

## Essential Pre-Uni Chemistry F3.4

A Level

Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4(\text{g})$	$-74.8$	$\text{C}_6\text{H}_6(\text{l})$	$-3267.4$
$\text{CCl}_4(\text{l})$	$-129.6$	$\text{H}_2(\text{g})$	$-285.8$
$\text{HCl}(\text{g})$	$-92.3$	$\text{C}_6\text{H}_{12}(\text{l})$	$-3919.5$
$\text{TiCl}_4(\text{l})$	$-804.2$	$\text{C}_2\text{H}_2(\text{g})$	$-1300.8$
$\text{TiCl}_3(\text{s})$	$-720.9$	$\text{C}_2\text{H}_6(\text{g})$	$-1559.7$
$\text{PCl}_3(\text{l})$	$-319.7$	$\text{C}_2\text{H}_5\text{OH}(\text{l})$	$-1367.3$
$\text{PCl}_5(\text{s})$	$-443.5$	$\text{C}_2\text{H}_4(\text{g})$	$-1410.8$
$\text{POCl}_3(\text{l})$	$-597.1$	$\text{CH}_3\text{COOH}(\text{l})$	$-874.1$
$\text{GeO}(\text{s})$	$-212.1$	$\text{C}_6\text{H}_{14}(\text{l})$	$-4163.0$
$\text{GeO}_2(\text{s})$	$-551.0$	$\text{CH}_3\text{COOC}_2\text{H}_5(\text{l})$	$-2237.9$
$\text{NH}_3(\text{g})$	$-46.1$	$\text{CO}(\text{g})$	$-283.0$
$\text{TiO}_2(\text{s})$	$-939.7$	$\text{Mg}(\text{s})$	$-601.7$

Use the reaction enthalpies given, and the combustion or formation enthalpies above to find the requested enthalpy change in each case:

Part A  $\text{NH}_4\text{Cl}(\text{s})$ 

$\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \longrightarrow \text{NH}_4\text{Cl}(\text{s}), \Delta_r H^\ominus = -176 \text{ kJ mol}^{-1}$  find  $\Delta_f H^\ominus$  of  $\text{NH}_4\text{Cl}(\text{s})$

**Part B**  $\text{MgCl}_2 (\text{s})$ 

$\text{TiCl}_4 (\text{l}) + 2 \text{Mg} (\text{s}) \longrightarrow 2 \text{MgCl}_2 (\text{s}) + \text{Ti} (\text{s})$   $\Delta_r H^\circ = -478.4 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{MgCl}_2 (\text{s})$

**Part C**  $\text{CH}_3 \text{COOCOCH}_3 (\text{l})$ 

$\text{CH}_3 \text{COOCOCH}_3 (\text{l}) + \text{H}_2 \text{O} (\text{l}) \longrightarrow 2 \text{CH}_3 \text{COOH} (\text{l})$   $\Delta_r H^\circ = -46 \text{ kJ mol}^{-1}$ , find  $\Delta_c H^\circ$  of  $\text{CH}_3 \text{COOCOCH}_3 (\text{l})$  Give your answer to 4 significant figures.

**Part D**  $\text{C}_6 \text{H}_5 \text{CHCH}_2$ 

$4 \text{C}_2 \text{H}_2 (\text{g}) \longrightarrow \text{C}_6 \text{H}_5 \text{CHCH}_2 (\text{l})$ ,  $\Delta_r H^\circ = -808.2 \text{ kJ mol}^{-1}$ , find  $\Delta_c H^\circ$  of  $\text{C}_6 \text{H}_5 \text{CHCH}_2$  Give your answer to 4 significant figures.

**Part E**  $\text{Al}_2 \text{O}_3 (\text{s})$ 

$4 \text{Al} (\text{s}) + 3 \text{GeO}_2 (\text{s}) \longrightarrow 2 \text{Al}_2 \text{O}_3 (\text{s}) + 3 \text{Ge} (\text{s})$   $\Delta_r H^\circ = -1698.4 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{Al}_2 \text{O}_3 (\text{s})$  Give your answer to 4 significant figures.

