

Observation Table:

S.No	Time (min)	Temperature ($^{\circ}\text{C}$)		t_m (of mixture)
		t_h (of hot water)	t_c (of cold water)	
1	0	46	30	
2	0.5	45.8	30	
3	1.0	45.6	30	
4	1.5	45.4	30	
5	2.0	45.3	30	
6	2.5	45.2	30	
7	3.0	45.2	30	
8	3.5	45.1	30	
9	4.0	45.1	30	
10	4.5	45	30	
11	5.0	<div> <div>←</div> <div>Mixing</div> <div>→</div> </div>		
12	5.5			36.3
13	6.0			36
14	6.5			35.9
15	7.0			35.9
16	7.5			35.9
17	8.0			35.9
18	8.5			35.9
19	9.0			35.9
20	9.5			35.9
21	10.0			35.9

Aim :

To determine the enthalpy of neutralisation of strong acid and strong base calorimetrically.

Apparatus :

Thermal flask, glass stirrer, thermometer, stop watch, beaker, measuring cylinder.

Theory :

Calorimeter: It is an apparatus which is used to determine the enthalpies of solⁿ. It is an isolated system which can neither exchange heat nor matter with the surroundings.

In laboratory, we use thermal flask as the calorimeter.

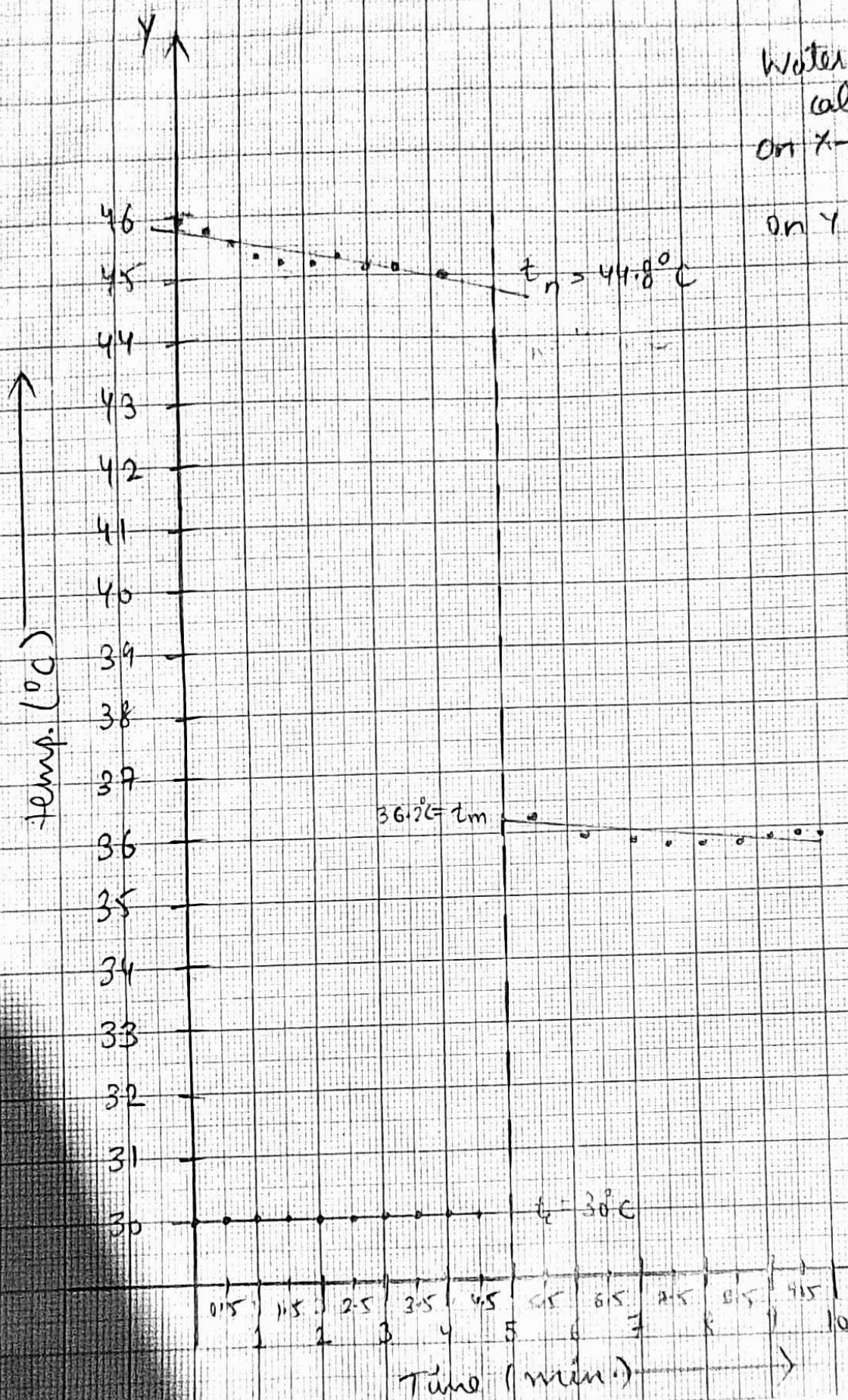
Part (a) of the experiment is to determine the heat capacity of calorimeter or water equivalent of calorimeter.

