ITEM 1

Scenario 1	*In a sports game at a certain sports club, many of the unfit players would get muscle sprains caused by accumulation of lactic acid in the muscles, during a vigorous exercise. This is further accompanied by excessive heat around the affected muscle area. The team doctor wishes to design a product from Substance Q (Na_2CO_3) or Substance X (KCl), to cool down the heated muscles and stabilize the players.*	
Task	Help the doctor to design an experiment that will help him to choose a better salt for using in the product.	
Experimental Aspect	**Descriptions**	**Scoring Areas**
Aim/Title of experiment	Experiment to investigate the nature of the solubility of salt X and Salt Q in water.	
Tools and materials used	i. Beaker ii. Thermometer iii. Water iv. Salt X and Salt Q v. Measuring cylinder vi. Boiling tube vii. Test tube viii. Petri dish	
Variables	Independent; The mass of salts X and Q. Dependent; The Temperatures of solution. Controlled; The Volume of the water were kept constant. The Mass of salt X and salt Q were kept constant.	
Hypothesis	The solubility of a salt in water depends on the type of salt X or salt Q ; Dissolving endothermically or Exothermically.	
Procedure	a) Measure about **100 cm^3** of distilled water, using measuring cylinder. b) Transfer into a plastic beaker or coverable plastic container of negligible heat capacity. c) Note it's initial temperature, T_0 (^0C), using a thermometer. d) Weigh about **5 g of salt X** using a weighing scale. e) Add the 5 g of salt X to the water in plastic beaker above and cover to avoid heat loss or gain from the surrounding.	

	f) Stir the mixture, using a thermometer and record the final temperature, $T_1(^0C)$. g) Repeat the procedures (a) to (f) using **salt Q**. h) The results were entered in the table and later analyzed.	
sk and Precautions	a) Breaking of thermometer, which can be mitigated by putting the thermometer back into its case after use. b) Cuts from broken glasses, mitigated by putting on closed shoes and protective gears as gloves, laboratory coat.	
Results	Mass of dish + salt X =.....(g) Mass of dish + salt Q =.....(g) Mass of empty dish =.....(g) Mass of salt X =.....(g) Mass of salt Q =.....(g) Volume of water = ...(cm^3)	
Data interpretation and Analysis	**Consider Salt X:** Change in temperature,$\Delta T = (Final\ temp - iniial\ temp)$ (^0C). $\Delta T = +\cdots\ldots(^0C)$. Then: salt X dissolves endothermically since,ΔT is a positive value. **Consider Salt Q:** Change in temperature,$\Delta T = (Final\ temp - iniial\ temp)$ (^0C). $\Delta T = -\cdots\ldots(^0C)$. Then: salt Q dissolves exothermically since,ΔT is a negative value.	
Conclusions	a) Salt X is less soluble in water than salt Q. b) Salt X dissolves endothermically by cooling(decrease in temperature) while salt Q dissolves exothermically(increase in temperature) c) Therefore, salt X can act as a better coolant for muscle strains	

Salt Solution	Initial temp (^0C) of water only.	Final temp (^0C) of salt solution.
Water + salt X		
Water + salt Q		

ITEM 2:

ıario 1	*In lake katwe of Uganda, the locals mine to extract some salts for processing into different uses. They use crystallization method to precipitate the salt. The common salts in the lake are Substance Q (Na_2CO_3) and Substance X (KCl).The site chemist needs to know the salt that will precipitate (solidify) out first for collection, among these two.*
k	Help the chemist to design an experiment that will help him to choose a better salt that will dissolve easily in the water. (Na=23,O=16, K=39,Cl=35.5)

erimental Aspect	Descriptions	Scoring Areas
a/Title of eriment	Experiment to investigate the heat of solution (Enthalpy of solution) of salt **X** and Salt **Q** in water.	
ols and materials :d	i. Beaker ii. Thermometer iii. Water iv. Salt X and Salt Q v. Measuring cylinder vi. Boiling tube vii. Test tube viii. Petri dish	
ariables	Independent; The mass of salts X and Q. The time take for the salts to di Dependent; The Temperatures of solution. Controlled; The Volume of the water were kept constant. The Mass of salt X and salt Q were kept constant.	
ypothesis	The heat of solution depends on the solubility of salt X or salt Q,in water and the nature of the salt.	
rocedure	a) Measure about **50 cm^3** of distilled water, using measuring cylinder. b) Transfer into a plastic beaker or coverable plastic container of negligible heat capacity. c) Note it's initial temperature,T_0 (^0C), using a thermometer. d) Weigh about **5 g** of **salt X** using a weighing scale.	

