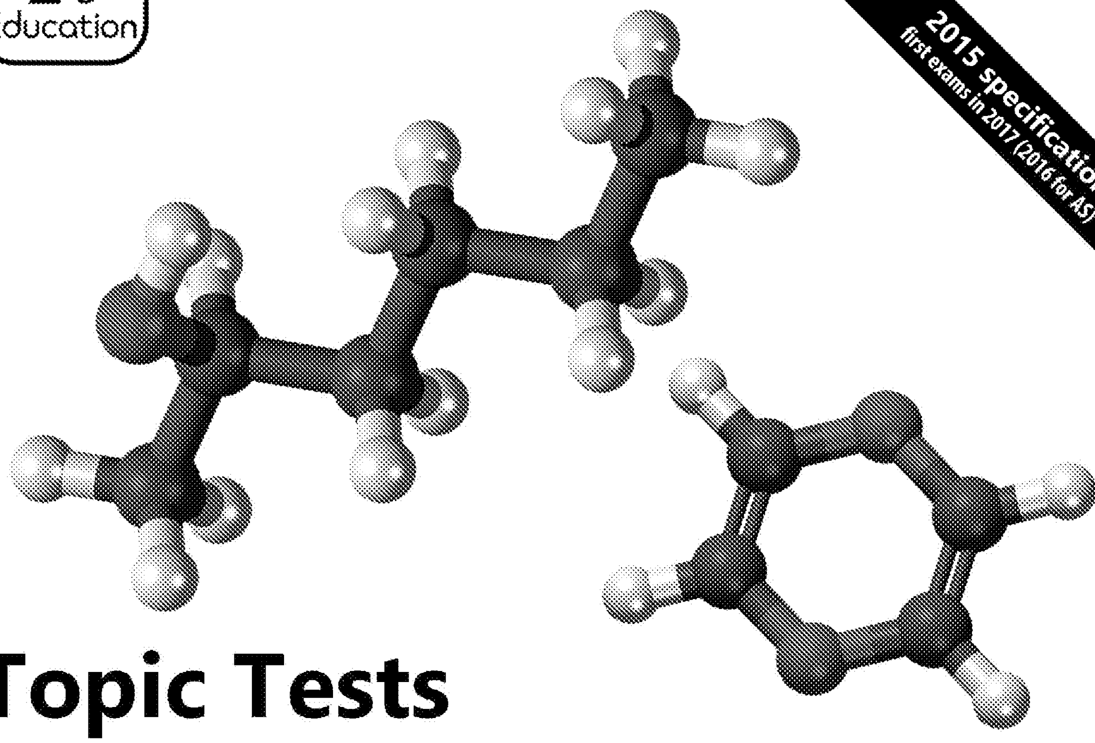
Chemistry AS and A Level | OCR A | H032 and H432

2015 specification
first exams in 2017 (2016 for AS)



Topic Tests

For OCR A Chemistry AS and A Level Year 1

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POD 6102

Contents

Teacher's Introduction

These topic tests have been designed to help comprehensively test your students' knowledge and understanding of the AS and A Level Year 1 OCR Chemistry A specification, modules 2, 3 and 4.

Each topic test closely follows the content of the specification and includes:

- **Factual questions**: Some simpler factual questions are included to ensure that all the content and basics are covered, and to allow weaker learners access to some marks.
- **Short-answer questions**: These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles.
- **Exam-style questions**: Where appropriate, topics may contain one or more exam-style questions, to prepare students for what they might meet in the exam, and to test exam skills.

Mathematical and practical skills are covered throughout these Topic Tests, including skills from practical module 1.

Tests have been designed to take between 30 and 40 minutes to complete, and average between 25 and 35 marks. Please note that some longer specification topics have been split to allow a realistic number of marks for a possible homework task (see table below).

Topic Number	Number of Marks
2.1.1	24
2.1.2	13
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4.2.2	21
4.2.3	26
4.2.4	23

The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

The number of marks awarded for each question is clearly shown, allowing the students to gauge the level of detail they will require for their answers. Full answers are included in the mark scheme, also making this a suitable tool for students to use independently.

Diagrams and graphs have been designed with photocopying in mind.

It is recommended that students have access to a periodic table and a calculator to complete the questions.

