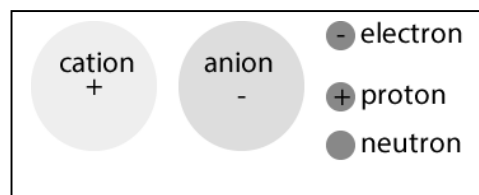
1 mark for calculation of "x"

$\Rightarrow x = 294.4 / 294 = 1$

1 mark for correct multiplication of empirical formula by x to get to the molecular formula.

Empirical formula is the same as the molecular formula.

2. Using some or all of the symbols shown on the right answer the questions below.



- a. In the box below draw a detailed, labelled diagram of a small section of the lattice of an ionic substance before and after impact with a hammer. Describe how the substance will respond to the impact. Explain your reasoning with reference to your diagram

4 marks

1 mark for a drawing showing alternate cation, anion structure before impact
1 mark suggesting the material will shatter.
1 mark for a drawing showing overlapping cations and anions after impact
1 mark suggesting repulsive forces will act to push the layers apart.

- i. Describe the forces acting in the ionic lattice prior to impact.

Directional electrostatic forces of attraction between anions and cations

1 mark for using the word directional.

1 mark for stating that the forces of attraction act between anions and cations

Any plausible explanation is taken as long as it is clear the directional forces of attraction act between anions and cations.

2 marks

- ii. Describe how these forces change after impact.

Directional electrostatic forces of repulsion between neighbouring anion and anion and between cation and cation

1 mark for using the word directional forces of repulsion.

1 mark for stating that the forces of repulsion act between anion to anion and cation to cation

Any plausible explanation is taken as long as it is clear the directional forces of repulsion act between like charges.

2 marks

- a. In the box below draw a detailed and correctly labelled diagram of a small section of the metallic lattice of pure iron. Explain, using correct terminology and with reference to your diagram, what is likely to happen when it is impacted hard with a hammer.

2 marks

1 mark for a drawing showing cations in a sea of delocalised electrons before and after impact

1 mark suggesting the material will not shatter but maintain its structural strength.

- i. Describe the metallic bonding model.

1 mark - lattice of positive ions (cations)

1 mark – sea of delocalised electrons.

Any plausible definition will suffice as long as delocalised electrons are mentioned and positive ions.

Positive ions in a sea of delocalised electrons.

2 marks

- ii. Describe the forces that hold the metal lattice together before impact

- non-direction electrostatic forces of attraction.

The word non-directional must be specified as must the word “attraction”.

1 mark

- iii. Describe how the forces that hold the metal lattice together change after impact.

No change- metals are malleable and maintain structural strength when bent out of shape.

1 mark for stating no change. No reason needs to be given.

1 mark

3. Propane is used to heat up the backyard BBQ.
Propane is a gas with the formula C_3H_8 .
If an amount of 8.80 kilograms of propane is present in the bottle calculate the following.

- a. The amount, in mol, of propane present in the bottle.

1 marks for converting 8.80 kilograms into 8,800 grams.

1 mark for correct calculation.

$$8,800 / F_m = 8,800 / 44.0 = 200$$

2 marks



- b. The amount in mol of atoms present in the bottle.

consequential marks given if answer to a. above is used.

1 mark for correctly identifying 11 atoms per molecule of propane.

1 mark for multiplying the mol of propane by 11.

$$\Rightarrow 11 \times 200 = 2200$$

2 marks

- c. Calculate the amount, in grams, of carbon present in the bottle.

consequential marks given if answer to a. or b. above is used.

This can be done through % composition or calculating the mol of carbon atoms and multiplying by atomic mass of carbon.

$$\Rightarrow \text{Mol of carbon atoms} = 3 \times 200 = 600$$

1 mark

$$\Rightarrow \text{mass of carbon} = 600 \times 12 = 7,200 \text{ grams or } 7.2 \text{ kg}$$

1 mark

Or

find percentage composition of carbon in propane

$$\Rightarrow (36/44) \times 100 = 81.8\%$$

1 mark

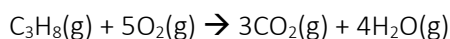
\Rightarrow multiply by the mass of propane

$$\Rightarrow 8,800 \text{ g} \times 0.818 = 7,200 \text{ g or } 7.2 \text{ kg}$$

1 mark

2 marks

- d. The chemical equation for the combustion reaction of propane with atmospheric oxygen is given below.



- i. Calculate the amount, in mol, of CO_2 produced if 3 mol of propane react completely with oxygen.

1 mark for proper use of stoichiometric ratio

1 : 3

1 mark for correct number of CO_2 mol produced

9 mol of CO_2

2 marks

- ii. What mass of oxygen must be supplied in order to fully burn 180.0 grams of propane?

1 mark for calculating the mol of propane

$180/44 = 4.1 \text{ mol}$

1 mark for using the correct stoichiometric ratio to derive the mol of oxygen needed

1:5

1 mark for calculating the mol of oxygen needed

$4.1 \times 5 = 20.5 \text{ mol}$ (consequential marks can be given if incorrect mol of propane was originally calculated)

1 mark for correct mass of oxygen (O_2)

$20.5 \times 32.0 = 0.656 \text{ kg}$ or 656 grams.

4 marks

4) Blacksmiths often used quenching to change the properties of iron.

- i. What is quenching?

1 mark for stating that quenching is the heating and rapid cooling of a piece of metal

1 mark

- ii. How does quenching change the properties of iron?

1 mark for stating the process hardens the metal.

1 mark

- iii. Explain how these changes come about?

1 mark for stating that rapid cooling creates smaller crystals in the metal structure.

1 mark for stating the relationship between small crystal structures and hardness. Smaller crystals prevent sliding of crystals past each other and hence provide some resistance to distortion.

2 marks

