1.

The water in outdoor swimming pools gradually evaporates.

How does the process of evaporation affect the temperature of the water in the swimming pool and what is the effect on the average kinetic energy of the water molecules?

	Temperature	**Average kinetic energy per molecule**
A	reduces	reduces
B	stays the same	stays the same
C	increases	increases
D	reduces	stays the same

Answer: A

Evaporation happens when the most energetic particles leave the surface of the swimming pool.

As these particles leave, they take their energy with them.

Since temperature is the average kinetic energy per molecule in a substance, the removal of this energy causes the average kinetic energy to fall, thus reducing the temperature

2.

Fig. 4.1 shows a smoke cell. The cell contains smoke particles and air molecules. It is lit from the side. A student views the motion of smoke particles in the cell by using a microscope.

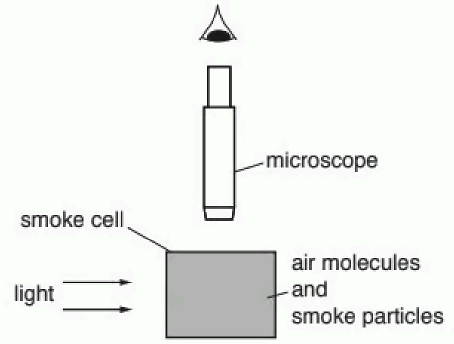


Fig. 4.1

Describe and explain what the student sees when viewing the smoke particles through the microscope.

<u>Observation:</u> Specks / dots of light

<u>Explanation:</u>

- The smoke / air particles are moving

- The movement is random
- Because fast moving air molecules collide with smoke particles
- This produces Brownian motion

3. **What takes place during evaporation of water, in terms of particles**
    - Molecules with higher kinetic energy
    - Escape the water surface

4. **Describe the movement of gas molecules**
    - They are at a high speed
    - They travel in any direction / all directions / in random motion

5. **Explain in terms of momentum, how gas molecules exert pressure on walls of box**
    - Molecules strike the walls
    - This causes change in momentum of molecules // momentum = mass × velocity
    - Force = rate of change of momentum
    - Pressure = force / area // pressure = rate of change of momentum / area

6. **How temperature of water changes as it is heated**
    - During the first few minutes the temperature rises
    - (Because) the internal energy of water rises (from thermal energy input)
    - During the next few minutes temperature is constant / stays the same
    - (Because) the internal energy does not rise (at the boiling point)

7.

Fig. 5.2 shows a volume of gas in a cylinder.

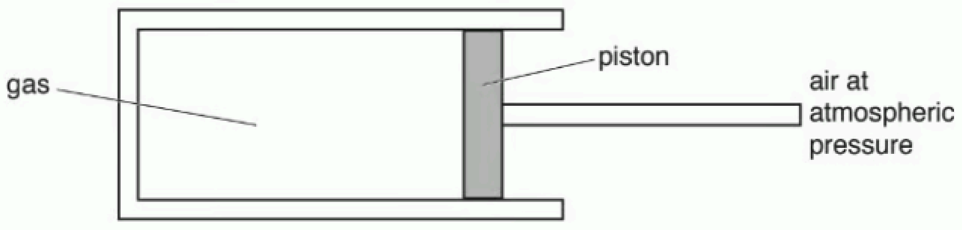


Fig. 5.2

The piston in the cylinder is free to move. The piston moves to the left when the temperature of the gas is decreased.

Explain, in terms of the molecules of the gas, why this happens.

- (The average) speed of the molecules decreases (when the temperature decreases)
- The molecules collide less often (with the piston and the walls of the cylinder)
- There is a smaller momentum change for molecules (on collision with the piston and walls of the container)
- (The piston moves because) it has a greater force on its right-hand side OR the pressure is less than atmospheric

8.

Fig 1.1 shows the graph showing how the volume changes with pressure for a gas at a constant temperature

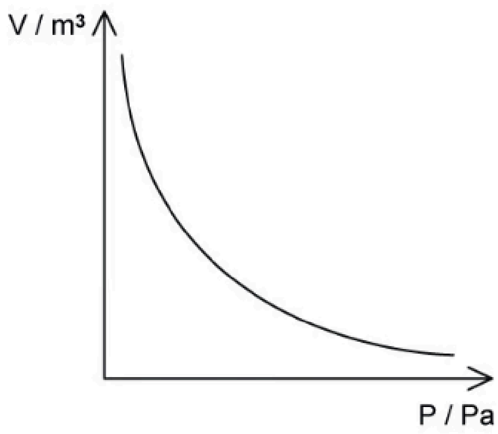
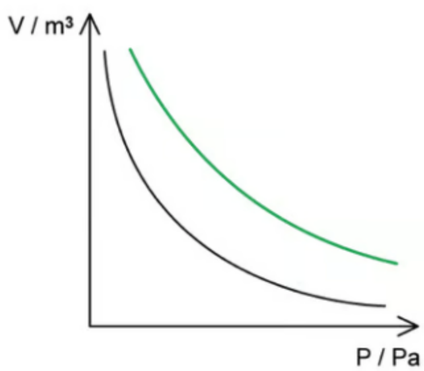


Fig 1.1

Sketch the graph for the same gas at a higher temperature.

Slightly shallower curve shifted upwards:



At a higher temperature, the gas will start with a higher initial pressure, so the product pV will be greater.

9.

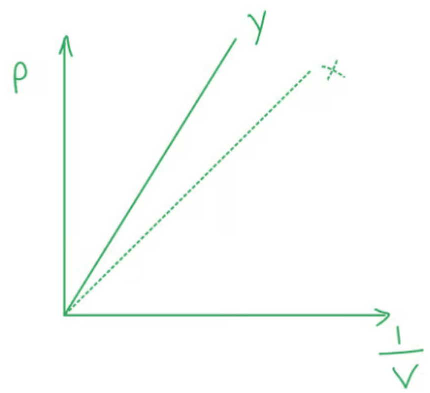
Sketch the graph of

(i) Pressure p against $\frac{1}{V}$ where V is the volume of a gas. Label this X.