**Part F**  $\text{Fe}_2 \text{O}_3$ 

$\text{Fe}_2 \text{O}_3 (\text{s}) + 3 \text{CO} (\text{g}) \longrightarrow 2 \text{Fe} (\text{s}) + 3 \text{CO}_2 (\text{g})$ ,  $\Delta_r H^\circ = -24.8 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{Fe}_2 \text{O}_3$

**Part G**  $\text{CuO} (\text{s})$ 

$3 \text{CuO} (\text{s}) + 2 \text{NH}_3 (\text{g}) \longrightarrow 3 \text{Cu} (\text{s}) + \text{N}_2 (\text{g}) + 3 \text{H}_2 \text{O} (\text{l})$ ,  $\Delta_r H^\circ = -293.3 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{CuO} (\text{s})$  Give your answer to 3 significant figures.

**Part H**  $\text{H}_3\text{PO}_4(\text{s})$



$2\text{PCl}_5(\text{s}) + 8\text{H}_2\text{O}(\text{l}) \longrightarrow 2\text{H}_3\text{PO}_4(\text{s}) + 10\text{HCl}(\text{g})$ ,  $\Delta_r H^\ominus = -307.6 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\ominus$  of  $\text{H}_3\text{PO}_4(\text{s})$   
Give your answer to 3 significant figures.

**Part I**  $\text{Ga}$



$\text{Ga}_2\text{O}_3(\text{s}) + 3\text{Mg}(\text{s}) \longrightarrow 2\text{Ga}(\text{s}) + 3\text{MgO}(\text{s})$ ,  $\Delta_r H^\ominus = -716.1 \text{ kJ mol}^{-1}$ , find  $\Delta_c H^\ominus$  of  $\text{Ga}$ .

**Part J**  $\text{HCl}(\text{g})$



$\text{TiCl}_4(\text{l}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow \text{TiO}_2(\text{s}) + 4\text{HCl}(\text{aq})$ ,  $\Delta_r H^\ominus = -232.3 \text{ kJ mol}^{-1}$ , find  $\Delta_{\text{sol}} H^\ominus$  of  $\text{HCl}(\text{g})$  Give your answer to 3 significant figures.

C<sub>3</sub>H<sub>6</sub> combustion

A Level



**A** and **B** are two isomers with the molecular formula C<sub>3</sub>H<sub>6</sub>. The standard enthalpies of formation,  $\Delta_f H^\ominus$ , of both **A** and **B** have been found by first measuring the standard enthalpies of combustion,  $\Delta_c H^\ominus$ , of each. These values are given in the table below, together with the standard enthalpies of combustion of carbon and hydrogen.

	<b>A</b>	<b>B</b>	<b>carbon</b>	<b>hydrogen</b>
$\Delta_c H^\ominus / \text{kJ mol}^{-1}$	−2058	−2091	−393.5	−241.8

**Part A** Combustion equation

Give the equation for the complete combustion of C<sub>3</sub>H<sub>6</sub>. (Balance it for one mole of the hydrocarbon.)

**Part B**  $\Delta_f H^\ominus$  of **A**

Calculate the standard enthalpy of formation of **A**.

**Part C**  $\Delta_f H^\ominus$  of **B**

Calculate the standard enthalpy of formation of **B**.

**Part D** Isomerisation

Gaseous **B** needs to be stored carefully since it can convert explosively to the elements, to isomer **A**, or to other hydrocarbons. Calculate the standard enthalpy change for the reaction **B** → **A**.



## Essential Pre-Uni Chemistry F3.3

A Level

Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4 (\text{g})$	$-74.8$	$\text{C}_6\text{H}_6 (\text{l})$	$-3267.4$
$\text{CCl}_4 (\text{l})$	$-129.6$	$\text{H}_2 (\text{g})$	$-285.8$
$\text{HCl} (\text{g})$	$-92.3$	$\text{C}_6\text{H}_{12} (\text{l})$	$-3919.5$
$\text{TiCl}_4 (\text{l})$	$-804.2$	$\text{C}_2\text{H}_2 (\text{g})$	$-1300.8$
$\text{TiCl}_3 (\text{s})$	$-720.9$	$\text{C}_2\text{H}_6 (\text{g})$	$-1559.7$
$\text{PCl}_3 (\text{l})$	$-319.7$	$\text{C}_2\text{H}_5\text{OH} (\text{l})$	$-1367.3$
$\text{PCl}_5 (\text{s})$	$-443.5$	$\text{C}_2\text{H}_4 (\text{g})$	$-1410.8$
$\text{POCl}_3 (\text{l})$	$-597.1$	$\text{CH}_3\text{COOH} (\text{l})$	$-874.1$
$\text{GeO} (\text{s})$	$-212.1$	$\text{C}_6\text{H}_{14} (\text{l})$	$-4163.0$
$\text{GeO}_2 (\text{s})$	$-551.0$	$\text{CH}_3\text{COOC}_2\text{H}_5 (\text{l})$	$-2237.9$
$\text{NH}_3 (\text{g})$	$-46.1$	$\text{CO} (\text{g})$	$-283.0$
$\text{TiO}_2 (\text{s})$	$-939.7$	$\text{Mg} (\text{s})$	$-601.7$