A company is investigating an appropriate chemical method to generate heat for portable stoves. The
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	e) I added the **5 g** of salt X to the water in plastic beaker above and covered to avoid heat loss or gain from the surrounding. f) I immediately started the clock or timer. g) Stirred the mixture, using a thermometer while recording the temperature, **T (^oC)**, after every 10 seconds for 1.0 minutes. h) Repeated the procedures (a) to (g) using **salt Q**. i) The results were entered in the table and later analyzed. j) Graph of temperatures against time is plotted on same axes for both salts.	
Risk and Precautions	a) Breaking of thermometer, mitigated by putting the thermometer back into its case after use. b) Cuts from broken glasses, mitigated by putting on closed shoes and protective gears as gloves, laboratory coat.	
Results	Mass of dish + salt X =.....(g) Mass of dish + salt Q =.....(g) Mass of empty dish =.....(g) Mass of salt X =.....(g) Mass of salt Q =.....(g) Volume of water = ...(cm^3) Initial temperature of water = ... **(^oC)**	

Time(minutes)	0.0	10.0	20.0	30.0	40.0	50.0	60.0
Temperature (^oC)							
Water + salt X							
Water + salt Q							

- A company is investigating an appropriate chemical method to generate heat for portable stoves. The idea involves using iron scrap material to displace copper(II) ions in a chemical reaction, offering an alternative to fossil fuels and charcoal stoves. The company aims at determining how much heat

interpretation Analysis	**Consider Salt X:** Change in temperature, $\Delta T_X = (Final\ temp - initial\ temp)$ (^0C). Total mass of solution, m = (mass of X + volume of water) (g) m = (5 + 50) = 55 g $\Delta H = +(mC\Delta T_X)$ ..... (Joules, J). $\Delta H = +(55x4.2\Delta T_X)\ Joules$ Then: salt X dissolves endothermically since, ΔT_X is a positive value. Molar mass of X (KCl) = 39 +35.5 =74.5g 5g of KCl gives $+(55x4.2\Delta T_X)\ Joules$ of heat energy. 74.5g gives $\left[\frac{74.5x55x4.2\Delta T_X}{5}\right] Joules\ of\ heat\ energy$ Then: enthalpy/heat of solution is $+\left[\frac{74.5x55x4.2\Delta T_X}{5}\right] Jmol^{-1}$ **Consider Salt Q:** Change in temperature, $\Delta T_Q = (Final\ temp - initial\ temp)$ (^0C). Total mass of solution, M = (mass of Q + volume of water) (g) M = (5 + 50) = 55 g $\Delta H = -(MC\Delta T_Q)$ ..... (Joules, J). $\Delta H = -(55X4.2\Delta T_X) Joules$ Then: salt Q dissolves exothermically since, ΔT_Q is a negative value. Molar mass of Q (Na_2CO_3) = (2x23)+(1x12)+(3x16) = 106g 5g of KCl gives $+(55x4.2\Delta T_X)\ Joules$ of heat energy. 106g gives $\left[\frac{106x55x4.2\Delta T_X}{5}\right] Joules\ of\ heat\ energy$ Then: enthalpy/heat of solution is $-\left[\frac{106x55x4.2\Delta T_X}{5}\right] Jmol^{-1}$	
Conclusions	a) Salt X dissolves endothermically by cooling (decrease in temperature) while salt Q dissolves exothermically (increase in temperature) b) Therefore, salt X is less soluble in water than salt Q. c) Hence, salt X will easily precipitate (solidify out of water) due to a positive heat of solution while salt Q will easily dissolve (more soluble or less solidifies out of water) due to negative heat of solution.	

