PHYS 1020 Final Exam

Monday, December 17, 6 - 9 pm

The whole course
30 multiple choice questions
Formula sheet provided

Seating (from exam listing on Aurora)

Brown Gym

A - SIM

Gold Gym

SIN - Z

Mastering Physics

Welcome to Physics 1020!

Instructors	Required Materials	Schedule	Policies/Evaluation	Suggested Problems	Formula Sheet
Answers to Even-Numbered Problems			Answers for tutorial test problems		
Answers for midterm test			Answers for final exam		
Marks files					

→ Mastering Physics Assignment #5 ←
Due Monday, December 3 at 11 pm

Information on "Mastering Physics"

→ Mastering Physics Survey ←

Specific Heat

The heat required to warm a mass m by ΔT is:

$Q = mc\Delta T$, c = specific heat

Latent Heat

Heat absorbed/released, $Q = mL$, L = latent heat.

Melting/freezing:
Latent heat of fusion L_f = heat absorbed per kilogram on melting and released on freezing.

Boiling/condensing:
Latent heat of vaporization L_v = heat absorbed per kilogram on boiling and released on condensing.

12.88/62: 2 g of liquid water are at 0°C and another 2 g are at 100°C. Heat is removed from the water at 0°C, completely freezing it at 0°C. This heat is used to vaporize some of the water at 100°C. How much liquid water remains?

$L_v = 22.5\times10^5$ J/kg
$L_f = 33.5\times10^4$ J/kg

Heat pump: removes heat from one object and transfers it to another. Example: refrigerator

Heat released in freezing water = $mL_f = 0.002\times(33.5\times10^4) = 670$ J

Mass of water at 100°C that is vaporized by 670 J of heat is:

$$m = \frac{Q}{L_v} = \frac{(670 \text{ J})}{(22.5 \times 10^5 \text{ J/kg})} = 0.00030 \text{ kg} = 0.3 \text{ g}$$

1.7 g of liquid water remain.

12.65: It is claimed that if a lead bullet goes fast enough, it can melt completely when it comes to a halt suddenly, and all its kinetic energy is converted into heat via friction. Find the minimum speed for this to happen for a bullet at 30°C.

Lead: c = 128 J/(kg.C°)
L_f = 23,200 J/kg, melting point 327.3°C

- Heat mass m of lead from 30°C to 327.3°C
- Melt mass m of lead

Heating: $Q_1 = m\,c\,\Delta T = m \times 128(327.3 - 30) = 38{,}054m$ J

Melting $Q_2 = m\,L_f = 23{,}200m$ J

Total heat needed $= (38{,}054 + 23{,}200)m = 61{,}254m \text{ J } = \frac{1}{2}mv^2$

$\rightarrow \; v = 350$ m/s

Summary of Temperature and Heat

Temperature: $T\,(^\circ\,\mathrm{C}) = T\,(\mathrm{K}) - 273.15$

Thermal expansion: $\Delta L = \alpha L_0 \Delta T$

$\Delta V = \beta V_0 \Delta T$

Specific heat: $Q = mc\Delta T$

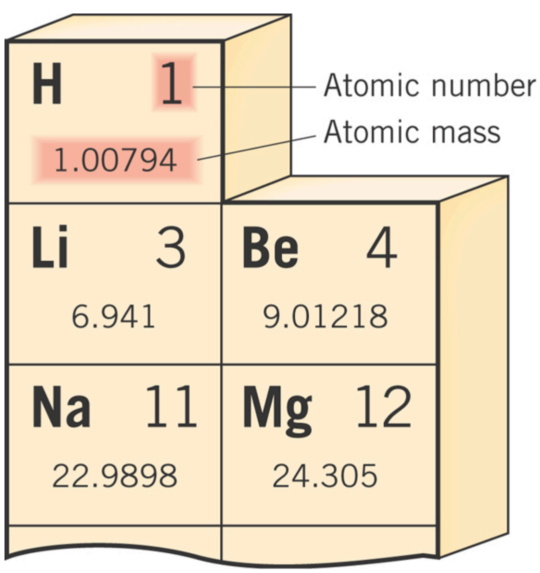
Latent heat: $Q = mL_f$ melting/freezing

$Q = mL_v$ boiling/condensation

Heat flows from high temperature to low

Chapter 14: Ideal Gas Law and Kinetic Theory of Gases

- Molecular mass, the mole, Avogadro's number
- Ideal gas law
- Kinetic theory of gases



Molecular Mass

Periodic Table: shows

- atomic number
  - identifies chemical element
  - equal to number of protons in the nucleus of the atom
- atomic mass (atomic weight)
  - the mass of the atom in atomic mass units, u
  - the mass is the average over all of the naturally-occurring isotopes of the element

Atomic mass unit (u): the mass of the ^{12}C atom is exactly 12 u

The mass of naturally-occurring carbon is 12.011 u (^{12}C, ^{13}C, ^{14}C)