3.1.1: Periodicity

You will need a periodic table to answer some of the following questior

1. Describe some general patterns seen **across** the periods of the periodi

2. Describe some general patterns seen **down** group 1 on the Periodic ta

3. What is meant by the term 'first ionisation energy'?

4. Describe and explain the general trend in first ionisation energies acro

5. Describe and explain the general trend in first ionisation energies dow

6. Identify the group (and block) this element belongs to, using the succe energies given below.

Ionisation	1st	2nd	3rd	4th	5th	6th	7
Energy ($kJmol^{-1}$)	738	1451	7733	10543	13630	18020	21

7. Describe the trend in the electronic configuration of the elements in p

8. Describe and explain how the atomic radii of the elements in period 2 across the period.

9. Describe and explain the trends in melting and boiling points across p

10. The following are the electronic configurations of two elements.
    $1s^2\ 2s^2\ 2p^6\ 3s^1$
    $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
    Identify the elements, state what group they are in and use the electro explain their similar reactivity.

11. Explain the difference in the boiling points of lithium (1,342 °C) and p

12. Describe the type of structure and bonding each of the following subs
    a) Diamond
    b) Sodium
    c) Graphite
    d) Silicon
    e) Graphene

3.1.2: Group 2

1. Group 2 elements participate in redox reactions. Give the change in o group 2 metals in a redox reaction.

2. Write the full balanced symbol equation, with state symbols, for the r and water.

3. Calcium reacts with water in the same way as strontium.
   a) What is the oxidation state of the calcium atoms in the reactant?
   b) What is the oxidation state of the calcium atoms in the product?
   c) Explain the reason for the change in oxidation states of the calciu
   d) Is calcium being reduced or oxidised?

4. Describe and explain the trend in reactivity of the elements in group 2
   a) W
   b) Oxygen
   c) Dilute hydrochloric acid

5. Write the full balanced symbol equation, with state symbols, for the r and oxygen.

6. Describe the trend in solubility of the group 2 oxides and state the tre resulting solutions.

7. a) The table below shows the atomic radii of magnesium and stront approximate atomic radii for calcium and barium.

Element	Atomic radius (nm)
Magnesium	0.160
Strontium	0.191

   b) With reference to atomic radii, state the trend in first ionisation er

8 Give one use of $Ca(OH)_2$ in agriculture.

9. a) Name the group 2 compound commonly found in indigestion tab this compound is used for such a purpose.
   b) Give the equation to show the reaction of this compound with sto

3.1.3: The Halogens

1. Describe and explain the trend in boiling point as you go down group

2. a) Halogens participate in redox reactions. Give the general change the halogens during these reactions and state whether this is an e or reduction.
   b) Give the electronic configuration of chlorine and the ion formed i

3. a) Use the following equations to deduce the order of reactivity for

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$$
$$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$$
$$Br_2 + 2I^- \rightarrow 2Br^- + I_2$$
$$I_2 + 2Br^- \rightarrow I_2 + 2Br^-$$
$$I_2 + 2Cl^- \rightarrow I_2 + 2Cl^-$$

   b) Explain this trend in reactivity.
   c) Explain the colour change that would be observed in the first rea in aqueous solution.

4. Predict the products formed, if any, by the addition of fluorine and so

5. Define the term 'disproportionation'.

6. Chlorine can be used in the purification of water.
   a) Write the symbol equation for this reaction.
   b) Indicate the oxidation state of the chlorine in the reactants and pr

7. a) Outline a benefit of water chlorination.
   b) Outline two potential risks of water chlorination.

8. Chlorine reacts with a solution of cold, dilute sodium hydroxide. Wri for this reaction, indicating the oxidation state of the chlorine in the re

9. Aqueous halide anions react with aqueous silver ions to form silver h
   a) What is the name given to this type of re[illegible]n.
   b) Write an ionic equation for the pr[illegible]d[illegible]ct[illegible] or silver chloride.
   c) The colours of the prod[illegible] can be used to identify the ha this is not alway[illegible] so aqueous ammonia can be added. De am[illegible] identify chloride, bromide and iodide ions.

3.1.4: Qualitative Analysis

1. Describe how you would test for the presence of carbonate ions (CO_3^{2} reaction and state what would be observed in the test if a carbonate is

2. a) What reagents can be used to test for sulfate ions in solution? If fu which of these reagents should be used?
   b) What is observed in the test tube when a sulfate is present?

3. a) Describe the test for halide ions. How can the halide be distinguis
   b) What further test may be required for identification of the halide

4. Some samples may require a combination of tests to identify which io Give the correct sequence for carrying out these tests and explain the

5. a) Describe how to test for the presence of ammonium ions in soluti
   b) Why is the solution warmed as part of this test?