Use enthalpies of formation and combustion to calculate the reaction enthalpy for the reaction:

 $\text{Ge} (\text{s}) + 2 \text{H}_2\text{O} (\text{l}) \longrightarrow \text{GeO}_2 (\text{s}) + 2 \text{H}_2 (\text{g})$  Give your answer to 3 significant figures.

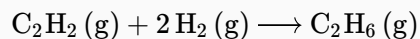
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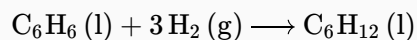
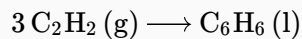
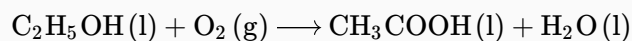
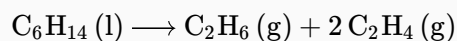
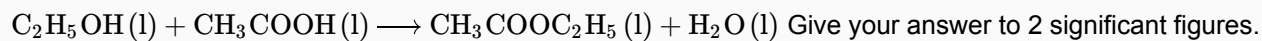
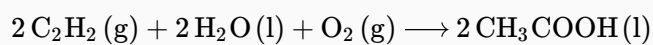
Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4 (\text{g})$	$-74.8$	$\text{C}_6\text{H}_6 (\text{l})$	$-3267.4$
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$\text{PCl}_3 (\text{l})$	$-319.7$	$\text{C}_2\text{H}_5\text{OH} (\text{l})$	$-1367.3$
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$\text{NH}_3 (\text{g})$	$-46.1$	$\text{CO} (\text{g})$	$-283.0$
$\text{TiO}_2 (\text{s})$	$-939.7$	$\text{Mg} (\text{s})$	$-601.7$

Use standard enthalpies of combustion to calculate the reaction enthalpies for the following reactions:

Part A (a)



**Part B (b)****Part C (c)****Part D (d)****Part E (e)****Part F (f)****Part G (g)****Part H (h)**





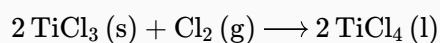
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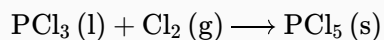
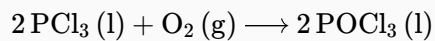
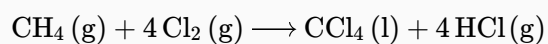
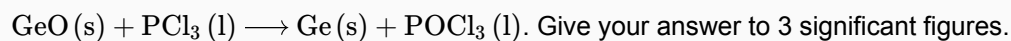
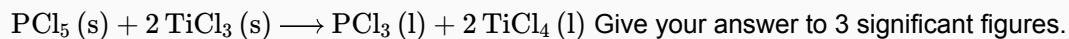
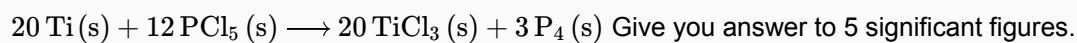
Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4 (\text{g})$	$-74.8$	$\text{C}_6\text{H}_6 (\text{l})$	$-3267.4$
$\text{CCl}_4 (\text{l})$	$-129.6$	$\text{H}_2 (\text{g})$	$-285.8$
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$\text{TiCl}_4 (\text{l})$	$-804.2$	$\text{C}_2\text{H}_2 (\text{g})$	$-1300.8$
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$\text{PCl}_3 (\text{l})$	$-319.7$	$\text{C}_2\text{H}_5\text{OH} (\text{l})$	$-1367.3$
$\text{PCl}_5 (\text{s})$	$-443.5$	$\text{C}_2\text{H}_4 (\text{g})$	$-1410.8$
$\text{POCl}_3 (\text{l})$	$-597.1$	$\text{CH}_3\text{COOH} (\text{l})$	$-874.1$
$\text{GeO} (\text{s})$	$-212.1$	$\text{C}_6\text{H}_{14} (\text{l})$	$-4163.0$
$\text{GeO}_2 (\text{s})$	$-551.0$	$\text{CH}_3\text{COOC}_2\text{H}_5 (\text{l})$	$-2237.9$
$\text{NH}_3 (\text{g})$	$-46.1$	$\text{CO} (\text{g})$	$-283.0$
$\text{TiO}_2 (\text{s})$	$-939.7$	$\text{Mg} (\text{s})$	$-601.7$

