Thermodynamic temperature

Temperature scale – indicates levels or degrees of hotness

(Fahrenheit and Celsius scale – the centigrade scale)

Fixing a scale of temperature

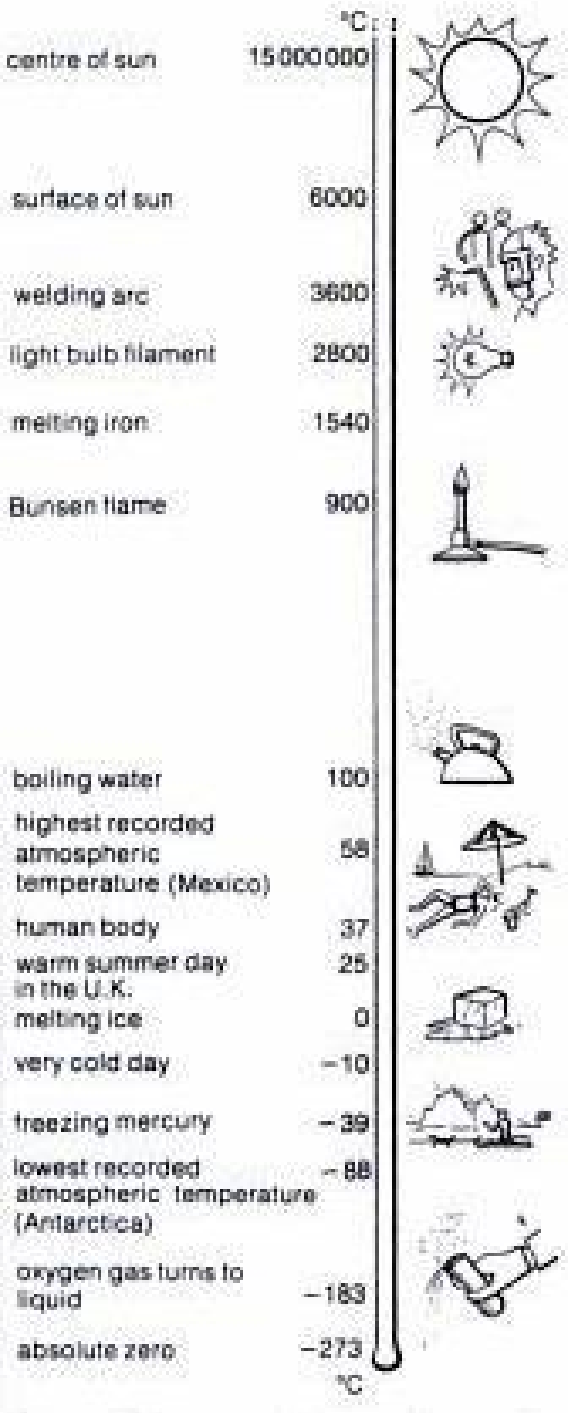
Celsius scale:

•The lower fixed point – melting point of pure ice

(zero degrees Celsius – 0°C)

•The upper fixed point – boiling point of pure water

(water is boiling under standart pressure – hundred degrees Celsius – 100°C)