3.2.1: Enthalpy Changes Part 1

1. Define the terms:
   a) Standard conditions
   b) Standard enthalpy change of reaction
   c) Standard enthalpy change of formation
   d) Standard enthalpy change of combustion
   e) Enthalpy change of neutralisation

2. a) Draw an enthalpy profile diagram for an exothermic reaction, inc products, activation energy and ΔH.
   b) Draw an enthalpy profile diagram for an endothermic reaction, in products, activation energy and ΔH.

3.2.1: Enthalpy Changes Part 2

1. The enthalpy change for the reaction $2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{\,(l)}$ was foun… measured under standard conditions.
   a) Calculate the enthalpy change for the reaction:
      $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$
   b) Deduce the enthalpy change of formation of water.
   c) Use this to calculate the enthalpy change of combustion for the hy…

2. 0.5 g of methane was completely burned in oxygen in a calorimeter co… water which increased by 66.22 K. Calculate the enthalpy change of co… The density of water is 1 gcm^{-3} and the specific heat capacity of water i…

3. Calculate the energy change for the following equation: $2H_{2(g)} + O_{2(g)}$ … enthalpy values and so deduce if this reaction is endothermic or exoth… O=O = [illegible] mol^{-1}, O–H = 464 kJ mol^{-1}.

4. It is impossible to calculate the enthalpy change of reaction of benzen… hydrogen directly.

   $$6C_{(s)} + 3H_{2(g)} \rightarrow C_6H_{6(l)}$$

   Construct an enthalpy cycle for this reaction and calculate the enthalp… of benzene.

Molecule	ΔH°$_c$ (kJ mol^{-1})
$C_6H_{6\,(l)}$	–3267
$C_{\,(s)}$	–394
$H_{2\,(g)}$	–286

5. Calcium hydroxide can be made by reacting calcium oxide and water…

   $$CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(s)}$$

   Construct an enthalpy cycle for this reaction and so calculate the enth… from the following enthalpy changes of formation.

Molecule	ΔH°$_f$ (kJ mol^{-1})
$CaO_{\,(s)}$	–635.1
$H_2O_{\,(l)}$	–285.8
$Ca(OH)_{2\,(g)}$	–986.1

3.2.2: Reaction Rates

1. Describe and explain the effect of increasing the concentration of reac rate of reaction.

2. Describe and explain the effect of increasing the pressure of a gaseous

3. Define and explain the term 'catalyst'.

4. Explain why using catalysts can lead to a reduction in pollution.

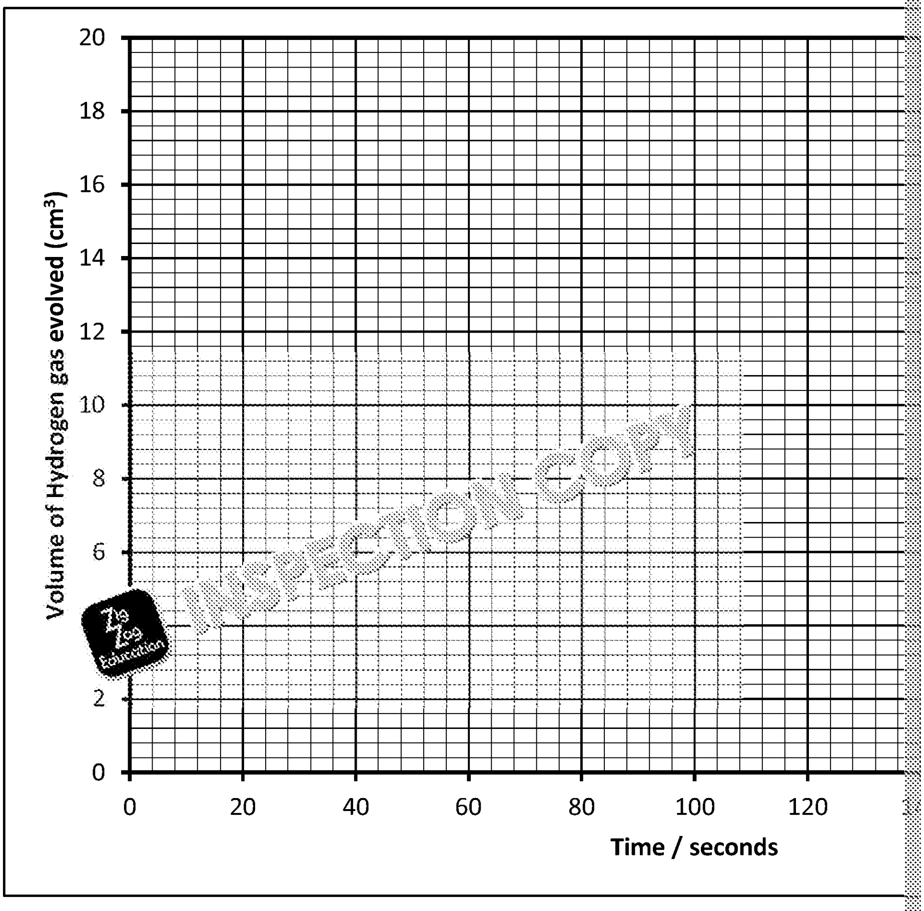
5. a) Explain what is meant by a heterogeneous catalyst?
   b) What is meant by a homogeneous catalyst?

