PHYS 301
HOMEWORK #9

Due : 27 March 2015

1. Consider the following two vector forces :

a) $\mathbf{F_1} = \{x\,y,\ 2\,y\,z,\ 3\,x\,z\}$

b) $\mathbf{F_2} = \left\{y^2,\ 2\,x\,y + z^2,\ 2\,y\,z\right\}$

Compute the work done in moving each force from (0, 0, 0) to (1, 1, 0) along the paths : i) y = x, and ii) $y = x^2$

2. The transformation equations for parabolic coordinates are :

$$x = u\,v\cos\phi$$

$$y = u\,v\sin\theta$$

$$z = \frac{1}{2}\left(u^2 - v^2\right)$$

Show that this is an orthogonal transformation, find scale factors and unit vectors.

3. The transformation equations for spherical coordinates are :

$$x = r\sin\theta\cos\phi$$

$$y = r\sin\theta\sin\phi$$

$$z = r\cos\theta$$

where r is the distance from the origin, θ is the polar angle measured down from the north pole, and ϕ is the azimuthal angle.

a) Find the scale factors for the spherical polar coordinate system.

b) Express the position vector entirely in terms of spherical polar coordinates (15)

c) Find expressions for velocity and acceleration in spherical polar coordinates. (25) (Keep this assignment, you will need these results in theoretical mechanics next year).

4. In lab we studied the Planck Distribution Law :

$$B_\nu(T)\,d\nu = \frac{2\,h\,v^3}{c^2}\,\frac{1}{e^{h\nu/k\,T} - 1}\,d\nu$$

where $B_\nu(T)$ represents the amount of energy that is emitted by a blackbody radiator per meter of surface per second per steradian (unit of sold angle) per unit of frequency, h is Planck's constant, k is Boltzmann's constant, c is the speed of light.

a) Use the relationship $c = \lambda\,\nu$ where λ is the wavelength of the radiation and find an expression for

B_λ(T).(5)

b) Use Mathematica to determine the wavelength at which the most energy is emitted by a black-body radiator of temperature T. Submit your output with this assignment. (15)