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GENERAL CERTIFICATE OF EDUCATION
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MARKING SCHEME

CHEMISTRY (NEW)
AS/Advanced

JANUARY 2009

INTRODUCTION

The marking schemes which follow were those used by WJEC for the January 2009 examination in GCE CHEMISTRY (NEW). They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

CHEMISTRY CH1 (new spec)

January 2009

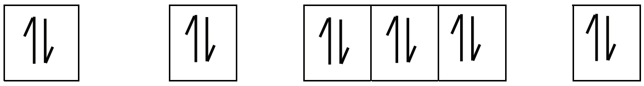
Mark Scheme

Section A

1. (a) (i) ^{27}Al [1]

(ii) 38 (minutes) [1]

(b) 1s 2s 2p 3s [1]



2. M_r CaO 56.1 (1) 0.5 × 56.1 (1) = 28.1 g [2]

3. (i) (1652 + 243) − (1585 +432) = −122 (kJ mol^{-1}) [1]

(ii) atom economy = 58 [1]

4. (i) (the electron is being removed) from an energy level further from the nucleus [1]

there is increased shielding for potassium [1]

(ii) the nuclear charge is greater for potassium [1]

Section A Total [10]

Section B

5. (a) Acidic solutions have a pH of less than 7 (1)
The lower the figure the 'higher' the degree of acidity (1) [2]

(b) (i) (When sulfur dioxide reacts with water) hydrogen ions / $H^+(aq)$ are produced [1]

(ii) The rate of the forward and reverse reactions are equal. [1]

(iii) The concentration of hydrogen ions / $[H^+]$ would increase (1)
as an increase in the concentration of the reactants moves the position of equilibrium to the right. (1) [2]

(c) Disadvantage 1 - calcium carbonate is needed, problems of quarrying etc. (1)
Disadvantage 2 - carbon dioxide is produced, contributes to global warming. (1) [2]

(d) (i) $20 \times 24 \times 5 = 2400$ (dm^3) [1]

(ii) $137 + 32.1 + 64 = 233.1$ [1]

(iii) $0.0047 / 233.1 = 2.0(2) \times 10^{-5}$ / 0.0000202 [1]

(iv) $2.0(2) \times 10^{-5}$ / 0.0000202 [1]

(v) 0.00048(5) [1]

(vi) $2.0(2) \times 10^{-5}$ [1]

Total [14]

6. (a) (i) 4.6 to 4.8 inclusive (minutes) [1]

(ii) Measuring the intensity of iodine by colorimetry / taking samples and measuring the concentration of iodine at intervals / taking tangents at the appropriate place [1]

(iii) I. Steeper line (1) finishing at a concentration of 0.010 mol dm^{-3} (1) [2]

II. Higher temperature ≡ higher energy (1)
More reactant molecules / ions have the activation energy (1) [2]

(iv) 0.010 mol dm^{-3} (1) since the reaction is in a 1: 1 ratio and all the peroxodisulfate ions are used up (1) [2]

(v) e.g., $\frac{0.002}{0.40}$ (1) = 0.005 (1) (mol dm^{-3} min^{-1}) accept up to 1.00 on the x axis [2]
accept an appropriate gradient

(b) (i) Low(er) temperature (1) low(er) pressure (1) [2]

(ii) Uses dilute sulfuric acid / difficult to separate products, catalyst [1]

(iii) e.g., Haber process (1) iron (1) / Contact process (1) vanadium(V) oxide (1) [2]

Total [15]

7. (a) 298 K / 25 ^{o}C and 1 atmosphere pressure / atmospheric pressure [1]

(b) (i) The enthalpy change in a reaction is independent of the pathway taken [1]

(ii) $-103 + (-81) = -184$ (kJ) [1]

(iii) I. 79 and 81 [1]

II. 50% of each (1)
158 and 162 are the same height (1) [2]

(c) (i) 0.100 [1]

(ii) $\Delta H = -\frac{\text{mc}\Delta \text{T}}{\text{n}}$

$m = 125$ (1) $\Delta T = 10.6$ (1)

$\Delta H = -\frac{125 \times 4.2 \times 10.6}{0.100} = -55650$ J (1)

$\therefore \Delta H = -55.7$ kJ mol^{-1} (1) must have negative sign [4]

(iii) Loss of heat etc. [1]

(iv) The sodium hydroxide is in excess [1]

Total [13]

8. (a) (i) The energy levels are quantised / only certain energy levels are possible (1)
therefore only certain frequencies are allowed (1) [2]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate (1) [1]

(ii) $E = hf$ (1) $f \propto \frac{1}{\lambda}$ / $c = f\lambda$ (1)

Wavelength / nm	*Frequency* / Hz	*Energy* / J
585	higher	higher
657	lower	lower

One mark for each correct row (1) (1) [4]

(b) (i) $Ne(g) \longrightarrow Ne^{+}(g) + e^{-}$ (1) (1) [2]

One mark for correct state and one mark for the equation

(ii) Relative isotopic mass is a term that describes the number of times one atom of ^{20}Ne is as heavy (1) as one-twelfth of a ^{12}C atom (1) [2]

(iii) Relative isotopic mass only considers one isotope, but the relative atomic mass considers a weighted average of the isotopes present. [1]

(iv) 1 mole of Ne has a mass of 20 g (1)
0.890 g has a volume of 1 dm^3
$\therefore$ 20 g has a volume of $\frac{20}{0.890}$ = 22.5 (dm^3) (1) [2]

OR

moles of neon = $\frac{0.890}{20}$ = 0.0445 (1)

$\therefore$ 1 mole of neon has a volume of 1/ 0.0445 = 22.5 (dm^3) (1)

Total [14]

9. (a) (i) Whether pure sodium hydroxide is needed / whether less pure sodium hydroxide is acceptable to the customer / whether high concentration sodium hydroxide is needed / whether lower concentration sodium hydroxide is acceptable to the customer / whether the cost of replacement diaphragms is an important economic consideration [1]

(ii) e.g., can it operate at a lower current / energy considerations
does it give a pure product, (thereby avoiding purification)
does it use or produce (other) toxic materials
do parts need replacing regularly

any two for (1) each (1) [2]

(b) (i) Measure out exactly 25.0 cm^3 (1) using a pipette / burette (1) for the first two marks then any **two** from the following:

Add this to a (250 cm^3) volumetric flask (1), dilute with (distilled) water and make up to the mark (1)
Use of a funnel (1)
Use of a dropping pipette (for making up to the mark) (1)
Now shake the mixture a number of times to ensure thorough mixing. (1) [4]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning. (1)
Selection of a form and style of writing appropriate to purpose and to complexity of subject matter. (1) [2]

(ii) I. 0.005(0) [1]

II. number of moles = $\frac{\text{concentration} \times \text{volume}}{1000}$ (1)

concentration = $\frac{1000 \times 0.005}{20.00}$ = 0.25(0) (mol dm^{-3}) (1) [2]

III. Original concentration = 2.5(0) (mol dm^{-3}) (1) [1]

IV. By using an indicator or named indicator eg. methyl orange / methyl red / phenolphthalein [1]

accept use of a pH meter

Total [14]

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GCE MARKING SCHEME

CHEMISTRY (NEW)
AS/Advanced

SUMMER 2009

CH1

Section A

1. *(a)* (i) Atomic number is the number of protons in the nucleus / in an element (e.g. 19 for potassium) [1]

(ii) Isotopes of elements have the same number of protons but different number of neutrons (e.g. chlorine has two isotopes ^{35}Cl and ^{37}Cl) / same atomic number but different mass number [1]

(b)

1s	2s	2p			3s	3p			3d					4s
↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓						↑

[1]

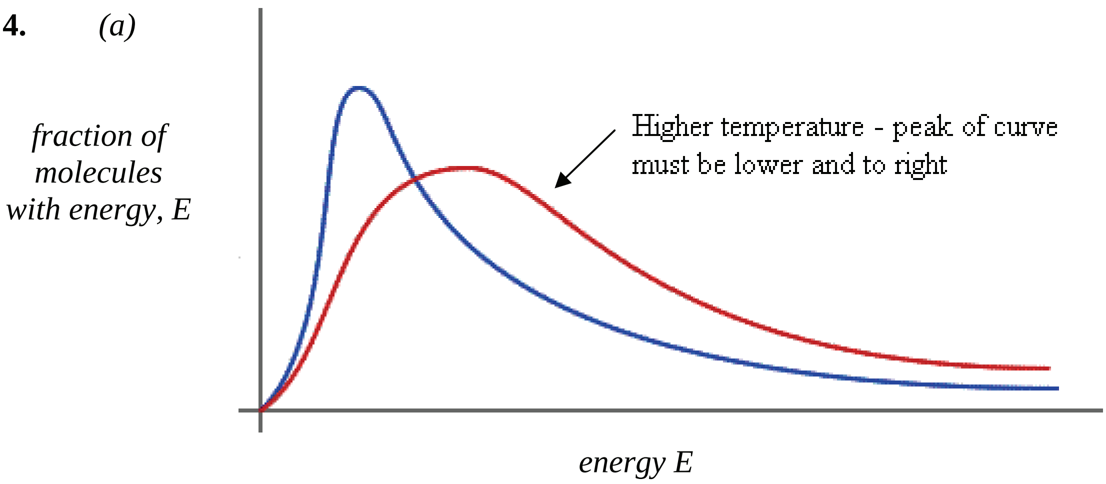
2. *(a)* (i) Measure (the volume of) hydrogen produced (using a gas syringe) / (mass of) hydrogen lost at constant time intervals [1]

(ii) Crush it into a powder / increase its surface area / heat it / stir it [1]

(b) 2 g [1]

3. 3 g / A [1]

4. *(a)*



(b) ΔH = (4 x 412) + 612 + 436 – ((6 x 412) + 348) [1]

= – 124 kJ mol^{-1} [1]

Total [10]

Section B

5. *(a)* (i) Correct plotting of 6 points (Allow ± ½ square) [3]

(ii) In He less shielding of outer electron (1)
outweighs smaller nuclear charge (1) /
He has greater effective nuclear charge (1) /
He outer electron closer to nucleus (1)

(Accept any two points) [2]

(iii) Ne has greater nuclear charge /
greater number of protons (in same orbital) [1]

(iv) N only has unpaired 2p electrons, O has two unpaired and two paired 2p electrons / N $1s^2\ 2s^2\ 2p^3$, O $1s^2\ 2s^2\ 2p^4$ (1), repulsion between the paired electrons makes it easier to remove one of the electrons / takes more energy to remove unpaired electron (1) [2]

(b) (i)

Pb	C	O	
$\frac{77.5}{207}$	$\frac{4.50}{12}$	$\frac{18.0}{16}$	
0.374	0.375	1.125	(1)
1	1	3	

Formula = $PbCO_3$ (1) [2]

(ii) I M_r Pb_3O_4 = (3 x 207) + (4 x 16) = 685 [1]

II Moles PbO = $\frac{134}{223}$ = 0.601 (1)

Moles Pb_3O_4 = 0.200 (1)

Mass Pb_3O_4 = 137 g (1) [3]

or alternative

1338 g PbO gives 1370 g Pb_3O_4 (1)

1 g PbO gives $\frac{1370}{1388}$ g Pb_3O_4 (1)

134 g PbO gives 137(.2) g Pb_3O_4 (1)

Total [14]

6. *(a)* (i) It provides a new route (1)
of lower activation energy (1) [2]

(ii) Heterogenous [1]

(iii) I Lower temperatures could be used (1)
(which would mean) increased yield (1) /
less energy consumption (1) / lower pressure used (1) /
equilibrium could be reached faster (1)
(Accept any two points) [2]

II More ammonia formed / equilibrium moves to right (1)
since more (gas) molecules on l.h.s. (1)
(Increases rate of reaction 1 mark) [2]

III Equilibrium moves to right / more ammonia formed (1)
since removing ammonia decreases its concentration in the mixture (1)
(Stops ammonia from returning to nitrogen and hydrogen 1 mark) [2]

(iv) Near a port / on the coast for exporting products (1),
good transport links for product (1), nearby workforce (1)

(Two valid reasons without one qualification 1 mark only) [2]

(b) (i) $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$ [1]

(ii) Ammonia accepts a proton (from the acid) / ammonia has a lone pair of electrons / ammonia neutralises the acid [1]

