Mon. 18th. 09. 2023

HEAT: CALORIMETRY AND VAPOURS

Guiding questions for the topic.

1.a) What is heat?
What is temperature?
b) What are the S.I units of
i) heat
ii temperature?
c) ~~What does~~ How does heat flow?
d) i) How is temperature measured?
ii) How is heat measured?

2.a) Suzan has the same amounts of water and of alcohol in two different but identical saucepans. She wishes to heat each of them on different but identical sources of heat.
i) of the water and the alcohol, which one will quickly get hot before the other.
ii) Explain your answer in (i) above.
b) Define the terms
i) Heat capacity ("C")
ii) Specific heat capacity ("c")
c) Give the S.I units of
i) Heat capacity
ii) Specific heat capacity
d) Workout various calculations using S.H.C and heat capacity.
e) Describe experiments by the method of mixtures to determine the specific heat capacity of a;
i) Solid
ii) liquid
f) State the assumptions in each experiments above.
g) Discuss the applications of the high specific heat capacity of water.

3.a) Write down some of the major effects of heat on matter.
b) Define the following terms, i) Latent heat
ii) Latent heat of fusion

iii) Latent heat of vapourisation.
iv) Specific latent heat (L)
v) Specific latent heat of fusion (L_f)
vi) Specific latent heat of vapourisation (L_v)

c) State the S.I units of specific latent heat of fusion of vapourisation.
d) Why does steam from boiling water cause more burning to the skin than the boiling water itself.
e) When steam of mass M_s condenses to water when it comes into contact with any other substance the temperature of the substance rises from θ_1 to θ_2. Write an expression for the heat lost by steam.

4(a) Distinguish between melting and freezing.
b) What is (i) Melting point? (ii) freezing point?
c) Define the following terms:
i) a vapour
ii) a saturated vapour
iii) Vapour pressure (V.P)
iv Saturated Vapour pressure (S.V.P)
d) What is boiling and boiling point?
e) What are the factors that affect the boiling point of a liquid.
f) Draw a warming curve for water from -10°c until it boils. Explain the graph.
f) Give the differences between boiling and evaporation.
g i) Write the factors that affect the rate of evaporation.
ii) State one major effect of evaporation.
iii) Explain why evaporation causes cooling.
iv) Describe one major application of cooling by evaporation

5(a) Explain why the boiling point of a liquid depends on altitude.
b) Explain why cooking food on a high mountain takes longer than at sea level.

c) Why is it that boiling at a high mountain starts earlier than at sea level or why water can boil below 100°C when on a high mountain.

d) Explain why cooking using a pressure cooker saves time and fuel.

6.a) How does perspiring maintain a constant temperature in mammals.

b) Why does land heat up at a different rate than water during day?

Solutions

1.a) Heat is the form of energy which flows from one point to another due to temperature difference between the two points.

a) Temperature is the degree of hotness or coldness of an object. Temperature is the average kinetic energy of molecules in a body or substance.

b)i) Heat → Joules
Temperature → Kelvin

c) Heat flows from a region of high temperature to a region of low temperature ~~and~~ by the conduction or convection or radiation.

d)i) Temperature is measured by a thermometer on the basis of physical property which changes with temperature.

ii) Heat is measured using an instrument called a calorimeter.

2.aii) The amount of heat needed to raise the temperature of alcohol by 1k or 1°C is lower than that needed by water i.e alcohol has a lower heat capacity, C or specific heat capacity than water.

2.a.i) Alcohol

b) HEAT CAPACITY (C)
Is the amount of heat required to raise the temperature of a substance by 1kelvin or 1°C

If H is the amount of heat; then;

$$H = C\Delta\theta \text{ or } H = C\theta$$

where $\Delta\theta$ or θ is temperature change $\theta_2 - \theta_1$.

From $H = C\Delta\theta$

$$\frac{H}{\Delta\theta} = C$$

$$C = \frac{H \text{ in joules}}{\Delta\theta \text{ in kelvins}}$$

So, the S.I units of heat capacity C are joules per Kelvin (JK^{-1})

NB: When we talk about temperature change, the value is always the same in K or °C.

E.g If a body is heated from 25°C to 29°C

$\Delta\theta = 29°C - 25°C = 4°C$

$25°C \longrightarrow K$

$T = 25 + 273 = 298K$

$29°C \longrightarrow K$

$T = 29 + 273 = 302K$

So, in kelvins; $\Delta\theta = 302 - 298 = 4k$

Further explanation; If the temperature of a body is 4°C, then that body has a temperature of $4 + 273 = 277K$.

But if the temperature of a body changed by 4°C; then that change in temperature is also 4k.

SPECIFIC HEAT CAPACITY ("c")

Is the amount of heat required to raise the temperature of a 1kg mass of a substance by 1kelvin.

If H is the amount of heat energy;

Then $H = mc\Delta\theta$ or $H = mc\theta$

where m is the mass of the substance in kg, small c is the specific heat capacity, and θ or $\Delta\theta$ is the change in temperature in kelvins or °C

So; from $H = mc\Delta\theta$

$$\frac{H}{m\Delta\theta} = c$$

S·I units of S·H·C

$$c = \frac{J}{Kg\,K}$$

So, the S·I units of S·H·C is joules per kilogram per kelvin ($J \cdot Kg^{-1} K^{-1}$)

Examples; Iron is heat from 26°C to 60°C. Calculate the amount of heat absorbed if its heat capacity is $200\,JK^{-1}$

$H = C\Delta\theta$

$\Delta\theta$

$60°C - 26°C$

$34°C$

$C = 200\,JK^{-1}$

$H = (200 \times 34)\,J$

$H = 6800\,J$

2. Calculate the amount of heat require to raise the temperature of 500g of Iron from 26°C to 60°C if the specific heat capacity of iron $450\,Jkg^{-1}K^{-1}$

$H = C\Delta\theta$

$\Delta\theta = 60°C - 26°C$

$= 34°C$

$C = 500g$

$1kg = 1000g$

$1g = \frac{1}{1000}g$

$500g = \left(\frac{1}{1000} \times 500\right) Kg$

$= 0.5\,kg$

SHC $= 450$

$= (450 \times 0.5 \times 34)\,J$

$= 7650\,J$

RELATION BETWEEN C and c

$H = C\Delta\theta$

$H = mc\Delta\theta$

$\therefore C\Delta\theta = mc\Delta\theta$

$\frac{C\cancel{\Delta\theta}}{\cancel{\Delta\theta}} = \frac{mc\cancel{\Delta\theta}}{\cancel{\Delta\theta}}$

$\boxed{C = mc}$

3. A block of iron of mass of 2kg absorbs 19KJ of heat and its temperature rises by 10°C. Find the S.H.C of iron. Calculate also the heat capacity of iron.
4. Two materials P and Q have specific heat capacities of $450\,Jkg^{-1}K^{-1}$ and $900\,Jkg^{-1}K^{-1}$ respectively. Which one of them is a better conductor of heat and explain why.