Use standard enthalpies of formation to calculate the reaction enthalpies for the following reactions. Unless stated otherwise in the question part, give your answers to 4 significant figures.

### Part A (a)



**Part B (b)****Part C (c)****Part D (d)****Part E (e)****Part F (f)****Part G (g)****Part H (h)**





## Essential Pre-Uni Chemistry F3.4

A Level - Practice (P2)

Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4 (\text{g})$	$-74.8$	$\text{C}_6\text{H}_6 (\text{l})$	$-3267.4$
$\text{CCl}_4 (\text{l})$	$-129.6$	$\text{H}_2 (\text{g})$	$-285.8$
$\text{HCl} (\text{g})$	$-92.3$	$\text{C}_6\text{H}_{12} (\text{l})$	$-3919.5$
$\text{TiCl}_4 (\text{l})$	$-804.2$	$\text{C}_2\text{H}_2 (\text{g})$	$-1300.8$
$\text{TiCl}_3 (\text{s})$	$-720.9$	$\text{C}_2\text{H}_6 (\text{g})$	$-1559.7$
$\text{PCl}_3 (\text{l})$	$-319.7$	$\text{C}_2\text{H}_5\text{OH} (\text{l})$	$-1367.3$
$\text{PCl}_5 (\text{s})$	$-443.5$	$\text{C}_2\text{H}_4 (\text{g})$	$-1410.8$
$\text{POCl}_3 (\text{l})$	$-597.1$	$\text{CH}_3\text{COOH} (\text{l})$	$-874.1$
$\text{GeO} (\text{s})$	$-212.1$	$\text{C}_6\text{H}_{14} (\text{l})$	$-4163.0$
$\text{GeO}_2 (\text{s})$	$-551.0$	$\text{CH}_3\text{COOC}_2\text{H}_5 (\text{l})$	$-2237.9$
$\text{NH}_3 (\text{g})$	$-46.1$	$\text{CO} (\text{g})$	$-283.0$
$\text{TiO}_2 (\text{s})$	$-939.7$	$\text{Mg} (\text{s})$	$-601.7$

Use the reaction enthalpies given, and the combustion or formation enthalpies above to find the requested enthalpy change in each case:

**Part A**    $\text{NH}_4\text{Cl} (\text{s})$ 

$\text{NH}_3 (\text{g}) + \text{HCl} (\text{g}) \longrightarrow \text{NH}_4\text{Cl} (\text{s}), \Delta_r H^\ominus = -176 \text{ kJ mol}^{-1}$  find  $\Delta_f H^\ominus$  of  $\text{NH}_4\text{Cl} (\text{s})$

**Part B**  $\text{MgCl}_2 (\text{s})$

$\text{TiCl}_4 (\text{l}) + 2 \text{Mg} (\text{s}) \longrightarrow 2 \text{MgCl}_2 (\text{s}) + \text{Ti} (\text{s})$   $\Delta_r H^\circ = -478.4 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{MgCl}_2 (\text{s})$

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**Part C**  $\text{CH}_3\text{COOCOH}_3 (\text{l})$

$\text{CH}_3\text{COOCOCH}_3 (\text{l}) + \text{H}_2\text{O} (\text{l}) \longrightarrow 2 \text{CH}_3\text{COOH} (\text{l})$   $\Delta_r H^\circ = -46 \text{ kJ mol}^{-1}$ , find  $\Delta_c H^\circ$  of  $\text{CH}_3\text{COOCOCH}_3 (\text{l})$  Give your answer to 4 significant figures.

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**Part D**  $\text{C}_6\text{H}_5\text{CHCH}_2$

$4 \text{C}_2\text{H}_2 (\text{g}) \longrightarrow \text{C}_6\text{H}_5\text{CHCH}_2 (\text{l})$ ,  $\Delta_r H^\circ = -808.2 \text{ kJ mol}^{-1}$ , find  $\Delta_c H^\circ$  of  $\text{C}_6\text{H}_5\text{CHCH}_2$  Give your answer to 4 significant figures.

