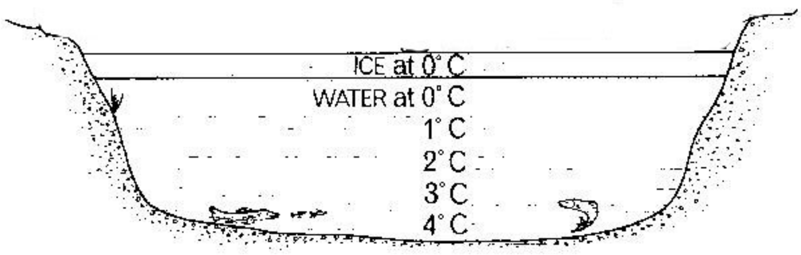
It is used to preserve aquatic life during cold weather.
As the temperature of the pond or lake fall the water contracts it becomes denser and sinks. a circulation is thus set up until all the water reaches its maximum density at 4^0c if furth cooling occurs any water below 4^0c will stay at the top due to its lighter density thus ice format the top of water.
The lower layer of water at 4^0c can only loss heat by conduction. So in deep water there will be always water beneath the ice in which fish and other creatures can live.

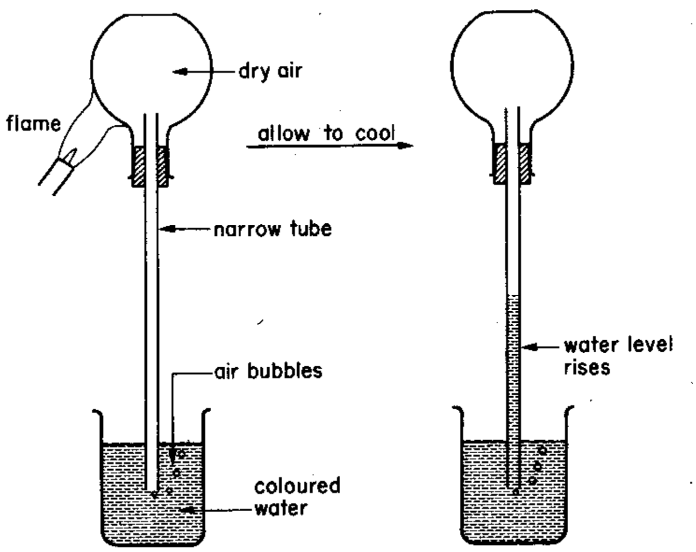


Disadvantages of anomalous behavior of water.
- it causes weathering of rocks due to its expansion and contraction
- it can cause water pipes to bust due to formation of ice inside the pipe
- it can have a satisfactory thermometer with water as the thermometric liquid.

EXPANSION OF GASES

A gas expands when heated almost 10,000 times more than solids this is due to the fact that cohesive exist between molecules are extremely weak.

Experiment to demonstrate expansion in gases



- In the above set up the flask is slightly heated.
- Air bubbles will be seen coming out from the other end of the tube
- This shows that air expand when heated.
- In the second set up, when the surface of heat is removed and the flask is allowed to cool by pouring cold water, the level of water will rise. This shows that air contacts when cooled.

Application of expansion of air.

1) Hot air balloon

Expansion of air is used in hot air balloon. When air in the balloon is heated, it expands and becomes less dense and as a result the balloon rises up.

THERMOMETRY

Thermometers: these are instruments used for measuring temperatures

Thermometric properties

A thermometric property is a property of a substance which continuously change with temperature and may be used for temperature measurements, these include:

- Increase in length.
- Change in difference
- *Change in volume*
- Change in pressure.

THERMOMETER SCALES.

There are 3 thermometer scales commonly used

1) Celsius / centigrade scale(^{0}C)
2) Fahrenheit (^{0}F)
3) Kelvin/ absolute(k)

a) Relation between Celsius and Fahrenheit

$F = \frac{9}{5}C + 32$

If Celsius scale reads ^{0}0c then $F = \frac{9}{5}\theta + 32$

And if Celsius scale reads 100^{0}c then $F = \frac{9}{5} X100 + 32$

$= 212^0F$

b) Converting from Fahrenheit to Celsius.

The formula is $C = \frac{5}{9}(F-32)$

$C = \frac{9}{5}(212 - 32)$

$= 100^0C$

c) Relationship between Celsius scale and Kelvin scale.

K = 273 + C where C is temperature in Celsius scale and is temperature in Kelvin scale.

d) Convert 0^0C to Kelvin scale

K = 273 + θ

= 273K.

Convert 100^0C to Kelvin scale (Absolute scale)

K = 273 + 100

= 373K

To obtain a standard scale on a thermometer. Two fixed points must be marked out on it. The upper and lower fixed points.

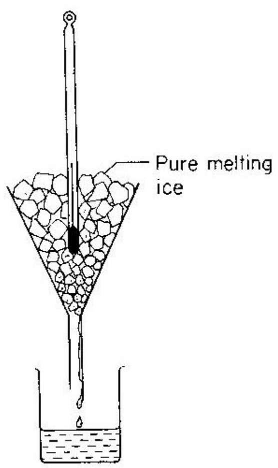
LOWER FIXED POINTS:

This is the temperature of pure melting ice at standard atmospheric pressure.

76cm Hg or 760mm Hg and – On Fahrenheit scale = 32^0F

- On Celsius scale = 0^0C
- Kelvin scale = 237K

DETERMINATION OF LOWER FIXED POINTS:



Procedure;

-support the funnel on a retort stand as shown above.

-put the thermometer in funnel packed with pure melting ice.

- Adjust the thermometer so that the mercury thread is clearly seen.