Answers

3. $H = mc\Delta\theta$

19KJ To J

$1KJ = 1000J$

$19KJ = (19 \times 1000)J$

$= 19000J$

10°c to K

$(10 + 273)K$

$283K$

S.H.C

$19000 = 2 \times c \times 283$

$19000 = 2c \times 283$

$\frac{19000}{566} = \frac{566c}{566}$

$33.569 = c$

$\therefore c = 33.569\,Jkg^{-1}K^{-1}$

Heat capacity

$C = \frac{H}{\Delta\theta}$

$= \frac{1900}{283}$

$C = 67.138\,JK^{-1}$

$19000 = 2 \times c \times 10$

$\frac{19000}{20} = \frac{20c}{20}$

$950\,Jkg^{-1}K^{-1} = c$

Heat capacity

$C = \frac{H}{\Delta\theta}$

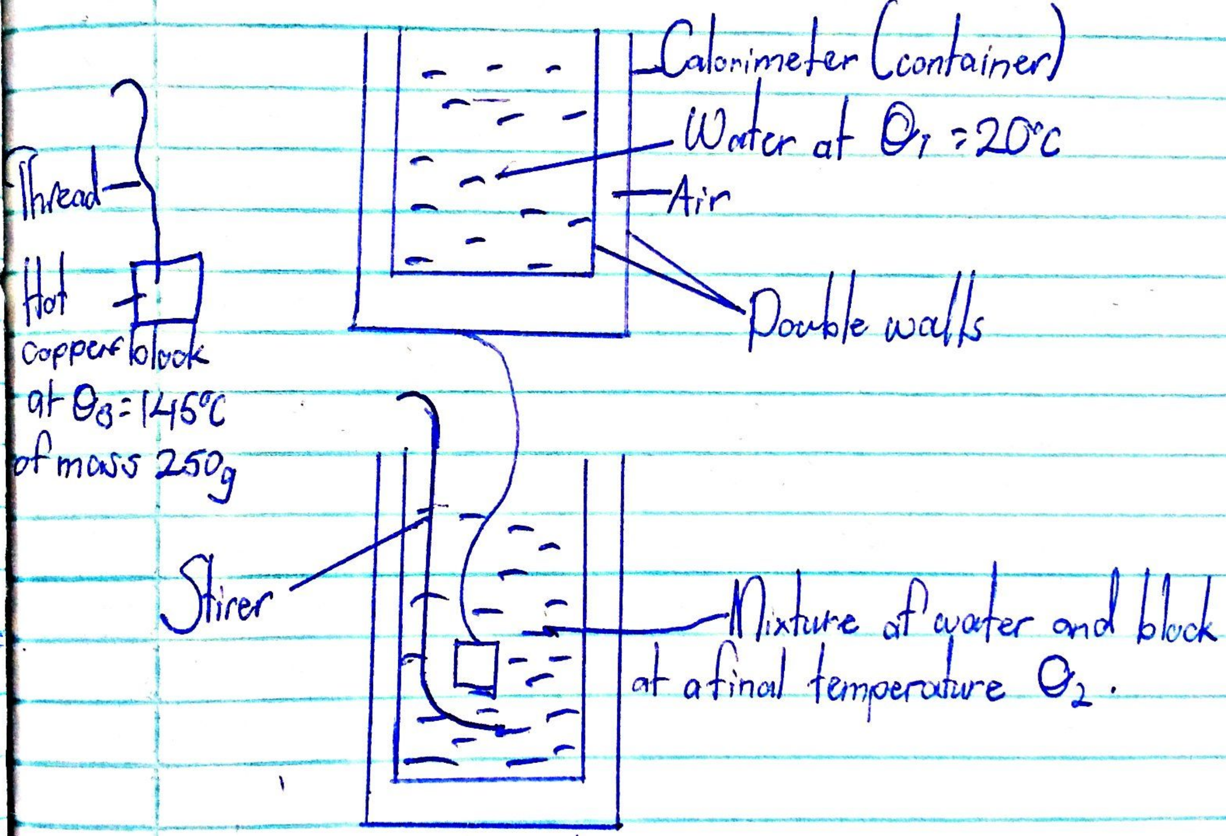
$= \frac{19000}{10}$

$= 1900\,JK^{-1}$

4. P is a better conductor of heat.
Because P has a lower specific heat capacity therefore it can easily or quickly become hot when heated. i.e it needs less heat to raise its temperature.

Thur. 28th. 09. 2023

Qn A copper block of mass 250g is heated to a temperature of 145°C and then dropped into a copper calorimeter (container) of mass 200g containing 250g of water at 20°C. Calculate the maximum temperature attained by the water. (S.HC of water is $4200 JKg^{-1}K^{-1}$ and of copper is $400 JKg^{-1}K^{-1}$)



$$\underset{\text{Hot block}}{\theta_3} \xrightarrow{\text{Cools}} \underset{\text{mixture}}{\theta_2} \xleftarrow{\text{Heats up}} \underset{\text{Cool water and its container}}{\theta_1}$$

$M_b = 250g = \left(\frac{250}{1000}\right)kg = \underline{0.25kg}$

$M_c = \left(\frac{200}{1000}\right)kg = 0.2kg$

$M_w = \left(\frac{250}{1000}\right)kg = \underline{0.25kg}$

Heat lost by the hot block to θ_2 = Heat gained by the water + Heat gained by the calorimeter

$M_b C_b(\theta_3-\theta_2) = M_w C_w(\theta_2-\theta_1) + M_c C_c(\theta_2-\theta_1)$

$0.25 \times 400 \times (145-\theta_2) = 0.25 \times 4200 \times (\theta_2-20) + 0.2 \times 400 \times (\theta_2-20)$

$100(145-\theta_2) = 1050(\theta_2-20) + 80(\theta_2-20)$

$14500 - 100\theta_2 = 1050\theta_2 - 21{,}000 + 80\theta_2 - 1600$

$14500 + 21{,}000 + 1{,}600 = 1050\theta_2 + 100\theta_2 + 80\theta_2$

$\frac{37{,}100}{1230} = \frac{1230\theta_2}{1230}$

$30.2°C = \theta_2$

Qn; A copper block of heat capacity $100\,JK^{-1}$ is heated to 140°C and then dropped into a kettle of specific heat capacity $400\,JKg^{-1}k^{-1}$ containing 250g of water. If the final maximum temperature of water is 32°C and the specific heat capacity of water is $4200\,JKg^{-1}k^{-1}$, what was the initial temperature of water

$\underset{(140°C)}{\theta_3} \longrightarrow \underset{(32°C)}{\theta_2} \longleftarrow \underset{(??)}{\theta_1}$ (water + kettle)

$H = C\Delta\theta$ and $H = mc\Delta\theta$

Heat lost by the hot block = Heat gained by the water + Heat gained by the Calorimeter.

$C_b(\theta_3-\theta_2) = m_w C_w(\theta_2-\theta_1) + M_k C_k(\theta_2-\theta_1)$

$100(140-32) = 0.25 \times 4200(32-\theta_1) + 0.25 \times 400 \times (32-\theta_1)$

$14{,}000 - 3{,}200 = 1{,}050(32-\theta_1) + 100(32-\theta_1)$

$10{,}800 = 33{,}600 - 1050\theta_1 + 3200 - 100\theta_1$

$10{,}800 - (33{,}600 + 3200) = -1050\theta_1 - 100\theta_1$

$10{,}800 - 36{,}800 = -1150\theta_1$

$\frac{-26{,}000}{-1{,}150} = \frac{-1{,}150\theta_1}{-1{,}150}$

$22.6°C = \theta_1$

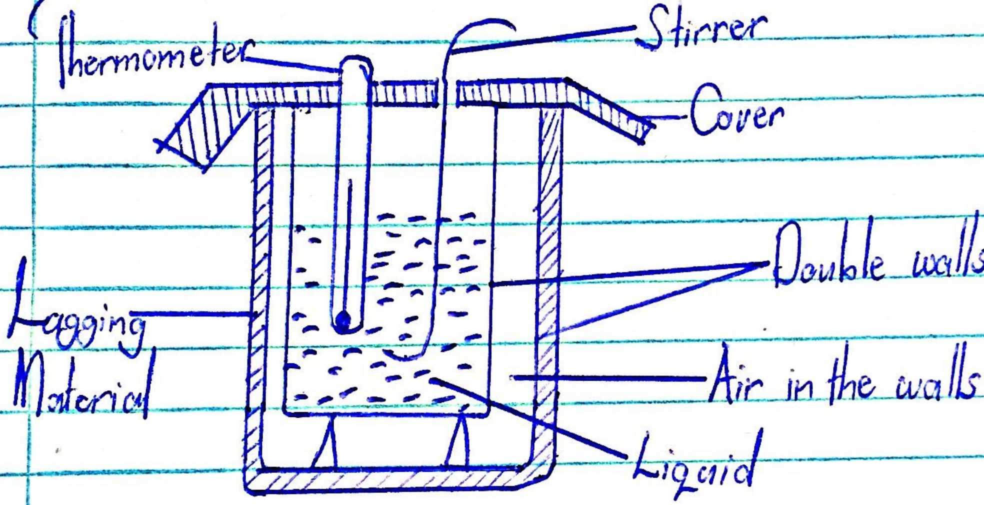
Mon. 2nd October. 2023.