[2]

(ii) The graph in part (i) but with the gas at a higher temperature. Label this Y.

[1]



10.

The fizz in a soda bottle is caused by carbonation. When the soda is bottled, carbon dioxide is added to the liquid to give it a fizzy taste. The carbon dioxide gas is kept in the liquid by the pressure inside the bottle.

When the bottle of soda is opened, state what happens to the pressure inside the bottle and why.

- Decreases
- Because the (carbon dioxide) gas molecules escape / take up a larger volume

11.

Fig 1.2 shows two mugs of tea, A and B. They both hold the same volume of tea.

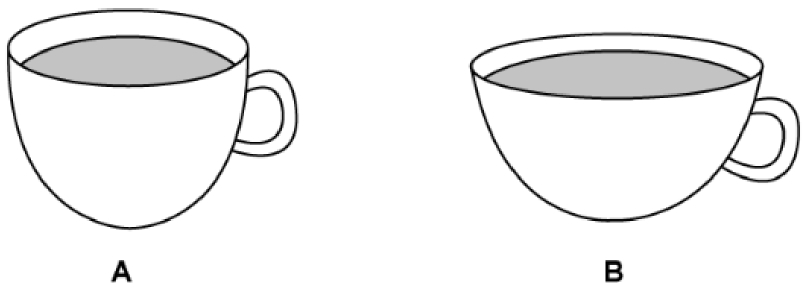


Fig 1.2

State from which mug the tea evaporates quicker. Explain why, in terms of the behaviour of molecules and the process of evaporation.

- The tea from mug (B) evaporates quicker
- When evaporating, the molecules gain more kinetic energy
- This means they break free from the surface (of the liquid / tea)
- There is a greater area for the gas molecules to escape (in mug B)
- So more molecules / moles escape in a given time (compared to from mug A)

12. State what the observed motion of microscopic particles shows about air molecules

- Air molecules exist - it means that air must consists of particles / is not continuous
- Air molecules bombard / collide with the smoke particles
- Air molecules are moving (freely) at high speed
- Air molecules are moving randomly
- Air molecules are very small (compared with smoke particles)

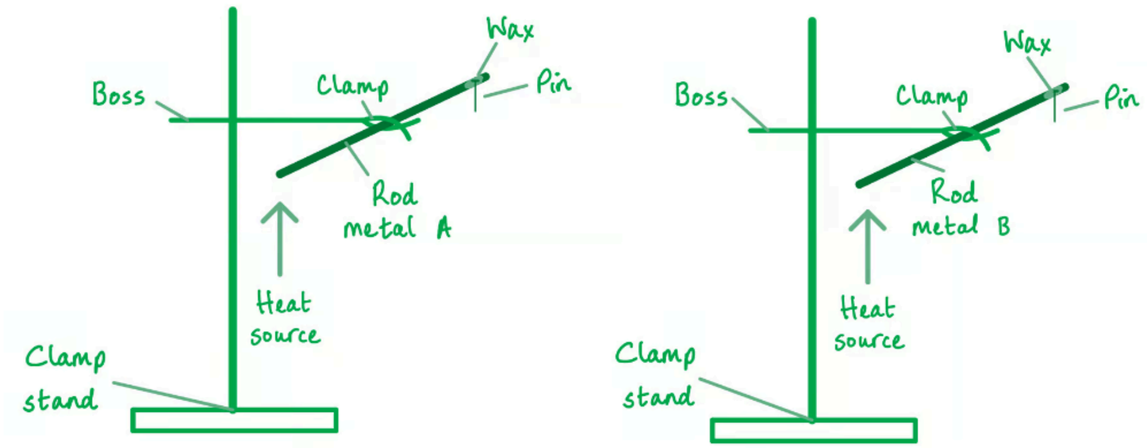
13. Define absolute zero

- The lowest possible temperature / –273 °C / 0 K
- Where the particles have the least kinetic energy

NOTE: water is not a good conductor of thermal energy!

14. Describe an experiment to identify which material is a better conductor of thermal energy

- Attach a pin/ paper clip to the rod with some melted wax / petroleum jelly / Vaseline
- Heat one end of both metal rods with the same type of heat source / Bunsen burner
- The first pin to fall shows the metal rod which is the best conductor



15.

Fig. 4.1 shows a cold plastic spoon that has just been placed in hot liquid in a cup.

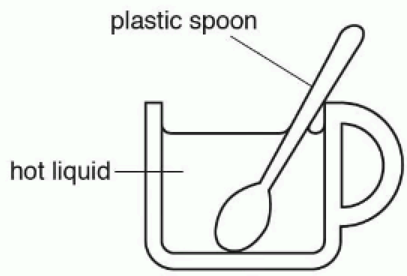


Fig. 4.1

Describe, in terms of molecules, why the temperature of the whole of the spoon increases.

- The molecules of hot liquid collide with the surface of the spoon
- Energy / heat is transferred from the hot liquid to the molecules of the spoon
- The amplitude of the vibration of the spoon's molecules increases / gets faster, this increases the spoon's temperature

16.

A student constructs a device for absorbing thermal energy from the Sun. Fig. 6.1 shows the device.