-mark the points where the level of mercury stops is the lower fixed point.

UPPER FIXED POINT:

This is the temperature as steam above the boiling water of standard atmospheric pressure.

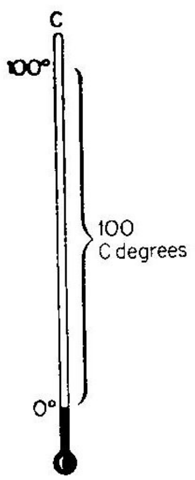
On Celsius scale is 100^0C

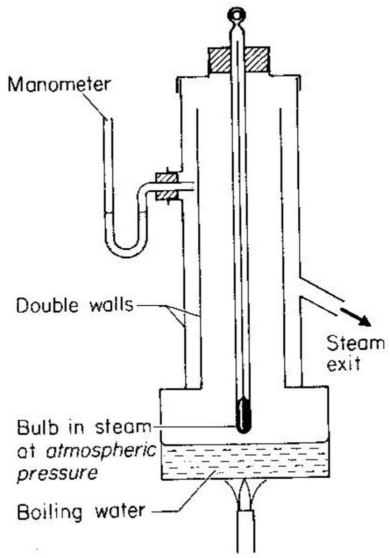
On Kelvin scale is 373K

On Fahrenheit scale is 212^0F.

Determination of upper fixed point using a hypsometer.

A hypsometer is a two walled vessel made out of a round bottom flask.





Procedure;

-Partly fill vessel with water and arrange the apparatus as in the diagram.

-Gently heat water in vessel using a Bunsen flame to its boiling point.

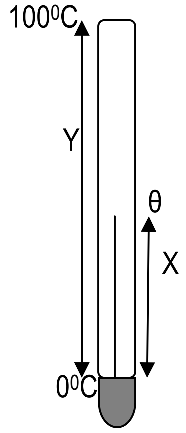
-Adjust the thermometer so that mercury thread is seen clearly when water is boiling.

-Make the end of mercury thread as the **upper fixed point.**

-With the upper and lower fixed marked points on the thermometer the distance between them is divided into 100 equal degrees so that the thermometer gets the scale. In the way it is said to be calibrated.

Using un calibrated thermometer to measure temperature:

The interval between the upper fixed point and the lower fixed point is called the fundamental interval. This is divided into a hundred equal parts and each is called a degree.



Example:

1. The top of a mercury thread of a given thermometer is 3cm from the ice point, if the fundamental interval is 5cm, determine the unknown temperature θ.

X = 3cm

Y = 5cm

$\theta = \frac{X}{Y} \times 100$

$= \frac{3}{5} \times 100$

$= 60^0C$

2. The length of a mercury thread at a low fixed point and upper fixed point are 2cm and 8cm respectively for a certain liquid X. Given that the length of mercury thread at un known temperature θ is 6cm determine the value of θ.

X = 6 – 2 = 4

Y = 8-2 = 6

$\theta = \frac{X}{Y} \times 100$

$= \frac{4}{6} \times 100$

$= 66.7^0C$

3. Find the temperature in ^oC if the length of mercury thread is 7cm from the point and fundamental interval is 20cm.

$\theta = \frac{X}{Y}$

$= \frac{7}{20} \times 100$

$= 35^0C$

4. Find the unknown temperature 0 given the following length of mercury.

-Length of steam = 25cm

-Length of ice point = 1cm

-Length of known temperature θ= 19cm

Y = 25 – 1 = 24 x 100

X = 19 – 1 = 18

= 3 x 25

$= 75^0C$

Thermometric liquids.

These include – mercury

- Alcohol
- Water

Water is not commonly used because of the following reasons:

-It is transparent i.e.
Its meniscus is difficult to see and read.

-It does not expand regularly

-It sticks on glass

-It has relatively low boiling point.

-It is poor conductor of heat.

QUALITIES OF A GOOD THERMOMETRIC LIQUID:

-Must easily be seen (opaque)

-Must expand regularly with temperature.

-Must have a high boiling temperature to measure high temperature.

-Must have low freezing point to measure low temperature.

-Must not stick on glass

-Must be a good conduct of heat.

-Must not be very expensive

-Must not be poisonous and it should be available.

Advantages of mercury over alcohol when used as thermometric liquid.

Mercury	**Alcohol**
It is opaque	It is colourless
Good conduct of heat	Poor conduct of heat as compared to mercury
Expand regularly	Does not expand regularly as mercury
Has a high boiling point (357^0C)	Has low boiling point 78^0C
and can be used to measure temperature.	
Mercury does not stick on glass.	Sticks on glass
It does not distill easily	Distills easily.

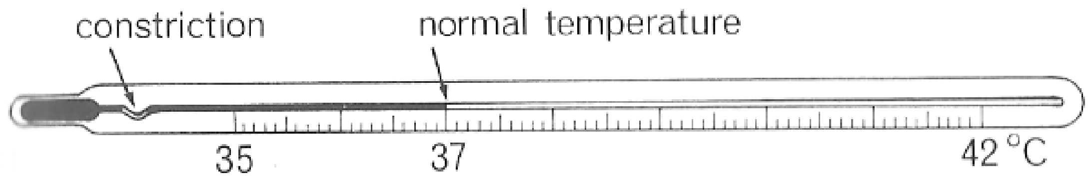
Advantages of alcohol over mercury

Alcohol	Mercury

Has a low freezing point (115⁰c)	Has a high freezing point of -39⁰c hence unsuitable to measure very low temperatures.
Has a high a linear expansively(expands so much for small temperature range)	Has a low linear expansivity (expands little for the same temperature range)

CLINICAL THERMOMETER:

This thermometer is used to measure the human body temperature.



