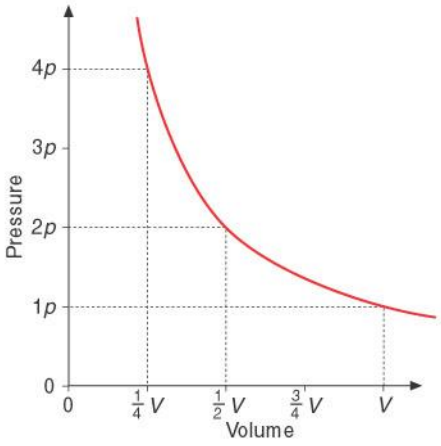
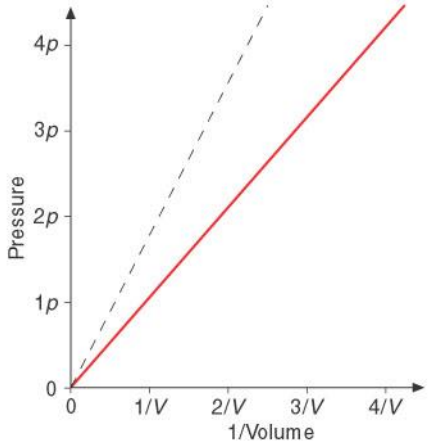
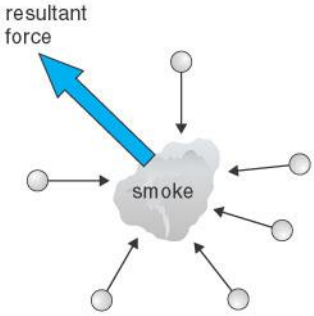
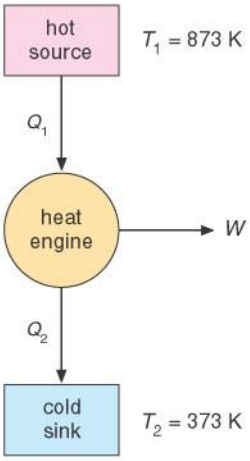
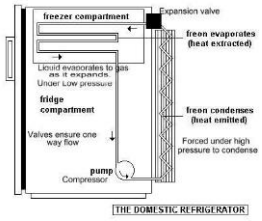

4p
3p
2p
1p
0
Pressure
0
$\frac{1}{4}V$
$\frac{1}{2}V$
$\frac{3}{4}V$
V
Volume


4p
3p
2p
1p
0
Pressure
0
1/V
2/V
3/V
4/V
1/Volume


resultant
force
smoke


hot
source
T_1 = 873 K
Q_1
heat
engine
W
Q_2
cold
sink
T_2 = 373 K


freezer compartment
Expansion valve
freon evaporates
(heat extracted)
Liquid evaporates to gas
as it expands.
Under Low pressure
fridge
compartment
freon condenses
(heat emitted)
Valves ensure one
way flow
Forced under high
pressure to condense
pump
Compressor
THE DOMESTIC REFRIGERATOR

5.2 Cooling by evaporation

For the enthusiast

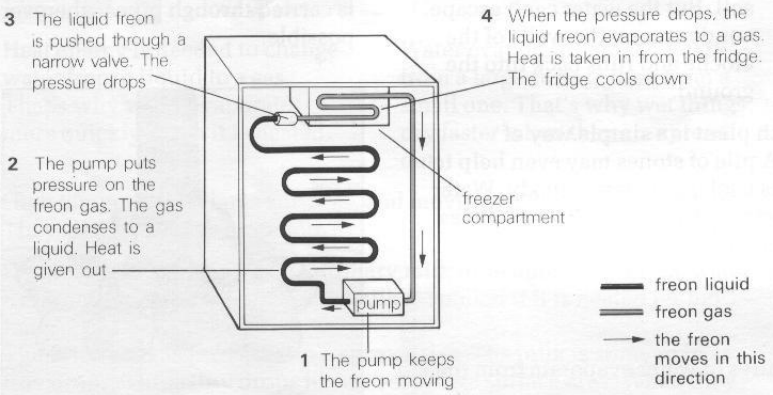
A drop of water is a mass of tiny, moving water molecules. The molecules in the drop all have different energies. They are all moving at different speeds. Some low energy molecules move very slowly. Some high energy molecules move very rapidly. Most molecules have a speed somewhere in between.

