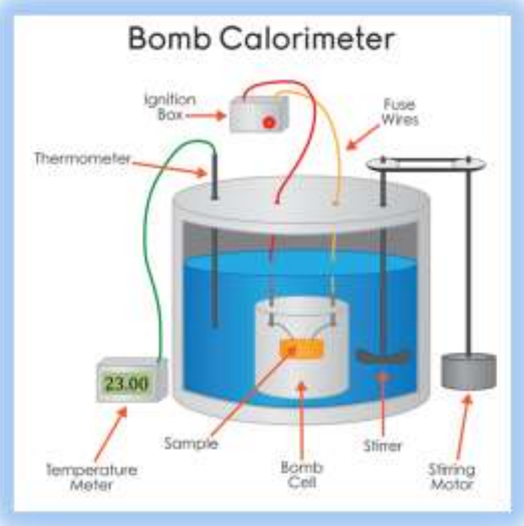
2020

QUANTITY OF HEAT



TEACHERS OF PHYSICS
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HEAT CAPACITY

1. Define specific latent heat of fusion of a substance (1mk)

- ✓ ***The quantity/amount of heat required to change a unit mass of a substance from solid to liquid at constant temperature.***

2. Distinguish between heat capacity and specific heat capacity of a substance.

- ✓ ***Heat capacity is the quantity/amount of heat required to raise the temperature of a given mass of a substance by one unit(1 K/1^{0}C) while specific heat capacity is the quantity/amount of heat required to raise the temperature of a unit mass(1 kg) of a substance by one unit(1 K/1^{0}C).***

3. Give the property of water which makes it suitable for use as a coolant in machines (1mk)

- ✓ ***Water has a high specific heat capacity hence absorbs a lot of heat per unit mass.***

4. Equal masses of water and paraffin are heated for same length of time. The final temperature of paraffin was found to be greater than the final temperature of water. Explain the observation. (2mk)

- ✓ ***Water has a higher heat capacity than kerosene hence more heat is required to raise its temperature by one unit compared to kerosene with a lower heat capacity.***

5. A student states that when two bodies at different temperatures are brought into contact the resulting rise of temperature in one will be equal to the fall in temperature in the other. Give two reasons why this statement is wrong

- ✓ ***The bodies may be of different materials hence different specific heat capacities.***
- ✓ ***The bodies may differ in size hence different heat capacities.***

6. (i) Describe how you would attempt to measure the specific heat capacity of aluminium by method of mixtures. (3mk)

Take a piece of aluminium, weigh it and record the mass, m_A. Heat water in a beaker to its boiling point, θ_1. Place the aluminium block in the boiling liquid for some minutes. Weigh a plastic beaker, m_B (known heat capacity, C_B). Take a known mass, m_L of a liquid whose specific heat capacity is known, c_L and pour in the plastic beaker and determine its initial temperature, θ_0. Quickly transfer the block from the boiling water to the plastic beaker, stir and measure the final steady temperature of the mixture, θ_2. Using the formula below calculate the specific heat capacity of aluminium.

$$m_A c_A(\theta_1 - \theta_2) = m_B C_B + m_L c_L(\theta_2 - \theta_0)$$

(ii) State one source of experimental error in this method. (1mk)

- ✓ ***Errors when reading temperature***
- ✓ ***Some heat is lost to the surroundings***

(iii) Give one way you could take to reduce the magnitude of the error you have mentioned. (1mk)

- ✓ ***Using a lagged calorimeter in place of a plastic beaker/Lagging the plastic beaker.***

7. Briefly describe an experiment to determine the specific heat capacity of a liquid substance using the electrical method. (6mk)

Take a well lagged calorimeter whose mass is known, m_c. Measure the mass of the liquid, m_L and pour it into the calorimeter(of known heat capacity, C_C. Determine the initial temperature T_o and record. Place an immersion heater with a known power rating, P in the the liquid. Switch the heater on and start a stop watch simultaneously. Stir the liquid while heating for about 5 minutes. Switch the heater off and stop the watch. Make the final temperature, T_i reading and time, t used for heating and record.

Use the formula below to calculate the specific heat capacity of the liquid, c_L.

$$Pt = m_c C_c + m_L c_L (T_i - T_0)$$

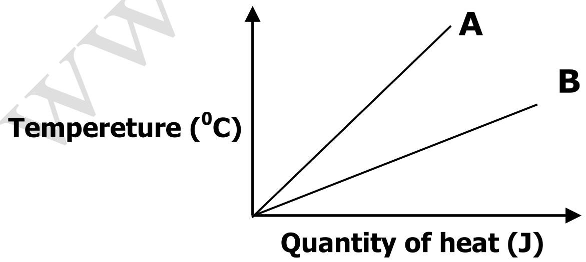
8. A liquid at 80°C in a cup was allowed to cool for 20 minutes. State **two** factors that determine the final temperature. (2mk)

- ✓ ***The surface area of the cup***
- ✓ ***The material making the cup***
- ✓ ***Temperature of the surroundings***

9. Equal masses of water and ice at 0^0C are added separately into two identical beakers containing equal amount of water. State the reason why ice may cause a greater change of temperature. (1mk)

- ✓ ***The ice has more heat to gain than water as it has to gain latent heat of fusion.***

10. Figure below shows the temperature changes against quantity of heat supplied to one kilogram each of liquids **A** and **B**.



Which of the two liquids has a high specific heat capacity? Give a reason.(2mk)

- ✓ ***B. more heat is required to raise its temperature compared to A.***

11. 500g of water at 20°c is mixed with 200g of water at **55°c**. Find the final temperature of the mixture.

$$Q_{lost}=Q_{gained}$$
$$m_1c\theta_1=m_2c\theta_2$$
$$0.2\times4200\times(55-T)=0.5\times4200\times(T-20)$$
$$46200-840T=2100T-42000$$
$$2940T=88200$$
$$T=30^0C$$

12. Calculate the heat evolved when **100g** of copper are cooled from **90⁰c** to **10⁰C.** (Specific Heat Capacity of Copper **= 390J/Kgk).**

$$Q=mc\theta$$
$$=0.1\times390\times80$$
$$= 3120J$$

13. An iron block of mass **20g** is left in water boiling at **95⁰C** for some minutes then transferred quickly to a well-lagged copper can of mass 40g containing 60g of water at **20⁰C**. The mixture is well stirred and the final temperature T is noted. Given that the specific heat capacity of copper = 400JKg^{-1}K^{-1}, Iron = 460JK^{g-1K-1} and water = 4200JK^{g-1K-1}, find the value of **T**.

$$Q_{lost}=Q_{gained}$$
$$m_bc_b(95-T)=m_cc_c(T-20) +m_wc_w(T-20)$$
$$0.02\times460(95-T)=0.04\times400(T-20)+0.06\times4200(T-20)$$
$$874-9.2T=16T-320+252T-5040$$
$$874-9.2T=268T-5360$$
$$277.2T=6234$$

$$T=22.50^0C$$

14. 100g of boiling water are poured into a metal vessel weighing 800g at a temperature of 20⁰C if the final temperature is 50⁰C. What is the specific heat capacity of the metal? (Specific Heat capacity of water 4.2 x 10^{3}J/kgk)

$$Q_{lost}=Q_{gained}$$
$$m_wc_w\theta=m_mc_m\theta$$
$$0.1\times4200\times(100-50)=0.8\times c_m\times(50-20)$$
$$21000=24c_m$$
$$c_m=875\ J/kg/K$$

15. You are provided with two beakers. The first beaker contains hot water at **70⁰C.** The second beaker contains cold water at **20⁰C**. The mass of hot water is thrice that of cold water. The contents of both beakers are mixed. What is the temperature of the mixture?

$$Q_{lost}=Q_{gained}$$
$$m_hc_h\theta=m_cc_c\theta$$
$$m_h=3m_c$$
$$3m_c \times4200\times(70-T)=4200\times m_c \times(T-20)$$
$$210-3T=T-20$$
$$4T=230$$
$$T=57.5^0C$$

16. Water at **24^0C** fall through a height of **72m** to the bottom of a dam. Calculate the temperature of the water at the bottom of the dam. (Take specific heat capacity of water as **$4200JKg^{-1}K^{-1}$**)

Potential Energy Lost=Heat energy gained

mgh=mc(T-24)

1x10x72=1x4200(T-24) (Taking a unit mass)

720÷4200=T-24

T=24+0.17

T=24.17^0C

17. A lead weight is dropped from a helicopter hovering at 100m above the ground. Assuming that all the energy is converted into heat energy, determine the rise in temperature of lead. Take specific heat capacity of lead to be 130J/kgk. (3mks)

Potential Energy Lost=Heat energy gained

mgh=mcθ

10x100=130θ

θ=7.7^0C

18. Water flows from a high dam down a vertical cliff 100m high. The temperature of the water reaching the ground is 23^0C Determine the temperature of water in the dam. Assume evaporation and sound produced due to the flow are negligible and the specific heat capacity of water is 4200J kg $^{-1}$ K^{-1} (3mk)

Potential Energy Lost=Heat energy gained

mgh=mc(23-T)

10x100=4200(23-T)

23-T=1000÷4200

T=23-0.24

=22.76^0C

19. An energy saving stove when burning steadily has an efficiency of **60%.** The stove melts **0.03kg** of ice at **0^0c** in **180 seconds**.

Calculate; -

i) The power rating of the stove.

Q=ml$_f$

=0.03x334000

=10020J

At 100% efficiency, Q=10020÷0.6

=16700J

P=Q/t

=16700÷180

=92.78W

ii) The heat energy wasted by the stove.

Heat lost=16700-10020

=6680J

20. Water at $\mathbf{20^0C}$ spills over a waterfall of height **10m**. Calculate the rise in temperature of water at the bottom of the waterfall if **80%** of potential energy at the top of waterfall is converted into heat at the bottom of the waterfall. Take specific heat capacity of water $\mathbf{4200J/kg^{-1}\,K^{-1})}$ (4mk)

Potential Energy Lost=Heat energy gained

$$mgh=mc\theta$$

$$0.8\times10\times10=4200\theta$$

$$80\div4200=\theta$$

$$\theta=0.019^0C$$

21. In a domestic oil-fired boiler, **0.5kg** of water flows through the boiler every second. The water enters the boiler at a temperature of $\mathbf{30^0C}$ and leaves at a temperature of $\mathbf{70^0C}$, re-entering the boilers after flowing around the radiators at $\mathbf{30^0C}$. $\mathbf{3.0\times 10^7J}$ of heat is given to the water by each kilogram of oil burnt. The specific heat capacity of water is $\mathbf{4200Jkg^{-1}K^{-1}}$

(i) Use the information above to calculate the energy absorbed by the water every second as it passes through the boiler

$$Q=mc\theta$$
$$=0.5\times4200\times(70-30)$$
$$=84000J/s$$

(ii) Use the same information above to calculate the mass of oil which would need to be burnt in order to provide this energy.

$$Mass=(1kg\times84000)\div30000000$$
$$=0.0028kg$$

ELECTRICAL METHOD

1. A heating element rated 2.5 kW is used to raise the temperature of 3.0 kg of water through 50^0 C. calculate the time required to effect this. (Specific heat capacity of water is 4200J/kgK). (3mk)

$$Pt=mc\theta$$
$$2500t=3.0x4200x50$$
$$t=630000\div2500$$
$$=252s$$

2. An electric heater rated 300 W heats some liquid of heat capacity 1680 J/K for 2 minutes. Find the rise in temperature. (3mk)

$$Pt=mc\theta$$
$$300x2x60=mx1680x\theta$$
$$36000=1680m\theta$$
$$\theta=36000\div1680m$$
$$=21.43K$$