$1 \text{ u} = 1.6605 \times 10^{-27}$ kg

The Mole, Avogadro's Number

- Molecular mass: the sum of the atomic masses of all of the atoms in the molecule

- Gram-mole: the quantity of atoms or molecules with a mass in grams equal numerically to the atomic or molecular mass. The gram-mole contains Avogadro's number, N_A, of atoms or molecules,

$$N_A = 6.022 \times 10^{23} \text{ atoms or molecules per mole}$$

Atomic mass of Li = 6.941 u, so 1 gram-mole of Li has a mass of 6.941 g and contains N_A atoms

Molecular mass of H_2 = 2 × 1.00794 = 2.01588 u, so 1 gram-mole of H_2 has a mass of 2.01588 g and contains N_A molecules

14.5/1: A mass of 135 g of a certain element is known to contain $N = 30.1 \times 10^{23}$ atoms. What is the element?

The number of moles that are present is $n = N/N_A$ with a total mass of 135 g.

The mass of 1 mole must be:

$$\frac{135}{n} = 135 \times \frac{N_A}{N} = 135 \times \frac{6.022 \times 10^{23}}{30.1 \times 10^{23}} = 27.0 \text{ g}$$

From the table at back of book: atomic mass of Al = 26.9815

The element is aluminum

14.2/4: The active ingredient in Claritin has the chemical formula

$$C_{22}H_{23}ClN_2O_2$$

The standard adult dosage utilizes 1.572×10^{19} molecules. Determine the mass in grams of the active ingredient in the standard dosage.

Atomic masses (table in back of book):
C: 12.011 H: 1.00794 Cl: 35.453 N: 14.0067 O: 15.9994

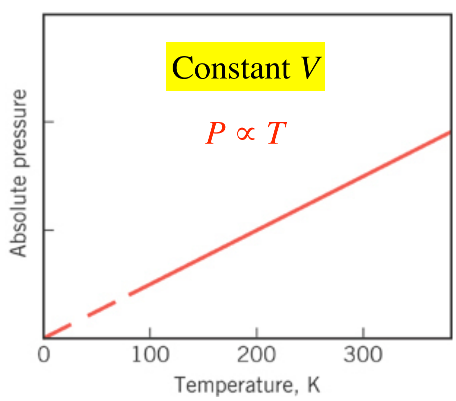
1 gram-mole has a mass of $22 \times M_C + 23 \times M_H + M_{Cl} + 2 \times M_N + 2 \times M_O$
= 382.9 g

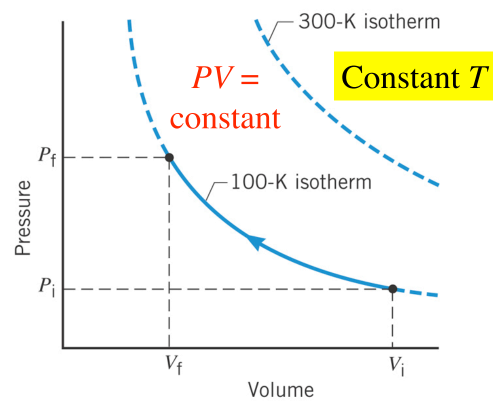
The dosage corresponds to:

$$\frac{1.572 \times 10^{19}}{N_A} = \frac{1.572 \times 10^{19}}{6.022 \times 10^{23}} = 2.61 \times 10^{-5} \text{ moles}$$

Therefore, the mass of the dosage is: $2.61 \times 10^{-5} \times 382.9 = 0.010 \text{ g}$

Ideal Gas Law





Ideal Gas: the atoms or molecules of the gas do not interact with each other, except through elastic collisions. Real gases approximate ideal if the pressure is not too high, so the density of the gas is low.

Then: $P \propto T$, if V, is held constant
PV = constant if temperature is constant (Boyle's law)

Ideal Gas Law

The behaviour of an ideal gas is described by the ideal gas law:

$$PV = nRT$$

n = number of moles of gas
R = universal gas constant = 8.314 J/(mol.K)
T in Kelvin

In terms of the number, N, of atoms or molecules of the gas:

$$PV = NkT$$

k = Boltzmann's constant = 1.38×10^{-23} J/K
$N = nN_A$, and nRT = NkT, so

$$k = \frac{R}{N_A}$$

Ideal Gas Law

For 1 mole of an ideal gas at standard temperature and pressure (STP)
[T = 273 K (0°C), P = 101.3 kPa]

the volume of the gas is, for n = 1 mole:

$$V = \frac{RT}{P} = \frac{8.31 \times 273}{1.013 \times 10^5} = 0.0224 \text{ m}^3 = 22.4 \text{ litres}$$

That is, 1 mole of gas at STP occupies 22.4 litres