ANSWER KEY

Chapter 10 Test Answer Key

Answers to Multiple-Choice Questions

1. c
2. d
3. d
4. a
5. b
6. c
7. d
8. a
9. c
10. c
11. a
12. d
13. d
14. a
15. b

Answers to Numerical Response Questions

16.	30.2 kJ
17.	NaCl, CO_2, O_2, C_2H_2
18.	–1161 kJ
19.	–2.99 kJ
20.	1.30 g

Answers to Written Response Questions

21. a) $CH_3OH(\ell) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

$$
\begin{aligned}
\Delta_c H^\circ &= \sum\left(n\Delta_f H^\circ \text{ products}\right) - \sum\left(n\Delta_f H^\circ \text{ reactants}\right) \\
&= \left[(1\text{ mol})\left(\Delta_f H^\circ\ CO_2(g)\right) + (2\text{ mol})\left(\Delta_f H^\circ\ H_2O(g)\right)\right] \\
&\quad - \left[(1\text{ mol})\left(\Delta_f H^\circ\ CH_3OH(\ell)\right) + \left(\frac{3}{2}\text{ mol}\right)\left(\Delta_f H^\circ\ O_2(g)\right)\right] \\
&= \left[\left(1\ \cancel{\text{mol}}\right)\left(-393.5\text{ kJ}/\cancel{\text{mol}}\right) + \left(2\ \cancel{\text{mol}}\right)\left(-241.8\text{ kJ}/\cancel{\text{mol}}\right)\right] \\
&\quad - \left[\left(1\ \cancel{\text{mol}}\right)\left(-239.2\text{ kJ}/\cancel{\text{mol}}\right) + \left(\frac{3}{2}\ \cancel{\text{mol}}\right)\left(0\text{ kJ}/\cancel{\text{mol}}\right)\right] \\
&= -637.9\text{ kJ per mol of } CH_3OH(\ell)
\end{aligned}
$$

b) Energy input:

$$\begin{aligned}\text{Mass of methanol burned} &= \text{Mass of burner before} - \text{Mass of burner after}\\ &= 127.35\ \text{g} + 124.28\ \text{g}\\ &= 207\ \text{g}\ \text{CH}_3\text{OH}(\ell)\end{aligned}$$

Using formulas:

$$\begin{aligned}n\text{CH}_3\text{OH}(\ell) &= \frac{m}{M}\\ &= \frac{2.07\ \cancel{\text{g}}}{32.05\ \frac{\cancel{\text{g}}}{\text{mol}}}\\ &= 0.06459\ \text{mol}\end{aligned}$$

$$\Delta H = n\Delta_c H$$

$$\begin{aligned}\Delta H\ \text{CH}_3\text{OH}(\ell) &= \left(0.06459\ \cancel{\text{mol}}\right)\left(-637.9\frac{\text{kJ}}{\cancel{\text{mol}}}\right)\\ &= -41.2\ \text{kJ}\end{aligned}$$

Using dimensional analysis:

$$\begin{aligned}x\ \text{kJ} &= 2.07\ \cancel{\text{g CH}_3\text{OH}(\ell)} \times \frac{1\ \cancel{\text{mol CH}_3\text{OH}(\ell)}}{32.05\ \cancel{\text{g CH}_3\text{OH}(\ell)}} \times \frac{-637.9\ \text{kJ}}{\cancel{\text{mol CH}_3\text{OH}(\ell)}}\\ &= -41.2\ \text{kJ}\end{aligned}$$

Energy output:

$$\begin{aligned}\text{Mass of water} &= \text{Mass of aluminium can and water} - \text{Mass of aluminium can}\\ &= 193.23\ \text{g} - 47.35\ \text{g}\\ &= 145.88\ \text{g}\end{aligned}$$

$$\begin{aligned}\text{Temperature change} &= 31.3\ ^\circ\text{C} - 22.5\ ^\circ\text{C}\\ &= 8.8\ ^\circ\text{C}\end{aligned}$$

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$$Q = mc\Delta t_{\text{water}} + mc\Delta t_{\text{aluminium}}$$
$$= (145.88\ \cancel{g})\left(\frac{4.19\ \text{J}}{\cancel{g}\bullet{}^{\circ}\cancel{C}}\right) + (47.35\ \cancel{g})\left(\frac{0.897\ \text{J}}{g\bullet{}^{\circ}\cancel{C}}\right)(8.8\ {}^{\circ}\cancel{C})$$
$$= 5.75\ \text{kJ}$$

$$\text{Efficiency} = \left|\frac{\text{Energy output}}{\text{Energy input}}\right| \times 100\%$$
$$= \left|\frac{5.75\ \text{kJ}}{-41.2\ \text{kJ}}\right| \times 100\%$$
$$= 14\%$$

c) The majority of the wasted energy would have been used to heat up the surroundings, which include the air surrounding the burner, the burner itself, the thermometer and stirring rod.