3. An immersion heater rated 1500W is used to heat a block of ice of mass 500g initially at -10°C for 2.5 minutes. If the final temperature is 20°C determine the specific latent heat of fusion of the ice (Take specific heat capacity of water as 4200J/KgK, specific heat capacity of ice = 2100J/KgK) (4mk)

$$Pt=mc_i\theta+ml_f+mc_w\theta$$
$$1500x2.5x60=(0.5x2100x10)+(0.5xl_f)+(0.5x4200x20)$$
$$225000=10500+0.5l_f+42000$$
$$0.5l_f=225000-(10500+42000)$$
$$l_f=172500\div0.5$$
$$=345000J/K$$

4. An immersion heater takes a current of 10A when connected to 240V supply. If it is used to heat 5kg of water at 20^0C, find the temperature of water after 4 minutes of heating. (3 mks)

$$VIt=mc\theta$$
$$240x10x4x60=5x4200x(T-20)$$
$$576000=21000(T-20)$$
$$T-20=576000\div21000$$
$$T=27.42+20$$
$$=47.42°C$$

5. A hot-water tank for a house contains 150kg of water at 15^0C. The tank itself has a heat capacity of 6000 JK^{-1}. An immersion heater is used to heat the water to 50^0C. The tank is well insulated and the power of the heater is 2500W (specific heat capacity of water =4200 $JKg^{-1}K^{-1}$)

(i) Find the amount of heat transferred to the water (2mk)

$$Q=mc\theta$$
$$=150x4200x35$$
$$=22,050,000J$$

(ii) find how much heat is absorbed by the tank (2mk)

$Q=C\theta$

$=6000 \times 35$

$=210{,}000J$

(iii) Determine the time it will take the heater to raise temperature to 50^0C. (3mk)

$Q=Pt$

$22{,}050{,}000+210{,}000=2500 \times t$

$t=22260000 \div 2500$

$=8904s$

6. A metal cylinder of mass 500g is heated electrically. If the voltmeter reads 15V, the ammeter 3.0A and the temperature of the block varies from 20^0 C to 85^0 C in 10 minutes. Calculate the specific heat capacity of the metal cylinder.(3mk)

$VIt=mc\theta$

$15 \times 3.0 \times 10 \times 60=0.5 \times c \times (85-20)$

$27000=32.5c$

$c=830.8J/kg/K$

7. An-immersion heater rated **150W** is placed in a liquid of mass **5 kg**. When the heater is switched on for **25 minutes**, the temperature of the liquid rises from **20^0C - 270^0C**. Determine the specific heat capacity of the liquid. (Assume no heat losses)

$Pt=mc\theta$

$150 \times 25 \times 60=5 \times c \times 250$

$225000=1250c$

$c=225000 \div 1250$

$=180J/kg/K$

8. An immersion heater which takes a current of 3A from 240V mains raised the temperature of 10kg of water 30^0c to 50^0c. How long did it take?

$VIt=mc\theta$

$240 \times 3 \times t=10 \times 4200 \times 20$

$720t=840000$

$t=1166.67s$

9. An immersion heater rated **90W** is placed in a liquid of mass **2kg**. When the heater is switched on for **15** minutes, the temperature of the liquid rises from **20^0C** to **30^0C**. Determine the specific heat of the liquid.

$Pt=mc\theta$

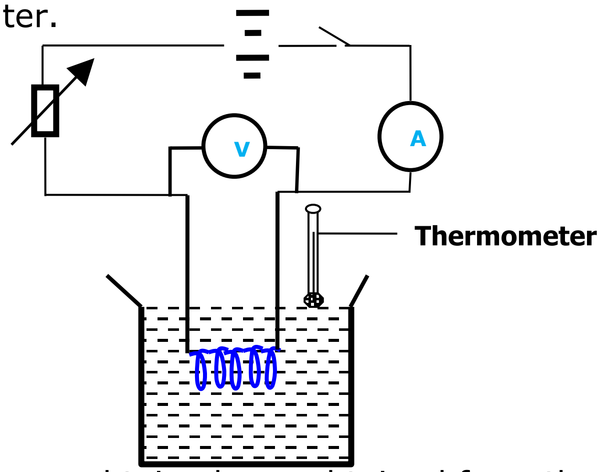
$90 \times 15 \times 60=2 \times c \times 10$

$81000=20c$

$c=81000 \div 20$

$=4050J/kg/K$

10. Figure below shows a set up in an experiment to determine specific heat capacity of water.



The data below was obtained was obtained from the experiment

- Voltage V across the heater **= 12V**
- Current I in the circuit **= 1.4A**
- Time (t) heating **= 600s**
- Mass m of water **= 0.4kg**
- Change in temperature ΔT **= 6ºc**

i) Define specific heat capacity

✓ ***The quantity/amount of heat required to raise the temperature of unit mass of a substance by one unit.***

ii) State two improvements that would be made in the set up to obtain accurate results.

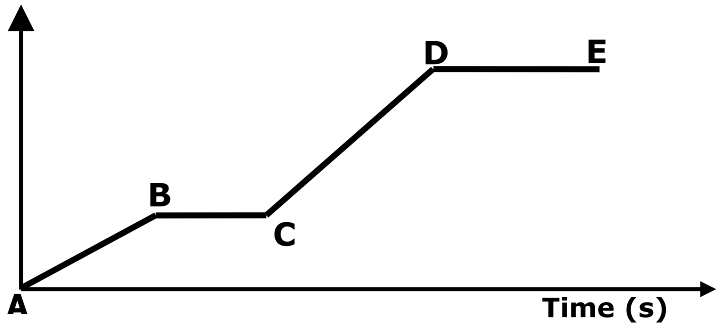
✓ ***Insulating the container with water to minimize heat losses***
✓ ***covering the container with a lid***
✓ ***Stirring the water to ensure uniform heating.***

iii) Use the above results to determine the specific heat capacity of water.

$$VIt = mc\theta$$
$$12 \times 1.4 \times 600 = 0.4 \times c \times 6$$
$$10080 = 2.4c$$
$$c = 4200 J/kg/K$$

GRAPH

1. The figure below shows a graph of the variation of temperature with time for a pure substance heated at a constant rate.

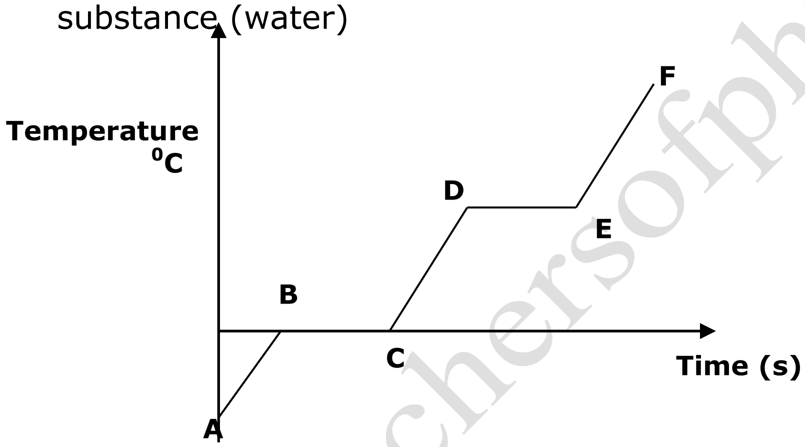


Assuming that heat transfer to the surrounds is negligible, state the changes observed on the substance in region.

a) **BC** ***Melting*** (1mk)

b) **DE** ***Boiling*** (1mk)

2. The figure below shows a graph of temperature against time for a given substance (water)



State what happens in the section labelled

(i) **BC** (1mk

✓ ***The particles absorb heat and acquire more kinetic energy at constant temperature and break away from the lattice.(melting)***

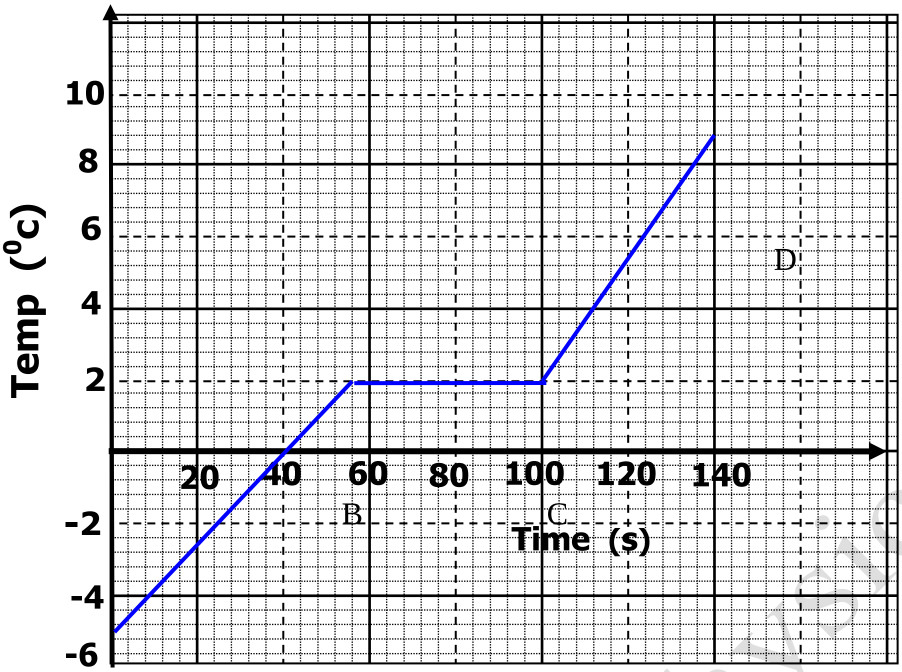
(ii) **CD** (1mk)

✓ ***Particles of the liquid absorb more heat and move faster due to increased kinetic energy. This leads to a rise in temperature.***

(iii) **DE** (1mk)

✓ ***The particles absorb heat and acquire more kinetic energy at constant temperature and break away from the liquid causing it to become vapour.***

3. A 250 g sample of a solid was heated steadily in a lagged colorimeter of negligible mass. The observations were represented in a graph as shown below.



(i) Explain the shape of the graph (3mks)

Between A and B particles of the solid gain more kinetic energy due to heating and move faster and over longer distances. This causes a rise in temperature.

Between B and C the temperature remains constant as all the heat absorbed is used to overcome the forces of attraction between particles leading to melting.

At CD there is a further raise in temperature as the heat absorbed raises the kinetic energy of the molecules causing them to move faster.

