GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

JANUARY 2013

GCE CHEMISTRY - CH1

JANUARY 2013 MARK SCHEME

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) $\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightarrow NO(g)$ 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)

$$\underset{106}{\underset{\downarrow}{Na_2CO_3}} \quad + \quad \underset{84}{\underset{\downarrow}{NaHCO_3}} \quad + \quad \underset{36}{\underset{\downarrow}{2H_2O}} \quad (1) \quad \rightarrow \quad 226$$

[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

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

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

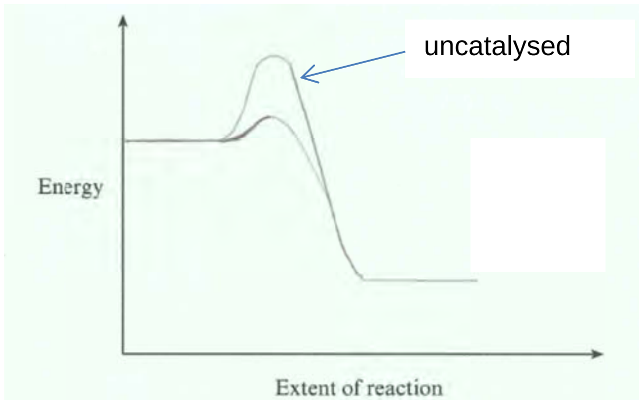
(ii) $\Delta H = \sum \Delta H_f$ products $- \sum \Delta H_f$ reactants (1)

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

$= -286 + 368 = (+)82$ (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)

$\therefore$ moles of phenol produced $= \dfrac{2000 \times 95}{100} = 1900$ (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)

$\therefore$ 1 (g / kg) of benzene gives 94/78 (g / kg) of phenol
$\therefore$ 156 (kg) of benzene gives 94 × 156/78 (kg) of phenol = 188 (kg) (1)
but 95% yield $\therefore$ $\dfrac{188 \times 95}{100}$ = 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 $\rightarrow$ $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ (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) $\Delta T = 4.8\ ^{o}C$ (1)

$$\Delta H = -\frac{250 \times 4.2 \times 4.8}{0.125} = -40320\ J\ mol^{-1}\ /\ -40.3\ kJ\ mol^{-1}$$ (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 $\rightarrow$ 872 1 C-O $\rightarrow$ 360
1 C-H $\rightarrow$ 412 1 O-H $\rightarrow$ 463
1 C=O $\rightarrow$ 743

Total +2850 kJ (1)

Bonds made

3 C-H $\rightarrow$ 1236
1 C-O $\rightarrow$ 360
3 O-H $\rightarrow$ 1389

Total -2985 kJ (1)

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