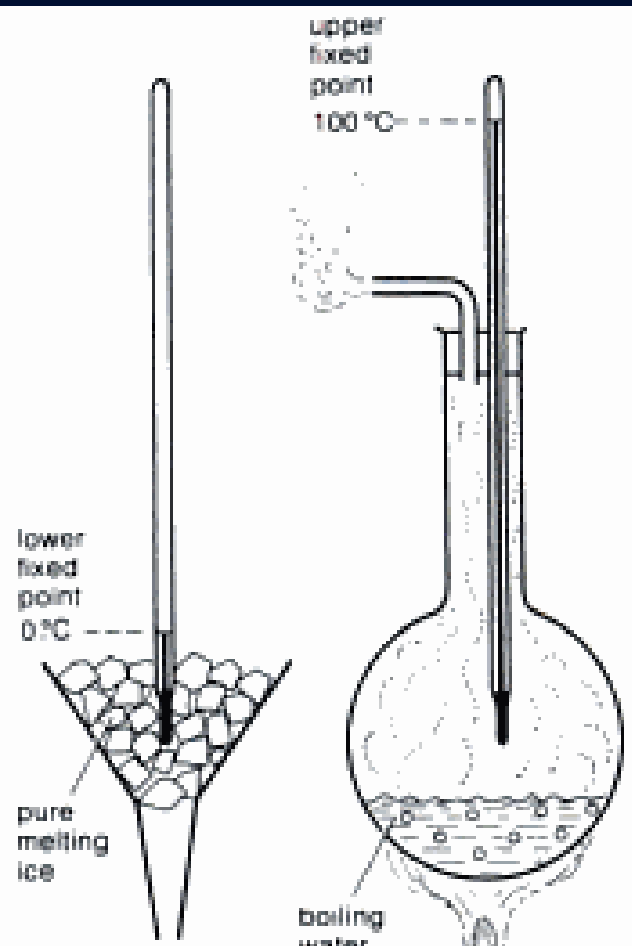


Figure 3a Figure 3b

Figures 3a, 3b Calibrating a thermometer: two 'fixed points' are needed; the space between them is portioned into equal divisions

What is temperature?

•The molecules of any object are constantly in motion. The hotter the object, the more kinetic energy its molecules have and the faster they move.

•If a hot object is placed next to a cold object, there is a transfer of thermal energy. One group of molecules loses KE by slowing down, the other group gaines KE by speeding up.

•The transfer of energy stops only when molecules of both objects have the same KE on average. The objects are then at the same temperature.

•Temperature – a measure of average KE.

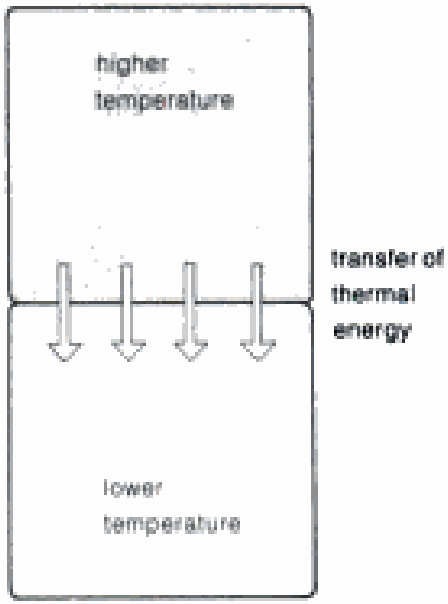


Figure 4 Thermal energy is transferred from hot objects to cooler ones

Absolute zero and the Kelvin temperature

•You might expect that there would be a temperature at which the molecules would have no energy at all.

•-273°C – they do have the minimum possible amount of energy – this temperature is called **absolute zero** – **no object can reach a temperature lower than this**.

•Tripple point of water: pure ice, water and saturated steam (273,16K).

•Absolute temperature scale – **The Kelvin scale** – the most commonly used absolute temperature scale.

•Each Kelvin (K) on the scale is the same size as a degree Celsius (°C).