(ii) The solid requires 12.5J of energy to change its state. Calculate its specific latent heat of fusion. (2mks)

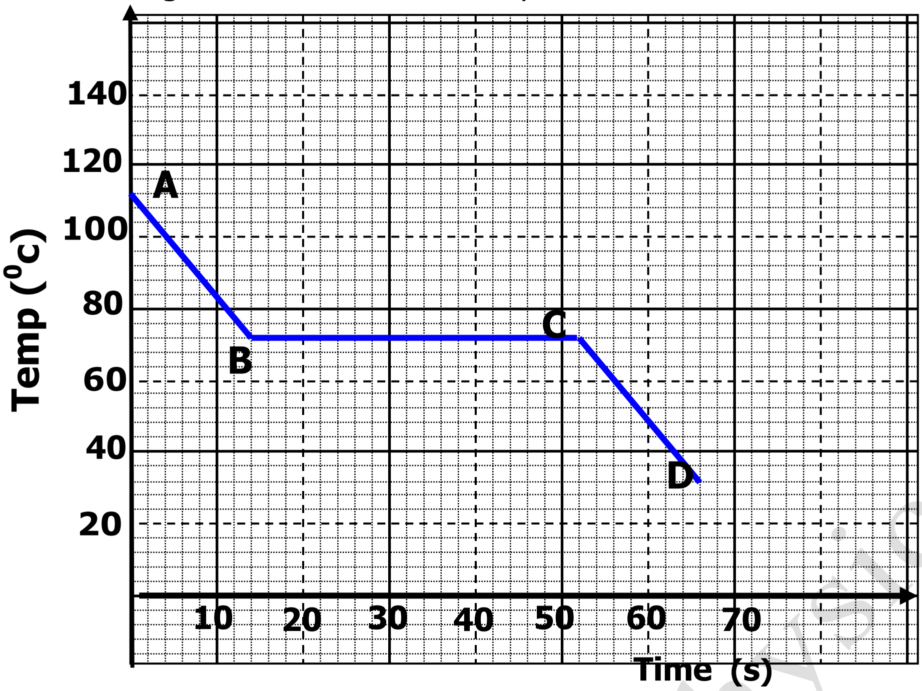
$Q = ml_f$

$12.5 = 0.25 l_f$

$l_f = 12.5 \div 0.25$

$= 60 J/kg$

4. The cooling curve below is for a pure substance



(a) What is the melting point of the substance (1 mk)

72^{0}C

(b) What point of the curve is the substance?

(i) solid (1mk)

CD

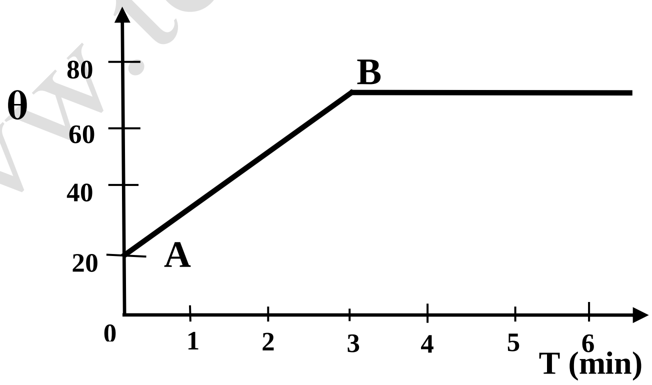
(ii) Liquid (1mk)

AB

(iii) Solid and liquid (1mk)

BC

5. Figure below shows the variation of temperature 'θ' with time t, when an immersion heater is used to heat a certain liquid. Study the figure and answer questions **(i)** and **(ii).**



(i) State the reason for the shape of the graph in the section labelled **BC**. (1mk)

The temperature remains constant despite further heating. The heat absorbed is used to overcome the forces of attraction between molecules.

(ii) Sketch on the same axes the graph for another liquid of the same mass but higher specific heat capacity when heated from the same temperature.(1mk)

6. In an experiment to determine the specific heat capacity of liquid, a student used **2.0kg** of each of the liquids, water, glycerin and paraffin. Each of the liquids was supplied with **21600J** of heat energy under the same conditions. The table below shows temperature rise for the liquids.

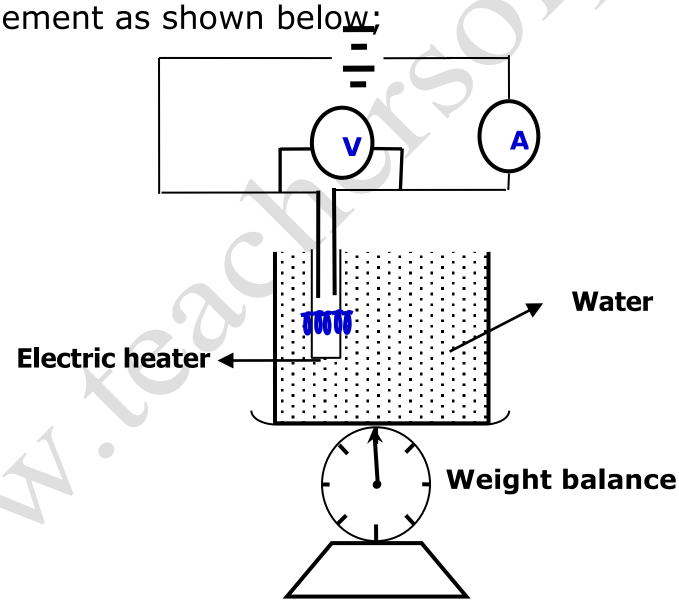
Liquid	**Water**	**Glycerine**	**Paraffin**
Temp' ^{0}c	**2.6**	**4.4**	**4.9**

(i) Suggest a reason for the difference in the rise of temperature. (1mk)
The liquids have different heat capacities with water having the highest and paraffin the lowest.

(ii) Calculate the specific heat capacity of paraffin (3mk)

Q=mcθ
21600=2.0xcx4.9
c=21600÷(2.0x4.9)
=2204.08J/kg/K

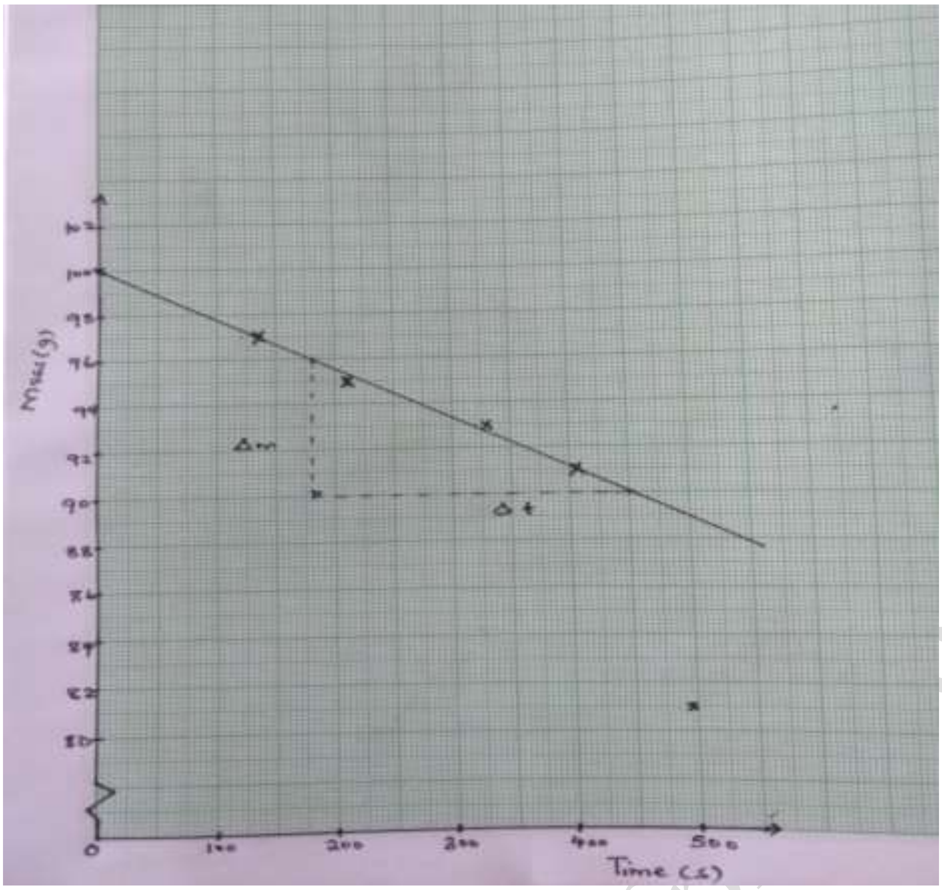
7. Njoroge wanted to determine the heat energy**, W,** required to change one kilogram of water into vapour at a constant temperature. He set up the arrangement as shown below;



He took the reading M, of the balance at a given time interval. He obtained the following data

Mass (g)	**100**	**97**	**95**	**93**	**91**	**81**
Time (s)	**0**	**135**	**210**	**330**	**405**	**495**

(a) Plot a graph of mass against time (5mk)



(b) Determine the gradient of the graph (3mk)

$$Gradient = \frac{\Delta mass}{\Delta time}$$
$$= \frac{96-90}{180-450}$$
$$= -0.0222 g/s$$

(c) What does the gradient represent? (1mk)

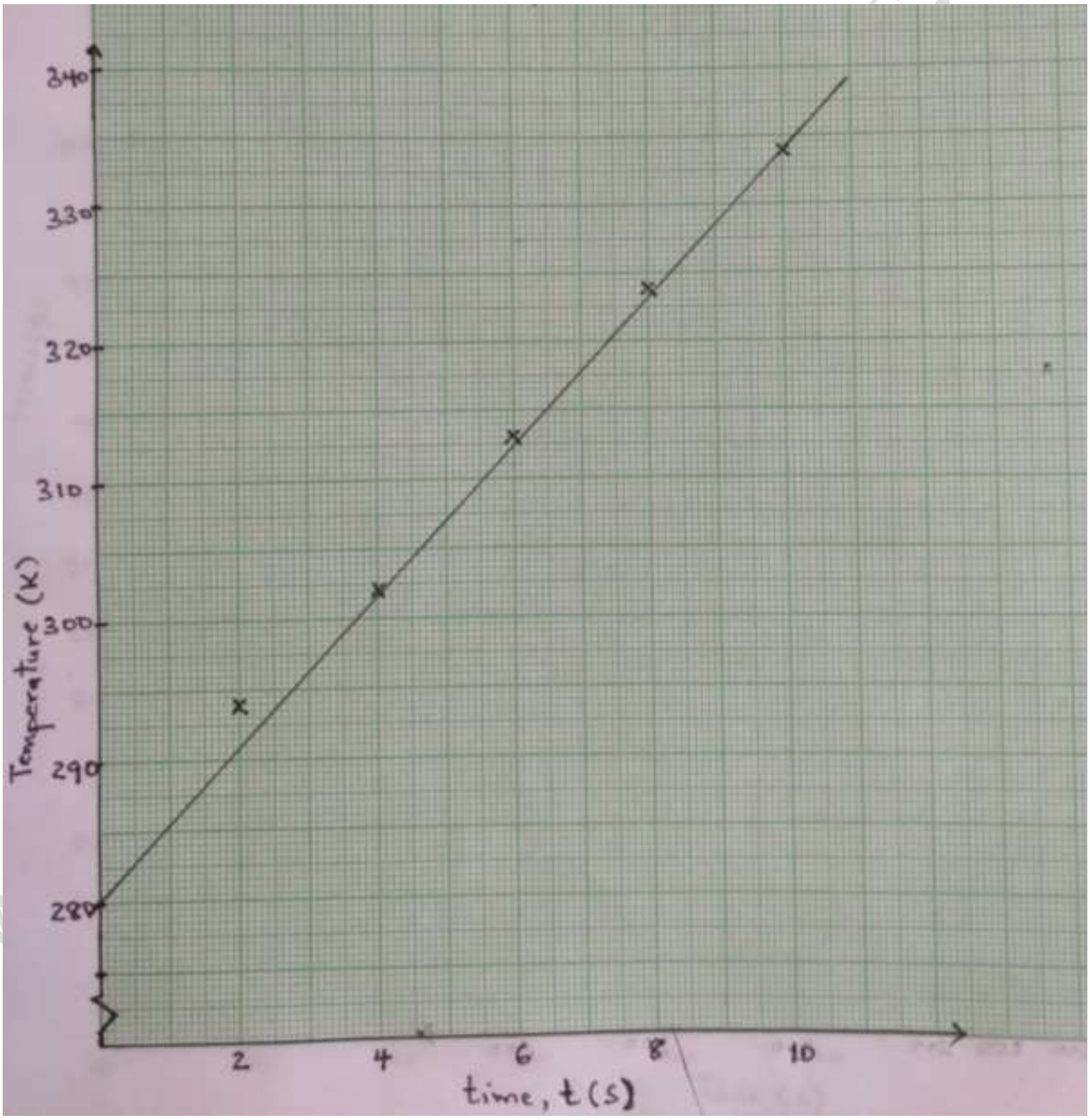
The mass of water evaporating per unit time.

