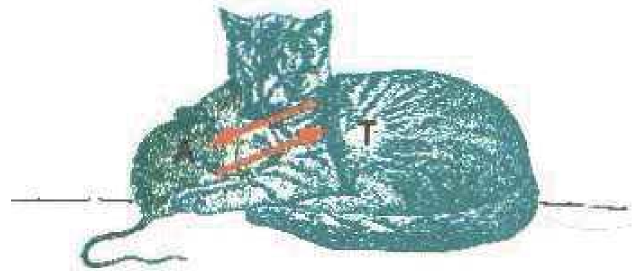
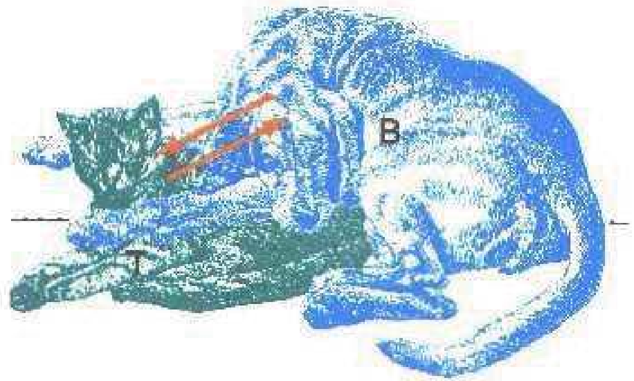
Temperature

The Zeroth Law of Thermodynamics

If no net heat flow between A and T



AND
If no net heat flow between B and T

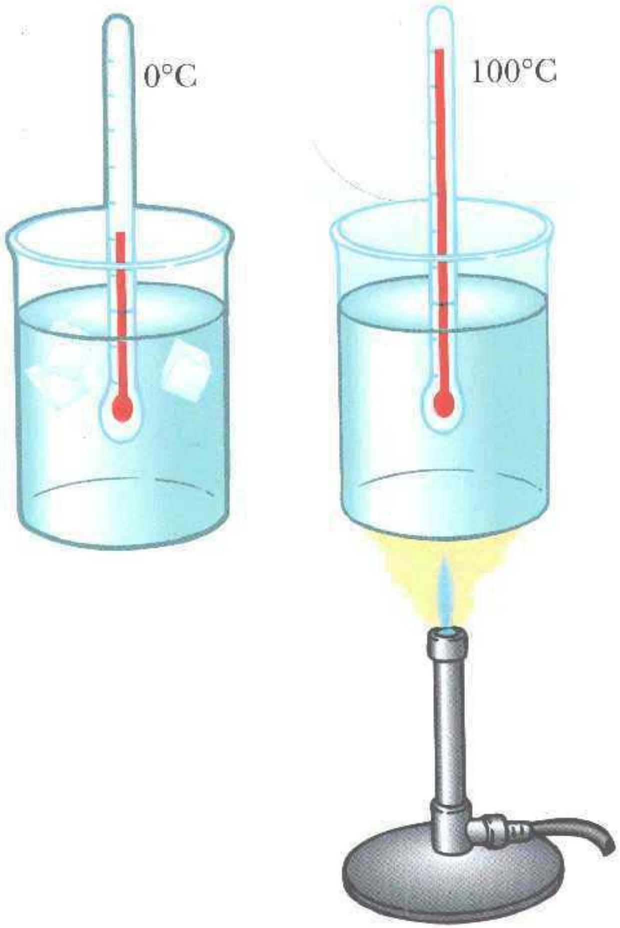


THEN
No net heat flow between A and B

THERMAL EQUILIBRIUM

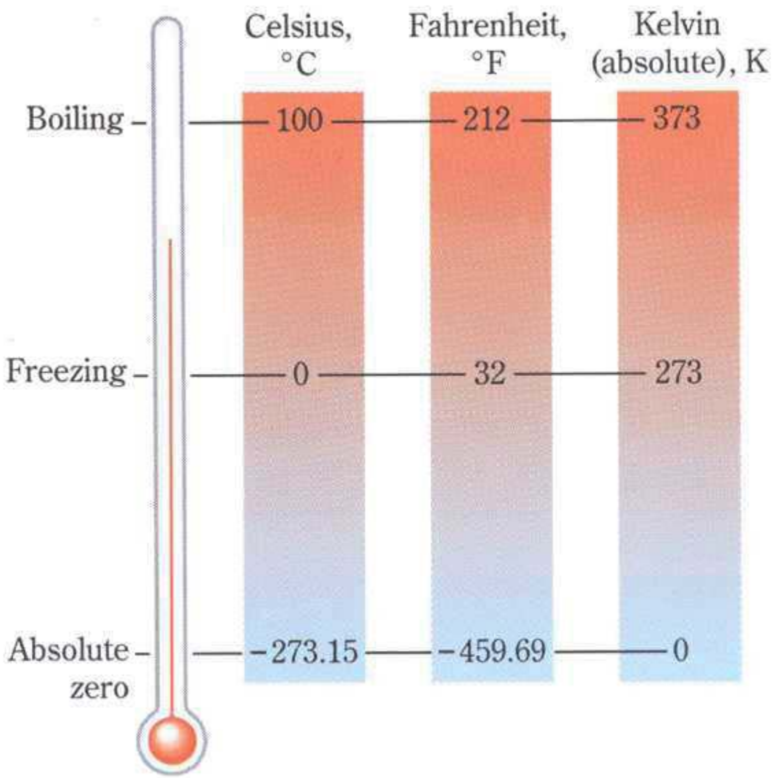
TEMP. A=TEMP.B

Acetate 8-3 (Figure 8.11)



Overhead transparencies to accompany Serway/Faughn: *College Physics, 4/e*
Figure 49 Text figure 10.1 page 300
Schematic diagram of a mercury thermometer

Fig. 10.1



T67 (Figure 17-10) Celsius and Fahrenheit temperature scales

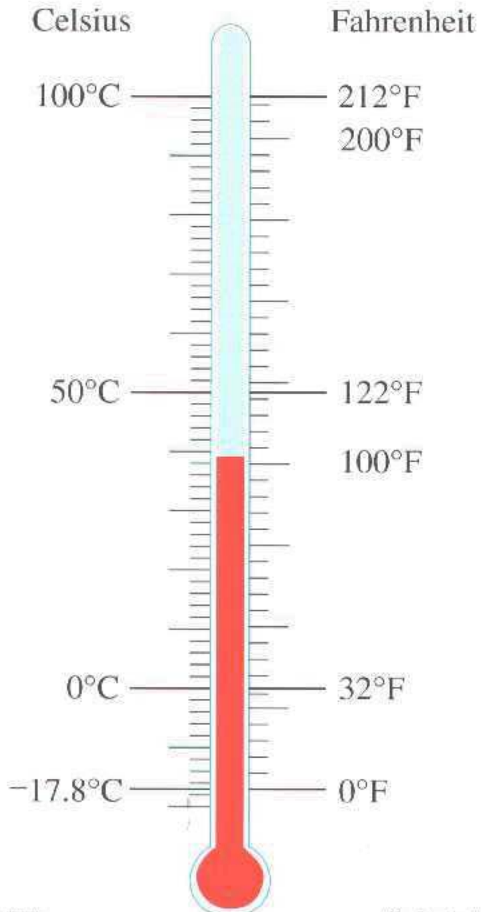


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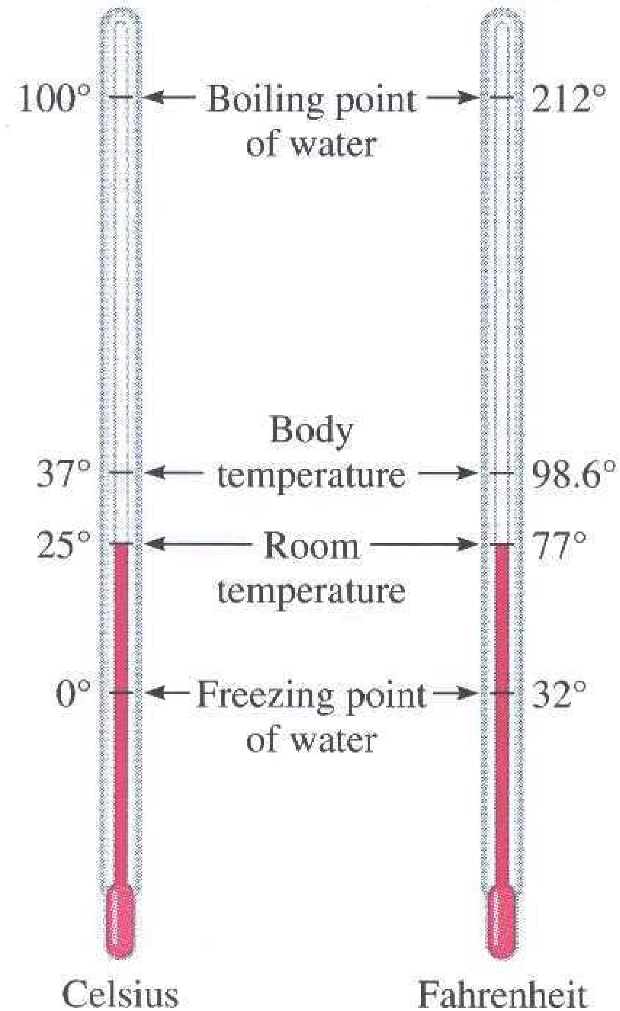
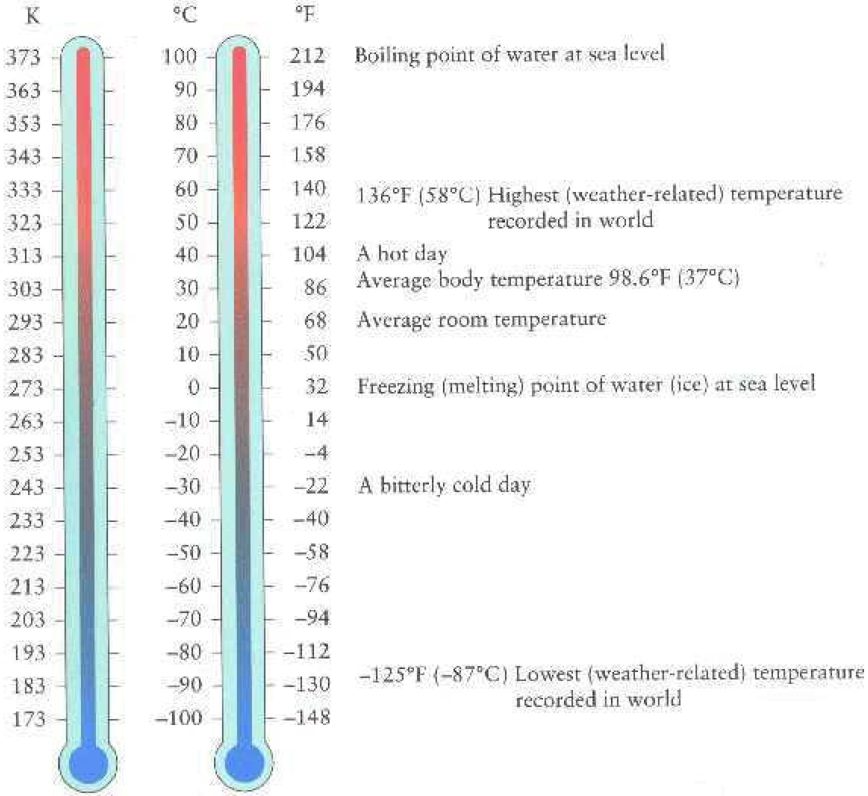
Figure 1.11



