Kirkcaldy High School

Chemistry

National 5

Unit 1 – Chemical Changes and Structure

TUTORIAL ANSWERS

Introduction to Chemistry

1.

(a) E, F

(b) C

2.

Elements	Compounds
Magnesium	Water
Iron	Carbon dioxide
Hydrogen	Sodium chloride
Lead	Nitrogen dioxide

3.

(a)

(i) C, E

(ii) A, B

(b)

(i) F

(ii) D

4.

(a) Iron Sulphide

(b) Magnesium chloride

(c) Zinc sulphate

(d) Lead carbonate

5.

(a) Aluminium, sulphur

(b) Magnesium, nitrogen, oxygen

(c) Hydrogen, chlorine

(d) Lithium, sulphur, oxygen

(e) Calcium, hydrogen, oxygen

(f) Silicon, oxygen

6.

(a) A compound is made up of elements that are chemically joined together and cannot be separated by a physical method. The elements in a mixture can be separated by a physical method.

(b) Red glow, black solid formed

(c) Copper sulphide, compound

7.

(a) Salt is the solute, water is the solvent

(b)

(i) More water

(ii) More salt

(c) Labelled diagram showing ethanoic acid as the solute and water as the solution.

8.

(a) Fertilisers

(b) 15 %

(a) Rates of Reaction

1.

(a) Increase the temperature, increase the concentration of the hydrochloric acid, add a catalyst, grind up the marble chips

(b) Decrease the temperature, decrease the concentration of the hydrochloric acid, use a smaller mass of calcium carbonate

2.

(a) A, F

(b) temperature

(c) A

3.

(a) B, C

(b) Two variables have been changed (concentration and volume)

4.

(a) The surface area of the powder is higher that the lump so the reaction is faster for the powder

(b) The temperature in the fridge is lower so the rotting reaction is slower

(c) The exhaust is hot and higher temperatures speed up chemical reactions.

5.

(a) The concentration of the acid is highest at the start so the reaction is faster. The concentration drops as the reaction proceeds.

(b)

(i) Lower curve that starts and finishes at the same point as the original

(ii) Higher curve that starts and finishes at the same point as the original

(c) Rate = $\frac{\text{change in volume}}{\text{change in time}} = \frac{100\text{-}0}{60\text{-}0} = \frac{100}{60} = 1.67\ cm^3s^{-1}$

6. C, D

7.

(a) A gas (carbon dioxide) is give off so atoms are being lost form the reaction mixture

(b) Line graph

(c) Higher curve that starts and finishes at the same point as the original

(d) Rate = $\frac{\text{change in volume}}{\text{change in time}} = \frac{1.70\text{-}1.29}{75\text{-}30} = \frac{0.41}{45} = 0.00911\ gs^{-1}$

8.

(a) Catalysts

(b) 2 g

9.

(a) A lit splint added to a test tube of the gas makes a popping sound

(b) Exothermic

(c) Rate = $\frac{\text{change in volume}}{\text{change in time}} = \frac{72\text{-}20}{40\text{-}10} = \frac{52}{30} = 1.73\ cm^3s^{-1}$

(d) The number of particles increases so the probability of collisions between particles is much higher than at the lower concentration.

(e) The concentration of the acid is highest at the start so the reaction is faster. The concentration drops as the reaction proceeds.

(b) Atomic structure and bonding related to properties of materials

(i) Periodic Table and atoms

1. Diagram showing protons and neutrons in the nucleus and electrons in "shells" around the nucleus.
2.

Name of particle	Mass (amu)	Charge
Proton	1	1
Electron	0	-1
Neutron	1	0

3. Positive
4. They have the same number of positive protons as negative electrons
5.

Element	Li	Na	K	Rb	Ca
Atomic number	3	11	19	37	55
Melting point /°C	181	98	63	39	28

(a) As the atomic number rises, the melting point lowers.

(b) They have the same number of outer electrons

(c) Alkali metals

6.

(a) 9 protons, 9 electrons and 10 neutrons

(b) 19 protons, 19 electrons and 20 neutrons

(c) 8 protons, 8 electrons and 8 neutrons

7. 12 protons, 12 electrons and 13 neutrons

Element	Atomic number	Mass number	Number protons	Number neutrons	Electron arrangement
Carbon	6	12	6	6	2,4
Potassium	19	39	19	20	2,8,8,1
Argon	18	40	18	22	2,8,8

8.

