551534 – Chemistry
Group 02 Pretest 4.2 answers

Answers

1 D

3 B

4 C

5 B

6 A

7 A

8 A

9 Work : (example)

$CH_{4(g)} \rightarrow C_{(s)} + 2\ H_{2(g)}$	74.8
$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$	-393.5
$2\ H_{2(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(g)}$	-483.6
$CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(g)}$	-802.3

Result : -802.3 kJ

10 **Example of an appropriate procedure**

Find the concentration of the H_2CO_3

Moles of H_2CO_3 = $\dfrac{3.1 \times 10^{-2}\ \text{g}}{62\ \frac{\text{g}}{\text{mol}}}$ = 5.0×10^{-4} mol

Molarity = $\dfrac{5.0 \times 10^{-4}\ \text{mol}}{0.500\text{L}}$ = $1.0 \times 10^{-3}\ \dfrac{\text{mol}}{\text{L}}$

Find the concentration of the $H^+_{(aq)}$

	$H_2CO_{3(aq)}$	$\leftrightarrow$	$H^+_{(aq)}$	+	$HCO_3{}^-{}_{(aq)}$	$K_a = 4.3 \times 10^{-7}$
Initial	$1.0 \times 10^{-3}\ \frac{\text{mol}}{\text{L}}$		0		0	
Change	$-x$		$+x$		$+x$	
Equilibrium	$1.0 \times 10^{-3}\ \frac{\text{mol}}{\text{L}} - x$		$0 + x$		$0 + x$	

$$K_a = \frac{[H^+{}_{(aq)}][HCO_3{}^-{}_{(aq)}]}{[H_2CO_{3(aq)}]}$$

$$4.3 \times 10^{-7} = \frac{(x)(x)}{1.0 \times 10^{-3}\ \frac{\text{mol}}{\text{L}} - x} = \frac{x^2}{1.0 \times 10^{-3}\ \frac{\text{mol}}{\text{L}}}$$

(note : assume x is negligible when subtracted from $1.0 \times 10^{-3}\ \frac{\text{mol}}{\text{L}}$)

$4.3 \times 10^{-10} = x^2$

$2.1 \times 10^{-5}\ \frac{\text{mol}}{\text{L}} = x = [H^+{}_{(aq)}]$

pH = $-\log[H^+{}_{(aq)}] = -\log(2.1 \times 10^{-5}) = 4.68$

Answer : The pH of this solution is 4.68.

11 **Example of an appropriate procedure**

Application of Hess' law

$CO_{2(g)} + 2H_2O_{(g)} \rightarrow \frac{3}{2} O_{2(g)} + CH_3OH_{(l)}$ $\Delta H = +726$ kJ

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta H = -393$ kJ

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$ $\Delta H = -484$ kJ

$C_{(s)} + 2H_{2(g)} + \frac{1}{2} O_{2(g)} \rightarrow CH_3OH_{(l)}$ $\Delta H = -151$ kJ

Answer

The molar heat of formation of methanol is –151 kJ/mol.

12 Work is complete and the result is correct. Example :

♦ From the experimental results, the molar heat of reaction 1 and 2 must be determined.

REACTION 1 :

- Heat absorbed by the water from the reaction of 4 g of calcium.
  $Q_{(water)} = m_{(water)} \bullet c_{(water)} \bullet \Delta T_{(water)}$
  $Q_{(water)} = 1.000 \text{ kg} \bullet 4.19 \text{ kJ/kg} \bullet {}^\circ\text{C} \times 10.3{}^\circ\text{C}$
  $Q_{(water)} = 43.2 \text{ kJ}$
- Heat for one mole of calcium
  $43.2 \text{ kJ}/4.0 \text{ g} \times 40 \text{ g/mol} = 432 \text{ kJ/mol}$

REACTION 2 :

- Heat absorbed by the water from the reaction of 5.6 g calcium oxide
  $Q_{(water)} = m_{(water)} \bullet c_{(water)} \bullet \Delta T_{(water)}$
  $Q_{(water)} = 1000 \text{ kg} \bullet 4.19 \text{ kJ/kg} \bullet {}^\circ\text{C} \bullet 1.9{}^\circ\text{C}$
  $Q_{(water)} = 8.0 \text{ kJ}$

- Heat for one mole of calcium oxide
  $8.0 \text{ kJ}/5.6 \text{ g} \times 56 \text{ g/mol} = 80 \text{ kJ/mol}$

▸ Using these three equations the molar heat of combustion of calcium can be calculated :

(1) $Ca_{(s)} + 2\, H_2O_{(l)} \rightarrow Ca^{2+}_{(aq)} + 2\, OH^-_{(aq)} + H_{2(g)}$ $\Delta H =$ -432 kJ

(2) $CaO_{(s)} + H_2O_{(l)} \rightarrow Ca^{2+}_{(aq)} + 2\, OH^-_{(aq)}$ $\Delta H =$ -80 kJ

(3) $H_{2(g)} + 1/2\, O_{2(g)} \rightarrow H_{(2)}O_{(l)}$ $\Delta H =$ -286 kJ

Inverting equation 2 to give (2a) :

(2a) $Ca^{2+}_{(aq)} + 2\, OH^-_{(aq)} \rightarrow CaO_{(s)} + H_2O_{(l)}$ $\Delta H =$ +80 kJ

Addition of equations 1, 2a and 3 gives the equation for the combustion of calcium :

(1) $Ca_{(s)} + 2\, \cancel{H_2O_{(l)}} \rightarrow \cancel{Ca^{2+}_{(aq)}} + \cancel{2\, OH^-_{(aq)}} + \cancel{H_{2(g)}}$ $\Delta H =$ -432 kJ

(2a) $\cancel{Ca^{2+}_{(aq)}} + \cancel{2\, OH^-_{(aq)}} \rightarrow CaO_{(s)} + \cancel{H_2O_{(l)}}$ $\Delta H =$ -80 kJ

(3) $\cancel{H_{2(g)}} + 1/2\, O_{2(g)} \rightarrow \cancel{H_{(2)}O_{(l)}}$ $\Delta H =$ -286 kJ

$Ca_{(s)} + 1/2\, O_{2(g)} \rightarrow CaO_{(s)}$ $\Delta H =$ -638 kJ

Other complete work to give the correct answer.