Year 12 Chemistry Using and Controlling Reactions ***SOLUTIONS***

Formative Test 1 Measuring Energy Changes, Fuels, and Electrochemistry

1. (a) Combustion and respiration

2. (a) Exothermic.

(b) (i) $M = 39.998 \text{ g mol}^{-1}$ $m_{water} = 100 \text{ g}$ $m_{NaOH} = 2 \text{ g}$

$$E = mc\Delta T$$
$$= 100 \times 4.18 \times 4.3$$
$$= 1797 \text{ J}$$
$$n = \frac{m}{M} = \frac{2}{39.998} = 0.0500 \text{ mol}$$
$$\frac{E}{n} = \frac{1797}{0.0500} = 35948 \text{ J mol}^{-1}$$
$$= 36 \text{ kJ mol}^{-1}$$

(ii) $NaOH_{(s)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$ $\Delta H = -36 \text{ kJ mol}^{-1}$

1 mark for states, 1 mark for ΔH and sign, 1 mark for equation

(iii) So that the heat is distributed evenly through the water and the thermometer is measuring accurately.

(iv) The metal container could be replaced with an insulating container so that less heat is escaping to the surroundings. The temperature change of the water will be ∴ a more accurate measure of energy released.
*The container could be sealed, though that wouldn't be very effective since the heat will still escape through the sides.
-OR-
The lumps could be replaced by powder, so that the reaction proceeds more quickly and heat has less time to leave the water and not be measured as temperature change. This answer is not preferred.

3.

(a) (i) They can be burnt to provide energy

(ii) Using petrol as fuel will free up more ethanol so that it may be a feedstock for chemical industry.
-or-
Since petrol is a mixture of fossil fuels, it is more readily available than biofuels such as ethanol.
-or-
Petrol is a more efficient fuel, producing more heat per litre and heat per gram compared to ethanol.

(iii) More petrol will be available for use as a feedstock for chemical industry.
-or-
Ethanol is a biofuel, so is renewable.

(iv) $n = \frac{m}{M} = \frac{785}{46} = 17.1 \text{ mol}$ -or- $\frac{23000}{785} = 29.299 \text{ kJ g}^{-1}$

$\therefore \frac{23000}{17.1} = 1348 \text{ kJ mol}^{-1}$ $29.299 \times 46 = 1348 \text{ kJ mol}^{-1}$

(v) $C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 3H_2O_{(g)} + 2CO_{2(g)}$ $\Delta H = -1348 \text{ kJ mol}^{-1}$

1 mark for states, 1 mark for ΔH and sign, 2 marks for balanced equation

(b) Any two (with any one adverse effect)
soot (carbon) - can create visual pollution, restrict light to leaves, damage the respiratory system, etc.
CO - can deprive the body of oxygen leading to adverse health effects
Unburnt hydrocarbons - react with other molecules in the atmosphere and produce secondary pollutants

4.

(a) Cathode. The half-equation shows electrons are being gained, so reduction is occurring.
(b) $CO + H_2O \rightarrow CO_2 + 2H^+ + 2e^-$
(c) (to the right, *must* be drawn on the alarm)
(d) (to the right, *must* be drawn on the electrolyte)
(e) Negative
(f) Galvanic
(g) The detection cell is a fuel cell, its reactants are in continuous supply.
(h) (see notes)