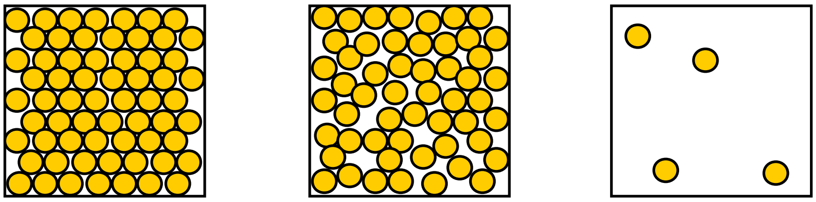
EDEXCEL INTERNATIONAL GCSE CHEMISTRY
EDEXCEL CERTIFICATE IN CHEMISTRY
ANSWERS

SECTION A

Chapter 1

1. a) melting
   b) freezing
   c) subliming / sublimation
   d) subliming / sublimation

2. a)



solid liquid gas

Note: Solids should have regularly packed particles touching. Liquids should have most of the particles touching at least some of their neighbours, but with gaps here and there, and no regularity. Gases should have the particles well spaced.

b) Solids: vibration around a fixed point. Liquids: particles can move around into vacant spaces, but with some difficulty because of the relatively close packing.

c) Evaporation: Some faster moving particles break away from the surface of the liquid. Boiling: Attractive forces are broken throughout the liquid to produce bubbles of vapour.

d) In a sealed container, vapour particles in the space above the liquid return and stick to the surface of the liquid at the same rate as liquid particles are evaporating.

a) A - gas ; B - liquid; C - solid; D - liquid; E – solid

b) C. It sublimes at a very high temperature and so takes the most heat energy to break the attractions between the particles to form a gas.

c) A. It turns to a gas at the lowest temperature and so takes the least heat energy to break the attractions between the particles to form a gas.

d) A, because it is a gas.

e) It sublimes. That means that it turns straight from a solid to a gas and so there is never any liquid to boil.

f) D. It has the lower boiling point of the two liquids (B and D), and therefore the weaker attractions between its particles. A higher proportion of its particles will have enough energy to escape from the surface.

4. a) The ammonia and hydrogen chloride particles have to diffuse through the air in the tube, colliding with air particles all the way.

b) (i) Its particles will move faster.

(ii) It would take slightly longer for the white ring to form, because the gas particles would be moving more slowly at the lower temperature.

c) Ammonia particles are lighter than hydrogen chloride particles and so move faster. The ammonia covers more distance than the hydrogen chloride in the same time.

d) (i) ammonium bromide

(ii) The heavier hydrogen bromide particles would move more slowly than the hydrogen chloride particles, and so the ring would form even closer to the hydrobromic acid end than it was to the hydrochloric acid end. The ring will also take slightly longer to form because of the slower moving particles.

5. There's no "right" answer to this. The question is designed to show students how carefully they need to think about practical details of experiments they suggest, and to stimulate discussion.

Key points:

The two liquids should be compared in identical apparatus, side by side so that the temperature is always identical for the two throughout the time needed to run the experiment. You would need equal volumes of liquids, and equal volumes of water. All this stresses the importance of a "fair test". Likely suggestions would involve having two tubes (gas jars, measuring cylinders, burettes, for example) of water with the coloured liquids introduced into the bottom of them. A simple observation of the progress of the colours up the tubes would be enough. There could be some problems if the liquids varied markedly in colour intensity. A student suggesting that you might put some white card or paper behind the tubes to make it easier to see would deserve some praise.

The main practical problem lies in getting the bottom coloured layer into place without any prior mixing. You could have the liquids in small weighing bottles (as in the text) which are lowered into water in a (wide) measuring cylinder or gas jar on a bit of cotton, but there will inevitably be some mixing. Alternatively, you could place the weighing bottle in the bottom of an empty gas jar or measuring cylinder, and then add water very carefully to avoid mixing (perhaps via a bit of rubber tubing to the bottom of the gas jar, and added very slowly). Students should be explicit about how they get the weighing bottle and the water into the gas jar with as little mixing as possible.

A better alternative, which would make comparisons easier, might be to use burettes full of water, and introduce the coloured liquids using the bulbs from teat pipettes (or similar). Fill the bulb with liquid, and attach it to the tip of the burette. Open the tap, squeeze very gently to force the coloured liquid into the burette, and then close the tap again. However, it would be a quite exceptional student who thought of that this early on in the course.

