**1.** *[1 mark]*

The standard enthalpy changes for the combustion of carbon and carbon monoxide are shown below.

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

$$CO(g) + \tfrac{1}{2}O_2(g) \rightarrow CO_2(g) \; \Delta H_c^{\ominus} =- 283 \; kJ \, mol^{-1}$$
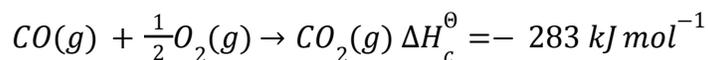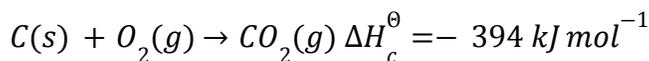
What is the standard enthalpy change, in kJ, for the following reaction?

$$C(s) + \tfrac{1}{2}O_2(g) \rightarrow CO(g)$$
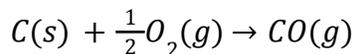
A.   −677

B.   −111

C.   +111

D.   +677

**2.** *[1 mark]*

Consider the equations below.

$$CH_4(g) + O_2(g) \rightarrow HCHO(l) + H_2O(l) \; \Delta H^{\ominus} = x$$

$$HCHO(l) + \tfrac{1}{2}O_2(g) \rightarrow HCOOH(l) \; \Delta H^{\ominus} = y$$

$$2HCOOH(l) + \tfrac{1}{2}O_2(g) \rightarrow (COOH)_2(s) + H_2O(l) \; \Delta H^{\ominus} = z$$

What is the enthalpy change of the reaction below?

$$2CH_4(g) + 3\tfrac{1}{2}O_2(g) \rightarrow (COOH)_2(s) + 3H_2O(l)$$
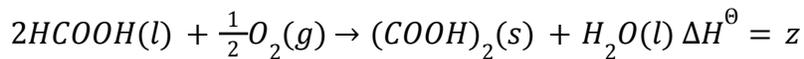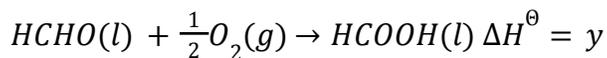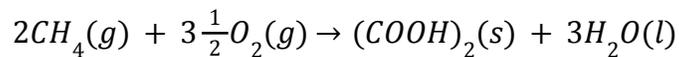
A.   $x + y + z$

B.   $2x + y + z$

C.   $2x + 2y + z$

D.   $2x + 2y + 2z$

**3.** *[1 mark]*

Given the enthalpy change for the reaction below:
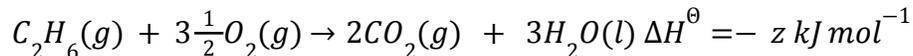
$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \ \Delta H^\ominus = - \ 572 \ kJ$$
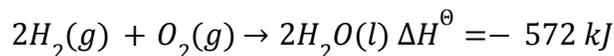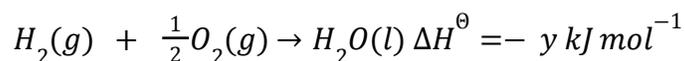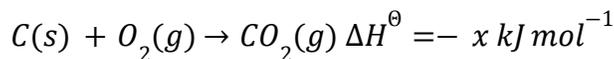
which statement is correct?

A.   The standard enthalpy change of combustion of $H_2(g)$ is $- \ 286 \ kJ \ mol^{-1}$.

B.   The standard enthalpy change of combustion of $H_2(g)$ is $+ \ 286 \ kJ \ mol^{-1}$.

C.   The standard enthalpy change of formation of $H_2O(l)$ is $- \ 572 \ kJ \ mol^{-1}$.

D.   The standard enthalpy change of formation of $H_2O(l)$ is $+ \ 572 \ kJ \ mol^{-1}$.


**4.** *[1 mark]*

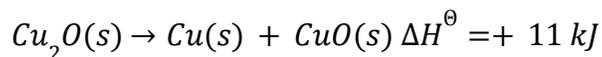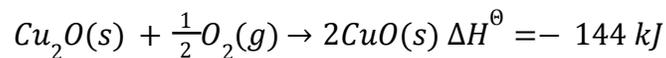Consider the following enthalpy of combustion data.

