WJEC
CBAC

GCE MARKING SCHEME

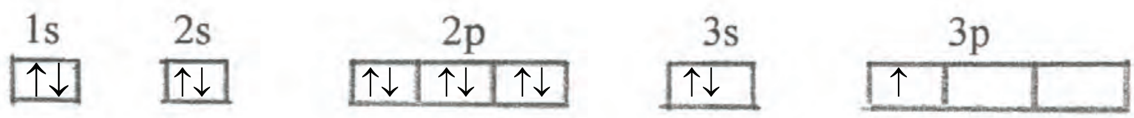
CHEMISTRY (NEW)
AS/Advanced

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

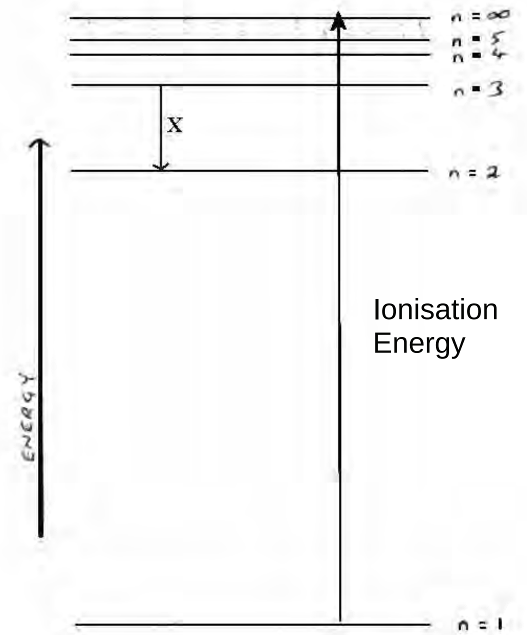
[2]

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]

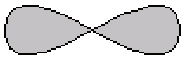
(b) Draw on the energy levels diagram an arrow to represent the transition which occurs when a hydrogen atom is ionised. [1]



(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 $\rightarrow$ 5 $\rightarrow$ 2.5 $\rightarrow$ 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]

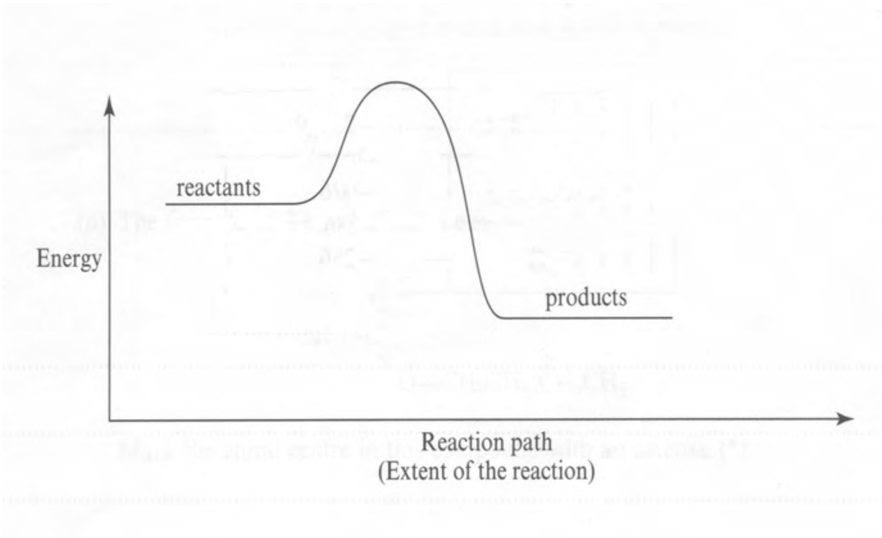
II *Either*
Energy must be supplied for heating (with cost implications)
or
CO_2(g) would be released into the environment (unless prevention measures taken, negating the point of using sodium carbonate to absorb CO_2(g)). 1 mark [1]

(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) = $-185 / 2 = -92.5 \text{ kJ mol}^{-1}$ (Mark consequentially if $\Delta H^{\ominus}$ value incorrect)	1 mark	[1]
		(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 provide sufficient energy to break the Cl_2 covalent bond	2 x 1 mark 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) $\Delta H = \dfrac{- v\, c\, \Delta T}{n}$

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 = $2.75 \times 10^{-3} \times 1000/25 = 0.11$ mol dm^{-3}
1 mark [1]

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

Concentration NH_3 = $31.23 \times 0.100 / 25 = 0.125$ 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

$\Delta H^{\ominus} = -1450.8 + 184.4 = -1266.4$ 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

$\Delta H^{\ominus} = -393.5 - 483.6 + 74.8 = -802.3$ 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 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]