Chapter 5: States of matter

Homework questions

1 Magnesium is a Group 2 metal and at 23 000 parts per million it is the seventh most abundant element in the Earth's crust. Once magnesium starts to burn in air it is impossible to extinguish since it reacts with both the main gases present – oxygen and nitrogen.

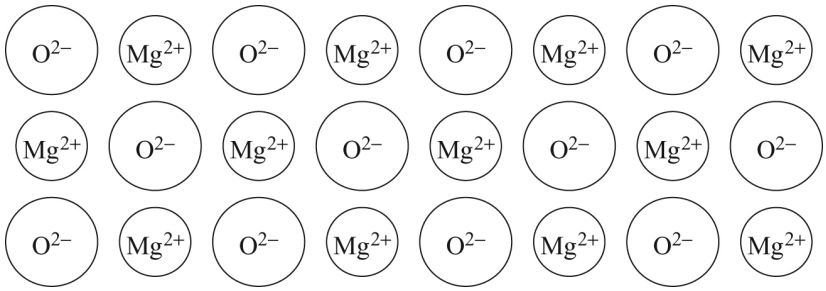
a In an experiment on burning magnesium in oxygen it was found that when 0.072 g of magnesium were burned in oxygen, 1.027 g of magnesium oxide were produced.

i Write the balanced symbol equation for the reaction, including state symbols. [2]

ii Calculate the theoretical mass of magnesium oxide that should be formed. [2]

iii Calculate the percentage yield for the formation of magnesium oxide. [1]

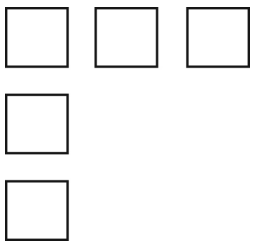
b The diagram below shows the layers of ions in magnesium oxide.
Use the diagram to explain the facts below:



i Magnesium oxide has a higher melting point than sodium chloride. [3]

ii Magnesium oxide does not conduct electricity in the solid state but does in the molten (liquid) state. [2]

c The other main product of magnesium burning in air is magnesium nitride (Mg_3N_2). This compound consists of magnesium ions and nitride ions (N^{3-}).



Copy and complete the diagram above for the nitride ion by:

i adding labels for the subshells [1]

ii using different colours for the electrons from the nitrogen atom and from the magnesium atom [1]

iii showing how the electrons are arranged [1]

Total = 13

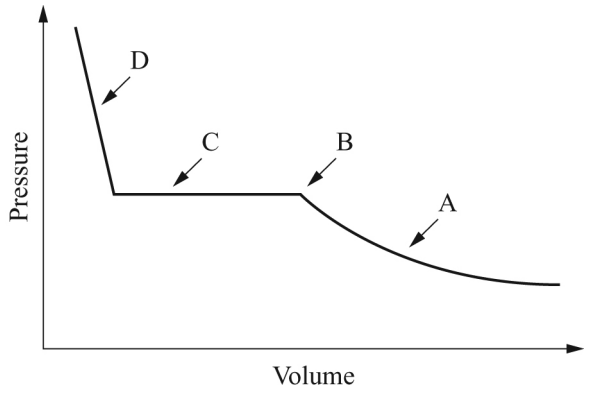
2 In order to find the relative molecular mass of a liquid hydrocarbon, X, the liquid was injected into a syringe oven that was kept at a temperature of 100 °C. After vaporisation of the injected liquid it was found that 0.172 g of liquid produced 61.4 cm^3 of vapour. The pressure was 1.01×10^5 Pa and the universal gas constant is 8.314 $J\ K^{-1}$.

a Calculate the relative atomic mass of the hydrocarbon. [5]

b When 20 cm^3 of the vapour of X was burned in oxygen, 120 cm^3 of carbon dioxide were produced. Calculate the number of carbons in a molecule of X and hence find the molecular formula of X. [2]

c Explain why iodine is soluble in X but sodium chloride is insoluble in X. [4]

d Another hydrocarbon, Y, has a boiling point below that of X. Its vapour is kept in a sealed vessel at a temperature fixed just above its boiling point. The volume of the container is then reduced using a piston. The pressure is also measured. A graph to show how the pressure of the vapour varies as the volume is reduced is shown below.



i Describe what is happening to the particles at A. [1]

ii What is starting to happen at B? Explain why this is possible. [3]

iii Describe the spacing of the particles and their movement at C. [2]

iv What is happening at D? Why is the graph so steep here? [2]

v Explain why the vapour of C is a real gas but not ideal. [2]

Total = 21

3 The table below shows the properties of five substances.

Substance	Electrical conductivity		Melting point / °C
	as solid	as liquid	
A	poor	poor	–7
B	poor	poor	1610
C	good	good	961
D	good	good	98
E	poor	good	775

a Which of the substances from **A** to **E** could be:

i potassium chloride

ii bromine

iii chromium

iv sodium

v silicon dioxide [5]

b Diamond has similar properties to substance **B**. Explain its poor electrical conductivity in the solid state. [2]

c Explain why a substance having similar properties to substance **E** has:

i a high melting point [2]

ii good electrical conductivity in the liquid state but poor electrical conductivity in the solid state. [2]

d The structures of metals can be used to explain their properties.

i Draw a diagram to show the structure of a metal and use it to explain the electrical conductivity of metals in both the solid and liquid states. [4]

ii Also use your diagram to explain why metals are ductile. [2]

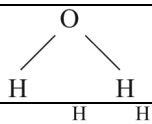
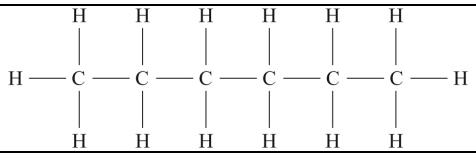
iii Explain why introducing atoms of another metal to make an alloy will make a metal less ductile. [2]

iv One alloy of copper is bronze. A typical bronze composition is 90% copper and 10% tin, by mass. In a 10 g sample of this alloy what is the molar ratio of Cu : Sn expressed to the nearest whole number? [A_r(Cu) = 63.5; A_r(Sn) = 119] [4]

Total = 23

4 One experiment used to compare the dipoles present in different liquid molecules is to run a stream of the liquid past a charged plastic rod. If the molecules have dipoles present then there will be a deviation of the liquid stream and its magnitude will depend on how polar the molecules are.

a The results for such an experiment are shown in the table below:

Compound	Structure	Relative deviation
water		very large
hexane		none

i Explain the different behaviours of these two liquids in this experiment. [2]

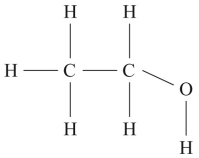
ii State the bond angles in both the molecules. [2]

iii For water, draw a diagram of at least **two** molecules and show the intermolecular bonding between them. Your diagram should contain any dipoles present and the intermolecular forces should be labelled. [3]

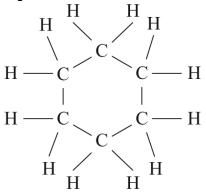
iv Explain why hexane does not mix with water. [2]

b Extend the table from part a above to predict the deviation that would be obtained if the following liquids were tested in the same way. Explain your answers.

i ethanol [1]



ii cyclohexane [1]



c **i** Write the symbol equation for the complete combustion of 1 mol of ethanol. [1]

ii Calculate the volume of carbon dioxide formed when 0.025 mol of ethanol are burned in excess oxygen at room temperature and pressure.
[Assume that 1 mol of gas occupies 24 dm^3 under these conditions.] [2]

Total = 14