Final Semester Exam

Modern Physics

Department of Physics, Faculty of Mathematics and Natural Sciences

Universitas Indonesia

Tuesday, December 20th 2016

Time Duration: 120 minutes

Lecturer : xxx

1. The electron in a Hydrogen atom is in a 3d state of excitation in a radiative transition to a 2p energy level.
    a) Draw the energy levels of 3d and 2p state in an energy level diagram if it is in space with an external magnetic field B = 0, regardless of spin orbit interactions.
    b) Determine the energy (in E_0) generated in the state of a radiative transition under conditions (a).
    c) Show the separation of energy levels of 3d and 2p in one energy level diagram and calculate its energy if located in space with the external magnetic field B = 2T, regardless of spin orbit interaction.
    d) List the conditions that are allowed under condition (c) and show in the energy level diagram above.
    e) Determine the energy (in E_0 and μ_0) generated in the event of a radiative transition under condition (c).
    f) Show the separation of energy levels of 3d and 2p in one energy level diagram and calculate its energy if located in space with the external magnetic field B = 0, considerate the spin orbit interaction.
    g) List the transitional conditions allowed under (i) and indicate in the energy level diagram above.
    h) Show the separation of energy levels of 3d and 2p in one energy level diagram and calculate its energy if located in space with the external magnetic field B = 2T, considerate the spin orbit interaction.
    i) List the transitional conditions allowed under (i) and indicate in the energy level diagram above.

2. Using the data in table 1, specify:
    a) The difference between the vibrational energy level of the diatomic molecule CO.
    b) The temperature required to thermally excite this vibrational energy level, if the molecule is considered a one-dimensional oscillator.

    By absorbing certain electromagnetic waves the CO molecule undergoes a transition of the rotational energy level from state $l = 3\ to\ l = 2$ by $1.43\ eV$. If known atomic mass $C = 12.00u$ and atomic mass $O = 15.99u$. Specify:

    c) the wavelength of the photon required for the excitation

d) The inertia moment of CO molecule
e) the average distance of the center of the C atoms and the O atoms

3. Assume all ^{206}Pb samples in uranium mines are the decay results of ^{238}U with half-life of ^{238}U is 4.5 10^9 years and the ratio of $^{206}Pb/\ ^{238}U$ is 0.6. Determine the age of the mine

Mid-Semester Exam

Mathematical Method for Physics 1

Department of Physics, Faculty of Mathematics and Natural Sciences

Universitas Indonesia

Friday, October 21st 2015

Time Duration : 120 minutes

Lecturer : xxx

1. Determine:
   a. The Laplacian from the scalar field $\varphi(x,y,z) = xy^2(x^2 - 2y^2 + z^2)e^{\sqrt{x^2+y^2}}$.
   b. Curl from the vector field $\vec{F}(r) = \frac{\hat{r}}{r^2}$.

2. Maxwell equation in vacuum space without charge and current can be written as:

$$\vec{\nabla}.\vec{E} = 0$$
$$\vec{\nabla}.\vec{B} = 0$$
$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$
$$\vec{\nabla} \times \vec{B} = \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

   Which $\vec{E}$ and $\vec{B}$ are electric and magnetic field.
   a. Show that by operating the curl to the equations, we can get 2 electric and magnetic wave equations (electromagnetic)

$$\nabla^2 E = \mu_0 \epsilon_0 \frac{\partial^2 E}{\partial t^2}$$
$$\nabla^2 B = \mu_0 \epsilon_0 \frac{\partial^2 B}{\partial t^2}$$

   b. With the value of $\epsilon_0 = 8{,}85 \times 10^{-12} C^2/Nm^2$, and $\mu_0 = 4\pi \times 10^{-7} N/A^2$ show that the electromagnetic field propagates with light velocity $c \approx 3 \times 10^8 m/s$

3. In classical physics, angular momentum can be defined as $\vec{L} = \vec{r} \times \vec{p}$, which $\vec{p}$ is linear momentum. In quantum mechanics, momentum is an operator which is linear momentum can be defined as $\vec{p} = -i\hbar\,\vec{\nabla}$. Show that the angular momentum operator in cartesian coordinate can be determined as:

$$L_x = -i\hbar\left(y\frac{\partial}{\partial z} - z\frac{\partial}{\partial y}\right)$$
$$L_y = -i\hbar\left(z\frac{\partial}{\partial x} - x\frac{\partial}{\partial z}\right)$$
$$L_z = -i\hbar\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial z}\right)$$

4. The paraboloid coordinate system (u, v, φ) can be defined as

$$x = uv\cos\varphi$$
$$y = uv\sin\varphi$$
$$z = \frac{1}{2}(u^2 - v^2)^2$$

Which $u \geq 0$, $v \geq 0$, $2\pi > \varphi \geq 0$. Determine

i. The gradient
ii. Curl
iii. Laplacian coordinate

Final Semester Exam

Statistical Physics

Department of Physics, Faculty of Mathematics and Natural Sciences

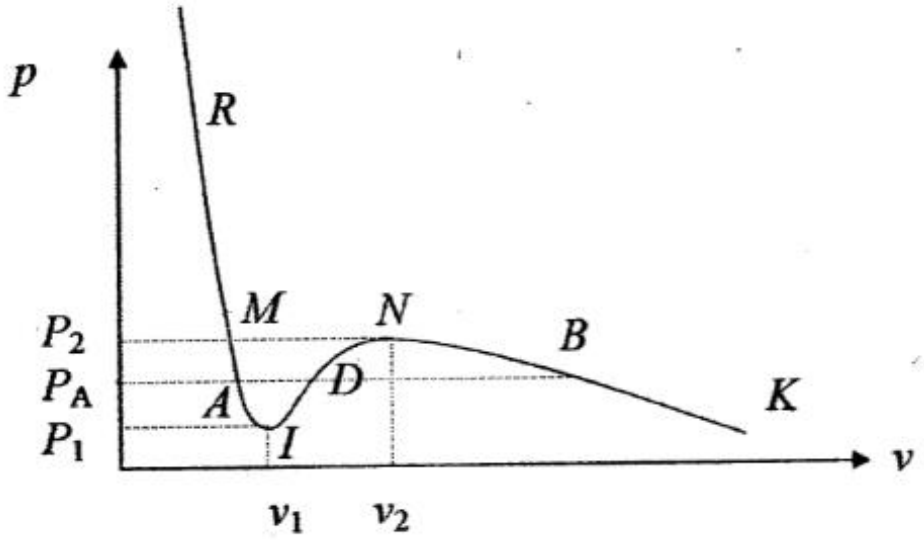
Universitas Indonesia

Wednesday, December 13th 2017

Time Duration: 120 minutes

Lecturer : xxx

1. What is the Gibbs paradox?
2. See the picture below, the lowest is the isothermal curve, this curve contains enough information. Explain what information can be obtained?



3. What is the equipartition theorem?
4. Review 2 particles with 3 probability of quantum state $s = 1, 2, 3$.
    a) Draw the probability matrix for all three statistics: Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac
    b) Calculate the probability ratio of finding particles in different states for all three statistics: Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac
    c) What is the physical interpretation from the ratio above