| Question		Expected Answers	Marks

1   (a)   the energy required to **break**   ✓

1 mole of **gaseous** bonds   ✓   [2]

(b)   (i)   Enthalpy of bonds broken = 4(410) + 2(500) = 2640
Enthalpy of bonds made = 2(805) + 4(465) = 3470
$\Delta H = -830$ (kJ mol^{-1})

values for bonds broken   ✓

values for bonds made   ✓

correct answer   ✓   [3]

(ii)   The *standard* enthalpy change of combustion requires H_2O to be
liquid, not gaseous *or* reaction not carried out under standard
conditions *or* bond energies are average values/
bond energies vary in different environments   ✓   [1]

(c)   (i) $C_3H_8(g) + 5 O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(l)$
(balancing ✓ state symbols ✓)   [2]

(ii)   The energy for making the bonds in the product exceeds the energy
required to break the bonds in the reactants/the difference between
successive ΔHc values is ΔH for
$-CH_2- + 1\frac{1}{2}O_2 \rightarrow CO_2 + H_2O$ ✓

this is because C=O bonds are very strong/ reason for increasing
energy based on specific bond strengths   ✓   [2]

(iii)

$$C_3H_8 \xrightarrow{\ x\ } C_2H_4 + CH_4$$

$$-2220 \qquad -1410 \quad -890$$

$$CO_2 + H_2O$$
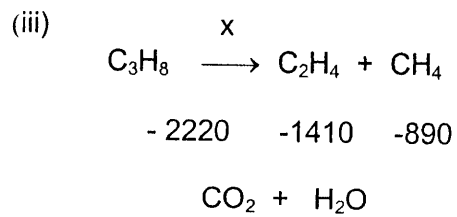
$x - 1410 - 890 = -2220$

$x = (+)\ 80$

cycle including $3CO_2$ and $4H_2O$ ✓

correct data   ✓

answer   ✓

OR

$\Delta H^{\ominus} = \Delta H$ reactants $-\Delta H$ products   ✓

$\Delta H^{\ominus} = -2220 + 890 + 1410$ ✓

$\phantom{\Delta H^{\ominus}} = (+)\ 80$ ✓
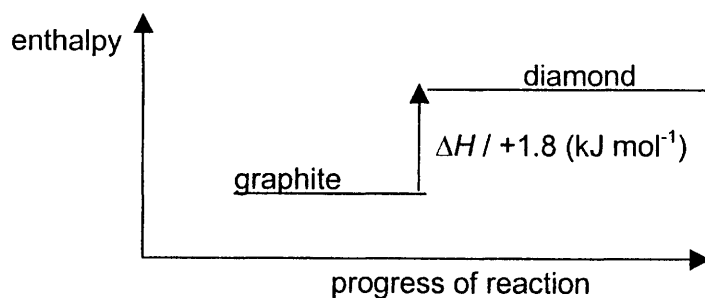
Total: 13

2   (a)

         labelled line for diamond above graphite   ✓

         ΔH/ 1.8 labelled   ✓   [2]

    (b)   graphite, **because** the change graphite $\longrightarrow$ diamond is endothermic/
         changes tend to go in direction of lower energy   ✓   [1]

    (c)   diamond, **because** its density is greater than that of graphite/
         reason based on known structures   ✓   [1]

    (d)   *(When a system in dynamic equilibrium is subjected to a change in
         conditions....)* the (position of) **equilibrium** will shift   ✓

         in the direction that minimises the effect of the change   ✓   [2]

    (e)   high pressure   ✓

         because the volume of 1 mol of diamond is less than that of 1 mol of graphite
                                                                ✓

         high temperature   ✓

         because the change graphite to diamond is endothermic   ✓   [4]

                                                                        Total: 10

3   (a)   (i) $Cl + O_3 \longrightarrow ClO + O_2$ equation 3.1 ✓

                              $ClO + O \longrightarrow Cl + O_2$ equation 3.2   ✓

                              $O + O_3 \longrightarrow 2O_2$ overall equation ✓   [3]

               (ii)   Cl is the catalyst   ✓

                       it is used up in one step and reformed in a subsequent step✓   [2]

    (b)   **Essential point**
                       heterogeneous means catalyst is in a different state
                       /phase from reagents/products   ✓

                       then
                       catalyst works by:

                       adsorption of gases onto surface/
                       forming(weak) bonds to catalyst to reactants   ✓

                       this weakens bonds in reactants/ reaction occurs on surface✓

                       activation energy is lowered/ reaction proceeds by different route✓

                       desorption of products from surface.   ✓ [4max]

                                                          Total: 9

4   (a)   (i)   acids are H^+ donors/ proton donors/ electron pair acceptors ✓   [1]

           (ii)   strong = completely ionised/dissociated   ✓   [1]

     (b)   (i) $2HCl \textbf{ (aq)} + Na_2CO_3 \textbf{ (aq)} \longrightarrow 2NaCl \textbf{ (aq)} + CO_2 \textbf{ (g)} + H_2O \textbf{ (l/aq)}$
                                                                     ✓   [1]

           (ii)   fizzing/effervescence/gas given off   ✓   [1]

           (iii) $2H^+ + CO_3^{2-} \longrightarrow CO_2 + H_2O$ ✓   [1]

Total: 5

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5   (a)   (i)   curve :
                     starts at (0,0) and has its maximum at a lower ordinate value than
                     given curve   ✓

                     and to the right of the maximum on the given curve   ✓   [2]

           (ii)   more molecules have $E > E_a$ (at higher T)/ shading on graph ✓

                     so more collisions are effective in causing reaction/
                     more successful collisions   ✓   [2]

     (b)   (i)   reaction rate increases with pressure   ✓

                     because the molecules are closer together   ✓   [2]

           (ii)   after the reaction has started the temperature/energy/speed of the
                     reactant molecules increases   ✓

                     allowing **many** molecules to have $E>E_a$, and thus speeding up the
                     reaction   ✓   [2]

Total: 8