

(Bond energies and energy calculations)

Q1. (2018)

$$\begin{aligned} \text{(bonds broken)} &= 4(412) + 193 \\ &= 1841 \end{aligned}$$

$$\begin{aligned} \text{(bonds formed)} &= 3(412) + 366 + \\ &\mathbf{X} = 1602 + \mathbf{X} \end{aligned}$$

$$-51 = 1841 - (1602 + \mathbf{X})$$

$$(\mathbf{X} =) 290 \text{ (kJ/mol)}$$

OR

alternative method ignoring the
3 unchanged C–H bonds

$$(412 + 193 =) 605 \text{ (1)}$$

$$366 + \mathbf{X} \text{ (1)}$$

$$-51 = 605 - (366 + \mathbf{X}) \text{ (1)}$$

$$(\mathbf{X} =) 290 \text{ (kJ/mol) (1)}$$

Q2. a). (2019)

$$\begin{aligned} \text{(for bonds broken)} \\ ((12 \times 391) + (3 \times 498) =) 6186 \end{aligned}$$

$$\begin{aligned} \text{(for bonds made)} \\ ((2 \times 945) + (12 \times 464) =) 7458 \end{aligned}$$

$$\begin{aligned} \text{(overall energy change)} &= 6186 - \\ &7458 =) (-)1272 \text{ (kJ)} \end{aligned}$$

Q2. b). (2019)

Energy Changes

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7458 (kJ) (released in making bonds) is greater than 6186 (kJ) (used in breaking bonds)

or

the products have 1272 (kJ) less energy than the reactants

(so) energy is released (to the surroundings)

Q3. (2021)

(bonds broken = $4(364) + 3(498)$
=) 2950

(bonds formed = $2950 + 1034$ =)
3984

$$4X + 4(464) = 3984$$

$$4X = (3984 - 1856) = 2128$$

$$X = 532 \text{ (kJ/mol)}$$

Q4.a). (2023)

$$436 + 346 - (2 \times 432) \text{ kJ/mol}$$

Q4. b). (2023)

energy is needed to break bonds

and

energy is released when bonds form

(and) the energy released is greater than the energy needed

Q5. (2024)

Energy Changes

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$$\begin{aligned} \text{(bonds broken =)} \\ 2(347) + 8\mathbf{X} + 5(498) = \\ 3184 + 8\mathbf{X} \end{aligned}$$

$$\begin{aligned} \text{(bonds made =)} \\ 6(805) + 8(464) = \\ 8542 \end{aligned}$$

$$\begin{aligned} \text{(energy released = bonds made} \\ \text{– bonds broken =)} \\ 2219 = 8542 - (3184 + 8\mathbf{X}) \end{aligned}$$

$$(8\mathbf{X} =) 3139 \text{ (kJ/mol)}$$