IB Chemistry II 5.2 Study Worksheet

To receive full credit, the method used and the steps involved at arriving at you final answer must be shown clearly. For numerical calculations please pay proper attention to significant figures.

1. **When 1.00g of sodium hydroxide is dissolved in 100.0 g of water in an insulated container the temperature rises from** 20.00°C to 22.66°C. Calculate the enthalpy change for the solution. State any assumptions made. NOTE: Dissolving reactions due not have limiting reagents.

2. When 100.0 ml of 1.00 moldm^{-3} NaOH is added to 100.0 ml of 1.00 moldm^{-3} HCl in an insulated container the temperature rises from 21.0°C to 34.6°C.

   NaOH(aq) + HCl (aq) → NaCl(aq) + H2O(l)

   Calculate the enthalpy change for the neutralization reaction. State any assumptions made.

3. Aluminum has a specific heat of 0.902 $Jg^{-1}K^{-1}$. How much heat is lost when a piece of aluminum with a mass of 23.984 g cools from a temperature of 415.0 ^{o}C to a temperature of 22.0 ^{o}C?
4. The temperature of a sample of water increases by 69.5 ^{o}C when 24 500 J are applied. The specific heat of liquid water is 4.18 $Jg^{-1}K^{-1}$. What is the mass of the sample of water?
5. 850 joules of heat are applied to a 250 g sample of liquid water with an initial temperature of 13.0 ^{o}C. Find a) the change in temperature and b) the final temperature.
6. When 34 700 J of heat are applied to a 350 g sample of an unknown material the temperature rises from 22.0 ^{o}C to 173.0 ^{o}C. Calculate the specific heat of this material.
7. Calculate how much energy in kJ is needed to warm 250.0 ml water from 25.0 °C to 95.0 °C in order to make a cup of coffee. (250 ml = 250 g) **answer key #5*
8. Determine the specific heat capacity of methanol if 1.80 x10^{2}J of heat is added to 70 g of liquid methanol and its temperature increases from 18.5^{o}C to 30.5^{o}C. *#6*
9. When 50.0 cm^3 of 1 moldm^{-3} HCl is mixed rapidly with 50.0 cm^3 of 1 moldm^{-3} NaOH, the temperature of the resulting solution increases by 6^{o}C. Determine the temperature change when:
   a) 100 cm^3 of each of these solutions is mixed
   b) 2 mol dm^{-3} of each solution is mixed *#7*

10. When 8.00 g of ammonium nitrate (NH_4NO_3) was dissolved in 100.0 ml water, the temperature fell from 19.0 °C to 14.5 °C.
a) Calculate the enthalpy (Q) of the solution in J and kJ.
b) The experiment was repeated but with 10.0 g of NH_4NO_3. State and explain if there would be a change in temperature. *#8*

11. An experiment was carried out to determine the amount of energy released in a "low fat" chocolate bar with a mass of 50.0 g. The complete combustion of a 10.0 g sample of the bar raised the temperature of 500.0g of water from 19.0 °C to 86.5°C. Calculate the energy value (kJ) of the chocolate bar. *#9*

12. 500.0g of water were heated on a gas camping stove from 20.0 °C to 100.0°C. If the pot was made of aluminum (specific heat capacity 875 kJ kg^{-1} K^{-1}) and it weighed 100.0 g, calculate the heat energy (Q) required in kJ to heat:
a) The pot
b) The water
c) The gas camping stove contained butane (C_4H_{10}). 14.5g of butane was used to boil the water. How many moles of butane was this? *#10*

13. For the reaction: N_2(g) + 3H_2(g) <-> 2NH_3(g) ΔH = - 92.0 kJ mol^{-1}
   a) Determine the heat energy released when 2 moles of nitrogen reacts.
   b) Determine the energy released when 0.50 mole of ammonia is formed.
   c) Calculate the number of moles of nitrogen that react to produce 1840 kJ mol^{-1} of energy?
   d) Determine the heat energy released when 10.0 g of hydrogen burns. *#12*

14. In cooking "Crepe Suzette", a delicious type of French pancake one tablespoon (2.50g) of brandy (containing ethanol) is poured over the pancakes and then it is ignited.
   a) The molar mass of the ethanol is 46.08 gmol^{-1}. Calculate the number of moles of ethanol, C_2H_5OH in the tablespoon.
   b) The enthalpy change for the reaction is –1350 kJmol^{-1}. Calculate the heat released when the brandy on the Crepe Suzette burns. *#13*

15. 10.0 g of NaOH is added to 100.0 g of water at 23.2°C in a glass beaker. The solution is stirred and the maximum temperature of 44.6°C is reached.

a) Calculate the heat produced by the reaction. (Assume the specific heat capacity of the solution is 4.20 Jg-1°C-1). Is the reaction exothermic or endothermic?

b) Calculate the enthalpy change for dissolving the solid NaOH in water in $kJmol^{-1}$.

c) Write an equation for the dissolving process.

d) The value given in the literature under similar conditions is -42.7 $kJmol^{-1}$. Suggest a reason why the calculated value of the enthalpy change of the solution is different from the literature value and propose an improvement in the procedure to obtain a more accurate result. *#14*

16. Describe an experiment that could be conducted in the school laboratory to determine the value of ΔH (in $kJmol^{-1}$) for the neutralization reaction between HCl and NaOH. Write an equation for the reaction and show the calculation that would need to be carried out to obtain the value for ΔH. *#15*

17. In a neutralization reaction 50.0 cm^3 of a 0.500 $moldm^{-3}$ solution of potassium hydroxide is mixed rapidly in a glass beaker with 50.0 cm^3 of a 0.500 $moldm^{-3}$ solution of hydrochloric acid.

Initial temperature of each solution = 19.6°C

Final temperature of the mixture = 23.1°C

a) Write an equation for the reaction.

b) State with a reason whether the reaction was exothermic or endothermic.

c) Explain why the solutions were mixed rapidly.

d) Calculate the enthalpy change in kJmol-1. Assume that the specific heat capacity of the solution is the same as that of water.

e) If the experiment was repeated with an HCl concentration of 1 $moldm^{-3}$ state and explain what the temperature change would be. *#16*

18. The reaction between a strong base, sodium hydroxide and a strong acid, sulfuric acid was studied by measuring the heat produced during neutralization. Volumes of 1.25 $moldm^{-3}$ of the base ranging from 10.0 to 50.0 cm^3 were mixed with the required volumes of 1.25 $moldm^{-3}$ solution of the acid to produce a total volume of 60.0 cm^3. The changes in temperature were measured and recorded in the table below.

Volume base (cm3)	**Temperature (°C)**
10.0	2.2
20.0	4.6
30.0	7.0
40.0	7.0
50.0	3.5

a) Write an equation to represent the neutralization reaction.

b) Draw a graph of the results.

c) From the graph determine the greatest temperature increase.

d) Calculate the number of moles of base and the number of moles of acid in (c).

e) Determine the limiting reagent.

f) Calculate the energy released, Q in joules by the reaction when the maximum temperature was obtained on the graph.

g) Calculate the enthalpy of neutralization, ΔH.

h) The accepted value for the enthalpy of neutralization is -55.5 kJmol-1. Outline two sources of error in the experimental procedure that could result in a calculated value of ΔH that is smaller than the accepted value and suggest a way that one of these could be minimized. *#17*