(d) A steady current of **4A** and potential difference of **12V** were recorded during the experiment. Determine the value of **W**. (4mks)

11. A 125W heater and a thermometer were immersed in 0.6kg of oil in a vessel of negligible heat capacity. The following observations were noted.

Temperature (K)	**294**	**302**	**313**	**324**	**334**
Time (minutes)	**2**	**4**	**6**	**8**	**10**

a) Plot a suitable graph and use it to find: (4mks)



i) the average rise in temperature per minute. (2mks)

$$gradient = \frac{\Delta Temperature}{\Delta time}$$

$$= \frac{320-295}{7.5-2.8}$$

=5.3195K/s

ii) the temperature at which the heating started. (1mk)

y-intercept=280K

iii) Hence, calculate the specific heat capacity of the oil. (2mks)

Pt=mcθ

125x1=0.6xcx5.3195

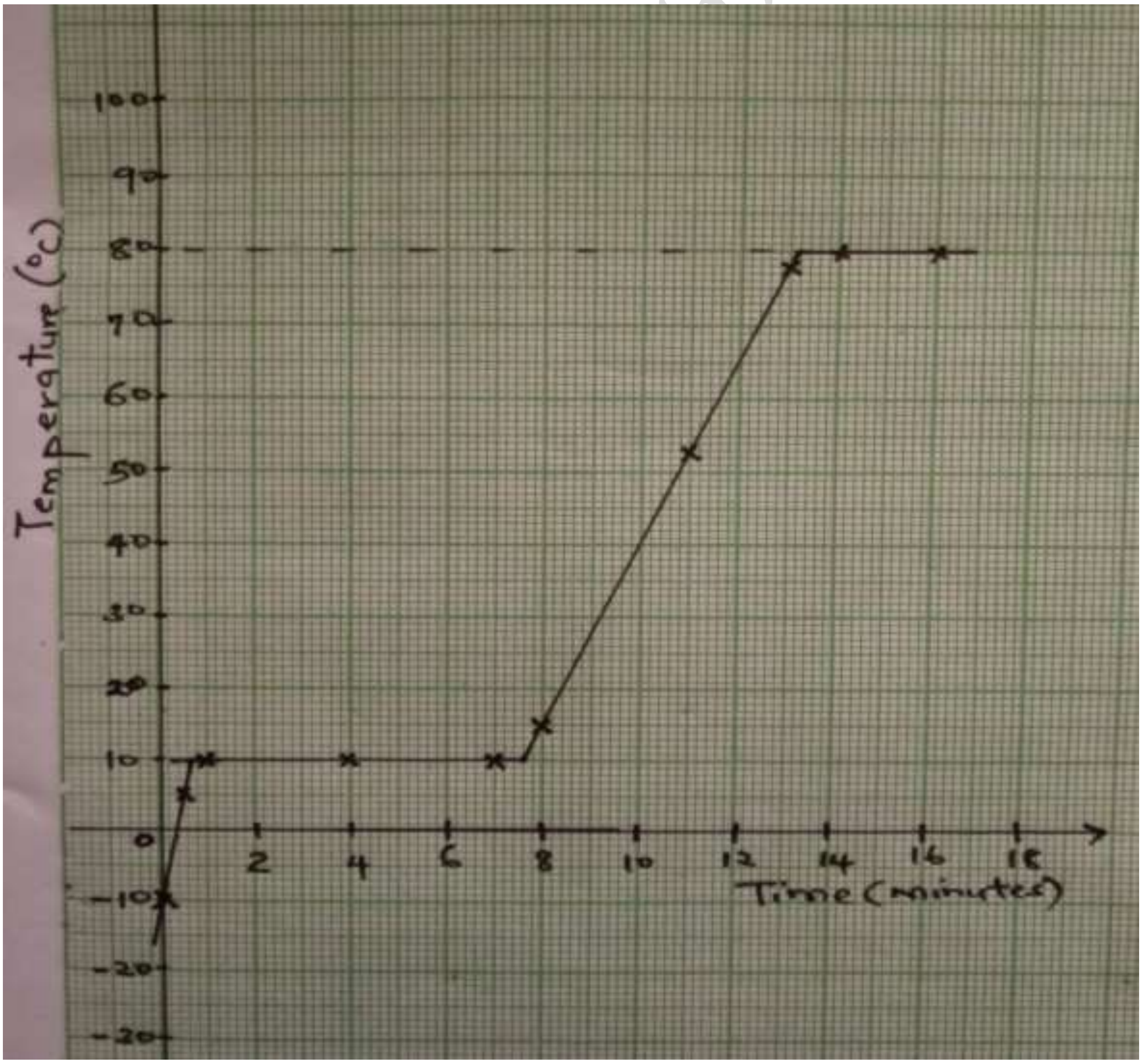
c=125÷(0.6x5.3195)

=39.16J/kg/K

8. The table below shows values of temperature against time for a pure substance subjected to heat

Time (min)	**0**	**0.5**	**1.0**	**4.0**	**7.0**	**8.0**	**11**	**13**	**14**	**16**
Temperature ^{0}C	**-10**	**5**	**10**	**10**	**10**	**15**	**53**	**78**	**80**	**80**

a) Draw a graph of temperature against time showing the effect of heating the solid substance (5mks)



b) From the graph, state the melting point and boiling point of the substance. (2mk)

Melting point= 10^0C
Boiling point= 80^0C

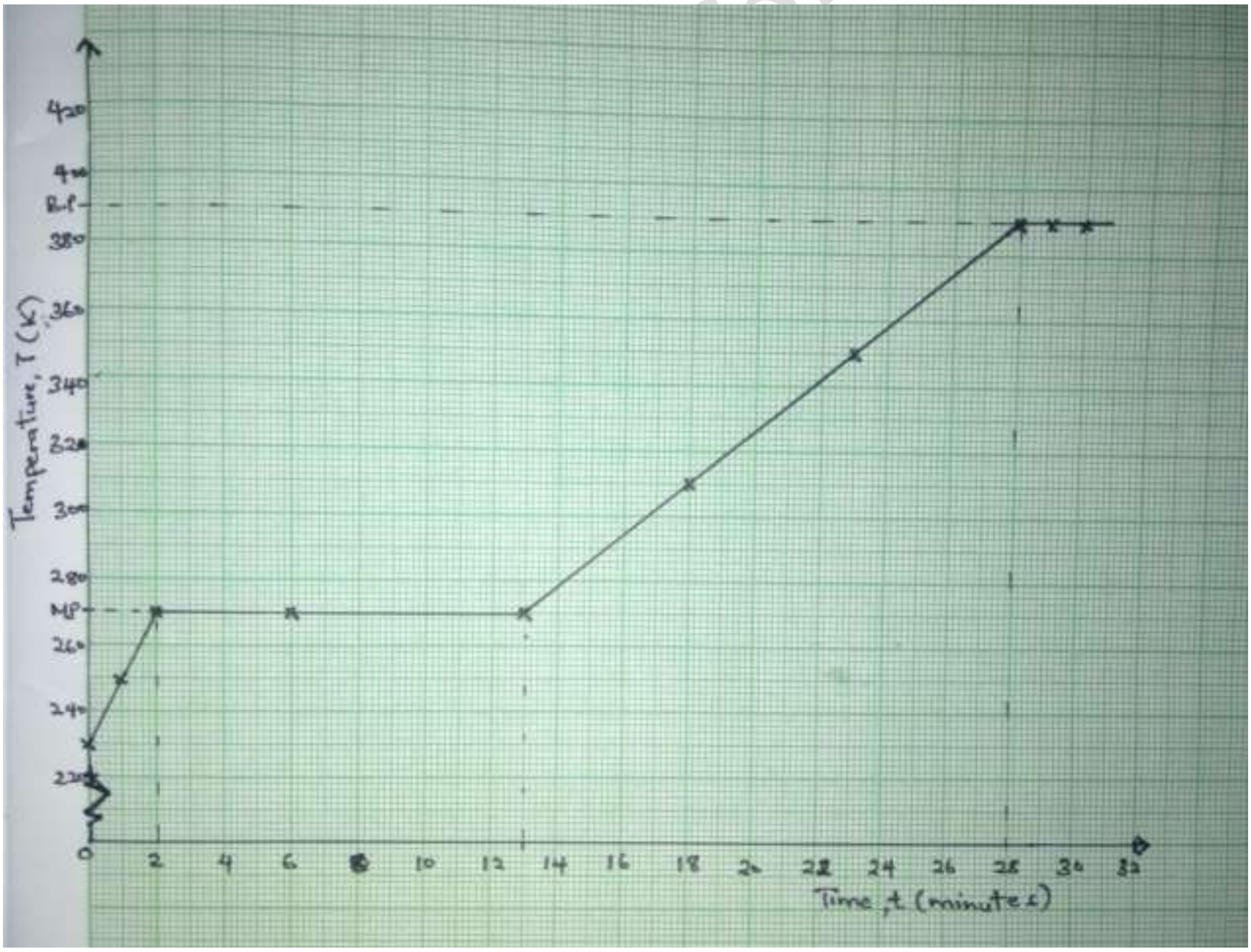
c) If the loss in mass of the substance during vaporization is 70g and the heat supplied at a rate of 720J/min, calculate the specific latent heat of vaporization n of the liquid substance (3mk)

Q=mn
720x(16-13.2)=0.07n
n=2128÷0.07
=30400J/kg

9. A 4g mass is receiving heat at the rate 100kJ per minutes and its temperature at various times recorded as follows

Time t (min)	**0**	**1**	**2**	**6**	**13**	**18**	**23**	**28**	**29**	**30**
Temperature T (K)	**230**	**250**	**270**	**270**	**270**	**310**	**350**	**390**	**390**	**390**

Plot a graph of temperature against time on the grid provided (4mks)



(a) Use your graph to find

(i) The specific heat capacity of the substance in its liquid state (3mk)

$Q=mc\theta$

$100000 \times 15 = 0.004 \times c \times 120$

$c = (100000 \times 15) \div (0.004 \times 120)$

$= 3125 kJ/K/kg$

(ii) Its boiling point (1mk)

390K

(iii) Its melting point (1mk)

270K

(iv) The specific latent heat of fusion of the substances (3mk)