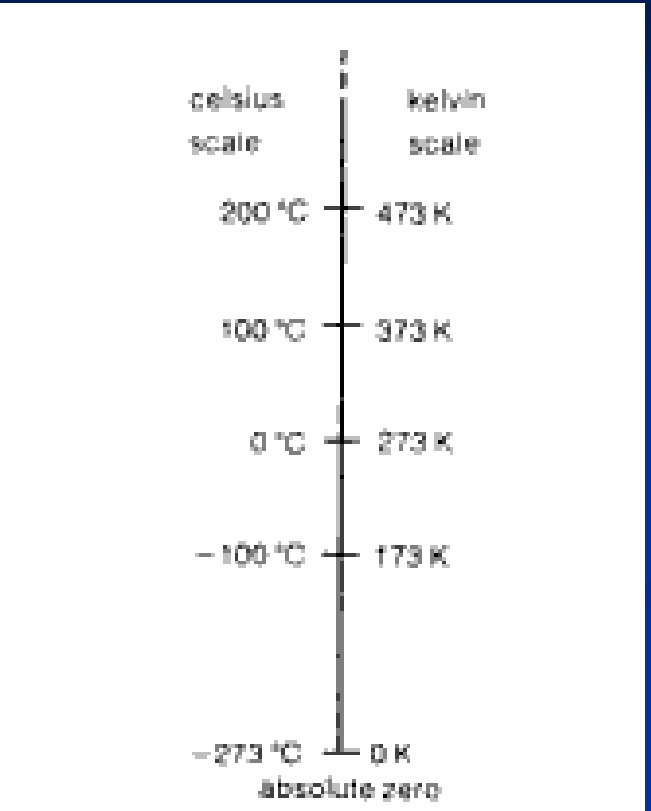
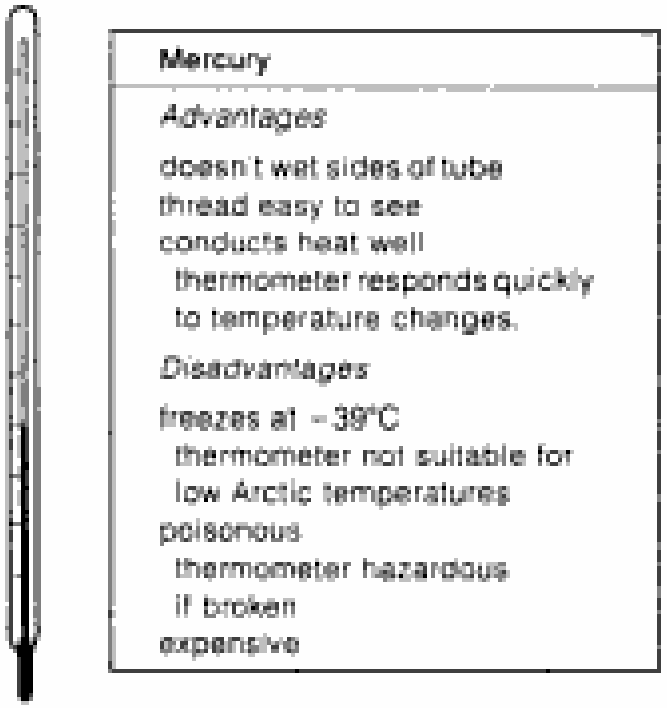


Figure 5 Absolute zero: the minimum possible thermal energy, therefore the minimum possible temperature

$t = (T - 273.15)°C \quad T = (t + 273.15)K \qquad \Delta T = \Delta t = (T_2 - T_1) = (t_2 - t_1)$

Liquid-in-glass thermometer

- Use the fact that most liquids expand slighltly when they are heatet.
- Narrow tube – small increase in the volume makes the „thread“ move long way up the tube. The narrower the tube, the more sensitive the thermometer is to changes in temperature.
- Alcohol, mercury