-The thermometer has a very fine bore which makes it sensitive.

-Expansion of mercury makes it shoot along the tube.

-The glass from which the tube is made very thin which body heat can reach the mercury quickly to read body temperature.

-When thermometer bulb is placed into the mouth or armpit, the mercury expands and it is forced past the constriction along the tube.

-When removed, the bulb cools and the mercury in it contracts quickly.

-The mercury column breaks at the constriction leaving mercury in the tube. The constriction prevents flow back of mercury to the bulb when the thermometer is temporary removed from the patients mouth or armpits.

The thermometer is reset by shaking the mercury back in the bulb.

Effect of heat on matter:

-When a solid is heated, the cohesive forces between its molecules are weakened and the molecules begin to vibrate vigorously causing the solid to change into a liquid state.

-The temperature at which a solid changes into liquid is called the melting point. At melting point the temperature remains constant until the solid has melted.

-When the entire solid has melted and more heat is applied, the temperature rises. The heat gained weakens the cohesive forces between the liquid molecules considerably causing the molecules to move faster until the liquid changes into gaseous state.

-The temperature at which a liquid changes into gaseous state is called the boiling point. At boiling point temperature of the liquid remains constant since heat supplied weakens the cohesive forces of attraction in liquid molecules.

-If the heated substance is water its temperature rises with time as shown below.

Properties/qualities of a thermometer.

i) Quick action
ii) Sensitivity.

- Quick action

This refers to the ability of a thermometer to measure temperature in the shortest time possible. This is attained by using a thin walled bulb using a liquid which is a good conductor of heat e.g. mercury.

- Sensitivity

This is the ability of a thermometer to detect a very small temperature change. It is attained by:

i) Using a thermometer with a big bulb
ii) Use of a liquid which has a high linear expansivity.
iii) Using a narrow bore or reducing the diameter of the bore hole

HEAT CAPACITY

This is the heat required to rise the temperature of a substance by 1^0c or 1k S.I units is ŋ1^oc or ŋ1^ok

Heat capacity = $\frac{heat}{temperature\ change}$

Specific heat energy

This is the heat required to raise the temperature of the substance by 10c S.I units is ŋ$kg^{-1}\ {}^oc^{-1}$

Specific capacity has a symbol C = $\frac{joules}{kgoc}$ = $\frac{heat}{mass\ xtemperature\ rise}$

Heat = mass x c x temperature

Example

1. 6000J of heat is used to heat a liquid of mass 3kg ^{0}C from 25^oC to 45^0C. Find the specific heat capacity of the liquid.

H = M C θ
6000 = 3 x c x20
C =100J$kg^{-1}\ {}^oC^{-1}$

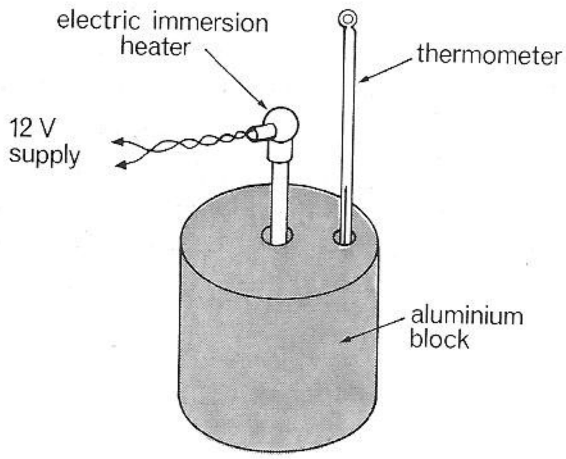
2. 10,000J of heat is used to heat the metal block of mass 400m 20^0c -100^0c.find the (C) of the metal block.

θ = (100 -20) = 80^0C
H =M C θ
10,000 = 0.4 x c x 80
C = 312.5$Jkg^{-1}\,{}^oC^{-1}$

3. Find the heat required to raise the temperature of a block of mass 200g from25^0C to 65^0C (specific heat capacity of the block is 130$Jkg^{-1o}C^{-1}$)

H = M C θ
H = 0.2 X 130 X 40 =1040J

DETERMINATION OF SPECIFIC HEAT CAPACITY OF A METALIC BLOCK



The mass (m) of the metallic block is first measured and recorded using a beam balance.

The heater of known power (P) and thermometer are placed in the block. The initial temperature of the block is recorded. The heater is switched on and left to heat for some time (t).

The purpose of cotton wool is to ensure that no heat is lost to the surrounding.