- A company is investigating an appropriate chemical method to generate heat for portable stoves. The idea involves using iron scrap material to displace copper(II) ions in a chemical reaction, offering an alternative to fossil fuels and charcoal stoves. The company aims at determining how much

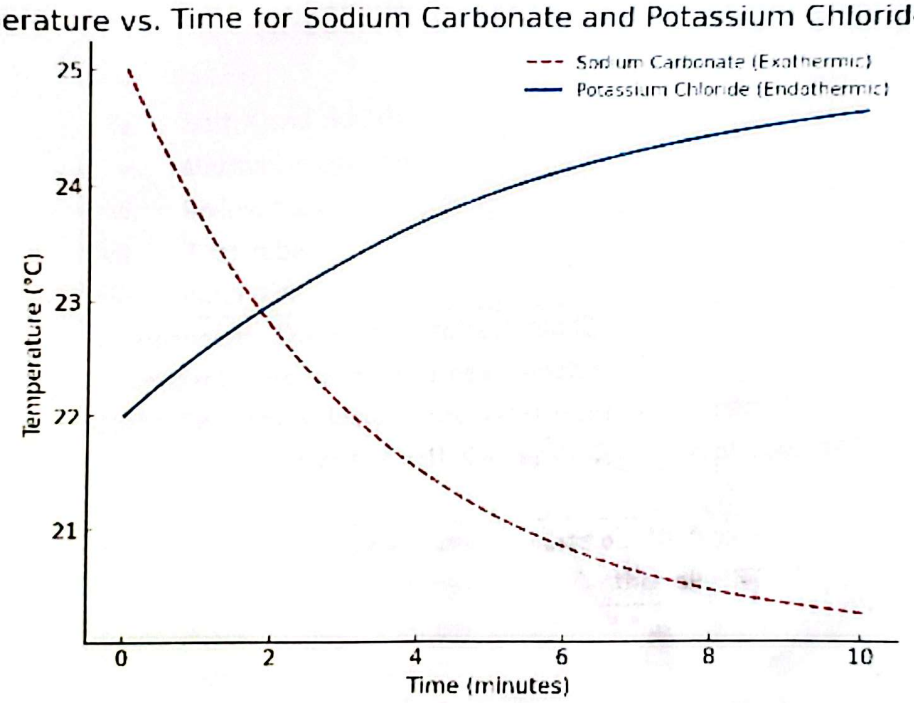
Here is the sketch of the temperature vs. time graph for sodium carbonate (exothermic) and potassium chloride (endothermic) solutions.

The graph shows how the temperature changes over time for both solutions, with the sodium carbonate curve rising and the potassium chloride curve falling.

Expected Behavior:

Sodium carbonate (exothermic): The temperature of the solution will increase as sodium carbonate dissolves because heat is released during the process.

Potassium chloride (endothermic): The temperature of the solution will decrease as potassium chloride dissolves because heat is absorbed from the surroundings.



- A company is investigating an appropriate chemical method to generate heat for portable stoves. The idea involves using iron scrap material to displace copper(II) ions in a chemical reaction, offering an alternative to fossil fuels and charcoal stoves. The company aims at determining how much heat is generated by the reaction for every 25 cm^3 of copper(II) sulphate solution used, so that they make it a viable option for outdoor cooking

$$Fe(s) + Cu^{2+} \rightarrow Fe^{2+} + Cu(s)$$

You are provided with;

- ❖ Solid A (6.0 g) which is iron fillings
- ❖ Solid B (6.0 g) which is copper(II) sulphate. Dissolve solid B in distilled water to make 100 cm^3 of solution. Label this solution
- ❖ Some apparatus that may be required for the investigation

Tasks

a) Design an experiment that can be used to determine the amount of heat evolved

(b) Carry out the experiment and record your findings

c) Analyse the results of your experiment and make a conclusion