Kelvin, Celsius, and Fahrenheit Temperature Scales



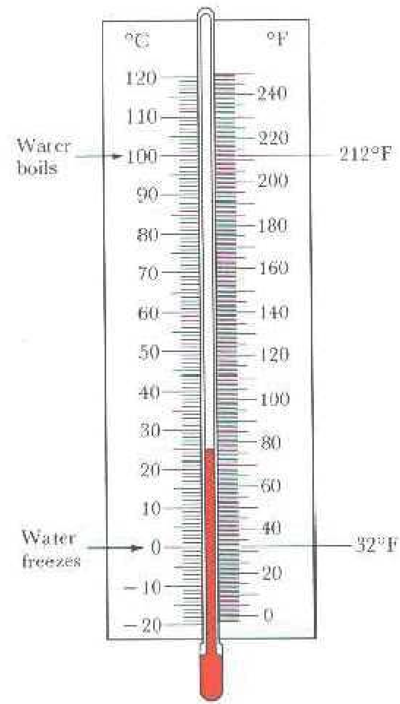


FIGURE 1.15

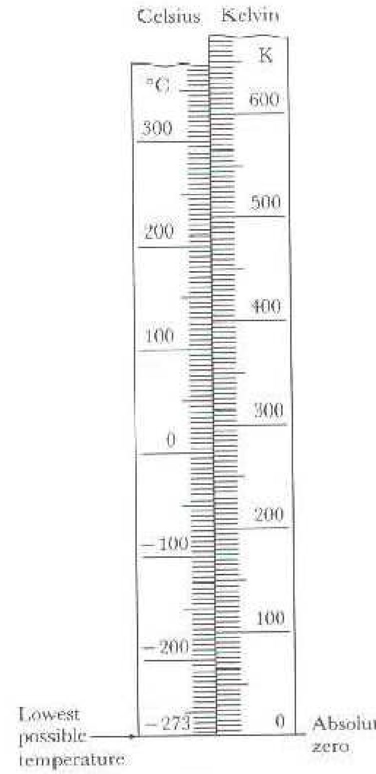
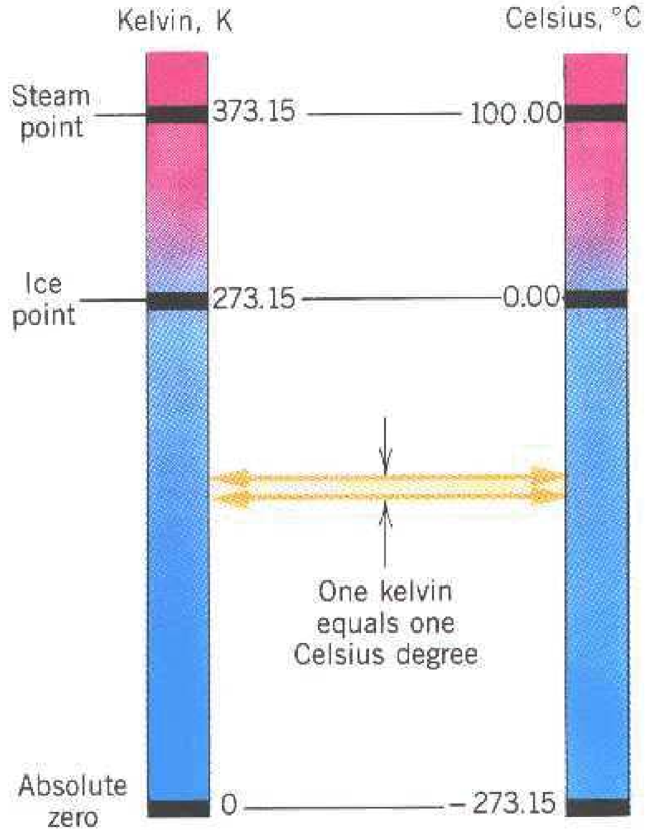


FIGURE 1.16

Atkins/Beran
GENERAL CHEMISTRY, Second Edition

4)

5)


Kelvin, K
Celsius, °C
Steam point
373.15
100.00
Ice point
273.15
0.00
One kelvin equals one Celsius degree
Absolute zero
0
– 273.15

6)

FIGURE 12.2

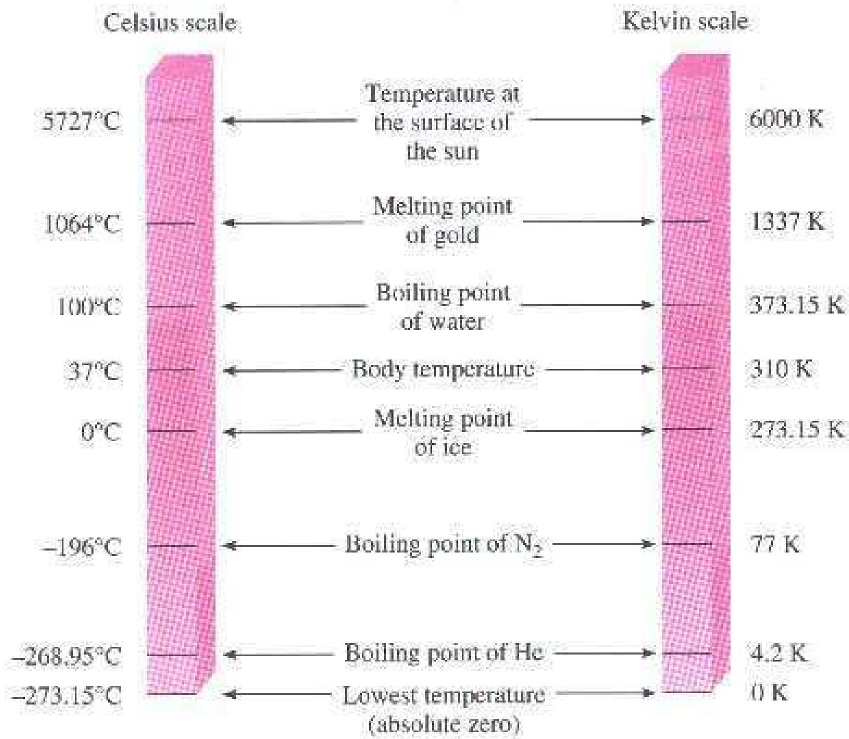

Celsius scale
Kelvin scale
5727°C
Temperature at the surface of the sun
6000 K
1064°C
Melting point of gold
1337 K
100°C
Boiling point of water
373.15 K
37°C
Body temperature
310 K
0°C
Melting point of ice
273.15 K
−196°C
Boiling point of N_2
77 K
−268.95°C
Boiling point of He
4.2 K
−273.15°C
Lowest temperature (absolute zero)
0 K

Figure 5.8

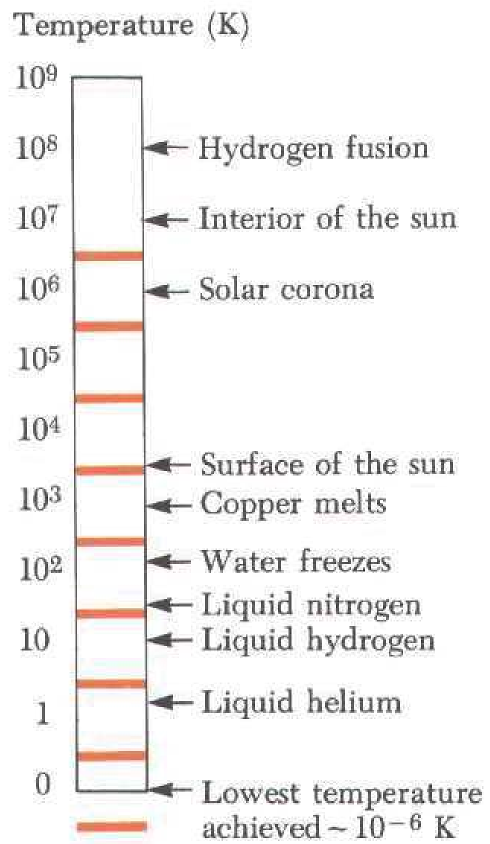
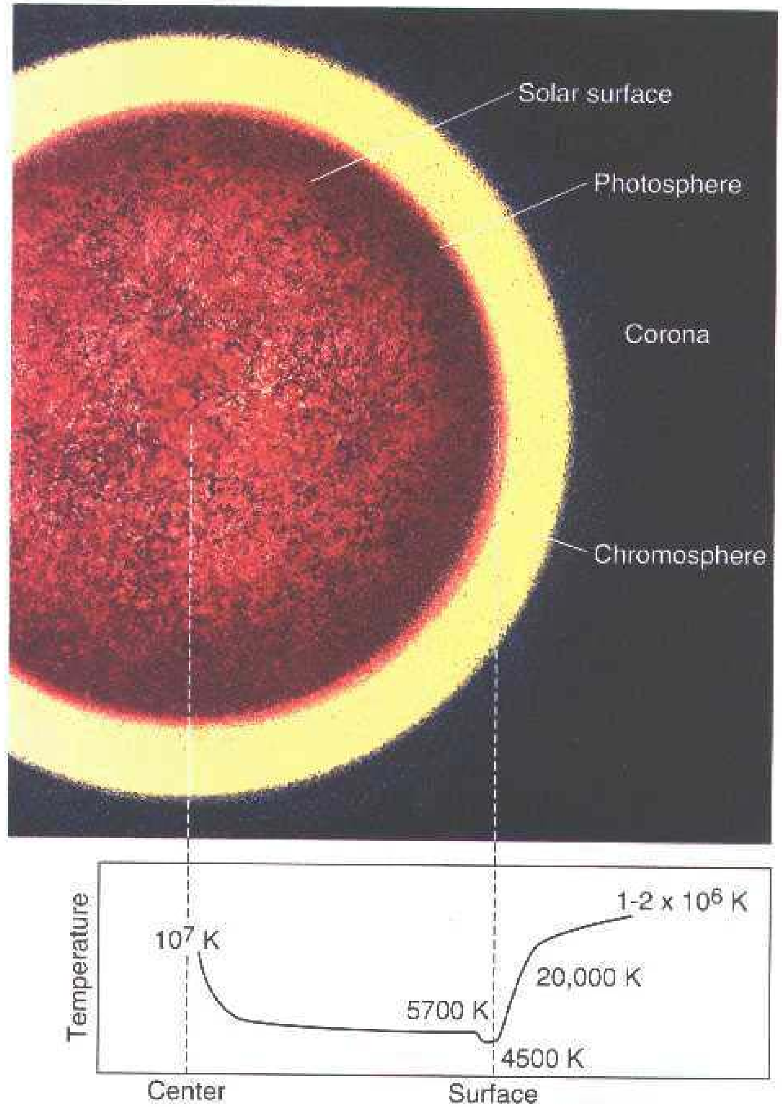