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

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

$$C_2H_6(g) + 3\tfrac{1}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \ \Delta H^\ominus = - \ z \ kJ \ mol^{-1}$$

What is the enthalpy of formation of ethane in $kJ \ mol^{-1}$?

$$2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$$
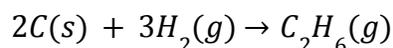
A.   $[(- \ x) + (- \ y)] - (- \ z)$

B.   $(- \ z) - [(- \ x) + (- \ y)]$

C.   $[(- \ 2x) + (- \ 3y)] - (- \ z)$

D.   $(- \ z) - [(- \ 2x) + (- \ 3y)]$
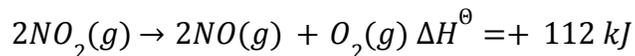
**5.** *[1 mark]*

Consider the following reactions.

$$Cu_2O(s) + \frac{1}{2}O_2(g) \rightarrow 2CuO(s) \; \Delta H^\ominus = - \; 144 \; kJ$$

$$Cu_2O(s) \rightarrow Cu(s) + CuO(s) \; \Delta H^\ominus = + \; 11 \; kJ$$

What is the value of $\Delta H^\ominus$, in kJ, for this reaction?

$$Cu(s) + \frac{1}{2}O_2(g) \rightarrow CuO(s)$$
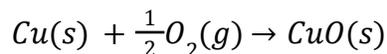
A. $- \; 144 + 11$

B. $+ \; 144 - 11$

C. $- \; 144 - 11$

D. $+ \; 144 + 11$


**6.** *[1 mark]*

Consider the following reactions.

$$N_2(g) + O_2(g) \rightarrow 2NO(g) \; \Delta H^\ominus = + \; 180 \; kJ$$

$$2NO_2(g) \rightarrow 2NO(g) + O_2(g) \; \Delta H^\ominus = + \; 112 \; kJ$$

What is the $\Delta H^\ominus$ value, in kJ, for the following reaction?

$$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$$
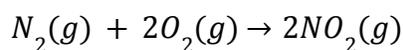
A. $- \; 1 \times (+ \; 180) + - \; 1 \times (+ \; 112)$

B. $- \; 1 \times (+ \; 180) + 1 \times (+ \; 112)$

C. $1 \times (+ \; 180) + - \; 1 \times (+ \; 112)$

D. $1 \times (+ \; 180) + 1 \times (+ \; 112)$

**7.** *[1 mark]*

Consider the two reactions involving iron and oxygen.

$$2Fe(s) + O_2(g) \rightarrow 2FeO(s) \; \Delta H^{\ominus} =- \; 544 \; kJ$$

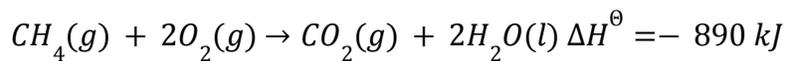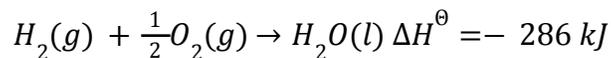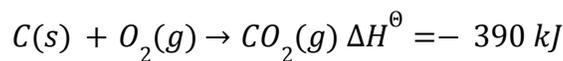$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \; \Delta H^{\ominus} =- \; 1648 \; kJ$$
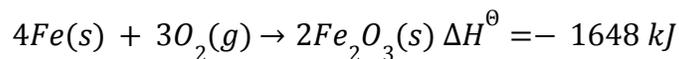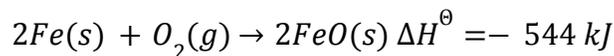
What is the enthalpy change, in kJ, for the reaction below?

$$4FeO(s) + O_2(g) \rightarrow 2Fe_2O_3(s)$$
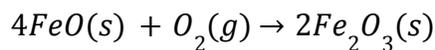
A. $- \; 1648 - 2(- \; 544)$