A CALORIMETER

This is a good conductor container inform of a cup used in heat experiments such as determining the specific heat capacity of substances.

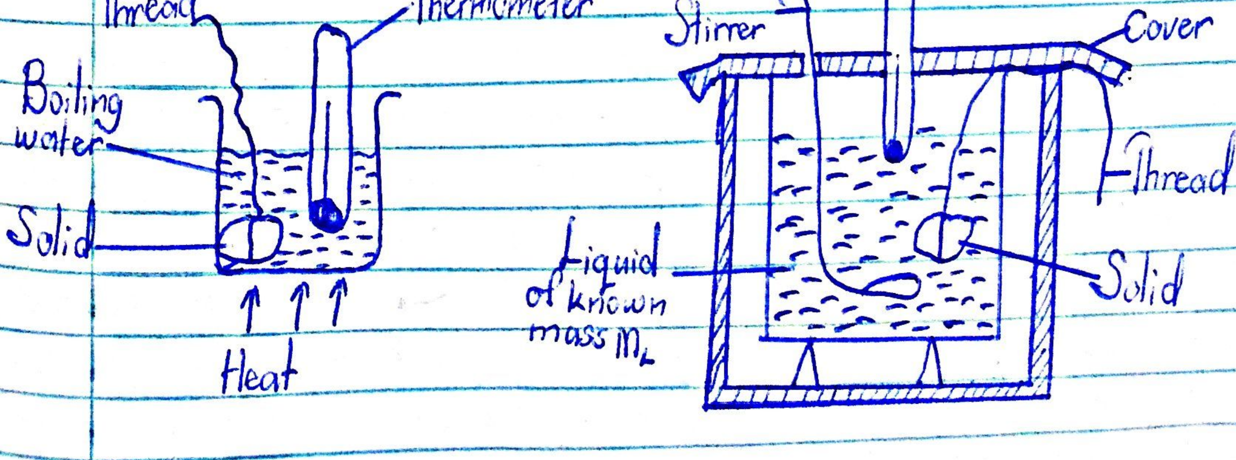
LAGGING: This is the covering of a good conductor of heat with an insulating material to minimise heat losses to the surrounding.

NB: A calorimeter is normally a double walled copper vessel and is normally lagged with a cover which has two holes one for a thermometer and another for a stirrer.



AN EXPERIMENT TO MEASURE THE SPECIFIC HEAT CAPACITY (C_s) OF A SOLID BY THE METHOD OF MIXTURES:

NB: The method of mixture is suitable for poor heat conducting solids like rubber, glass, ebonite



A Liquid of known mass M_L and known specific heat capacity C_L is poured in a lagged calorimeter of mass M_c and specific heat capacity C_c.

A stirrer and a thermometer are inserted in the liquid and the initial temperature θ_1 of the liquid is measured and recorded.

A solid of known mass M_s whose specific heat capacity C_s is required is first heated in boiling water to a higher temperature θ_3 which is equal to 100°C

The solid is then quickly transfered into the liquid in the calorimeter which is then covered.

The mixture is stirred continuously until its temperature reaches a steady value θ_2 read from the thermometer and recorded.

The specific heat capacity C_s of the solid is calculated as follows;

Heat lost by the hot Solid from θ_3 to θ_2 = Heat gained by the liquid by θ_1 to θ_2 + Heat gained by the calorimeter from θ_1 to θ_2

$$M_s C_s (\theta_3 - \theta_2) = M_L C_L (\theta_2 - \theta_1) + M_c M_c (\theta_2 - \theta_1)$$

$$C_s = \frac{M_L C_L (\theta_2 - \theta_1) + M_c C_c (\theta_2 - \theta_1)}{M_s (\theta_3 - \theta_2)}$$

Assumptions

- The heat gained by the thermometer and the stirrer are negligible.
- No heat is lost to the surrounding

NB; The word negligible means so small or so little that it can be neglected or ignored.

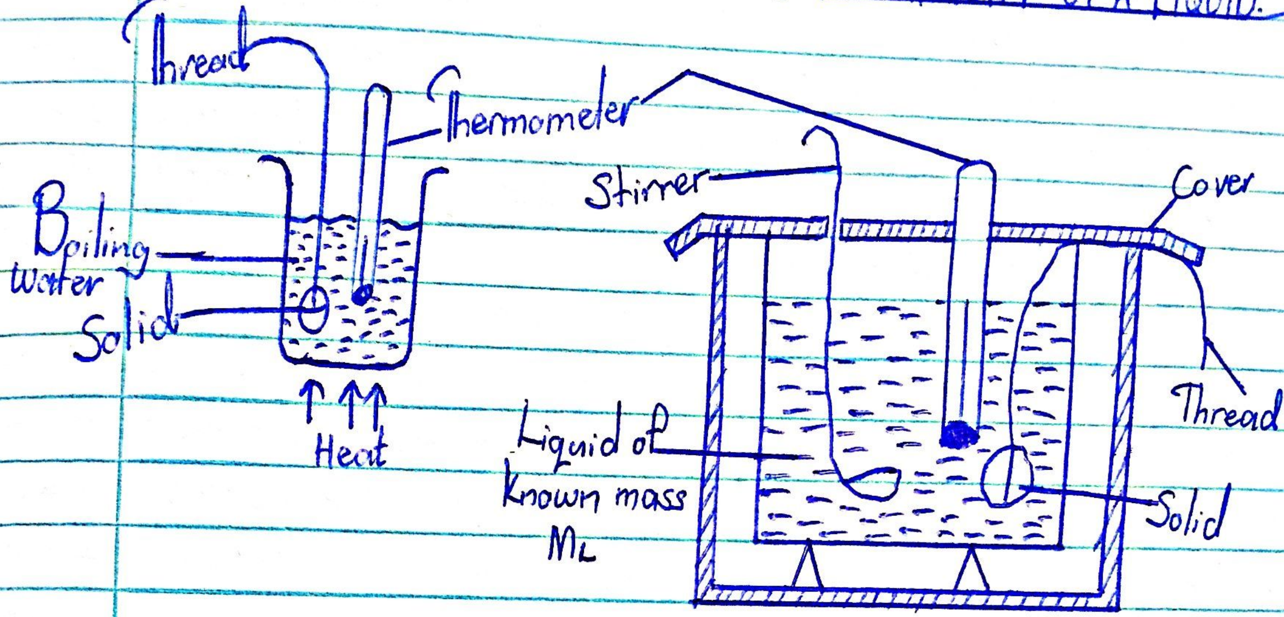
Precautions in the experiment so as to minimise heat losses;

i) The calorimeter should be lagged to prevent heat losses.

ii) The hot solid should be quickly transferred into the calorimeter to minimise heat loss.

iii) The top of the calorimeter should be covered.
iv) The mixture should be stirred thoroughly and continously to ensure a uniform heat distribution.

DETERMINATION OF SPECIFIC HEAT CAPACITY OF A LIQUID.



A liquid of mass M_L and unknown specific heat capacity C_L is poured in a lagged calorimeter of mass M_c and specific heat capacity C_c.

A stirrer and a thermometer are inserted in the liquid and the intial temperature θ_1 is read and recorded.

A solid of mass M_s and known specific heat capacity C_s is heated in boiling water to higher temperature θ_3 which is equal to 100°C.

The solid is then quickly transfered into the liquid and the calorimeter is covered.

The mixture is stirred continuously until a steady temperature θ_2 is recorded.

