Illinois Institute of Technology

Physics

M.Sc. Comprehensive and Ph.D. Qualifying Examination

PART I

Thursday, January 11, 2018

4:00 - 8:00 PM

Physical Constants

Speed of light in vacuum	c	=	$2{:}998 \quad 10^{8}$ m/s
Planck's constant	h	=	$6{:}626 \quad 10^{-34}$ J s
	$\hbar$	=	$h/2$
		=	$1{:}055 \quad 10^{-34}$ J s
		=	$6{:}582 \quad 10^{-16}$ eV s
Permeability constant	$_{o}$	=	$4 \quad 10^{-7}$ N/A^2
Permittivity constant	$\frac{1}{4 \ _{o}}$	=	$8{:}988 \quad 10^{9}$ N m^2/C^2
Fine structure constant		=	$\frac{e^2}{4 \ _{o}\hbar c}$
		=	$7{:}30 \quad 10^{-3} = \frac{1}{137}$
Gravitational constant	G	=	$6{:}67 \quad 10^{-11}$ m^3/s^2 kg
Avogadro's number	N_A	=	$6{:}023 \quad 10^{23}$ mole $^{-1}$
Boltzmann's constant	k	=	$1{:}381 \quad 10^{-23}$ J/K
		=	$8{:}617 \quad 10^{-5}$ eV/K
kT at room temperature	k 300 K	=	0.0258 eV
Universal gas constant	R	=	8:314 J/mole K
Stefan-Boltzmann constant		=	$5{:}67 \quad 10^{-8}$ W/m^2 K^4
Electron charge magnitude	e	=	$1{:}$

Problem 3:

A board of length L and mass M

Problem 6: A thermally insulated cylinder contains either Argon, Methane, or Air at room temperature. The contents are rapidly compressed to a volume 1/2 of the initial volume, and the pressure increases to approximately 2.5 of the initial pressure. Which gas is in the cylinder?

Problem 7:

A system in equilibrium at temperature T of noninteracting spin-one particles of magnetic moment is placed in a constant magnetic eld B. Derive an expression for the magnetization as a function of temperature.

Problem 8:

A potential energy of molecules in a certain central 3D eld depends on a distance r from the eld center as $U = ar^2$, where a is a positive constant. The gas temperature is T, the molecules concetration at the center of the eld is n_0. Find:

a) The number of molecules at the distance from the center of the eld between r and $r + dr$.

b) The most probable distance between a molecule and the center of the eld.

c) The fraction of molecules in a spherical layer between r and $r + dr$.

d) How many times the molecules concentration at the center of the eld will increase if the temperature increses times.