

Beatty Secondary School Science Department (Chemistry Unit) Chemistry 6092

Name: _____ () Date: _____

Class: 4E____

TOPIC: ENERGY CHANGES REVIEW

Multiple-Choice Questions

1 Burning fuels such as methane is an exothermic process.

 $CH_4 \ (g) \ + \ 2O_2 \ (g) \ \rightarrow \ CO_2 \ (g) \ + \ 2H_2O \ (l)$

Which statement explains this fact?

- A Molecules release energy when they react.
- **B** More bonds are formed than are broken.
- **C** The bonds formed are weaker than the bonds broken.
- D That energy is released to the surroundings and maybe detected by an increase in temperature.
 (D)
- **2** In which equation is the sign of the energy change, ΔH , shown correctly?

	equation	ΔH	
Α	$2AgCl (s) \rightarrow 2Ag (s) + Cl_2 (g)$	positive	
В	$CH_4(g) \rightarrow C(g) + 4H(g)$	negative	
С	$H_2O(l) \rightarrow H_2O(g)$	negative	
D	$CH_{4}\left(g\right) \ + \ 2O_{2}\left(g\right) \ \rightarrow \ CO_{2}\left(g\right) \ + \ 2H_{2}O\left(l\right)$	positive	

(**A**)

- 3 On combustion, which fuel never produces pollutants?
 - AdieselBhydrogenCmethaneDpetrol(B)
- 4 The energy profile diagram for a chemical reaction is shown.



Which statement is correct?

- A The overall enthalpy change is equal to x + y.
- **B** The reaction is exothermic
- **C** The value of x would increase in the presence of a catalyst.
- **D** The value of y would decrease in the presence of a catalyst.

5 An equation for respiration is shown.

 $C_6H_{12}O_6$ (s) + $6O_2$ (g) $\rightarrow 6CO_2$ (g) + $6H_2O$ (g) $\Delta H = -2830$ kJ/mol

What can be deduced from the equation?

- **A** Δ H for photosynthesis is +2830 kJ/mol.
- **B** Energy from sunlight is needed for this reaction.
- **C** Respiration is only carried out by animals.
- D The equation shows the reaction between one volume of glucose and six volumes of oxygen to produce six volumes of carbon dioxide and six volumes of water.
 (A)
- 6 The equation for the combustion of hydrogen is shown.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

	H-H	O-H	O=O
bond energy in kJ/mol	436	463	498

What is the enthalpy change of this reaction?

Α	–482 kJ/mol	В	–444 kJ/mol			
С	+444 kJ/mol	D	+482 kJ/mol	(Α)

7 When steam is passed through excess hot coke a reaction occurs and the coke cools.

 $C~(s)~+~H_2O~(g)~\rightarrow~CO~(g)~+~H_2~(g)$

The activation energy for the reaction is X. Which energy profile diagram for this reaction is correct?



(**C**)

8 The energy profile diagram for the reversible reaction, $2NH_3 \rightleftharpoons N_2 + 3H_2$, is shown.



Which statements about this reaction are both correct?

	statement 1	statement 2
Α	Forward reaction is endothermic.	The activation energy is different for the forward and reverse reactions.
В	Forward reaction is endothermic.	The activation energy is same for the forward and reverse reactions.
С	Forward reaction is exothermic.	The activation energy is different for the forward and reverse reactions.
D	Forward reaction is exothermic.	The activation energy is same for the forward and reverse reactions.

Structured questions

9 The temperature of the mixture initially begins to rise as the potassium hydroxide is added to sulfuric acid. It then reaches a maximum and eventually falls as more potassium hydroxide is added. The graph below shows how the temperature of the mixture varies with the volume of aqueous potassium hydroxide added.



(a) Why does the temperature initially rise?

Neutralisation is an exothermic reaction. As such, thermal energy is released to the surroundings, resulting in the rise of the temperature observed.

(b) What volume of aqueous potassium hydroxide gives the highest temperature reading?

17.5 cm³

(c) Explain why the temperature falls if more than this volume of aqueous potassium hydroxide in (b) is added.