Assume no heat is lost to the surrounding

Heat supplied = heat absorbed or gained by the metal

$$Pt = m\, c_m \times \theta$$

$$C_m = \frac{Pt}{m\theta}$$

Where c_m is the specific heat capacity of the metal

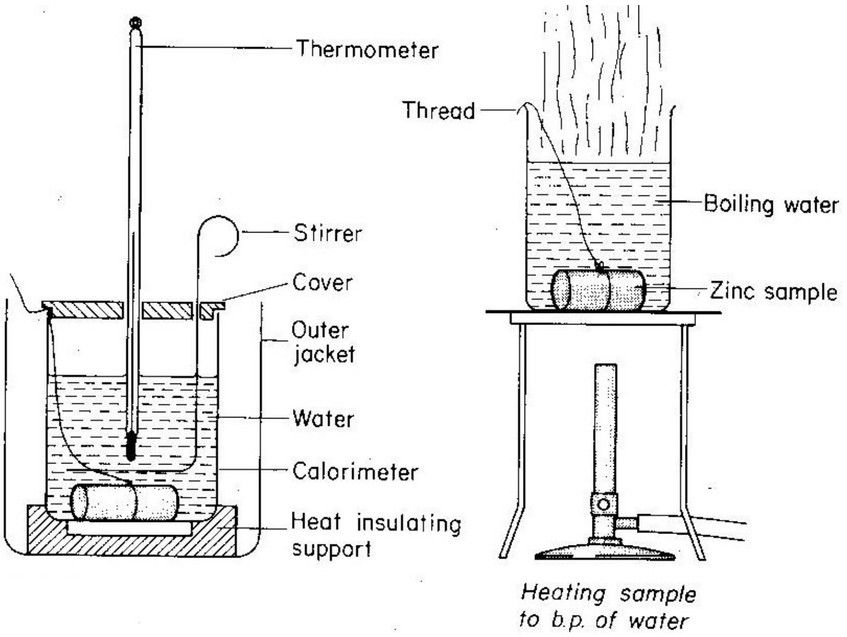
Θ- Is the temperature change i.e. ($\theta = \theta_2 - \theta_1$)

Question

A heater rated 2kw Find the heat in

i) 5 seconds
ii) 10 minutes
iii) 2 hour

DETERMINATION OF SPECIFIC HEAT TEMEPRATURE OF A SOLID BY METHOD OF MIXTURES.



Procedure

- Put water of mass m_1 in a container of heat capacity c_1
- Put calorimeter and its contents in a calorimeter jacket and record the initial temperature θ_1
- Mean while, put the solid of mass m in boiling water in a beaker as shown in figure(i) above for 5 minutes
- Record the boiling point θ_2
- Quickly transfer the solid from boiling water to the calorimeter using a string.
- Begin to stirrer until the final steady temperature θ_3 is obtained the heat shield is to prevent the heating from boiling water to reach the calorimeter.
- Assume eligible heat to the surrounding.

Heat lost by solid = heat gain θ d by the calorimeter + heat gained by H20.

$MC_S(\theta_3 - \theta_2) = M_1C_1(\theta_3 - \theta_1) + M_2C_2(\theta_3 - \theta_1)$

$C_s = \frac{(M1C1 + M2C2)\ (\theta3 - \theta1)}{M\ (\theta2 - \theta3)}$

Knowing values of C_1,M_1, M_2, C_2,M and temperature changes, specific heat capacity of a solid C_s can be obtained from the above expression.

Examples:

1. 252,000J of heat are supplied to 4kg of H20 at 400c.Find the final temperature of water (specific capacity of H_20 is 4200JKg^{-1o}C^{-1})

   $H = MC\ (\theta_2 - \theta_1)$

   $252,000 = 4 \times 4200\ (\theta_2 - 40)$

   Final temperature = 55^{0}C

2. In an experiment to determine the specific heat capacity of a solid. was put in boiling H_20 for 5min.It was then quickly transferred in 5kg liquid at 46^{0}C in plastic beaker. The final temperature of the mixture was found to be 500C.Find the specific capacity of the solid (specific capacity of solid is 2000JKg^{-10}C^{-1}.

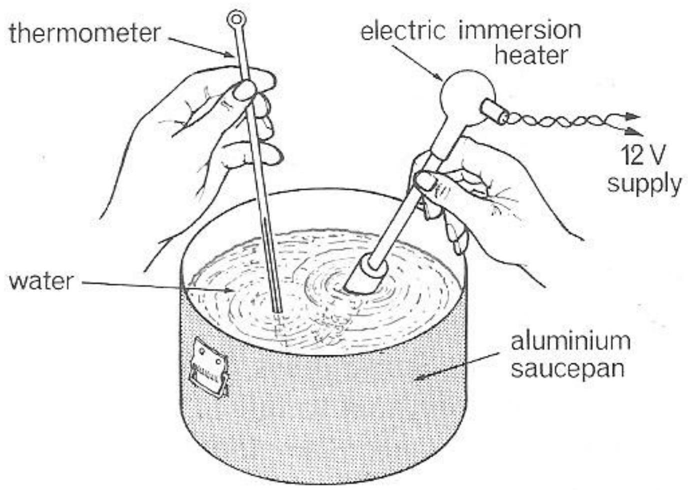
   1. Heat lost by = Heat gained by liquid.
   Solid

   $MC\ (\theta_1\text{-}\theta_2) = M_1C_1\ (\theta_3\text{-}\theta_2)$

   $2 \times C\ (100\text{-}50) = 5 \times 2000\ (50 - 46$

   $C = 400JKg^{-1o}C^{-1}$

Determination of specific heat capacity of a liquid by electrical method



Procedure;

- Pour the liquid of known mass (m) in a plastic beaker or insulated aluminium pan
- Put the heater of known power (P) and the thermometer in the plastic beaker containing a liquid.
- Measure and record the initial temperature θ_1 of the liquid.
- Switch on the heater to warm the liquid for time (t).
- Read and record the final stable temperature θ_2 of the liquid.

Calculate the specific capacity.

Heat gained by liquid = Heat supplied by the heater.

$$MC(\theta_2 - \theta_1) = Pt$$

Specific heat capacity of the liquid $C = \frac{Pt}{M(\theta 2 - \theta 1)}$

Assumptions the;

- The amount of heat absorbed by the plastic beaker is negligible.
- No heat is absorbed by H_20 (liquid) from the surroundings.