(a)

(i) Sodium
(ii) Argon
(iii) Carbon
(iv) Bromine

(b)

(i) Sodium
(ii) Iodine
(iii) argon

9.

(a) $^{18}_{8}O$

(b) $^{13}_{6}C$

(c) $^{37}_{17}Cl$

(d) $^{3}_{1}H$

10.

(a) isotopes

(b) They have the same atomic number (number of protons)

(c) There is a higher proportion of $^{24}_{12}Mg$ atoms

11. An atom has atomic number 23 and mass number 51. The number of electrons is

(a) 23

(b)

(c)

(d)

12.

(a)

(b) the number of electrons equals the number of protons

(c)

(d)

13.

(a) 2,8,1

(b)

(c)

(d)

14.

(a)

(b)

(c)

(d) number of protons

15.

Particle	Ion or atom?	Atomic number	Mass number	Number of protons	Number of electrons	Number of neutrons
$^{27}_{13}Al^{3+}$	ion	13	27	13	10	15
$^{35}_{17}Cl^{-}$	ion	17	35	17	18	18
$^{24}_{12}Mg$	atom	12	24	12	12	12
$^{18}_{8}O^{2-}$	ion	8	18	8	10	10
$^{40}_{20}Ca^{2+}$	**ion**	**20**	**40**	**20**	**18**	**20**

(ii) Covalent Bonding

1.

(a) C_2H_6O or C_2H_5OH

(b) CH_4

(c) C_2H_7N or $C_2H_5NH_2$

(d) C_3H_8O or C_3H_7OH

2. B, C

3.

(a) A molecule with two atoms

(b) Bromine, oxygen, fluorine, iodine, nitrogen, chlorine, hydrogen (and perhaps astatine)

4.

(a) F_2

(b) Mg

(c) N_2

(d) P or P_4

5.

(a) HCl

(b) P_2O_3

(c) NH_3

(d) CI_4

(e) SiO_2

(f) H_2S

6.

(a) CO_2

(b) NCl_3

(c) SO_3

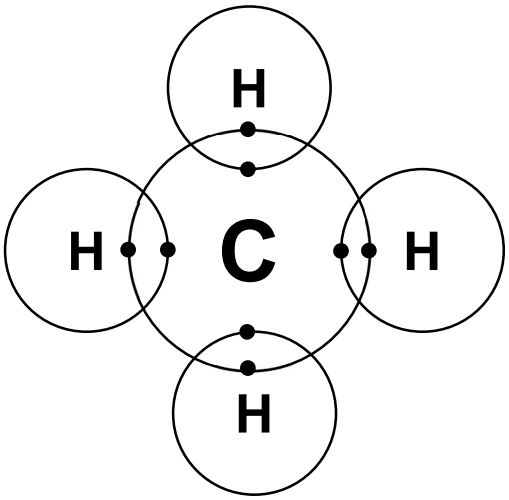
(d) CO

(e) CCl_4

(f) SiF_4

7.

(a)



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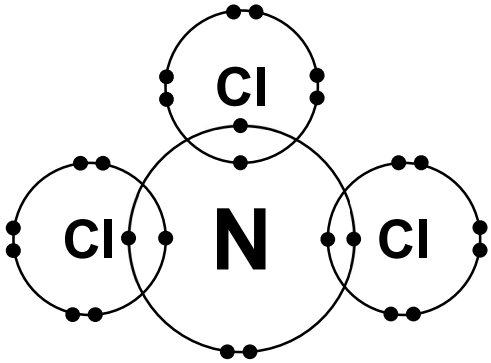

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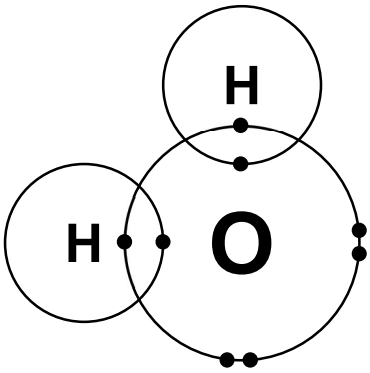
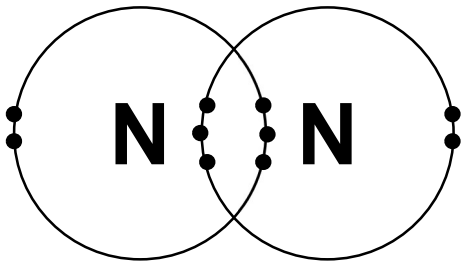


(d)



8.