The specific heat capacity of the solid is calculated as follows;

Heat lost by hot solid = Heat gained by liquid + Heat gained by calorimeter.

$$M_sC_s(\theta_3-\theta_1) = M_LC_L(\theta_2-\theta_1) + M_cC_c(\theta_2-\theta_1)$$

$$M_sC_s(\theta_3-\theta_2) - M_cC_c(\theta_2-\theta_1) = M_LC_L(\theta_2-\theta_1)$$

$$\frac{M_sC_s(\theta_3-\theta_1) - M_cC_c(\theta_2-\theta_1)}{M_L(\theta_2-\theta_1)} = C_L$$

NB; The assumption and precautions are the same as in the previous experiment.

IMPORTANCE OF LIQUIDS WITH HIGH SPECIFIC HEAT CAPACITIES SUCH AS WATER:-

- They are used as coolants of hot systems like car engines and X-ray tubes.

This is because the higher the specific heat capacity of a substance, the more heat it can absorb from a hot system to raise the temperature of that substance just by 1kelvin or 1°c.

Qn; The specific heat capacity of water is 4200J $Kg^{-1}K^{-1}$. what does the statement mean.

> It means that 1 kg of water require 4200joules of heat energy to raise its temperature by 1 kelvin or by 1°c

OR: It means that 1kg of water loses 4200joules of heat energy to lower its temperature by 1kg or 1°C.

LATENT HEAT

- The word latent means hidden or dormant.
- During change of state, the temperature of a substance neither increases nor decreases but remains constant
- So, when a substance is being heated and it starts changing state, the thermometer stops showing temperature change. The heat being supplied is not indicated by the thermometer, hence it is hidden. The heat is used in changing state by breaking bonds.

Define the following;
i) Latent heat
ii) Specific latent heat
iii) Latent heat of vapourisation
iv) Specific latent heat of vapourisation
v) latent heat of fusion
vi) Specific latent heat of fusion.

Answers

i) Latent heat - Is the amount of heat required to change state of a substance at a constant temperature.

Examples of changes of state during latent heat.
- Melting of ice at 0°C.
- Water evaporating at 100°C.

ii) Specific latent heat - Is the amount of heat required to change the state of a substance of 1Kg mass at a constant temperature.

iii) Latent heat of vapourisation - Is the amount of heat required to change a liquid to gas at a constant temperature.

iv) Specific latent heat of vapourisation - Is the amount of heat required to change 1kg of a liquid to a vapour gas/vapour (SLv).

v) Latent heat of fusion - Is the amount of heat required to change a solid to liquid at a constant temperature.

vi) Specific latent heat of fussion (Lf) - Is the amount of heat required to change 1kg of a solid to liquid at a constant temperature.

Note; During melting, a solid turns in to liquid. The heat absorbed is used to weaken the intermolecular forces, this increases the separation of molecules by a small volume.
The temperature remains constant until all the ice has melted.

$$H = MLf \ (JKg^{-1})$$

H = Heat supplied (absorbed)
m = mass of the substance melting
Lf = specific latent heat of fusion

Why specific latent heat of vapourisation is greater than the specific latent heat of fusion.

During latent heat of vapourisation, the heat supplied is used to rise temperature of the liquid to it's boiling point and give a surface molecules kinetic energy to escape however during latent heat of fusion, the heat supplied weakened the intermolecular forces.

NB; The following are common values used in heat;
i) The S.H.C of water is $4200 J Kg^{-1}K^{-1}$.
ii) The S.H.C of copper is $400 JKg^{-1}k^{-1}$.
iii) The specific latent Heat of vapourisation of water is $l_v = 2,260,000 \ J Kg^{-1}$.
The specific latent Heat of fusion of ice is 336,000 or $3.36 \times 10^5 JKg^{-1}$.
The four formulae used in Heat calculation under quantity of Heat are;

(i) $H = C\Delta\theta$
(ii) $H = mc\Delta\theta$
(iii) $H = ML_v$
(iv) $H = ML_f$

Qn. Explain why steam from boiling water causes more harm to the skin than the water itself boiling at 100°C.

When ~~heat~~ steam comes into contact with the skin, it first loses latent heat to the skin which

The water formed from steam is also as hot at 100°C as the boiling ~~p~~ water. This causes another skin burn as hot water loses heat

Mon. 16th. 10. 2023

1. How much heat is required to melt 20g of ice at 0°C given that the specific latent heat of fusion is 3.34×10^5 J/Kg

$H = mL_f$ But $m = 20g = \frac{20}{1000}$ kg

$= \frac{20}{1000} \times 3.34 \times 10^5$

$= \frac{20}{1000} \times 334000$

$= \underline{6680J}$

2. How much heat is required to change 20g of ice at -10°C to water given that the specific heat capacity of ice is 2100 J/KgK^{-1} and the specific latent heat of fusion is $3.34 \times 10^5 J Kg^{-1}$? Sketch the graph for the temperature change with time

H = Heat to raise temperature from -10°C to 0°C + Heat to melt ice at 0°C

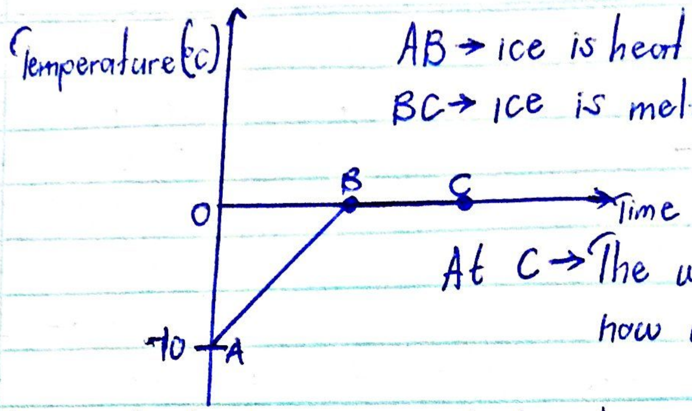
$= M_i C_i (0 - -10) + M_i L_f$

$= \left(\frac{20}{1000} \times 2100 \times 10\right) + \left(\frac{20}{1000} \times 334000\right)$

$= 420 + 6680$

$= \underline{7100 J}$

Scale



AB → ice is heat up to 0°C
BC → ice is melting at 0°C.

At C → The whole ice is now water.

3. How much heat is required to change 20g of ice at -10°c to water at 60°c given that the specific heat capacity of ice is $2100 JKg^{-1}K^{-1}$, the specific latent heat of fusion of ice is 3.34×10^5 JKg^{-1} and the specific heat capacity of water is $4200 JKg^{-1}K^{-1}$? Sketch a graph for the temperature change with Time

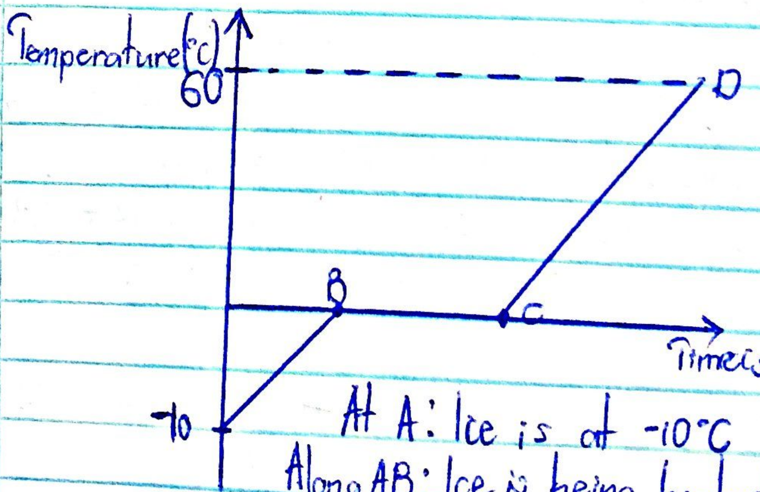
H = Heat to raise temperature from -10°c to 0°c + Heat to melt ice at 0°c + Heat to warm water from 0°c to 60°c

$= m_i c_i (0 - -10) + m_i L_f + m_i c_w (60 - 0)$

$= \frac{20}{1000} \times 2100 \times 10 + \frac{20}{1000} \times 334000 + \frac{20}{1000} \times 4200 \times 60$

$= 420 + 6680 + 5040$

$= \underline{12140 J}$



At A: Ice is at -10°C
Along AB: Ice is being heated upto 0°C.
AB; Ice is at 0°C starting to melt.
BC: Ice is change to liquid (water).
At C; It is water at 0°c.
CD; Water is being heated upto 60°C
At D; Warm water at 60°c.