Example;

1. An immersion heater of 60W was used to heat a liquid of 1Kg for $\frac{1}{2}$ a minute. Find the specific capacity of the liquid if the initial temperature was 27^0C and 87^0CHeat absorbed by water = Heat supplied by the heater

$MC(\theta_2 - \theta_1) = Pt$

$1x\ C(87 - 27) = 60 \times 30$

$C = 30JKg^{-1o}C^{-1}$

2. Atifa was to have a warm bath. She mixes 5Kg of hot H20 at 850C with 15Kg of cold water at 250C taking C to be $4200JKg^OC^{-1}$. Find the final temperature of the mixture.

Heat lost by hot water = Heat gained by cold water

$M_hC(\theta 2 - \theta_3) = M_cC(\theta_3 - \theta_1)$

$5 \times 4200(85 - \theta_3) = 15 \times 14200(\theta_3 - 25)$

$\theta_3 = 40^oC$

Importance of high specific capacity of H_20 $C = 4200JKg^{-1o}C^{-1}$

4400J of heat required to increase the temperature by 1^0C is extremely high, because of this high value of (C) of H_20, it is commonly used as a cooling agent in many cooling systems e.g. car radiators

LATENT HEAT

Latent heat is the heat lost or absorbed by the body during change of state at constant temperature.

There 2 types of latent heat

(i) latent heat of vaporization (L_v)
(ii) Latent heat of fusion (L_f)

Latent heat of vaporization;

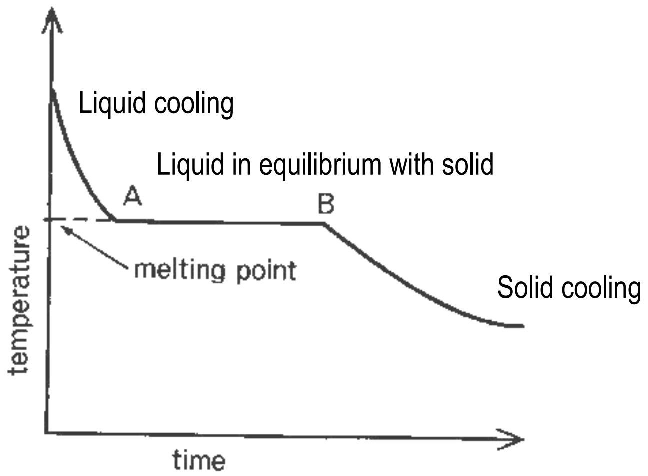
This is the amount of heat absorbed by a body to change its state 4rm liquid to vapour at constant temperature.

NB: The constant temperature is the boiling point of the liquid.

Latent heat of fusion;

This is the amount of heat absorbed by a body to change its state from solid to liquid at constant temperature. The constant temperature is the melting or freezing point.

Cooling curve of a substance



Specific latent heat of vaporization L_v

This is the amount of heat required to change 1Kg M of a substance from liquid to vapour at constant temperature.

$H = ML_v$ where H is amount of heat supplied or lost by a body.

M = mass of the body. L_v = Specific latent heat of vaporization of the body.

Examples

1. Find the amount of heat required to convert 5kg of water at boiling point to steam (Take l_v of steam as 2.3×10^6 Jkg^{-1})

Quantity of heat H = MLV

$= 5 X 2.3 X 10J$

$= 11.5 \times 10^6 J$

$= 1.15 X 10^5 J$

2. How much heat is needed to change 4kg of water at 10^0c to steam at 100^0c

H = mlv

$H = 4 X2 .3 X10^6 J$

$H = 9.2 X 10^6 J$

3. A three (kilowatt electrical kettle is left on for 2 minutes after the water starts boiling. What mass of water is boiled off in this time ?

Latent heat absorbed by H_20 = Heat supplied by heater

$M \times 2.3 \times 10^6 = 3 \times 1000 \times 2 \times 60$

M = 0.1565kg = 156.5g

4. Find the heat given out when 10g of steam at 100^0C condenses and cool to water at 50^0C

Heat given = heat required to cool steam to water + heat required to cool water from 100^0C to 50^oC.

$H = mlv + mc (\theta_2 - \theta_1)$

$= \frac{10\ x2300000}{1000} + \frac{10\ x\ 4200(100-50)}{1000}$

= 25100J

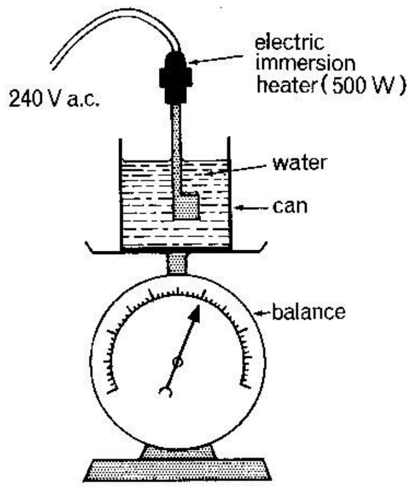
Since the amount of heat in steam is 5 times of heat in boiling water, therefore steam is more fatal than boiling water.

Importance of high value of specific latent heat of vapourization

1. Because of high value, steam is used as a heating agent e.g. cooking .

2. Can be used for sterilizing medical tools e.g. blades, forceps.

Determination of specific latent heat of vaporization of steam.



Procedure

- Assume the apparatus as in the diagram above.
- When the weight mass of in the beaker and record it as m_1.
- Switch on the heater to heat water in the beaker.
- While water is boiling, read the position of the pointer of the stop clock.
- After time (t) weigh the mass of water (m_2)
- Calculate the mass of steam from

  $M = m_1 - m_2$

  Obtain specific latent heat of vapourization from:

  Latent heat absorbed by boiling water = heat supplied by heater

$$Mlv = pt$$

$$Lv = \frac{pt}{m}$$

Where lv is the specific latent heat of vaporization.