B. $- \; 544 - (- \; 1648)$

C. $- \; 1648 - 544$

D. $- \; 1648 - 2(544)$

**8.** *[1 mark]*

Using the equations below:

$$C(s) + O_2(g) \rightarrow CO_2(g) \; \Delta H^{\ominus} =- \; 390 \; kJ$$

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

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \; \Delta H^{\ominus} =- \; 890 \; kJ$$

what is $\Delta H^{\ominus}$, in kJ, for the following reaction?

$$C(s) + 2H_2(g) \rightarrow CH_4(g)$$
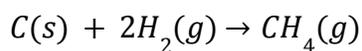
A. −214

B. −72

C. +72

D. +214

**9.** *[1 mark]*

Consider the equations:

$$N_2(g) + 2H_2(g) \rightarrow N_2H_4(l) \quad \Delta H^{\ominus} = +\ 50.6\ kJ\ mol^{-1}$$

$$N_2H_4(l) \rightarrow N_2H_4(g) \quad \Delta H^{\ominus} = +\ 44.8\ kJ\ mol^{-1}$$

What is $\Delta H^{\ominus}$, in kJ, for the following reaction?

$$N_2(g) + 2H_2(g) \rightarrow N_2H_4(g)$$
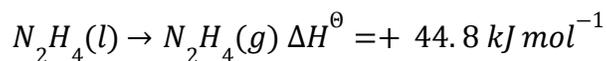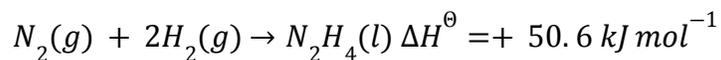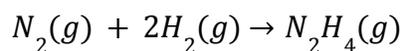
A.  $-\ 95.4$

B.  $-\ 5.80$

C.  $+\ 5.80$

D.  $+\ 95.4$


**10.** *[1 mark]*

Consider the following two equations.

$$2Ca(s) + O_2(g) \rightarrow 2CaO(s) \quad \Delta H^{\ominus} = +\ x\ kJ$$

$$Ca(s) + 0.5O_2(g) + CO_2(g) \rightarrow CaCO_3(s) \quad \Delta H^{\ominus} = +\ y\ kJ$$

What is $\Delta H^{\ominus}$, in kJ, for the following reaction?

$$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$$
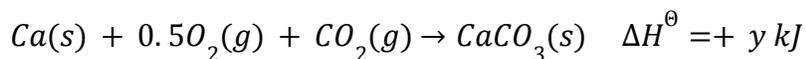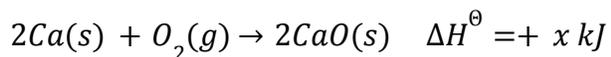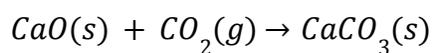
A.  $y - 0.5x$

B.  $y - x$

C.  $0.5 - y$

D.  $x - y$

**11.** *[1 mark]*

Consider the following two equations.

$$2Ca(s) + O_2(g) \rightarrow 2CaO(s) \quad \Delta H^\ominus = + \ x \ kJ$$

$$Ca(s) + 0.5O_2(g) + CO_2(g) \rightarrow CaCO_3(s) \quad \Delta H^\ominus = + \ y \ kJ$$

What is $\Delta H^\ominus$, in kJ, for the following reaction?
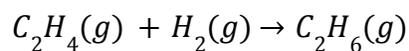
$$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$$
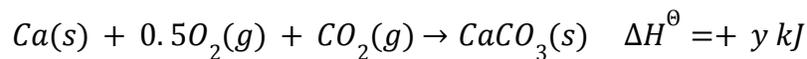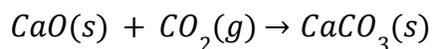
A.  $y - 0.5x$

B.  $y - x$

C.  $0.5 - y$

D.  $x - y$


**12.** *[1 mark]*

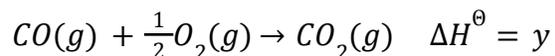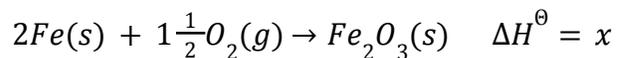Enthalpy changes of reaction are provided for the following reactions.