4 i) How much heat ~~is~~ must be removed from 20g of water to change it to ice at -5°C given that the specific heat capacity of water 4200 $JKg^{-1}K^{-1}$, the specific latent heat of fusion of ice is $3.34 \times 10^5 JKg^{-1}$ and the specific heat capacity of ice is 2100 $JKg^{-1}K^{-1}$.
ii) Sketch a cooling curve for the above process.
iii) Distinguish between a cooling curve and a warming curve

Solution

20g of water at 60°C $\xrightarrow{to}$ Ice at -5°C
Step I: water cools to 0°C.
Step II: water turns to ice (freezes) at 0°C.
Step III: Ice cools to -5°C.

Heat lost (removed) = Heat lost in cooling water + Heat lost during freezing + Heat lost in cooling ice

$= mc_w\Delta\theta + ml_f + mc_i\Delta\theta$

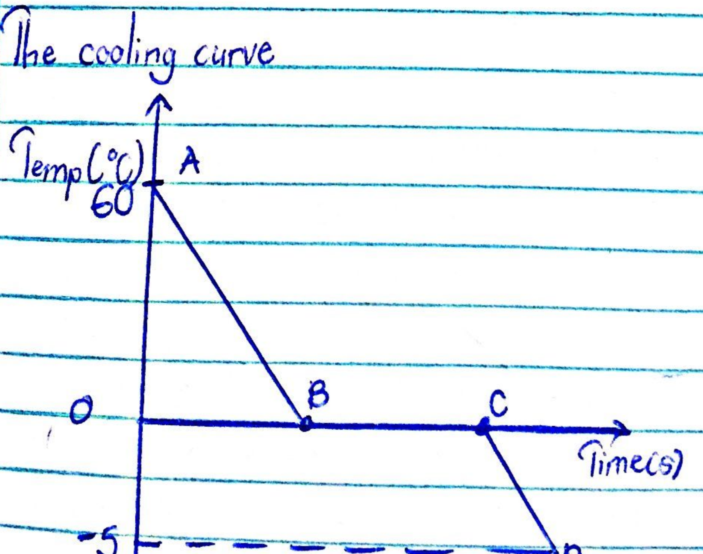
$= \frac{2\cancel{0}}{1\cancel{000}} \times 42\cancel{00} \times (60-0) + \frac{20}{1\cancel{000}} \times 334\cancel{000} + \frac{2\cancel{0}}{1\cancel{000}} \times 21\cancel{00} \times (0--5)$

$= 84 \times 60 + 6680 + 42 \times 5$

$= 5040 + 6680 + 210$

$= 11930 J$

ii) The cooling curve



iii A warming curve is a graph of rising temperature of a substance with time.
A cooling curve is a graph of decreasing temperature of a substance with time.

5. How much heat is required to change 15g of ice at −8°C to steam given that the specific capacity of water is $4200 JKg^{-1}K^{-1}$, the specific latent heat of fusion of ice is $3.34\times10^{5} J kg^{-1}$ and the specific heat capacity of Ice is $2100 JKg^{-1}K^{-1}$ and the specific latent heat of vaporisation is $2,260,000 Jkg^{-1}$? Sketch a warming curve for the process.

15g of ice at −8°C $\xrightarrow{to}$ Steam (100°C)

Step I; Ice warms to 0°C
Step II; Ice melts to 0°C
Step III; Water warms to 100°C
Step IV; Water evaporates to steam at 100°C

Heat required = Heat required to warm ice to 0°C + Heat required to melt ice + Heat required to rise water to 100°C + Heat required to change water to steam

$= m c_i \Delta\theta + mL_f + m$

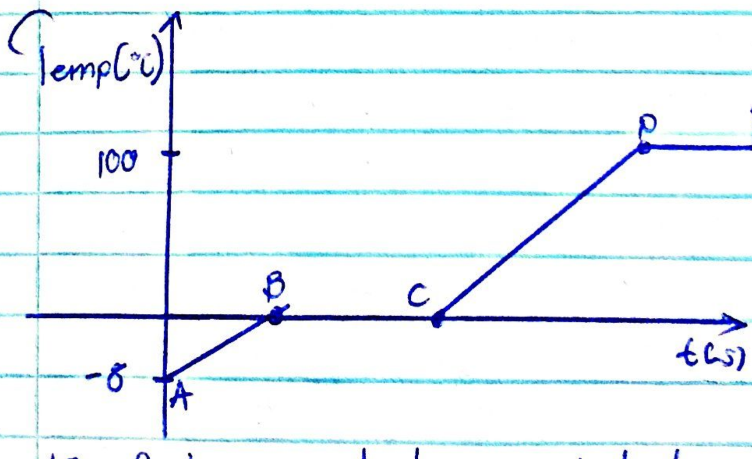
$= m c_i \Delta\theta + mL_f + m c_w \Delta\theta + mL_v$

$= \frac{15}{1000}\times 2100(0-^-8) + \frac{15}{1000}\times 334000 + \frac{15}{1000}\times 4200(100-0) + \frac{15}{1000}\times 2260000$

$= 15\times21\times8 + 15\times334 + 15\times42\times100 + 15\times2260$

$= 252 + 5010 + 6300 + 33900$

$= \underline{\underline{45462 J}}$



1. 10g of steam are to be converted to ice at −5°C. Using the usual constants, calculate the amount of heat required to be absorbed from the steam. Sketch the cooling curve for the whole process.
2. A copper container of heat capacity $60 JK^{-1}$ contains 0.5kg of water at 20°C. Dry steam is passed into the water until the

temperature of the container reaches 50°C. calculate the mass of steam condensed given that the specific heat capacity is $4200\,JKg^{-1}K^{-1}$ and the specific latent heat of vapourisation of water is $2260000\,JKg^{-1}$.

3. During day the sun hits both the water in the lake and the land surrounding the lake. Which of the two will be hotter and explain why.

ii) Distinguish between a sea breeze and a land breeze and explain the occurance of each

iii) What is a breeze?

Solutions

~~0-100~~
~~100-0~~

1. 10g of steam at 100°c $\xrightarrow{\text{to}}$ ice(-5°C)

~~Heat lost required~~ = ~~Heat lost in cooling steam~~
Heat required to = Heat required

Step I; Condensing of steam to water
Step II; Cooling of water from 100°C to 0°C
Step III; freezing of water to ice at 0°C
Step IV; Cooling ice to -5°C.

Heat lost = Heat lost in condensing steam + Heat lost in cooling water to 0°C + Heat lost in freezing + Heat lost in cooling ice.