6. a) Explain how the reaction rate can be measured for the following r

$$Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$$

   b) Explain how the rate of this reaction can be determined from a gr
   c) Use the data below to plot a graph of volume of hydrogen evolve and calculate the rate of the reaction at 60 seconds.

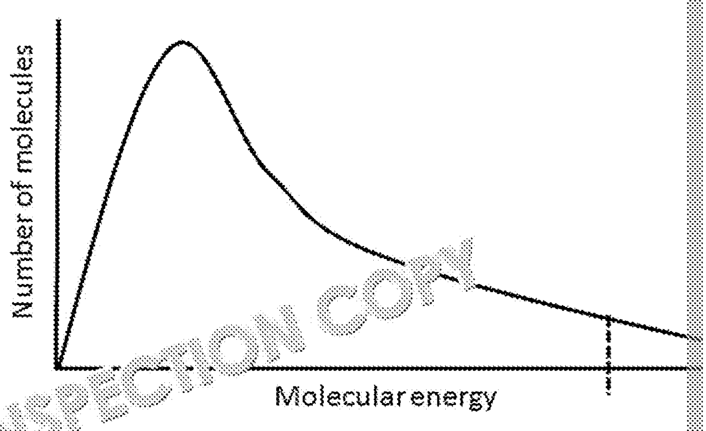
Time / seconds	H_2 evolved/cm^3
0	0
10	3
20	6
30	8
40	10
50	12
60	13.5
70	15
80	16
90	17
100	17.5
110	18
120	18
140	18
160	18
180	18



7. Using an example, explain why catalysts have a great deal of econom

8. Draw enthalpy profile diagrams for an exothermic reaction and an en
the effect of the addition of a catalyst, and explain how catalysts incre

9. The graph below shows the molecular energy distribution of molecul



a) W… the name given to this distribution curve?
b) What is represented by the dotted line?
c) What would be the effect upon the graph of increasing the tempe
Explain how this will affect the molecules involved in the reactio
on the graph above to illustrate this point.
d) What would be the effect upon the graph of the addition of a cata
above to explain how this will affect the molecules involved in th

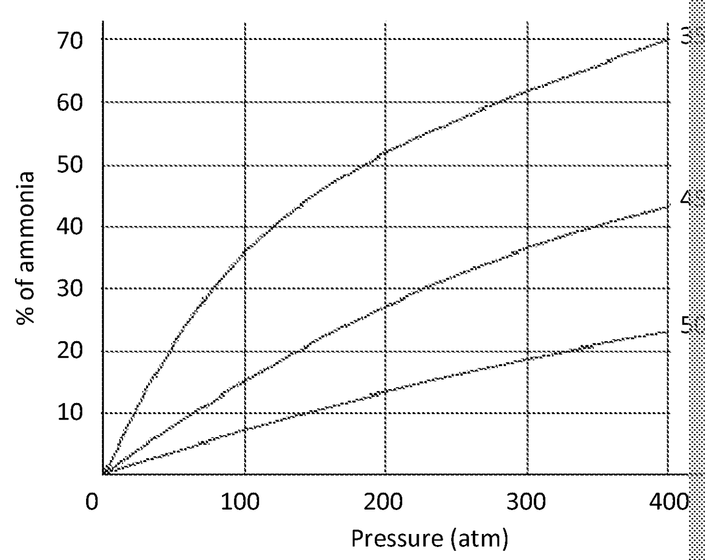
3.2.3: Chemical Equilibrium

1. Define the term 'dynamic equilibrium'.

2. Outline Le Châtelier's principle.

3. The following reaction is a reversible reaction: $CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH$ is exothermic.
   a) Use Le Châtelier's principle to describe and explain the effect of i temperature of the reaction.
   b) Use Le Châtelier's principle to describe ... xplain the effect of i of the reaction.
   c) Use Le Châtelier's prin... describe and explain the effect of a monoxide to th...
   d) W... the effect of adding a catalyst to the reaction?

