

Calorimetry 1

A Level

Essential Pre-Uni Chemistry F1.1

Part A (a)

Calculate the heat capacity of an object with mass $1.80\,\mathrm{kg}$ and specific heat capacity $0.32\,\mathrm{J\,g^{-1}\,K^{-1}}$.

Part B (b)

Calculate the heat capacity of a calorimeter if its temperature is raised $2.5\,\mathrm{K}$ by $35\,\mathrm{kJ}$ of heat.

Part C (c)

Calculate the expected increase in temperature when $2.4\,\mathrm{kJ}$ of heat is transferred to a calorimeter of heat capacity $720\,\mathrm{J\,K^{-1}}$.

Part D (d)

Calculate the heat required to raise the temperature of a calorimeter of heat capacity $1.6\,\mathrm{kJ\,K^{-1}}$ by $3.8\,^\circ\mathrm{C}$.

Part E	(e)
	the specific heat capacity of a calorimeter if it has a mass of $375\mathrm{g}$ and its temperature is raised $2160\mathrm{J}$ of heat.
Part F	(f)
Calculate	the heat required to raise the temperature of $3.14\mathrm{kg}$ of water by $12.2\mathrm{K}$.
Part G Calculate	(g) the mass of water whose temperature is raised through $16.0\mathrm{K}$ by $6.7\mathrm{kJ}$ of heat.
	(h) eter consists of $140\mathrm{g}$ of aluminium and $300\mathrm{g}$ of water. $6100\mathrm{J}$ of heat raises its temperature by calculate to three significant figures: apacity;
the specif	fic heat capacity of aluminium.



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Calorimetry 3

Essential Pre-Uni Chemistry F1.3



Specific heat capacity of water $=4.18\,\mathrm{J\,g^{-1}\,K^{-1}}.$

The enthalpy change of combustion of naphthalene is $-5156\,\mathrm{kJ\,mol^{-1}}$. Its molar mass is $128.2\,\mathrm{g\,mol^{-1}}$. Calculate the temperature change expected when $1.00\,\mathrm{mmol}$ is burnt in excess oxygen in a calorimeter containing $4.0\,\mathrm{kg}$ of water.

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Calorimetry 5

Essential Pre-Uni Chemistry F1.5



Specific heat capacity of water $=4.18\,J\,g^{-1}\,K^{-1}.$

Complete combustion of $0.020\,\mathrm{mol}$ of ethane, with a standard enthalpy of combustion of $-1410.8\,\mathrm{kJ\,mol^{-1}}$ raises the temperature of the water in an insulated calorimeter from $17.4\,^{\circ}\mathrm{C}$ to $22.4\,^{\circ}\mathrm{C}$. Calculate the mass of the water in the calorimeter.

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Calorimetry 7

Essential Pre-Uni Chemistry F1.7



Specific heat capacity of water $=4.18\,\mathrm{J\,g^{-1}\,K^{-1}}$.

 $25.0\,\mathrm{cm^3}$ of sulfuric acid at $1.00\,\mathrm{mol\,dm^{-3}}$ and $19.10\,^\circ\mathrm{C}$ is placed in an insulated polystyrene cup. When $25.0\,\mathrm{cm^3}$ of sodium hydroxide at $2.00\,\mathrm{mol\,dm^{-3}}$ and $19.10\,^\circ\mathrm{C}$ is added, the temperature rises to $32.45\,^\circ\mathrm{C}$.

Assuming that no heat is lost, that the specific heat capacity of water may be used, and that the solutions have a density of $1.00\,\mathrm{g\,cm^{-3}}$ at $19.10\,^\circ\mathrm{C}$, find the enthalpy change of the reaction per mole of water produced by neutralisation.

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Calorimetry 8

Essential Pre-Uni Chemistry F1.8



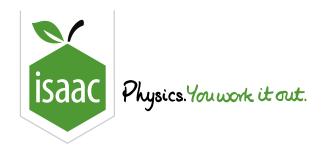
Specific heat capacity of water $=4.18\,\mathrm{J\,g^{-1}\,K^{-1}}$

 $30.0\,\mathrm{cm^3}$ of ethanoic acid at $1.60\,\mathrm{mol\,dm^{-3}}$ and $18.65\,^\circ\mathrm{C}$ is placed in an insulated polystyrene cup. When $40.0\,\mathrm{cm^3}$ of sodium hydroxide at $1.00\,\mathrm{mol\,dm^{-3}}$ and $18.65\,^\circ\mathrm{C}$ is added, the temperature rises to $25.80\,^\circ\mathrm{C}$.