Temperature (K)
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
1
0
Hydrogen fusion
Interior of the sun
Solar corona
Surface of the sun
Copper melts
Water freezes
Liquid nitrogen
Liquid hydrogen
Liquid helium
Lowest temperature achieved ~ 10^{-6} K

Fig. 11-5

The structure of the Sun's outer layers



Transparency 59 (Figure 11.4)

8)

Representative Temperatures in the Three Temperature Scales

Description	°F	°C	K
Absolute zero	-459.67	-273.15	0
Helium boiling point	-452	-268.9	4.25
Nitrogen boiling point	-320.4	-195.8	77.35
Oxygen boiling point	-297.35	-182.97	90.18
Alcohol freezing point	-175	-115	158
Mercury freezing point	-37.1	-38.4	234.75
Water freezing point	32	0	273.15
Normal body temperature	98.6	37	310.15
Water boiling point	212	100	373.15
"Red hot" (approx.)	800	430	700
Aluminum melting point	1,220	660	933
Iron melting point	2,797	1,536	1,809
Sun's surface (approx.)	10,000	5,700	6,000
Sun's interior (approx.)	27×10^6	15×10^6	15×10^6
Highest laboratory temperature	410×10^6	230×10^6	230×10^6

Acetate 51 (Table 5.1)

CONSTANT VOLUME GAS THERMOMETER

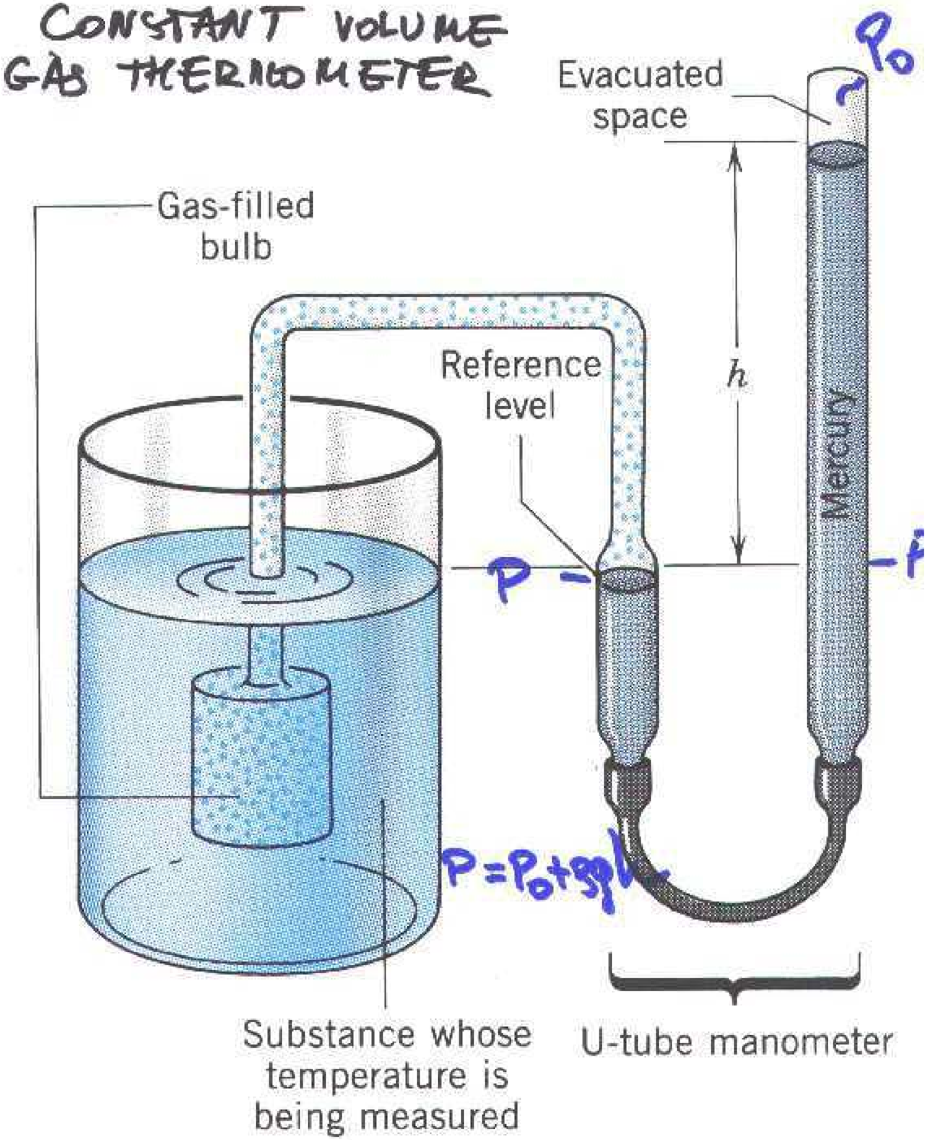


FIGURE 12.3

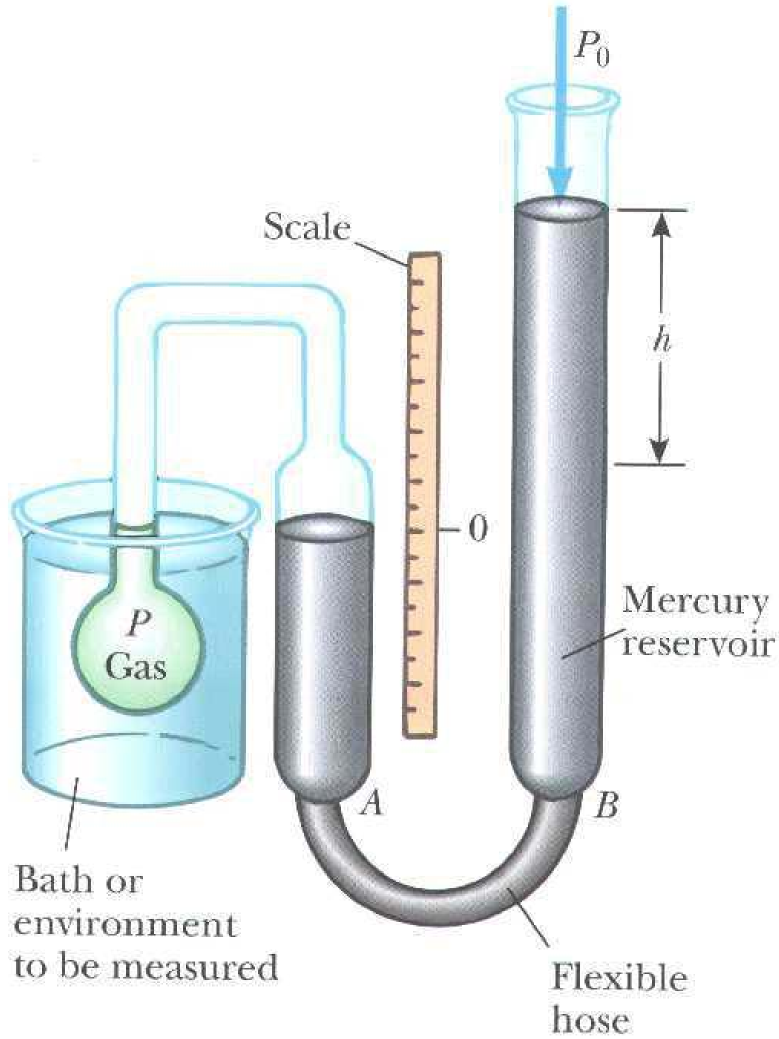


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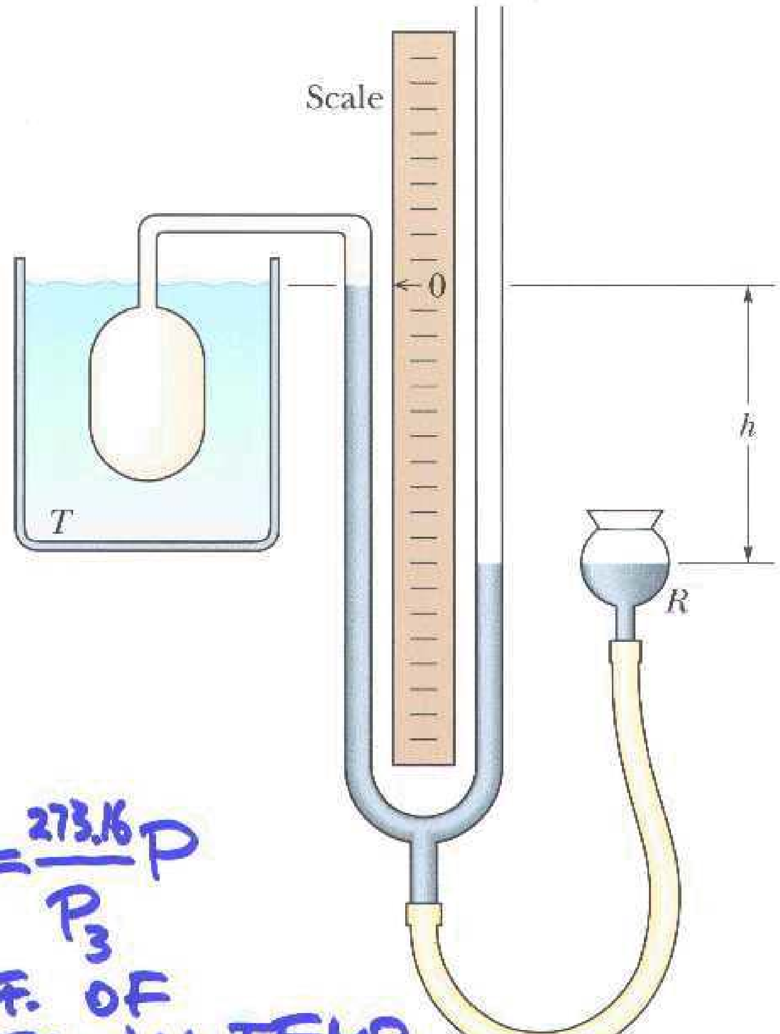
Figure 50 Text figure 10.2

10) A constant volume gas thermometer



$$T = \frac{273.16}{P_3} P$$

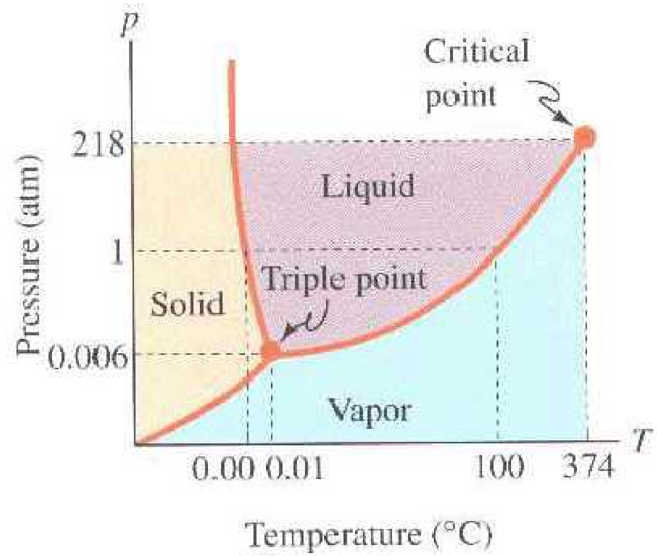
DEF. OF KELVIN TEMP.