Chapter 2

1. a) 9
   b) sum of protons + neutrons in the nucleus
   c) 9p, 10n, 9e
   d) Dots or crosses diagram showing 2,7

2. a) 26 p, 30 n, 26 e
   b) 41 p, 52 n, 41 e
   c) 92 p, 143 n, 92 e

3. a) Atoms with the same atomic number but different mass numbers. They have the same number of protons, but different numbers of neutrons.
   b) ^{35}Cl: 17 p, 18 n, 17 e; ^{37}Cl: 17 p, 20 n, 17 e
   c) Both: 2,8,7

4. Dots or crosses diagrams showing a) 2,8,1; b) 2,8,4; c) 2,8,6

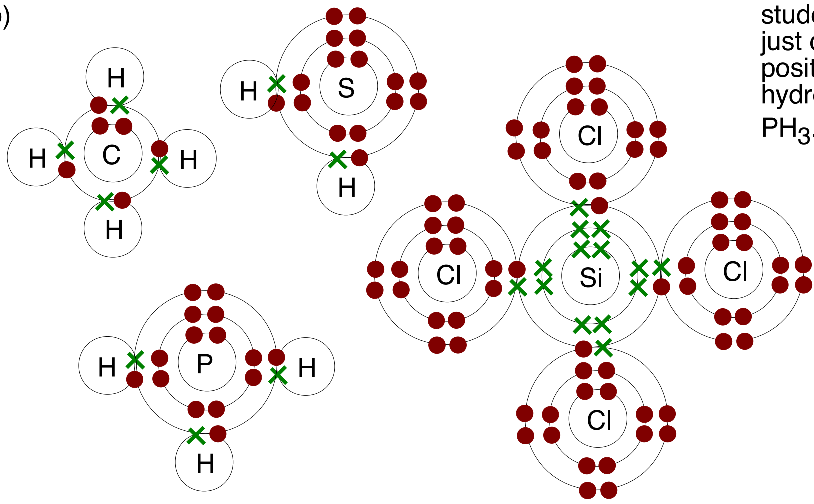
5. a) 5; b) 7; c) 4; d) 8

6. a) A, F
   b) A
   c) C
   d) B, D
   e) calcium
   f) 82, lead
   g) Dots or crosses diagram showing 2,8,8,1

Chapter 3

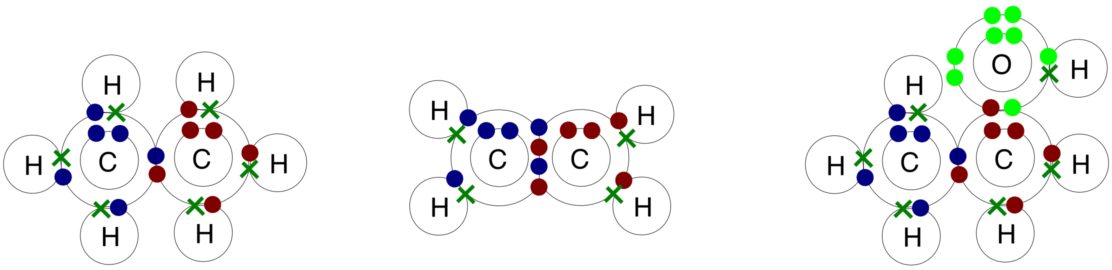
1. a) A pair of electrons which is shared between two atoms. The atoms are held together because the nucleus of each is attracted to the shared pair.

   b)



It doesn't matter whether students use dots or crosses or just different colours - or what positions (N,S,E,W) the hydrogens occupy in the H_2S or PH_3.

2.



It doesn't matter what variations of colours or dots and crosses are used. In the ethanol case, the -OH group could equally well have been drawn swapped with either of the other two hydrogens on the right-hand carbon atom.

3. a) (i) An atom or group of atoms which carries an electrical charge.

   (ii) Attractions between positively and negatively charged ions holding them together.

   b) Correct electronic structures for

   (i) Na 2,8,1 and Cl 2,8,7

   (ii) Li 2,1 and O 2,6

   (iii) Mg 2,8,2 and F 2,7.

   Diagrams (similar to those in the chapter) showing transfer of electrons, and the charges and electronic structures of the ions formed. (or words to the same effect).

