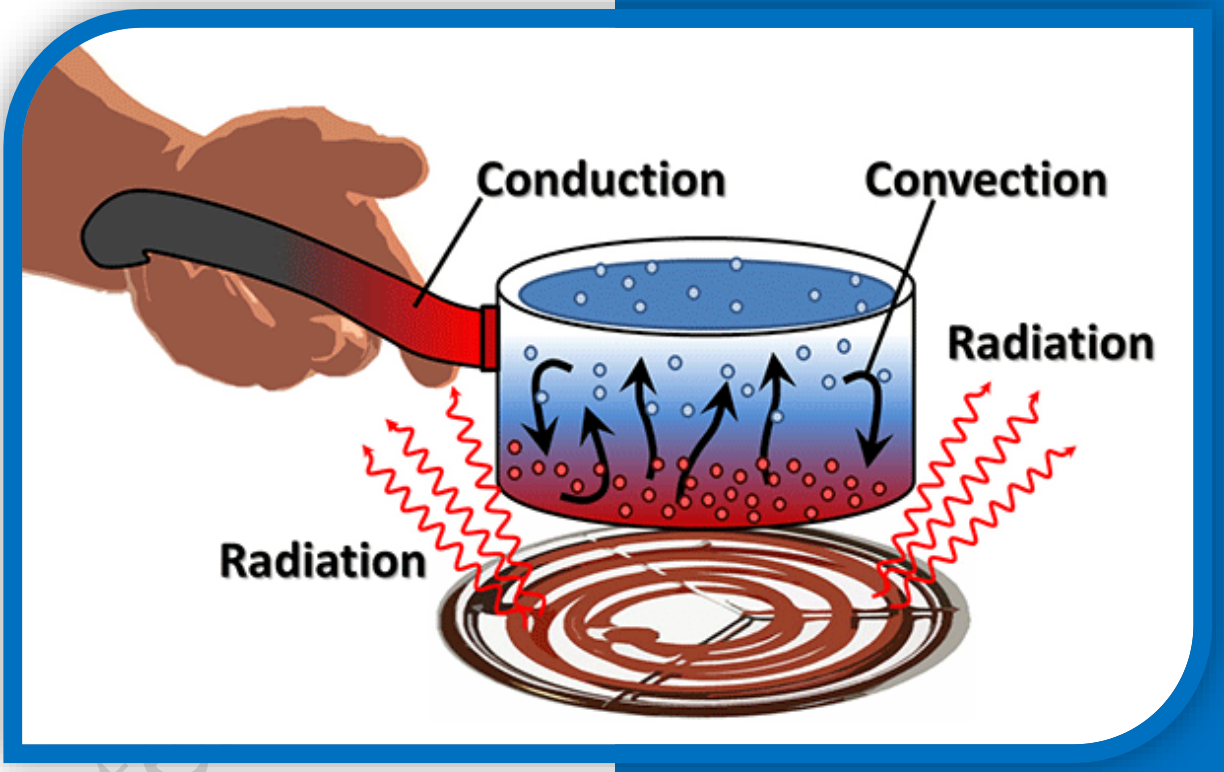
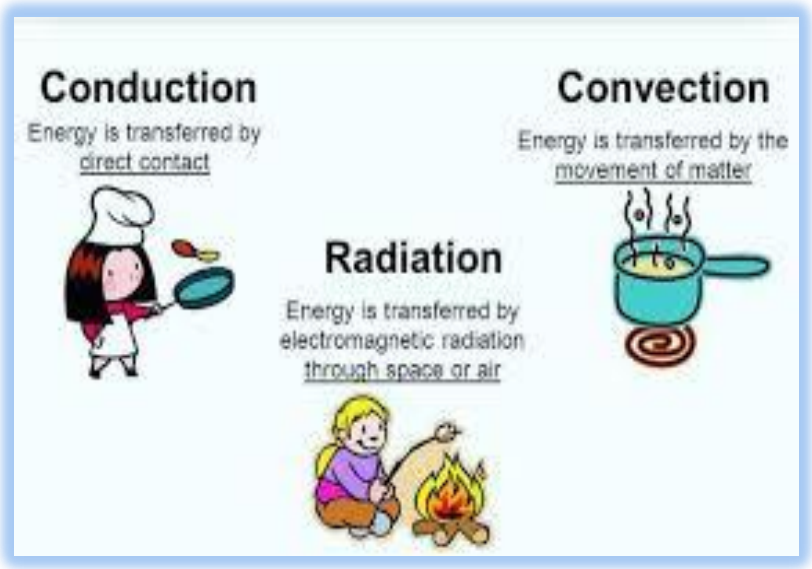
KNOWLEDGEBASE

2020

HEAT TRANSFER





TEACHERS OF PHYSICS

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10/15/2020

CONDUCTION

1. Explain why in cold weather the metal blade of a knife feels colder that the wooden handle. **(1mk)**

Thermal conductivity of metal is greater than wood. Metal conducts heat away from the hand faster than wood, which is a poor conductor.

2. Why are metals good conductors of heat? (2mks)

-Metals have free electrons, which help transfer(conduct) heat energy.
-They conduct through vibration of atoms.

3. Fire fighter puts in suits made of asbestos material. State the property of asbestos that make it suitable for the services of extinguishing fires. (1mk)

-It is resistant to heat and it improves durability of the suit.

4. A wooden bench and a metal bench are both left in the sun for a long time. Explain why the metal bench feels hotter to touch **(2mks)**

-metals are good conductors of heat energy than wood, they also release Heat quickly to skin in contact.

5. Explain why walking on a tiled surface feels cold than carpeted surface.

Tile feel cold because it is a good conductor of heat, it draws heat faster from the body. Carpet acts as an insulator slowing flow of heat.