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**Part E**  $\text{Al}_2\text{O}_3 (\text{s})$

$4 \text{Al} (\text{s}) + 3 \text{GeO}_2 (\text{s}) \longrightarrow 2 \text{Al}_2\text{O}_3 (\text{s}) + 3 \text{Ge} (\text{s})$   $\Delta_r H^\circ = -1698.4 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{Al}_2\text{O}_3 (\text{s})$  Give your answer to 4 significant figures.

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**Part F**  $\text{Fe}_2\text{O}_3$

$\text{Fe}_2\text{O}_3 (\text{s}) + 3 \text{CO} (\text{g}) \longrightarrow 2 \text{Fe} (\text{s}) + 3 \text{CO}_2 (\text{g})$ ,  $\Delta_r H^\circ = -24.8 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{Fe}_2\text{O}_3$

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**Part G**  $\text{CuO} (\text{s})$

$3 \text{CuO} (\text{s}) + 2 \text{NH}_3 (\text{g}) \longrightarrow 3 \text{Cu} (\text{s}) + \text{N}_2 (\text{g}) + 3 \text{H}_2\text{O} (\text{l})$ ,  $\Delta_r H^\circ = -293.3 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{CuO} (\text{s})$  Give your answer to 3 significant figures.

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**Part H**  $\text{H}_3\text{PO}_4(\text{s})$

$2\text{PCl}_5(\text{s}) + 8\text{H}_2\text{O}(\text{l}) \longrightarrow 2\text{H}_3\text{PO}_4(\text{s}) + 10\text{HCl}(\text{g})$ ,  $\Delta_r H^\circ = -307.6 \text{ kJ mol}^{-1}$ , find  $\Delta_f H^\circ$  of  $\text{H}_3\text{PO}_4(\text{s})$

Give your answer to 3 significant figures.

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**Part I**  $\text{Ga}$

$\text{Ga}_2\text{O}_3(\text{s}) + 3\text{Mg}(\text{s}) \longrightarrow 2\text{Ga}(\text{s}) + 3\text{MgO}(\text{s})$ ,  $\Delta_r H^\circ = -716.1 \text{ kJ mol}^{-1}$ , find  $\Delta_c H^\circ$  of  $\text{Ga}$ .

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**Part J**  $\text{HCl}(\text{g})$

$\text{TiCl}_4(\text{l}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow \text{TiO}_2(\text{s}) + 4\text{HCl}(\text{aq})$ ,  $\Delta_r H^\circ = -232.3 \text{ kJ mol}^{-1}$ , find  $\Delta_{\text{sol}} H^\circ$  of  $\text{HCl}(\text{g})$  Give your answer to 3 significant figures.

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## C<sub>3</sub>H<sub>6</sub> combustion

A Level - Practice (P2)

**A** and **B** are two isomers with the molecular formula C<sub>3</sub>H<sub>6</sub>. The standard enthalpies of formation,  $\Delta_f H^\ominus$ , of both **A** and **B** have been found by first measuring the standard enthalpies of combustion,  $\Delta_c H^\ominus$ , of each. These values are given in the table below, together with the standard enthalpies of combustion of carbon and hydrogen.

	<b>A</b>	<b>B</b>	<b>carbon</b>	<b>hydrogen</b>
$\Delta_c H^\ominus / \text{kJ mol}^{-1}$	−2058	−2091	−393.5	−241.8

### Part A Combustion equation

Give the equation for the complete combustion of C<sub>3</sub>H<sub>6</sub>. (Balance it for one mole of the hydrocarbon.)

### Part B $\Delta_f H^\ominus$ of A

Calculate the standard enthalpy of formation of **A**.

### Part C $\Delta_f H^\ominus$ of B

Calculate the standard enthalpy of formation of **B**.

### Part D Isomerisation

Gaseous **B** needs to be stored carefully since it can convert explosively to the elements, to isomer **A**, or to other hydrocarbons. Calculate the standard enthalpy change for the reaction **B** → **A**.