   In (i), show 1 electron transferred from Na to Cl leaving Na^+ $[2,8]^+$ and Cl^- $[2,8,8]^-$

   In (ii), show 2 lithium atoms each giving 1 electron to O leaving 2 x Li^+ $[2]^+$ and O^{2-} $[2,8]^{2-}$

   In (iii) , show 1 Mg giving an electron each to 2 fluorines leaving Mg^{2+} $[2,8]^{2+}$ and 2 x F^- $[2,8]^-$

4. a) Mg 2,8,2. Explanation in words or diagrams showing the 2 outer electrons forming a sea of electrons (becoming delocalised) - similar to the sodium diagram in the chapter, but with 2 outer electrons rather than 1, and 2 positive charges on the ions.

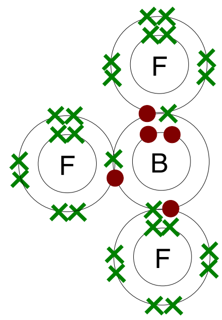
b) Boiling point is a guide to the energy needed to break the metallic bond. The stronger the bond, the more energy is needed to separate the particles and the higher the boiling point. The bonds get stronger from Na to Mg to Al.

c) The metals have 1, 2 and 3 electrons respectively in their outer energy level. These can be delocalised to leave increasingly positively charged ions and an increasing number of electrons in the "sea" as you go from Na to Mg to Al. This leads to increasing amounts of attraction between ions and "sea", and hence more energy is needed to break them.

d) Delocalised electrons are mobile.

5. (weakest) hydrogen, phosphorus trifluoride, ammonia, ethanol, water, ethanamide (strongest). Higher intermolecular attractions produce higher boiling points.

6. a)



Note: This is included because it is a simple example of a perfectly stable covalent compound where there aren't four pairs of electrons around one of the atoms - in other words, it is nothing like a noble gas structure. Despite the impression often given at GCSE, such compounds are very common - although in the great majority of cases, there are *more* than 8 electrons around one atom rather than fewer.

Students might ask why it doesn't form ionic bonds. The amount of energy needed to remove 3 electrons so close to the boron nucleus is too great. Point out that this will be explored in some detail in chemistry at a higher level.

b) Correct electronic structures for Al 2,8,3 and F 2,7. Diagrams (similar to those in the chapter) showing transfer of electrons, and the charges and electronic structures of the ions formed. (or words to the same effect).

Show 1 Al giving an electron each to 3 fluorines leaving Al^{3+} $[2,8]^{3+}$ and 3 x F^- $[2,8]^-$

(c) The outer level of the boron in BF_3 only contains 3 pairs of electrons (6 electrons) whereas there would be room for 4 pairs (8 electrons).

Chapter 4

1. a) Diagrams as those in chapter. Graphite diagram should show the layer structure or state this in words. The diamond structure must be accurate, with no “spare” bonds between unconnected atoms.

   b) Similar: One of, for example: high melting points (strong covalent bonds all have to be broken); lack of solubility in solvents (same reason).

   Different: 2 of: diamond hard, graphite soft (strong covalent bonds in 3D in diamond difficult to break; weaker forces between layers in graphite allow layers to slide); graphite less dense than diamond (comparatively large distances between the layers in graphite mean that less atoms can be fitted into a given volume); graphite conducts electricity, diamond doesn't (each carbon in graphite forms only 3 ordinary covalent bonds, with the other electron free to move. All diamond's outer electrons are locked in single covalent bonds and aren’t free to move).

2. a) The atoms in the metal crystal can roll over each other into new positions. Diagram similar to the one in the chapter would be useful.

   b) Any of:

   Strong *or* high melting point *or* high boiling point, because of the powerful attractions in the metallic bond which take a lot of force *or* heat energy to break.

   Conducts electricity, because the delocalised electrons in the metallic bond are free to move.

   Conducts heat, because heat energy is transferred by the movement of the delocalised electrons.

   c) The presence of differently sized atoms breaks up the regular pattern and stops layers sliding easily. Diagram similar to the one in the chapter would help.

3. a) Strong attractions between positive and negative ions need large amounts of energy to break.

   b) A small displacement of the layers of ions if subjected to a stress brings like charges together. Repulsion shatters the crystal.

   c) Attractions between ions and polar water molecules are strong enough to overcome the attractions between the ions themselves. Crystal is pulled apart.

4. a) Giant covalent

   b) Molecular

   c) Molecular

   d) Giant ionic

   e) Giant metallic

   f) Molecular

   g) Giant metallic

   h) Giant covalent

5. a) Solid. Giant covalent structure with strong covalent bonds in 3-dimensions.

   b) Hard. Explanation as in a).

   c) No. No ions present to give strong attractions with water molecules, and the bonds in silicon dioxide are too strong to be easily broken.

   d) Occurs as quartz - a component of rocks like granite. Quartz is a hard solid which doesn’t dissolve in water (otherwise it would wash out of the rocks which contain it). This is all consistent with the predictions in a) to c).