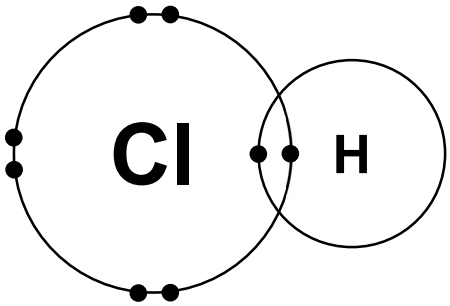
(a) CH_4

(b) NCl_3

(c) H_2O

(d) N_2

9. The positive nuclei are attracted to the shared pair of electrons



10. Because each hydrogen atom has a single electron. In order to achieve a full outer shell of electrons (2 electrons), the hydrogen atoms share electrons in a covalent bond to make diatomic hydrogen, H_2.

11.

(a) PI_3

(b) CF_4

(c) $SiBr_4$

(d) $SiCl_4$

(e) P_2O_3

(f) H_2S

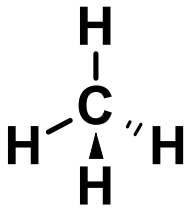
(g) SI_2

(h) O_2

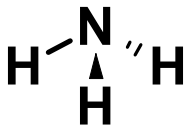
(i) F_2

12.

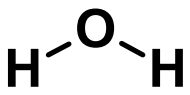
(a) CH_4 – tetrahedral



(b) NH_3 – pyramidal

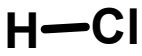


(c) H_2O – bent

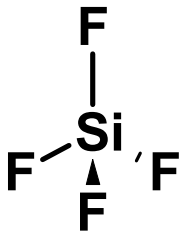


(d) PF_3 – pyramidal

(e) HCl – linear

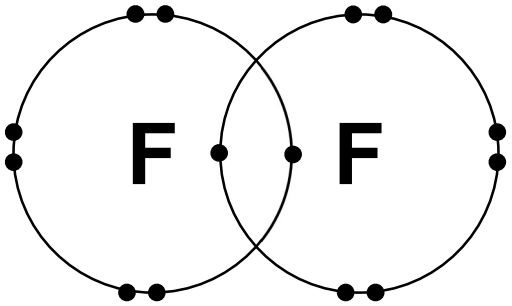


(f) SiF_4 - tetrahedral

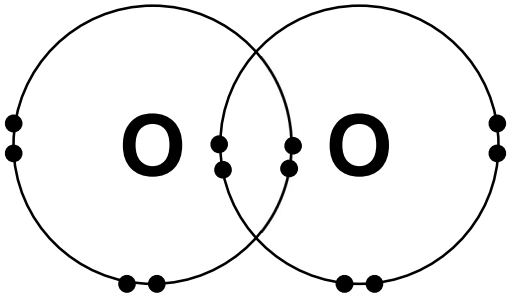


13.

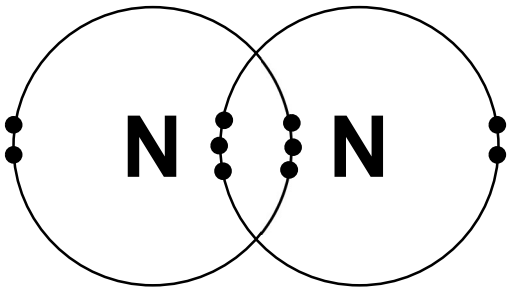
(a)



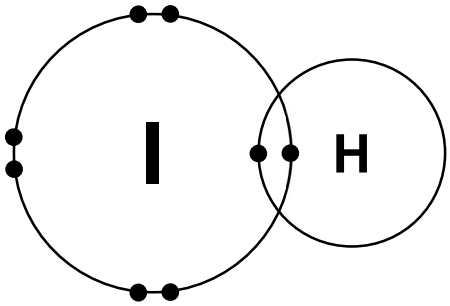
(b)



