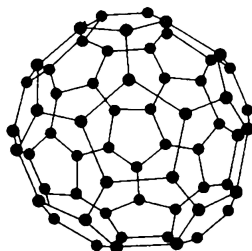


1. A fullerene is a nanomaterial consisting of carbon atoms arranged in a regular shape such as the ball-like shape below:



- (a) State what is meant by the term 'nanomaterial'.

_____ (1)

- (b) Fullerenes are potentially useful due to their unique properties, including excellent electrical conductivity and extreme durability (strength).
Suggest one possible use for fullerenes, and give a reason for this suggestion.

_____ (2)

2. Consider a mixture of salt, sand, and water. The salt completely dissolves in the water, but the sand is insoluble (does not dissolve at all). The melting points and boiling points of the three substances are listed below:

Substance	Melting point (°C)	Boiling point (°C)
Water	0	100
Salt	801	1465
Sand	1713	2950

- (a) State whether this mixture is homogeneous or heterogenous.

_____ (1)

- (b) Describe a method to separate the salt from the sand and water. You may include multiple steps if necessary.

_____ (3)

3.
(a) Describe, using a diagram, the particles that all materials consist of.

(2)

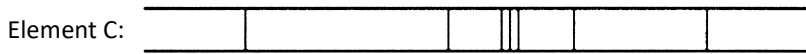
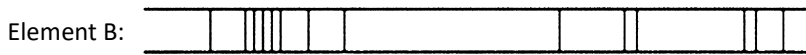
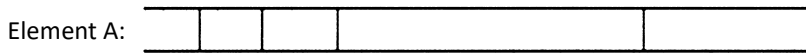
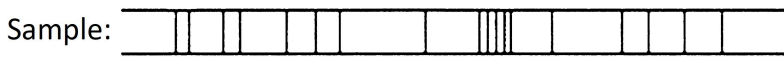
- (b) When these particles are energised by heat or electricity, they produce specific colours (wavelengths) of light, often represented as lines on a spectrum:



State what the presence of specific lines tells us about the structure of the particles that all materials consist of.

(1)

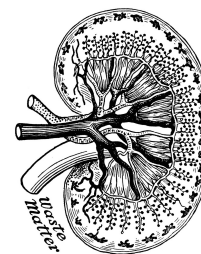
- (c) Consider a sample of a material being analysed using absorption spectroscopy by comparing its spectrum with the spectra of pure elements:



State which of the elements A, B, and C are present in the sample of material.

(1)

4. Consider the isotope copper-63, which can be converted into chemicals which measure blood flow in the kidneys.



- (a) Calculate the number of neutrons in copper-63.

_____ (1)

- (b) Write copper-63 in A_ZX form.

_____ (1)

- (c) Another isotope of copper is copper-65.

State whether the physical and/or chemical properties of copper-65 are different from copper-63.

_____ (1)

- (d) Write the electron configuration of copper, using subshell notation.

_____ (2)

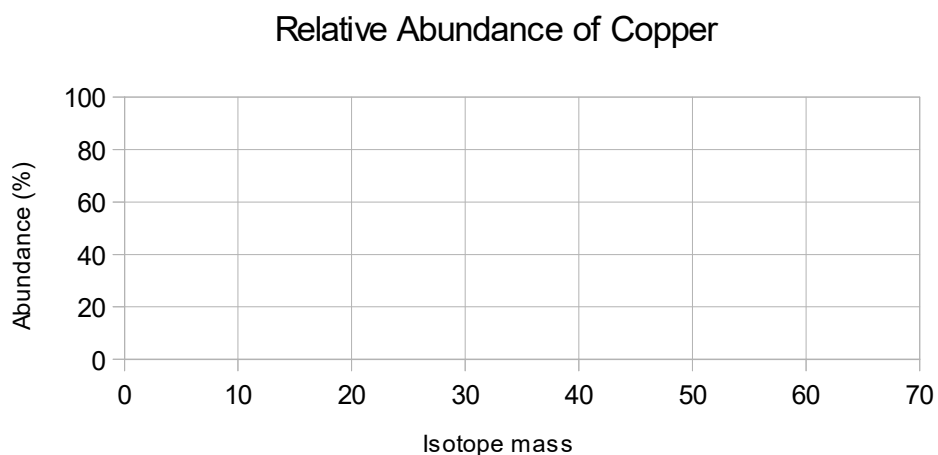
- (e) Write the electron configuration of Cu^{2+} , using subshell notation.

_____ (2)

- (f) Calculate the relative atomic mass of copper, given that the relative atomic masses of its naturally occurring isotopes are 62.93 (69.17%) and 64.93 (30.83%).

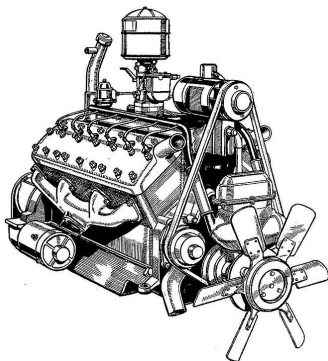
_____ (2)

- (g) On the axes below, plot the relative abundance of copper.



(1)

5. The engines of cars are powered by burning petrol with oxygen from air. For the engine to work well, there must be around 13 times as many oxygen molecules compared to fuel molecules.



- (a) One molecule that can be burnt as fuel is octane, C_8H_{18} .

Calculate the molar mass of C_8H_{18}

_____ (1)

- (b) Calculate the number of moles of O_2 in 130 g.

_____ (2)

- (c) Explain whether an engine would work well if 130 g of O_2 is reacted with 10 g of octane.

_____ (3)

6. The periodic table arranges the elements in way that helps to see patterns (trends) in properties.

- (a) State whether calcium or carbon has a larger atomic radius.

_____ (1)

- (b) State whether boron or fluorine has a higher electronegativity.

_____ (1)

- (c) State which block of the periodic table strontium is found in.

_____ (1)