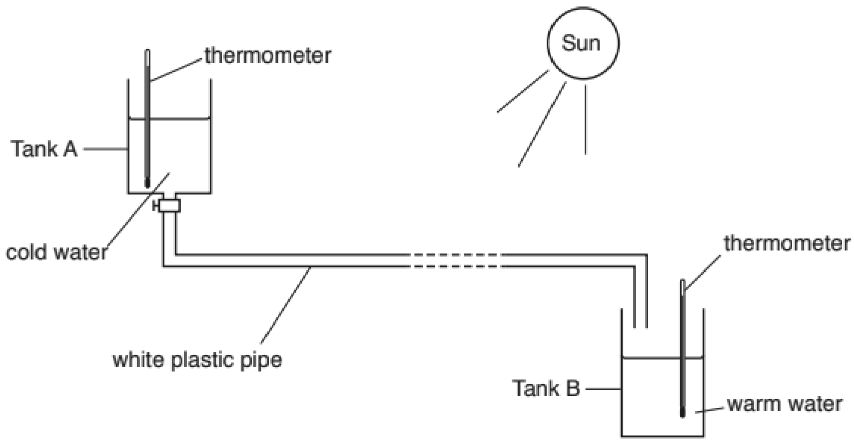


Fig. 6.1

The student places the white plastic pipe in sunlight. The cold water flows slowly from Tank A to Tank B. Energy from the Sun heats the water in the pipe.

Improvements that can be made to increase the amount of thermal energy absorbed by water in the pipe.

- Use metal pipe
- Use black pipe
- Use matte painted pipe
- Use longer pipe
- Use pipe with greater surface area
- Use slower flow rate
- Place glass or a clear plastic cover over pipe

Explain how thermal energy is transferred from the sun to water inside the pipe

- Thermal energy is transferred by infra-red radiation (from the Sun to the pipe)
- The heat transfers by conduction (through the material of the pipe)

17. When cooling a can of water, it is observed that the water cools down at a faster rate at the start, but the rate of cooling lowers towards the end. Why?

- Because water is hotter at the start
- So there is a greater temperature difference between the can and the surroundings

NOTE: pockets of air trapped between objects reduces heat loss by conduction & convection.

18.

The manufacturer of the hot-water tank says that when the outside surface is polished regularly and kept bright and shiny, the hot water will cool more slowly.

Describe an experiment that shows whether a container with a bright and shiny surface is better at keeping its contents warm than one with a dull and dark surface.

Describe the two vessels:

- One vessel shiny / bright AND one vessel dull / dark; [1 mark]

Describe how to fill the vessels:

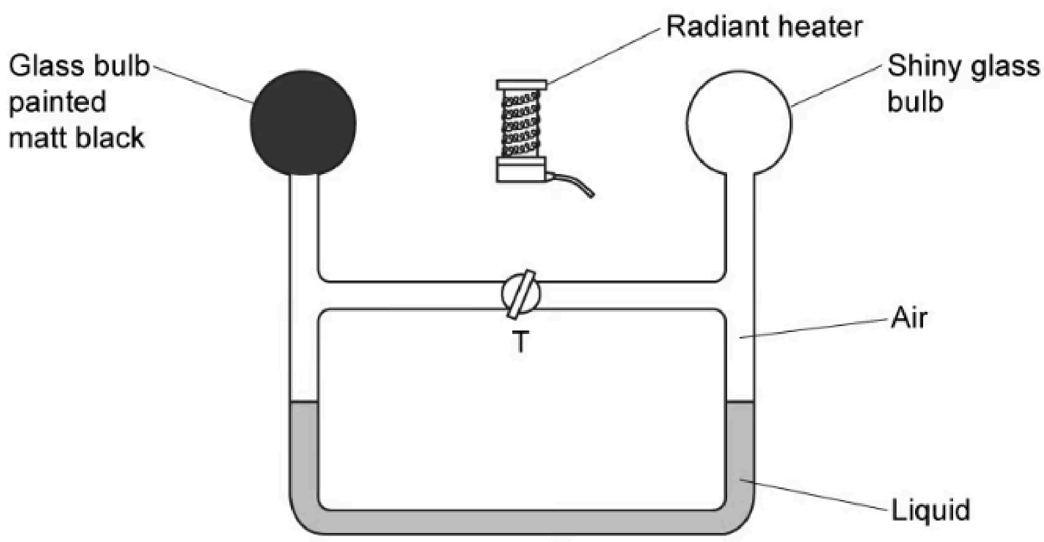
- Fill (the vessels) with the same mass / volume of hot water; [1 mark]
- With the same initial temperature; [1 mark]

Describe the comparison:

- Measure the final temperature AND compare the temperature change; [1 mark]
- After the same period of time; [1 mark]

19.

The apparatus shown in Fig. 1.1 is known as Leslie's Differential Air Thermometer.



The heater is switched off. Tap T is opened so that the air on the two sides of T has the same pressure. Tap T is then closed.

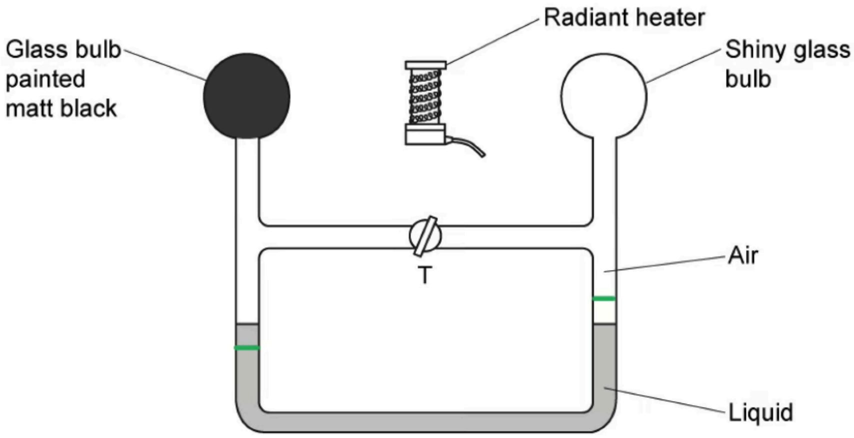
(i) The heater is switched on. On Fig. 1.1, mark clearly where the two liquid levels might be a short time later.

[1]

(ii) Explain your answer to **(a)(i)**.

[2]

(i)



Left side down AND right side up AND by equal amounts (by eye)

(ii) - The left / black side has a greater temperature rise / absorbs more energy
- (Therefore) on the left / black side there is a greater expansion of air / greater pressure of air

20.