SPECIFIC LATENT HEAT OF FUSION (L_F)

Specific latent heat of fusion is a mount of heat required to change the state of 1 kg mass of a substance from solid to liquid at constant temperature S.I unit J/kg

Example

1(a) how much heat will change 10g of ice at 0°C to water 0°C (take specific latent heat of fusion of ice to be 340,000J/kg)

$$H = mlv$$

$$H = \frac{10\ x340{,}000}{1000} = 3400J$$

2. What quantity of heat must be removed from 20g of water at 0°C to change it to ice at 0°C.

$H = ml_f$

$= \frac{20\ x 340,000}{1000}$ = 6800J.

3. How much heat is needed to change 5 g of ice at -5°C .

H = mcθ + *mlf* + *mcwθ*

$= \frac{5\ x\ 2100(0--5)}{1000} + \frac{5\ x3\ x000}{1000} + \frac{5\ x\ 200}{1000}$

= 2,802.5J

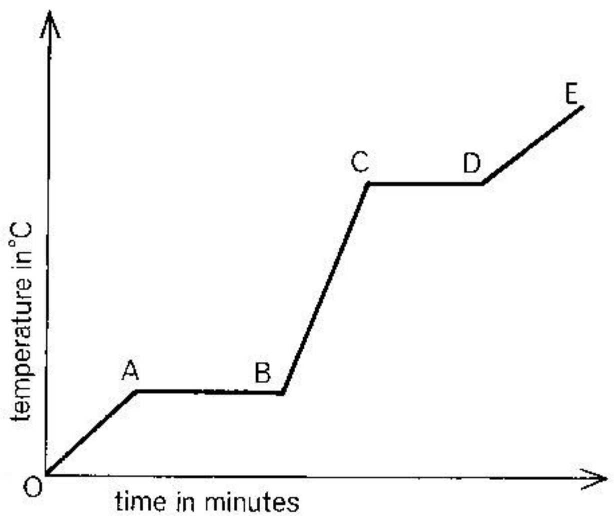
Question

1. (a)What is meant by specific heat capacity?

b) 2 kg of ice initially at -10 °C is heated until it changes to steam at 100°C.

i) Sketch a graph to show how the temperature changes with time.
Ii) Calculate the thermo energy required at each section of the graph sketched in b(i) above .
Specific latent heat of fusion of ice is = 3.36 $x10^5Jkg^{-1}$
Specific latent heat of vapourization of water is = 2.26 x 10^6Jkg^{-1}.
Specific heat capacity of water = 42 $X10^3$ J/kgk
Specific heat capacity of ice is = 2.1 $x10^3J/kgk$.

GRAPH TO SHOW HOW TEMPERATURE CHANGES WITH TIME



(iii) Thermal energy along AB,

= MC_{ice} θ

= 2 x 2.1 x 10^3 (0 - -5) = 4.2 x 10^4J

Thermal energy along BC

$H = ML_f$

$= 2 \times 3.36 \times 10^5 = 6.72 \times 10^5 J$

Thermal energy along CD,

$= MCw\theta$

$= 2 \times 4.2 \times 10^3 \times (100-0) = 8.4 \times 10^5 J$

Thermal energy along DE,

$= Mlv$

$= 2 \times 2.26 \times 10^6 = 4.52 \times 10^6 J$

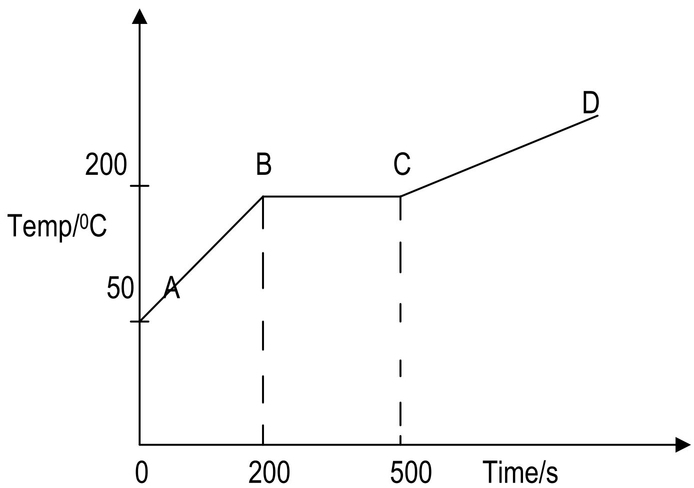
Exercise;

1. (i)State and define the 3 major methods of heat transfer.

2.(a) Distinguish between specific heat capacity and specific latent heat of a substance.

(b)Describe an experiment to determine the specific latent heat of fusion of ice.

3. The Graph showing a heating curve of a metal



(i) Explain what happens to the metal.

.

(ii)If the metal absorbs heat at the rate of 3000J/S and specific heat capacity is $400JKg^{-1}{}^{o}C^{-1}$, calculate mass of the metal.

(ii) Find the specific latent heat of the metal,

3. (a) Find the ways you would modify a liquid in glass thermometer so that it can register temperature more quickly.

