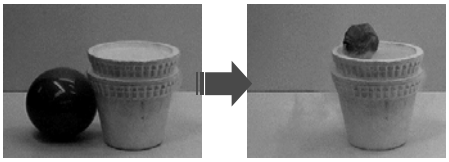
Charles's Law

THE RELATIONSHIP BETWEEN TEMPERATURE AND VOLUME

How Volume Varies With Temperature

If we place a balloon in liquid nitrogen it shrinks:



So, gases shrink if cooled.

Conversely, if we heat a gas it expands (as in a hot air balloon).

Let's take a closer look at temperature before we try to find the exact relationship of V vs. T.

Temperature scales

Is 20°C twice as hot as 10°C?

No. 68°F (20°C) is not double 50°F (10°C)

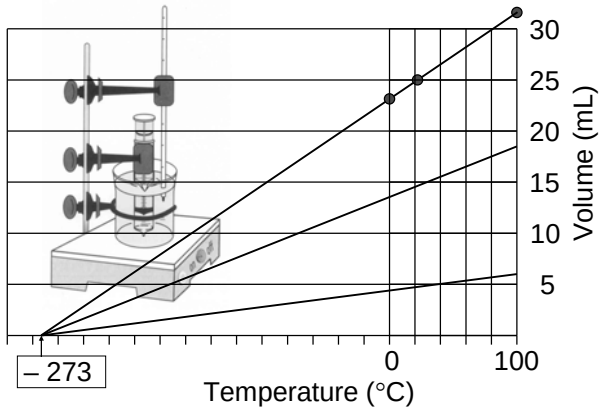
Is 20 kg twice as heavy as 10 kg?

Yes. 44 lb (20 kg) is double 22 lb (10 kg)

What's the difference?

- Weights (kg or lb) have a minimum value of 0.
- But the smallest temperature is not 0°C.
- We saw that doubling P yields half the V.
- Yet, to investigate the effect of doubling temperature, we first have to know what that means.
- An experiment with a fixed volume of gas in a cylinder will reveal the relationship of V vs. T…

Temperature vs. Volume Graph (fig.7,8 pg.430)



The Kelvin Temperature Scale

- If a volume vs. temperature graph is plotted for gases, most lines can be interpolated so that when volume is 0 the temperature is -273 °C.
- Naturally, gases don't really reach a 0 volume, but the spaces between molecules approach 0.
- At this point all molecular movement stops.
- –273°C is known as "absolute zero" (no E_K)
- Lord Kelvin suggested that a reasonable temperature scale should start at a true zero value.
- He kept the convenient units of °C, but started at absolute zero. Thus, K = °C + 273.
  62°C = ? K: K=°C+273 = 62 + 273 = 335 K
- Notice that kelvin is represented as K not °K.

Kelvin Practice

What is the approximate temperature for absolute zero in degrees Celsius and kelvin?

Calculate the missing temperatures

0°C = _____ K		100°C = _____ K	
100 K = _____ °C		–30°C = _____ K	
300 K = _____ °C		403 K = _____ °C	
25°C = _____ K		0 K = _____ °C	

Charles's Law

- Looking back at the temperature vs. volume graph, notice that there is a direct relationship.
- It can be shown that V/T = constant

Read pages 432-3. Answer these questions:

1. Give Charles's law in words & as an equation.

2. A sample of gas occupies 3.5 L at 300 K. What volume will it occupy at 200 K?

3. If a 1 L balloon is heated from 22°C to 100°C, what will its new volume be?

4. Do questions 16, 17, 19 on page 434