After a marathon in winter, the athlete has sweated a large amount.

(i) Explain why this could be dangerous.

[3]

- Heat is transferred / radiated from the athlete to the sweat
- The sweat evaporates
- The temperature of the athlete reduces

21.

For the end of the marathon, the athlete's coach has a double-walled vacuum flask (Fig. 1.2), which is designed to maintain the temperature of its contents. It is partially filled with a hot liquid.

The lid is made of black plastic and sealed tight. The walls are silvered metal.

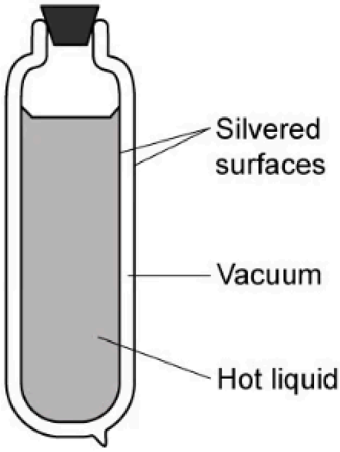


Fig. 1.2

Eventually the liquid cools. Explain how thermal energy is transferred from the hot liquid through the lid over time.

- The hot liquid emits radiation
- The black lid is a good absorber / poor reflector

<u>Discuss convection and conduction</u>

- The air (near the lid) is heated by convection
- (A small amount of) thermal energy is transferred from the air to the lid by thermal conduction

NOTE: Points to remember when explaining evaporation:

- During evaporation particles with highest energy escape from the surface of the liquid
- (As a result of this,) the average kinetic energy of molecules in the liquid decreases
- The temperature of the liquid decreases
- Energy transfers from the surroundings to the liquid

NOTE: common insulating materials: Wool; Polystyrene; Glass; Foam; Plastic; Cardboard

22.

Two metal cylinders, P and Q, are heated using an electric heater. Both of the cylinders receive exactly the same amount of thermal energy.

The temperature of P increases by a smaller amount than the temperature of Q.

What conclusion can be drawn?

A. P is a better thermal conductor.

B. Q is a better thermal conductor.

C. P has a higher thermal capacity.

D. Q has a higher thermal capacity.

Answer: C

- The energy required to raise the temperature of a substance by 1 ℃ is given by its thermal capacity, mc.
- If the temperature of P increases by less than the temperature of Q when the same amount of energy is supplied to both, its thermal capacity must be greater.

23.

A student takes two blocks, block 1 and block 2, of different metals and heats them until the temperature of both has risen by 20°C.

She then leaves both blocks on the desk to cool.

Block 2 has a greater thermal capacity than block 1.

Which of the blocks loses more energy as it cools to room temperature, and which of the blocks required more energy to raise its temperature by 20°C?

	Lost more energy when cooling	**Required more energy to heat up.**
A	block 1	block 1
B	block 1	block 2
C	block 2	block 1
D	block 2	block 2

Answer: D

24. Explain in terms of molecules, why liquids are difficult to compress

- molecules (already very) close / touching B1
- (repulsive) forces (very) large

25.

Fig. 3.1 shows a device that uses liquid pressure to lift heavy boxes.

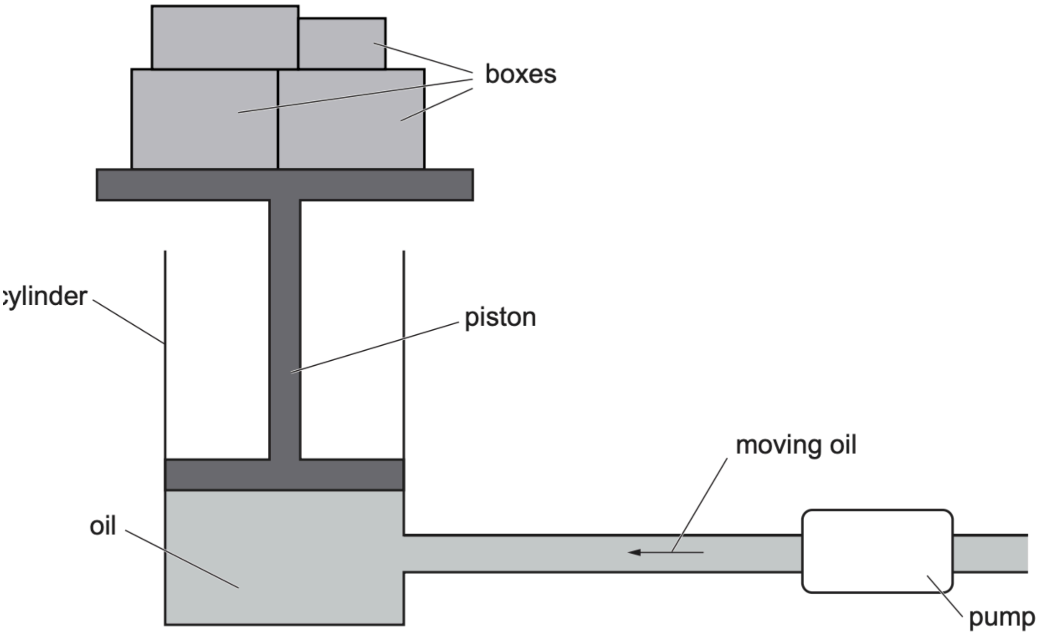


Fig. 3.1

The boxes are lifted by pumping oil into the cylinder.

The force upwards on the piston due to the oil, and the force downwards on the piston due to the air above the piston, combine to produce a constant force of 8800 N.

The pressure of the air is 1.0×10^5 Pa and the cross-sectional area of the bottom surface of the piston is $0.016\,m^2$.