6. A metal pail feels colder to touch than a plastic pail on a cold morning even though both have the same temperature. Explain this observation. (2mk)

- Metal has higher thermal conductivity, it conducts heat faster from hand.
Plastic acts as an insulator.

7. Explain why it is safe to hold the other end of a burning match stick. (1mk)

To protect the hand from burning, since wood is a poor heat conductor.

8. State one feature of a solar heater that enable it to absorb and retain more heat. (1 mk

It's blackened.

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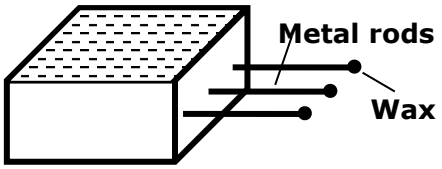
9. State two variables that must be controlled in an experiment for comparing the thermal conductivities of different metal rods of the same diameter. (2mk)

- Type of the material. (nature of conductor)
-Length of the conductor.

10. The Fig shows a hot water bath with metal rods inserted through one of its sides. Some wax is fixed at the end of each rod.



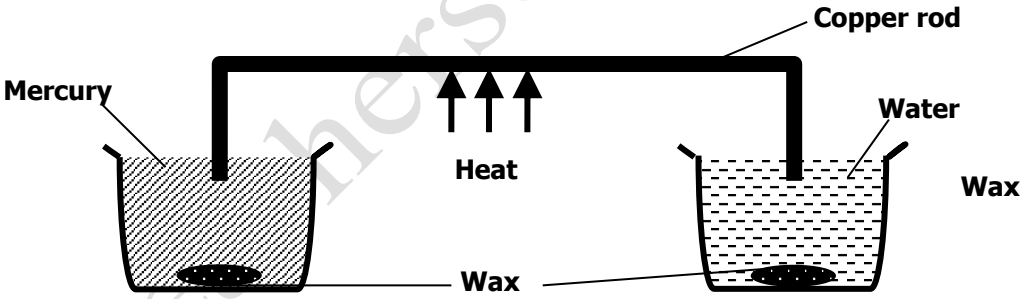
(i) What property of metals could be tested using this set-up? (1mk)

- Thermal conductivity.

(ii) Besides the length of the rods that is kept constant, what else should be kept constant when comparing the property for the different metal rods. (2mk)

- Thickness (cross section area)
- Temperature at the ends of the conductors

11. Figure below shows a metal rod of uniform thickness being heated. The ends of the rod are dipped In water and mercury with wax at the bottom



State and explain the observation made **(2mks)**

- Wax at the bottom of mercury fall off first. Mercury is a good heat conductor, it heats the wax.

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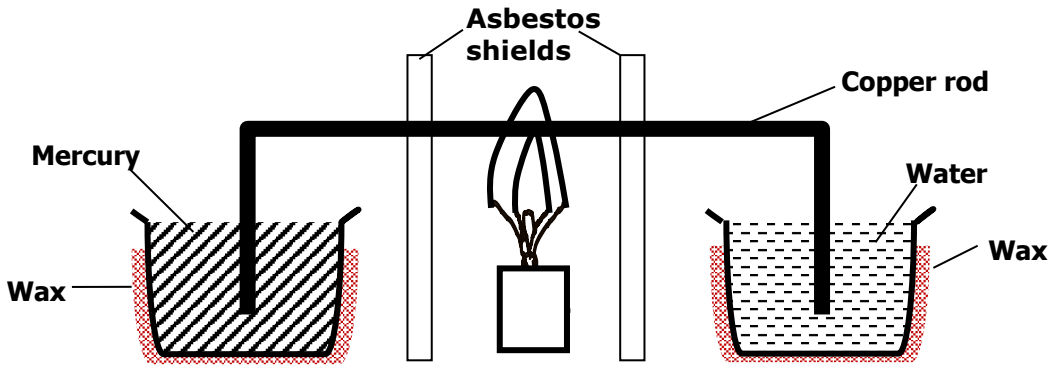
12. The Figure below shows a copper rod of uniform thickness being heated. The ends of the rod are dipped In water and mercury with wax at the bottom.



a) State the use of asbestos shields. (1mk)

- to prevent heat from reaching the wax by radiation

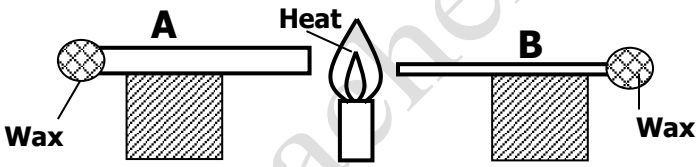
b) State two observations made in this experiment. (2mk)

- all the wax at the bottom of mercury falls.
- Wax at the bottom of water remains.

c) What conclusion can be made from the experiment above. (1mk)

- copper and mercury are good heat conductors.

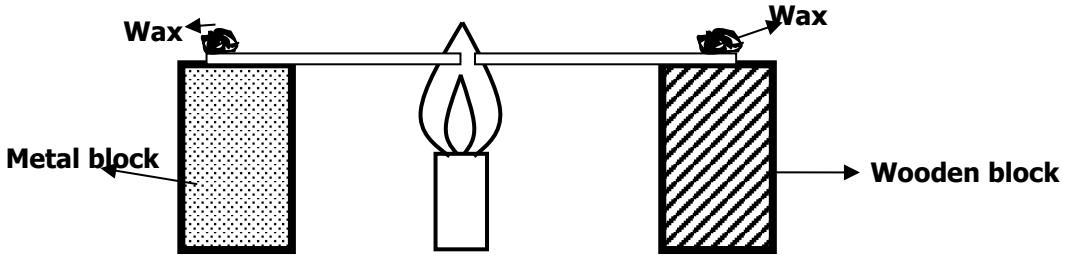
13. Two rods of copper **A** and **B** of the same length but different thickness with candle wax attached to either end are heated as shown below.