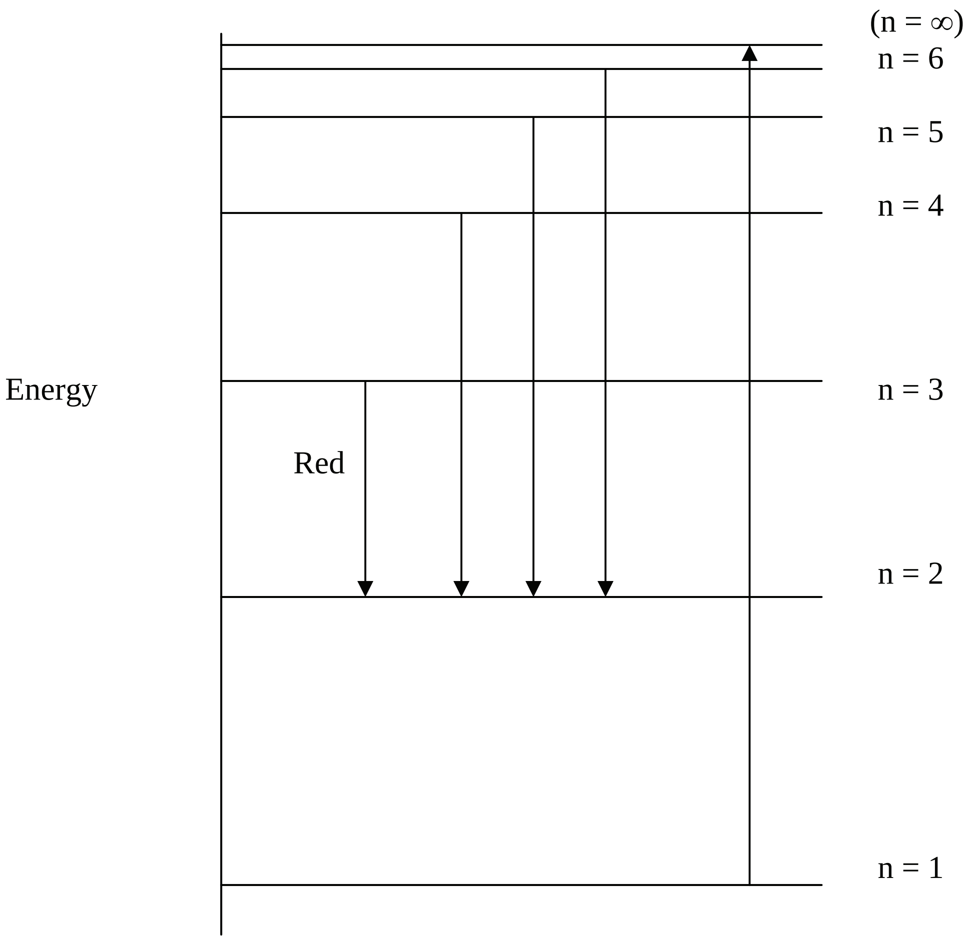
(iii) % N = 28/132 × 100 (1)
= 21.2% (1) [2]

Total [15]

7. *(a)* (i) Only changes between energy levels allowed /
electron falls from higher energy levels to lower energy levels (1)

Energy emitted related to frequency / E = hf / the difference between any two energy levels are fixed / energy levels are quantised (1) [2]

(ii)



Labelling of any 3 horizontal lines (1)

Transitions going to n = 2 (1)

Red line from n = 3 to n = 2 (1)

(If all lines go to n = 1, accept red line from n = 2 to n = 1) [3]

(iii) Transition from n = 1 to n = ∞ [1]

(b) (i) A_r H = $\frac{(1 \times 99.2) + (2 \times 0.8)}{100}$ (1)

= 1.008 (1) [2]

(ii) Some of the hydrogen molecules are split into atoms [1]

(c) (i) Electron gun / source of electrons / heated filament [1]

(ii) Electric field / charged plates / accelerator / collimator [1]

(iii) To ensure a vacuum /
prevents collisions between sample and air molecules [1]

(d)

Type	*Nature*	*Effect on atomic number*
α particle	**Cluster of 2 protons and 2 neutrons** (1) / $^{4}_{2}$**He <u>nucleus</u>**	**Decrease by 2** (1)
β particle	**Electron (1)**	**Increase by 1 (1)**
γ radiation	Electromagnetic radiation of high energy	No effect

(Accept '*decrease*' and '*increase*' in 'atomic number' for 1 mark only)
[4]

Total [16]

8.	*(a)*	(i)	Increases CO_2 levels / causes global warming	(1)	
			Gas is a non renewable energy source / will run out	(1)	[2]
		(QWC)	*The information is organised clearly and coherently, using specialist vocabulary where appropriate*		[1]
		(ii)	Wind / hydro / biomass / solar / geothermal	(1)	
			Rotation of blades turns turbine / falling water turns turbine / combustion steam turns turbine / sunlight on photovoltaic cell produces electricity (1)		
			(Accept answers in terms of energy changes)		[2]
	(b)	(i)	$C_2H_5OH + \mathbf{3}O_2 \longrightarrow \mathbf{2}CO_2 + \mathbf{3}H_2O$		[1]
		(ii)	ΔH = (2 x -394) + (3 x -286) – (-278)	(1)	
			ΔH = – 1368 kJ mol^{-1}	(1)	[2]
		(iii)	Energy for ethanol $= \frac{1368}{46}$ = 29.7 kJ g^{-1}	(1)	
			Energy for octane $= \frac{5512}{11\ 4}$ = 48.4 kJ g^{-1}	(1)	[2]
		(iv)	Ethanol is a renewable fuel (if obtained by fermentation) / ethanol is cheaper in countries with plentiful sugar cane growth / ethanol is more carbon neutral / ethanol burns more cleanly		[1]

Total [11]

9. *(a)* Volumetric / graduated / standard flask [1]

(b) 23.10 23.95 23.20 23.15 [1]

(c) Anomalous result = 23.95 cm^3

Mean = 23.15 cm^3 [1]

(d) (i) Moles HCl $= \frac{0.1 \times 23.15}{1000} = 2.315 \times 10^{-3}$ [1]

(ii) Moles $Na_2CO_3 = 1.158 \times 10^{-3}$ [1]

(iii) Moles in original solution = 1.158×10^{-2} [1]

(iv) Mass Na_2CO_3 = 1.227 g [1]

(v) % Na_2CO_3 = 59.9 % [1]

(Consequential marking applies)

(e) e.g. funnel left in burette (1) / air in pipette (1) /

not reading meniscus (1) / solution in flask not mixed thoroughly (1) /all of solid not used to make solution (1)

(Maximum 2 marks for sources of error)

If end-point overshot, too much acid would have been added (1),

so moles (mass) carbonate calculated would have been more than actual moles (mass) present (1)

[4]

(QWC) Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning (1)
Selection of a form and style of writing appropriate to purpose and to complexity of subject matter (1) [2]

Total [14]

Section B Total [70]

GCE MARKING SCHEME

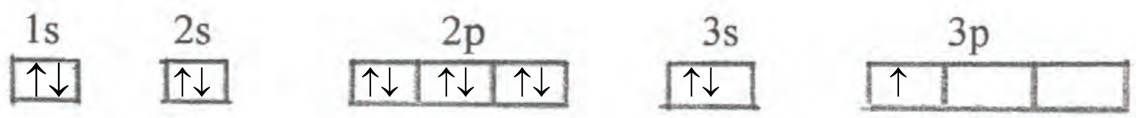
CHEMISTRY (NEW)
AS/Advanced

JANUARY 2010

CH1

SECTION A

1.



1 mark [1]

2. Letter: B 1 mark

Reason: Three electrons in outer shell, so largest jump between 3rd and 4th Ionisation Energies. 1 mark

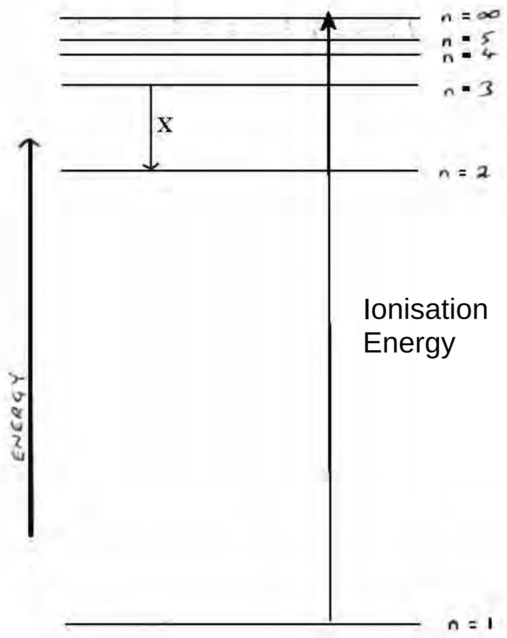
[2]

3 (a) *A mole is the amount of material containing the same number of particles as there are atoms in* 12 g of the ^{12}C isotope. 1 mark [1]

(b) 0.9 mol sulfur atoms. 1 mark [1]

4. (a) C The first line in the Balmer series. 1 mark [1]

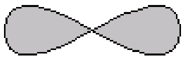
(b) Draw on the energy levels diagram an arrow to represent the transition which occurs when a hydrogen atom is ionised. [1]



(Arrow must be directed upwards for mark).

5. Sketch a diagram to show the shape of a p-orbital. [1]

Dumbbell shape or appropriate diagram 1 mark



6. (a) *Dynamic equilibrium* is when the rate of the forward reaction is equal (and opposite) to the rate of the reverse reaction. 1 mark [1]

(b) A chemical system is in *equilibrium* when:
there is no change in the amount of each species present /
there is no change in the concentrations present /
the physical properties are constant. 1 mark [1]

Section A Total [10]

SECTION B

7. (a) (i) *Isotopes* are atoms with the
same atomic number but different mass number /
same number of protons but different numbers of neutrons.
1 mark [1]

(ii) (^{191}Ir) 77 protons 114 neutrons 77 electrons 1 mark

(^{193}Ir) 77 protons 116 neutrons 77 electrons 1 mark
[2]

(iii) *Height of each peak*: [2]
(^{191}Ir) 19 units (^{193}Ir) 31 units 1 mark
or (by ruler) 38 mm 62 mm
% abundance
(^{191}Ir) $\frac{19 \times 100}{50}$ = 38% (^{193}Ir) $\frac{31 \times 100}{50}$ = 62% 1 mark

(b) (i) Loss of an electron (from the nucleus). 1 mark [1]

(ii) Mass number 192 Symbol Pt 1 mark for each [2]

(c) (i) *Half-life* is the time taken for half the amount of material to decay.
1 mark [1]

(ii) Half-life of ^{192}Ir = 73 (± 1) days 1 mark [1]

(iii) 1.25 g left (10 → 5 → 2.5 → 1.25 g)
/ 3 half lives elapsed 1 mark

3 x 73 days = 219 days 1 mark
(2 marks for correct answer with no working. Mark consequentially on the half life obtained in (c) (ii)) [2]

(iv) Rate of decay of ^{192}Ir (g day^{-1}) during the first 20 days.