4. The formation of ammonia via the Haber process is a very important equilibrium reaction. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$. The forward reaction is e below shows the percentage of ammonia produced at different tempe



   a) Use the graph to identify the temperature and pressure which wo yield of ammonia.
   b) Explain why the temperature you stated ab... s not used in prac temperature used and why.
   c) Explain why the pressure ... d above is not used in practice, pressure used an... y.

5. Descr... the effect of changing temperature on the position of eq monito... with a reaction involving cobalt chloride.

6. In the reaction $Q + R \rightleftharpoons T$ the concentration of product T at equilib concentration of both reactants was 1.2 mol dm^{-3}. Calculate the value

7. If a reaction has a large value of K_c (17.6), estimate the position of equ Give a reason for your answer.

Preview of Questions Ends Here

Answers

2.1.1: Atomic Structure and Isotopes

1. (Award 1 mark for every correct row) (3)

Subatomic particle	Location within atom	Relative c
Proton	Nucleus	+1
Neutron	Nucleus	0
Electron	In orbit or shells around nucleus	–1

2. a) The number of protons found within the nucleus of an atom (1)
   b) The total number of protons and neutrons within the nucleus of an aton
   c) Atoms of the same element with differing nu of neutrons and pos
      Atoms with the same number of proton but different numbers of neutr
      masses (1)
3. a) 11 (1)
   b) 22 (1)
   c) 7
   d) 3 (
   e) 12 (1)
   f) 10 (1)
4. ^{12}C (1)
5. a) The mass of an isotope of an element relative to 1/12 of the mass of a car
   b) The weighted mean mass of an atom of an element relative to 1/12 of the
6. $((66 \times 24) + (34 \times 25)) \div 100 = 24.34$ (1)
7. Relative molecular mass is the term used to describe the relative mass of 1 m to 1/12 of an atom of carbon-12, e.g. the molecular mass of water is 18 (accep Relative formula mass is used to describe the relative mass of the chemical fo do not exist in molecules, again compared to 1/12 of an atom of carbon-12, e. magnesium oxide is 40 (accept any giant example) (1).
8. a) Because the element has two isotopes (1)
   b) $[(10 \times 23) + (11 \times 100)] \div 123 = 10.8$ (1)
9. Plum-pudding model: a positive mass with negative electrons within the stru on the gold-foil experiment (1) showing alpha particles passing through the

2.1.2 Formulae and Equations

1. Mg^{2+} (1)
2. Br^- (1)
3. NH_4^+ (1)
4. Zn^{2+} (1)
5. Ag^+ (1)
6. a) Nitrate (1)
   b) Carbonate (1)
   c) Sulphate (1)
   d) Hydroxide (1)
7. HCl + N … (2)
8. Cu^{2+} (a … H (aq) → $Cu(OH)_2$ (s) (2)

2.1.3: Amount of Substance

1. The quantity of the atoms, molecules or particles present in a sample (1)
2. Unit = mole. Symbol = mol. (1)
3. 6.02×10^{23} mol^{-1} (1). The number of particles that can be found in a mole of a
4. The mass of 1 mole of any substance (in g mol^{-1}) (1). 18 g mol^{-1} (1).
5. 24 dm^3 or 24 000 cm^3
6. Empirical formula gives the smallest whole-number ratio of atoms of a parti a compound (1), whereas the molecular formula gives the total number of at the molecule (1)
7. a) 82.8 ÷ 12.0 = 6.9 17.2 ÷ 1.0 = 17.2 (1)
   6.9:17.2 = 1:2.49 or approx. 1:2.5; in lowest integers this is 2:5 (1)
   C_2H_5 (1)
   b) C_2H_5 = 29 58 ÷ 29 = 2 (1)
   hence C_4H_{10} (1)
8. Without water (1)
9. a) Water of crys s (1)
   b) M hy s $CuSO_4$ = 159.6(1)
   M hydrous $CuSO_4$ = 0.766 ÷ 159.6 = 4.79×10^{-3} mol (1)
   Mol of water = (1.2 – 0.766) ÷ 18 = 0.02411 mol (1)
   Molar ratio = 4.79×10^{-3}:0.02411 = 1:5 therefore formula = $CuSO_4.5H_2O$ (1)
   c) Mass of hydrated copper sulfate measured with a balance followed by m measured with a balance (1) and find the difference between the two ma mass (1)
10. Convert pressure in kPa to Pa (x1000) = 101 000Pa (1)
    Convert Temperature 25°C to Kelvin = 298K (1)
    pV = nRT $n = \frac{pV}{RT} = \frac{(101000 \times 0.05)}{(8.314 \times 298)}$ = 2.03 mol
11. (330 ÷ 1000) × 0.235 = 0.07755 mol. 0.07755 × 40 = 3.10 g (3sf) (2).
12. Formula mass KI = 39.1 + 126.9 = 166.0 (1)
    molarity = 8.30 ÷ 166.0 = 0.0500 mol dm^{-3} (1)
13. a) 24 dm^3 (1)
    b) 1:5:3 (1)
    c) Water (1)
    d) Hydrocarbon: 0.0208 mol. O_2: 0.104 mol. CO_2: 0.0625 mol. Ratio 1:5:3. (1)
    3 C per hydrocarbon. 10 – 6 = 4 H_2O and 8 H produced per hydrocarbon
    e) $C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)}$ (1)
14. To minimise waste (1) [Accept any comment about high atom economy bein
15. Moles of Fe = 1.5 ÷ 55.8 = 0.0268 (1)
    Molar ratio from equation = 2:1 therefore Moles of Fe_2O_3 = 0.0134 use to find
    0.0134 x 159.6 = 2.145g (1)
    % Yield = $\frac{Actual\ Mass}{Theoretical\ Mass} \times 100 = \frac{1.960}{2.145} \times 100 = 91.4\%$
    OR
    Using moles: $\%\ Yield = \frac{0.01228}{0.01344} \times 100$ 4%