The drop is held together because the water molecules pull on or **attract** each other. But this attraction is not strong enough to keep every molecule in the drop. Some high energy molecules near the surface move so fast that they escape. As this happens, the drop slowly evaporates.

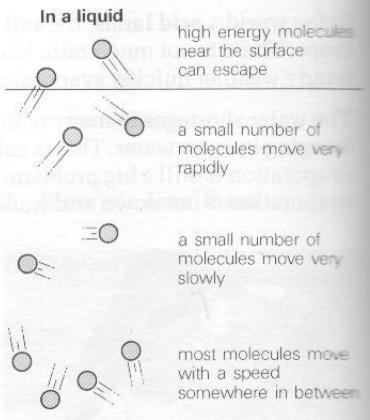
Only the fastest moving molecules have enough energy to escape from the drop. But evaporation does not stop once they have gone. Instead, the water drop takes in heat energy from its surroundings (if it can). This energy speeds up the molecules which are left in the liquid, and more escape. All of this means that:

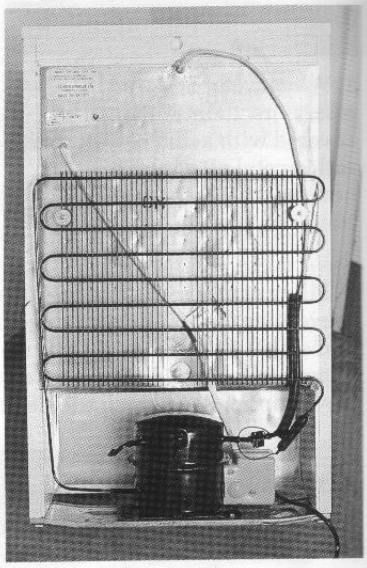
when a liquid evaporates, it takes in heat from its surroundings and makes the surroundings colder.

This cooling effect is used in a refrigerator. The refrigerator's pipes contain **freon**, a substance which evaporates and condenses easily.



