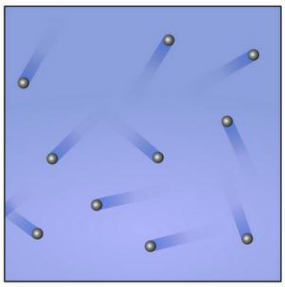
Thermal Physics review question answers

1) Molecular models



In both solids and liquids particles can move past each other,

(a) "Brownian" motion can be observed in both states of matter. Explain what "Brownian" motion is and how it can be observed.

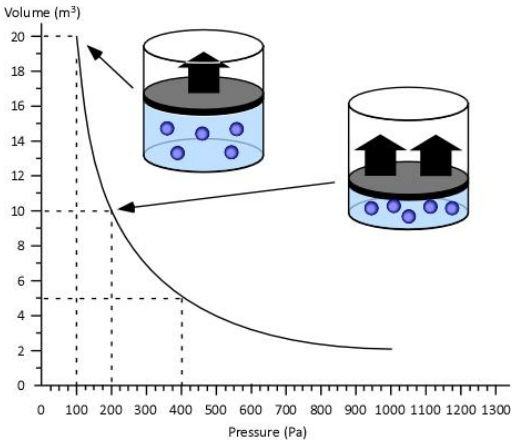
A fluid with tiny particles visible in a microscope can show brownian motion. It was first seen observing pollen particles getting jostled around by water particles but is more commonly observed looking at soot particles in air.

(b) Why do gases fill a container but liquids don't?

In a gas the particles are free to move apart from each other and travel all around the container but in a liquid the particles stay in contact

(c) What happens to the motion of particles as temperature is increased?

The motion of particles is faster as temperature is increased



2) Pressure changes

(a) In the graph the changing pressure results in a changing volume. Copy and complete this table:

P (Pa)	V (m^3)	PV (Nm)
100	20	2,000
200	10	**2,000**
400	5	**2,000**
800	**2.5**	**2,000**

(b) If the gas was squeezed to 1000 Pa what would the volume be?

1000Pa is ten time the pressure of the first measurement so volume would be 1/10 th of the first measurement = 2 m3

(c) If the gas is heated how would this affect the pressure? **The pressure would increase (in proportion to the absolute (Kelin) temperature of the gas.**

3) Expansion and contraction

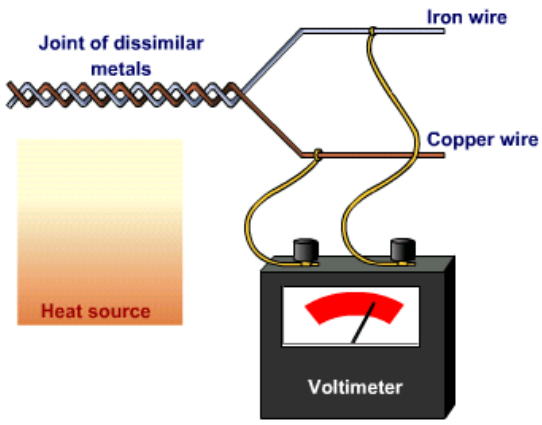
In many countries temperatures vary by up to 50°C from the extremes of winter to the extremes of summer. Steel expands by x% for a 50 degree change temperature. 10 metres of track will expand by 5mm with this temperature change.

(a) Explain why most materials expand when heated.
The gaps between the particles get slightly bigger because the particles are moving around.

(b) By how much would a continuously welded section of 500m expand for the same temperature change?
500m is 50 times bigger than 10m so the 500m section would expand by 50x5mm = 250mm or 0.25m

(c) Explain why the buckling shown opposite is cause by this expansion.
The track is unable to expand if it is held in place by welds so will try to push outwards on bends.

(d) How might this kind of buckling be prevented? (home research - http://news.bbc.co.uk/1/hi/uk/3126441.stm)



4) Measuring temperature

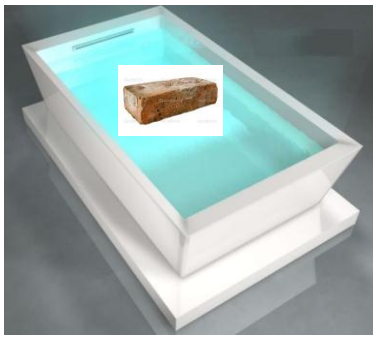
The diagram shows a thermocouple where the voltage recorded changes if the jointed metals temperature changes. Write down possible missing words in these sentences

(a) A mercury thermometer is quite easy to design because the **volume** is proportional to **temperature**

(b) A liquid in glass thermometer reacts quite slowly because glass is an **insulator** so the heat takes time to transfer.