CONSTANT VOLUME GAS THERMOMETER

11)

FIGURE 19-5

T68 (Figure 17-11) Phase diagram for water



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12)

(3)

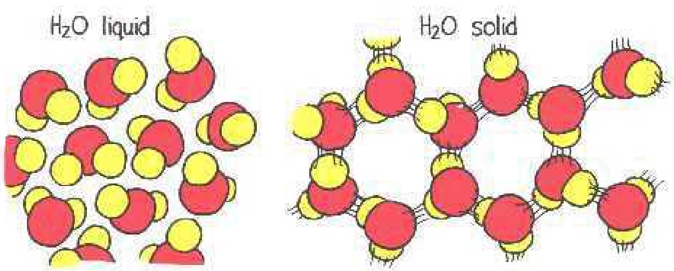


Figure 14.15
Conceptual Physics, Seventh Edition, by Paul G. Hewitt

(4)

$$T = \lim_{P_3 \to 0} 273.16 \frac{P}{P_3}$$

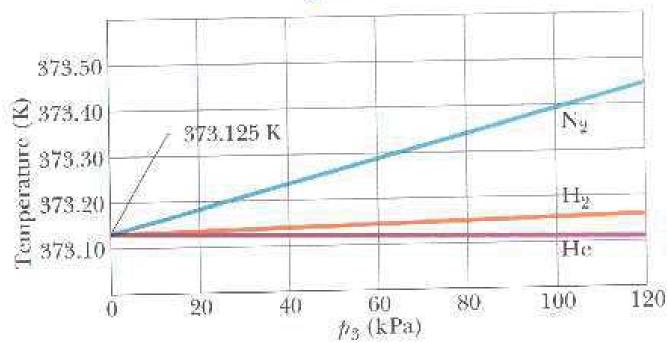
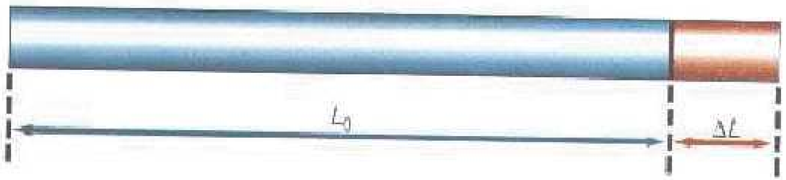


FIGURE 19-6

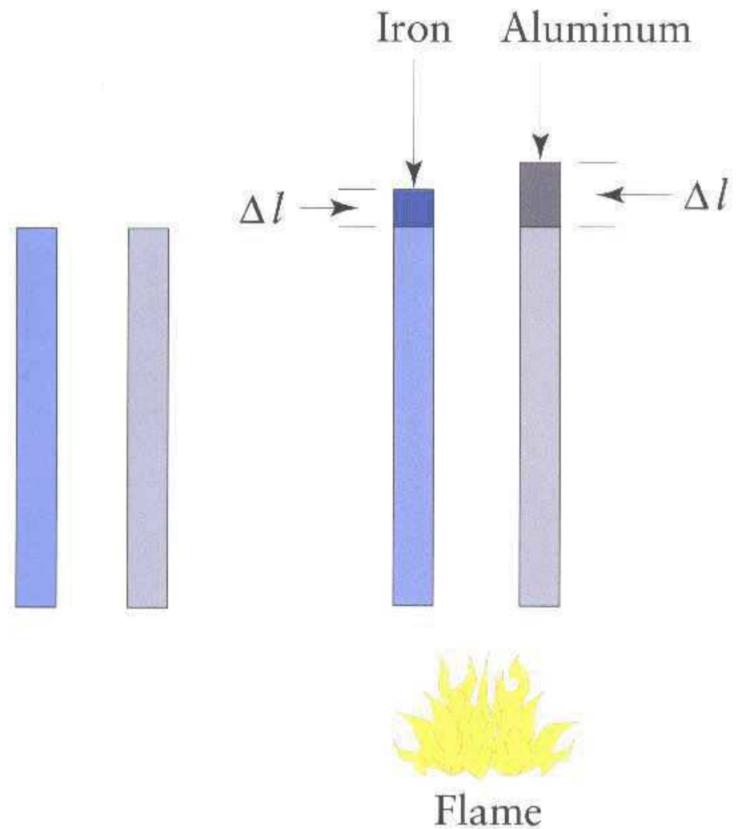
AS THE AMOUNT OF GAS (~ TO P_3) IN A THERMOMETER IS DECREASED, ALL GASES TEND TO INDICATE THE SAME TEMPERATURE

THERMAL EXPANSION



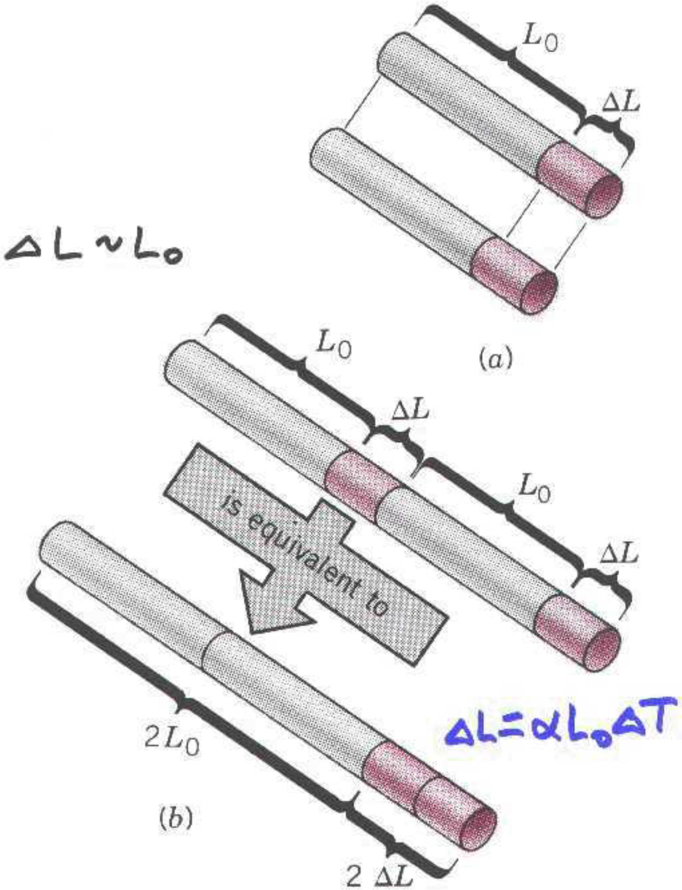
15) 15 Linear expansion
Figure 15.1

Thermal Expansion of Iron and Aluminum



16) Acetate 56 (Figure 5.7)

$\Delta L \sim L_0$



$\Delta L = \alpha L_0 \Delta T$

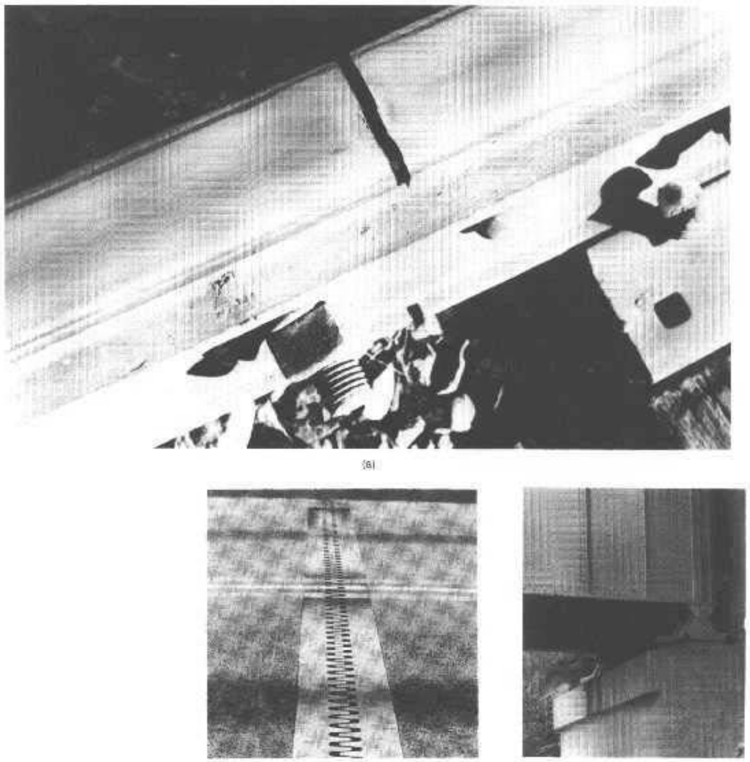
FIGURE 12.10 107

17)

Some Coefficients of Linear Expansion

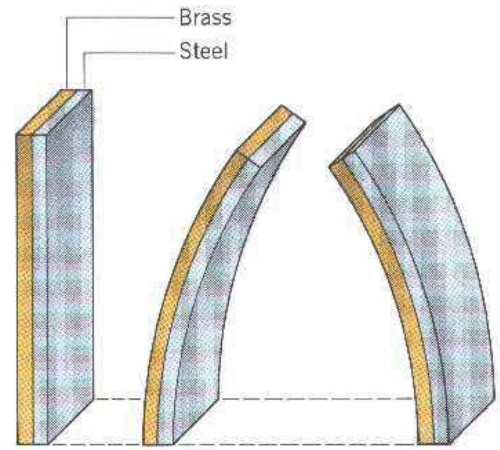
Solid	$\alpha\ (\times 10^{-6}/°C)$
Aluminum	25
Brass or bronze	19
Brick	9
Copper	17
Glass (plate)	9
Glass (Pyrex)	3
Ice	51
Iron or steel	12
Lead	29
Quartz (fused)	0.4
Silver	19

Acetate 67 (Table 3.2)



(a) (b) (c)

19)



$\alpha_{BRASS} = 19 \times 10^{-6} / °C$
IS LARGER THAN
$\alpha_{STEEL} = 12 \times 10^{-6} / °C$

20)

FIGURE 12.15

21)