State and explain the observation made. (2mK)

- Wax on rod A melts first, then on B.
A conducts heat faster than B because it has more particles per unit area.

14. Two identical rods are placed as shown in the figure below. One rests on a metal block and the other on a wooden block. The protruding ends are heated on a Bunsen burner as shown.



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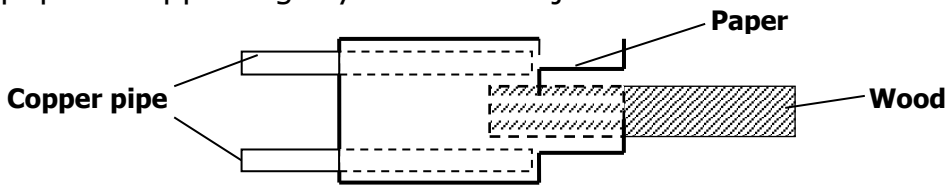
State with a reason on which rod wax is likely to melt sooner. **(2mk)**

Wax on rod resting on wooden block, wood does not conduct heat away, It heats the wax, metal conducts heat away, the wax melts later.

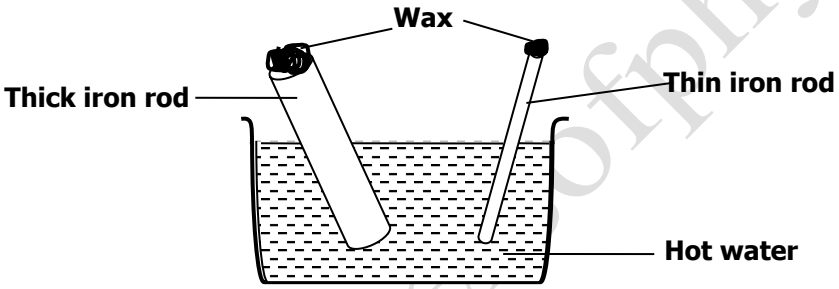
15. The figure below shows a piece of wood fitted into a copper pipe and a piece of paper wrapped tightly around the junction.



It is observed that when a flame is applied around the paper at the junction, the side of the paper around the wood burns first. Explain this observation. (2mk)

- Thermal conductivity of Wood is lower than that of metal, heat is not easily conducted away it concentrates and burns the paper. Metal conducts heat away faster.

16. The figure below shows an experiment carried out by form one students.



(i) The students dipped two iron rods of the same length but different thickness into a beaker of hot water at the same time. What was the experiment about? (1mk)

To determine the effect of thickness of a conductor of heat.

(ii) State and explain the observations made after about 10 minutes. (2mk)

The end of the thick rod held becomes hot faster than the end of the thin rod. Student drops the thick rod first. Thick rod conducts heat faster than the thin rod.

(iii) If the **two** rods were much longer, state and explain any difference from C (ii) above that would be made in the observation. (2mk)

There would be no difference in observation

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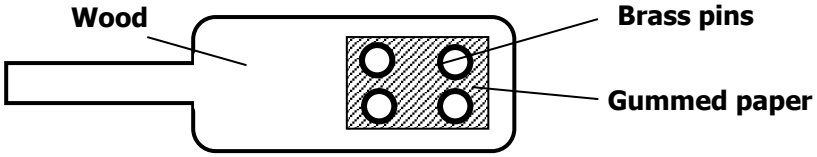
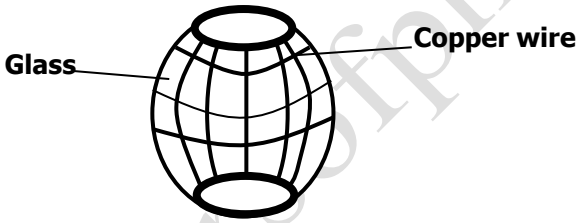
17. The figure below shows four brass pins pressed on a cooking stuck until they are flat on the wood. A white gummed paper was then stuck on the wood covering the pins. The stick was then passed over a Bunsen flame a few times.



It was observed that the paper got charred leaving four white spots. Explain this observation. (3mk)

The white spots are parts with brass pins. Brass has higher thermal conductivity than wood it conducted heat away faster. Charred spots were in contact with wood, heat concentrated at the point hence burning the paper.

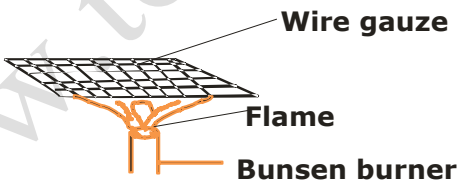
18. Figure below shows the glass shade of a lamp with a copper wire wound round it. It was observed that the glass is less likely to crack than when there is no copper wire wound around it.

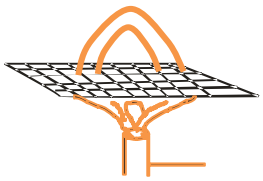


Explain the above observation. (2mks)

-Copper wire conducts heat spreading it uniformly, that prevents cracking.

19. When a Bunsen burner is lit below wire gauze, it is noted that the flame initially burns below the gauze as shown in figure 4 below. After sometime the flame burns below as well as above the gauze.





After some **time**

Explain this observation (3mk)

The wire gauze conducts the heat away from the upper region of the wire gauze, but after some time the gas above reaches its ignition temperature and hence the flame starts showing on the upper region.