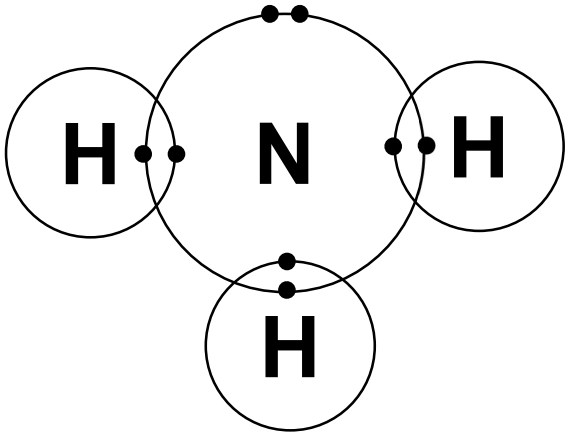
(c)



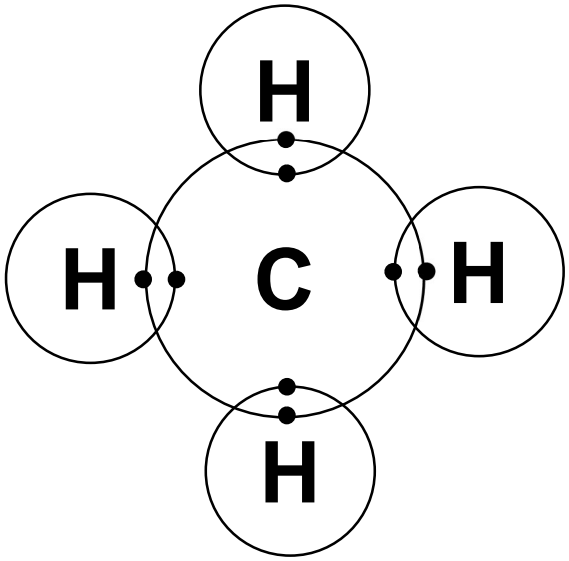
(d) Hydrogen iodide



(e) Nitrogen hydride



(f) Carbon hydride



14.

(a) N_2

(b) Al

(c) H_2

(d) Cl_2

(e) Br_2

(f) H_2O

(g) CCl_4

(h) NF_3

(i) $SiBr_4$

(j) SiO_2

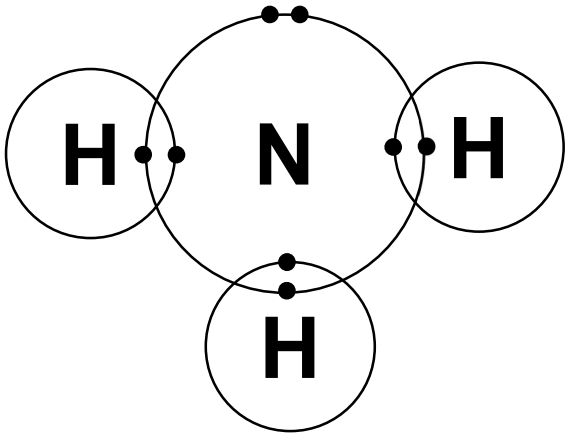
(k) SiO_4

(l) N_2O_4

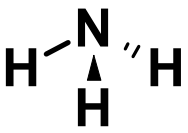
15.

(a) The positive nuclei are attracted to the shared pair of electrons

(b)

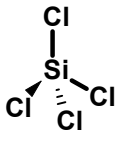


(c)



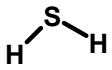
16.

(a)



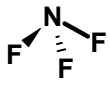
tetrahedral

(b)



angular

(c)

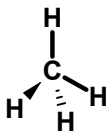


pyramidal

(d)

linear

(e)



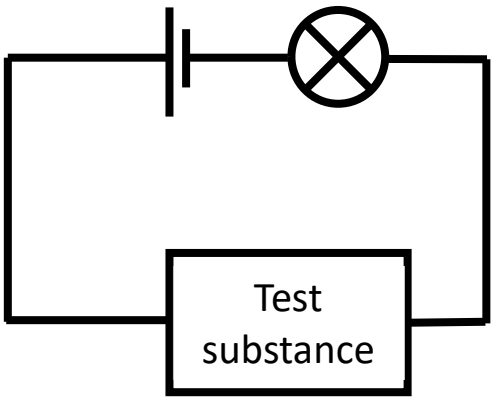
tetrahedral

17.