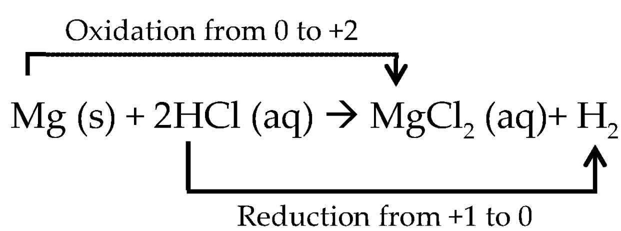
2.1.4: Acids

1. H^+ (1)
2. a) HC
   b) H_2SO_4
   c) HNO_3
   d) CH_3COOH [(1) for all four correct]
3. An acid that is completely dissociated in aqueous solution (1)
4. An alkali is a base which is soluble in water (1). OH^- (1).
5. a) NaOH
   b) KOH
   c) NH_4OH [(1) for all three correct]

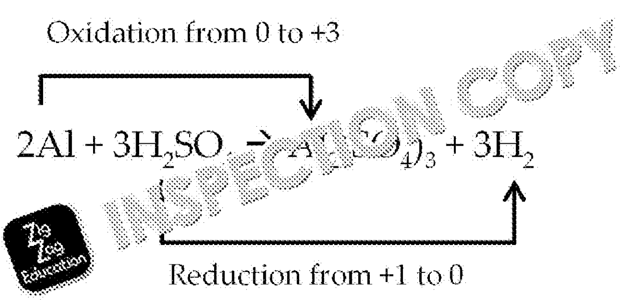
6. The H^+ ion in the acid is replaced with a metal ion (1)
7. The H^+ ion in the acid is replaced with a NH_4^+ ion (1)
8. a) $H^+_{(aq)} + OH^-_{(aq)} = H_2O_{(l)}$. Solution will give out a small amount of heat. (1)
   b) $2H^+_{(aq)} + Ba_{(s)} = Ba^{2+}_{(aq)} + H_{2(g)}$. Solution will get hot, effervescence seen. (1)
   c) $2H^+_{(aq)} + NiCO_{3(s)} = Ni^{2+}_{(g)} + CO_2 + H_2O_{(l)}$. Vigorous effervescence, some hea
9. Because the OH– ion in the base is a proton acceptor (H^+ acceptor) and so wa
   $OH^- \rightarrow H_2O$]
10. A solution of known/exact concentration (1); dissolve known mass of sample
    water (1); add to volumetric flask and top up to the line with distilled water (
11. No moles of NaOH = (17.4 ÷ 1000) × 1 = 0.0174 (1)
    Balanced equation shows reacting ratio of NaOH:HCl = 1:1
    Thus there are 0.0174 moles of HCl in 50 cm³, which [illegible] dm³
    The molarity of the hydrochloric acid therefo[illegible] 0.0174 ÷ 0.05 = 0.348 (1) mo
12. Each individual reading has an erro[illegible] (1); therefore, there is a total
    The percentage error = 0.1 / [illegible] (average titre) x 100 = 0.548 = 0.55% (1