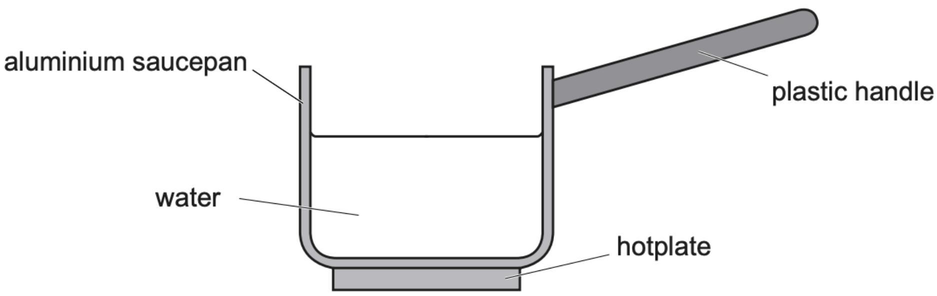
As the boxes are lifted, the depth of oil increases. Explain why the pump must exert an increasing pressure on the oil as the depth of oil increases.

- pressure due to (increased height of) oil in cylinder mentioned or pressure (in liquid) increases as depth increases
- to keep the upwards force constant or to lift the (extra) oil // to counteract / oppose the increased pressure / force / weight of the oil

26.

An aluminium saucepan with a plastic handle contains cold water.

Fig. 4.1 shows the saucepan on a hotplate.



State why pan is made from aluminium but handle is made of plastic

aluminium is a (good) conductor (of heat) and plastic is a poor conductor / does not conduct (heat)

Explain, in terms of atomic lattice and electrons, how thermal energy is transferred through the aluminium

- atoms (touching the hotplate) / lattice vibrate (faster)
- atoms pass on energy / vibration to neighbouring atoms / to other atoms by collision
- atoms pass on energy to electrons
- electrons hit distant atoms or electrons move (through lattice)

Eventually the water reaches its boiling point. Thermal energy from hot plate is still being transferred to water. Explain in terms of molecules, effect of this thermal energy on water

- molecules escape from the liquid (as a vapour)
- bonds broken / (attractive) forces overcome
- molecules gain potential energy // work done (to separate molecules / break bonds / overcome forces)

27. State, in terms of molecules, what is meant by an increase in internal energy

- increase in kinetic energy of molecules or increase in potential energy of molecules

28.

The mass of the water decreases by 0.11 kg in 300 s. The specific latent heat of vaporisation of water is 2.3×10^6 J/kg.

Calculate the rate at which the water gains thermal energy.

rate of gain of energy = ... [3]

- $E = ml_v = 0.11 \times 2.3 \times 10^6$
- rate = $ml_v / t = (0.11 \times 2.3 \times 10^6) / 300$
- 840 W

29. Explain in terms of molecules, why a liquid expands more than a solid when heated

- forces between liquid molecules weak(er than in solids)
- less energy / work done to separate molecules or greater separation for same work done / same increase in energy

30.

A machine delivers a hot drink in a plastic cup, which is uncomfortably hot to hold.

Fig. 5.1 shows the cup with the hot drink.

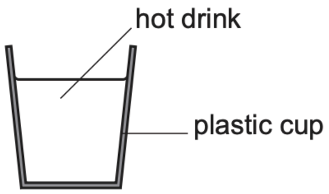


Fig. 5.1

Fig. 5.2a shows the cup with the hot drink and a holder for the sides of the cup.

Fig. 5.2b shows a cross-section through the holder. The holder is made from two strong paper cylinders separated by a wavy piece of strong paper to make air gaps.

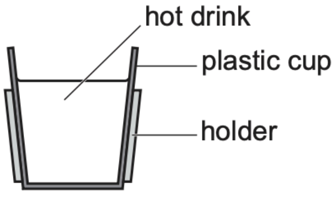


Fig. 5.2a

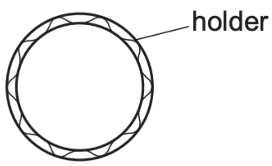


Fig. 5.2b

Explain how using the holder makes it more comfortable to hold the cup.

- Prevents thermal energy transfer to the hand
- Trapped air is an insulator
- holder / it stops / reduces conduction OR no / less thermal energy conducted to hand

A student carries out experiments on the cooling of the hot drink described in (a), with and without the holder in place. He finds that the holder only reduces the rate of cooling slightly. Suggest and explain another action that reduces the rate of cooling more effectively.

- (put a) lid / cover (on cup)

- mention of convection
- less / no convection (from surface)

OR

- mention of evaporation
- less / no evaporation (from surface / container)

31. **Specific latent heat of fusion**

    Energy transferred when <u>1 kg / unit mass</u> of a substance freezes or melts [2 marks]

32. **Specific latent heat of vaporisation**

    energy to change 1 kg / unit mass of a substance from liquid to gas / gas to liquid (without changing its temperature)

33. **Define thermal capacity**

    - quantity of thermal energy / energy (transferred by heating)
    - to increase temperature (of an object) per degree Celsius 1 °C

34. **Several ice cubes are at a temperature of 0°C. The ice cubes are dropped into the water and the internal energy of the water decreases.**

    Give a simple molecular account of this decrease in internal energy.

    - (internal energy) depends on kinetic energy (of molecules) B1
    - kinetic energy (of molecules) decreases or potential energy (of molecules) decrease

    As the temperature of the water decreases, some of the ice melts. Explain why this ice melts.

    - k.e. of molecules / (thermal) energy absorbed (from water / surroundings) or energy absorbed from (cooling) water
    - supplies latent heat / energy used to overcome intermolecular forces / break bonds

Describe how to determine the specific latent heat of fusion of ice using this experiment. State any other measurements that the student needs to make.

- any determination of mass
- determine change in mass (of ice) / increase in mass of water
- use l_f = E / m in any form

35. **Explain what happens to the pressure of a constant volume of air when the temperature of the air increases. Use ideas of momentum of molecules in your explanation.**
    - (temperature of air increases) so molecules move faster / their KE increases
    - molecules collide with walls of container and change momentum
    - greater change of momentum when temperature is higher OR collisions more frequent OR harder collisions OR force = rate of change of momentum
    - higher force and hence higher pressure

36.