## Essential Pre-Uni Chemistry F3.3

A Level - Practice (P2)

Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4 (\text{g})$	-74.8	$\text{C}_6\text{H}_6 (\text{l})$	-3267.4
$\text{CCl}_4 (\text{l})$	-129.6	$\text{H}_2 (\text{g})$	-285.8
$\text{HCl} (\text{g})$	-92.3	$\text{C}_6\text{H}_{12} (\text{l})$	-3919.5
$\text{TiCl}_4 (\text{l})$	-804.2	$\text{C}_2\text{H}_2 (\text{g})$	-1300.8
$\text{TiCl}_3 (\text{s})$	-720.9	$\text{C}_2\text{H}_6 (\text{g})$	-1559.7
$\text{PCl}_3 (\text{l})$	-319.7	$\text{C}_2\text{H}_5\text{OH} (\text{l})$	-1367.3
$\text{PCl}_5 (\text{s})$	-443.5	$\text{C}_2\text{H}_4 (\text{g})$	-1410.8
$\text{POCl}_3 (\text{l})$	-597.1	$\text{CH}_3\text{COOH} (\text{l})$	-874.1
$\text{GeO} (\text{s})$	-212.1	$\text{C}_6\text{H}_{14} (\text{l})$	-4163.0
$\text{GeO}_2 (\text{s})$	-551.0	$\text{CH}_3\text{COOC}_2\text{H}_5 (\text{l})$	-2237.9
$\text{NH}_3 (\text{g})$	-46.1	$\text{CO} (\text{g})$	-283.0
$\text{TiO}_2 (\text{s})$	-939.7	$\text{Mg} (\text{s})$	-601.7

Use enthalpies of formation and combustion to calculate the reaction enthalpy for the reaction:

 $\text{Ge} (\text{s}) + 2 \text{H}_2\text{O} (\text{l}) \longrightarrow \text{GeO}_2 (\text{s}) + 2 \text{H}_2 (\text{g})$  Give your answer to 3 significant figures.



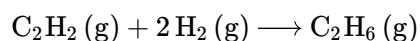
## Essential Pre-Uni Chemistry F3.2

A Level - Practice (P1)

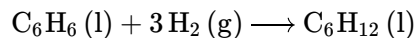
Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4 (\text{g})$	$-74.8$	$\text{C}_6\text{H}_6 (\text{l})$	$-3267.4$
$\text{CCl}_4 (\text{l})$	$-129.6$	$\text{H}_2 (\text{g})$	$-285.8$
$\text{HCl} (\text{g})$	$-92.3$	$\text{C}_6\text{H}_{12} (\text{l})$	$-3919.5$
$\text{TiCl}_4 (\text{l})$	$-804.2$	$\text{C}_2\text{H}_2 (\text{g})$	$-1300.8$
$\text{TiCl}_3 (\text{s})$	$-720.9$	$\text{C}_2\text{H}_6 (\text{g})$	$-1559.7$
$\text{PCl}_3 (\text{l})$	$-319.7$	$\text{C}_2\text{H}_5\text{OH} (\text{l})$	$-1367.3$
$\text{PCl}_5 (\text{s})$	$-443.5$	$\text{C}_2\text{H}_4 (\text{g})$	$-1410.8$
$\text{POCl}_3 (\text{l})$	$-597.1$	$\text{CH}_3\text{COOH} (\text{l})$	$-874.1$
$\text{GeO} (\text{s})$	$-212.1$	$\text{C}_6\text{H}_{14} (\text{l})$	$-4163.0$
$\text{GeO}_2 (\text{s})$	$-551.0$	$\text{CH}_3\text{COOC}_2\text{H}_5 (\text{l})$	$-2237.9$
$\text{NH}_3 (\text{g})$	$-46.1$	$\text{CO} (\text{g})$	$-283.0$
$\text{TiO}_2 (\text{s})$	$-939.7$	$\text{Mg} (\text{s})$	$-601.7$

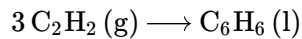
Use standard enthalpies of combustion to calculate the reaction enthalpies for the following reactions:

**Part A (a)**

**Part B (b)**



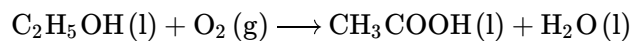
**Part C (c)**



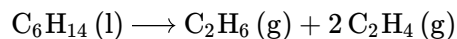
**Part D (d)**



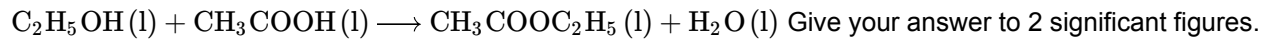
**Part E (e)**



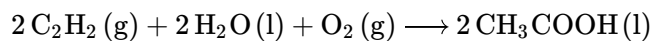
**Part F (f)**



**Part G (g)**



**Part H (h)**







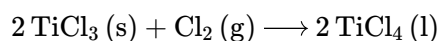
## Essential Pre-Uni Chemistry F3.1

A Level - Practice (P1)