$Q=ml_f$

$100000 \times 11 = 0.004 l_f$

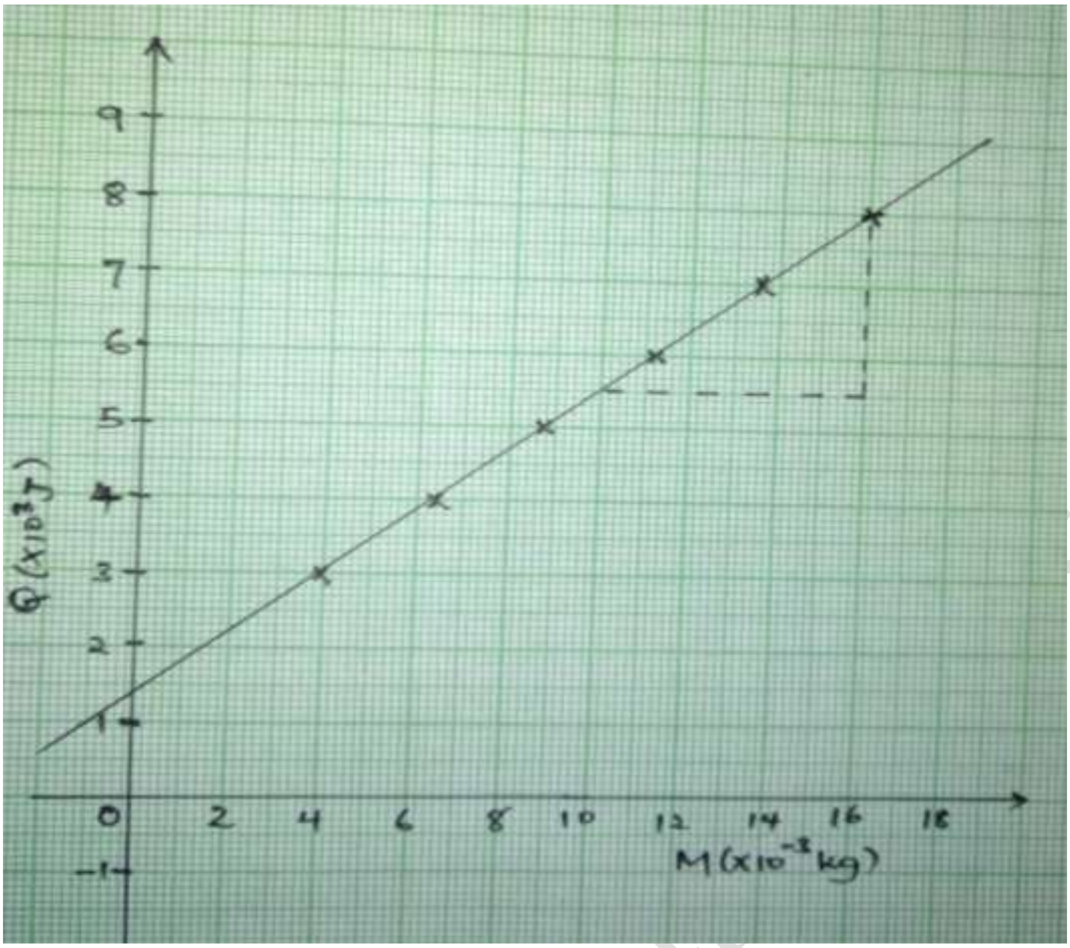
$l_f = 1100000 \div 0.004$

$= 275000 kJ/kg$

10. In an experiment to determine the specific latent heat of vaporization of a liquid using an electrical method, the amount of heat, Q, required to vaporize a given mass, m, of a liquid were recorded as shown.

Q (J) X 10^3	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**
M (kg) X10^{-3}	**4.0**	**6.4**	**8.8**	**11.2**	**13.6**	**16.0**

(i) On the grid provided plot a graph of Q (y-axis) against m. (5mks)



(ii) From the graph, determine the specific latent heat of vaporization of the liquid. (3mks)

$$gradient = \frac{\Delta Q}{\Delta M}$$

=(8-5.5)÷(16-10)

=4.167x10^{5}J/kg

(ii) Suggest a reason why the graph does not pass through the origin. (1mk)

Because there is some heat absorbed by the container holding the liquid.

(iv) Write a possible equation of this graph. (1mk)

LATENT HEAT OF FUSION AND VAPORIZATION

11. Define latent heat of fusion of a substance (1mk)

✓ ***The amount of heat energy required to change a given mass of a substance into a liquid from solid at constant temperature.***

12. Define specific latent heat of fusion of a substance (1mk)

✓ ***The amount of heat energy required to change a unit mass of a substance into a liquid from solid at constant temperature.***

13. Define specific latent heat of vaporization of a substance (1mk)

- ✓ ***The amount of heat energy required to change a unit mass of a substance into a vapour from liquid at constant temperature.***

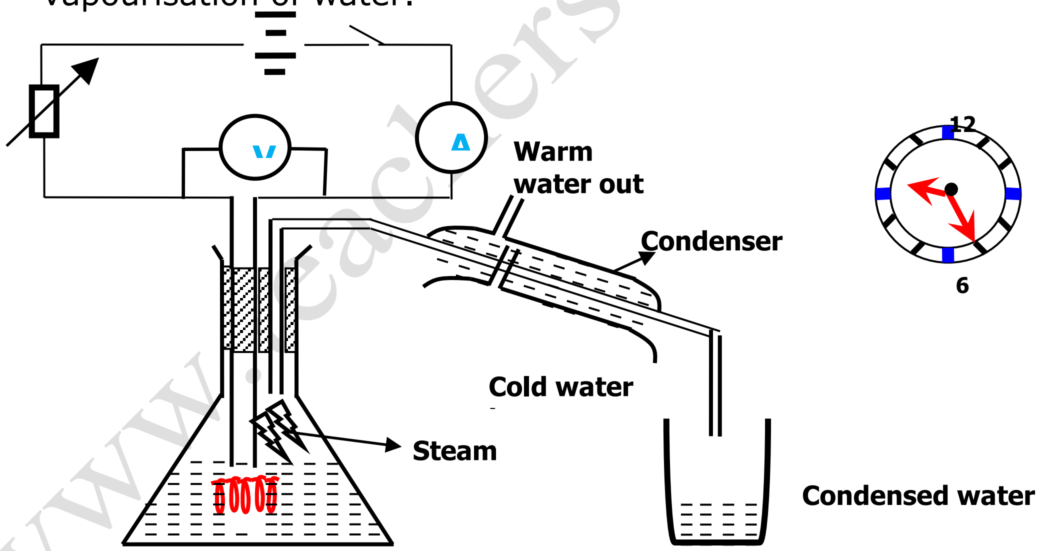
14. State **two** physical quantities that remain constant while pure ice is being converted to water.
- ✓ ***Temperature***
- ✓ ***Mass***

15. State two factors that affect the melting point of ice. (2mk)
- ✓ ***Pressure***
- ✓ ***Purity of the substance***

16. Explain why a burn from the steam of boiling water is more severe than that of water itself?
- ✓ ***Steam has absorbed latent heat of vaporization hence has more heat than boiling water which has no heat of vaporization.***

17. A burn from steam is more severe than one from water boiling at the same temperature .Give reasons.
- ✓ ***Steam has absorbed latent heat of vaporization hence has more heat than boiling water which has no heat of vaporization.***

18. The setup shown below was used to determine the specific latent heat of vapourisation of water.



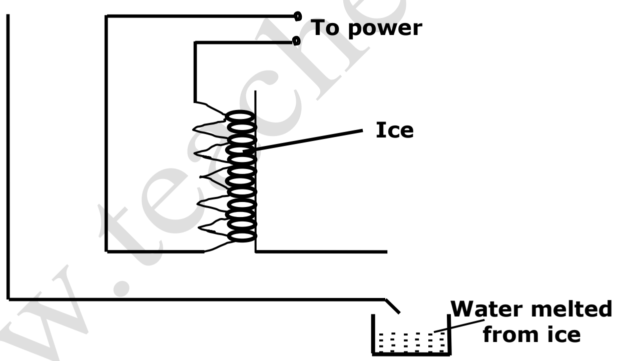
Describe how you would use the apparatus to determine the specific latent heat of vapourisation of water stating any assumption made and the measurements one would take. (6mks)

*Close the circuit and adjust the rheostat to get a steady reading of current, **I** and voltage, **V**. heat the water until it starts to boil. Measure the mass of the empty collecting beaker, m_1 and record it. Place the weighed beaker under the outlet of the condenser and simultaneously start the stop watch. When a sufficient amount of water has been collected in the beaker stop the watch and withdraw the beaker. Measure the weight of the beaker with water, m_2 and record. Note down also the* *time taken to collect the water, **t**. Use the formula below to determine the specific latent heat of vapourisation.*

$$c = \frac{VIt}{(m_2 - m_2)l_f}$$

19. You are provided with the following apparatus:A filter funnel, a thermometer, a stop watch, ice at **0°C**, an immersion heater rated **P** watts, a beaker, a stand, boss and clamp and a weighing machine. Describe an experiment to determine the specific latent heat of fusion of ice. Clearly state the measurements to be made. (4mk)

20. In an experiment to determine the power of an electric heater, melting ice was placed in a container with an outlet and the heater placed in the ice as shown below. The heater was connected to a power supply and switched on for some time. The melted ice was collected.



a) Other than the current and voltage, state the measurement that would be taken to determine the quantity of heat absorbed by the melted ice in unit time. (2mk)
- *Amount of time*
- *Mass of melted ice*

b) If the latent heat of fusion of ice is L, show how measurements in (i) above would be used in determining the power P, of the heater, (2mk)

*pxt=mxL where **t** is the amount of time, **m** is the mass of melted ice*

$$p = \frac{mxL}{t}$$

c) It is found that the power determined in this experiment is lower than the manufacturer's value indicated on the heater. Explain. (1mk)

Some heat energy from the heater is lost to the surrounding

CALCULATIONS

1. **50g** of steam at **100°C** was passed into cold water at **20°C**. The temperature on the water rose to **60°C**. Determine the mass of cold water used (specific heat capacity of water **= 4200J/KgK** and specific latent heat of vapourisation of water **= 2.26 x 10^6 JKg-1**) (4mk)

heat lost by steam=heat gained by cold water

$m_sL_v+mc\Delta\theta=m_wc_w\Delta\theta_w$

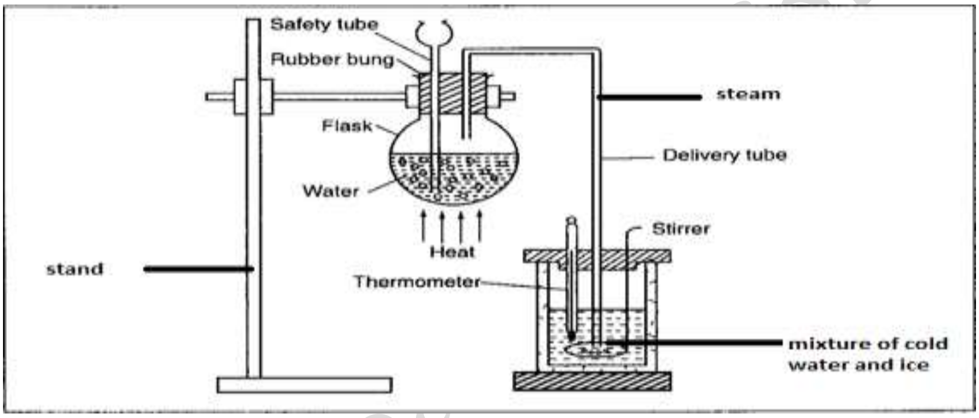
$0.05x2.26x10^6+0.05x4200x(100-60)=m_wx4200x(60-20)$

$121400=168000m_w$

$m_w=0.7226Kg$

2. Dry steam is passed into a well-lagged copper can of mass **250g** containing **400g** of water and **50g** of ice at **0^0**. The mixture is well stirred and the steam supply cut off when the temperature of the can and the contents reach **20^0C**.