Fig. 3.1 and Fig. 3.2 show how a puddle of water changes on a warm windy day.

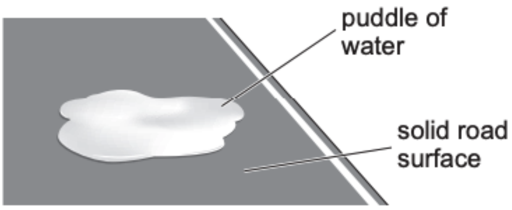


Fig. 3.1

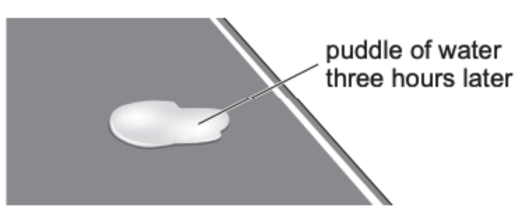


Fig. 3.2

Describe process by which volume of water in the puddle decreases.

- amount of water in pool decreases as water evaporates / becomes water vapour / gas
- more energetic molecules escape OR molecules with more kinetic energy escape
- from the <u>surface</u> of the water

Change in weather that would cause volume of water in puddle to decrease more slowly

- lower temperatures / colder day: produces smaller pool more slowly because rate of evaporation decreases with decreasing temperature
- less windy weather: produces smaller pool more slowly as a draught over surface removes water vapour enabling faster rate of evaporation

37. **How sweating helps to cool the body on a hot day (refer to molecules)**
    - thermal energy in the skin / body transferred to (molecules of) sweat
    - these molecules (have enough KE to) escape from the skin / become water vapour

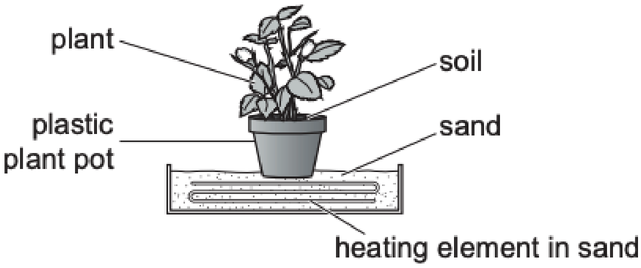
- leaving behind molecules with lower energy
- which leaves the skin / body at a lower temperature

NOTE:

Thermal capacity Unit: J / °C

38.

In some countries, the soil is too cold for plants to grow well. In these countries, plants are grown in plastic pots and kept inside. The pots, containing soil, are placed on sand. The sand is heated using an electrical heater, as shown in Fig. 4.1.



Describe (in terms of molecules) how thermal energy is transferred from heated sand through the base of the plastic pot.

- sand molecules gain KE/ vibrate more/ hit other molecules when heated OR thermal energy is transferred by conduction
- energy is transferred to molecules of plastic pot in contact with sand through collisions OR lattice vibrations transferred to neighbouring molecules

The heating element remains switched on. The temperature of sand remains constant at a value above room temperature. Explain why temperature remains constant.

- sand is warmer than surroundings and so thermal energy is constantly lost from sand.
- at constant temperature, rate of thermal energy supplied to sand is equal to rate of thermal energy lost from sand

39. 2 ways that thermal energy is conducted in a metal

- delocalised / free / mobile electrons
- electrons move through metal OR electrons collide with distant particles OR electrons carry energy through the metal
- lattice vibrations transfer energy to neighbouring particles OR particles vibrate and cause nearby / adjacent particles to vibrate OR vibrating particles collide with particles transferring energy

40. Explain, in terms of force & distance between particles, why gas occupies much greater volume than liquid.

- attractive forces between particles are much greater in liquids than in gases
- particles in gases are much further apart than in liquids

41. How molecular structure of liquid metal differs from that of solid metal
- (molecules /they) have an irregular arrangement / not ordered/random arrangement
- (molecules /they) are (slightly) further apart (on average)
- (molecules /they are) not fixed in place

42. Two metal spheres of different diameters are heated to 900°C in a hot oven. The two spheres are removed from the oven. State and explain any difference in the initial rates of emission of radiation of thermal energy between the two spheres.
- Larger sphere emits / radiates / loses thermal energy more
- Greater (surface) area

43. One hot sphere is now heated in a hotter oven. State and explain any effect on the rate of emission of radiation of thermal energy from that sphere when it is removed from the hotter oven.

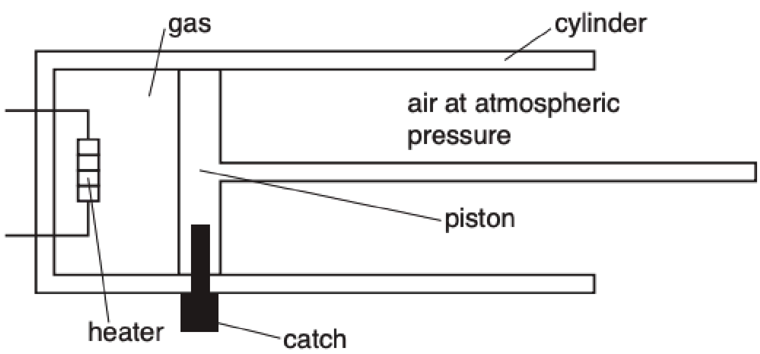
greater (rate of radiation)

44. In practice, it takes much longer to increase the temperature of a substance (than what is calculated). Why?

Because thermal energy is lost to the surroundings

45.

Gas of mass 0.23 g is trapped in a cylinder by a piston. The gas is at atmospheric pressure which is 1.0×10^5 Pa. Fig. 4.1 shows the piston held in position by a catch.



Volume initially = 1.9×10^{-4}

When the temperature of the gas has increased by 550°C, its pressure is 2.9×10^5Pa. The catch is then released allowing the piston to move. As the piston moves, the temperature of the gas remains constant.