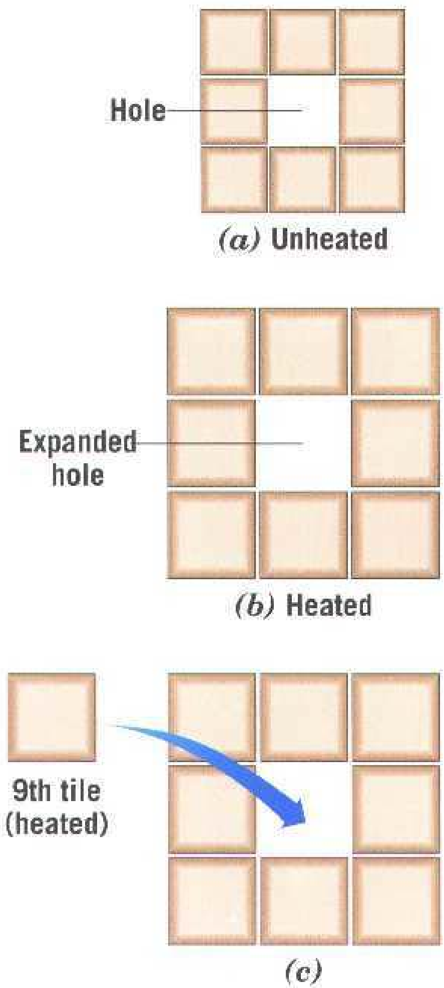
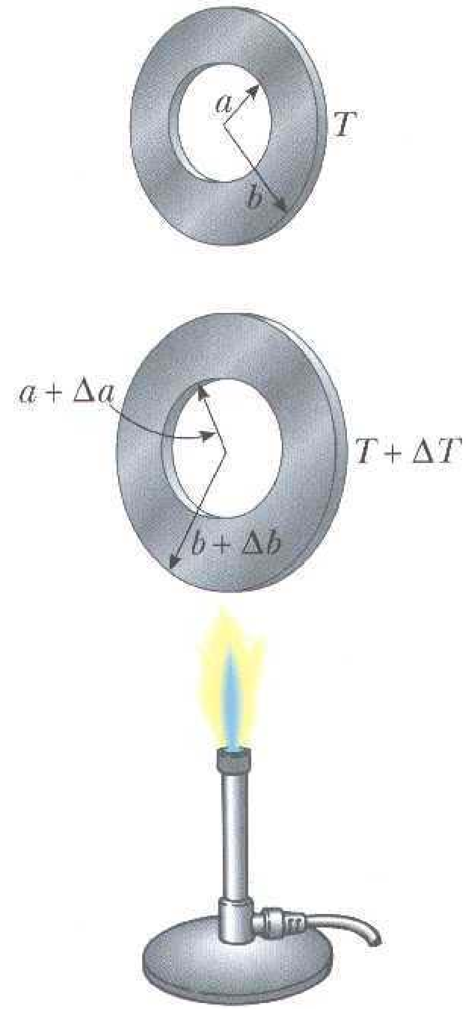


FIGURE 12.17



22)

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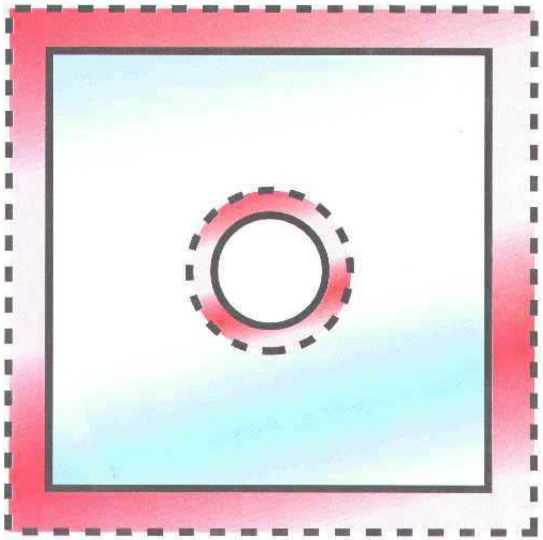
Figure 51 Text figure 10.6
Thermal expansion



46 The empty hole expands at the same rate as if there were material in the hole
Figure 15.3

23)

24)

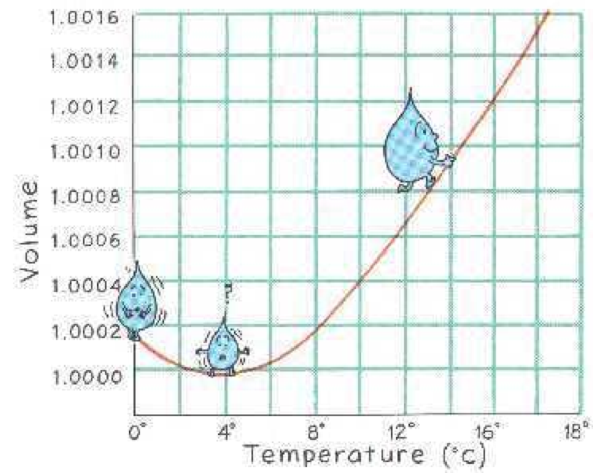
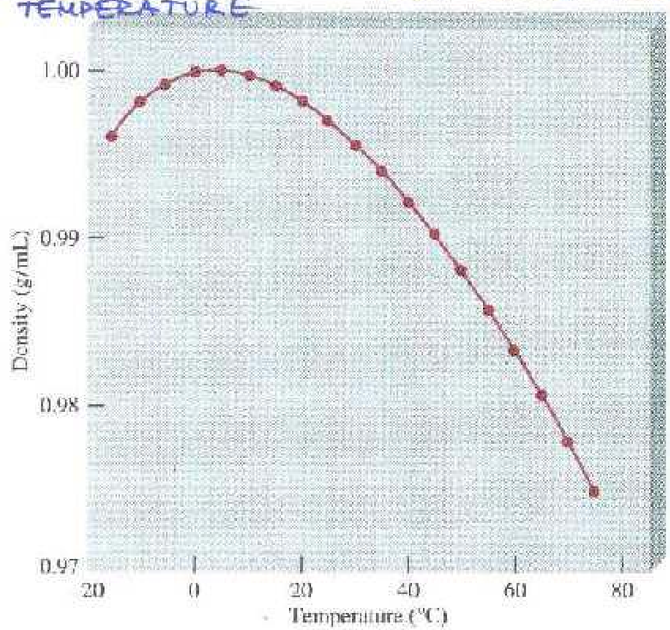


Figure 14.14
Conceptual Physics, Seventh Edition, by Paul G. Hewitt

24)

DENSITY VS TEMPERATURE FOR LIQUID WATER



25)

T-29

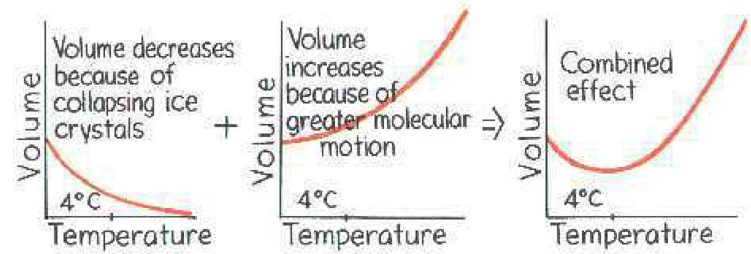
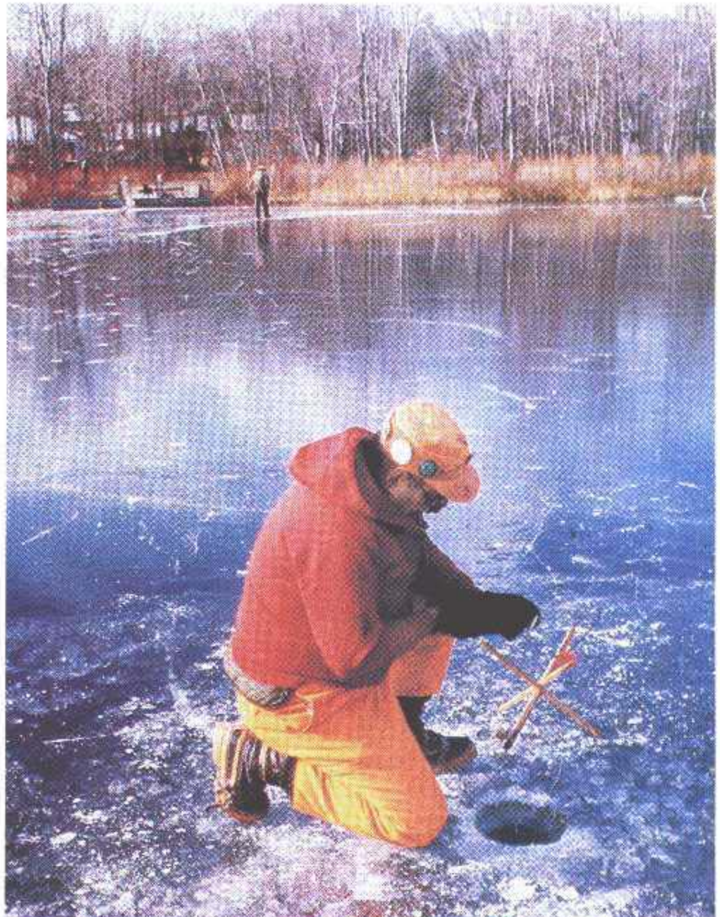


Figure 14.16
Conceptual Physics, Seventh Edition, by Paul G. Hewitt

ICE FISHING

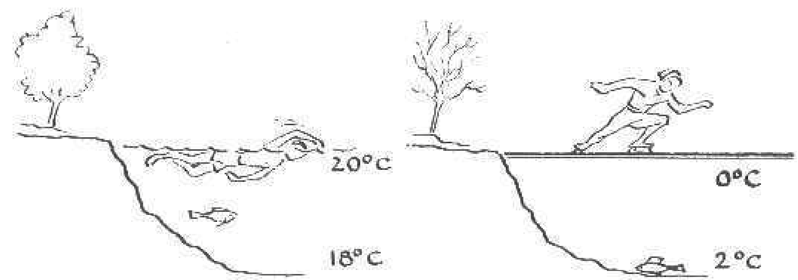
Figure 11.12



THE ICE LAYER ON THE SURFACE OF A LAKE INSULATES THE WATER BENEATH AND
25) SUSTAINS AQUATIC LIFE

26)

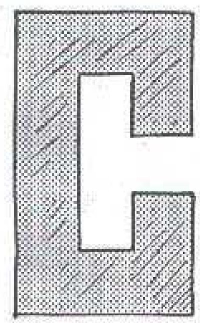
Depth Variation of Temperature in Warm and Cold Water



Acetate 57 (Figure 5.12)

CONCEPTUAL **Physics**

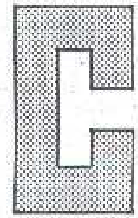
WHEN THE TEMPERATURE OF THE PIECE OF METAL IS INCREASED AND THE METAL EXPANDS, WILL THE GAP BETWEEN THE ENDS BECOME NARROWER, OR WIDER, OR REMAIN UNCHANGED?



Hewitt Drawit!

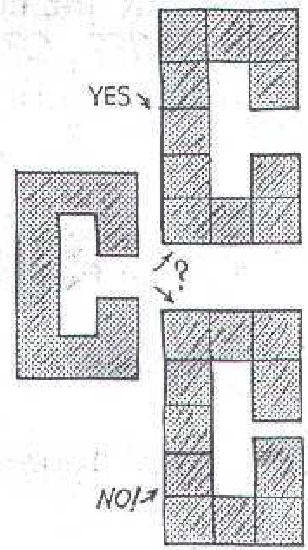
26)

WHEN THE TEMPERATURE OF THE PIECE OF METAL IS INCREASED AND THE METAL EXPANDS, WILL THE GAP BETWEEN THE ENDS BECOME NARROWER, OR WIDER, OR REMAIN UNCHANGED?



ANSWER:

THE GAP WILL BECOME WIDER WHEN THE METAL EXPANDS. TO SEE THIS, PRETEND THE SHAPE IS COMPOSED OF LITTLE BLOCKS, EACH THE SIZE OF THE GAP. WHEN HEATED, EACH BLOCK EXPANDS THE SAME. SO IF THE METAL IS HEATED UNIFORMLY, EVERY PART EXPANDS AT THE SAME RATE--- EVEN THE GAP.