(a) Electron

(b) Carbon (as graphite)

(c)



(iii) Ionic Compounds

1.

(a) Ionic
(b) Ionic
(c) Ionic
(d) Covalent
(e) Covalent
(f) Ionic
(g) Covalent

2.

(a) E
(b) B, C
(c) D, E
(d) B
(e) A, F
(f) D, E

3.

(a) The breaking up of an ionic solution using electricity.
(b) Lead chloride
(c) Ionic
(d) Ions can only move is the substance is liquid or in solution
(e) Negative
Positive

(f) $Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$
$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

4.

(a)

(i) Iodine
(ii) Lithium

(b)

(i) Chlorine
(ii) Calcium

(c)

(i) Fluorine
(ii) Zinc

(d)

(i) Bromine
(ii) Nickel

5.

(a) $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
(b) $Li^+(aq) + e^- \rightarrow Li(s)$
(c) $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$
(d) $2F^-(aq) \rightarrow F_2(g) + 2e^-$

6.

(a) High – ionic
(b) Low – covalent molecule
(c) High - ionic
(d) Low – covalent molecule

7.

(a) There are no mobile charged particles
(b) The electrons can move and carry a current
(c) The ions are fixed in position and cannot move.
(d) The forces between the ions (ionic bonds) are very strong.
(e) The covalent bonds holding the atoms together in the network are very strong.

8. In sodium chloride, the sodium atoms donate an electron each to the chlorine atoms to from positive sodium ions (Na^+) and negative chloride ions (Cl^-). The attraction between the ions hold the solid substance together

   In hydrogen chloride, the hydrogen and chlorine atoms share a pair of electrons. The attraction between the positive nuclei and the shared pair of negative electrons is a covalent bond.

9.

Particle	**Atomic no.**	**Mass no.**	**No. of neutrons**	**Electron arrangement**
Ar	18	40	22	2,8,8
F^-	9	20	11	2,8
Al^{3+}	13	27	14	2,8

10. O^{2-}

11.

(a) $Ca^{2+}O^{2-}$
(b) Li^+Br^-
(c) $(Al^{3+})_2(O^{2-})_3$
(d) $(Na^+)_2SO_4^{2-}$
(e) $Mg^{2+}(OH^-)_2$
(f) $Zn^{2+}S^{2-}$
(g) $Pb^{2+}(Cl^-)_2$
(h) $(Ag^+)_2O^{2-}$
(i) $Cu^{2+}(NO_3^-)_2$
(j) $NH_4^+NO_3^-$
(k) $(K^+)_3PO_4^{3-}$
(l) $Al^{3+}PO_4^{3-}$

12.

(a) Green
(b) Orange
(c) Colourless
(d) Green

(c) Formulae and reacting quantities

(i) Chemical Formulae

1.

(a) HCl
(b) P_2O_3
(c) NH_3
(d) MgH_2
(e) CI_4
(f) SiO_2
(g) NaCl
(h) KCl

2.

(a) SO_2
(b) CO_2
(c) N_2O_4
(d) H_2O
(e) CO
(f) NH_3
(g) H_2O_2

3.

(a) $Cu^{2+}O^{2-}$
(b) $Ag^{+}H^{-}$
(c) $Co^{2+}(Cl^{-})_2$
(d) $Zn^{3+}(I^{-})_3$
(e) $(Fe^{3+})_2(O^{2-})_3$
(f) $Cu^{+}H^{-}$
(g) $Ni^{2+}S^{2-}$
(h) $(Pb^{+})_2S^{2-}$

4.

(a) $(Na^+)_2SO_4^{2-}$
(b) $Mg^{2+}(OH^-)_2$
(c) $NH_4^+NO_3^-$
(d) $Ca^{2+}CO_3^{2-}$
(e) $(K^+)_3PO_4^{3-}$
(f) $Ca^{2+}CrO_4^{2-}$
(g) K^+OH^-
(h) $Li^+NO_3^-$

5.