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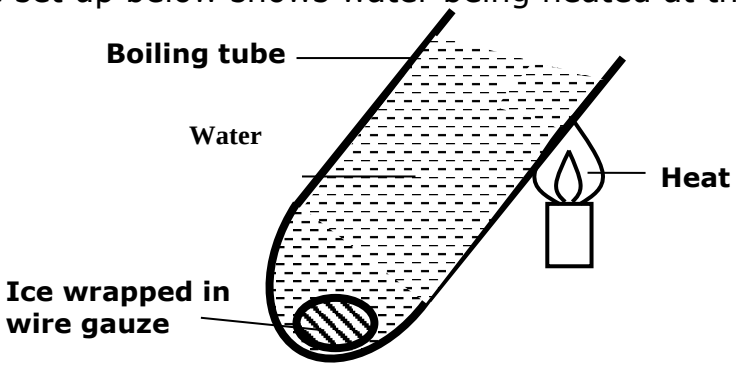
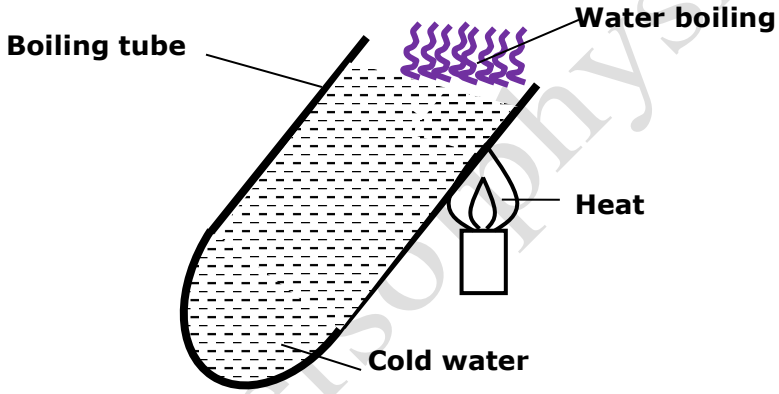
20. The set up below shows water being heated at the top.



State and explain the observation made. (3mK)

-Water boils at the top due to convection, water at the bottom remains cold, because water is a poor heat conductor. Ice does not melt.

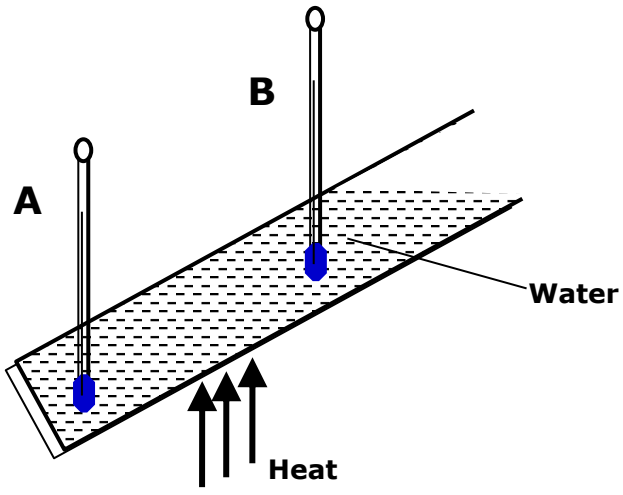
21. In the set up shown in the figure below, water near the top of the boiling tube boils while at the bottom remained cold.



Explain this observation.

Water boils at the top due to convection.
At the bottom it remains cold because water cannot conduct heat to the bottom.

22. The figure below shows a glass tube with water fitted with two identical thermometers A and B. it is heated as shown.



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State the reason which one of the two thermometers shows a higher temperature.

Thermometer B records higher temperature. water at the top will receive heat. Water at A will not receive heat because water is a poor heat conductor.

23. A car radiator has several thin blackened copper fins. Explain. (2mk)

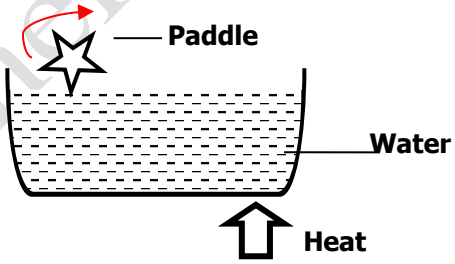
-Thin copper pins conducts heat away from the liquid, cooling the engine.

CONVECTION

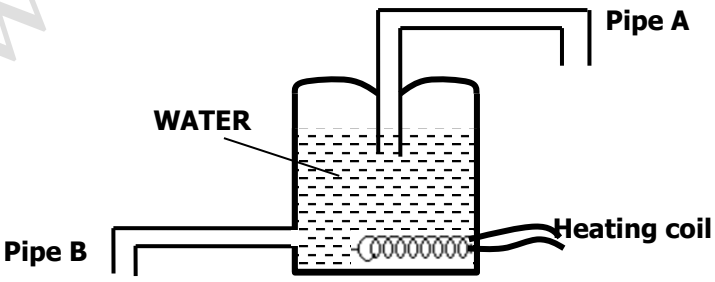
1. A paper vane in a horizontal axis was placed above a Bunsen burner as shown below. When the burner was lit, the paper vane begun to rotate. Explain the observation. (2mks)

As the air above the flame gets heated convectional currents are formed and rise upwards as these currents brush against the paper-vane it rotates

2. The figure below shows a paddle wheel made of light material. Show on the diagram the direction of its rotation when heat is applied at one end of the container as shown.