Mass decayed in 20 days = 10 – 8.3 = 1.7 g 1 mark

(Since for the first 20 days the line is indistinguishable from linear)
rate = 1.7 / 20 = 0.085 g day^{-1} 1 mark [2]
(No penalty if units omitted, but do not allow if wrong units given)

(d) (i)

	Sodium	Iridium	Chlorine
Moles	10.2 / 23 = 0.443	42.6 / 192 = 0.222	47.2 / 35.5 = 1.330
			1 mark
Ratio	0.443 / 0.222	0.222 / 0.222	1.330 / 0.222
Hence	Na_2IrCl_6		1 mark

[2]

(ii) **P** is Na_2IrCl_6

So for $2NaCl + IrCl_x \rightarrow Na_2IrCl_6$

x must be 4 / $IrCl_4$ 1 mark [1]
(Mark consequentially if formula of P is incorrect)

Total [17]

8. (a) (i) **Reaction 1** is the most effective. 1 mark
Lowest number moles Na_2CO_3 needed per mole CO_2 /
Highest number moles CO_2 absorbed per mole Na_2CO_3 /
or equivalent statement 1 mark [2]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate.
1 mark awarded if candidate has clearly explained their reasoning with appropriate use of words such as *mole* or *ratio*. [1]

(ii) Le Chatelier's Principle:
When a system in equilibrium is subjected to a change, the processes which occur are such as to oppose the effect of the change. 1 mark [1]
(or equivalent statement)

(iii) More efficient at high gas pressure. 1 mark
(Whichever reaction is used gases only occur amongst the reactants, so by Le Chatelier's Principle) high pressure will favour the forward reaction because of the reduction in the number of moles of gas.
1 mark [2]

(b) (i) Exothermic. 1 mark
As the temperature increases, less product ($NaHCO_3$) / more reactants (Na_2CO_3, CO_2 and H_2O) are present so reverse reaction is favoured and forward reaction must be exothermic
(or any equivalent statement) 1 mark [2]

(ii) I (NaHCO$_3$ can be used to regenerate sodium carbonate) by heating (to 90˚C) 1 mark [1]

II *Either*
Energy must be supplied for heating (with cost implications)
or
CO_2(g) would be released into the environment (unless prevention measures taken, negating the point of using sodium carbonate to absorb CO_2(g)). 1 mark [1]

(c)	(i)	Relative molecular mass CO_2 = 44	1 mark	
		No moles CO_2 = 275 / 44 = 6.25	1 mark	[2]
	(ii)	6.25 x 24.0 = 150 dm^3	1 mark	[1]
	(iii)	150 x 100 / 1000 = 15%	1 mark	[1]
(d)	(i)	An acid is an H^+ / proton donor.	1 mark	[1]
	(ii)	(Although CO_2 does not contain any hydrogen) it reacts with water to produce H^+ ions / to form carbonic acid / to form H_2CO_3.	1 mark	[1]
	(iii)	Carbon dioxide from air will produce H^+ ions / make the water acidic and acids have pH less than 7.	1 mark	[1]

Total [17]

9. *(a)* (i) 1 mark for setting up correctly

$\Delta H^{\ominus} = 243 + 436 - (2 \times 432)$

1 mark for calculation

$\Delta H^{\ominus} = -185 \text{ kJ mol}^{-1}$ [2]

(ii) $\Delta H_f^{\ominus}$ HCl (g) = - 185 / 2 = - 92.5 kJ mol^{-1} 1 mark [1]

(Mark consequentially if $\Delta H^{\ominus}$ value incorrect)

(iii) 2 x 1 mark for:

Temperature 25˚C / 298 K

Pressure 1 atm [2]

(iv) Chlorine – chlorine bond (as it is the weakest). 1 mark [1]

(v) Blue and violet light 2 x 1 mark

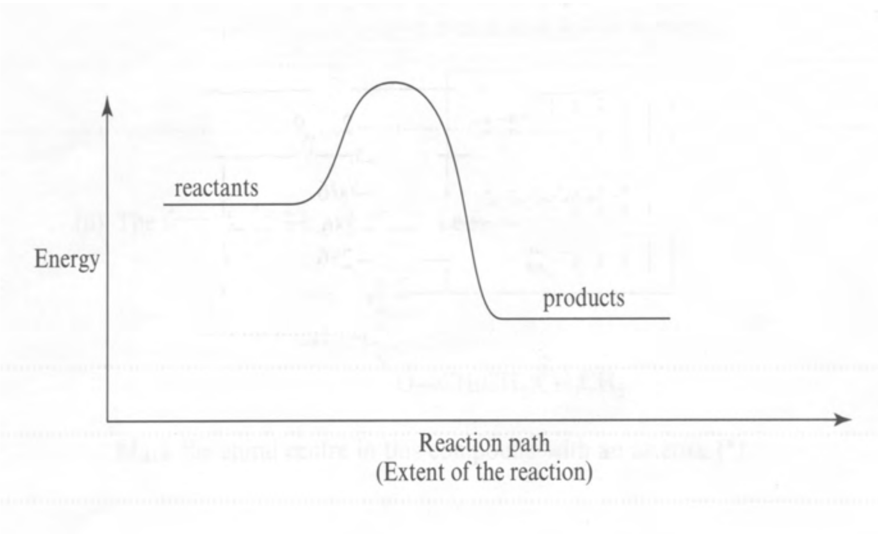
provide sufficient energy to break the

Cl_2 covalent bond 1 mark. [3]

(vi) No visible light has sufficient energy to break

the H-Cl bond. 1 mark [1]

(b)



6 x 1 mark:

- Correct drawing of profile (must be exothermic and show reactants / products)
- Activation Energy is the minimum energy necessary for a reaction to occur
- Increasing temperature increases the (kinetic) energy of molecules
- so more molecules have greater than the activation energy (and reaction speeds up)
- A catalyst lowers the activation energy
- so speeds up the reaction.
  (the points may be made in conjunction with the profile diagram). [6]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning. 1 mark

Selection of a form and style of writing appropriate to purpose and to complexity of subject matter. In particular, relating text to the profile diagram. 1 mark [2]

Total [18]

10. *(a)* Transfer of H^+ (from HCl to NH_3) 1 mark
HCl acid, NH_3 base 1 mark [2]

(b) (i) $\Delta H = \frac{- v\ c\ \Delta T}{n}$

1 mark for total volume = 50cm^3

1 mark for converting kJ to J (or vice versa)

1 mark for calculating n (*mark consequentially if set up wrongly above*)

$$-53.4 \times 1000 = \frac{- 50 \times 4.2 \times 0.7}{n}$$

n, no moles NH_3 = 2.75×10^{-3} [3]

(ii) 2.75×10^{-3} mol NH_3 in 25 cm^3

so concentration = 2.75×10^{-3} x 1000/25 = 0.11 mol dm^{-3}
1 mark [1]

(c) (i) Mean titre = 31.23 cm^3 1 mark

Concentration NH_3 = 31.23 x 0.100 / 25 = 0.125 cm^3
1 mark [2]

(ii) Titration will give the more precise value for concentration 1 mark

2 marks for two of the following:

Temperature change only read to one significant figure, titre to three significant figures / titration is a more precise technique than thermometry. 1 mark

The titration is repeated three times (to obtain consistent results), but only one measurement of temperature change. 1 mark

Thermometric method susceptible to heat loss (but no corresponding problem in titrations). 1 mark [3] *(d)* (i) Both already elements in their standard states / no change needed to form them. 1 mark [1]

(ii) I the standard enthalpy change, $\Delta H^{\ominus}$, for the combustion of ammonia

$4NH_3 (g) + 3O_2 (g) \rightarrow 2N_2 (g) + 6H_2O (g)$

1 mark for setting up

$\Delta H^{\ominus} = (2 \times 0) + (6 \times -241.8) - (4 \times -46.1) - (3 \times 0)$

1 mark for calculation

$\Delta H^{\ominus} = -1450.8 + 184.4 = -1266.4 \text{ kJ mol}^{-1}$ [2]

II the standard enthalpy change, $\Delta H^{\ominus}$, for the combustion of methane

$CH_4 (g) + O_2 (g) \rightarrow CO_2 (g) + 2H_2O (g)$

1 mark for setting up

$\Delta H^{\ominus} = (1 \times -393.5) + (2 \times -241.8) - (1 \times -74.8) - (1 \times 0)$

1 mark for calculation

$\Delta H^{\ominus} = -393.5 - 483.6 + 74.8 = -802.3 \text{ kJ mol}^{-1}$ [2]

(iii) Advantage of using ammonia:
No CO_2 / greenhouse gases emitted 1 mark

Disadvantage of using ammonia:
Much less energy produced per mole on combustion (318.6 v $802.3 \text{ kJ mol}^{-1}$) /more ammonia needed than methane to produce the same amount of energy /sharp smell of ammonia/ ammonia more corrosive. 1 mark [2]

Total [18]

Section B Total [70]

WJEC
CBAC

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2010

CH1

SECTION A

1.	(i)	C	[1]
	(ii)	0.120 g	[1]
2.	(i)	C_2N_2	[1]
	(ii)	CN	[1]
3.	(i)	79 and 81	[1]
	(ii)	142	[1]
4.	D		[1]
5.	(i)	100	[1]
	(ii)	142.5 / 143 kg	[1]
6.	B		[1]

Total [10]

SECTION B

7. (a) (i) A lower pressure gives a reduced equilibrium yield / less ammonia (accept – the reaction rate is slower) [1]

(ii) The position of equilibrium will shift to the right (1) as more nitrogen and hydrogen react to restore the position of equilibrium. (1) [2]

(iii) Unchanged [1]

(b) (i) ammonia 17.03 (g) ammonium sulfate 132.2 (g) [1]

(ii) molar ratio 2 : 1 (1)

2×17.03 tonnes ammonia give 132.2 tonnes of ammonium sulfate (1)

66.1 (tonnes) (1) [3]

(c) The pH scale is a measure of acidity/alkalinity (1)

values below 7 are acidic / above 7 are alkaline / pH 7 is neutral / pH 6 is a weak acid (1) [2]

(d) Number of moles of ammonium nitrate $= \dfrac{4 \times 10^8}{80} = 5 \times 10^6$ / 5 000 000 (1)

Energy produced $= 296 \times 5 \times 10^6 = 1.48 \times 10^9$ (kJ) (1) [2]

(e) (i) It is exothermic because the heat evolved maintains the temperature of the platinum wire, keeping it red-hot (and maintaining the reaction) [1]

(ii) A reaction where the catalyst is in a different (physical) state to the reactants / products [1]

Total [14]

8. (a) (i) orange-yellow (accept sodium/590 mm)

frequency $\propto \dfrac{1}{\text{wavelength}}$

shorter wavelength/shorter wavelength, higher frequency) [1]

(ii) energy = h × frequency (accept energy ∝ frequency)
E = hf [1]

(b) (i) Lines represent the energy emitted (1) when an excited electron drops back (1) from one energy level to another (1) [3]

(ii) This represents the energy needed to remove the electron from the hydrogen atom / ionise the atom [1]

(iii) In each series the excited electron drops back to a different energy level [1]

(c) (i)

	Change
Atomic number	No change/0
Mass number	Increases by one/+1

[1]

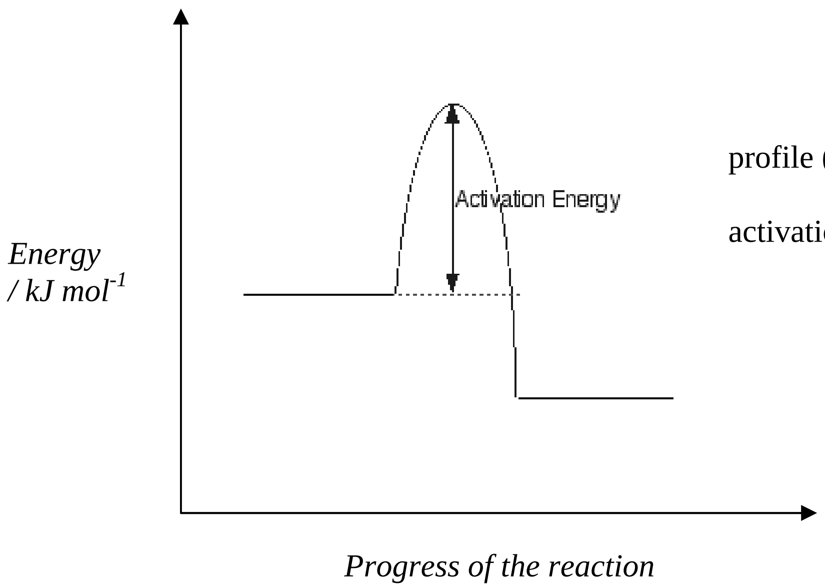
(ii) ^{24}Mg [1]

(d)

1s	2s	2p			3s	3p		
↑↓	↑↓	↑↓	↑↓	↑↓	↑↓			

[1]

(e) (i)



profile (1)

activation energy (1)

[2]

Total [12]

9. (a) (i) I **N** (1) the yield is 75%, as for **L**, but only water is formed (1) [2]

II e.g. use renewable energy resources
keep energy use to a minimum/low temperature/low pressure
use the most effective catalyst
use non-toxic materials wherever possible
the co-products should be non-toxic / or capable of being converted to non-toxic materials
use renewable feedstocks/sustainable feedstocks
re-use / recycle waste product
'high atom economy'

any two (1) (1) [2]

(ii) $0.0 + \Delta H = -400 + (-858)$ (1)
$\Delta H = -1258$ kJ mol^{-1} (1) [2]

(b) Bonds broken = 3748 kJ (1) Bonds made = 4824 kJ (1)

$\Delta H = \Sigma$ bonds broken $-$ Σ bonds made (1)

$= 3748 - 4824 = -1076$ kJ mol^{-1} (1) [4]

(c) (i) When more carbon dioxide dissolves in sea water the position of equilibrium for the first equation is moved to the right producing more H^+ (and more HCO_3^-) ions (1) making the water more acidic / pH decreases (1) [2]

(ii) The concentration of carbonate ions / CO_3^{2-} will decrease [1]