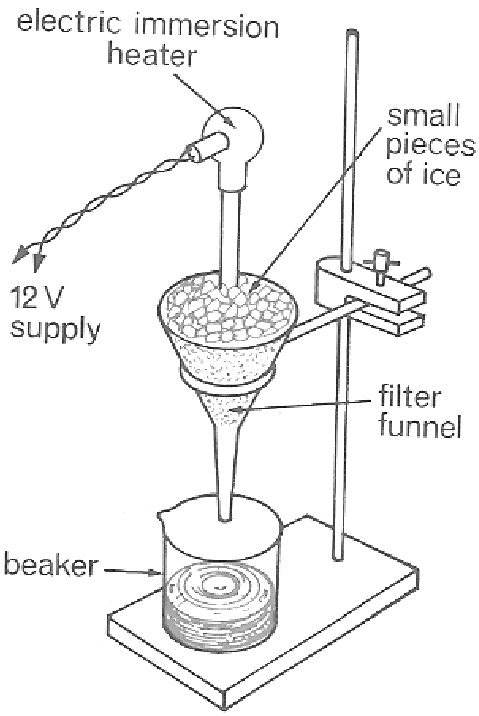
(b) Why is it usually not a good idea to have a thermometer with high heat capacity?

4. (a) Explain why the freezing compartment of a refrigerator is at the top.

   (b)A glass of orange squash contains 0.2 kg of water at temperature of 24^0C.What is the minimum amount of ice you would need to add in order that the temperature of the drink is 0^0C?

Experiment to determine the specific latent heat of fusion of ice

Set up.



Procedure;

Support the plastic funnel using the retort stand.

Arrange the apparatus as in the diagram without the beaker.

When the water in the funnel starts dripping at a uniform rate, switch on the immersion heater and place the beaker under the funnel at the same time.

After sometime (t) of warming ice using the heater (of known power (p),

Remove the beaker and the mass (m) of the water collected in the beaker is weighed.

Calculate the specific latent heat of fusion of ice from:

Heat absorbed by ice = Heat supplied by heater

$MLf = Pt$

$Lf = \frac{Pt}{M}$

Assumption;

-No heat is absorbed from the surrounding.

- All heat supplied by the heater has been absorbed by the ice only.

Significance of high value of specific latent heat of fusion

Ice is often used as a cooling agent e.g. ice cubes are added to juice to keep it cold.

Example:

An aluminum tray of mass 400g containing 300g of water is placed in a refrigerator, after 80 minutes, of tray is removed and it is found that 60g of water remain un frozen at 0^0C. If the initial temperature of tray and its content was 200c, determine the average amount of heat removed per minute by the refrigerator.

Specific capacity of aluminum = $1J/g^0C^{-1}$

Specific capacity of water = $4Jg^{-1o}C^{-1}$

Specific latent heat of fusion of ice = 340J/g

Heat removed by the fridge = Heat loss by water from 20^0C to 0^0C + Heat loss by water to ice + heat loss by tray.

$= M_wC_w (\theta_2 – \theta_1) + M_{ice} L_f + M_tC_1 (\theta_2 – \theta_1)$

$= 0.3 \times 4000 (20 – 0) + 0.24 \times 340{,}000 + 0.4 \times 1000 (20 – 0)$

= 113600J

Heat removed per minute = $\frac{113600}{60}$

= 1420J/min

question1:

In an experiment to determine specific latent heat of fusion of ice, the following results were obtained.

Mass of water obtained in the beaker = 20g

Power of the heater = 50W.

Time heater is switched on = 2min 6seconds

Determine specific latent heat of fusion of ice.

Latent heat and kinetic theory

(a) Latent heat of fusion.

During change of state from solid to liquid (melting at constant temperature, the heat supplied weakens the intermolecular forces of attraction, the molecular spacing increase, changing from static molecules of solid to fast moving molecules in liquid state.

The average K.E of molecules remaining constant because melting takes place at constant temperature.

(b) Latent heat of vaporization;

During change of state from liquid to vapour, the molecules must overcome of intermolecular forces of attraction so that they gain freedom to move about independently. As a result, the supplied is used to overcome these forces resulting in gain molecular potential energy but not their kinetic energy and also the work to expand against atmospheric pressure.

Why specific latent heat of vaporization of a substance is always greater than specific latent heat of fusion for the same substance.

Specific latent heat of vaporization is always greater than Lf because for molecules of a liquid to escape. $they\ require\ a\ lot\ of\ heat\ which\ increase\ K.E\ in\ order\ to\ overcome\ the\ intermolecular\ forces\ of\ attraction.$

While for latent heat of fusion very low amount of heat is required to weaken the intermolecular forces of attraction.

CHANGE OF STATE

1. Melting

It is a process by which a solid substance changes into a liquid e.g ice (solid) changes to water (liquid) when heated. Temperature at which solid substance changes to liquid is called melting point.

NB: There is no change in temperature of substance at its melting point. This is because the heat supplied is used to

weaken cohesive forces of attraction between molecules.

2. Boiling

This is the process by which a liquid when heated changes to the gaseous state at a fixed temperature e.g pure

water at 100^0c changes to vapour by the process of boiling.

There is no change in temperature at boiling point because the heat supplied is used to weaken cohesive attraction

of molecules and the rest is converted to kinetic form of energy.

3. Evaporation;

It is the process by which a liquid changes to gaseous state at any temperature. The rate of evaporation is affected

by the following factors;

Factors;

1. Temperature
2. Amount of humidity in the atmosphere
3. Pressure
4. Surface area
5. Nature of the liquid
6. Wind and dryness of air

Temperature;

The higher the temperature, the higher the average speed at which molecules move and therefore there will be more molecules moving to the liquid surface.

Pressure;

Increase in pressure lowers the rate of evaporation.

Surface area:

When the surface area of a liquid is increased, more molecules are brought to the surface and more rate of evaporation is increased.

Nature of the liquid

Different liquids have different cohesive forces ,those which have greater cohesive forces tend to evaporate less than liquids with less cohesive forces.