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

$$2C(s) + 3H_2(g) \rightarrow C_2H_6(g) \ \Delta H^\ominus = - \ 85 \ kJ \ mol^{-1}$$
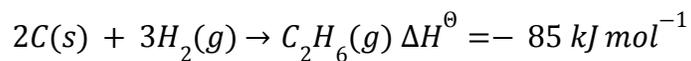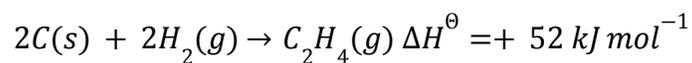
What is the enthalpy change, in $kJ \ mol^{-1}$, for the reaction between ethene and hydrogen?
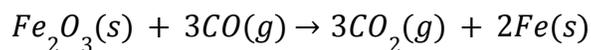
$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

A.   −137

B.   −33

C.   +33

D.   +137

**13.** *[1 mark]*

Consider the following equations.

$$2Fe(s) + 1\tfrac{1}{2}O_2(g) \rightarrow Fe_2O_3(s) \quad \Delta H^{\ominus} = x$$

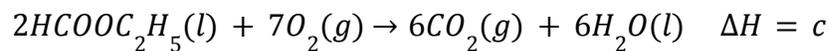$$CO(g) + \tfrac{1}{2}O_2(g) \rightarrow CO_2(g) \quad \Delta H^{\ominus} = y$$

What is the enthalpy change of the reaction below?

$$Fe_2O_3(s) + 3CO(g) \rightarrow 3CO_2(g) + 2Fe(s)$$
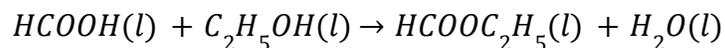
A.  $3y - x$

B.  $3y + x$

C.  $-3y - x$

D.  $-3y + x$

**14.** *[1 mark]*

The enthalpy changes of three reactions are given below.

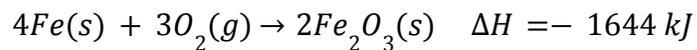$$2HCOOH(l) + O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l) \quad \Delta H = a$$

$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \quad \Delta H = b$$

$$2HCOOC_2H_5(l) + 7O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) \quad \Delta H = c$$
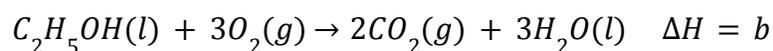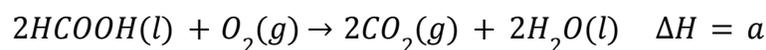
What is the enthalpy change for the following reaction?

$$HCOOH(l) + C_2H_5OH(l) \rightarrow HCOOC_2H_5(l) + H_2O(l)$$
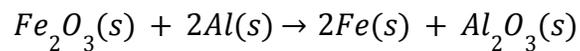
A.  $a + b + c$

B.  $a + 2b - c$

C.  $\tfrac{1}{2}a + b + \tfrac{1}{2}c$

D.  $\tfrac{1}{2}a + b - \tfrac{1}{2}c$

**15.** *[1 mark]*

When four moles of aluminium and four moles of iron combine with oxygen to form their oxides, the enthalpy changes are –3338 kJ and –1644 kJ respectively.

$$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s) \quad \Delta H = -3338 \; kJ$$

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \quad \Delta H = -1644 \; kJ$$
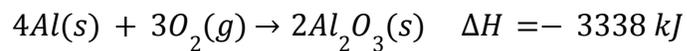
What is the enthalpy change, in kJ, for the reduction of one mole of iron(III) oxide by aluminium?

$$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(s) + Al_2O_3(s)$$

A.  + 1694

B.  + 847

C.  − 847

D.  − 1694