(d) Solubility is 1.45 g dm^{-3} (1)
Concentration of carbon dioxide $= \frac{1.45}{M_r} = \frac{1.45}{44} = 0.033$ (mol dm^{-3}) (1)
[2]

Total [15]

10. (i) $\frac{0.20}{12.5}$ = 0.016 (1) mol dm^{-3} min^{-1} (1) [2]

(ii) As the reaction proceeds the rate becomes less / reaction slows down (1)
As the concentration of the reactant becomes smaller (1)
At the beginning of the reaction there is more chance of a successful collision (hence rate is faster) (1)
The collision rate becomes slower as the reactant is used up (1)

Text is legible; spelling is accurate and its meaning is clear, and punctuation and grammar are correct. QWC (1)
The candidate has selected a form and style of writing that is appropriate to purpose and complexity of the subject matter. QWC (1)
[6]

(iii) I Accept values between 0.30 and 0.65 (mol dm^{-3}) [1]

II The final concentration would be the same (1) as a catalyst does not affect the overall yield (1) [2]

(iv) 1 mole of the solvent gives 1 mole of the acid
∴ Number of moles of the solvent **A** is also 0.650 (1)

$M_r = \frac{\text{mass}}{\text{number of moles}} = \frac{48.1}{0.650} = 74$ (1) [2]

Total [13]

11. (a) (i) To make sure that the potassium carbonate/soluble substances had dissolved [1]

(ii) Filtrate added to a 250 cm^3 volumetric flask (1)
Use of a funnel (1)
Mention of washing out original vessel etc. (1)
Made up to the mark (with distilled water) (1)
Shaken/inverted (1)
Any 4 points [4]

(iii) I 24.65 (cm^3) [1]

II Any 5 from
25.00 cm^3 of the potassium carbonate solution **pipetted** into a conical flask (1)
(A few drops of) indicator added (1)
Titrate (with the acid) until the indicator just (1) turns pink (1)
Shake/swirl/mix (1)
Reads burette before and after (1)
Wash sides with distilled/deionised water (1)

Organisation of information clearly and coherently; using specialist vocabulary where appropriate QWC (1)
[6]

(b) (i) M_r of potassium carbonate 138.2 (1)

% potassium $= \frac{78.2 \times 100}{138.2}$ (1) = 56.6 (1) [2]

(ii) The relative (molecular) mass of the hydrate is higher (than the anhydrous salt) but a ‘molecule’ still only contains two potassium ‘atoms’ [1]

(c) e.g. wood needs to be burnt, forming carbon dioxide (a greenhouse gas)/ deforestation [1]

Total [16]

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2011

CH1

Section A

1.

1s	2s	2p	3s	3p	3d	4s
↑↓	↑↓	↑↓ ↑↓ ↑↓	↑↓	↑↓ ↑↓ ↑↓		↑↓

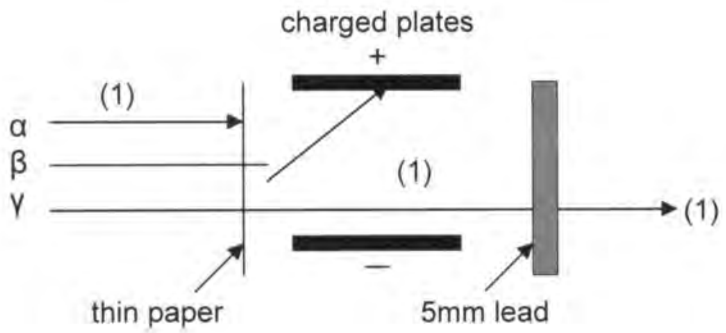
[1]

2. (a) M_r = 172.24 [1]

(b) % = 20.9 [1]

3. D [1]

4.



[3]

5. (a)

C	H	O	
40	6.7	53.3	
12	1.01	16	
3.33	6.63	3.33	(1)
1	2	1	

Empirical Formula = CH_2O (1) [2]

(b) $\frac{180}{30.02}$ = 6

Molecular Formula = $C_6H_{12}O_6$ [1]

Total [10]

Section B

6. (a) (i) Average mass of one atom of the element (1) relative to 1/12th mass of one atom of carbon-12. (1) [2]

(ii) $A_r = \frac{(39 \times 93.26) + (40 \times 0.012) + (41 \times 6.73)}{100}$ (1)

$= 39.14$ (1) [2]

(b) (i) (Gaseous potassium) atoms bombarded by electrons. [1]

(ii) Deflected through a magnetic field. [1]

(c) (i) ${}^{40}_{19}K \longrightarrow {}^{40}_{20}Ca + {}^{0}_{-1}\beta$ (accept ${}^{0}_{-1}e$)

(1 mark for ${}^{40}_{20}Ca$, 1 mark for balanced equation) [2]

(ii) 3.75×10^9 years. [1]

(d) (i) Energy required to remove one mole of electrons from 1 mole of atoms / an electron from each atom in 1 mole (1) in the gaseous state. (1) [2]
(Accept equation)

(ii) I In K greater shielding of outer electron (1) outweighs larger nuclear charge (1) / Na has greater effective nuclear charge (1) / Na outer electron closer to nucleus (1).
(Maximum 2 marks) [2]

II Shielding effect on outer electron is less (1) / 2nd electron is removed from inner shell / closer to nucleus (1) / after 1st electron is removed effective nuclear charge is greater. (1) [2]

(Maximum 2 marks)

Total [15]

7. (a) Bubbles (of gas) / fizzing / $CaCO_3$ disappears / apparatus gets warmer [1]

(b) Gas syringe / burette / graduated tube/measuring cylinder [1]

(c) (Use scales to) weigh aqueous product / sampling and titration / change in pH at set times [1]

(d) (i) Moles HCl = 0.020 [1]

(ii) Moles $CaCO_3$ = 0.01 (1)
Mass = 1.00 g (1) [2]

(iii) Moles CO_2 = 0.010 (1)
Volume = 0.240 dm^3 (1) [2]

(e) (i) Smooth curve passing through 150 cm^3 ending at 200 cm^3 [1]

(ii) Curve less steep (1) ending at 100 cm^3 (1) [2]

(iii) When the acid is less concentrated it has fewer (acid) particles (1) therefore there is less chance of (successful) collisions (between the acid and carbonate) / fewer collisions per unit time. (1) [2]

(f) Diagram with two reasonable curves. (1 mark) Activation energy labelled (1) The fraction of molecules that have the required activation energy is much greater at a higher temperature. (1) [3]

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter. [1]

Total [17]

8. (a) (i) Between 1800 and 1900 the global temperature was fairly constant as was the concentration of CO_2 in the atmosphere. (1)
Since 1900 the global temperature has risen steadily as has the concentration of CO_2 in the atmosphere. (1)

As concentration of CO_2 increases, global temperature increases. (1 mark only). [2]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning [1]

(ii) There is an uncertainty in the results / temperature dropped between 1900 and 1910 / between 1940 and 1950 / at some points. [1]

(iii) Before 1900 the instruments were less accurate (1) and there were fewer records (1)
Temperatures are estimates. (1)
Any 2 from 3 [2]

(iv) More burning of fossil fuels / more industries / more transportation / deforestation. (Any two) [2]

(b) (i) Rate of forward reaction = rate of back reaction. [1]

(ii) (Molecules can escape from the bottle) so concentration amount of CO_2(g) falls / pressure falls (1) and position of equilibrium moves to the left (so concentration of CO_2(aq) falls) / rate of molecules entering solution is less than rate leaving solution. (1) [2]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

Total [12]

9. (a) (i) Furthest line on left hand side. [1]

(ii) The (electron) energy levels of a hydrogen atom become closer. [1]

(b) (i) If a system at equilibrium is subject to a change the equilibrium tends to shift so as to minimize the effect of the change. [1]

(ii) I Yield increases. (1)
Forward reaction is endothermic. (1) [2]

II Yield decreases. (1)
More (gaseous) molecules on the right hand side. (1) [2]

(iii) Atom economy = $\frac{\text{mass hydrogen}}{\text{mass reactants}}$ x 100 (1)

= 17.8% (1) [2]

(c) Bonds broken = 3296 kJ Bonds formed = 3132 kJ (1)

ΔH = 3296 – 3132 = 164 kJ mol^{-1} (1) [2]

Total [11]

10. (a) To ensure that the (initial) temperature is constant / temperature difference is required between initial and maximum temperature. [1]

(b) (i) Best fit lines (1)
Temperature rise = 9.6°C (1) [2]
(Accept ±0.2°C)

(ii) Extrapolation gives the temperature that would have been reached if the reaction occurred instantly / to allow for heat loss during the experiment [1]

(c) Heat = 50 x 4.18 x 9.6
= 2006 J [1]

(d) (i) Moles Mg = 0.037 [1]

(ii) Moles $CuSO_4$ = 0.025 [1]

(e) $\Delta H = \frac{2006}{0.025}$ (1)

$= -80.2 \text{ kJ mol}^{-1}$ (1) [2]

(f) Burette / pipette [1]

(g) Magnesium was in excess. [1]

(h) Rate of reaction is quicker. Allow greater surface area if qualified. [1]

(i) $\frac{12.9}{93.1} \times 100 = 13.9\%$ [1]

(j) Energy/Heat is lost to the environment. (1)
States how insulation could be improved e.g. place a lid on the polystyrene cup (1) [2]

Total [15]

Section B Total [70]

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2011

CHEMISTRY - CH1

SECTION A

Q.1

Atom/ion	No. of protons	No. of neutrons	No.of electrons
^{24}Mg	12	12	12
^{26}Mg	12	14	12
$^{24}Mg^{2+}$	12	12	10

One mark for each correct line [3]

Q.2 An iron atom, Fe

3s	3p			3d					4s
↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑	↑	↑	↑↓

[1]

Q.3 58.5 - working must be shown [1]

Q.4 **C** [1]

Q.5 ΔH (1), **both** activation energies (1) [2]

Q.6 (a) NO_2

(b) N_2O_4 [2]

Total [10]

SECTION B

Q.7 (a) The electrons absorb energy from the radiation (1) and are excited up to a higher energy level (1)leaving dark lines or bands in the spectrum (1)
- 2 max. [2]

(b) A **series** (four) of sharp (bright) **lines** (on a dark background) (converging towards the violet end). (1)
The atom's electron energy levels have fixed values/ are quantized (1), the lines arise when electrons fall between these levels (1) and thus have fixed energies and wavelengths. (1)
Any two in this sentence for two marks. [3]

QWC: Information organized clearly and coherently, using specialist vocabulary where appropriate. [1]

(c) (i) IEs increase (1) due to increasing nuclear charge / more protons and same orbitals being filled. (1)

(ii) IEs decrease (1) since increase in nuclear charge is outweighed by increased shielding by electrons in inner orbitals (or similar sense). (1)
[4]

(d)

Radiation	**Effect on atomic number**	**Effect on mass number**
alpha particle	-2	-4
beta particle	+1	0
gamma radiation	0	0

One mark per correct line. [3]

(e) (i) The time taken for one half of a (radioactive) isotope to decay. (1)
By measuring how much of the isotope has decayed the period of time over which it has been decaying can be calculated and the age of the rock or organic material found. (1)
[2]

(ii) Accept any two realistic examples - not x-ray / MRI. [2]

Total [17]

Q.8	(a)	(i)	96.8 g	(1) for 1.5 mol if answer incorrect	[2]
		(ii)	81.7 %	(1) for 1.22 mol if answer incorrect	[2]

(b) (i) The amount or % by mass of all the reactants that ends up in the desired product. [1]

(ii) **A** 100 % (1); **B** 31.9 % (1) [2]

(iii) **A** is preferred giving complete use of materials and no waste or co-products to be removed. [1]

(c) General statement of meaning of the term (1) and examples of individual aims such as to maximise yield, prevent waste, avoid materials toxic to health and damaging to the environment, minimise energy use, work at lower temperatures and pressures, increase safety, avoid the use of organic solvents, etc., etc.,
Any three of above or similar points. Mark flexibly! [3]

QWC: Selection of form and style of writing appropriate to purpose and to complexity of subject matter. [1]

Total [12]

Q.9 (a) If the temperature, pressure or concentration of a system in equilibrium is changed the position of equilibrium shifts in the direction to oppose the change (or similar). [1]

(b) This is a measure of the acidity or alkalinity of an (aqueous) solution (and relates to the hydrogen ion concentration.) pH 7 is neutral, lower values are acidic and higher values alkaline and the further the values are from 7 the more acidic or alkaline the solution is. [1]
Accept pH = $-\log_{10}[H^+]$

(c) (i) I Acidity will increase since, from Le Chatelier, increased CO_2 pushes the equilibrium to the right. [1]
II pH will fall since $[H^+]$ increases [1]

(ii) This will decrease since the increase in H^+ moves the equil. to the left, (reducing carbonate and increasing hydrogencarbonate). [1]

(iii) It will be more difficult to make shells since the reduction in carbonate will displace the equil. to the left and the solid shell will tend to dissolve rather than form. [1]
Accept error carried forward from (ii).