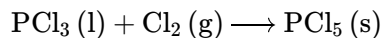
Data (all in  $\text{kJ mol}^{-1}$ ):

	$\Delta_f H^\ominus$		$\Delta_c H^\ominus$
$\text{CH}_4 (\text{g})$	$-74.8$	$\text{C}_6\text{H}_6 (\text{l})$	$-3267.4$
$\text{CCl}_4 (\text{l})$	$-129.6$	$\text{H}_2 (\text{g})$	$-285.8$
$\text{HCl} (\text{g})$	$-92.3$	$\text{C}_6\text{H}_{12} (\text{l})$	$-3919.5$
$\text{TiCl}_4 (\text{l})$	$-804.2$	$\text{C}_2\text{H}_2 (\text{g})$	$-1300.8$
$\text{TiCl}_3 (\text{s})$	$-720.9$	$\text{C}_2\text{H}_6 (\text{g})$	$-1559.7$
$\text{PCl}_3 (\text{l})$	$-319.7$	$\text{C}_2\text{H}_5\text{OH} (\text{l})$	$-1367.3$
$\text{PCl}_5 (\text{s})$	$-443.5$	$\text{C}_2\text{H}_4 (\text{g})$	$-1410.8$
$\text{POCl}_3 (\text{l})$	$-597.1$	$\text{CH}_3\text{COOH} (\text{l})$	$-874.1$
$\text{GeO} (\text{s})$	$-212.1$	$\text{C}_6\text{H}_{14} (\text{l})$	$-4163.0$
$\text{GeO}_2 (\text{s})$	$-551.0$	$\text{CH}_3\text{COOC}_2\text{H}_5 (\text{l})$	$-2237.9$
$\text{NH}_3 (\text{g})$	$-46.1$	$\text{CO} (\text{g})$	$-283.0$
$\text{TiO}_2 (\text{s})$	$-939.7$	$\text{Mg} (\text{s})$	$-601.7$

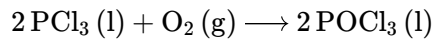
Use standard enthalpies of formation to calculate the reaction enthalpies for the following reactions. Unless stated otherwise in the question part, give your answers to 4 significant figures.

**Part A**   (a)

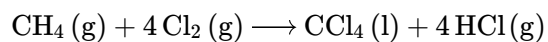
**Part B (b)**



**Part C (c)**



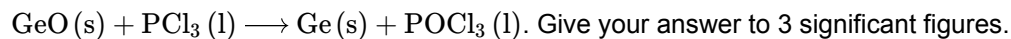
**Part D (d)**



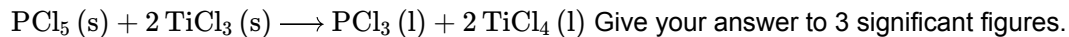
**Part E (e)**



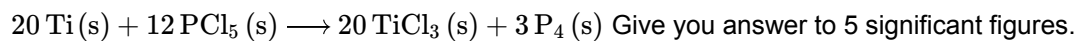
**Part F (f)**



**Part G (g)**



**Part H (h)**









## Ethene Combustion

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A Level - Practice (P1)

The standard enthalpy change of combustion of but-1-ene,  $\text{C}_4\text{H}_8(\text{g})$ , is  $x \text{ kJ mol}^{-1}$ .

The standard enthalpy change of the reaction  $2 \text{C}_2\text{H}_4(\text{g}) \longrightarrow \text{C}_4\text{H}_8(\text{g})$  is  $y \text{ kJ mol}^{-1}$ .

Write down an expression, in terms of  $x$  and  $y$ , for the standard enthalpy change of combustion of ethene,  $\text{C}_2\text{H}_4(\text{g})$  when expressed in  $\text{kJ mol}^{-1}$  (your answer should not feature any units).