(c) A thermocouple reacts **quickly** to changes in temperature because the metals are good **conductors** and the voltage change occurs **quickly**.

5) Thermal (heat) capacity



One ancient method of warming bath water was to place hot bricks from the fire into the bath. A brick has a heat capacity of about 2.5 kJ/ ^{o}C.

(a) Explain what heat capacity means.

The amount of energy needed to increase the temperature of something by one degree (Kelvin or Celsius) is its heat capacity

(b) If the brick was at 180 ^{o}C and cools to 30 ^{o}C in the bath how much thermal energy has it provided?

Temperature change is 180 – 30 = 150 ^{o}C

Thermal energy = 2.5 kJ/oC * 150 ^{o}C = 375 kJ

The specific heat capacity of water is 4.2 kJ/kg ^{o}C and the bath has 50kg of water.

(c) Calculate how much energy would be needed to heat up the bath from 20 ^{o}C to 30 ^{o}C and hence the number of bricks needed to warm the bath.

Q = mCΔ T = 50 x 4.2 x 10 = 2100 kJ

2100 ÷ 375 = 5.6 so 6 bricks should be used

6) In the sauna

a) The latent heat of vaporization of water is 2260 kJ/kg. What does this mean?

It takes 2260 kJ to evaporate 1 kg of water

In the sauna a ladle of water is poured onto hot rocks. The rocks must first heat the water to it boiling point before boiling it.

b) What is the boiling point of water i) in ^{o}C, ii) in Kelvin.

i) 100 ^{o}C ii) 373 K

c) Explain, using ideas about particles and bonds, why energy is needed to boil water.

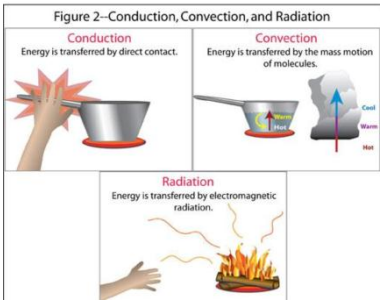
To turn water into water vapour the water molecules need to break their bonds and this requires (work) energy.

d) If 0.01 kg (10g) of water is boiled by the rocks how much energy was transferred?

Q = mL = 0.01 x 2260 = 22.6 kJ

e) If the heat capacity of the rocks was 50 kJ/ °C by how much would they cool down.

22.6 ÷ 50 = 0.45 °C



7) How heat transfer occurs.

a) Explain how conduction, convection and radiation occur. You **must** use the following words in your explanation. vibration, bonds, expand, density, infra-red, electro-magnetic radiation.

Good answers should be similar to:

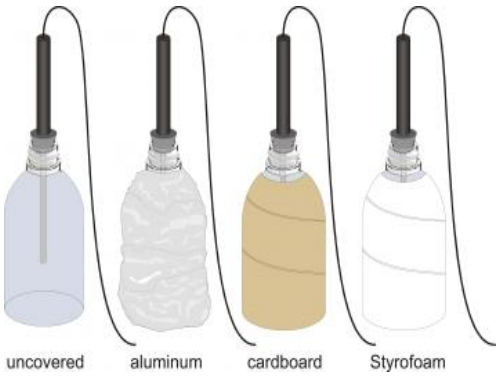
http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/energy/heatrev1.shtml

b) Explain how evaporation occurs and why the liquid left behind can be cooler than it surroundings.

Evaporation occurs when a liquid particle on the surface of the liquid has enough energy to break the bonds of the neighbouring particles and become a gas. The particle has more than the average amount of energy so the particles left behind have less that the average amount of energy so are cooler.

8) Insulation

The diagram shows an experiment to test three materials insulating abilities. The bottles are filled with hot water.



(a) What measurements will be taken?

Temperature and time

(b) What control variables need to be kept the same to make the test fair?

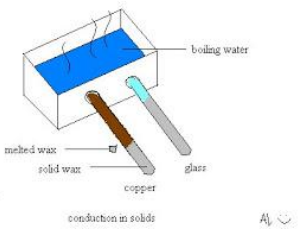
Amount of water, start temperature, temperature of the surroundings

(c) Which type of heat transfer will the aluminium be the best at reducing?

radiation

(d) Which type of heat transfer will Styrofoam be the best at reducing?

Conduction (and convection)



9) Describe one of the following experiments:

a) Measuring the latent heat of fusion (melting) of ice.

http://personal.tsss.edu.hk/fac/F4%20physics%20solution/04%20latent%20heat%20of%20fusion.pdf

b) Measuring the latent heat of vapourization (boiling) of water

http://ramadan.50megs.com/IGC_Exp_2Y_HeatOfVaporization.htm

c) Comparing the conduction rates of glass and metal

http://alyssa-low-physicsproject2009.blogspot.co.uk/