

Chemistry

Question (2)

(22 Marks)

- (a) Define each of the following:
- The first law of thermodynamics.
 - Bond enthalpy.
 - Molar heat capacity.
 - Thermochemical equation.

Answer

- In any process the total change in energy of the system ΔE is equal to the sum of the heat q and the work w transferred between the system and the surroundings $\Delta E = q + w$.*
 - The bond enthalpy is defined as ΔH when one mole of bonds is broken in the gaseous state*
 - The amount of heat required to raise the temperature of one mole of substance one degree centigrade.*
 - Thermochemical equation is defined as a balanced chemical equation, together with its value of ΔH*
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- (b) Calculate the amount of heat q for the following processes:
- An endothermic process in which the system receives 12J of work from its surrounding and the change of internal energy is 77J .
 - Converting 55 g of ethanol C_2H_5OH from liquid to vapor at its boiling point if the heat of vaporization is 38.5 KJ/mole.
 - Increasing the temperature of 100 g of copper from 10°C to 100°C the specific heat of copper is 0.389 J/g °C.

Answer

Answer:

(i) $\Delta E = q + w$

$77 = q + 12 \rightarrow q = 65 J$

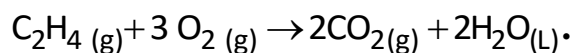
(ii) number of moles of 55 gm of $C_2H_5OH = \frac{55}{46} = 1.19$

1 mole \rightarrow 38.5

1.19 \rightarrow ?? $\therefore q = 46.032 KJ$

(iii) $q = s \times m \times \Delta T = 0.389 \times 100 \times 90 = 3501 J$

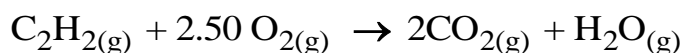
(c) Standard heat of formation ΔH_f° of $C_2H_4(g)$, $CO_2(g)$ and $H_2O(l)$ are, 52.3KJ/mole, -393.5 KJ/mole and -285.8 KJ/mole respectively. Determine the heat of combustion of one mole of $C_2H_4(g)$



Answer

$$\begin{aligned}\Delta H_r^\circ &= \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants} \\ &= (2\Delta H_f^\circ CO_2(g) + 2\Delta H_f^\circ H_2O(l)) - (\Delta H_f^\circ C_2H_4(g) + 3\Delta H_f^\circ O_2(g)) \\ &= \{2 \times -393.5 + 2(-285.8)\} - \{52.3 + (3) \times (0)\} = -1410.9 \text{ KJ/mol}\end{aligned}$$

(e) If $\Delta E = -1254.3$ kJ, at $25^\circ C$. Calculate ΔH for the reaction



Answer

$$\begin{aligned}\Delta H &= \Delta E + \Delta nRT \\ \Delta H &= -1254.3 + (-0.5)(8.31 \times 10^{-3} \times 298) \\ \Delta H &= -1255.5 \text{ KJ/mol}\end{aligned}$$

Dr. Shahera Shohyeb