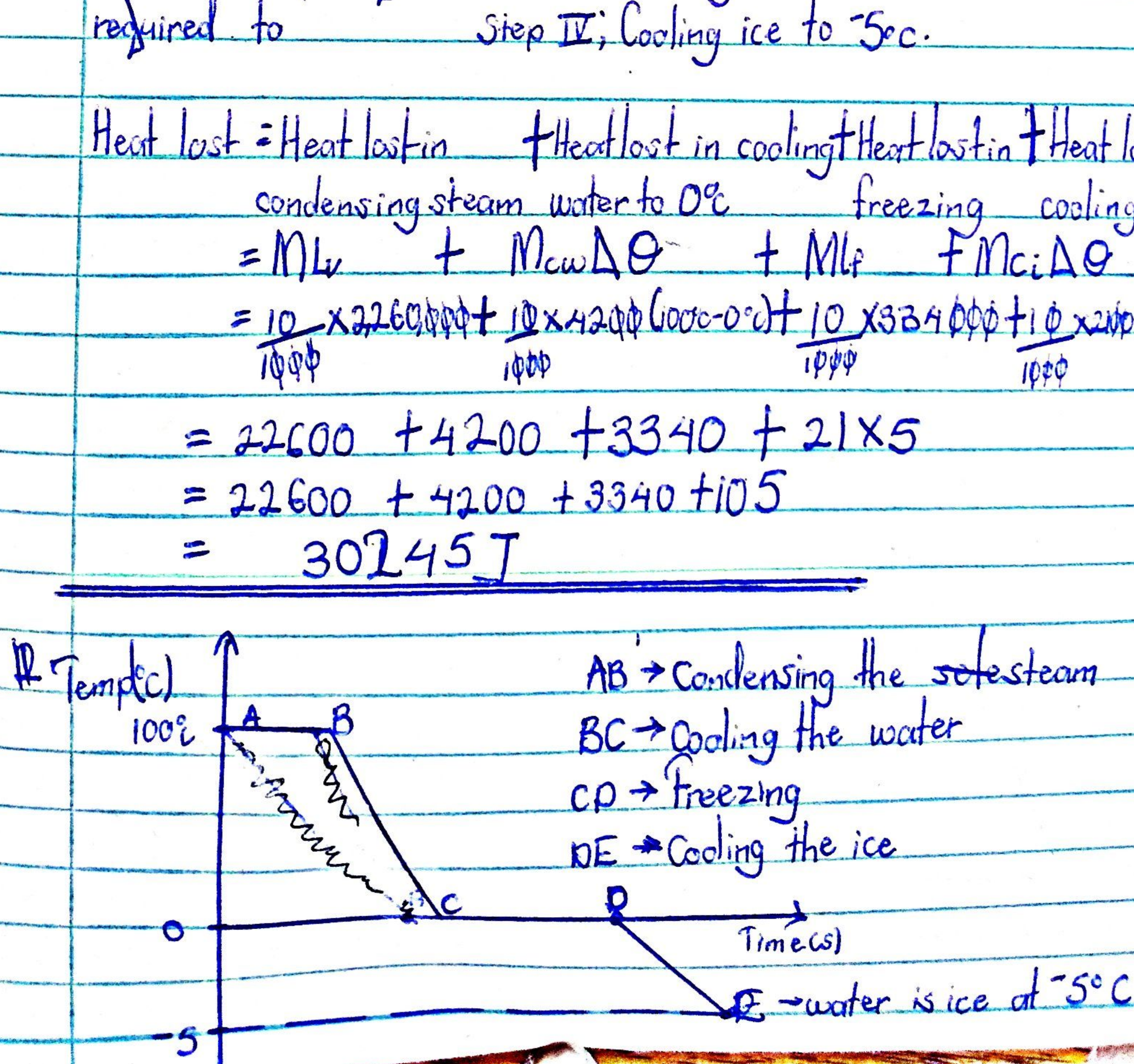
$= ML_v + Mc_w\Delta\theta + ML_f + Mc_i\Delta\theta$

$= \frac{10}{1000} \times 2260000 + \frac{10}{1000} \times 4200(100-0) + \frac{10}{1000} \times 334000 + \frac{10}{1000} \times 2100(0-5)$

$= 22600 + 4200 + 3340 + 21 \times 5$

$= 22600 + 4200 + 3340 + 105$

$= 30245\,J$



Water (0.5kg at 20°c) $\longrightarrow$ Water at 50°c $\longleftarrow$ Water 100°c $\longleftarrow$ Steam at 100
θ_1 θ_2

Heat lost by + Heat lost by = Heat gained by + Heat gained by the
Steam condensed H_2O water in a container container

$Ml + Mc\Delta\theta = Mc\Delta\theta + C\Delta\theta$

$M(2,260,000) + 4200(100-50) = 0.5 \times 4200(50-20) + 60(50-20)$

$M(2,264,200 \times 50) = 2100(30) + 60 \times 30$

$2,470,000M = 64,800$

$\frac{2,470,000m}{2,470,000} = \frac{64,800}{2,470,000}$

$M = 0.03Kg$

3 i)

EVAPORATION

Mon-23rd-Oct-2023.

This is the escape of molecules of aliquid from its surface to form vapour.

Is a process by which a liquid changes to gas or vapour at any temperature above absolute zero temperature.

So evaporation occurs only at a surface of a liquid.

Evaporation occurs at any temperature so long as it is above the absolute Zero temperature.

Absolute Zero temperature is the temperature at which molecules of a substance stop moving. i.e when they have zero Kinetic energy.

The value of absolute zero temperature is zero K.

Factors affecting the rate of evaporation

> Surface area of the liquid

The bigger the surface area, the higher the rate of evaporation.

> Temperature of the liquid.

The liquid at a higher temperature evaporates at a high rate and the liquid at a lower temperature evaporates at a lower rate.

> Presence of blowing wind

When their is wind blowing, the rate of evaporation is high

> Humidity

When there is a high humidity in the atmosphere, the rate of evaporation is low and vice versa.

Effects of evaporation

Causes cooling of the body

Results into reduction of volume of a liquid.

A VOLATILE LIQUID

Is a liquid which evaporates faster or easily. Such a liquid has a very low boiling point.

Examples of volatile liquids

- Ethanol
- Methylated liquid
- Ether

Applications of evaporation

» It is applied in a refrigderator to cool substances.
» It causes wet ~~co~~ clothes to dry in the absence of sunlight.
» It is used in the cooling of hot food.

Relationship between the Kinetic energy of molecules of a substance and its absolute temperatures.

Thur 26th. 10. 2023

Molecules of a substance and their Kinetic energy;

The average kinetic energy of molecules of a substance is proportional to the absolute temperature of the substance.
So, the molecules of a substance more energetic when their temperature is high.

EXPLAINING WHY EVAPORATION CAUSES COOLING (USING THE KINETIC THEORY OF MATTER)

The liquid molecules at the surface are hotter and hence more energetic than the molecules below them.
These surface molecules are thus able to over come the attractive forces from the molecules below them and they escape into space.
The liquid remains with low energetic molecules of low temperature hence cooling.

Explain how evaporation takes place.

The liquid molecules at the surface are warmer and hence more energetic than the molecules below them.
These surface molecules are thus able to over come the attractive forces from the molecules below them and they escape into space. This is evaporation.

WHY SOMEBODY FEELS COLD OR COOL WHEN HE/SHE SWEATS

When the skin is wet with sweat, the sweat absorbs latent heat of vapourisation from the skin and escapes as vapour into space.

The skin thus loses heat and it feels cold.