(a) Draw an experiment set-up that can be used to find the mass of steam condensed (4mk)



(b) Neglecting heat losses, find the mass of steam condensed (4mk)

Heat lost by steam=heat gained by (copper can +water+ice)

$m_sL_v+m_sc_w\Delta\theta_{w1}=m_cc_c\Delta\theta_{w2}+m_wc_w\Delta\theta_{w2}+m_iL_f+m_ic_w\Delta\theta_{w2}$

$m_sx2.26x10^6+m_sx4200x(100-20)=0.25x390x(20-0)+0.4x4200x(20-0)+0.05x3.340x10^5+0.05x4200x(20-0)$

$2.56x10^6m_{s=}5.645x10^4$

$m_s=0.0221Kg$

3. In an experiment to determine the specific latent heat of vaporization of water steam at **100^0C**was passed into water contained in a well lagged Calorimeter, the following measurements were made.

Mass of calorimeter	=60g
Initial mass of water	=80g
Final mass of calorimeter + condensed stem.	=143g.
Initial temperature of mixture	=17^0C
Final temperature of mixture	=32^0C
Specific heat capacity of copper	=390J/KgK

i) Determine the mass of condensed steam. 1mk

$m_s=143-(80+60)$

$=3g$

ii) Determine the heat gained by calorimeter and water. 3mk

$Q = m_c c_c \Delta\theta + m_w c_w \Delta\theta$

$0.06x390x(32-17)+0.08x4200x(32-17)$

$=5391J$

iii) Determine the latent heat of vaporization of steam. 3mk

Heat lost by steam=heat gained by (copper can +water)

$$m_s L_v + m_s c_w \Delta\theta_{w1} = m_c c_c \Delta\theta_{w2} + m_w c_w \Delta\theta_{w2}$$

$$0.003xL_v + 0.003x4200x(100-32) = 5391$$

$$L_v = 1.5117x10^6 J/Kg$$

4. In an experiment to determine the specific latent heat of vaporization of water, steam at **100^0c** was passed into water contained in a well-lagged copper calorimeter. The following measurements were made:

- Mass of calorimeter = **50g**
- Initial mass of water = **70g**
- Final mass of calorimeter **+** water **+** condensed steam = **123g**
- Initial temperature of water = **5^oc**
- Final temperature of mixture = **30^0C**

(Specific heat capacity of water = **4200 J kg $^{-1}$K** and specific heat capacity for copper = **390 J kg $^{-1}$ K^{-1}**)

Determine the

a) Mass of condensed steam

$m_s=123-(50+70)$

$=3g$

b) Heat gained by the calorimeter and water

$Q=m_c c_c \Delta\theta + m_w c_w \Delta\theta$

$0.05x390x(30-5)+0.07x4200x(30-5)$

$7837.5J$

c) Given that **L** is the specific latent heat of evaporation of steam

(i) Write an expression for the heat given out by steam

$0.003L+1197J$

(ii) Determine the value of **L**.

0.003L+0.003x4200x(100-5)=7837.5

$L=2.2135x10^6$ J/Kg

5. Steam of **mass 3.0g** at **100^0c** is passes into water of mass **400g** at **10^0c.** The final temperature of the mixture is T. The container absorbs negligible heat. (Specific latent heat of vaporization of steam= **2260 kJ/kg,** specific heat capacity of water= **$4200Jk^{-1}$**)

i) Derive an expression for the heat lost by the steam as it condenses to water at temperature **T**. (2mk)

$Q_S=0.003x2260000+0.003x4200x(100-T)$

$6780+1260-12.6T$

$=8040-12.6T$

ii) Derive an expression for the heat gained by the water. (2mk)

$Q_W=m_wc_w\Delta\theta$

$=0.4x4200x(T-10)$

$1680T-16800$

iii) Determine the value of **T**. (2mk)

heat lost=heat gained

$8040-12.6T=1680T-16800$

$1692.6T=24840$

$T=14.68℃$

6. What mass of steam initially at 130^0C is needed to warm 200g of water in a glass container of mass 100g from 20^0C to 50^0C.?

Specific heat capacity of steam = $200JKg^{-1}K^{-1}$

Specific heat capacity of water = $4200\ JKg^{-1}K^{-1}$

Specific latent heat of vaporization of water = $2.26\ x\ 10^6JKg^{-1}$

Specific heat capacity of glass = $840JK^{-1}K^{-1}$ 4mks

Hear lost = heat gained

$m_sc_s\Delta\theta_1+m_sL_v+m_sc_w\Delta\theta_2=m_wc_w\Delta\theta_3+m_gc_g\Delta\theta_3$

$m_sx200x(130-100)+m_sx2.26x10^6+m_sx4200x(100-50)=0.2x4200x(50-20)+0.1x840x(50-20)$

$2476000m_s=27720$

$m_s=0.0112Kg$

7. A can together with stirrer of total heat capacity **60J/k** contains **200g** of water at **10^0 c.** dry steam at**100^0c** is passed in while the water is stirred until the whole reaches a temperature of **30^0c** Calculate the mass of steam condensed.

Heat lost by steam= heat gained by(can+water)

$m_sL_v+m_sc_w\Delta\theta=C\Delta\theta+m_wc_w\Delta\theta$

$m_sx2.26x10^6+m_sx4200x(100-30)=60x(30-10)+0.2x4200x(30-10)$

$2554000m_s=18000$

$m_s=0.00705Kg$

8. 0.02kg of ice and 0.01kg of water 0^0c are in a container. Steam at 100^0c is passed in until all the ice is just melted. How much water is now in the container?

Heat absorbed by ice=heat lost by steam

$m_iL_f=m_sl_v+m_sc_w\Delta\theta$

$0.02x3.34x10^5=m_sx2.26x10^6+m_sx4200x(100-0)$

$2680000m_s=6680$

$m_s= 0.0025Kg$

total mass=0.02+0.01+0.0025

=0.0325Kg

9. **200 g** of ice **at 0°C** is added to **400g** water in a well lagged calorimeter of mass **40g.** The initial temperature of the water was **40°C.** If the final temperature of the mixture is **X°C**, (Specific latent of fusion of ice **L = 3.36 x 10^5 Jkg^{-1}**, specific heat capacity of water, **C = 4200$Jkg^{-1}K^{-1}$**, specific heat capacity of copper = **400 $Jkg^{-1}K^{-1}$.)**

(i) Derive an expression for the amount of heat gained by ice to melt it and raise its temperature to **X°C** (2mk)

$Q=m_iL_f+m_ic_w\Delta\theta$

$0.2x3.36x10^5+0.2x4200(x-0)$

=67200+840x joules

(ii) Derive an expression for the amount of heat lost by the calorimeter and its content when their temperature falls **to X°C**. (2mks)

$Q=m_wc_w\Delta\theta+m_cc_c\Delta\theta$

=0.4x4200(40-x)+0.04x400x(40-x)

=67840-1696x Joules

(iii) Determine the value of **X**. (3mks)

Heat lost=hear gained

67840-1696x=67200+840x

X=0.252℃

10. In an experiment to determine the specific latent heat of vaporization L of water, steam at 100°C was passed into water contained in a well legged copper calorimeter. The following measurements were made.

Mass of calorimeter = 80g
Initial mass of water = 70g
Initial temperature of water = 5°C
Final mass of calorimeter + water +condensed steam =156g
Final temperature of mixture = 30°C
Specific heat capacity of water = 4200$JKg^{-1}K^{-1}$and specific heat capacity for copper = 390$J/Kg^{-1}K^{-1}$)

(a) Determine the:

(i) Mass of condensed steam (2mks)

Mass=156-(80+70)

=6g

(ii) Heat gained by the calorimeter and water (1mk)

$Q=m_cc_c\Delta\theta+m_wc_w\Delta\theta$

0.08x390x(30-5)+0.07x4200x(30-5)

=8130J

(b) Given that L. is the specific latent heat of vaporization of steam

(I) Write an expression for the heat given out by steam. (1mk)

$Q=m_s l_v+m_s c_w \Delta\theta$

$0.006Lv+0.006x4200x(100-30)$

$=0.006L_v+1764$

(II) Determine the value of L (3mks)

Heat lost=heat gained

$0.006Lv+1764=8130$

$L_v=1.06x10^6 J/Kg$

11. In an experiment to determine specific latent heat of water, steam at **100^0C** was passed into the water container, the following measurements were made.

- Initial temperature of water = **15^0C**
- Mass of Calorimeter = **60g**
- Initial mass of water = **80g**
- Final mass of water + calorimeter + condensed steam = **160g**
- Final temperature of mixture = **40^0C**
- Specific heat capacity of water = **4200 J/Kg**
- Specific heat capacity of copper = **390J/Kgk**

(a) Calculate

(i) Mass of condensed steam. (1mk)

Mass=160-(60+80)

=20g

(ii) Heat gained by calorimeter and water. (5mk)

$Q=m_c c_c \Delta\theta+m_w c_w \Delta\theta$

$0.06x390x(40-15)+0.08x4200x(40-15)$

=8985J

(b) Given that **L_v** is the specific latent heat of vaporization of steam.

i) Write an expression for the heat given out by steam. (1mk)

$Q=m_s l_v+m_s c_w \Delta\theta$

$0.02L_v+0.02x4200x(100-40)$

$0.02L_v+5040$

ii) Determine the value of **L_v.** (3mk)

heat lost= heat gained

$0.02L_v+5040=8985$

$L_v=1.9725x10^5 J/Kg$

12. In an experiment to determine the specific latent heat of vaporization of water. Steam at 100^0C was passed into water container in a well lagged calorimeter. The following results were obtained Mass of calorimeter =50g

- Initial temperature of water $=20^0C$
- Initial mass of water =60g
- Final mass of calorimeter +water +condensed steam =115g
- Final temperature of mixture $=30^0C$
- Specific heat capacity of water =4200J/kgk
- Specific heat capacity of copper =400J/kgk

(a) **Draw** a possible set up that can be used in the above experiment (3mks

(b) **Determine.**

(i)The mass of condensed steam (1mk)

Mass=115-(60+50)

=5g

(ii)The heat gained by the calorimeter and water (3mks)

$Q=m_wc_w\Delta\theta+m_cc_c\Delta\theta$

$=0.06x4200x(30-20)+0.05x390x(30-20)$

$=2715J$

(c) Given that L is the specific latent heat of vaporization of steam,

(i)Write down an expression for the heat given out by steam (1mk)

$m_sL+m_sc_w\Delta\theta$

$0.005L+0.005x4200x(100-30)$

$0.005L+1470J$

(ii)Determine the value of L (2mks)

Heat supplied= heat gained

$0.005L+1470=2715$

$L=2.49x10^5 J/Kg$

13. Water of mass 200g at a temperature of 60^oC is put in a well lagged copper calorimeter of mass 80g. A piece of ice at 0^oC and mass 20g is placed in the calorimeter and the mixture stirred gently until all the ice melts. The final temperature of the mixture T is then measured (Latent heat of fusion of ice = **$33400Jkg^{-1}$**, specific heat capacity of water = **$4200Jkg^{-1}K^{-1}$**)

Determine:

(i) The heat absorbed by the melting ice at 0^oC (2mks)

$Q=mL_f$

$0.02x\ 334000$

$=6680J$

(ii) The heat absorbed by the melted ice (water) to rise to temperature T (2mks)

$Q=mc\Delta\theta$

$0.02x4200x(T-0)$

$=84T$

(iii) The heat lost by the warm water and the calorimeter (Specific heat capacity of the calorimeter = $900Jkg^{-1}K^{-1}$) (2mks)

$Q=m_wc_w\Delta\theta+m_cc_c\Delta\theta$

$0.2x4200x(60-T)+0.08x900x(60-T)$

$54720-912T$ ***J***

(iv) The final temperature T of the mixture (3mks)