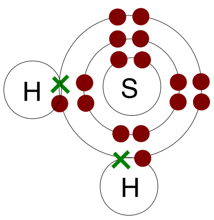
Chapter 5

1.

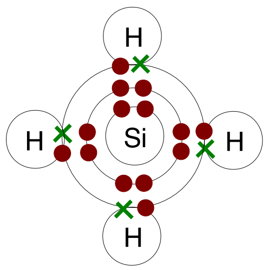
PbO	$NaBr$
$MgSO_4$	$ZnCl_2$
K_2CO_3	$(NH_4)_2S$
$Ca(NO_3)_2$	$Fe(OH)_3$
$FeSO_4$	$CuCO_3$
$Al_2(SO_4)_3$	$Ca(OH)_2$
$CoCl_2$	CaO
$AgNO_3$	FeF_3
NH_4NO_3	RbI
Na_2SO_4	Cr_2O_3

2. (a) (i) H: 1; S: 2,8,6

(ii)



(iii) H_2S



(b) There are 4 unpaired electrons in the outer level of silicon, and therefore room for 4 hydrogens to form covalent bonds.

The formula is SiH_4. (Allow H_4Si. Nothing so far has determined which way around it is likely to be written.)

3. a) $Ca + 2H_2O$ ----> $Ca(OH)_2 + H_2$

b) $2Al + Cr_2O_3$ ----> $Al_2O_3 + 2Cr$

c) $Fe_2O_3 + 3CO$ ----> $2Fe + 3CO_2$

d) $2NaHCO_3 + H_2SO_4$ ----> $Na_2SO_4 + 2CO_2 + 2H_2O$

e) $2C_8H_{18} + 25O_2$ ----> $16CO_2 + 18H_2O$

f) $Fe + 2HCl$ ----> $FeCl_2 + H_2$

g) $Zn + H_2SO_4$ ----> $ZnSO_4 + H_2$

h) $Fe_3O_4 + 4H_2$ ----> $3Fe + 4H_2O$

i) $2Mg + O_2 \longrightarrow 2MgO$

j) $Pb + 2AgNO_3 \longrightarrow Pb(NO_3)_2 + 2Ag$

k) $2AgNO_3 + MgCl_2 \longrightarrow Mg(NO_3)_2 + 2AgCl$

l) $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

m) $Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

4. a) $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$

b) $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

c) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

d) $2Na + Cl_2 \longrightarrow 2NaCl$

e) $Fe_2O_3 + 6HNO_3 \longrightarrow 2Fe(NO_3)_3 + 3H_2O$

f) $2Zn + O_2 \longrightarrow 2ZnO$

g) $CuO + 2HCl \longrightarrow CuCl_2 + H_2O$

h) $BaCl_2 + Na_2SO_4 \longrightarrow BaSO_4 + 2NaCl$

i) $Zn + Pb(NO_3)_2 \longrightarrow Pb + Zn(NO_3)_2$

j) $CuSO_4 + 2KOH \longrightarrow Cu(OH)_2 + K_2SO_4$

k) $Mg + CuO \longrightarrow MgO + Cu$

l) $4Na + O_2 \longrightarrow 2Na_2O$

m) $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$

5. a) $CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

b) $Zn(s) + CuSO_4(aq) \longrightarrow Cu(s) + ZnSO_4(aq)$

c) Mg(s) + H_2SO_4(aq) ----> $MgSO_4$(aq) + H_2(g)

d) $Fe_2(SO_4)_3$(aq) + 6NaOH(aq) ----> 2$Fe(OH)_3$(s) + 3Na_2SO_4(aq)

e) 2Al(s) + 6HCl(aq) ----> 2$AlCl_3$(aq) + 3H_2(g)

f) Fe_2O_3(s) + 3H_2SO_4(aq) ----> $Fe_2(SO_4)_3$(aq) + 3H_2O(l)

