Q1. The table below shows data for the four hydrocarbons ethyne, propyne, propene and propane. Δ*H*c is the standard enthalpy of combustion of these hydrocarbons.

Compound	Name	M_r	$-\Delta H_c^{\ominus}$ / kJ mol^{-1}
HC≡CH	ethyne	26	1300
HC≡CCH$_3$	propyne	40	1940
H$_2$C=CHCH$_3$	propene	42	2060
CH$_3$CH$_2$CH$_3$	propane	44	2220

The complete combustion of 2.0 g of one of the above hydrocarbons releases exactly 100 kJ of heat energy.

This hydrocarbon is

A ethyne

B propyne

C propene

D propane

(Total 1 mark)

Q2. When 0.10 g of propane was burned the quantity of heat evolved was 5.0 kJ. The enthalpy of combustion of propane in kJ mol^{-1} is

A −800

B −1500

C −2200

D −2900

(Total 1 mark)

Q3. This question is about the reaction given below.

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

Enthalpy data for the reacting species are given in the table below.

Substance	CO(g)	$H_2O(g)$	$CO_2(g)$	$H_2(g)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	−110	−242	−394	0

The standard enthalpy change for this reaction of carbon monoxide and steam is

A +42 kJ mol^{-1}

B −42 kJ mol^{-1}

C +262 kJ mol^{-1}

D −262 kJ mol^{-1}

(Total 1 mark)

Q4. Use the information below to answer this question.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H^{\ominus} = -394 \text{ kJ mol}^{-1}$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta H^{\ominus} = -286 \text{ kJ mol}^{-1}$$

$$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g) \qquad \Delta H^{\ominus} = -126 \text{ kJ mol}^{-1}$$

The standard enthalpy of combustion of butane, in kJ mol^{-1}, is

A −2880

B −2590

C −806

D −554

(Total 1 mark)

Q5. Use the information below to answer this question.

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\quad \Delta H^{\ominus} = -393.5$ kJ mol^{-1}

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\quad \Delta H^{\ominus} = -285.8$ kJ mol^{-1}

$3C(s) + 4H_2(g) \rightarrow C_3H_8(g)$ $\quad \Delta H^{\ominus} = -104.0$ kJ mol^{-1}

$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$ $\quad \Delta H^{\ominus} = -125.2$ kJ mol^{-1}

The value in kJ mol^{-1} of the enthalpy of thermal dissociation when butane forms propane, hydrogen and carbon is

A −26.3

B −17.5

C +17.5

C +21.2

(Total 1 mark)

Q6. Use the information below to answer this question.

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\quad \Delta H^{\ominus} = -393.5$ kJ mol^{-1}

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\quad \Delta H^{\ominus} = -285.8$ kJ mol^{-1}

$3C(s) + 4H_2(g) \rightarrow C_3H_8(g)$ $\quad \Delta H^{\ominus} = -104.0$ kJ mol^{-1}

$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$ $\quad \Delta H^{\ominus} = -125.2$ kJ mol^{-1}

The value in kJ mol^{-1} for the enthalpy of combustion of propane is

A −211.7

B −419.7

C −2220

C −2878

(Total 1 mark)

Q7. The data below refer to the industrial production of nitric acid from ammonia.

Reaction 1 $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$ $\Delta H^{\ominus} = -909$ kJ mol^{-1}

Reaction 2 $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ $\Delta H^{\ominus} = -115$ kJ mol^{-1}

Reaction 3 $3NO_2(g) + H_2O(l) \rightleftharpoons 2HNO_3(aq) + NO(g)$ $\Delta H^{\ominus} = -117$ kJ mol^{-1}

The direct oxidation of ammonia to nitrogen dioxide can be represented by the equation

$$4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$$

for which the standard enthalpy change, in kJ mol^{-1}, is

A −1139

B −1024

C −794

D −679

(Total 1 mark)

Q8. Using the information below, answer this question.