All the sulfuric acid has been completely neutralised and no more thermal energy is produced, allowing the temperature to fall back to room temperature.

10 Instant cooling packs are used to treat sport injuries. The packs contain a small bag of solid ammonium nitrate in a bag of water.



When the pack is squeezed, the small bag breaks open and the ammonium nitrate mixes with the water. An endothermic change occurs and the water in the bag becomes very cold.

(a) The endothermic change has a positive value of Δ H. Why does this endothermic change cause the water to become cold?

Thermal energy is absorbed from the surroundings / water, causing the temperature of the water to drop. This causes the water to become cold.

(b) When the pack is squeezed, ammonium nitrate solution forms.

 NH_4NO_3 (s) + (aq) $\rightarrow NH_4NO_3$ (aq) $\Delta H = +26 \text{ kJ/mol}$

Complete the energy profile diagram below. Label clearly the **reaction enthalpy** change and the activation energy.



progress of reaction

(c) Ammonium nitrate is also used as a fertiliser. It is made from ammonia. Crops use nitrogen from ammonium nitrate for growth. A typical bag of fertilisers contain 50 kg of ammonium nitrate, NH₄NO₃. Calculate the mass of nitrogen in this bag of fertiliser.

M_r of ammonium nitrate = 14 + 4 + 14 + 48 = 80.0

% of nitrogen in ammonium nitrate = [(14 × 2) ÷ 80] × 100% = 35.0%

Mass of nitrogen = [(35 ÷ 100] × 50 kg = 17.5 kg

11 Car manufacturers are developing fuel cells for use in cars. Fuel cells produce electrical energy from the reaction between a fuel and oxygen.

Two possible fuels for use in fuel cells are hydrogen and methanol. The table gives some data about these two fuels. \checkmark

	fuel	melting point / °C	boiling point / °C	energy change of combustion in kJ/mol
CHAN	hydrogen	-259	-252	256
0130	methanol	-97.7	64.5	715

- (a) The table gives values for the energy change of combustion for each fuel in kJ/mol.
 - (i) Calculate the energy output for 1 g of each fuel. Mr of H₂ = 2 Energy output for 1 g of H₂ = 256 ÷ 2 = <u>128 kJ</u> Mr of CH₃OH = 12 + 4(1) + 16 = 32 Energy output for 1 g of CH₃OH = 715 ÷ 32 = 22.3 kJ
 - (ii) Use the values you have calculated and information in the table to discuss the advantages and disadvantages of using each fuel in cars.

U E E E

- The advantage of using hydrogen is that it produces more energy than methanol for every gram that is used.
 - The advantage of using methanol is that it is a liquid at room temperature and pressure. Thus, it is easier to be stored and transported.
- The disadvantage of using hydrogen is that it is a gas at room temperature and pressure. Thus, in order to transport large amounts of hydrogen, it needs to be compressed into a liquid.
- (iii) Hydrogen and methanol have different effects on the environment when used as fuels. State the environmental advantage of hydrogen as a fuel cell.

Hydrogen when burnt produces only water. Thus, it is clean fuel and pollution free.

(b) The energy output of a fuel cell can be shown using either an energy profile diagram or an energy level diagram.

- (i) Draw an energy profile diagram for the combustion of methanol. Your diagram should include labels for the reaction enthalpy change and activation energy,
- (ii) draw an energy level diagram for the combustion of hydrogen.



12 The diagrams show the energy changes when lithium chloride and sodium chloride are dissolved in water.



Describe the differences in the **energy changes** and **temperature changes** that happen as each compound dissolves.

When LiC*l* is dissolved in water, the process is exothermic and heat energy is released to the surroundings, resulting in an increase in temperature. The enthalpy change is negative.

When NaCl is dissolved in water, the process is endothermic and heat energy is absorbed from the surroundings, resulting in a decrease in temperature. The enthalpy change is positive.

The amount of energy change / enthalpy change is higher in LiC/ than NaC/, resulting in a larger temperature change observed in LiC/ than in NaC/.