Hewitt
Drew It!

IDEAL (DILUTED) GAS LAW

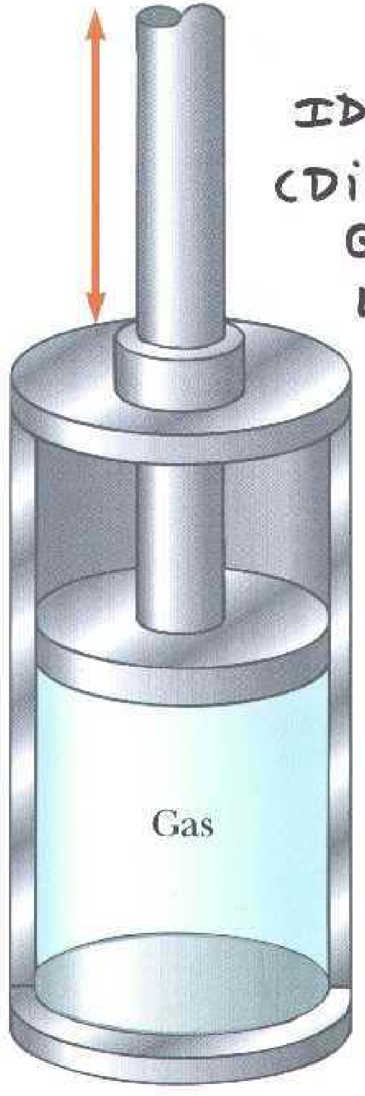


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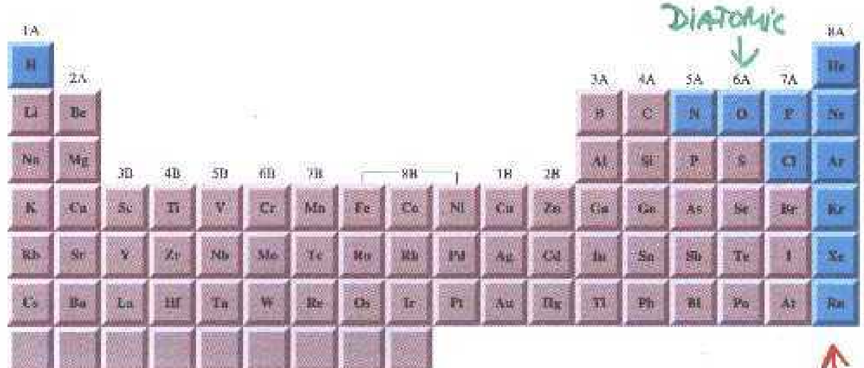
Figure 52 Text figure 10.9 page 308

28) Gas confined to a cylinder with a movable piston

28)

ELEMENTS THAT EXIST AS GASES AT 25°C AND 1 ATM.

DIATOMIC ↓

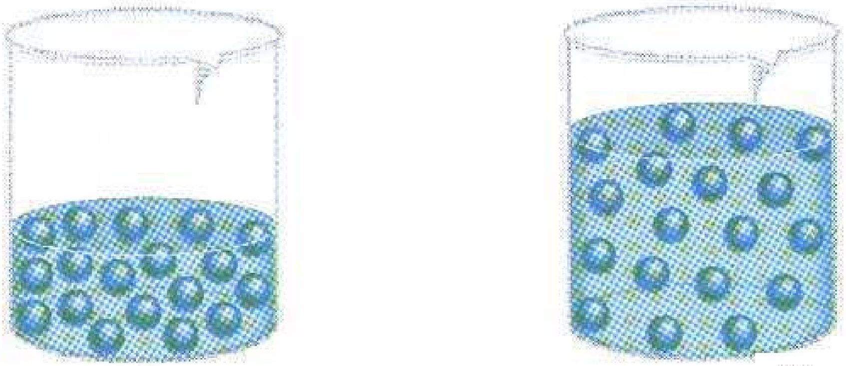


↑ NOBLE GASES – MONATOMIC

Figure 5.1

28)

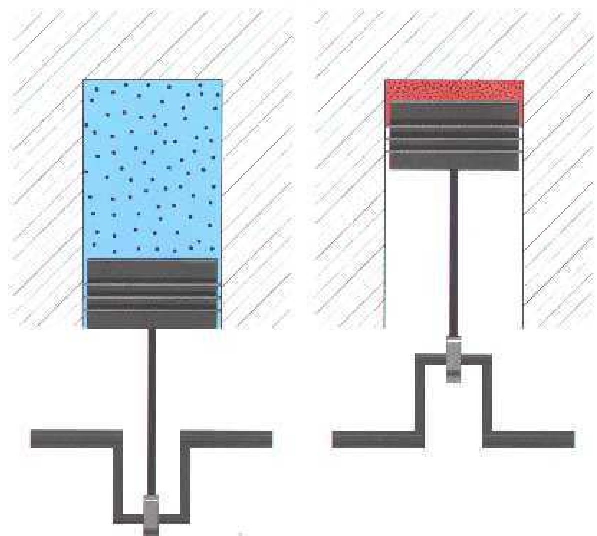
DILUTION



(a) (b)

29)

Air Compression in a Diesel Engine



Acetate 58 (Figure 5.17)

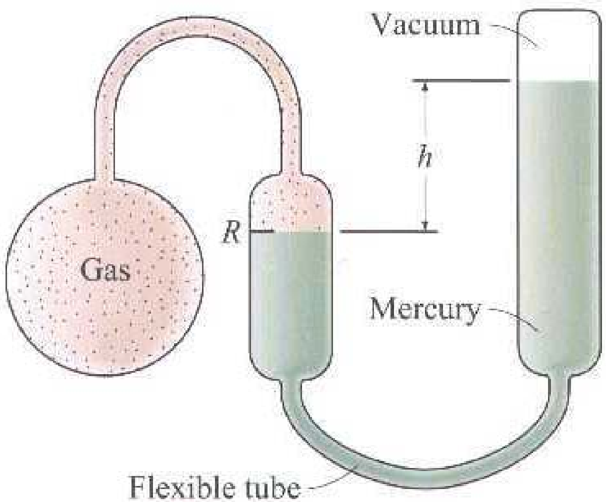
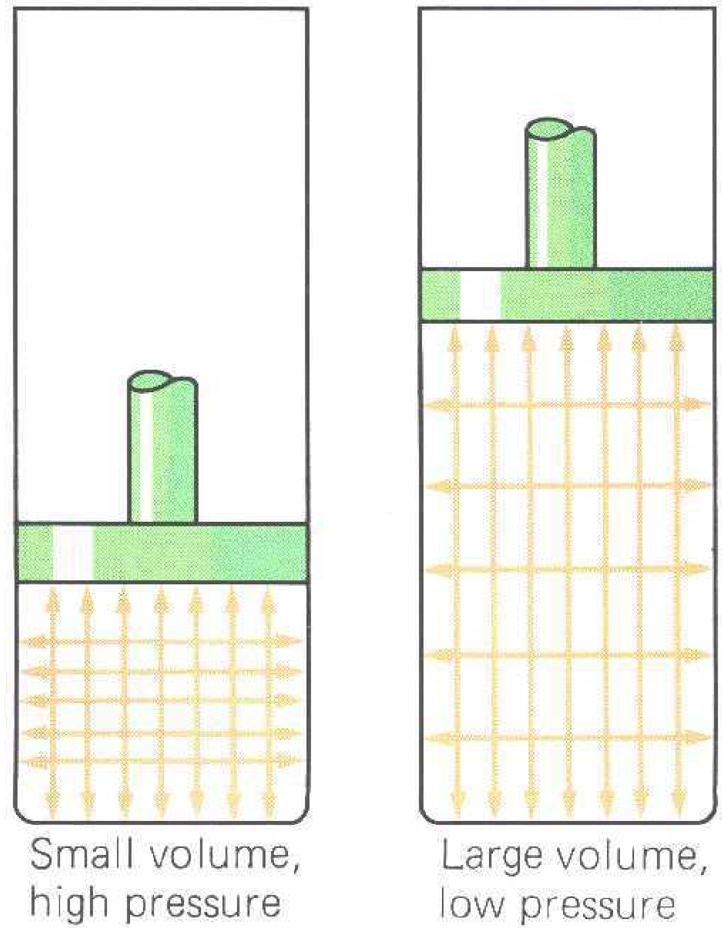


Figure 4-19



30)