The working parts of a refrigerator



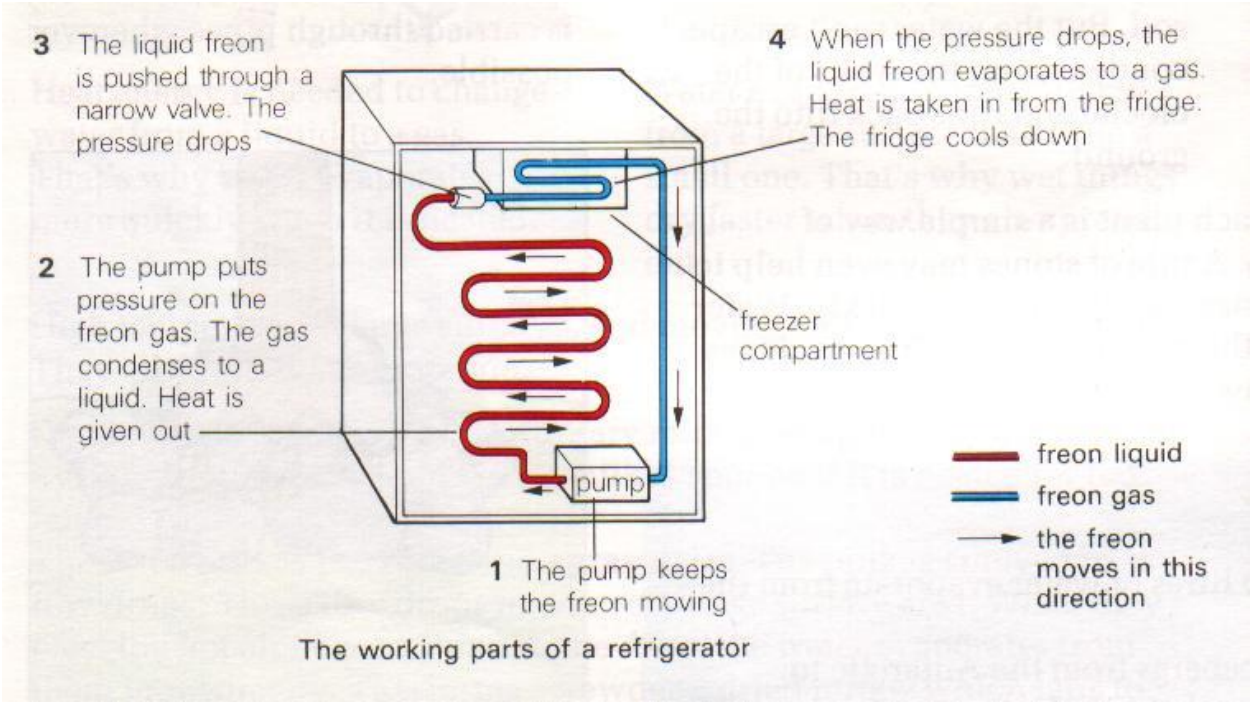


Rear view of fridge. You can see the pump and the tubes through which warm freon flows

1 Complete these sentences:
   a) A water drop is held together because ....
   b) A water drop slowly evaporates because ....
   c) When a water drop evaporates, the surroundings become ... because .... ▲
2 Is energy given out or taken in when: a) a gas changes to a liquid b) a liquid changes to a gas? ▲
3 Where does the cooling take place in a refrigerator? Why does cooling take place there?
4 Why does a refrigerator warm the room it is in?
5 Why do you feel cold when you stand around wet after swimming?
6 **Try to find out:** about some old fashioned methods of keeping food cool.

Did you know?

- Heat is given out when a gas condenses.
- One large store uses the heat given out by its freezers to heat the water needed by its hairdressing salon.



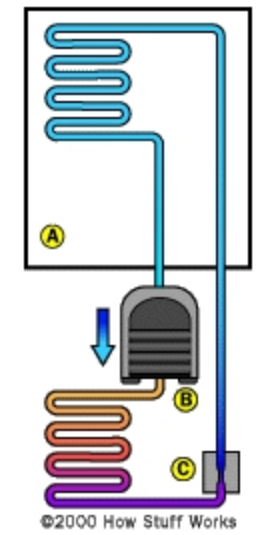
The working parts of a refrigerator

The Refrigeration Cycle

The refrigerator in your kitchen uses a cycle that is similar to the one described in the previous section. But in your refrigerator, the cycle is continuous. In the following example, we will assume that the refrigerant being used is pure ammonia, which boils at -27 degrees F. This is what happens to keep the refrigerator cool:

1. The **compressor** compresses the ammonia gas. The compressed gas heats up as it is pressurized (orange).
2. The **coils** on the back of the refrigerator let the hot ammonia gas dissipate its heat. The ammonia gas condenses into ammonia liquid (dark blue) at high pressure.
3. The high-pressure ammonia liquid flows through the **expansion valve**.

   You can think of the expansion valve as a small hole. On one side of the hole is high-pressure ammonia liquid. On the other side of the hole is a low-pressure area (because the compressor is sucking gas out of that side).



A Inside the refrigerator
B Compressor
C Expansion valve

4. The liquid ammonia immediately boils and vaporizes (light blue), its temperature dropping to -27 F. This makes the inside of the refrigerator cold.
5. The cold ammonia gas is sucked up by the **compressor**, and the cycle repeats.