**Explaining endothermic and exothermic reactions**

**2022**

1. Freon-11, CCl3F, works as a refrigerant in a refrigerator by evaporating, as shown in the equation below.

CCl3F() → CCl3F(*g*) Δr*H* = +25.2 kJ mol–1

(i) Draw a labelled energy diagram for the evaporation of freon-11, showing reactants, products, and the change in enthalpy (Δr*H*).

(ii) By referring to both the change in enthalpy and the attractive forces between particles in freon-11, explain how this process can be used to cool down a refrigerator.

2. (i) The equation for the dissolving of solid potassium bromide, KBr(*s*), in water, is shown below.

KBr(*s*) → K+(*aq*) + Br–(*aq*) Δr*H* = +19.9 kJ mol–1

Both lithium bromide, LiBr(*s*), and solid potassium bromide, KBr(*s*), are dissolved in 200 ml of water, in

separate beakers. 20.0 g of LiBr is dissolved in the first beaker, resulting in an energy change.

Calculate the mass of solid potassium bromide, KBr(*s*), that would need to be dissolved in the second beaker in

order to have an energy change of equal magnitude (size).

*M*(LiBr) = 86.8 g mol–1 *M*(KBr) = 119 g mol–1

(ii) By considering the enthalpy change of each process, explain any difference in the resultant temperatures of each

solution. *No calculations are needed in your answer.*

2021



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**2020**

Octane, C8H18(l), is used as a fuel.

The equation for the complete combustion of octane is shown below.

2C8H18() + 25 O2(*g*) → 16CO2(*g*) + 18H2O(*g*) *H* = –11 018 kJ mol–1

(i) Classify this reaction as endothermic or exothermic, with a reason.

**2019**

Ice, H2O(*s*), is often placed into drinks. As the ice melts, the drink cools.



Use your knowledge of enthalpy changes associated with changes of state to elaborate on the reason why the drink cools.

**2018**

(a) Water formed in the respiration reaction evaporates. Explain whether this process is endothermic or exothermic

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**(b)** Butane is used to fuel a camping stove. Butane burns readily in oxygen. The following is an energy profile

diagram for the combustion of butane.



Explain how the diagram shows that the enthalpy change for this reaction is negative.

**2017**

(a) When solid calcium chloride, CaCl2(*s*), reacts with water, the temperature increases. Explain.

(b) When a person sweats, water is lost from the body by evaporation. This evaporation speeds up when a person exercises. Explain.

**2016**

(a) Instant cold packs are useful for treating sports injuries on the field. They contain salts such as ammonium nitrate, NH4NO3. When the packs are activated, the salt dissolves in water, causing the temperature to decrease. Explain.

(b) The equation for hydrating anhydrous copper sulfate is as follows. Explain.

CuSO4(*s*) + 5H2O(l) → CuSO4.5H2O(*s*) Δr*H* º = −78.2 kJ mol–1

(c) Pentane, C5H12, is a liquid at room temperature. It evaporates at 36.1°C. Explain.

**2015**

(a) Hand warmers contain a supersaturated solution of sodium ethanoate which, when activated, crystallises and releases heat. Explain.

(b) Glucose is made in plants during photosynthesis when carbon dioxide gas, CO2(*g*), and water, H2O(l),

react to produce glucose, C6H12O6(*aq*), and oxygen gas, O2(*g*). The photosynthesis reaction can be

represented by the following equation: Explain.

6CO2(*g*) + 6H2O(l) → C6H12O6(*aq*) + 6O2(*g*) Δr*H*° = 2803 kJ mol–1

**2014**

(i) When solid sodium hydroxide is added to water, the temperature increases. Explain.

(ii) The freezing of water to form ice can be represented by the following equation. Explain.

H2O(l) → H2O(*s*)

**2013**

(a) Dissolving ammonium nitrate in a beaker containing water can be represented by the following equation:

NH4NO3(*s*) → NH4+(*aq*) + NO3–(*aq*) Δr *H*° = 25.1 kJ mol–1

Explain this process.

Circle the description below that best describes what you would observe happening to the beaker during this

process. Explain.

**gets colder stays the same gets warmer**

(b) Glucose is an important source of energy in our diet. The equation below shows the combustion of glucose

to form carbon dioxide and water. Explain this process.

C6H12O6(*s*) + 6O2(*g*) → 6CO2(*g*) + 6H2O(*l*) Δr *H°* = *–*2820 kJ mol–1

(c) (i) Many portable BBQ and camping gas canisters contain butane, C4H10. Butane is a gas at room

temperature, and has a boiling point of – 0.5°C. The gas canisters contain both gas and liquid butane. As the

gaseous butane is used, some of the liquid evaporates. Is this an endothermic or exothermic process?

Give a reason for your choice, and use your knowledge of structure and bonding, and energy changes, to explain the changes occurring as the liquid evaporates.

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