$P = \frac{CONST}{V}$

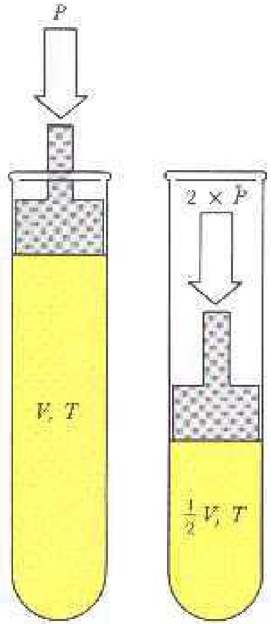


FIGURE 5.5

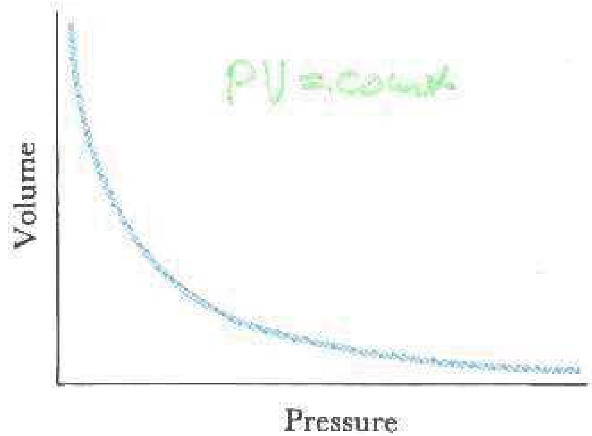


FIGURE 5.6

P–V PLOT
AT T = CONST

T-30
FIGURES 5.5, 5.6

THE RELATIONSHIP BETWEEN PRESSURE AND VOLUME OF A GAS

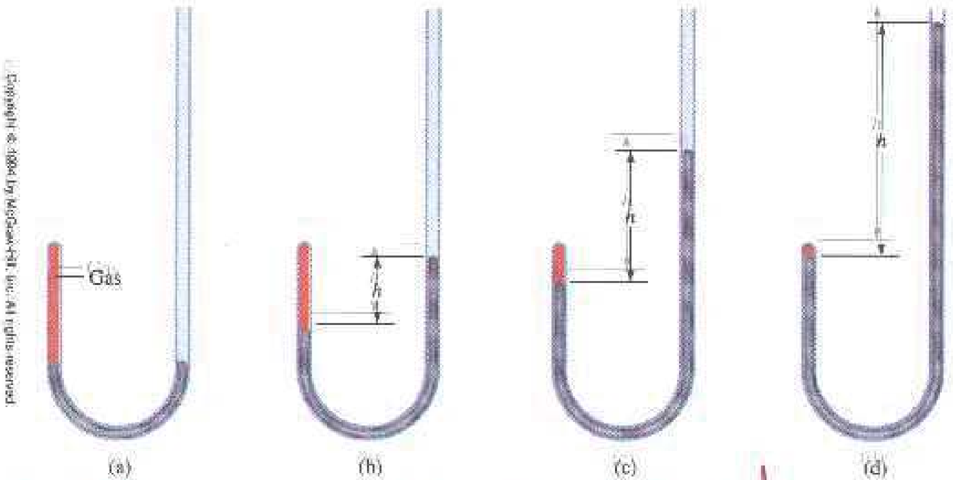


Figure 5.4

$P_{GAS} = P_{ATM}$

$P_{GAS} = P_{ATM} + \rho_{Hg} g h$

BOYLE'S LAW: $P = \frac{CONST}{V}$

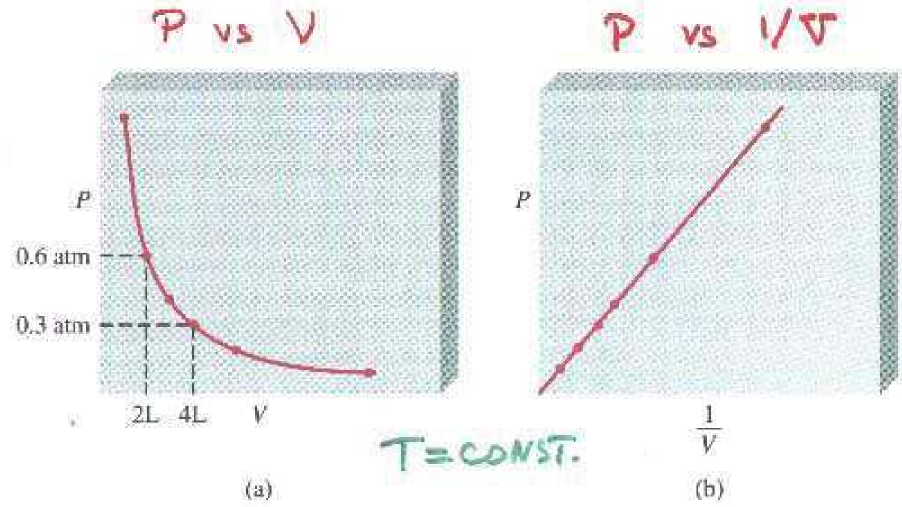


Figure 5.5

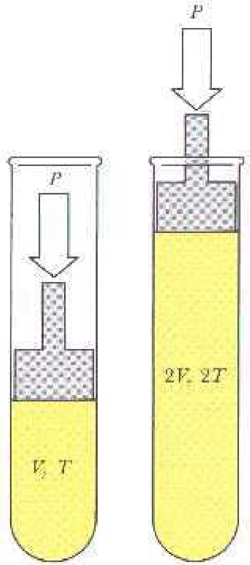
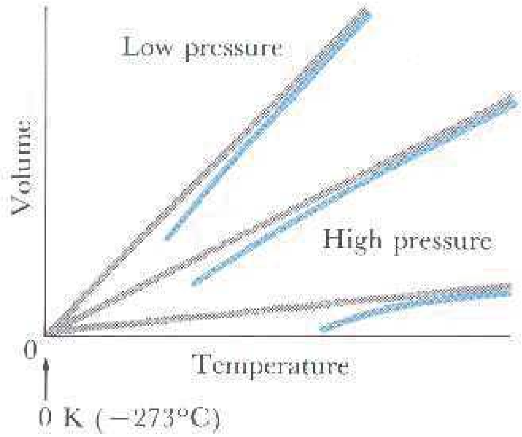


FIGURE 5.8



V = CONST × T

FIGURE 5.9

T-31
FIGURES 5.8, 5.9

V–T PLOT
AT P = CONST.

Atkin
GENERAL CHEMISTRY, Second
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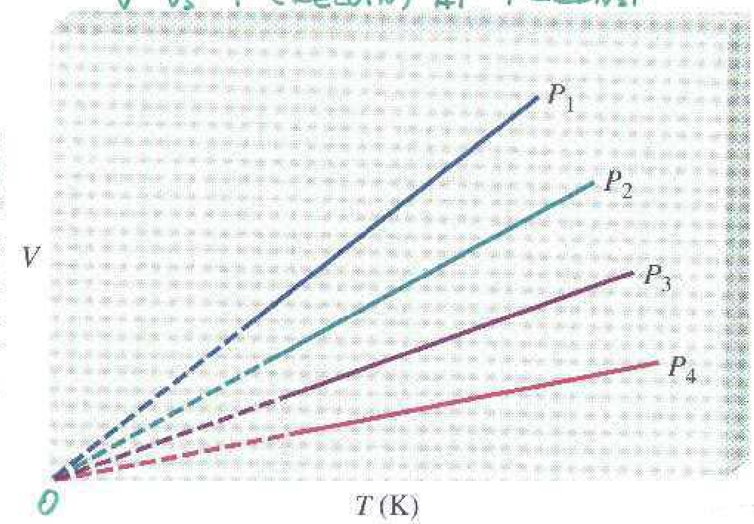
V vs T (KELVIN) AT P=CONST



30

Figure 5.9

VARIATION OF THE GAS VOLUME WITH TEMPERATURE AT P = CONST.

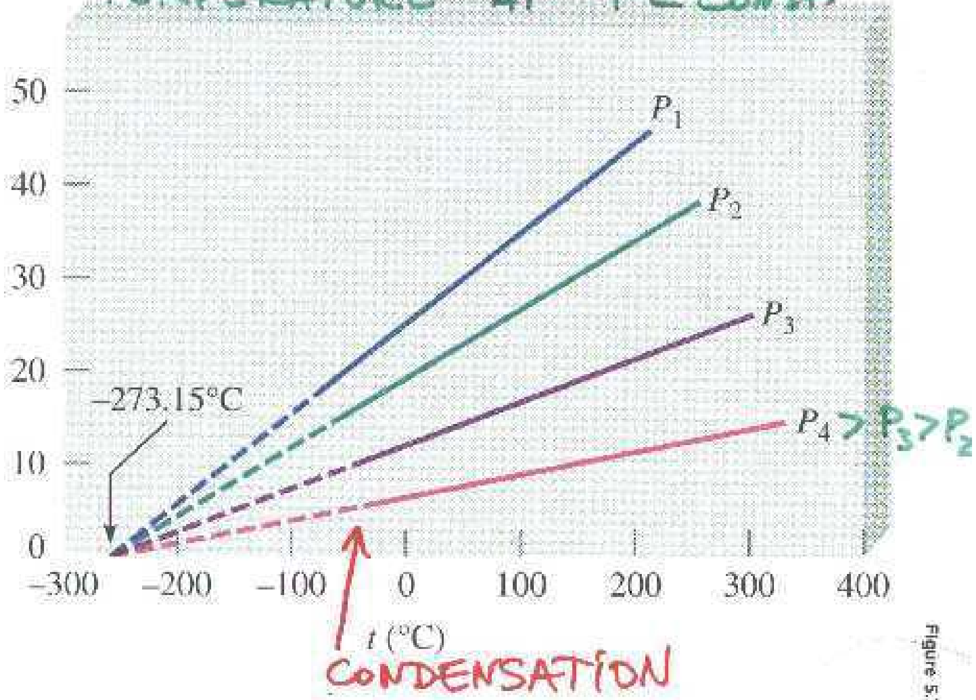


Figure 5.7

32 (5) 18

Figure 4-16

ABSOLUTE ZERO OF TEMPERATURE

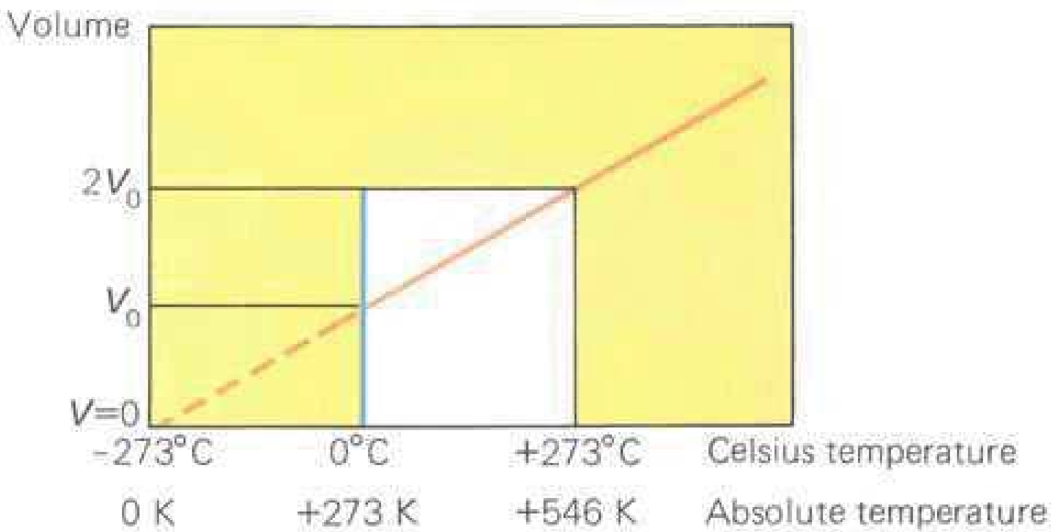
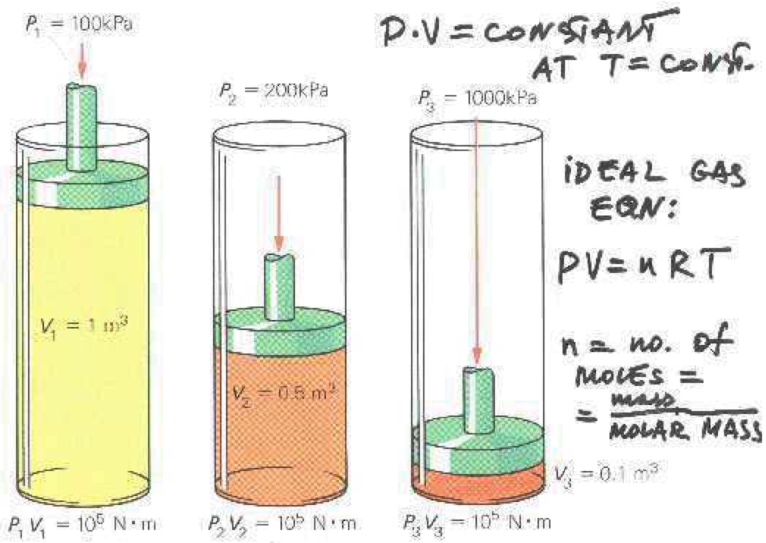
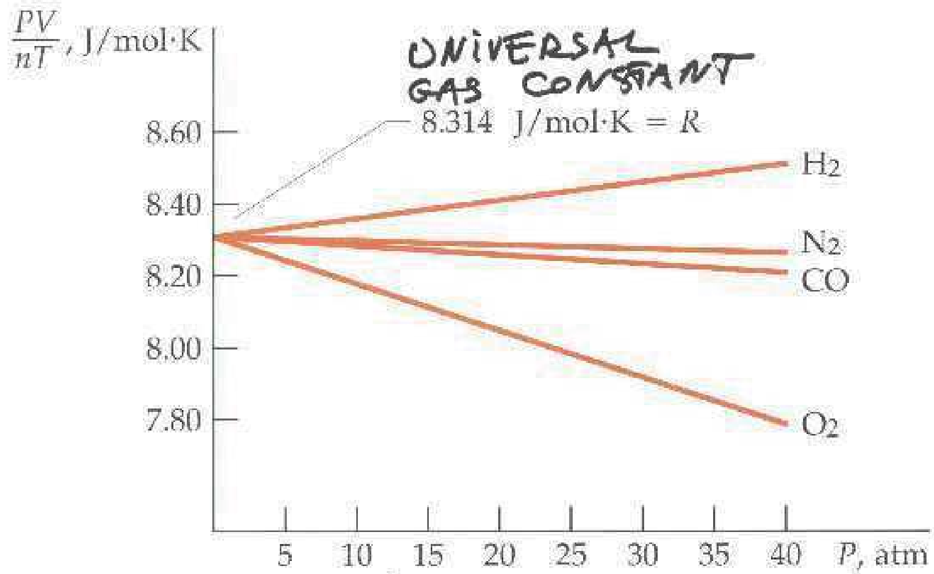


Figure 4-13



Transparency 67
Figure 15-10, page 497
Plot of PV/nT versus P for real gases.