2.1.5: Red

1. a) +1 (1)
   b) +6 (1)
   c) +1 (1)
   d) –1 (1)
   e) –1 (1)
   f) +5, +3, +1, –3 (4)
   g) +6, +3, +2 (3)
   h) +6 (1)
   i) +6 and +6 (2)
2. a) Oxidation reactions involve the loss of electrons (1) and an increase in o
   b) Reduction reactions involve the gain of electrons (1) and a decrease in o
3. Iron(II) oxide, FeO (1)
4. Co^{3+} (1)
5. (2)



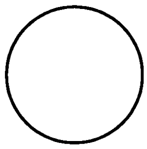
6. (2)



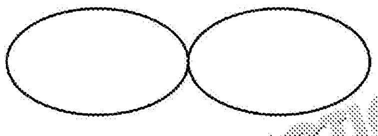
7. a) Potassium chlorate(V) (1)
   b) Manganese(II) carbonate (1)
   c) Sodium nitrate(III) (1)
8. $2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} +$ **Sn^{4+}** (1). Fe^{3+} is reduced to Fe^{2+} (1) Sn^{2+} is oxidised to Sn

2.2.1: Electron Structure

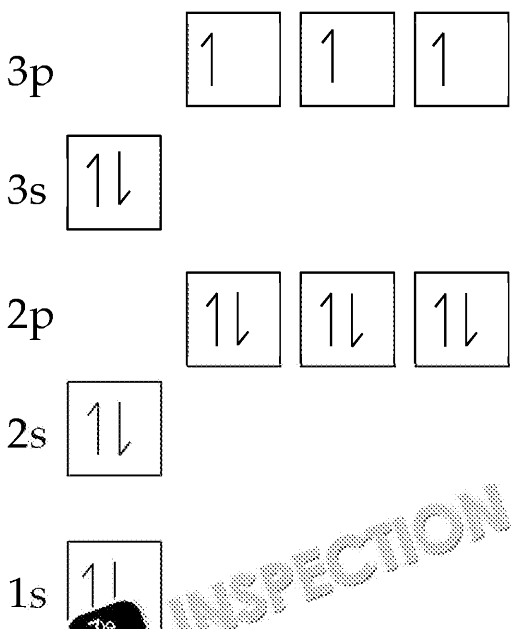
1. n1 = 2, n2 = 8, n3 = 18, n4 = 32 (1)
2. A region within the atom that electrons can occupy (1) which holds a maxim opposite spin) (1)
3. a) Spherical (1)



   b) Dumbbell shaped (1)

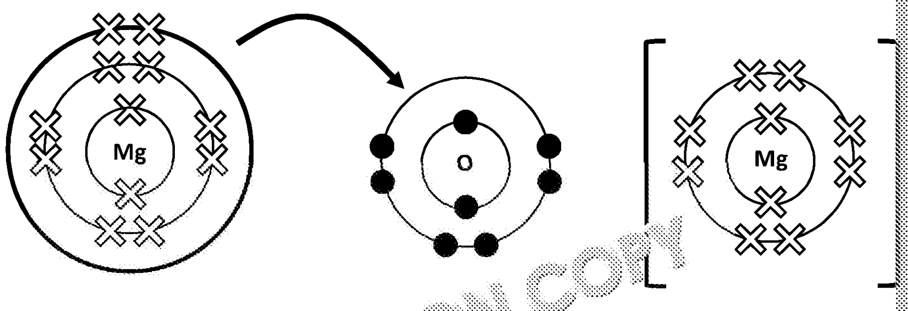


4. a) s = 1 (1)
   b) p = 3 (1)
   c) d = 5 (1)
5. a) s = 2 (1)
   b) p = 6 (1)
   c) d = 10 (1)
6. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$ (2)
7. $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$ (2)
8. a) s (1)
   b) s (1)
   c) d (1)
   d) p (1)
   e) p (1)
9. (3)

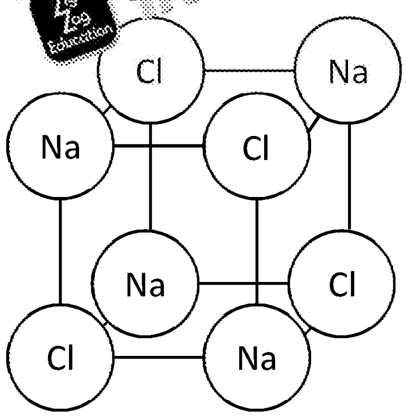


2.2.2: Bonding and Structure Part 1

1. Ions are created by the mutual transfer of 1 or more electrons from a metal to electrostatic forces of attraction are therefore generated between ions of oppo
2. (1 mark for each correct ion)