3. The figure shows a hot water system.



a) From which pipe is the hot water drawn.

pipe A

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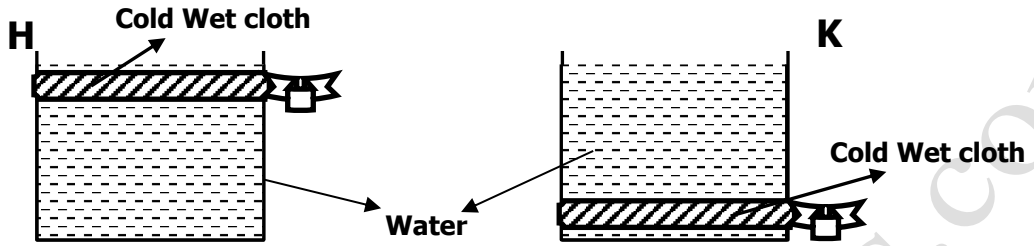
b) Explain your answer in (a) (1mk)

Pipe A carries Hot water since the water rises up because of its low density when heated

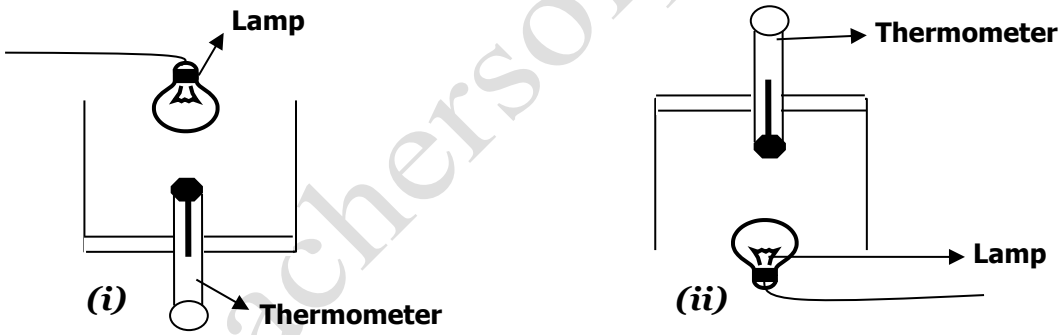
4. The figure below shows two identical beakers **H** and **K** full of water at **90°C**. Two similar cold wet clothes are wrapped, one around the top of **H** and the other around the bottom of **K**.



State with a reason, the beaker in which the water cools faster. 2mks

H cools fasterbthan K. Cold water is denser than hot water. The cold dense water occupies the bottom of the beaker while the hot water rises upwards as the cooling continues

5. Figure below shows two setups by a student using identical lamps and thermometers.



If the lamps are switched on for the same duration, state and explain which setup is thermometer reading at higher temperature? (2mk)

Thermometer(ii) heat reaches the thermometer through convection and radiation.

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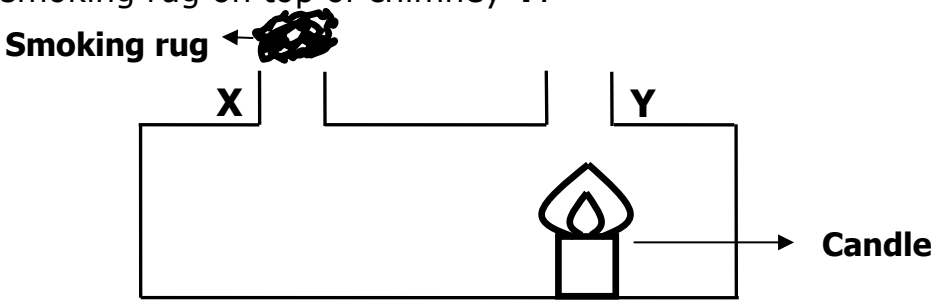
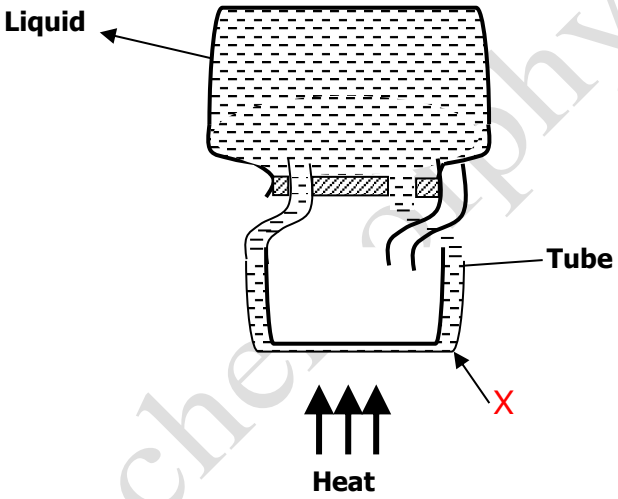
6. The figure below shows a smoke box with a candle inside below chimney **X** and a smoking rug on top of chimney **Y**.



State and explain the observation made. (2mk)

The smoke is sucked into the box through chimney X and exits through chimney Y. This is due to convection current which are set up when the air in the box is heated.

7. The set-up below was used to demonstrate heat transfer in liquids



Mark as **X** position where the heater should be placed to make the liquid in the tube to move anti -clockwise direction. (1mk)

8. Rooms that are well ventilated have ventilations close to the ceiling and some close to the Floor. Explain why? (1mk)

This is to allow Warm air exhaled by the occupants of the room rises and gets out through ventilators close to the ceiling since it is less dense. Fresh cold air flows into the room through ventilators close to the floor. This way convection current is set up and there is always supply of fresh air.