(a) $Zn^{2+}SO_4^{2-}$
(b) $Pb^{2+}S^{2-}$
(c) $(Ag^+)_2O^{2-}$
(d) $Cu^{2+}(NO_3^-)_2$
(e) Na^+Cl^-
(f) $Cu^{2+}CO_3^{2-}$
(g) Na^+OH^-
(h) $Ag^{2+}(NO_3^-)_2$

(ii) Calculations involving the mole and balanced equations

1.

(a) 58.5 amu
(b) 30 amu
(c) 111 amu
(d) 46 amu
(e) 367 amu

2.

(a) 32 g
(b) 440 g
(c) 77.5 g
(d) 1.59 g
(e) 447 g

3.

(a) 0.5 moles
(b) 2.5 moles
(c) 2 moles
(d) 0.588 moles
(e) 0.00313 moles

4.

(a) $\mathbf{2}H_2 + O_2 \rightarrow \mathbf{2}H_2O$
(b) $2Fe + \mathbf{3}Cl_2 \rightarrow \mathbf{2}FeCl_3$
(c) $Cu + \mathbf{2}AgNO_3 \rightarrow Cu(NO_3)_2 + \mathbf{2}Ag$
(d) $Zn + \mathbf{2}HCl \rightarrow ZnCl_2 + H_2$
(e) $\mathbf{3}Pb(NO_3)_2 + \mathbf{2}AlCl_3 \rightarrow \mathbf{3}PbCl_2 + \mathbf{2}Al(NO_3)_3$

5. 192.5 g
6. 373 g
7. 1314 kg
8. 14 200 g or 14.2 kg
9. 10.1 g
10. 112 g
11. 600 tonnes.
12. 900 kg

(iii) Percentage Mass

1.

(a) 82 %
(b) 89 %
(c) 28 %
(d) 27 %
(e) 16 %
(f) 30 %
(g) 43 %
(h) 24 %
(i) 29 %
(j) 8 %

(d) Acids and bases

(i) pH

1.

(a) B (sulfur dioxide), F (carbon dioxide)
(b) E (calcium oxide)
(c) A (Magnesium oxide), C (copper oxide), D (hydrogen oxide)

2. Sulfur dioxide and nitrogen dioxide produced from car engines dissolve in rainwater to give an acid solution. The effects of this are acidification of rivers, ponds etc. and erosion of buildings.

3.

(a) Nitrogen and oxygen from the air combine for from nitrogen dioxide NO_2 in a petrol engine. The spark used in the ignition provides the energy for this.
(b) Platinum, palladium and/or rhodium
(c) Nitrogen dioxide converted to nitrogen and oxygen. Carbon monoxide converted to carbon dioxide.

4. The hydrogen and citrate ions are not free to move in the solid. They are free to move when dissolved in solution so can conduct electricity.

5.

(a) Negative electrode
(b) $2H^+(aq) + 2e^- \rightarrow H_2(g)$
(c) A lit splint produces a "squeaky pop".

6. It contains H^+ and OH^- ions (charged particles) which are free to move.

7.

(a) A, C, D
(b) B, D
(c) D, E, F

8.

(a) Na^+OH^-

(b) H^+Cl^-

(c) $H^+NO_3^-$

(d) $(H^+)_2SO_4^{2-}$

(e) K^+OH^-

9.

(a) Any reasonable statement based on the information in the table

(b) Oxygen and hydrogen.

(c) The potassium and chloride ions are not free to move in the solid

(ii) Neutralisation Reactions

1. Putting vinegar on a wasp sting, putting bicarbonate of soda on a bee sting, taking tablets for acid indigestion etc.
2. D
3.

(a) Potassium chloride

(b) Calcium sulfate

(c) Lithium nitrate

(d) Sodium sulfate

4.

(a) Hydrochloric acid + potassium hydroxide → Potassium chloride + Water

$HCl + KOH \rightarrow KCl + H_2O$

(b) Sulphuric acid + calcium hydroxide → Calcium sulfate + Water

$H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$

(c) Lithium hydroxide + nitric acid → Lithium nitrate + Water

$LiOH + HNO_3 \rightarrow LiNO_3 + H_2O$

(d) Sodium hydroxide + sulphuric acid → Sodium sulfate + Water

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

5.

