Chapter 5: States of matter

Homework marking scheme

1 **a** **i** $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
balanced equation [1]
correct state symbols [1]

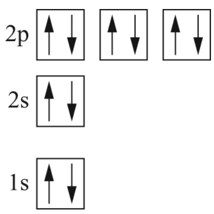
ii number of moles of magnesium oxide = number of moles of magnesium = $\frac{0.072}{24.3}$ [1]
$= 2.96 \times 10^{-3}$ mol
mass of magnesium oxide that should be formed = $2.96 \times 10^{-3} \times 40.3 = 1.193$ g [1]

iii percentage yield of magnesium oxide = $\frac{1.027}{1.193} \times 100\% = 86.1\%$ [1]

b **i** The ions in sodium chloride are Na^+ and Cl^- [1]
The electrostatic attractive forces between magnesium ions and oxide ions are greater because of the greater charges on each of the ions. [1]
Therefore, magnesium oxide has a higher melting point because a greater amount of energy is required to separate the ions and form a liquid. [1]

ii In the solid state the charge-carrying ions are not free to move and therefore a current cannot flow. [1]
However, in the liquid state the charge carrying ions are free to move and therefore a current will flow. [1]

c **i**



Correct labelling of the energy levels (see diagram). [1]

ii Three electrons (from the magnesium) labelled as arrows in the three 2p orbitals or pointing in the same direction. [1]

iii The other five electrons from the nitrogen that should be easily distinguishable from the three electrons from the magnesium. [1]

2 **a** Use the equation $n = \frac{PV}{RT}$ [1]
Use the correct quantities in the equation:
373 K for the temperature [1]
61.4×10^{-6} m^3 for the volume [1]
$n = \frac{1.01 \times 10^5 \times 61.4 \times 10^{-6}}{8.314 \times 373} = 0.002$ mol [1]
$M_r = \frac{m}{n} = \frac{0.172}{0.002} = 86$ g mol^{-1} [1]

b The volume of carbon dioxide is 6× that of the hydrocarbon, X. Therefore, there must be six carbons in the molecule. [1]
mass of carbons = 6 × 12 = 72; remainder = 86 – 72 = 14 and so the formula is C_6H_{14} [1]

c Iodine is a non-polar molecule; [1]
non-polar substances dissolve well in non-polar solvents like hexane (C_6H_{14}). [1]

Sodium chloride consists of charged ions, [1]
which dissolve well in polar solvents but not non-polar solvents like hexane (C_6H_{14}). [1]

d **i** The particles are coming closer together or the space between the particles is being reduced. [1]

ii The gas is condensing to a liquid, [1]
the particles are becoming close enough together [1]
so that the intermolecular forces are strong enough to hold the particles in liquid form. [1]

iii The particles are very close together [1]
but 'roll over' each other. [1]

iv All the particles are in liquid form and very close together [1]
because the particles are very close together they cannot be compressed easily. [1]

v There are attractive forces between the particles in real gases, but in ideal gases there should be no attractive forces between the particles. [1]
The particles have a finite volume in real gases, but in ideal gases the volume of the particles should be negligible. [1]

3 **a** **i** E [1]

ii A [1]

iii C [1]

iv D [1]

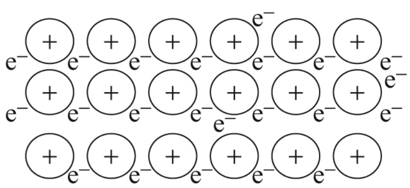
v B [1]

b There are no free electrons [1]
the outer-shell electrons are all 'used up' in covalent bonding. [1]

c **i** E is a giant ionic substance, the electrostatic attractive forces between the ions are very strong [1]
and therefore a lot of energy is required to separate the particles and melt the substance. [1]

ii In the solid state, the current-carrying ions are not free to move and therefore no current will flow [1]
in the liquid state the ions are free to move and carry the current. [1]

d **i**



at least two rows of ions [1]
electrons in between ions. [1]
The delocalised electrons [1]
are able to move and carry the current in both states of matter. [1]

ii If one layer of ions moves across another [1]
the structure is identical and therefore not disrupted. [1]

iii The new atoms are of a different size [1]
they stop the layers sliding over each other so readily. [1]

iv In 10 g of alloy, there are 9 g of Cu and 1 g of tin [1]

$10 \text{ g Cu} = \frac{10}{63.5} \text{ mol} = 0.157 \text{ mol}$ [1]

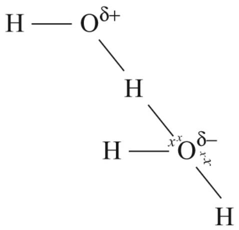
$1 \text{ g tin} = \frac{1}{119} \text{ mol} = 0.00840 \text{ mol}$ [1]

molar ratio Cu : Sn = 0.157 : 0.00840 = 19 : 1 (has to be whole number ratio) [1]

4 **a** **i** Water is polar, hexane is non-polar. [1]
Water molecules will align themselves and be deviated by the electrostatic field; hexane will not. [1]

ii In water the H–O–H angle is 104.5°. [1]
In hexane the H–C–H angle is 109.5°. [1]

iii



correct dipoles [1]
lone pairs on oxygen [1]
hydrogen bond, shown as dashed line, between lone-pair on oxygen on one molecule and an electron-deficient hydrogen on the other. [1]

iv Hexane is non-polar and so no intermolecular interactions are formed between the water and the hexane, [1]
it is not energetically favourable for the liquids to mix. [1]

b **i** Ethanol has a dipole in the molecule/is polar. Therefore, a stream of ethanol will be deviated. [1]

ii Cyclohexane is non-polar/has no dipole in the molecule. Therefore, a stream of cyclohexane will not be deviated. [1]

c **i** $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ [1]

ii number of moles of carbon dioxide = 2 × no. of moles of ethanol = 0.050 mol [1]
volume of carbon dioxide = $n \times 24\ dm^3 = 0.050 \times 24\ dm^3 = 1.2\ dm^3$ [1]