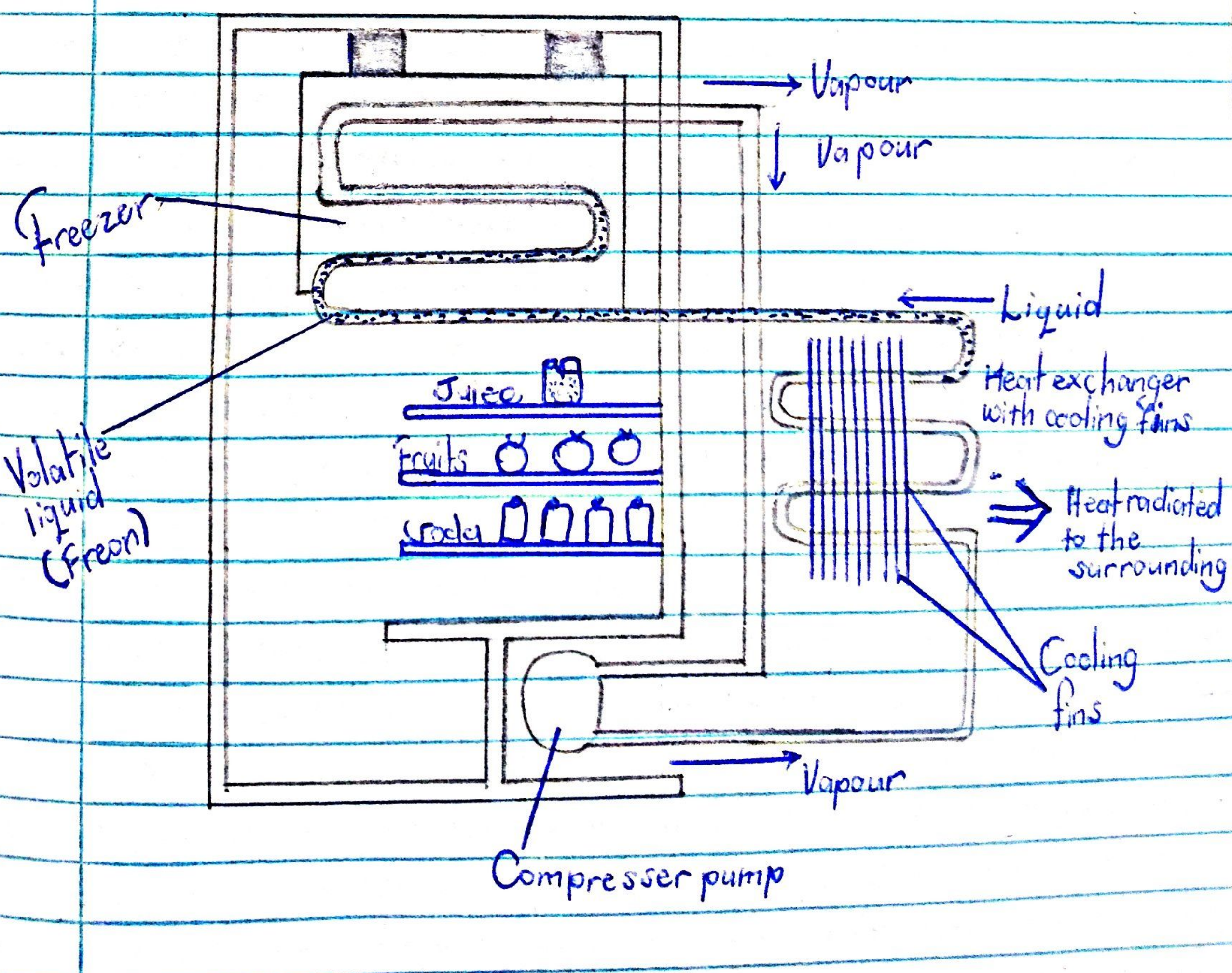
PROPERTIES OF EVAPORATION

- It occurs at any temperature above absolute zero temperature.
- It occurs only at the surface of a liquid.
- No bubbles in a liquid are formed during evaporation.

Example of a device that applies evaporation at its cooling effect.

It is a refrigerator.

Diagram and working of a refrigerator.



The coiled copper pipe/tube surrounding the freezer contains a volatile liquid called Freon which evaporates and takes the latent heat of vapourization from its surrounding and so causes the surrounding (ie the inside of refrigerator) to cool.

The compresser pump which is electrically driven removes the vapour formed and so reduces the pressure and lowers the boiling point of freon.

The pump forces the vapour into the heat exchanger where it's compressed and condensed back to liquid freon.

The latent heat of vapourization is removed from the condensing vapour at the heat exchanger by conduction through the cooling fins and then lost the surrounding and radiation.

The liquid formed returns to the coils surrounding the freezer and the process continues resulting into further cooling in the refrigerator i.e

Evaporation ⟶ Compression ⟶ Condensation

Note;

An adjustable thermostat is used to switch on and off the refrigerator hence controlling the rate of evaporation. This regulates the temperature of the inside of the refrigerator.

Questions

1. Why is heat exchanger of a refrigerator blackened?
   To make it a good emitter or radiator of heat.

2. Why is the heat exchanger of the refrigerator covered with small pieces of metals (cooling fins)?
   To incr

3. Why is the freezer always located up not down and not on the side?

Mon. 30th. 10. 2023.

MELTING AND FREEZING OF STEARIC ACID.

Melting point is the constant temperature at which a solid turns into liquid.

Freezing point is the constant temperature at which a liquid turns into a solid.

For the same substance, freezing point and melting point are the same.

Stearic acid is along chain fatty acid found in combined form in natural animal and vegetable fats.

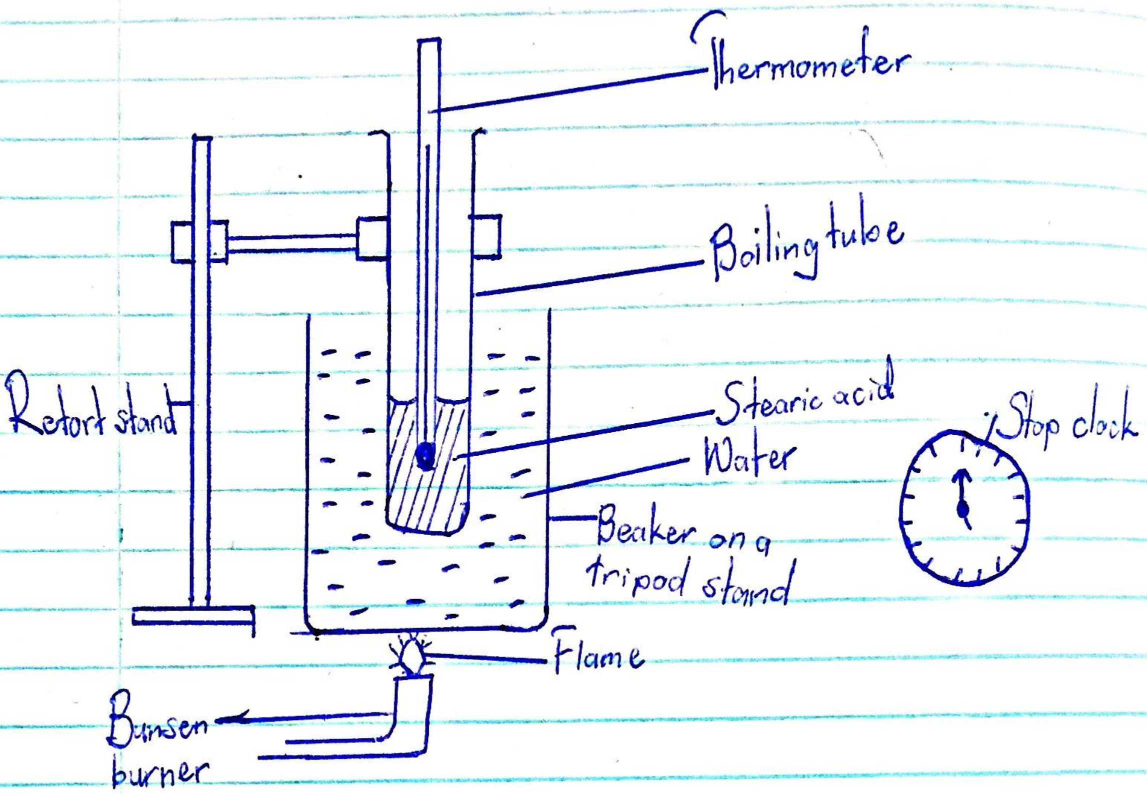
1. Describe an experiment to investigate the melting of stearic acid.
2. Describe an experiment to investigate the freezing of stearic acid.
3. At what temperature does stearic acid start to (a) melt (b) freeze.
4. What happens to stearic acid when it reaches room temperature?
5. What are the applications of stearic acid?
6. Draw heating curves and cooling curves of stearic acid.
7. How will you obtain total energy absorbed?