Tipler: Physics for Scientists and Engineers
Third Edition, Volume 1



(34.1)

One mole of a real gas

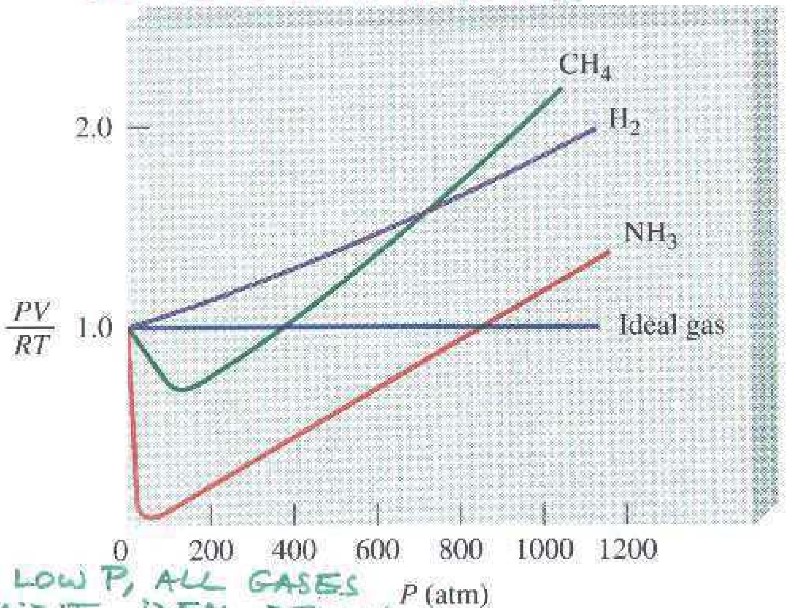


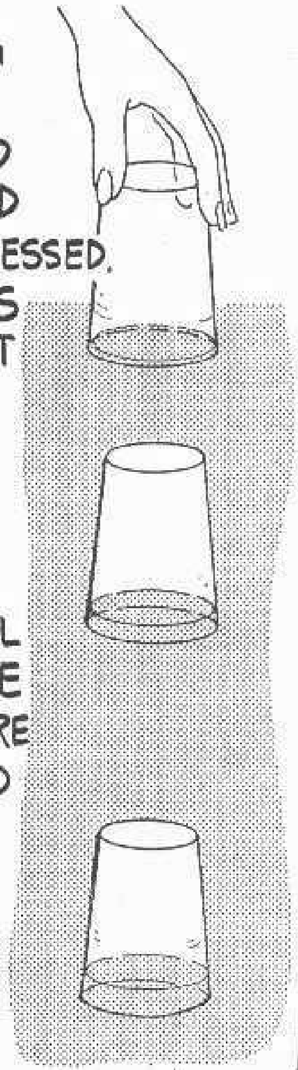
Figure 5.23

AT LOW P, ALL GASES EXHIBIT IDEAL BEHAVIOUR

CONCEPTUAL **Physics**

THE INVERTED DRINKING GLASS FILLED WITH AIR IS PLACED MOUTH DOWNWARD IN WATER. AS IT IS PUSHED DEEPER, THE AIR IS COMPRESSED. HOW DEEP MUST THE GLASS BE PUSHED IN ORDER THAT THE AIR BE COMPRESSED TO HALF ITS ORIGINAL VOLUME?

AT THIS DEPTH, HOW WILL THE BUOYANT FORCE ON THE SUBMERGED GLASS COMPARE TO WHEN IT WAS SUBMERGED AT THE SURFACE?

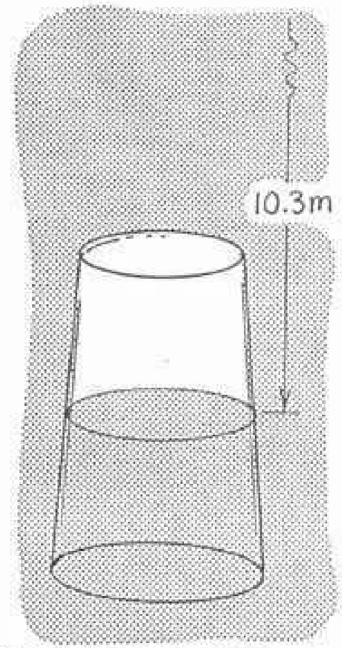


Hewitt Drew it!

35)

THE INVERTED DRINKING GLASS FILLED WITH AIR IS PLACED MOUTH DOWNWARD IN WATER. AS IT IS PUSHED DEEPER, THE AIR IS COMPRESSED. HOW DEEP MUST THE GLASS BE PUSHED IN ORDER THAT THE AIR BE COMPRESSED TO HALF ITS ORIGINAL VOLUME?

AT THIS DEPTH, HOW WILL THE BUOYANT FORCE ON THE SUBMERGED GLASS COMPARE TO WHEN IT WAS SUBMERGED AT THE SURFACE?



ANSWER:

THE AIR IN THE GLASS WILL BE SQUEEZED TO HALF VOLUME WHEN IT IS PUSHED 10.3 METERS BENEATH THE SURFACE. AT THIS DEPTH THE PRESSURE DUE TO WATER IS EQUAL TO THE PRESSURE OF THE ATMOSPHERE AT THE SURFACE. THIS MEANS THE PRESSURE ON THE AIR IS TWICE AT THIS DEPTH. TWICE THE PRESSURE, THEN HALF THE VOLUME.

HALF THE VOLUME MEANS HALF AS MUCH WATER IS DISPLACED BY THE GLASS, SO THE BUOYANT FORCE ON IT IS <u>HALF</u> THAT NEAR THE SURFACE.

Hewitt drawit!

36)

VOL. of 1 MOLE $V = nRT/P$ AT $P = 1$ ATM
(in Liters) $T \approx 300$ K

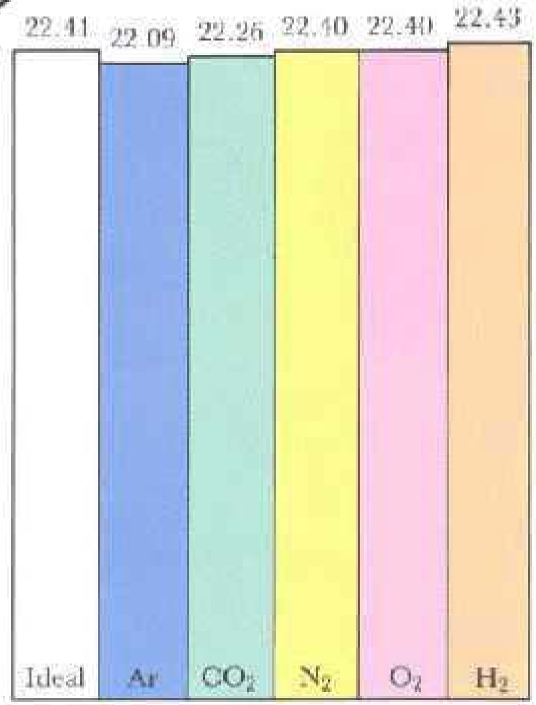


FIGURE 5.10

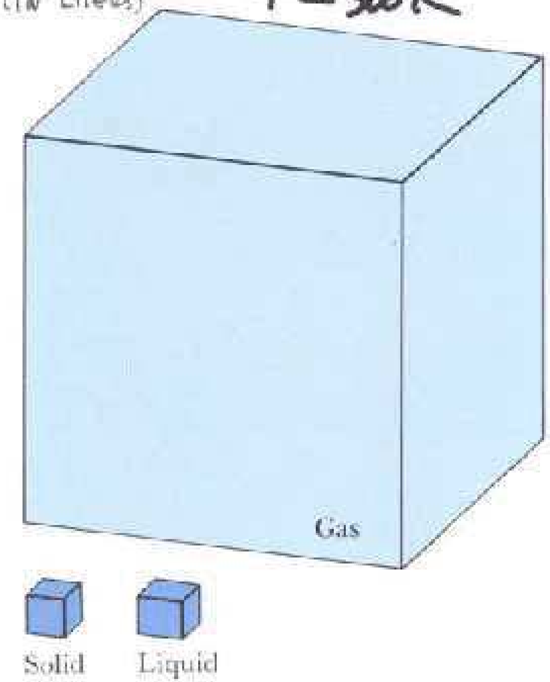
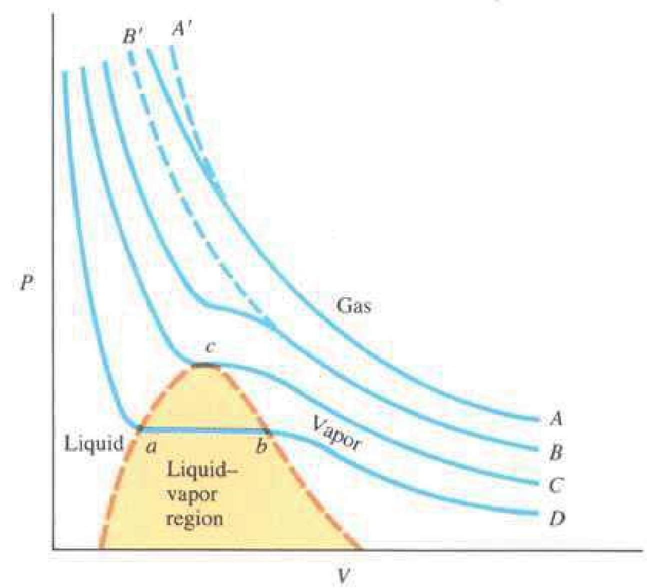


FIGURE 5.15

T-32
FIGURES 5.10, 5.15

VOLUMES OCCUPIED BY 1 MOLES (AT NORMAL P,T

FIGURE 13–13 ***PV* diagram for a real substance.**



GIANCOLI'S PHYSICS:
PRINCIPLES WITH APPLICATIONS, 3/E

38)