9. Give two reasons why liquids are poor conductors of heat compared to solids. (2mk)

i. *Because liquids have weaker intermolecular forces between their particles*
ii. *Vibration of energy is less easily transmitted through liquids*

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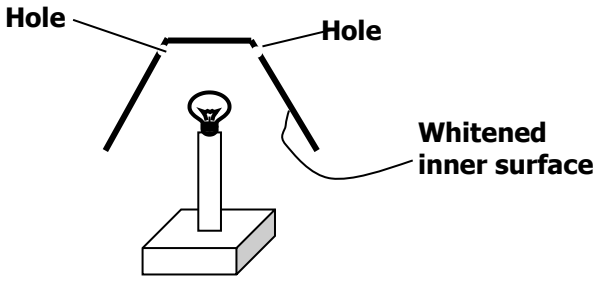
10. The Figure below shows a desk lamp. The lamp has small holes near the top of the metal lampshade. The inner surface of the lampshade is also whitened.



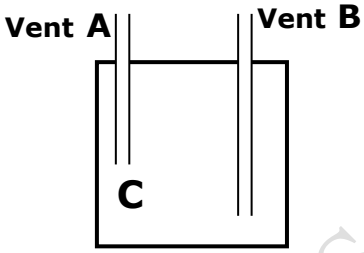
a) Explain why the inner surface of the lampshade is whitened. (1mk)

to reflect heat and light energy

b) State the purpose of the small holes near the top of the metal lampshade (1mk)

to allow hot light air get out

11. The figure below shows how an underground room was ventilated. It had two vents, one at A and other at B. A fire was lit at point C.



Explain what happened to the ventilation when the fire was lit. (3mk)

Room was ventilate. cold denser air gets in through vent B warm light air gets out through vent A.

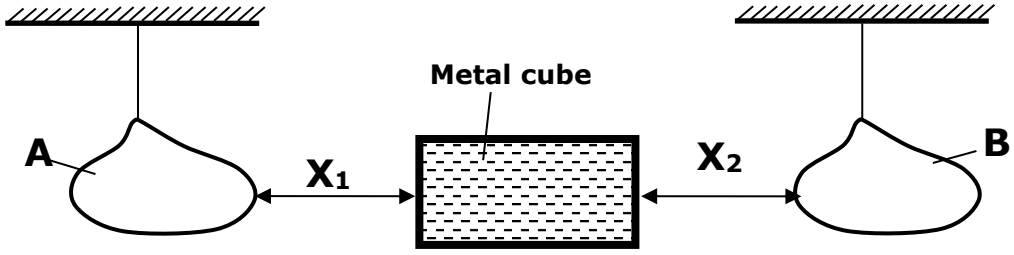
RADIATION

1. Highlight **two** facts which shows that heat from the sun does not reach the earth surface by convection.

i. Convection takes place in air upwards direct due to density effect

ii. Convection requires a material medium but the space between the sun and the earth has no material medium

2. Figure below shows two identical balloons **A** and **B**. The balloons were filled with equal amounts of the same type of gas. The balloons are suspended at distances $\mathbf{X_1}$ and $\mathbf{X_2}$ from a metal cube filled with boiling water.



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i) State the mode by which heat travels from the cube to the balloons
radiation **(1mk)**

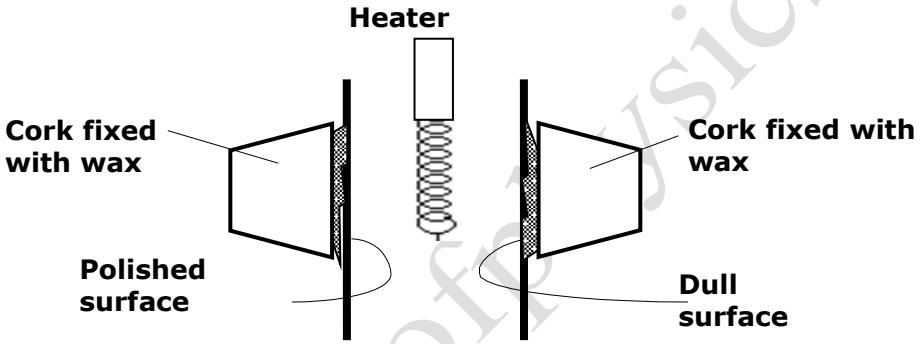
ii) The face of the cube towards **A** is bright and shiny and the face towards **B** is dull black. State and explain which balloon is likely to burst first. (2mks)

Balloon B. This is because the dull black surface emits heat more than shiny surface.

iii) State with reason the adjustments that should be made on the distances $\mathbf{X_1}$ and $\mathbf{X_2}$ so that the rate of change of temperature in both balloons is the same. (1mk)

Increase X_2.

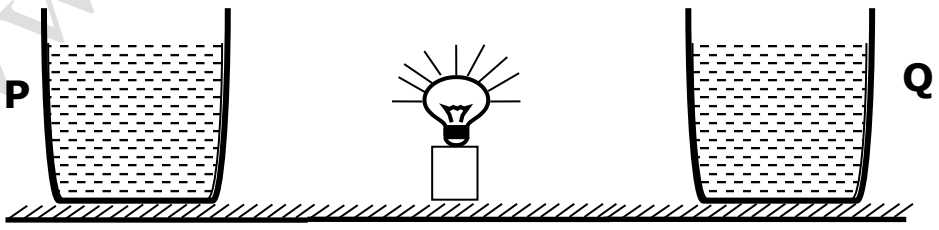
3. Figure shows two corks **P** and **Q** fixed on a polished and a dull surface with wax.



State and Explain the observation, when the heater is switched on for a short time given that the heater is equidistant from the two surfaces. (2mk)

It is observed that the cork fixed on dull surface fell faster after a short period of time while that on polished surface took a long time to fall This is because the dull surface absorbed heat faster than the polished surface thus emitting it to the wax

4. Equal amount of hot water at **100^0C** is poured into vessels **P** and **Q** as shown below and left to cool up to room temperature. **P** is painted black and **Q** is polished.