Heat lost= heat gained
54720-912T=6680+84T
T=48.23℃

14. A copper block of mass **800g** is suspended in a freezing mixture **-60^{0}C** for some time and then transferred to a large volume of water at **0^{0}C**. A layer of ice is formed on the block. Take specific heat capacity of copper **=360JKg^{-1}K^{-1}**, latent heat of fusion **336,000JKg^{-1}**

i) Give a reason for the formation of ice (1mk)

The copper block absorbs latent heat fusion from the water at freezing point

ii) State the temperature of the copper block after this change is complete (2mk)

0℃

iii) Determine the mass of ice formed (3mk)

Heat lost=heat gained

$m_iL_f=m_cc_c\Delta\theta$

$m_i x336000=0.8x360x(0- -60)$

$m_i=0.05143Kg$

15. In a cooling system **100g** of steam at **100^{0}C** was passed into cold water at **40^{0}C**. The temperature rose to **70^{0}C (**specific heat capacity of water = **4200J kg^{-1}K^{-1}**, latent heat of vaporization of steam **= 2.2 x 10^{6}Jkg^{-1}**)

Calculate

i) Heat lost by steam (2mk)

$Q=mL_v$

$=0.1x2.26x10^6$

$=226000J$

ii) Heat lost by condensed steam (3mk)

$Q=mc\Delta\theta$

$=0.1x4200x(100-70)$

$=12600J$

iii) The mass of cold water used (3mk)

heat lost=heat gained

$226000+12600=m_w x4200x(70-40)$

$m_w=1.8937Kg$

16. Water of mass **400g** at a temperature of **60^{o}C** is put in a well lagged copper calorimeter of mass **160g**. A piece of ice at **0^{o}C** and mass **40g** is placed in the calorimeter and the mixture stirred gently until all the ice melts. The final temperature, **T**, of the mixture is then measured. Determine;

(i) The heat absorbed by the melting ice **at 0^{o}C** (2mk)

$Q=mL_f$

$=0.04x334000$

$=13360J$

(ii) The heat absorbed by the melted ice (water) to rise the temperature **T** (Answer may be given in terms of **T**) (2mk)

$Q=mc\Delta\theta$
$=0.04x4200xT-0)$
$=168TJ$

(iii) The heat lost by the warm water and the calorimeter (The answer may be given in terms of **T**) (2mk)

$Q=m_wc_w\Delta\theta+m_cc_c\Delta\theta$
$=0.4x4200x(60-T)+0.16x900x(60-T)$
$=109440-1824TJ$

(iv) The final temperature **T** of the mixture (Specific latent heat of fusion of **ice** = **334000J/kg**, specific heat capacity of water **= 4200J/kgK**, specific heat capacity of copper **= 900J/kgK**) (4mk)

Heat lost=heat gained
$109440-1824T=13360+168T$
$T=48.23℃$

17. The melting point of a certain bullet is **300^{0}c**. If the initial temperature of the bullet is **20^{0}c** , determine the least speed at which the bullet would be moving so that it just melt when suddenly stopped. Specific heat capacity of bullet **= 840 J/kgK**; specific heat of fusion of material making bullet **= 6.3 x 10^4 J/kgK** (3mk)

KE of bullet=Heat energy of bullet
$\frac{1}{2}mv^2=mc\Delta\theta+mL_f$
$\frac{1}{2}v^2= 840(300-20)+63000$
$V=772.27m/s$

18. **32g** of dry ice was added to **200g** of water at **25^{0}C** in a beaker of negligible heat capacity. When all ice had melted the temperature of water was found to be **10^{0}C**. (Take specific heat capacity of water to be 4200JKg^{-1}K^{-1})

(i) **Calculate** the heat lost by water (2mks)

$Q=mc\Delta\theta$
$=0.2X4200(24-10)$
$= 11760J$

(ii) **Write** an expression for the heat gained by ice to melt and for temperature to rise to **10^{0}C**. (2mks)

$Q=m_iL_f+mc\Delta\theta$
$=0.032L_f+0.032x4200(10-0)$
$=0.032L_f+1344$

(iii) **Calculate** the specific latent heat of fusion of ice. (2mks)

Heat gained=heat lost
$0.032L_f+1344=11760$

L_f=3.255x10^5J/Kg

19. A jet of dry steam at 100^0C is sprayed on to the surface of 100g of dried ice at 0^0C contained in a well-lagged calorimeter of negligible heat capacity, until all the ice has melted and the temperature begin to rise. The mass in the calorimeter when the temperature reaches 40^0C is found to be
120g.Assuming that the specific latent heat of fusion of ice is 336000JKg^{-1}, specific heat capacity of water is 4200JKg^{-1}K^{-1}, **Determine** the specific latent heat vaporization of water. (4mks)

Heat lost by steam=heat gained by dry ice

$m_sL_v+m_sc_w\Delta\theta_1=m_iL_f+m_ic_w\Delta\theta_2$

$0.02L_v+0.02x4200x(100-40)=0.1x336000+0.1x4200x(40-0)$

$0.02Lv+5040=33600+16800$

$L_v=2.268x10^6J/Kg$

20. **5 grammes** of water at **20^0C** is heated until it boils at **95^0C.** On further heating the temperature of Water does not change until it has all evaporated.

(i) State what happens to the energy supplied to the water after attaining a temperature of **95^0C**. (1 mk)

The heat energy is absorbed as latent heat of vaporization. This energy breaks free the water molecules and some heat is used as the KE of the vapour.

i) Calculate the amount of heat required to convert all the **5g** of water to steam.
Latent heat of vaporization of water **= 2260000 J/Kg)** (6mk)

$Q=mc\Delta\theta+mL_v$

$=0.005x4200x(95-20)+0.005x2260000$

$=12875J$

21. What mass of steam initially at **130^0C** will raise the temperature of **2.0 Kg** of water contained in a **1.0 Kg** glass container, from **20^0C** to **50^0C?** (4mks)

- Specific heat capacity of steam = **200J Kg^{-1} K^{-1}**
- Specific heat capacity of water = **4200 J Kg^{-1} K^{-1}**
- Specific latent heat steam = **2.26 x 10^6 J Kg^{-1}** ✦ Specific heat capacity of glass = **840 J Kg^{-1} K^{-1}**

Heat lost= heat gained

$m_sc_s\Delta\theta_1+m_sL_v+m_sc_w\Delta\theta_2=m_wc_w\Delta\theta_3+m_gc_g\Delta\theta_3$

$m_sx200x(130-100)+m_sx2.26x10^6+m_sx4200(100-50)=2x4200x(50-20)+1x840x(50-20)$

6000ms+2260000ms+210000ms=252000+25200

Ms=0.112Kg

ELECTRICAL

1. An immersion heater rated 1000W is used to heat a block of ice of mass 500g initially at -10°C until the all the water evaporates at 95°C. Assuming that all the heat supplied is used to heat the ice, calculate the time in minutes for the whole process to take place. (Take specific heat capacity of water as 4200J/KgK, specific heat capacity of ice = 2100J/KgK specific latent heat of fusion = 3.35 x 10^5 J/Kg and specific latent heat of vapourization = 2.26 x 10^5J/Kg) (5mk)

$Pxt=mc_i\Delta\theta_1+mL_f+mc_w\Delta\theta_2+mL_v$

$1000xt=0.5x2100x(0- -10)+0.5x335000+0.5x4200x(95-0)+0.5x2260000$

$t= 1507.5s$

2. An electric kettle rated at 2.5kW contains 1.6kg of water. It is left switched on after boiling.

(i) How much heat energy will be used in turning all the water to steam?**(2mk)**

$Q=mL_v$

$1.6x2.26x10^6$

$3.616x10^6J$

(ii) Determine how long will it take for the 2.5kw kettle to boil dry **(2mk)**

$Pxt=mL_v$

$2500xt=3.616x10^6$

$t=1446.4s$

3. An electric heater rated at **1.5 kW** is used to melt **1.5 kg** of ice at **0°C**. Calculate the specific latent heat of fusion of ice, if it takes **5** minutes for the heater to melt all the ice. (3mk)

$pxt=mL_f$

$1500x5x60=1.5xL_f$

$L_f=3.0x10^5J/Kg$

4. A 180W heater is immersed in a copper calorimeter of mass 100g containing 200g of alcohol. When the heater is switched on after 36sec the temperature of the calorimeter and its contents raises by 12^0C. What is the specific heat capacity of alcohol. (SHC of Cu = 400J kg^{-1} K^{-1}) (4mks)

$Pxt=m_cc_c\Delta\theta+m_ac_a\Delta\theta$

$180x36=0.1x400x12+0.2xc_ax12$

$6480=480+2.4c_a$

$C_a=2500J/KgK$

5. An electric heater rated **6000W** is used to heat **1kg** of ice initially at **-10^0c** until all the mass turns to steam. Given that

- Latent heat of fusion = **334kJ kg^{-1}**
- Specific heat capacity of ice = **2,260J kg^{-1} K^{-1}**
- Specific heat capacity of water = **4, 200J kg^{-1} K^{-1}**

- Latent heat of vaporization = **2, 260KJ kg $^{-1}$ K $^{-1}$**

Calculate the minimum time required for this activity.

$Pxt=m_ic_i\Delta\theta_1+m_iL_f+m_wc_w\Delta\theta_2+mL_v$

$6000xt=1x2100(0- -10)+1x334000+1x4200x(100-0)+1x2260000$

$6000t=21000+334000+420000+2260000$

$t=505.83s$

EVAPORATION AND BOILING

1. Distinguish between evaporation and boiling (2 mks)

- *Evaporation occurs on the surface of the liquid while boiling occurs in the whole liquid*
- *Evaporation occurs at all temperatures while boiling occurs at a fixed temperature*
- *Decreasing the atmospheric pressure increases the rate of evaporation while decreasing atmospheric pressure lowers the boiling point*

2. State the **two** factors that affect the boiling point of water and in each case, explain how the boiling is affected. (4 mk)

i) Pressure- increase in pressure raises the boiling point

ii) Impurities-presence of impurities raises the boiling point

3. State two factors that would raise the boiling point of water to above **100^0c**

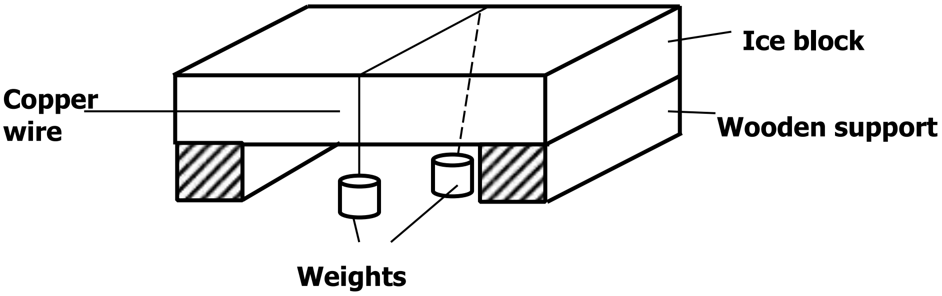
i) *Increase in pressure*

ii) *Presence of impurities*

4. When two pieces of ice blocks are squeezed together once they form one block. Explain

Squeezing exerts pressure between the blocks of ice making them melt at the junction at a temperature lower than its melting point. Once the ice has melted, the water formed solidifies when the force is withdrawn since it is no longer under pressure thus the two ice blocks form one block.

5. Figure below shows a block of ice with two heavy weights hanging such that the copper wire / string connecting them passes over the block of ice.