The following symbols may be useful:  $x$ ,  $y$

---

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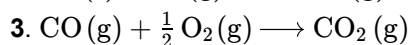
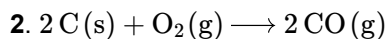
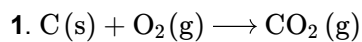
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## Formation and Combustion

A Level - Practice (P1)

For which of the following reactions does the value of  $\Delta H^\circ$  represent **both** a standard enthalpy change of combustion and a standard enthalpy change of formation?



☐ None of the above

☐ 1 only

☐ 2 only

☐ 3 only

☐ 1 and 2 only

☐ 1 and 3 only

☐ 2 and 3 only

☐ All of the above

Adapted with permission from UCLES, A Level Chemistry, June 1994, Paper 4, Question 31



## Reducing carbon dioxide

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A Level - Practice (P1)

The standard enthalpy changes of formation of carbon monoxide and carbon dioxide are  $-110 \text{ kJ mol}^{-1}$  and  $-393 \text{ kJ mol}^{-1}$ , respectively.

### Part A Carbon monoxide formation

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Write an equation, including state symbols, for the first of these enthalpy changes (formation of carbon monoxide).

---

### Part B Carbon dioxide formation

---

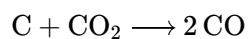
Write an equation, including state symbols, for the second of these enthalpy changes (formation of carbon dioxide).

---

### Part C Standard enthalpy change

---

Use the two standard enthalpy of formation values to calculate, in  $\text{kJ mol}^{-1}$ , the standard enthalpy change of the reaction



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## Part D    Condition

In light of the result obtained in the previous part, suggest what condition is necessary to obtain a reasonable yield of carbon monoxide by this reaction.

- ☐ Low pressure
  - ☐ Presence of O<sub>2</sub>
  - ☐ Low temperature
  - ☐ High temperature
- 

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## Ethene Combustion

A Level



The standard enthalpy change of combustion of but-1-ene,  $\text{C}_4\text{H}_8(\text{g})$ , is  $x \text{ kJ mol}^{-1}$ .

The standard enthalpy change of the reaction  $2 \text{C}_2\text{H}_4(\text{g}) \longrightarrow \text{C}_4\text{H}_8(\text{g})$  is  $y \text{ kJ mol}^{-1}$ .

Write down an expression, in terms of  $x$  and  $y$ , for the standard enthalpy change of combustion of ethene,  $\text{C}_2\text{H}_4(\text{g})$  when expressed in  $\text{kJ mol}^{-1}$  (your answer should not feature any units).

The following symbols may be useful:  $x$ ,  $y$

Adapted with permission from UCLES, A Level Chemistry, November 1993, Paper 4, Question 8

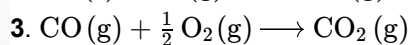
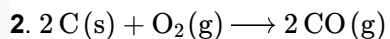
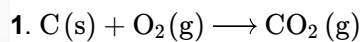


## Formation and Combustion

A Level



For which of the following reactions does the value of  $\Delta H^\circ$  represent **both** a standard enthalpy change of combustion and a standard enthalpy change of formation?



- ☐ None of the above
- ☐ 1 only
- ☐ 2 only
- ☐ 3 only
- ☐ 1 and 2 only
- ☐ 1 and 3 only
- ☐ 2 and 3 only
- ☐ All of the above

Adapted with permission from UCLES, A Level Chemistry, June 1994, Paper 4, Question 31



## Reducing carbon dioxide

A Level



The standard enthalpy changes of formation of carbon monoxide and carbon dioxide are  $-110 \text{ kJ mol}^{-1}$  and  $-393 \text{ kJ mol}^{-1}$ , respectively.

### Part A Carbon monoxide formation



Write an equation, including state symbols, for the first of these enthalpy changes (formation of carbon monoxide).

---

### Part B Carbon dioxide formation



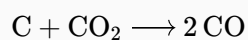
Write an equation, including state symbols, for the second of these enthalpy changes (formation of carbon dioxide).

---

### Part C Standard enthalpy change



Use the two standard enthalpy of formation values to calculate, in  $\text{kJ mol}^{-1}$ , the standard enthalpy change of the reaction



---

In light of the result obtained in the previous part, suggest what condition is necessary to obtain a reasonable yield of carbon monoxide by this reaction.

- ☐ High temperature
  - ☐ Low pressure
  - ☐ Low temperature
  - ☐ Presence of O<sub>2</sub>
- 

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