(d) 7.6 ± 0.1 [1]

(e) moles H^+ = 0.095 x 19.6/1000 = 0.00186 (1)

concn HCO_3^- = 0.00186 x 1000/25 = 0.0744 (1) (mol dm^{-3}) [2]

Total [9]

Q.10 (a) Temperature, pressure/concentration, catalyst, light, particle size.
- any three for 1 mark each [3]

(b) (i) Results correctly plotted (2), one error (1), more than one (0).
Good curve (and tangent) (1).
Correct rate 0.1 (1), cm^3/s (1) [5]

(ii) The rate is lower at 250 s (1) since the concentration of peroxide has fallen through decomposition (1) (and there are fewer collisions/the rate depends on concentration) [2]

(iii) A gas syringe or gas volume-measuring device is attached to the reaction flask, a stopwatch/timer is started and the volume of gas in the syringe measured at (50 s) time intervals. [2]

(c) Rate increases with increasing pressure and temperature (1).
Increasing pressure increases concentration (1).
Increasing temperature increases number of molecules with E_a. (1)
Rate increases with rate of successful collisions. (1) [4]

QWC: Legibility of text; accuracy of spelling, grammar and punctuation; clarity of meaning. [1]

Total [17]

Q.11 (a) (i) A known mass / volume of water is placed into an insulated vessel (calorimeter)(1) and the temperature measured every 30s. When the temperature is constant (1) a known mass of $NaNO_3$ is rapidly added (and stirred to dissolve) (1). The temperature continues to be measured every 30 s for some minutes (1), a temperature/time plot is made from the results, ΔT (max) is found from the graph(1) – extrapolation (1)- and ΔH calculated from the equation below.
- 4 max. [4]

(ii) Extrapolate (1)
$\Delta T = -10.0 \pm 0.4^o$ (1)

$\Delta H = +21\ kJ\ mol^{-1}$ (2); -1 if wrong sign, consequential [4]
[21 000 $kJ\ mol^{-1}$ (1)]

(b) (i) The overall enthalpy change for a reaction is independent of the reaction route taken (or equivalent). [1]

(ii) $\Delta H = \Delta H^o_f(H_2SO_4) – [\Delta H^o_f(SO_3) + \Delta H^o_f(H_2O)$ (1)

$= (-811)-[(-395) + (-286)] = -130\ kJ\ mol^{-1}$ (1) [2]
- 1 max. for $+130\ kJ\ mol^{-1}$

(c) The (average) energy needed to break the O-H bond. (1)
O-H bonds in different molecules will have slightly different bond energies and so a mean or average value is useful. (1) [2]

(d) These are fossil fuels, that are non-renewable and finite in amount so will eventually run out. (1)
Turn to renewable sources of energy (such as solar, wind, biofuels and nuclear.) (1)
OR
Combustion of carbon compounds gives CO_2 in the atmosphere that is causing global warming. (1)
Reduce the use of these fuels / capture / store the CO_2. (1)
OR
Sulfur in fuels producing sulfuric acid in atmosphere –acid rain-(1).
Remove sulfur dioxide from flues (FGD), use low sulfur fuels, etc. (1) [2]

Total [15]

Section B Total [70]

WJEC
CBAC

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2012

GCE Chemistry – CH1

SECTION A

Q.1

1s	2s	2p			3s	3p		
↓↑	↓↑	↓↑	↓↑	↓↑	↓↑	↓↑	↑	↑

[1]

Q.2 B / 13 [1]

Q.3 Acid: Proton donor (1)

Dynamic equilibrium: Reversible reaction where the **rate** of forward and reverse reactions is equal (1) [2]

Q.4 (a)

	1	2	3	4
Volume used / cm^3	20.75	20.20	20.10	20.30

[1]

(b) 20.20 cm^3 [1]

Q.5 A [1]

Q.6 (a) Ratio of C:H is 1:1.33 (1)
Emp. Formula = C_3H_4 (1) [2]

(b) Molecular formula = C_9H_{12} [1]

SECTION A TOTAL [10]

SECTION B

Q.7 (a) (i) Temperature: 298K / 25°C (1) Pressure: 1 atm / 101.325 kPa or 100 kPa (1) [2]

(ii) Hydrogen gas is an element in its standard state [1]

(iii) $\Delta H = \Delta H_f\ (C_5H_{12}) + 5\ \Delta H_f\ (H_2O) – 5\ \Delta H_f\ (CO) – 11\Delta H_f\ (H_2)$ (1)

$\Delta H_f\ (C_5H_{12}) = -1049 - 5\ (-286) + 5\ (-111)$ (1)

$\Delta H_f\ (C_5H_{12}) = -174\ kJ\ mol^{-1}$ (1) [3]

(b) (i) Catalyst in different state to reactants [1]

(ii) Catalysts provide an alternative route (1) with a lower activation energy (1) [2]

(iii) Lower temperature or less time so less energy needed / Can make alternative production method possible with sustainable starting materials or less waste products [1]

(iv) At higher temperatures particles have more energy (1)

More collisions have energy above activation energy (1)

(Can obtain these two marks from correctly labelled Boltzmann energy distribution plot with two temperature lines (1) and Activation energy (1))

Successful collisions occur more frequently (1) – 3 max [3]

QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

(c) (i) No effect (1)

Same number of (gas) molecules on both sides of reaction (1) [2]

(ii) Lower yield of hydrogen (1)

Reaction shifts in endothermic direction to (try to counteract increase in temperature) (1) [2]

(iii) No effect [1]

Total [19]

Q.8 (a) Be: 800 - 1000 kJ mol^{-1} (1)

Ne: 1700 – 2300 cm^{-1} (1) [2]

(b) Be (g) → Be^+ (g) + e [1]

(c) (i) Greater nuclear charge on He (1)

No increase in shielding / Outer electrons same distance from nucleus / Outer electrons in same shell (1) [2]

(ii) Outer electron in O is paired in orbital / Outer electron for N is unpaired (1)

Repulsion between paired electrons makes it easier to remove outer electron of oxygen (1) [2]

(d) (i) Electrons excited to a higher energy level (1)

Energy levels are quantised (1)

Electrons drop from higher to lower energy levels (1)

Energy is emitted as light (1) – 3 max [3]

Lines represent the energy emitted (1) when an excited electron drops back (1) from one energy level to another (1)

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning [1]

(ii) Find frequency of convergence limit (1) for Lyman series (1)

Ionisation energy is given by E=hf / Energy $\propto$ frequency (1) [3]

Total [14]

Q.9 (a) M_r (PbS) = 239.1 M_r (PbO) = 223 (1)

Moles of PbS = 20,000 ÷ 239.1 = 83.65 moles (1)

Mass of PbO = 83.65 x 223 ÷1000 = 18.7 kg (1) [3]

(b) (i) Sulfur dioxide: Acid rain (1)

Carbon dioxide: Climate change / global warming / acidification of oceans (1) [2]

(ii) I. Sum of M_r of reactants = 223 + 28 = 251 (1)

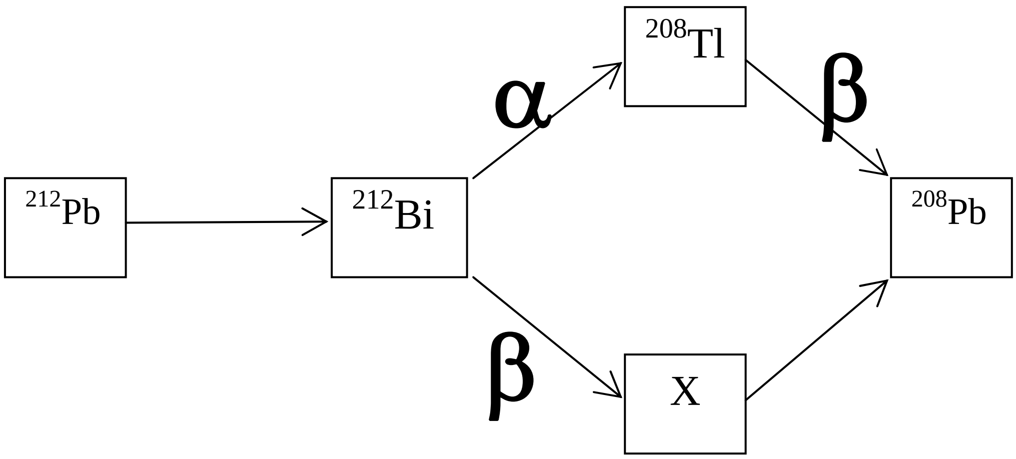
Atom economy = (207 ÷ 251) x 100 = 82.5% (1) [2]

(ii) II. Method 1 as higher atom economy means less waste / more useful product [1]

(c) (i) Symbol = Po (1) Mass number = 212 (1) [2]

(ii) All three arrows labelled correctly, as shows below, gives two marks

Any two arrows labelled correctly gives one mark [2]



(iii) γ-radiation is high energy / frequency electromagnetic waves (1)

It affects neither atomic number nor mass number / it changes neither the number of protons nor neutrons (1) [2]

(iv) 31.8 hours = 3 half lives (1)

Mass remaining after 3 half lives = 3mg (1) [2]

(d) A_r = [(206.0 x 25.48) + (207.0 x 22.12) + (208.0 x 52.40)] ÷ 100 (1)

A_r = 207.3 (1)

1 mark for correct significant figures (answer must be reasonable) [3]

Total [19]

Q.10 (a) (i) M_r ($CuSO_4.5H_2O$) = 249.7 [1]

(ii) I. Moles of copper(II) sulfate

= 0.250 x 250/1000 = 6.25 x 10^{-2} moles (1)

Mass = 6.25 x 10^{-2} x 249.7 = 15.6 g (1) [2]

II. 1 mark each for:

- Weighing method
- Dissolve copper sulfate in a smaller volume of distilled water
- Transfer to 250.0 cm^3 volumetric / standard flask
- Use of funnel
- Wash funnel / glass rod / beaker with distilled water into volumetric flask
- Add distilled water up to mark
- Shake solution / mix thoroughly 5 max [5]

QWC: organisation of information clearly and coherently; use of specialist vocabulary where appropriate [1]

(b) (i) Powder has a greater surface area (1) so gives a higher rate of reaction (1) [2]

(ii) Extrapolate lines from start (level at 21.3°C) and end (through points at 180-270 seconds) (1)

Temperature rise = 6.0°C (Range 5.8-6.2°C) (1) [2]

(iii) I. Moles = 0.250 x 0.05 = 1.25 x 10^{-2} moles [1]

II. Zinc is the limiting reagent / Copper(II) sulfate is in excess [1]

III. ΔH = -(50)x 4.18 x 6.0 ÷ (6.12 x 10^{-3}) (1)

ΔH = -204902 J mol^{-1}

ΔH = -205 kJ mol^{-1} (1) [2]

IV. Enthalpy measures chemical energy, and as heat energy increases, chemical energy must decrease [1]

Total [18]

SECTION B TOTAL [70]

GCE MARKING SCHEME

CHEMISTRY
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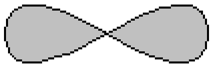
CH1

Section A

1. 