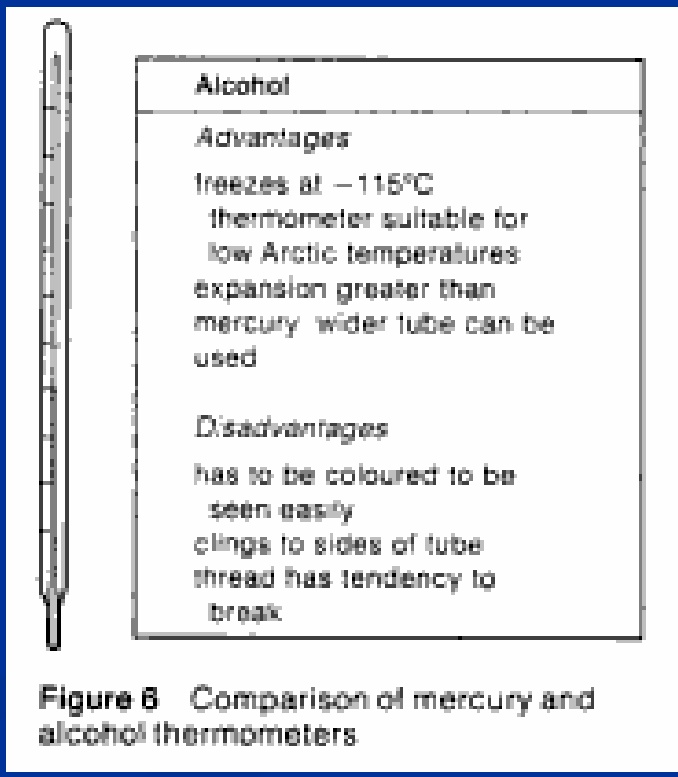


Figure 6 Comparison of mercury and alcohol thermometers

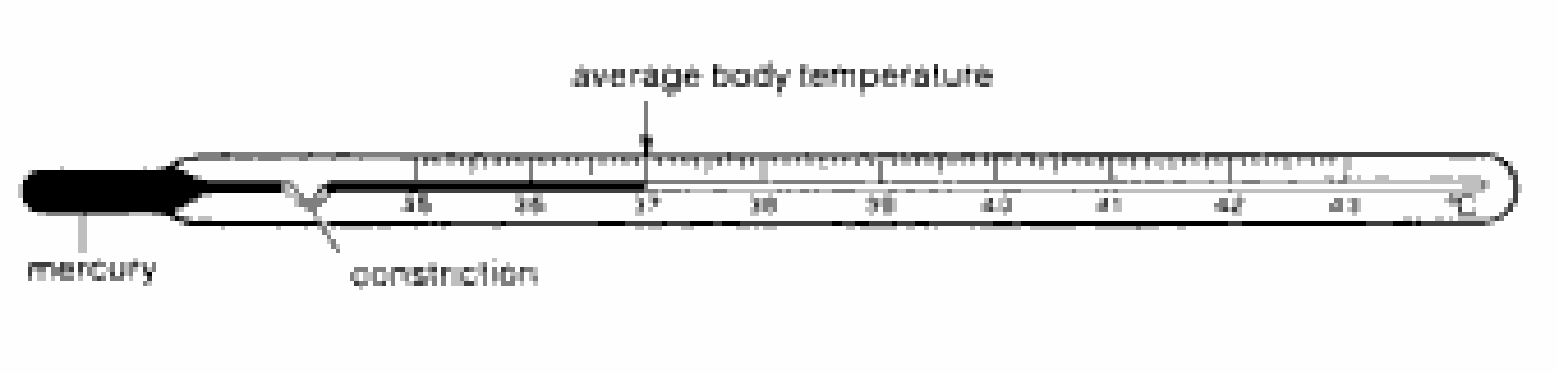
The clinical thermometer

•Special type of mercury thermometer – its scale covers only temperatures a few degrees either side of the average body temperature of about 37°C.

•Constriction (narrowing) – stops mercury thread running back into the bulb, so the temperature reading can be taken after the thermometer has been removed from the patient´s mouth.

•The thermometer has to shaken to get the mercury back past the constriction.

•Disadvantage – temperature range is too limited.



Thermometers for industry

•**Resistance thermometer:**

•Based on the principle that resistance of conductors rises, so less current can flow through them.

•Temperatures from -200°C to 1200°C.

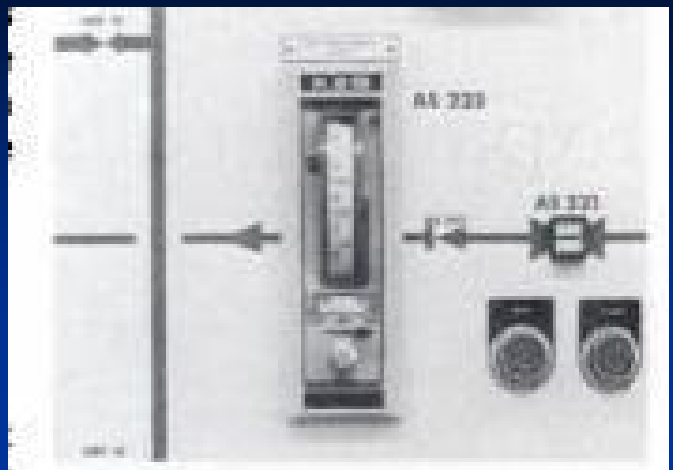


Figure 8 A computer linked temperature reading

•**Thermistor thermometers:**

•A termistor is a small device which offers less and less resistance to a flow of electricity as its temperature rises.