(b) To determine the enthalpy of neutralisation of strong acid (HCl) and strong base (NaOH) using heat capacity measured in part (a).

Heat evolved in any process = mst

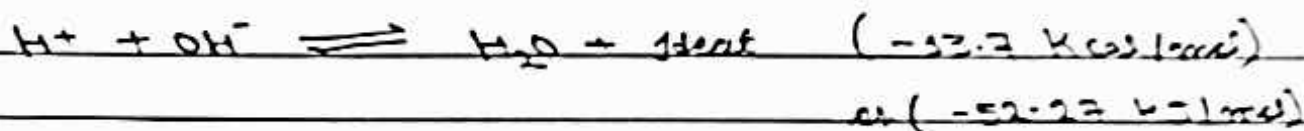
(where m = mass, s = specific heat, Δt = change in temp.)

Water equivalent of
calorimeter
on X-axis 1 cm
= 1 gram
on Y-axis 2 cm = 1°C



Heat lost = Heat gained

Water equivalent of calorimeter is defined as the amount of heat required to raise the temp. of water contained in calorimeter. Enthalpy of neutralization is defined as the amount of heat evolved when 1 mol of a strong acid is completely neutralised by a strong base.



Procedure:

1. Took 100ml of distilled water in a beaker using pipette and heat it to $\sim 45^\circ\text{C}$
2. Took 100 ml of distilled water in another beaker (using pipette).
3. Poured the hot water in the thermoflask (and clipped a thermometer having least count 0.1°C and also in the water in the beaker (least count 1°C))
4. Recorded the temperature of both hot water as well as cold water for 5 min at intervals of 30 sec each.
5. At exactly 5 min, poured the water at room temp. into the hot water in the flask and mixing.

Calculations for water equivalent:

$$m_h S (t_h - t_m) = m_c S (t_m - t_c) + c (t_m - t_c)$$
$$= 100 \times 1 (44.8 - 36.2) = 100 \times 1 (36.2 - 30) + c (36.2 - 30)$$

$$= 100 (8.6) = 100 (6.2) + c (6.2)$$

$$= 860 = 620 + c (6.2)$$

$$\Rightarrow 6.2c = 240$$

$$c = \frac{2400}{62}$$

$$c = 38.71 \text{ cal/}^\circ\text{C}$$

Q =

copper wire stirs and continue recording the temp of the mixture for another 5 min (after every 30 sec)

Calculations:

Heat lost by the hot water = Heat gained by cold water + Heat gained by calorimeter.

$$m_h s (t_h - t_m) = m_c s (t_m - t_c) + c (t_m - t_c)$$
$$100 \times 1 \times (t_h - t_m) = 100 \times 1 (t_m - t_c) + c (t_m - t_c)$$
$$100 (t_h - t_m) = (c + 100) (t_m - t_c)$$

$$c = \frac{100 (t_h - t_m)}{t_m - t_c} - 100$$

$$Q = 100 (t_f - t_i) + c (t_f - t_i)$$
$$\Delta H = Q \times 10$$

(a) Calculation for water equivalent:

$$m_h s (t_h - t_m) = m_c s (t_m - t_c) + c (t_m - t_c)$$
$$100 \times 1 (44.8 - 36.2) = 100 \times 1 (36.2 - 30) + c (36.2 - 30)$$

$$100 (8.6) = 100 (6.2) + c (6.2)$$

$$860 - 620 = 6.2c$$

$$\Rightarrow c = \frac{240}{6.2}$$

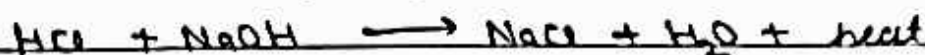
$$c = +38.71 \text{ cal/}^\circ\text{C}$$