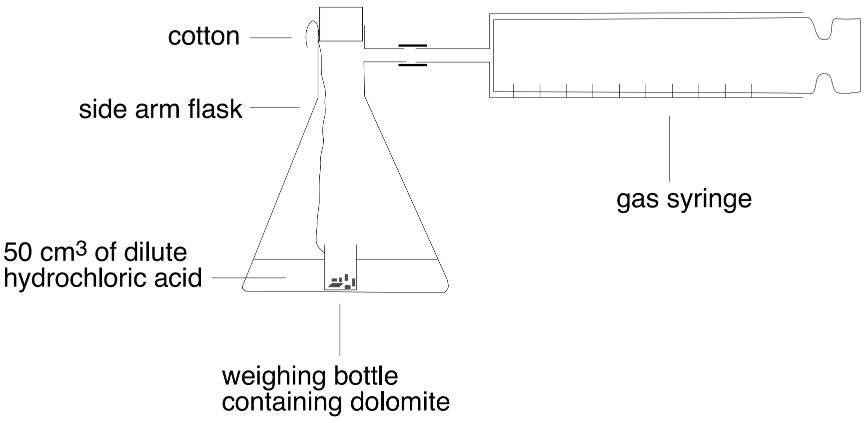
g) $PbCO_3$(s) + 2HNO_3(aq) ----> $Pb(NO_3)_2$(aq) + CO_2(g) + H_2O(l)

h) Mg(s) + H_2O(g) ----> MgO(s) + H_2(g)

i) C(s) + 2CuO(s) ----> 2Cu(s) + CO_2(g)

Chapter 6

1. a)



Collection of gas over water into an inverted measuring cylinder is an acceptable alternative. Pieces of dolomite in weighing bottle so that reaction can be started with no loss of gas. Description should include shaking the flask to upset the weighing bottle, followed by constant shaking, and recording the volume of gas in syringe at 30 second intervals.

b) Graph should be completely smooth with the axes properly labelled.

c) At the very beginning of the reaction. Reaction can only happen when acid particles hit the solid dolomite. Numbers of acid particles are greatest at the beginning of the reaction before any get used up - therefore the greatest number of collisions per second and the fastest reaction is at the beginning.

d) 70 secs (read this off the graph, and allow some tolerance depending on the size of graph paper available.)

e) (i) lower initial rate; same volume of gas.

(ii) initial rate lower; half the volume of gas (50 cm^3).

(iii) initial rate the same; half the volume of gas (50 cm^3). (The initial rate depends on the original concentration of the acid which is still the same.)

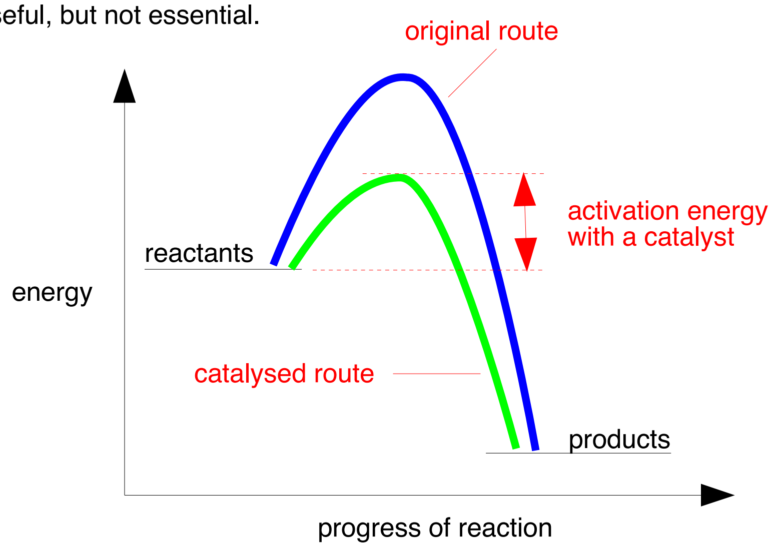
(iv) initial rate faster; same volume of gas.

2. a) Time taken for the reaction would increase. Reaction happens when acid particles collide with the magnesium. The concentration of acid is less and so there will be fewer collisions per second, and therefore a slower reaction.

b) Time taken for the reaction would decrease. The acid particles are moving faster and so collide with the magnesium more often. Reaction only happens if the energy of the collision equals or exceeds activation energy. At higher temperatures the collisions are more energetic and so a greater proportion of them are effective.

(c) Answers could include: Acid will be used up quickly immediately around the magnesium; stirring brings fresh acid into contact with it. Bubbles of hydrogen form around the magnesium, preventing acid from reaching it; stirring helps to dislodge the bubbles. Bubbles of hydrogen lift the magnesium to the surface (sometimes above the surface) of the acid, lowering contact between acid and magnesium; stirring helps to prevent this.