The melting point of stearic acid is 69.3°C

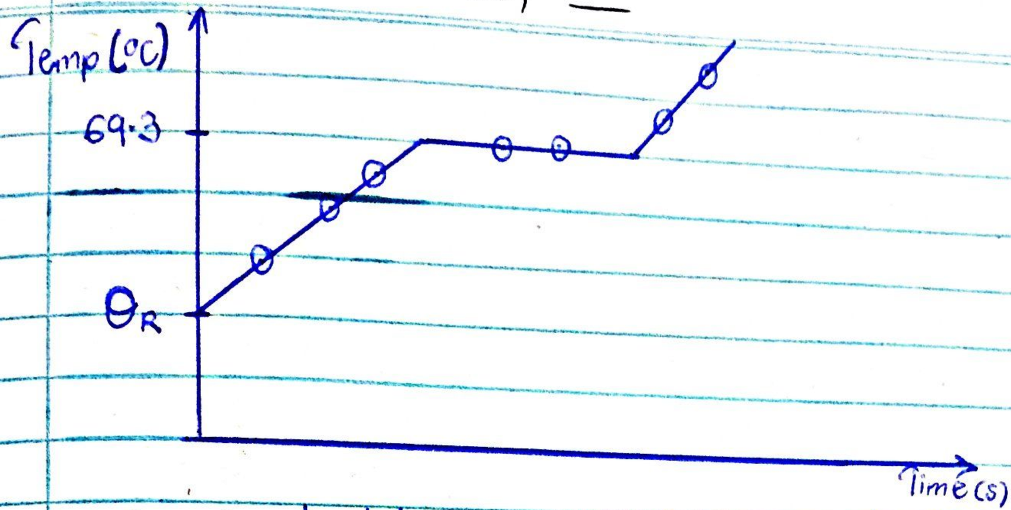
So, the freezing point of stearic acid is 69.3°C if stearic acid is pure.

But if stearic acid is impure, the freezing point and melting point are quite different but all lie in 55°C-70°C

AN EXPERIMENT TO INVESTIGATE THE MELTING POINT OF STEARIC ACID



- Water is poured into a beaker and heated until it just starts to boil.
- A boiling tube containing stearic acid (solid) and a thermometer is placed in the hot water.
- The temperature of the acid rises slowly.
- Using a stop clock and a thermometer, the temperatures of the stearing acid are recorded after every 30 seconds ~~minute~~ until a temperature of about 80°C is reached.
- The results are put in a table.
- A graph of temperature against time is plotted (warming curve)
- The temperature where melting starts is noted and it is the melting point.



NB; In order to determine the freezing point of stearic acid, the boiling tube above is removed from the hot water and then allowed to cool slowly.
The temperatures of the cooling acid are recorded after every ~~minute~~ 30 seconds.
The cooling curve of the acid is plotted and freezing point is determined.

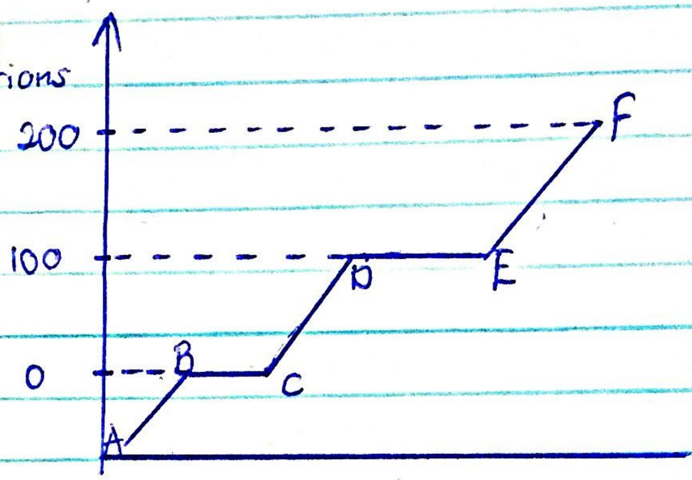
Precautions in the experiment.
- Wear an eye protection to avoid damage to the eyes.
- The heating of the boiling water should be continuous.
- The heating of the boiling water should be regulated to avoid the vigorous spilling out of water.

Uses of stearic acid
- Its products reduce or treat eczema.
- Its products reduce inflammation.
- Its products retain the body skin moisture.

~~Examples~~ Effects of using stearic acid.
It can damage the ~~sur~~ skin.
It can damage the eyes.
It causes difficulty in breathing.
NB; At room temperature, stearic acid is in solid form.
It melts at temperatures far higher than room temperature.

Some of the products from stearic acid
- Detergents
- Soap
- Candles
- Cosmetics such as shampoos and shaving creams.

Questions

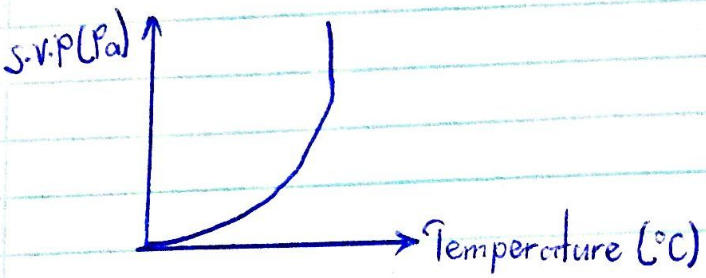


a) In what region of the graph is the substance a
i) Solid ii) liquid iii) Vapour
b) At what temperature does the substance
i) Start boiling
ii) Start freezing
iii) finish melting
c) What is happening to the Kinetic energy of the particles in region; i) BC ii) CD
d) What happens to the distance between molecules as the substance goes through BC?

VAPOURS

a) A vapour is the gaseous state of a substance.
b) A saturated vapour (S.V) is the vapour which is in dynamic equilibrium with its own liquid.
c) Dynamic equilibrium is the state reached when the number escaping from a liquid into space is equal to the number of molecules entering back to the liquid from the vapour formed.
d) Unsaturated vapour is a vapour which is not in dynamic equilibrium with its own liquid.
e) Vapour pressure (V.P) is the pressure exerted by the vapour on its own liquid.
f) Saturated vapour pressure (S.V.P) is the pressure a vapour exerts on its own liquid when the vapour is in dynamic equilibrium with the liquids.

The S.V.P of a liquid increases as temperature increases.



g) Dew point is the temperature at which the water vapour present in air is just enough to saturate the air (to soak or wet the air).

BOILING

Is the process by which bubbles are formed from inside a liquid being heated and rise to the surface when the saturated vapour pressure is equal to the external pressure (atmospheric pressure).

As the liquid is heated, its temperature rises and so its S.V.P increases. When the S.V.P becomes equal to the atmospheric pressure, the liquid boils.

Hence boiling occurs at a particular temperature called boiling point.

BOILING POINT; Is the temperature of a liquid at which its saturated vapour pressure (S.V.P) is equal to the external atmospheric pressure.

Factors affecting boiling point of a liquid

i) External pressure; The higher the external pressure, the higher the boiling point and vice versa.

At sea level, the boiling point of liquid is higher than its boiling point at the mountain top or at the upper levels of a storeyed building. This is because the atmospheric pressure at sea level is higher than at high altitudes.

B+ B+ AB+

ii) Presence of impurities; The presence of impurities in a liquid alters its boiling point.

ts

Exercise

a) How does boiling form bubble?
b) Explain why the boiling point of a liquid depends on altitude.
c) Why is it that boiling at the mountain top starts earlier than at sea level or why water at the mountain top boils below 100°C
d) Explain why cooking food at the mountain top takes quite longer than at sea level.
e) Explain why cooking using a pressure cooker saves time and fuel than using a sauce pan.
f) Why does water boiling in a source first stop boiling when opened?

Answers

a) When water is boiled, the heat energy is transferred to the molecules of water which begin to move quickly, eventually the molecules have too much energy to stay connected as a liquid. When this occurs, they form gaseous molecules of water vapour which float to the surface as bubbles and travel into the air

Differences between boiling and evaporation

Boiling	Evaporation
- Occurs at a specific temperature called boiling point.	Occurs at any temperature above absolute zero.
- Occurs throughout the liquid	Occurs only at the liquid surface.
- Bubbles are formed	No bubbles are formed.