State and explain what happens to the piston.

- It moves to the right
- pressure (of gas) greater / pressure greater (on left) / resultant force to right

Determine the volume of the gas when the piston stops moving

V2 = p1V1 / p2

$(2.9 \times 10^5 \times 1.9 \times 10^{-4}) / 1.0 \times 10^5 = 5.5 \times 10^{-4}$ m^3

46. Before injecting a patient, a doctor wipes a small amount of a volatile liquid on to the patient's skin. Explain, in terms of molecules, how this cools the patient's skin.

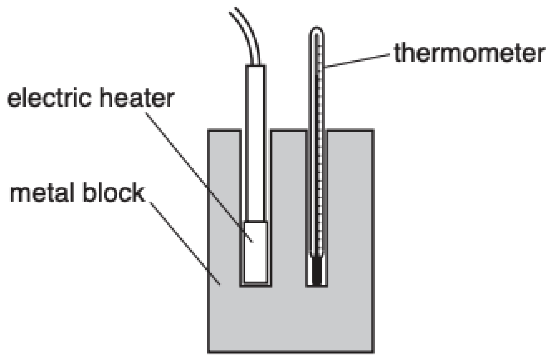
- more energetic molecules escape from the liquid OR molecules gain energy and escape OR molecules overcome intermolecular forces / break bonds
- average speed decreases OR molecules with less kinetic energy left behind
- temperature of liquid decreases
- thermal energy conducted / gained from skin / body // thermal energy lost by skin / body

47. Explain, in terms of molecules, why liquids are incompressible.

- molecules touching / close together OR no space between molecules
- Forces of repulsion between particles of liquid are large

48.

Fig. 5.1 shows apparatus used to determine the power output of a heater.

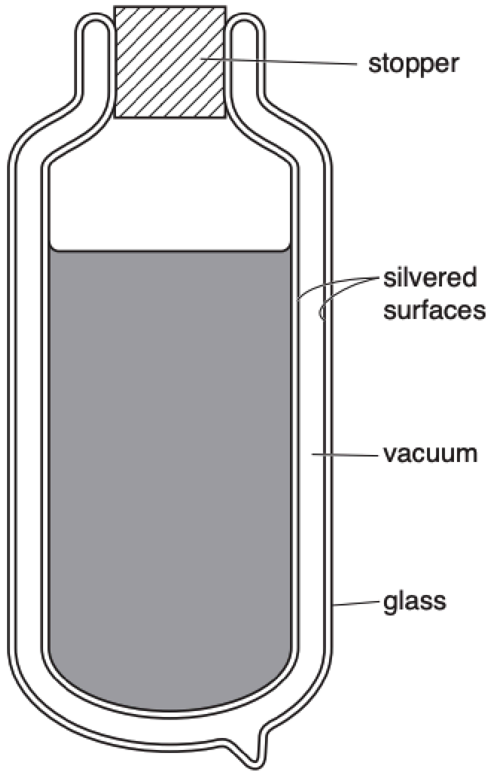


State and explain a precaution that can be taken to improve accuracy of the experiment.

- lagging/insulation/named insulator (around/on block)
- reduction of thermal energy/heat losses

49.

Fig. 5.1 shows a cross-section of the inside of a vacuum flask containing a cold liquid. The walls of the vacuum flask are made of glass.



The vacuum flask is being used to keep a liquid cool on a hot day. Explain how the labelled features of the vacuum flask keep the liquid cool by reducing thermal energy transfer. Include the names of the processes involved.

- mention of radiation/infra-red radiation with respect to silvered surfaces
- silvered surfaces are poor emitters / poor absorbers / good reflectors
- glass is a poor conductor OR glass reduces thermal energy / heat gain by conduction
- vacuum prevents thermal energy / heat gain by conduction and convection
- stopper reduces thermal energy / heat gain by convection

NOTE: change in internal energy of an object = $c\Delta T$
Unit: joule

50. **When the temperature of a gas in a container is decreased, its volume decreases, while the pressure is still equal to atmospheric pressure. Explain in terms of particles of gas, how pressure remains equal to original value.**
    - As temperature decreases, particles collide less violently
    - As volume decreases, the particles collide more often
    - These 2 effects **cancel out** to leave the pressure unchanged

NOTE: always refer to infrared in radiation related questions. This earns an extra mark.

51. Three identical dishes A,B,C contain equal volumes of water. Dish A is outside in sunlight and experiences no wind during the day. Dish B is outside in sunlight and experiences strong wind during the day. Dish C is in a dark room.
Water evaporates from each dish. After 12 hours, a student measures the volume of water in each dish. Dish C contains the largest volume of water and dish B contains the smallest volume of water. Explain, in terms of particles, why the three dishes have different volumes of water

- energy from the Sun transfers to / is absorbed by (water) molecules, (so KE of (water) molecules increases)
- molecules with higher energy / KE / faster moving molecules escape (from surface)
- wind removes molecules when they have left the surface (so they do not re-enter the liquid)

any one from:

- wind increases the rate of evaporation
- (absorption of) energy from the Sun increases the rate of evaporation
- least /less water evaporates / lower rate of evaporation from dish C
- most / more water evaporates / higher rate of evaporation from dish B

52.

Fig. 4.1 shows apparatus used to observe the motion of smoke particles (Brownian motion).

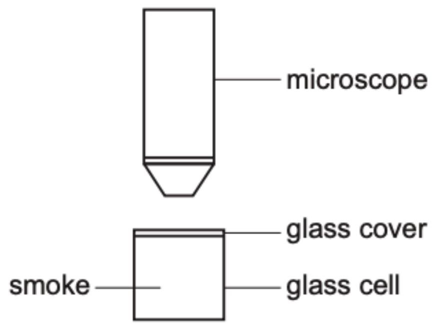


Fig. 4.1

The glass cell has light shining on it from the side.

