WJEC CBAC

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 = $\dfrac{(12.0 \times 6) + (88.0 \times 7)}{100}$ (1)   = $\dfrac{72.0 + 616.0}{100}$ =   6.88 (1)   [2]

Q.4   (a) ΔH = ΔH_2 + ΔH_3 - ΔH_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 $\dfrac{60}{48}$ O $\dfrac{40}{16}$ (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 / $^4He^{2+}$ [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 $NaHCO_3$ $2H_2O$

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 = $\dfrac{V}{T}$ (1) ∴ k = $\dfrac{130}{298}$ / 0.436

∴ V = 0.436 × 323 = 141 (cm^3) (1)

or $\dfrac{V_1}{V_2}$ = $\dfrac{T_1}{T_2}$ (1) ∴ V_1 = $\dfrac{323 \times 130}{298}$ = 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
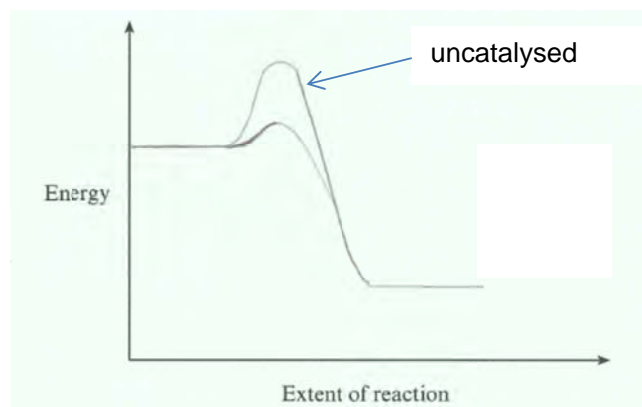
eg. sample at intervals / quench (1) titration (1) [2]

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)

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

              mass $= M_r \times$ number of moles $= 94 \times 1900 = 178.6 / 179$ 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) $\Delta T = 4.8\ ^oC$ (1)

$\Delta H = -\dfrac{250 \times 4.2 \times 4.8}{0.125} = -40320\ J\ mol^{-1}\ /\ -40.3\ kJ\ mol^{-1}$ (2) [3]
$\checkmark$ for negative sign
$\checkmark$ 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) $(0.050 \times 24.0) = 1.20\ (dm^3)$ [1]

(iii) % v/v $= \dfrac{1.20 \times 0.001 \times 100}{2}$ (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)

              ΔH = 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]