3. a) Reactions only happen if collisions have energies equalling or exceeding activation energy. Catalysts provide an alternative route for the reaction with a lower activation energy. A diagram would be useful, but not essential.



b) To find out whether it speeds the reaction up: You could do this most simply by having two test tubes with equal volumes of the same hydrogen peroxide solution side-by-side. Add some copper(II) oxide to one and look for the faster production of bubbles. Trying to measure the difference is unnecessary.

To show that it is unchanged: Use a known mass of copper(II) oxide. When the reaction stops, filter through previously weighed filter paper, allow to dry, and reweigh. Show that the mass of copper(II) oxide is unchanged. (If it *had* changed, and you hadn't lost any during the separation process, it must have reacted in some way.)

End of Section A Questions

1. a) B: Equal numbers of protons and electrons.

   b) Li^+. 1 mark for Li, one for correct charge.

   c) 1 mark each for 1, 1, -1 (reading vertically).

   d) Sr: 2; Br 7

   e) one Sr gives an electron to each of 2 bromines (or equivalent using diagrams).

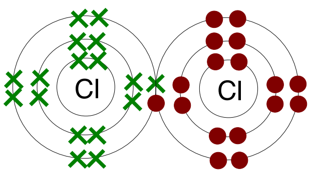
   f) $SrBr_2$

   g) High. Strong forces between positive and negative ions need large amounts of energy to break.

2. a) (i) diagram showing 2,8,7 (1 mark)

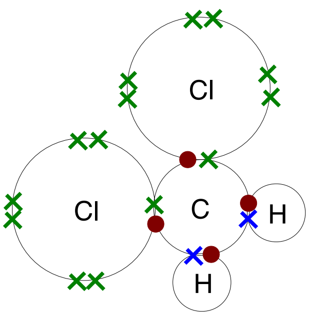
   (ii) diagram showing 2,8,8 (1 mark)

   (iii) Diagram as shown: everything correct (2); showing shared pair of electrons with flaw(s) elsewhere (1).



b) Everything correct (ignore inner electrons if drawn) showing covalent bonding (3). Lose 1 mark for each error.

The placing of the two chlorines and the two hydrogens around the carbon doesn't matter. For example, the two chlorines could just as well be drawn north and south, or north and east, or any other combination!



c) Covalent bonds not broken on melting/boiling. Intermolecular forces are weak.

3. a) (i) B, (ii) C, (iii) A. All correct (2). 1 correct (1)

   b) (i) Atoms can slide over each other on stretching. (1)

   (ii) Delocalised electrons (allow "sea of electrons" or equivalent) are free to move.

   (iii) Small displacement brings ions of like charge together causing repulsion.

   (iv) Strong bonds in 3-dimensions.

c) (i) Any acceptable property showing a difference (e.g. hardness, conduction of electricity, density (1).

(ii) For example: Graphite has layer structure. Sliding layers make graphite soft. Diamond is hard because strong bonds in 3-D. OR: Graphite has delocalised electrons, which are free to move. In diamond all the electrons are fixed between the atoms. OR: Larger gaps between layers in graphite than between atoms in diamond structure. Wasted space in graphite makes it less dense.

4. a) Any correct formula with ratio 1:2 (or 2:1). (1)

b) Before the reaction the substances taking part would have atoms of a particular mass. (1) Reaction rearranges them but would involve no change in total mass. (1)

c) (i) isotopes

(ii) ^{20}Ne: 10p, 10n, 10e; ^{22}Ne: 10p, 12n, 10e (1 mark per isotope)

(iii) No - chemical properties are governed by electrons; same number in each isotope.

5. a) $2H_2O_2(aq) \text{ ----> } 2H_2O(l) + O_2(g)$ balancing (1); state symbols all correct (1)

b) Sensible collection (e.g. gas syringe) (1). Gas tight apparatus (1).

c) Uses most of graph paper (1). Labels axes (1). Correct plot of points (1). Smooth and accurate curve (1).

d) 130 s (+/- 2) (1)

e) Reaction has stopped (1), because all the hydrogen peroxide has decomposed (1).

f) Same volume of gas produced at end of reaction. (1) More shallow curve than original plot. (1)

g) Half volume of gas (30 cm^3) produced at end of reaction. (1) More shallow curve than original plot. (1)

6. a) (i) Gas particles move faster. More frequent collisions. More energetic collisions. More reach activation energy. More energy to break bonds. (any 3 points)

(ii) Particles closer together. More frequent collisions.

(iii) Reaction happens on surface. Gauze has greater surface area.

b) More product formed in given time. Catalyst not used up. Otherwise need to spend more on heating . . . or on increased pressure. (any 2 points)