Assuming that no heat is lost, that the specific heat capacity of water may be used, and that the solutions have a density of $1.00\,\mathrm{g\,cm^{-3}}$ at $18.65\,^\circ\mathrm{C}$, find the enthalpy change of the reaction per mole of water produced by neutralisation.

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Calorimetry 9

Essential Pre-Uni Chemistry F1.9



Specific heat capacity of water $=4.18\,\mathrm{J\,g^{-1}\,K^{-1}}$.

When $5.0\,\mathrm{g}$ of ammonium nitrate dissolves in $100\,\mathrm{g}$ of water, the temperature of the water drops from $18\,^{\circ}\mathrm{C}$ to $14\,^{\circ}\mathrm{C}$. Calculate the enthalpy of solution of ammonium nitrate in $\mathrm{kJ}\,\mathrm{mol}^{-1}$ using the following scheme.

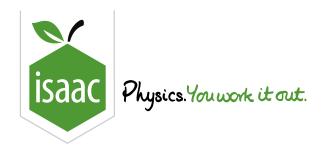
Formula Part A Write down the formula of ammonium nitrate. Relative formula mass Part B

Calculate the relative formula mass of ammonium nitrate. Give your answer to 3 significant figures.

Part C Number of moles

Calculate the number of moles of ammonium nitrate in $5.0\,\mathrm{g}.$

Part D Heat loss of water				
Calculate the heat lost from the $100\mathrm{g}$ of water. Give your answer to 2 significant figures.				
Part E Molar heat loss of ammonium nitrate				
Calculate the heat lost per mole of ammonium nitrate.				
Part F Enthalpy of ammonium nitrate				
Give the enthalpy of solution of ammonium nitrate.				
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Calorimetry 10

A Level

Essential Pre-Uni Chemistry F1.10

The enthalpies of combustion of three fuels are shown below:

Fuel	$\Delta H_{ m c}$ / ${ m kJmol^{-1}}$
CH_4	-890.3
$\mathrm{C_{3}H_{8}}$	-2219.2
$\mathrm{C_4H_{10}}$	-2876.5

Part A (a)

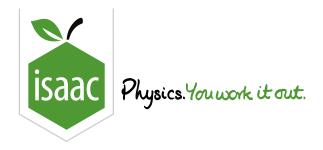
Which gives out most heat per gram?

Part B (b)

Which gives out most heat per mole?

Part C (c)

Which gives out most heat per cubic foot?



Home Gameboard Chemistry Physical Energetics Average Bond Enthalpy

Average Bond Enthalpy



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?

- $\frac{1}{4}\operatorname{CF}_4(g) \longrightarrow \frac{1}{4}\operatorname{C}(g) + \operatorname{F}(g)$
- $\qquad \mathrm{CF_4(g)} \longrightarrow \mathrm{CF_3}^+(\mathrm{g}) + \mathrm{F^-(g)}$
- $2 \operatorname{F}_{2}(\operatorname{g}) + \operatorname{C}(\operatorname{s}) \longrightarrow \operatorname{CF}_{4}(\operatorname{g})$
- $\operatorname{CF}_{4}(\operatorname{g}) \longrightarrow \operatorname{CF}_{3}(\operatorname{g}) + \operatorname{F}(\operatorname{g})$
- $\operatorname{CF}_4(\operatorname{s}) \longrightarrow \operatorname{CF}_4(\operatorname{g})$

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

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Home Gameboard Chemistry Physical Energetics Bond Enthalpies 3

Bond Enthalpies 3



Essential Pre-Uni Chemistry F2.3

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

C=C	146	$\mathrm{C}\equiv\mathrm{O}$	258
O=O	119	Н-О	111
С-Н	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)

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

Part C (c)

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



Home Gameboard Chemistry Physical Energetics Bond Enthalpies 4

Bond Enthalpies 4

Essential Pre-Uni Chemistry F2.4



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