$Fe_2O_3(s) + 3H_2(g) \rightarrow 2Fe(s) + 3H_2O(g)$ $\Delta H^{\ominus} = +96$ kJ mol^{-1}, $\Delta S^{\ominus} = +138$ J K^{-1} mol^{-1}

	$Fe_2O_3(s)$	$H_2(g)$	Fe(s)
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	−822.0	0	0
$\Delta S^{\ominus}$ / J K^{-1} mol^{-1}	90.0	131.0	27.0

The standard enthalpy of formation of steam is

A +286 kJ mol^{-1}

B +242 kJ mol^{-1}

C −242 KJ mol^{-1}

D −286 kJ mol^{-1}

(Total 1 mark)

Q9. Using the data below, which is the correct value for the standard enthalpy of formation for $TiCl_4(l)$?

$C(s) + TiO_2(s) + 2Cl_2(g) \rightarrow TiCl_4(l) + CO_2(g)$ $\Delta H^{\ominus} = -232$ kJ mol^{-1}

$Ti(s) + O_2(g) \rightarrow TiO_2(s)$ $\Delta H_f^{\ominus} = -912$ kJ mol^{-1}

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H_f^{\ominus} = -394$ kJ mol^{-1}

A −1538 kJ mol^{-1}

B −1094 kJ mol^{-1}

C −750 kJ mol^{-1}

D +286 kJ mol^{-1}

(Total 1 mark)

Q10. When ethanamide (CH_3CONH_2) burns in oxygen the carbon is converted into carbon dioxide, the hydrogen is converted into water and the nitrogen forms nitrogen gas.

Substance	ethanamide	carbon dioxide	water
Enthalpy of formation ($\Delta H_f^{\ominus}$) / kJ mol^{-1}	−320	−394	−286

Using the data above, which one of the following is a correct value for the enthalpy of combustion of ethanamide?

A −1823 kJ mol^{-1}

B −1183 kJ mol^{-1}

C −1000 kJ mol^{-1}

D −360 kJ mo1^{-1}

(Total 1 mark)

Q11. In which one of the following reactions is the standard enthalpy change equal to the standard enthalpy of formation of lithium fluoride?

A Li(g) + F(g) → LiF(s)

B $Li^+(g) + F^-(g)$ → LiF(s)

C $Li^+(aq) + F^-(g)$ → LiF(s)

D Li(s) + $\frac{1}{2}F_2(g)$ → LiF(s)

(Total 1 mark)

Q12. Consider the reactions

$C_2H_4(g) + 2O_2(g) \rightarrow 2CO(g) + 2H_2O(g)$ $\quad \Delta H^{\ominus} = -758$ kJ mol^{-1}

$2C(s) + 2H_2(g) \rightarrow C_2H_4(g)$ $\quad \Delta H^{\ominus} = +52$ kJ mol^{-1}

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g)$ $\quad \Delta H^{\ominus} = -242$ kJ mol^{-1}

The enthalpy of formation of carbon monoxide is

A −111 kJ mol^{-1}

B −163 kJ mol^{-1}

C −222 kJ mol^{-1}

D -464 kJ mol^{-1}

(Total 1 mark)

Q13. Given the following data

$C(s) + 2H_2(g) \rightarrow CH_4(g)$ $\quad \Delta H = -75$ kJ mol^{-1}

$H_2(g) \rightarrow 2H(g)$ $\quad \Delta H = +436$ kJ mol^{-1}

which one of the following is the enthalpy change, in kJ mol^{-1}, of the reaction below?

$CH_4(g) \rightarrow C(s) + 4H(g)$

A −947

B +511

C +797

D +947

(Total 1 mark)

Q14. Nitric acid is produced industrially from ammonia, air and water using the following sequence of reactions:

(1) $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$ $\Delta H = -909$ kJ mol^{-1}

(2) $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = -115$ kJ mol^{-1}

(3) $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$ $\Delta H = -117$ kJ mol^{-1}

Which is the enthalpy change (in kJ mol^{-1}) for the following reaction?

$4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$

A −679

B −794

C −1024

D −1139

(Total 1 mark)