Tutorial 1

PH 101: PHYSICS I

Note: These are some selected problems from various books. Some of these are (only authors mentioned)

- Kleppner and Kolenkow.
- Ghosh and Basavaraju
- Takwale and Puranik

Students are urged to attempt and solve many more questions posed in these books.

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1. A car starts from rest with an acceleration of 4 m/s^2 at $t = 0$. Subsequently, the acceleration is given by $a\,(t) = 4 - t/2$ (a is in m/s^2 and t in s) till it becomes zero. What is the final velocity? How much distance was covered during $t = 1s$ and $t = 4s$?

2. A ball is thrown up with an initial speed v_0. Acceleration due to air resistance is given by $-kv$ (where v is instantaneous velocity and k is a positive constant). Find the maximum height reached and time taken to reach the highest point.

3. A projectile takes of with an initial velocity of 10 m/s at an angle of 45°. It is just able to clear two hurdles of height 2 m each, separated by a distance d. Find d and distance of the first hurdle from the point of projection.

4. For a given initial speed v_0, show that the maximum range of a projectile on a plane inclined at an angle θ to the horizontal, is $(v_0^2/g)\,/\,(1 + \sin\theta)$.

5. A particle is moving in a circle of radius 12 m. Starting from the rest the, its speed increases at a constant rate of 3 m/s^2. Calculate its accelration after 4 s.

6. A particle is moving on a spiral track given by $r = \theta/10$ (r in m, θ in rad) with a constant angular speed of 1 rad/s. Calculate the magnitude of its velocity and acceleration when it has completed two revolutions.

7. Show that the areal velocity, $\frac{1}{2}r^2\dot{\theta}$ of a particle is constant if its acceleration is central, that is acceleration always points towards the origin.

8. A particle is moving on a path given by

$$\begin{aligned} r &= at, \\ \theta &= b/t. \end{aligned}$$

   Show that the acceleration is central. Express it in terms of r instead of t.

9. A particle is moving on a circle

$$r = a\cos\theta$$

such that its acceleration is central. Find the acceleration in terms of r.

10. Two electric dipoles are kept at positions $(4, 0)$ and $(0, 3)$. The dipole moment of the dipole at $(4, 0)$ is $\mathbf{p}_1 = 3\hat{\mathbf{r}} + 4\widehat{\theta}$. (Dont worry about units.) The dipole moment of the other dipole is $\mathbf{p}_2 = 2\hat{\mathbf{r}}$. Find the energy of this configuration which is given by $\mathbf{p}_1 \cdot \mathbf{p}_2/r^3$, where r is the distance between two dipoles.