The smoke particles are seen as bright specks of light when looking through the microscope.

Draw the path of one of the bright specks of light

- zig zag motion / random changes of direction
- random length of path in each direction

Explain in terms of forces and motion of air molecules, the cause of the motion of smoke particles

- air molecules bombard smoke particles

- air molecules are small (compared to smoke particles) / have small(er) mass
- air molecules are very fast moving
- air molecules move in random directions
- (collisions exert unbalanced) forces on smoke particles

53.

A bowl contains 500 cm^3 of water at a temperature of 5.0 °C. The bowl of water is placed in a freezer for several hours. When the bowl is removed from the freezer, it contains ice at a temperature of –18.0 °C. The density of water is 1000 kg/m^3.

The specific heat capacity of water is 4200 J/(kg °C). The specific heat capacity of ice is 2100 J/(kg °C). The specific latent heat of fusion of water is 3.3×10^5 J/kg.

Calculate the energy given out as the water cools from 5.0 °C to ice at –18.0 °C.

mass of water in the bowl when it is placed in the freezer = 0.5kg

$c_w = 4200\ J/(kg\ ^\circ C)$

$c_i = 2100\ J/(kg\ ^\circ C)$

$l_f = 3.3 \times 10^5\ J/kg$

$5^\circ C \rightarrow -18^\circ C$

$\Delta E = mc_w \Delta T = 0.5 \times 4200 \times 5 = 10500\ J$

$\Delta E = ml_f = 0.5 \times 3.3 \times 10^5 = 165000\ J$

$\Delta E = mc_i \Delta T = 0.5 \times 2100 \times 18 = 18900\ J$

total ΔE =

$10500 + 165000 + 18900 =$

$1.9 \times 10^5\ J$

54. On a warm, dry day, a metal can of lemonade is wrapped in damp cloth. Evaporation cools the water in the cloth.

Explain how evaporation cools the water in the cloth, in terms of molecules.

- fast(er) / high(er) speed / (more) energetic molecules escape into air
- average speed / average kinetic energy of molecules decreases
- temperature related to speed / energy of molecules or slow(er) / low(er) speed / less energetic molecules remain (in water)

Explain how electrons transfer thermal energy through the metal of the can.

- free/ delocalised/ mobile electrons
- Electrons gain thermal energy from vibrating particles (vibrating particles hit electrons)

- Electrons move throughout the metal/ to distant particles
- Electrons transfer energy from regions of higher temperature to regions of lower temperature // electrons collide with distant particles/ transfer energy to distant particles

55.

Fig. 5.1 shows a kitchen tap that supplies instant boiling water.

Fig. 5.1

Cold water passes over an electric immersion heater inside the tap.

The boiling point of water is 100 °C.

The immersion heater is powered by the mains at a voltage of 230 V. When the tap is opened, the heater switches on and the current in the heater is 13 A.

(i) Calculate the thermal energy produced by the heater in 60 s.

$E = VIt = 230 \times 13 \times 60$

$= 1.8 \times 10^5$ J

(ii) The specific heat capacity of water is 4200 J / (kg °C). The cold water that enters the tap is at 22 °C.

Calculate the rate at which water at its boiling point emerges from the tap.

$\Delta T = 100 - 22 = 78°C$

rate = $180000 / (4200 \times 78 \times 60) = 9.1 \times 10^{-3}$ kg/s

56. Describe, in terms of particles, the transfer of thermal energy through the metal of a gate after transfer from a person's hands.

- Electron move
- lattice / molecular / particle vibration

57.

A student investigates the efficiency of a filament lamp. Fig. 4.1 shows the filament lamp with its glass bulb immersed in water in a beaker.

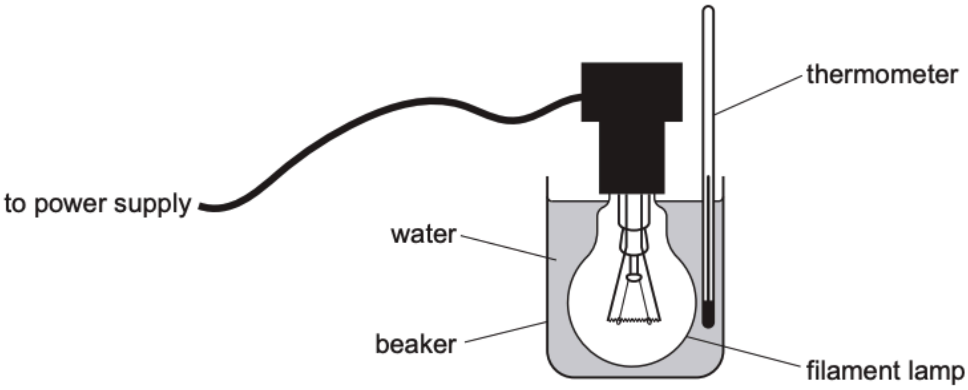


Fig. 4.1

The reading on the thermometer in the water is 19.0 °C.

Only the glass of the lamp is in contact with the water and the electrical connections are completely insulated.

The lamp is switched on.

At the end of the experiment, the temperature of the water is 21.5 °C.

a.

(ii) In the experiment, the lamp is switched on for 500 s. The power supplied to the filament lamp is 13 W. The useful energy from the lamp is transferred as light. The energy that increases the temperature of the water is wasted energy.

Determine the maximum possible efficiency of the filament lamp.

Maximum possible efficiency calculated to be 3.1%

The efficiency of the lamp is less than the value determined in (a)(ii). Suggest a reason for this

- Thermal energy is transferred from the water to the beaker/air/bench
- Energy (other than light) is transferred in the lamp
- Some water evaporates
- Temperature change is an underestimate (due to the thermal energy losses)

58. Advantage of keeping the surface of a saucepan shiny

- Shiny surfaces are poor emitters of radiation
- They reduce energy loss from the pan/ less energy transferred to the surroundings