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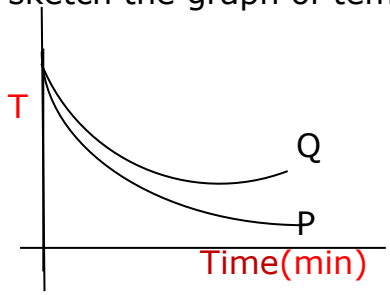
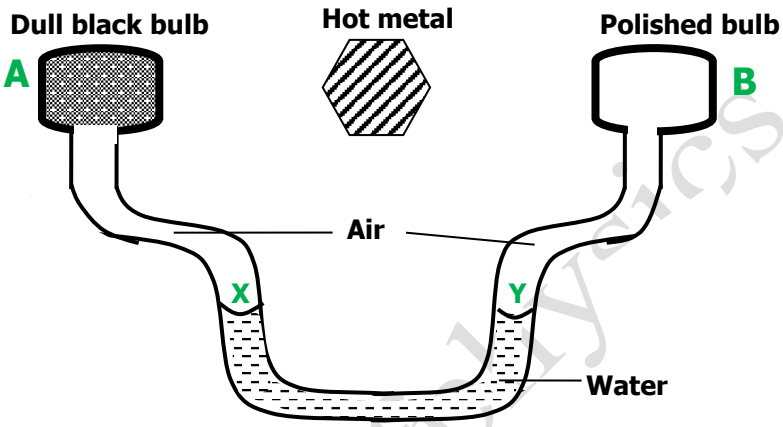
The readings of temperature are taken at intervals of five minutes. On the same axes sketch the graph of temperature against time. (2mk)



5. The figure below shows **two** glass bulbs **A** and **B** of the same size. Bulb **A** is painted dull black and a hot metal ball is placed equidistant from the two bulbs.



(i) State and explain what will happen to the levels of the liquid after some time

It is observed that water level in limb Y rises up while that in limb X falls. This is because bulb A receives more heat than bulb A warming the air inside it more. The air expands and therefore pushes down the water in limb X. As a result water level in limb Y rises (2mk)

(ii) After the apparatus has cooled and the levels in **X** and **Y** are again equal, the hot ball is placed nearer to the polished bulb in such a position that there is no difference in the levels of **X** and **Y** although the bulbs are heated. State and explain what will happen to the levels of the liquid in the manometer when the metal ball is removed (2mk)

(iii) State how the heat from the hot metal ball reaches bulb **A** and **B** (1mk)

By radiation

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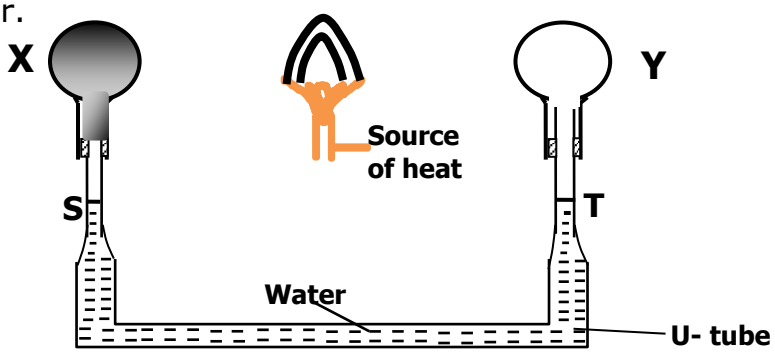
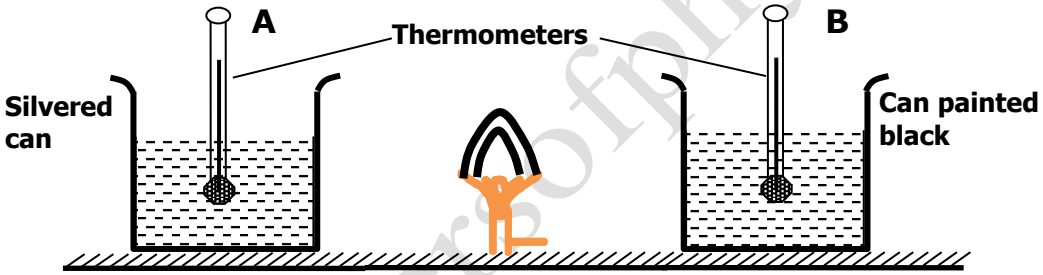
6. The figure below shows a source of heat placed at equal distances form two identical flasks X and Y containing air. The surface of X is painted black while Y is clear.



X and **Y** are linked by a U-tube filled with water whose level **S** and **T** are initially the same. State and explain the observation made after heating. (3mk)

It is observed that water level at Y rises up while that at S falls. This is because flask X receives more heat than flask Y warming the air inside it more. The air expands and therefore pushes down the water at point S. As a result water level at point T rises

7. Two similar cans are partly filled with equal quantities of water. Each holds a thermometer and are placed at equal distances from a radiant heater as shown in the figure below.



