Average Bond Enthalpy

A Level

The average bond enthalpy of the $C{-}F$ bond in tetrafluoromethane is given by the standard enthalpy change for one of the following reactions. Which one is it?

- ○ $CF_4(g) \longrightarrow CF_3(g) + F(g)$

- ○ $\frac{1}{4}CF_4(g) \longrightarrow \frac{1}{4}C(g) + F(g)$

- ○ $2F_2(g) + C(s) \longrightarrow CF_4(g)$

- ○ $CF_4(g) \longrightarrow CF_3{}^+(g) + F^-(g)$

- ○ $CF_4(s) \longrightarrow CF_4(g)$

Adapted with permission from UCLES, OCSEB A Level Chemistry, June 1995, Paper 1, Question 10

Essential Pre-Uni Chemistry F2.4

A Level

Given that the bond energy of $H-H$ is $4.53\,\text{eV}$, $D-D$ is $4.59\,\text{eV}$, and the energy change on reaction $H_2 + D_2 \longrightarrow 2\,HD$ is $+0.02\,\text{eV}$, find the bond energy of $H-D$. Give your answer to 3 significant figures.

Essential Pre-Uni Chemistry F2.1

MEAN BOND ENTHALPIES $\left(\text{in kJ mol}^{-1}\right)$

H−H	436	C−Cl	327
C−H (average)	413	I−I	151.2
C−H (in CH_4 and CH_3X)	435	H−I	298.3
C−C	347	C−I	228
C=C	612	Br−Br	193
C $\equiv$ C	838	H−Br	366.3
H−Cl	432	N $\equiv$ N	945.4
Cl−Cl	243.4	O=O	498.3

Use the mean bond enthalpies given above to calculate the reaction enthalpies for the following reactions in the gas phase:

Part A   (a)

$H_2 + Cl_2 \longrightarrow 2\,HCl$. Give your answer to 3 significant figures.

Part B   (b)

$H_2 + I_2 \longrightarrow 2\,HI$. Give your answer to one significant figure.

Part C   (c)

$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$. Give your answer to 2 significant figures.

Part D **(d)**

$C_2H_4 + H_2 \longrightarrow C_2H_6$. Give your answer to 3 significant figures.

Part E **(e)**

$C_2H_2 + 2H_2 \longrightarrow C_2H_6$. Give your answer to 3 significant figures.

Part F **(f)**

$C_4H_{10} \longrightarrow C_2H_6 + C_2H_4$. Give your answer to 2 significant figures.

Part G **(g)**

$C_2H_4 + HCl \longrightarrow CH_3CH_2Cl$. Give your answer to 2 significant figures.

Part H **(h)**

$\frac{1}{2}Cl_2 \longrightarrow Cl$. Give your answer to 4 significant figures.

Part I **(i)**

$C_2H_4 + I_2 \longrightarrow C_2H_4I_2$. Give your answer to 2 significant figures.

Part J **(j)**

$CH_2CHCHCH_2 + 2H_2 \longrightarrow C_4H_{10}$. Give your answer to 3 significant figures.

Essential Pre-Uni Chemistry F2.3

GCSE   A Level

Use some of the following bond enthalpies in $\mathrm{kcal\,mol^{-1}}$ to calculate the enthalpy changes for the reactions (in the gas phase):

$C=C$	146	$C\equiv O$	258
$O=O$	119	$H-O$	111
$C-H$	99	$H-H$	104
$C=O$	178		

Part A   **(a)**

$C_2H_4 + O_2 \longrightarrow 2\,CH_2O$. Give your answer to 2 significant figures.

Part B   **(b)**

$CO + H_2O \longrightarrow CO_2 + H_2$. Give your answer to 2 significant figures.

Part C   **(c)**

$CH_2O \longrightarrow CO + H_2$. Give your answer to 2 significant figures.

Essential Pre-Uni Chemistry F2.2

A Level

P P P

MEAN BOND ENTHALPIES $\left(\text{in kJ mol}^{-1}\right)$

H$-$H	436	C$-$Cl	327
C$-$H (average)	413	I$-$I	151.2
C$-$H (in CH_4 and CH_3X)	435	H$-$I	298.3
C$-$C	347	C$-$I	228
C$=$C	612	Br$-$Br	193
C $\equiv$ C	838	H$-$Br	366.3
H$-$Cl	432	N $\equiv$ N	945.4
Cl$-$Cl	243.4	O$=$O	498.3

Use the reaction enthalpies given (for the gas phase reaction), and the bond enthalpies above, to find the bond enthalpy requested:
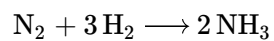
Part A $E(\text{I}-\text{Cl})$

$$\text{I}_2 + \text{Cl}_2 \longrightarrow 2\,\text{ICl}$$
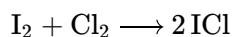
$\Delta_r H^{\ominus} = -70.2\,\text{kJ mol}^{-1}$, find $E(\text{I}-\text{Cl})$. Give your answer to 4 significant figures.
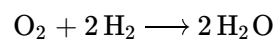
Part B $E(\text{C}-\text{Br})$

$$\text{CH}_4 + \text{Br}_2 \longrightarrow \text{CH}_3\text{Br} + \text{HBr}$$
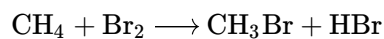
$\Delta_r H^{\ominus} = -28.3\,\text{kJ mol}^{-1}$, find $E(\text{C}-\text{Br})$.

Part C $E(\mathrm{N{-}H})$

$\mathrm{N_2 + 3\,H_2 \longrightarrow 2\,NH_3}$

$\Delta_r H^\circ = -92.2\,\mathrm{kJ\,mol^{-1}}$, find $E(\mathrm{N{-}H})$.

Part D $E(\mathrm{O{-}H})$

$\mathrm{O_2 + 2\,H_2 \longrightarrow 2\,H_2O}$

$\Delta_r H^\circ = -483.6\,\mathrm{kJ\,mol^{-1}}$, find $E(\mathrm{O{-}H})$.

Part E $E(\mathrm{O{-}O})$

$\mathrm{3\,O_2 \longrightarrow 2\,O_3}$

$\Delta_r H^\circ = 285.4\,\mathrm{kJ\,mol^{-1}}$, find $E(\mathrm{O{-}O})$.