[1]

2. 1/12th mass of one atom of carbon-12. [1]

3. C [1]

4. (a)

	C	O	Cl		
	$\frac{12.1}{12}$	$\frac{16.2}{16}$	$\frac{71.7}{35.5}$	(1)	
	1.01	1.01	2.02		
	1	1	2		
	Formula = $COCl_2$			(1)	[2]

(b) M_r / molecular mass / number of atoms of any element in compound [1]

5. (a) **C B D E A** [2]

(1 mark if one mistake e.g. **A** in wrong place)

(b) **Z** (1)

Si is in Group 4 therefore large jump in ionisation energy would be after the fourth ionisation, not before it / **W**, **X** and **Y** have a large jump before the fourth ionisation energy so cannot be in Group 4 (1)

[2]

Total [10]

Section B

6. (a) (i) 12 [1]

(ii) 14 [1]

(iii) Percentage / abundance / ratio / proportion of each isotope [1]

(b) (i) 0.125 g [1]

(ii) e.g. Cobalt-60 (1) in radiotherapy (1) / Carbon-14 (1) in radio carbon dating (1) / Iodine-131 (1) as a tracer in thyroid glands (1) [2]

(c) (i) Atoms are hit by an electron beam / electrons fired from an electron gun (and lose electrons) [1]

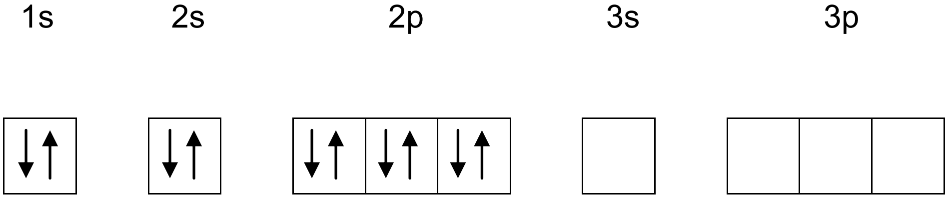
(ii) To be able to accelerate the ions (to high speed) / so that they can be deflected by a magnetic field

- no credit for ‘so that *atoms* can be deflected…’

[1]

(iii) They are deflected by a magnetic field / according to the m/z ratio [1]

(d)



[1]

(e) (i) Mg_3N_2 + **6**H_2O ⟶ **3**$Mg(OH)_2$ + **2**NH_3 [1]

(ii) moles $Mg(OH)_2$ = 1.75/58.32 = 0.0300 (1)

moles Mg_3N_2 = 0.0100 (1)

mass Mg_3N_2 = 0.01 x 100.9 = 1.01 g (1) [3]

- must be **3 significant figures** to gain third mark

Total [14]

7.	(a)	Plotting		(2)	
		Best fit line		(1)	[3]
	(b)	(i)	C	(1)	
			Curve steeper	(1)	[2]
		(ii)	Concentration of acid is greatest		[1]
	(c)	44 cm^3 (±1 cm^3)			[1]
	(d)	Moles Mg = 0.101/24.3 = 0.00416		(1)	
		Moles HCl = 2 x 0.02 = 0.04		(1)	[2]
	(e)	(i)	Mg is not the limiting factor / Mg now in excess / HCl not in excess		[1]
		(ii)	Moles acid = 0.5 x 0.04 = 0.02	(1)	
			Volume H_2 = 0.01 x 24 = 0.24 dm^3 - correct unit needed	(1)	[2]
	(f)	Lower the temperature of the acid		(1)	
		Reactants collide with less energy		(1)	
		Fewer molecules that have the required activation energy		(1)	[3]
	or	Use pieces of magnesium (1) less surface area (1) less chance of successful collisions (1)			

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter. [1]

Total [16]

8. (a) Oil is non-renewable / will run out (1)

Contribution of CO_2 to global warming (1)

Oil has other important uses (1) [2]

(Maximum 2 marks)

(b) (i) Power stations / fossil fuels used to generate the electricity needed to make H_2 (1)

Resulting in CO_2 formation (global warming) / acid rain (1)

Manufacture of car produces pollution (1) [2]

(Maximum 2 marks)

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning [1]

(ii) Disagree, no fuel is 100% safe /
petrol can burn explosively
(Accept agree if valid reason given e.g. in terms of lives being lost) [1]

(c) (i) Hydrogen since frequency is inversely proportional to wavelength / smaller wavelength [1]

(ii) Hydrogen since energy is proportional to frequency / greater frequency / E = hf [1]

(d) In Ne greater shielding of *outer* electron (1) outweighs larger nuclear charge (1) / He has greater effective nuclear charge (1) / He *outer* electron closer to nucleus (1)
- max 1 if no reference to *outer* electron [2]

(Maximum 2 marks)

(e) (i) ^{218}Po [1]

(ii) Since radon is a gas / inhaled, α particles will be given off in the lungs (which may cause cancer) [1]

Total [12]

9. (a) Low temperature (1)
As temperature is decreased equilibrium moves in exothermic direction. (1)

High pressure (1)

As pressure is increased equilibrium moves towards side with smaller number of gas moles (1) [4]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(b) ΔHreaction = ΔH_f products – ΔH_f reactants (1)

-46 = ΔH_f ethanol – (52.3 – 242)

ΔH_f ethanol = -46 – 189.7 (1)

ΔH_f ethanol = -235.7 kJ mol^{-1} (1) [3]

(c) Bonds broken = 1648 + 612 + 926 = 3186 kJ mol^{-1} (1)

Bonds formed = 2060 + 348 + 360 + 463 = 3231 kJ mol^{-1} (1)

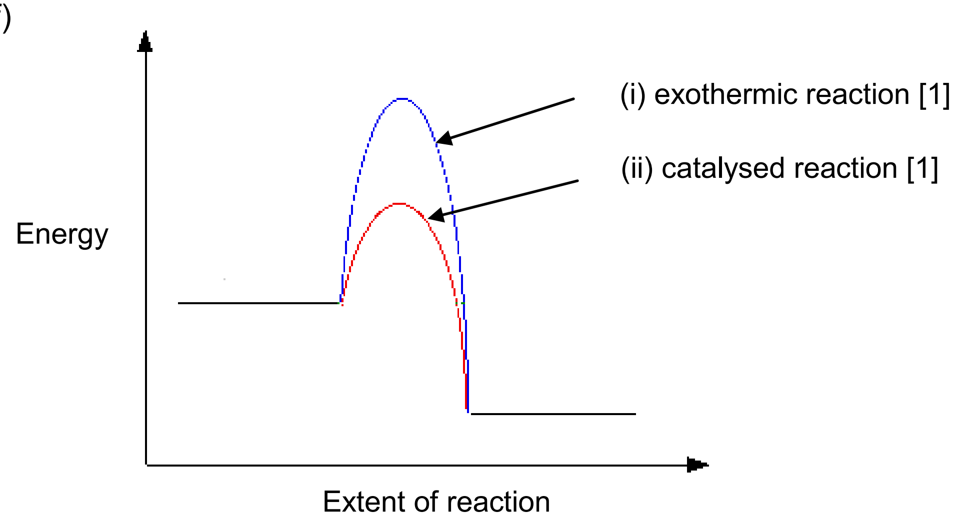
ΔH reaction = 3186 – 3231 = -45 kJ mol^{-1} (1)
[3]

(d) (i) Average bond enthalpies used (not actual ones) [1]

(ii) Yes, since answers are close to each other [1]

(e) Catalyst is in different (physical) state to reactants [1]

(f)



Total [16]

10. (a) Weighing bottle would not have been washed / difficult to dissolve solid in volumetric flask / final volume would not necessarily be 250 cm^3 [1]

(b) Pipette [1]

(c) To show the end point / when to stop adding acid / when it's neutralised [1]

(d) So that a certain volume of acid can be added quickly before adding drop by drop / to save time before doing accurate titrations / to give a rough idea of the end point [1]

(e) To obtain a more reliable value [1]

(f) (i) Moles = 0.730/36.5 = 0.0200 (1)

Concentration = 0.02/0.1 = 0.200 mol dm^{-3} (1) [2]

(ii) Moles = 0.2 x 0.0238 = 0.00476 [1]

(iii) 0.00476 [1]

(iv) 0.00476 x 10 = 0.0476 [1]

(v) M_r = 1.14/0.0476 = 23.95 [1]

(vi) Lithium [1]

- mark consequentially throughout (f)

Total [12]

Section B Total [70]

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SECTION A

Q.1 39 [1]

Q.2 C [1]

Q.3 $A_r = \frac{(12.0 \times 6) + (88.0 \times 7)}{100}$ (1) $= \frac{72.0 + 616.0}{100} = 6.88$ (1) [2]

Q.4 (a) $\Delta H = \Delta H_2 + \Delta H_3 - \Delta H_1$ [1]

(b) $½N_2(g) + ½O_2(g) \rightarrow NO(g)$ state symbols requires [1]

Q.5 The position of equilibrium moves to the right / more COS is formed (1)
(By Le Chatelier's principle) the system 'removes' added 'material' to restore the position of equilibrium / accept explanation in terms of pressure (1) [2]

Q.6 Ti $\frac{60}{48}$ O $\frac{40}{16}$ (1)

$= 1.25$ $= 2.5$ $\therefore$ 1 : 2

$\therefore$ TiO_2 (1) [2]

Section A Total [10]

SECTION B

Q.7 (a) (i) A helium (atom) nucleus / 2 protons and 2 neutrons / $^{4}He^{2+}$ [1]

(ii) b………22 (1) X……………Ne (1) [2]

(iii) (4 × 2.6) = 10.4 [1]

(b) The frequency of the green line at 569 nm is HIGHER. than the frequency of the yellow-orange line at 589 nm. Another line is seen at 424 nm, this is caused by an electronic transition of HIGHER. energy than the line at 569 nm. [1]

(c) (i) Na_2CO_3 → 106, $NaHCO_3$ → 84, $2H_2O$ → 36

106 + 84 + 36 (1) → 226 [1]

(or by other appropriate method – note mark is for the working)

(ii) Atom economy $= \dfrac{\text{‘}M_r\text{ required product} \times 100}{\text{Total ‘}M_r\text{’ of the reactants}}$ (1)

$= \dfrac{318 \times 100}{452}$ = 70.4 / 70.35 (%) (1) [2]

(iii) Carbon dioxide is produced (and released into the air) and this contributes to the greenhouse effect / increases acidity of sea (1)
It should be trapped / a use found for it. (1) [2]

(d) (i) Water is acting as a proton donor (1) and this combines with the carbonate ion / CO_3^{2-}, giving the hydrogencarbonate ion / HCO_3^- (1) [2]

(ii) The pH scale runs from 0-14 / measure of acidity / alkalinity (1)
pH <7 acid / >7 alkali (1)
acid stronger as pH value decreases / alkali stronger as pH value increases / 11.4 is strong alkali (1) [3]

Total [15]

Q.8 (a) (i) He may have lost carbon dioxide through leaks, this would have given a lower volume than expected. (1)
He used lower concentration of acid / diluted the acid with water and the rate of carbon dioxide evolution was slower than expected. (1) [2]

(ii) The concentration of acid is higher in the first half (1) the collision rate is higher (1) [2]

(iii) eg $k = \frac{V}{T}$ (1) $\therefore k = \frac{130}{298}$ / 0.436

$\therefore V = 0.436 \times 323 = 141$ (cm^3) (1)

or $\frac{V_1}{V_2} = \frac{T_1}{T_2}$ (1) $\therefore V_1 = \frac{323 \times 130}{298} = 141$ (cm^3) (1) [2]

(b) (i) 260 (cm^3) [1]

(ii) 0.45 (g) (0.43–0.48) [1]

(c) The diagram shows two reasonable distribution curves with T_2 flatter and 'more to the right' than T_1. (1)
Activation energy correctly labelled, or mentioned in the writing (1)
Fraction of molecules having the required activation energy is much greater at a higher temperature (thus increasing the frequency of successful collisions) (in words) (1) [3]

The candidate has selected a form and style of writing that is appropriate to purpose and complexity of the subject matter QWC [1]

(d) Place the mixture on a balance and measure the (loss in) mass (1)
at appropriate time intervals (1)

OR BY OTHER SUITABLE METHOD

eg. sample at intervals / quench (1) titration (1) [2]

Total [14]

Q.9 (a) (i) They are both elements in their standard states. [1]

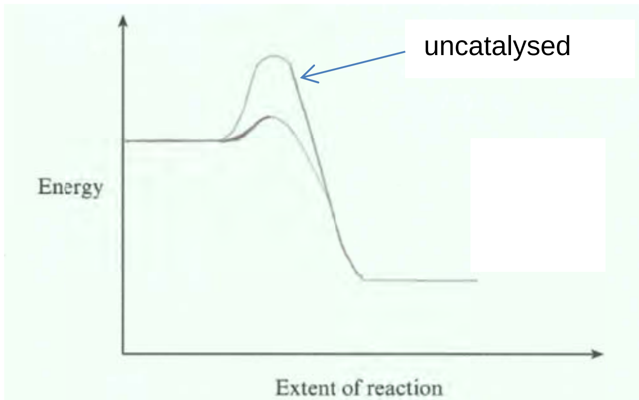
(ii) $\Delta H = \sum \Delta H_f$ products $- \sum \Delta H_f$ reactants (1)

$= (-286 + 0) - (-368 + 0)$

$= -286 + 368 = (+)82$ (kJ mol^{-1}) (1) [2]

or by a cycle where correct cycle drawn (1) correct answer (1)