Wind and dryness of air

Dryness of air around the liquid surface causes rapid evaporation. Wind blows away water vapor along the body and this causes rapid evaporation to take place.

Differences between boiling and evaporation

Boiling	Evaporation
Takes place at a fixed temperature called boiling .	Occurs at any temperature

Boiling takes place throughout the liquid.	Takes place only on the surface of the liquid
Boiling is a vigorous process	Evaporation is a gentle process
Bubbles are formed with in the liquid	No bubble is formed on the surface of the liquid.
Boiling doesn't result into cooling	Evaporation result into cooling.

Cooling by evaporation

The molecules which escape from the surface of liquids are those with greater kinetic energy, the molecules which remain in the liquid are those with very low kinetic energy. The energy, the molecules use, as their kinetic energy is the latent heat which they absorb. The absorption of this latent heat from the liquids brings about a fall in temperature, thus a body cools.

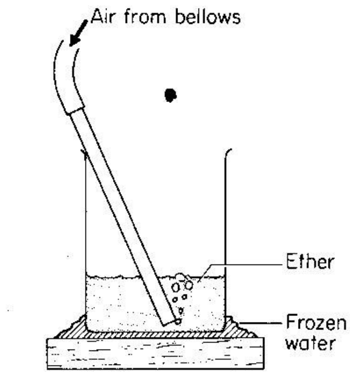
Application of cooling by evaporation

-cooling of a body by evaporation of sweat from the body

-cooling water using a porous pot or refrigerator

-cooling of the dog by the saliva on its tongue evaporation

Demonstration of cooling by evaporation



A beaker about one third full of ether is stood in a small pour of water on a flat piece of wood

Air is then bubbled through the ether. The ether evaporates into bubbles and the vapour is carried quickly away as the bubbles rise to the surface and burst thus increasing the rate of evaporation.

After sometime, the water on the wooden block cools to 0^0c and freezes to form ice. This demonstrates that evaporation causes cooling.

Explanation

As the ether evaporates, it absorbs latent heat from its liquid state with the result that it cools below 0^0c. At the same time heat becomes conducted through the walls the beaker from the pool of water below it and eventually the water cools to 0^0c. After this, it begins to loose latent heat and freezes.

The refrigerator

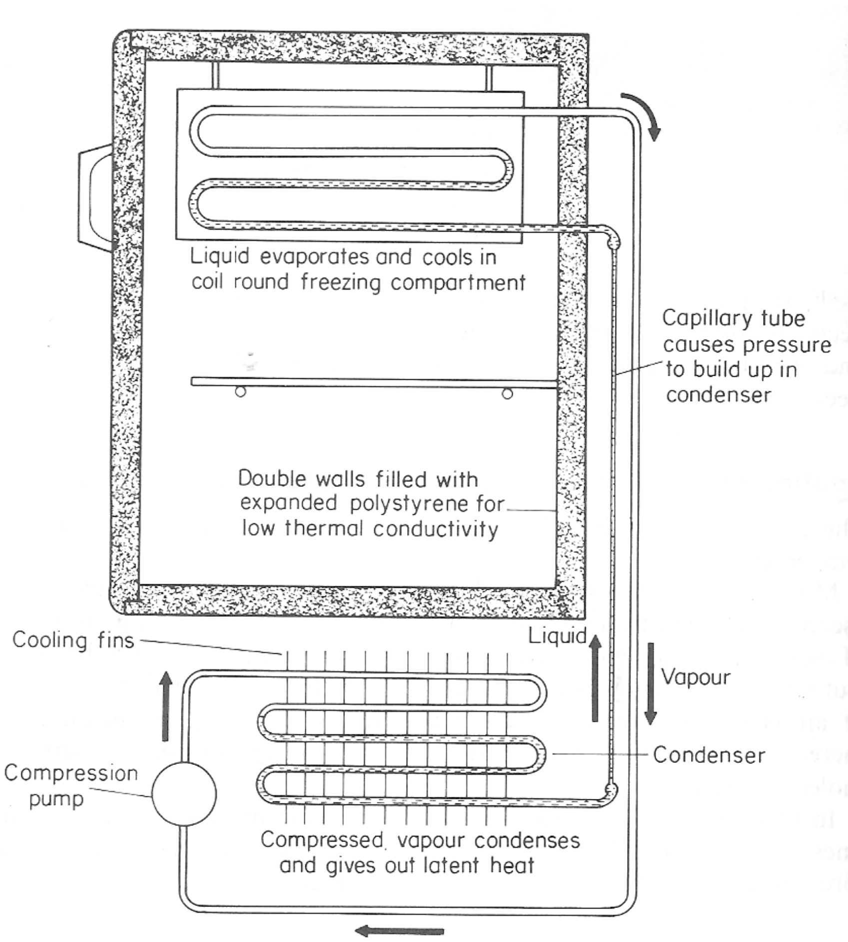


Fig. 19.5. Domestic electric refrigerator

It operates on the evaporation by cooling principle.

The liquid used in a refrigerator is Freon which is volatile (Freon is collective term for suitable refrigerants e.g. dichlorodifluoromethane boiling point about -30^{0}c or 243k).

Freon evaporates inside the coiled tubes surrounding the freezing compartment assisted by a pump which reduces the pressure.

When Freon evaporates, it absorbs heat from the surrounding air and this causes the refrigerator and its content to cool. The vapour produced is pumped away and compressed in the condenser where it condenses to liquid again.

The heat released during condensation is quickly removed by cooling fins at the back of the refrigerator.

The process of evaporating and condensing Freon is repeated on and on, thus causing the refrigerator to cool further.

Demonstration of effect of pressure on melting point (regelation)