Teacher's Signature : _____

Observation Table:

S.No	Time (in min)	Temperature ($^{\circ}\text{C}$)		M t_m (mixture)
		t_b (NaOH)	t_a (HCl)	
1	0	29.9	33	
2	0.5	29.9	33	
3	1.0	29.9	33	
4	1.5	29.9	33	
5	2.0	29.9	33	
6	2.5	30	33	
7	3.0	30	33	
8	3.5	30	33	
9	4.0	30	33	
10	4.5	29.9	33	
11	5.0	← Mixing →		
12	5.5			46.4
13	6.0			46.4
14	6.5			46.4
15	7.0			46.4
16	7.5			46.4
17	8.0			46.4
18	8.5			46.4
19	9.0			46.4
20	9.5			46.3
21	10			46.3

Part B: To determine the enthalpy of neutralisation of strong acid and strong base using heat capacity measured in (a)



Procedure:

1. Took 100 ml of 1N NaOH solⁿ (using pipette) and poured it in the thermoflask.

Took 100 ml of 1N HCl solⁿ (using pipette) in a separate beaker.

Recorded the temperature of both the solutions for 5 min at intervals of 30 sec each.

At exactly 5 min, poured the HCl solⁿ into the NaOH solⁿ in the thermoflask and stir using copper wire stirrer.

Continued the recording of the temp for another 5 min at intervals of 30 sec.

Calculation: Determination of enthalpy of neutralisation of strong acid and strong base.

$$\begin{aligned} Q &= m(t_f - t_i) + c(t_f - t_i) \\ &= 200(46.5 - 31.45) + 38.71(46.5 - 31.45) \\ &= 200(15.05) + 38.71(15.05) \\ &= 3010 + 582.58 \\ &= 3592.58 \text{ cal/mol} \\ &= 24 \end{aligned}$$

Temp. ($^{\circ}\text{C}$) \uparrow

47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29

46.8°C t_2

$t_1 = 33^{\circ}\text{C}$

$$t^* = \frac{t_0 + t_1}{2} = 31.45^{\circ}\text{C}$$

$t_0 = 29.9^{\circ}\text{C}$

0.5 1.5 2.5 3.5 4.5 5.5 6.5 7.5 8.5 9.5
1 2 3 4 5 6 7 8 9 10

Time (min.) \rightarrow

Calculus of neutralizing
4 strong acid & strong
base

On y-axis $\text{cm} \times 1^{\circ}$
On x-axis $\text{cm} \times 1 \text{ min}$

Enthalpy :

$$\Delta H = \frac{Q}{m \times V (\text{in L})} = \frac{Q}{0.1}$$

$$\begin{aligned}\Delta H &= 1.90 \times Q \quad 2) \\ &= 1.90 \times 3592.58 \\ &= -35925.8 \text{ cal/mol}\end{aligned}$$

Result:

The heat capacity of calorimeter is $+38.71 \text{ cal/}^\circ\text{C}$
and enthalpy of neutralization of strong
acid and strong base is -35.92 k cal/mol
(exothermic) ✓

Vandana
27/6/2022

Aim: To prepare 2,4,6-tribromoderivative of phenol and determine its mp and percentage yield.