(b) (i)



exothermic profile drawn (1)
uncatalysed / catalysed line labelled (1) [2]

(ii) I number of moles of benzene = 2000 [1]

II mole ratio is 1 : 1 (1)

∴ moles of phenol produced $= \frac{2000 \times 95}{100} = 1900$ (1)

mass = M_r × number of moles = 94 × 1900 = 178.6 / 179 kg (1)

alternatively

78 (g / kg) of benzene gives 94 (g / kg) of phenol (1)

∴ 1 (g / kg) of benzene gives 94/78 (g / kg) of phenol
∴ 156 (kg) of benzene gives 94 × 156/78 (kg) of phenol = 188 (kg) (1)
but 95% yield ∴ $\frac{188 \times 95}{100}$ = 178.6 / 179 (kg) (1) [3]

(iii) Look for at least four relevant positive points [4]

e.g.
- the process uses a (heterogeneous) catalyst, which can easily be separated from the gaseous products (thus saving energy)
- the only other product of the reaction is gaseous nitrogen, which is non-toxic / safe / not a harmful product
- the process uses nitrogen(**I**) oxide which is used up, rather than being released into the atmosphere from the other process (and causing global warming)
- the process is exothermic and the heat produced can be used elsewhere
- a relatively moderate operating temperature reduces overall costs
- high atom economy

Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning QWC [1]

Total [14]

Q.10 (a) K $\rightarrow$ $1s^22s^22p^63s^23p^64s^1$ (1)
There is one outer electron and the loss of this electron gives a stable potassium ion with a full outer shell/ ion more stable than the atom (1) [2]

(b) (i) $\Delta T = 4.8\ ^oC$ (1)

$$\Delta H = -\frac{250 \times 4.2 \times 4.8}{0.125} = -40320 \text{ J mol}^{-1} \ / \ -40.3 \text{ kJ mol}^{-1}$$ (2) [3]

✓ for negative sign
✓ correct value with relevant units

(ii) e.g. The volume used was not precise in measurement as the readings on a beaker are only approximate (1)
The experiment was performed in a beaker and this was not insulated and heat was lost to the surroundings (1) [2]

there may be other acceptable answers here, for example based on slow dissolving

(c) (i) 0.050 [1]

(ii) (0.050 × 24.0) = 1.20 (dm^3) [1]

(iii) $\% \text{ v/v} = \frac{1.20 \times 0.001 \times 100}{2}$ (1) = 0.06 (1) [2]

(d) An increase in the concentration of (aqueous) carbon dioxide causes the position of equilibrium to move to the right. (1)
This causes calcium carbonate to become aqueous calcium (and hydrogencarbonate) ions / dissolve (1)
weakening shells / causing difficulty in formation of shells (1) [3]

Organisation of information clearly and coherently; using specialist vocabulary where appropriate QWC [1]

Total [15]

Q.11 (a) (i) I burette / (graduated) pipette [1]

II volumetric / graduated / standard flask [1]

(ii) 0.0064 [1]

(iii) 1.20 g / 100 cm^3 solution [1]

(iv) 12.0 g / 100 cm^3 solution [1]

(b) (i) The catalyst is in a different physical state to the reactants. [1]

(ii) Bonds broken

2 H-H → 872		1 C-O → 360	
1 C-H → 412		1 O-H → 463	
1 C=O → 743			

Total +2850 kJ (1)

Bonds made

3 C-H → 1236	
1 C-O → 360	
3 O-H → 1389	

Total -2985 kJ (1)

$\Delta H = 2850 - 2985 = -135 \text{ kJ mol}^{-1}$ (1) [3]

(c) Relative molecular mass is a relative quantity (based on $^{1}/_{12}$th of the ^{12}C atom as one unit). [1]

(d) (i) The rate of the forward reaction is equal to the rate of the backward reaction. [1]

(ii) C_2H_4O [1]

Total [12]

Total Section B [70]

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SECTION A

Q.1 number of protons 6

number of neutrons 8

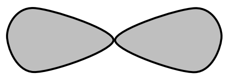
number of electrons 6 (all correct 2 marks, 2 correct 1 mark) **[2]**

Q.2 electron (1)

β-particle (1) (max 1 if three circled, 0 if four or more) **[2]**

Q.3 Provides an alternative pathway (1)
with lower activation energy / more particles have energy above E_A (1) **[2]**

Q.4 **[1]**



Q.5 nitrogen / phosphorus (or any other Group 5 element) **[1]**

Q.6 (a) (dissociates to) release H^+ ions **[1]**

(b) 2.5-6.0 **[1]**

Total [10]

SECTION B

Q.7 (a) percentage Be by mass = 5.03% (1)

division of percentage by A_r for Be and at least one other element as shown below (1)

Al	10.04 ÷ 27 = 0.3719 → 1.00
Be	5.03 ÷ 9.01 = 0.5583 → 1.50
O	53.58 ÷ 16 = 3.3488 → 9.00
Si	31.35 ÷ 28.1 = 1.1566 → 3.10

molecular formula = $Al_2Be_3O_{18}Si_6$ or x=3 (1) **[3]**

(b) (i) Hess' Law states that where a reaction can occur by more than one route the total enthalpy **change** for each route will be the same **[1]**

(ii) ΔH = –393.5 – (–395.4) (1) = +1.9 kJ mol^{-1} (1) **[2]**

(iii) Kyran is **incorrect** as diamond is not the **standard state** of carbon **[1]**

(iv) I mass of diamond = 7.30 g **[1]**

II mass of graphite = 7.30 ÷ (93/100) (1) = 7.85 g (1) **[2]**

Total [10]

Q.8 (a) (i) all ionisation energies showing gradual increase and one large jump (1)

large jump after 8 electrons (1) **[2]**

(ii) eighth and ninth electrons come from different shells (1)

ninth electron is closer to nucleus / has less or no shielding / has greater effective nuclear charge (1) **[2]**

(b) the compound formation has the noble gas atom being ionised (1)

ionisation energy of argon is much higher than that of xenon (1)

because the outer electron in argon is closer to the nucleus / has greater effective nuclear charge / shielding (1) - 2 max **[2]**

(c) electrons move from lower energy levels to higher energy levels (1)

by absorbing **specific frequencies** of light (1) **[2]**

(d) 1 mol of XeO_3 released 2.5 mol gas products (1)

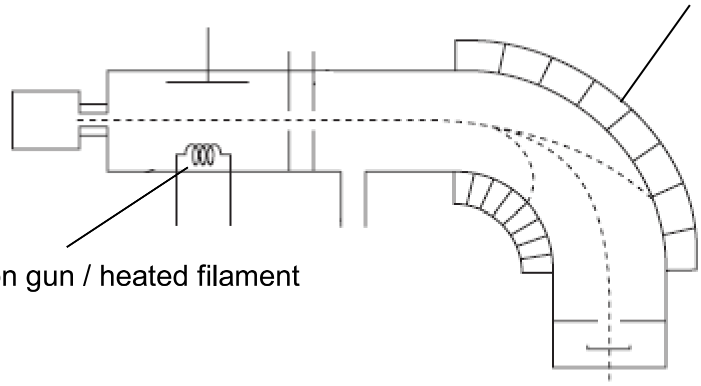
2.5 mol of gas occupies 24.0 x 2.5 = 60.0 dm^3 (1) – follow through error (ft)

if candidates calculate the volumes of the two gases separately, then (1) for one gas volume correct and (1) for total volume correct **[2]**

Total [10]

Q.9 (a) (i) both needed

B electromagnet



A electron gun / heated filament

[1]

(ii) electron gun bombards sample and **ionises** atoms/molecules (1)

negatively charged plates / electric field **accelerates** (positive ions in) sample (1)

electromagnet **deflects** ions according to mass and charge / m/z (1)

current in electromagnet / electromagnetic field is varied so different mass ions hit detector (1)

[4]

QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter (1)

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning (1)

QWC **[2]**

(b) A_r = (78 x 12.2) + (79 x 26.4) + (80 x 61.4) ÷ 100 (1) [for method] = 79.5 (1)

(1) for 3 sig figs for sensible answer (above 79.0 and below 80.0) (1) **[3]**

(c) (i) a 81

X Br /bromine both needed **[1]**

(ii) 75 minutes = 4 half-lives (1)

2.72g → 1.36g → 0.68g → 0.34g → 0.17g (1) – no ft **[2]**

Total [13]

Q.10 (a) $x = 10$ **[1]**

(b) (i) number of moles = 250 x 0.200 ÷ 1000 = 0.05 mol (1) – ft

mass of sodium carbonate = 0.05 x $M_r(Na_2CO_3)$ = 0.05 x 286.2
= 14.31g (1) **[2]**

(ii) any two points from:

weigh by difference (1)

add less water initially (1)

wash out beaker / glass rod / funnel and put water into volumetric flask (1)

add water up to mark in volumetric flask (1)
- 2 max **[2]**

(c) add few drops of indicator (1) do not accept 'universal indicator'

take initial and final reading on burette (1)

swirl the conical flask (1)

add acid until the indicator changes colour (1) **[4]**

QWC: organisation of information clearly and coherently; use of specialist vocabulary where appropriate. *QWC* **[1]**

Total [10]

Q.11 (a) (i) $\Delta H = 9 \times (-394) + 10 \times (-286) - (-275)$ (1)

$= -6131 \text{ kJ mol}^{-1}$ (1) for correct value and (1) for correct sign **[3]**

(ii) temperature 298K, 25°C (1) pressure 1 atm, 101 kPa (1) **[2]**

(b) (i) $M_r = (9 \times 12) + (20 \times 1.01) = 128.2$ (1)

number of moles = 1.56×10^{-3} mol (1) **[2]**

(ii) $\Delta H = -50 \times 4.18 \times 42 \div 1.56 \times 10^{-3}$ (1)

$= -5626698 \text{ J mol}^{-1} = -5627 \text{ kJ mol}^{-1}$ (1) **[2]**

(iii) heat loss to environment / incomplete combustion / not standard conditions **[1]**

Total [10]

Q.12 (a) killing marine life / killing trees **[1]**

(b) (i) either gas syringe or inverted burette attached to sealed vessel **[1]**

(ii) different surface area would affect rate of reaction **[1]**

(iii) concentration / volume / nature of acid (1)

temperature (1) **[2]**

(c) (i) increasing pressure will shift the reaction to side with fewer gas molecules (1)

increasing yield of SO_3 (1) – reason must be given **[2]**

(ii) I increasing temperature shifts equilibrium in endothermic direction (1)

as SO_3 yield is decreased forward reaction must be exothermic (1) **[2]**

II increasing temperature increases energy of particles (1)

more collisions have energy above activation energy (1)

successful collisions occur more frequently (1)

can gain first two points from labelled Boltzmann distribution curve **[3]**

III e.g. iron in production of ammonia or any valid example **[1]**

(d) (i) atom economy = 100% **[1]**

(ii) any two points from:

lower pressure used in B (1)

methanol is a renewable starting material (1)

higher atom economy in B or less waste in B (1)

[ignore reference to cost]
2 max **[2]**

(iii) no effect on position of equilibrium **[1]**

Total [17]

GCE MARKING SCHEME

CHEMISTRY
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JANUARY 2014

CH1

Section A

Q.1		**D**		[1]
Q.2		**A**		[1]
Q.3	(a)	An electron formed when a neutron changes into a proton / an electron emitted by the nucleus		[1]
	(b)	^{32}S		[1]
	(c)	Time taken for half of the atoms in a radioisotope to decay (or similar)		[1]
	(d)	42 days		[1]
Q.4		Combustion of C and H_2 = (2 × –394) + (3 × –286) = –1646 kJ mol^{-1}	(1)	
		ΔH = –1646 – (–1560) = –86 kJ mol^{-1}	(1)	[2]

Q.5

	Ag	S	
Mass	1.08	0.16	
A_r	108	32	
Moles	0.01	0.005	(1)
	2	1	

Formula = Ag_2S (1) [2]

Total Section A [10]

Section B

Q.6	(a)	(i)	**B** is $^{37}Cl^{+}$	(1)	
			C is $(^{35}Cl—^{35}Cl)^{+}$	(1)	[2]
		(ii)	**C** = 54, **E** = 6	(1)	
			Ratio of **C**:**E** is 9:1	(1)	[2]
		(iii)	Ratio of ^{35}Cl:^{37}Cl is 3:1	(1)	
			Ratio of $^{35}Cl—^{35}Cl$: $^{37}Cl—^{37}Cl$ is 3:1 × 3:1 = 9:1	(1)	
			or		
			Probability of atom being ^{35}Cl is ¾ and that of ^{37}Cl is ¼	(1)	
			Probability of $^{35}Cl—^{35}Cl$ is ¾ × ¾ = 9/16 and $^{37}Cl—^{37}Cl$ is ¼ × ¼ = 1/16	(1)	[2]
	(b)		$A_r = \frac{(79 \times 50.69) + (81 \times 49.31)}{100}$	(1)	
			A_r = 79.99	(1)	[2]