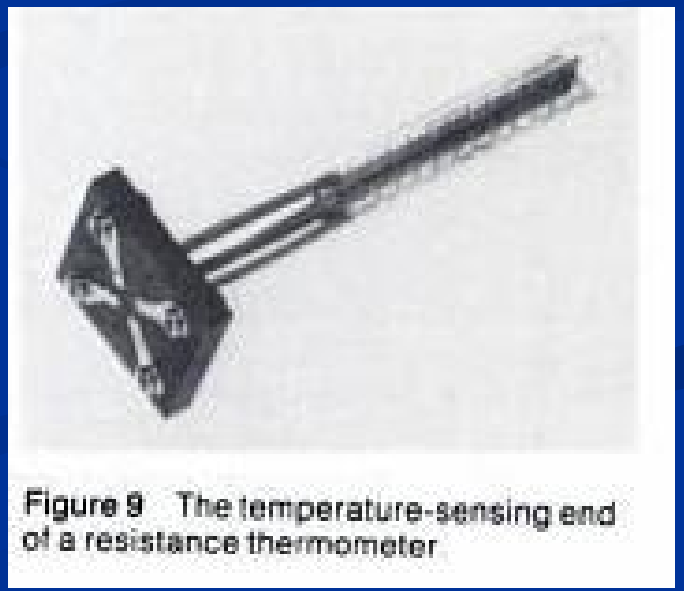


Figure 9 The temperature-sensing end of a resistance thermometer

•**Thermocouple thermometers:**

•Two different types of metals are joined together at two junctions. A temperature difference between the junctions makes the metals produce a small electric current, which makes the meter needle across the scale.

•Oven and furnace temperature.

•They can operate over a temperature range from about -200°C to 1600°C.

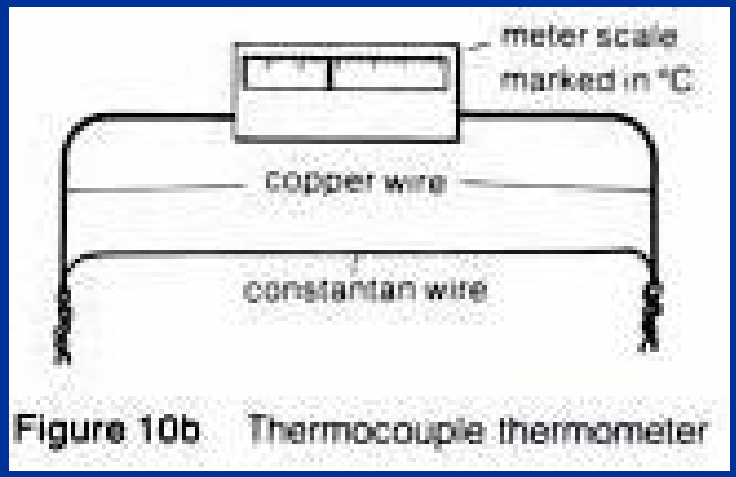


Figure 10b Thermocouple thermometer

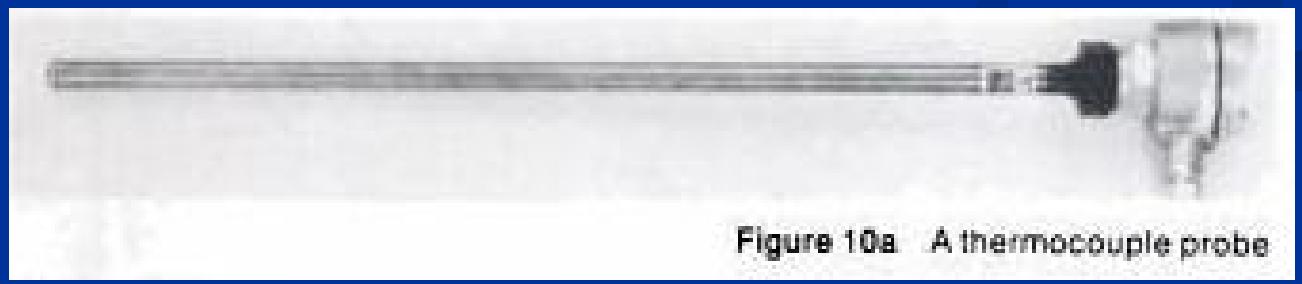


Figure 10a A thermocouple probe

Question:

Convert the following temperatures into kelvin:

-273°C, 0°C, 27°C, 100°C