Material Required:

Phenol = 1ml

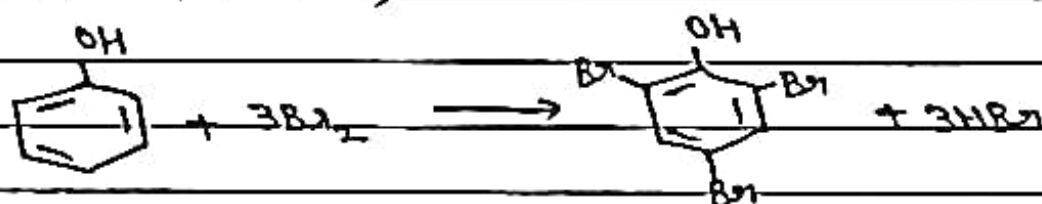
Bromine =

Water = 50ml

Theory:

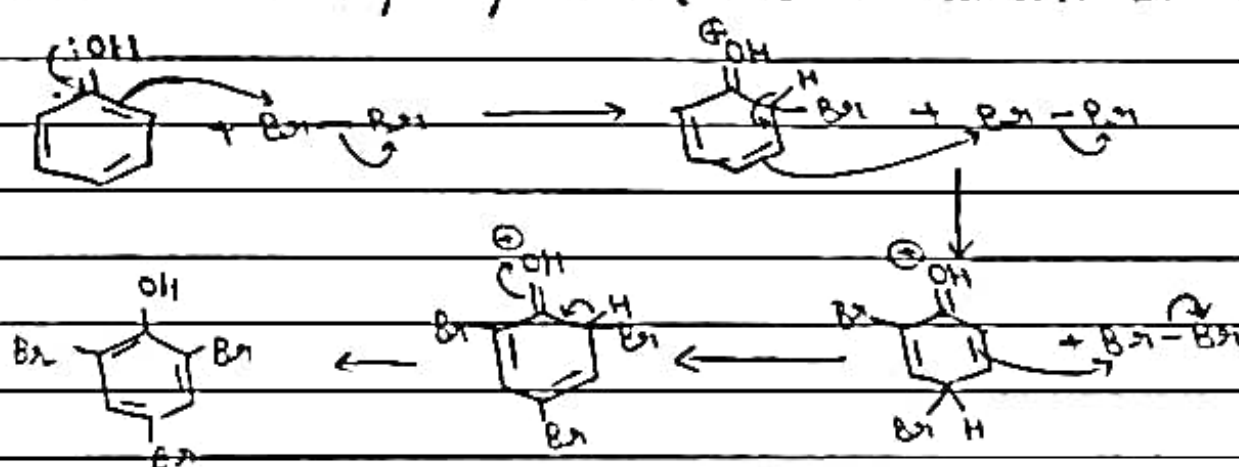
2,4,6-Tribromophenol is obtained by bromination of phenol with an aq solution of bromine.

Reaction involved,



Mechanism:

The -OH group is an electron donating, ortho-para directing group. Hence bromination takes place in both o- and p- positions. The mechanism is as follows.



Teacher's Signature : _____

Calculation of % yield:

Starting compound = Phenol = C_6H_6O : MW = 94 g

Product = 2,4,6-tribromophenol = $C_6H_3OBr_3$: MW = 331 g

94 g of phenol gives 331 g of 2,4,6-tribromophenol.

\therefore 1 g of phenol gives $\frac{331}{94} \times 1 = 3.5$ g of 2,4,6-tribromophenol

$$\% \text{ yield} = \frac{\text{observed yield}}{\text{calculated yield}} \times 100$$

$$\text{observed yield} = 1.4 \text{ g}$$

$$\text{calculated yield} = 3.5$$

$$\begin{aligned} \% \text{ yield} &= \frac{1.4}{3.5} \times 100 \\ &= 40\% \end{aligned}$$

Procedure:

In a stoppered conical flask we took 1 ml of phenol and added 50 ml of water. After this we added dropwise solution of bromine (2 ml in 20 ml of H_2O) in a fumes hood with continuous stirring till we obtained a white ppt of 2,4,6-tribromophenol [in case if we get yellow ppt which indicates excess of bromine, added a pinch of $NaHSO_3$ to the mixture to oxidise excess of bromine - ppt would become white after adding $NaHSO_3$]. Added ~ 50 g of crushed ice and ~ 20 ml of cold water. Filtered the ppt obtained and washed thoroughly with cold water so that there is no smell of either phenol or bromine. Dried the ppt with the help of filter paper. Recorded its % yield and recrystallised some of it in alcohol. Dato At least determined the melting point of the recrystallised sample.

Result:

The % yield of 2,4,6-tribromophenol = 90%.

MP of 2,4,6-tribromophenol =