Total [8]

Q.7	(a)		Use weighing scales to weigh the metal oxide	(1)	
			Use measuring cylinder to pour hydrogen peroxide solution and water into a conical flask	(1)	
			Immerse flask in water bath at 35 ˚C	(1)	
			Add oxide to flask and connect flask to gas syringe	(1)	
			Measure volume of oxygen every minute for 10 minutes / at regular time intervals	(1)	
			(any 4 of above, credit possible from labelled diagram)		[4]
	(b)		Oxide **A** because reaction is faster		[1]
	(c)	(i)	18 cm^3		[1]
		(ii)	10 cm^3		[1]
	(d)		Concentration of hydrogen peroxide has decreased	(1)	
			reaction rate decreases / fewer successful collisions	(1)	[2]
	(e)		All the hydrogen peroxide has decomposed / the same quantity of hydrogen peroxide was used		[1]
	(f)		25 cm^3		[1]
	(g)		Reaction will take less time	(1)	
			Reactants collide with more (kinetic) energy	(1)	
			More molecules have the required activation energy	(1)	[3]
			QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter		[1]

Total [15]

Q.8 (a) Electrons within atoms occupy fixed energy levels or shells of increasing energy / nitrogen has electrons in two shells (1)
$1s^2\ 2s^2\ 2p^3$ (1)

Electrons occupy atomic orbitals within these shells /
The first shell in nitrogen has s orbitals and the second shell s and p orbitals (1)

A maximum of two electrons can occupy any orbital /
Each s orbital in nitrogen contains two electrons (1)

Each with opposite spins (1)

Orbitals of the same type are grouped together as a sub-shell /
There are three p orbitals in nitrogen's p sub-shell (1)

Each orbital in a sub-shell will fill with one electron before pairing starts / In nitrogen's p sub-shell each orbital contains one electron (1)

(configuration mark + any 3 of above) [4]

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(b) Atomic spectrum of hydrogen is a series of lines (1)
that get closer as their frequency increases (1)
(credit possible from labelled diagram)

Lines arise from atom / electrons being excited by absorbing energy (1)
electron jumping up to a higher energy level (1)
falling back down and emitting energy (in the form of electromagnetic radiation) (1)
to the n = 2 level (1)
(any **three** points for maximum 3 marks)

Since lines are discrete energy levels must have fixed values /
Since energy emitted is equal to the difference between two energy levels, ΔE is a fixed quantity or quantum (1) [6]

(c) (i) It has greater nuclear charge (1)
but little / no extra shielding (1) [2]

(ii) In Be less shielding of outer electron (1)
outweighs smaller nuclear charge (1)

or

Be outer electron closer to nucleus (1)
Be has greater effective nuclear charge (1) [2]

(iii) I. Too much energy required to form B^{3+} ion [1]

II. $K^{+}(g) \rightarrow K^{2+}(g) + e^{-}$ [1]

III. Value of 1st and 3rd I.E. will be higher (1)
Value of 2nd I.E. will be smaller (1)
(accept large jump in I.E. value would be between 2nd and 3rd electrons for 1 mark) [2]

Total [19]

Q.9 (a) Enthalpy change when one mole of a compound is formed from its (constituent) elements (1)
in their standard states / under standard conditions (1) [2]

(b) (i) $H_2 + ½O_2 \rightarrow H_2O$ [1]

(ii) $–242 = 436 + 248 – 2(O—H)$ (1)
$2(O—H) = 926$
$O—H = 463\ kJ\ mol^{-1}$ (1) [2]

(c) (i) I. Burning hydrogen will not produce CO_2 (or SO_2) as pollutants [1]

II. Hydrogen is very flammable, storing as MgH_2 is safer / MgH_2 is solid therefore volume occupied by given amount of hydrogen is less [1]

(ii) If the MgH_2 is not kept dry, hydrogen will be formed and there could be a potential explosion [1]

(iii) Moles $MgH_2 = \frac{70000}{26.32} = 2659.6$ (2660) (1)

Moles H_2 = 5319.2 (5320) (1)

Volume $H_2 = 1.28 \times 10^5\ dm^3$ (1) [3]

(d) (i) An increase in temperature would decrease the yield and an increase in pressure would increase the yield [1]

(ii) Forward reaction is exothermic so equilibrium shifts to the left as temperature is increased (1)

More gaseous moles on the l.h.s. so equilibrium shifts to the right as pressure is increased (1) [2]

(e) Lower temperatures can be used (1)
Energy costs saved (1)
More product can be made in a given time (so more can be sold) (1)
Enable reactions to take place that would be impossible otherwise (1)
Less fossil fuels burned to provide energy (so less CO_2 formed) (1)
(any 3 of above) [3]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning [1]

Total [18]

Q.10	(a)		Moles NaCl = $\frac{900}{58.5}$ = 15.38	(1)	
			Moles Na_2CO_3 = 7.69	(1)	
			Mass Na_2CO_3 = 7.69 × 106 = 815(.4) g	(1)	[3]
	(b)	(i)	2.52 g		[1]
		(ii)	Moles Na_2CO_3 = 0.02	(1)	
			Moles H_2O = 0.14 (1) x = 7	(1)	[2]
	(c)	(i)	Moles = 0.5 × 0.018 = 0.009		[1]
		(ii)	0.0045		[1]
		(iii)	0.0045 × 106 = 0.477		[1]
		(iv)	% = 0.477/0.55 = 86.7 %		[1]

Total [10]

Total Section B [70]

GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2014

GCE CHEMISTRY - CH1

SUMMER 2014 MARK SCHEME

SECTION A

Q.1 $1s^2 2s^2 2p^6 3s^2 3p^6$ [1]

Q.2 carbon-12 / ^{12}C [1]

Q.3 any example e.g. [1]
iron for Haber process / manufacture of ammonia
vanadium(V) oxide in Contact process / manufacture of sulfuric acid
platinum / palladium / rhodium in catalytic converters / to remove toxic gases from exhaust fumes
nickel in hydrogenation of alkenes / unsaturated oils

Q.4 (a) M_r = 286.2 allow 286 [1]

(b) mass = $\frac{286.2 \times 0.1}{4}$ = 7.155 / 7.16 allow 7.15 / 7.2 based on 286 [1]

Q.5 enthalpy changes = –110 [1]

Q.6 $^{234}_{90}Th$ (1) $^{234}_{91}Pa$ (1) (award 1 mark for 2 correct symbols) [2]

Q.7 portion to right of Ea_1 labelled as molecules that react / shaded [1]

Ea_2 marked, at lower energy than Ea_1, and portion to right labelled as molecules that react / shaded [1]

Section A Total [10]

SECTION B

Q.8 (a) same number of protons and electrons (1)

0, 1 and 2 neutrons (1) [2]

(b) (i) 3 energy levels between n = 2 and n = ∞
becoming closer together
first gap must be < that between n = 1 and n = 2 [1]

(ii) any arrow pointing upwards (1)

from n = 1 to n = ∞ (1) [2]

(c) (i) visible [1]

(ii) (not correct because) Balmer series corresponds to energy transitions involving n = 2 (1)

for ionisation energy need Lyman series / energy transitions involving n = 1 (1) [2]

(d) (i) $Q(g) \rightarrow Q^{+}(g) + e$ / accept any symbol [1]

(ii) Group 6 [1]

(iii) In T there is more shielding (1)

The outer electron is further from the nucleus (1)

The increase in shielding outweighs the increase in nuclear charge / there is less effective nuclear charge (1) [3]

Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning QWC [1]

Total [14]

Q.9	(a)	(i)	line drawn that is deflected less by magnetic field	[1]
		(ii)	increase strength of the magnetic field allow decrease charge on charged plates	[1]
	(b)	(i)	1+ (1) ^{37}Cl - ^{37}Cl (1) $^{37}Cl_2^+$ (2)	[2]
		(ii)	line drawn as m/z 72 (1) ratio height 6 (1) allow ½ square tolerance	[2]
	(c)	(i)	% H = 0.84 (1) C : H : Cl = 10.04 / 12 : 0.84/ 1.01 : 89.12 / 35.5 (1) = 0.84 : 0.83 : 2.51 = 1 : 1 : 3 empirical formula = $CHCl_3$ (1)	[3]
		(ii)	the relative molecular mass / M_r / molar mass	[1]
		(iii)	right hand / largest / heaviest m/z peak from mass spectrum	[1]

Total [11]

Q.10 (a) (a reaction in which) the rate of the forward reaction is equal to the rate of the backward reaction [1]

(b) goes darker / more brown (1)

because the (forward) reaction has a +ve ΔH / is endothermic (1)

goes paler / less brown (1)

because there are more moles / molecules on RHS (1)

no change (because catalysts do not affect the position of an equilibrium) (1) [5]

(c) (i) moles N_2H_4 = 14000/32.04 = 437.0 (1)

this produces 437.0 × 3 = 1311 moles of gas (1)

volume = 1311 × 24 = 3.15×10^4 dm^3 (1) [minimum 2 sf] [3]

(ii) (large volume of) gas produced [1]

(d) (i) an acid is a proton / H^+ donor [1]

(ii) $\rightarrow NO_2^- + H_3O^+$ [1]

(iii) sulfuric acid is behaving as the acid / nitric acid is behaving as a base (1)

as it donates a proton / as it accepts a proton (1) [2]

Total [14]

Q.11 (a) (i) $2C(s) + 3H_2(g) + ½O_2(g) \rightarrow C_2H_5OH(l)$ (state symbols needed)

C(s) allowed as C(gr) or C(graphite) [1]

(ii) (if these elements were reacted together) other products would form/ carbon does not react with hydrogen **and** oxygen under standard conditions [1]

(b) (i) energy = 100 × 4.2 × 54 =22680 [1]

(ii) moles ethanol = 0.81/46 = 0.0176 (1)

energy change = $\frac{22.68}{0.0176}$ ΔH = –1290 (1)

–ve sign and correct to 3 sf (1) [3]

(c) internet value numerically larger (1)

heat losses / incomplete combustion / thermal capacity of calorimeter ignored (1) no credit for energy loss [2]

(d) (i) $C_3H_7OH + 4½O_2 \rightarrow 3CO_2 + 4H_2O$ (ignore state symbols) [1]

(ii) negative enthalpy change means energy in bonds broken is less than that in bonds made [1]

(iii) more bonds broken and made in propanol and therefore more energy released [1]

(e) any 4 from:

both conserve carbon / non-renewable fuel sources / fossil fuels / use renewable sources

(these gas / liquid) suitable for different uses e.g. ethanol to fuel cars

atom economy gasification is less (some C lost as CO_2) / CO_2 produced in gasification is a greenhouse gas

CO is toxic

gasification at high temperature / enzymes need low temperature

enzyme approach therefore saves fuel / gasification needs more energy [4]

3 max if any reference to destruction of ozone layer

QWC [2]
The candidate has selected a form and style of writing that is appropriate to purpose and complexity of the subject matter (1)

Answer has suitable structure (1)

Total [17]

Q.12 (a) to increase rate of reaction / to increase surface area [1]

(b) $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$ (ignore state symbols) [1]

(c) rate starts fast and gradually slows (1)

because concentration becomes less so fewer collisions (per unit time) / less frequent collisions / lower probability of collisions (1)

at time = 17/18 min rate = 0 (1) [3]

(d) all the solid would all have disappeared / if more carbonate is added further effervescence is seen [1]

(e) (i) volume CO_2 = 200 cm^3 (1)

moles CO_2 = 200 / 24000 = 0.008333 = moles $MgCO_3$ (1)
[minimum 2 sf] [2]

(ii) mass $MgCO_3$ = 0.008333 × 84.3 = 0.702 g (1)

% $MgCO_3 = \frac{0.702}{0.889} \times 100$ = 79.0% / 79% [2]

(e) carbon dioxide is soluble in water / reacts with water (1)

volume collected less therefore % / moles of $MgCO_3$ less (1) [2]

(f) use of 40.3 and 84.3 (1)

atom economy = 40.3 / 84.3 × 100 = 47.8% (1) [2]

Total [14]

Section B Total [70]