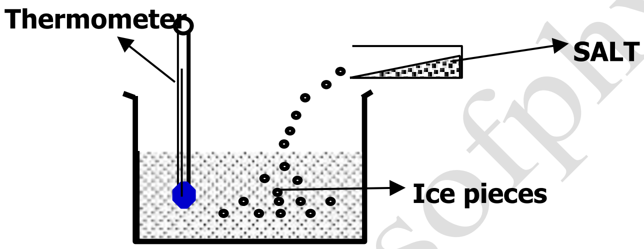
(i) It is observed that the wire gradually cuts its way through the ice block, but leaves it as one piece. Explain

The wire exerts pressure on the ice beneath it and therefore makes it melt at a temperature lower than its melting point. Once the ice has melted, the water formed flows over the wire and immediately solidifies since it is no longer under pressure.

(ii) What change would be observed if the copper wire used in the experiment was replaced by a cotton thread. Explain your answer.

Cotton thread will not cut through the ice block since it is a poor conductor of heat.

6. A student put some small pieces of ice in a beaker and sprinkled salt on the ice. He stirred until the ice melted and took the temperature of the content in the beaker- as shown.



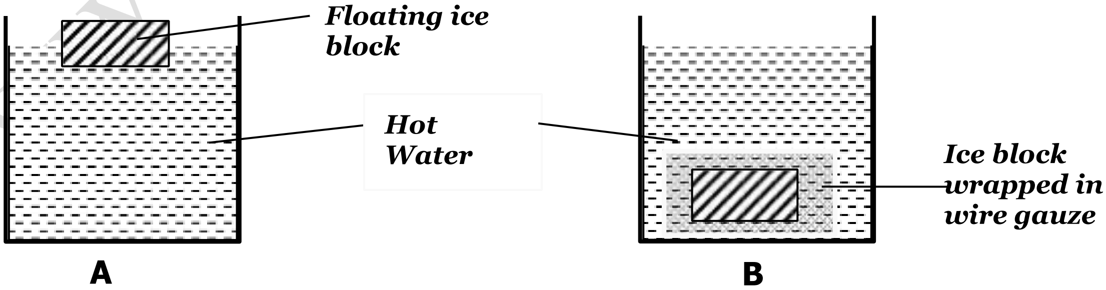
(i) **State** the observation made. (1mk)

Temperature is lowered

(ii) **Explain** the observation. (1mk)

Salt is an impurity and therefore lowers the melting point

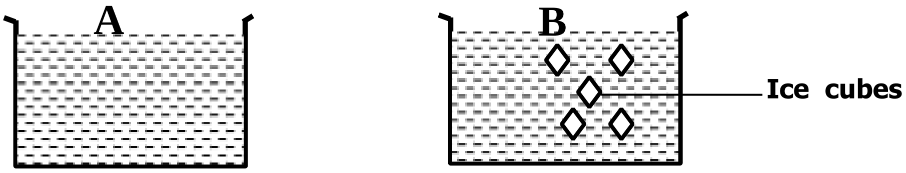
7. The figure below shows two identical containers A and B containing hot water and ice block.



State with reason which water cools faster assuming that the wire gauge absorbs negligible heat (2mk)

A cools faster than B- since cold water is more dense than warm water, in A warm water moves up to replace the cold water as the cold water moves down causing a convectional current hence water cools faster than in B where no convectional currents are formed

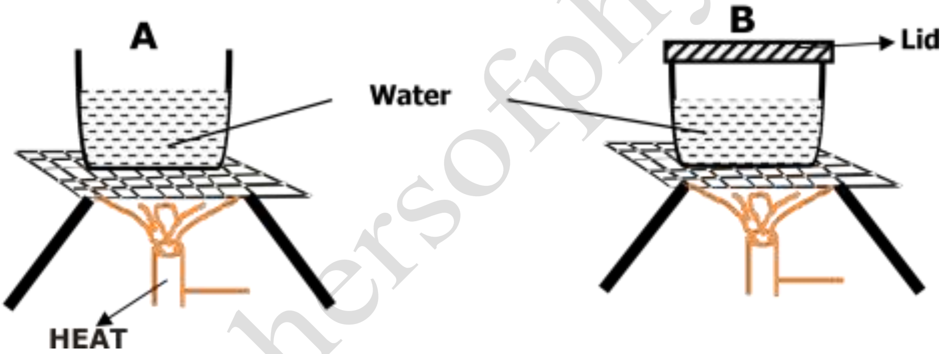
8. Figure below shows two identical beakers **A** and **B**. Beaker A contains water at **0°C** while **B** contains water and pieces of ice at **0°C**. Both contents have the same mass.



Two identical metal blocks are removed from the same hot furnace and dropped into each of the beakers. Identify which of the two beakers would experience more evaporation and give a reason for your answer.(2mk)

A experiences more evaporation-the ice cubes in B will absorb more heat due to latent heat of fusion hence less evaporation

9. Figure below shows two sufurias with equal amount of water R heated at the same rate.



i) State which water boiled first. A (1mk)

Explain your answer - (1mk)

Closing the sufuria causes an increase in vapour pressure within it. This makes it more difficult for molecules from the surface of the liquid to escape, raising the boiling point of the water. Hence water in B takes longer to boil.

10. The diagram below shows two cups of tea containing equal volumes of hot tea. The cups have different diameters.

State giving reasons, the cup whose tea will cool faster than the other. (2mk)

The cup with a wider diameter cools faster since it experiences a higher rate of evaporation

11. Ether is put into a beaker which is placed on a thin film of water. A student blows the ether through a pipe continuously. State and explain the observation made after some time **(2mk)**

Frost forms around the beaker. The evaporating ether draws latent heat of vaporization from the liquid ether, the beaker and the surrounding space.. Bubbling increases the surface area of ether exposed to air.

12. The rate of evaporation can be increased in a number of ways. State two ways in which this could be achieved **(2mk)**

increasing temperature

increasing the surface area of liquid exposed

decreasing atmospheric pressure

13. Some water is stored in a bag made of a porous material e.g. canvas which is hung where it is exposed to a draught of air (wind). Explain why the temperature of the water is lower than that of the air. (2 mk)

Water leaks out of the porous pot through very tiny pores and absorbs latent heat of vaporization from the pot as it evaporates thus lowering the temperature of water

14. Explain why food cooks faster in a pressure cooker than in an open sufurias

The pressure cooker has a tightfitting lid which causes an increase in vapor pressure within the pressure cooker. This makes it more difficult for molecules of the liquid to escape, raising the boiling point of the liquid thus food cooks faster

15. Explain why the cooling unit (freezer) inside a refrigerator is placed near the top but an elastic immersion heater in water tank should be near the bottom.(2mk)

The cooled air near the top of the refrigerator moves to the bottom since it is more dense creating space for warm air to move up to the cooling unit causing a connectional current.

Warm water at the bottom of the tank rises up since it is less dense than cold water

Giving room for cold water to move down to the heater through convectional current

16. A thin layer of water underneath a beaker containing ether freezes when air is blown through ether. Explain why the water freezes. (1mk)

As ether evaporates, it absorbs latent heat of vaporization from the beaker and water. This lowers the temperature of the beaker and water causing water to freeze

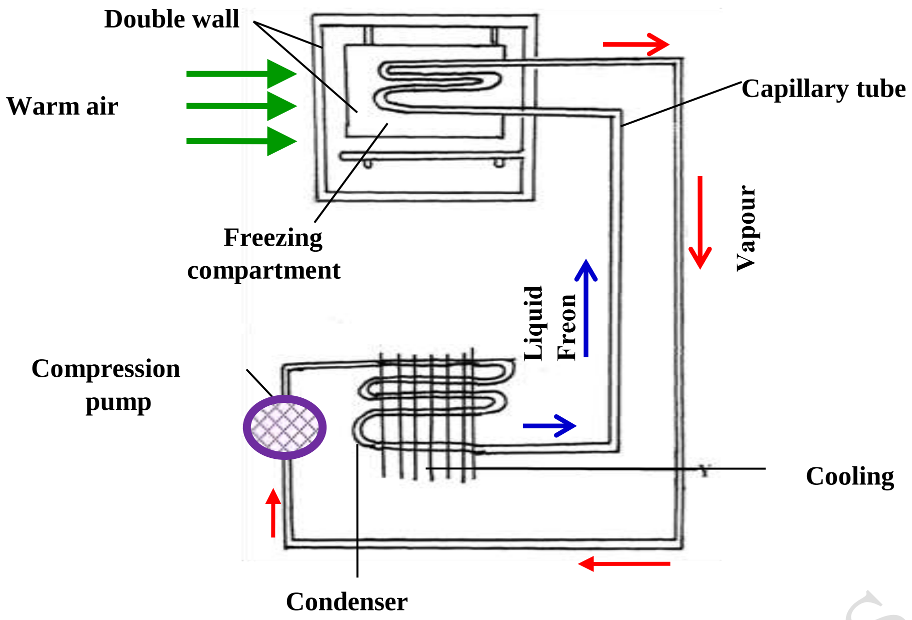
17. Hot milk in a bottle cools faster when wrapped in a wet cloth than when the bottle is immersed in cold water in a bucket. Explain why. (3 mk)

Water from the wet cloth absorbs latent heat of vaporization and evaporates causing cooling

18. State the property of Freon that makes it useful as a refrigerant liquid (1mk)

It is highly volatile

19. Figure shows the features of a domestic refrigerator. A volatile liquid circulates the capillary tubes under the action of the compression pump.



(i) State the reason for using a volatile liquid. (1mk)

It easily evaporates at low temperature

(ii) Explain how the volatile liquid is made to vaporize in the cooling compartment and to condense in the cooling fins. (2mk)

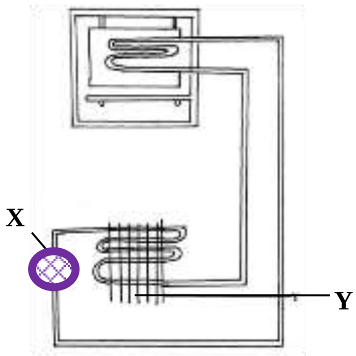
The volatile liquid takes latent heat from the air around and evaporates, causing cooling in cabinet.

(iii) Explain how cooling takes place in the refrigerator. (3mk)

In the upper coil, the volatile liquid (freon) takes latent heat from the air around and evaporates, causing cooling in cabinet. The vapour is removed by the pump into the lower coil outside the cabinet, where it is compressed and changes back to liquid form. During this process, heat is given out and conducted by the copper fins to the surrounding air. The liquid goes back to the copper coil and the cycle is repeated.

(iv) **(iv)** What is the p urpose of the double wall? (1mk)

20. Figure below shows a domestic electric refrigerator



(i) Label the parts

X_______*compressor pump*_____ (1mk)

Y_______*copper fins*_____ (1mk)

(ii) What property is considered when selecting the liquid used as refrigerant? (1mk)

The liquid must be volatile

(iii) If you stand near the back of a refrigerator you feel warm. Explain.

During the cooling process, heat is given out and conducted by the copper fins to the surrounding air. (1mk)

(iv) Explain how the refrigerator works (4mks)

The highly volatile liquid (Freon) takes latent heat of vaporization from contents(food)in refrigerator and evaporates. The pump removes the vapor into lower coil outside the cabinet where it is compressed and changed to liquid form. The evaporator and condenser pipes are highly coiled to increase surface area for absorption and loss of heat respectively.

The pipes are made of good conductor of heat (copper) to increase heat conductivity.

The copper fins enhance heat surrounding at the condenser pipe.