(a) Carbon dioxide

(b) It contains sodium

(c) Sodium chloride, NaCl

6.

(a)

(i) Sodium hydroxide + sulphuric acid → Sodium sulfate + Water

(ii) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(b)

(i) hydrochloric acid + calcium carbonate → Calcium chloride + Water + Carbon dioxide

(ii) $2HCl + CaCO_3 \rightarrow CaCl_2 + 2H_2O + CO_2$

(c)

(i) copper(II) carbonate + nitric acid → copper nitrate + Water + carbon dioxide

(ii) $CuCO_3 + HNO_3 \rightarrow Cu(NO_3)_2 + H_2O + CO_2$

(d)

(i) potassium carbonate + sulfuric acid → potassium sulfate + water + carbon dioxide

(ii) $K_2CO_3 + H_2SO_4 \rightarrow K_2SO_4 + H_2O + CO_2$

7.

(a)

(i) magnesium + hydrochloric acid → magnesium chloride + hydrogen

(ii) $Mg + 2HCl \rightarrow MgCl_2 + H_2$

(b)

(i) calcium oxide + sulfuric acid → calcium sulfate + water

(ii) $CaO + H_2SO_4 \rightarrow CaSO_4 + H_2O$

(c)

(i) copper (II) oxide + nitric acid → copper nitrate + water

(ii) $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$

(d)

(i) sodium hydroxide + sulphuric acid → sodium sulfate + water

(ii) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(e)

(i) sodium oxide + nitric acid → sodium nitrate + water

(ii) $Na_2O + 2HNO_3 \rightarrow 2NaNO_3 + H_2O$

(f)

(i) zinc + hydrochloric acid → zinc chloride + hydrogen

(ii) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

8. Copper is too low in the electrochemical series to react with an acid (it is below hydrogen in the series). Instead, copper sulphate could be made by an acid/base reaction such as copper carbonate reacted with sulfuric acid.

9.

(a) $OH^- + H^+ \rightarrow H_2O$

(b) $OH^- + H^+ \rightarrow H_2O$

(c) $CO_3^{2-} + 2H^+ \rightarrow CO_2 + H_2O$

(d) $Mg + 2\ H^+ \rightarrow Mg^{2+} + H_2$

(e) $O^{2-} + 2H^+ \rightarrow SO_4^{2-} + H_2O$

10.

(a) silver nitrate (aq) + sodium chloride (aq) → <u>silver chloride(s)</u> + sodium nitrate (aq)

(b) barium nitrate (aq) + copper sulfate (aq)→ <u>barium sulfate(s)</u> + copper nitrate(aq)

(c) sodium carbonate (aq) + calcium nitrate (aq)→ sodium nitrate (aq)+ <u>calcium carbonate(s)</u>

11.

(a) $Ag^+NO_3^-(aq) + Na^+Cl^-(aq) \rightarrow Ag^+Cl^-(s) + Na^+NO_3(aq)$

$Ag^+(aq) + Cl^-(aq) \rightarrow Ag^+Cl^-(s)$

(b) $Ba^{2+}(NO_3^-)_2(aq) + Cu^{2+}SO_4^{2-}(aq) \rightarrow Ba^{2+}SO_4^{2-}(s) + Cu^{2+}(NO_3^-)_2(aq)$

$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow Ba^{2+}SO_4^{2-}(s)$

(c) $(Na^+)_2CO_3^{2-}(aq) + Ca^{2+}(NO_3^-)_2(aq) \rightarrow 2Na^+NO_3^-(aq) + CaCO_3^{2-}(s)$

$CO_3^{2-}(aq) + Ca^{2+}(aq) \rightarrow Ca^{2+}CO_3^{2-}(s)$

(iii) Neutralisation reactions can be used to prepare soluble salts

1. 0.5 mol l^{-1}
2. 2 mol l^{-1}
3. 0.133 l (133 cm^3)
4.

(a) When the indicator changed colour

(b)

(i) 20.6 cm^3 (0.0206 l)

(ii) 0.00412 moles

(c) 0.00824 moles

5.

(a) Cl^-, Na^+

(b) Filtration

6. 6.73 g
7.

(a) A, D

(b) F

8.

(a) B

(b) A,C

9.

(a) A, B

(b) E

10. 0.075 mol l^{-1}