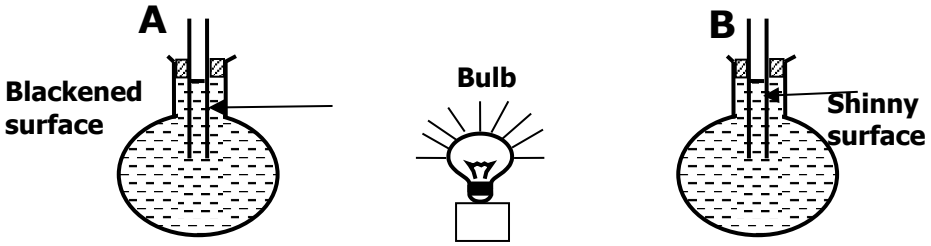
State with reason, the container in which the thermometer is likely to be higher after a few minutes. (2mk)

Thermometer in Container B reads higher temperature than that in container A This is because the can painted black absorbs more heat emitting it to the water thus the water heats up faster in can B than in can A making the thermometer record high temperatures

8. Explain why plants in greenhouse, experience higher temperature than the ones outside.

The radiations of heat from the greenhouse are trapped by the roofs and walls of the house and remain within hence keeping the place warm

9. The figures below shows two identical flasks **A** and **B** filled with water. Show the levels of water one minute after the bulb placed in between the flasks is switched on



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Explain your observations (2mks)

10. Give a reason why fuel tanks of Kenya Pipeline Company are silvery painted.
To reflect heat away to prevent fuel from bursting into of flame (1mk)

11. An electric heater is placed at equal distances from two similar cans **A** and **B** filled with water at room temperature. The outer surface of can **A** is shiny while that of can **B** is dull black. State with reasons, which of the cans will be at higher temperature after the heater is switched on for some time.

Can B This is because its outer surface is black in colour and black surfaces are good absorbers of heat thus they absorb heat faster raising the temperature of can B

12. **Give** a reason why heat transfer by radiation is faster than heat transfer by conduction

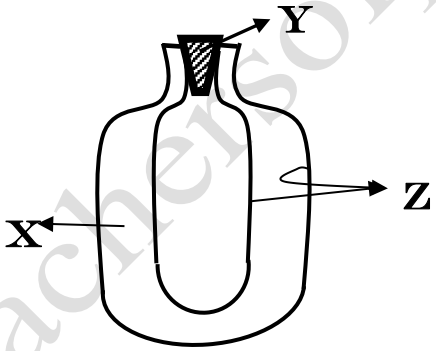
It doesn't require material medium for transmission

13. Explain briefly how the temperature in a green house is kept higher than outside.

Green house acts as heat traps by preventing longer wavelength radiations from passing through the glass

THERMOS FLASK

1. (a) The diagram below shows a vacuum flask.



(a) Name the parts labelled **X, Y** and **Z.**
***X**-vacuum*
***Y**-cork/stopper*
***Z**-silvered surfaces* (3mk)

(b) Name the material the part labelled **Y** is made of.
Rubber/plastic (1mk)

(c) State how the thermos flask minimizes heat loss. (3mk)
(i) Heat transfer through radiation is minimized by the silvery surfaces since the shiny surface is a poor radiator and emitter of heat
(ii) Heat transfer through convection is minimized by the vacuum between the double walls
(iii) Heat transfer through conduction is minimized by the vacuum between the double walls and the rubber stopper
(iv) Heat loss through evaporation is minimized by a well fitting rubber stopper

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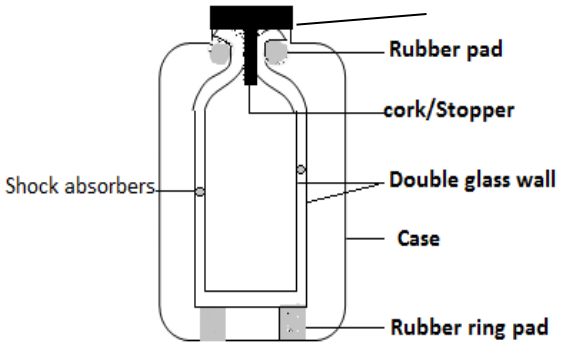
2.Draw a well labeled diagram of a vacuum flask



Describe how the vacuum flask is adapted to its function **(2mk)**

The stopper rubber pad *and* ***rubber ring pad*** *prevent heat loss through* ***conduction*** *since rubber is a poor conductor of heat*

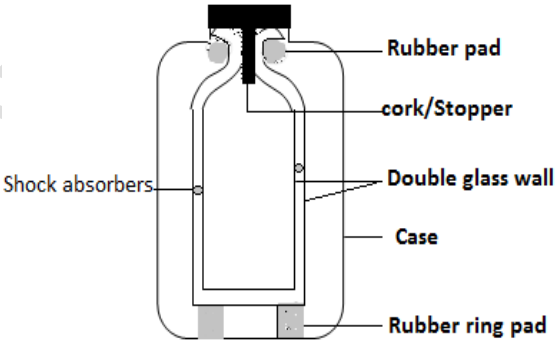
Silvered wall *prevents heat loss through* ***radiation*** *since the shinny surface is a poor radiator and emitter of heat.*

Vacuum *prevent heat loss through* ***conduction*** *and* ***convection*** *since the two modes of heat transfer require material medium for transfer of heat.*

Shock absorber *prevents breaking of the glass walls due to pressure from the outside.*

Vacuum seal *prevents air from reoccupying the vacuum. It is through the vacuum seal that air was sucked out.*

2. With the aid of a well labeled diagram of a vacuum flask, describe how thermos flask minimizes heat loss.



(6mk)

3. In a vacuum flask, the walls enclosing the vacuum are silvered on the inside. State the reason for this.

Because shiny surface is a poor radiator and emitter of heat

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4. In a vacuum flask how is heat loss by radiation minimized. **(1mk)**

By use of silvery surfaces since the shiny surface is a poor radiator and emitter of heat

5. Stating the specific parts in the flask explain how heat loss is reduced through:

(i) Conduction-*vacuum*

(ii) Convection-*vacuum*

(iii) Radiation-*silvered walls*

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