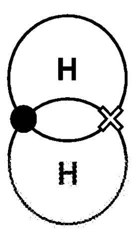


3. a) Giant ionic lattice (1)
   b) Electrostatic att… between oppositely charged ions in all directi
   c) (1) … correct labels

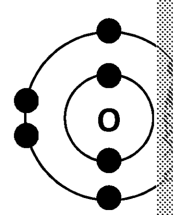


4. a) Melting sodium chloride requires the strong electrostatic attraction to be large amount of energy hence the high melting point (1)
   b) When molten the ions are free to move (and can conduct electricity) whe position (1)

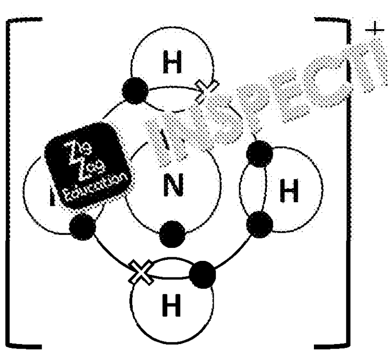
5. a)



(2) b)



c)



(2)

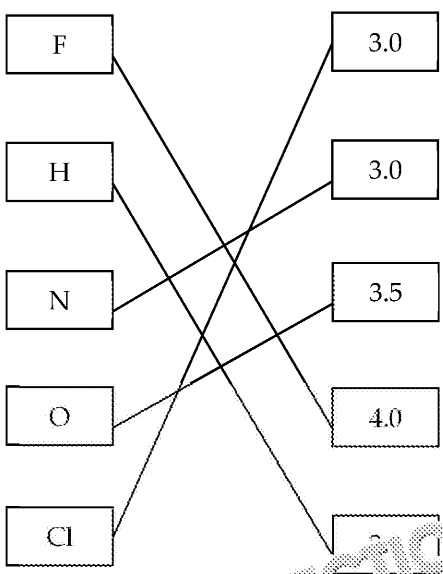
6. A covalent bond is the sharing of a pair of electrons (1) between two nuclei (1) average bond enthalpies (1)

2.2.2: Bonding and Structure Part 2

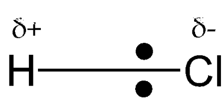
1. The repulsive force which exists between pairs of electrons. The electron pai as to minimise those repulsions./ (bonds will form at a maximum distance ap
2. Bond pair-Bond pair <Bond pair-Lone Pair < Lone pair-Lone pair (1 mark for correct order)
3. (1 mark for name of shape, 1 mark for bond angle, 1 mark for explanation)
   a) Trigonal planar. 120°. There are 3 bonded pairs of electrons and 0 lone p minimise the repulsive force.
   b) Tetrahedral. 109.5°. There are 4 bonded pairs of electrons and 0 lone pai minimise the repulsive force.
   c) Octahedral. 90°. There are 6 bonded pairs of electrons and 0 lone pairs s minimise the repulsive force.
   d) Pyramidal. 107°. There are 3 bonded pai[illegible]ons so the Hs move to repulsive force. As there is 1 lo[illegible] the angle is decreased by the extr
   e) Non-linear or bent/an[illegible]. There are 2 bonded pairs of electrons minimise the [illegible]orce. As there are 2 lone pairs the angle is decre
   f) L[illegible]80[illegible]re are 4 bonded pairs of electrons (arranged as 2 sets of m[illegible]an angle to minimise the repulsive force.
   g) Tetrahedral. 109.5°. There are four bonded pairs of electrons and 0 lone minimise the repulsive force.
   h) Trigonal planar. 120°. There are 6 bonded pairs of electrons (arranged as so the Os move to an angle to minimise the repulsive force .
   i) Tetrahedral. 109.5°. There are 4 bonded pairs of electrons and 0 lone pai minimise the repulsive force.

2.2.2: Bonding and Structure Part 3

1. The ability of an atom to attract the bonding electrons within a covalent bond
2. (3)



3. If the cov[illegible]ntl[illegible] atoms have a difference in electronegativity (1) then distrib[illegible]tween the atoms and are closer to the atom with the higher ele permar[illegible]pole arises (1). Diagram showing partial charges via the use of



4. Permanent dipole (1) one side of the molecule,(Cl end), is more negative and slightly positive (1). The positive end of one molecule is therefore attracted to molecule via a dipole–dipole interaction (1).

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