Sci1 2025 Quiz 1 Solutions

Questions

1. A simple pendulum of mass m and length l has its point of support moving horizontally given by
$$x(t) = a\sin(\omega t)$$
(assume that string remains "straight" at all times). Find the equation of motion of the bob, and then for small oscillations, comment on the expected solution.

2. On a particle the force is of the form
$$\vec{F}(\vec{r}) = \big(- ze^{-x},\, \ln z,\, e^{-x} + \tfrac{y}{z}\big),$$
where the position vector is $\vec{r} = (x, y, z)$. Does the work done when the particle is moved from $(1, 1, 1)$ to $(2, 2, 2)$ depend on the path taken? Why or why not? Find the work for at least one such path by doing the line integral.

3. A rod of length L_0 in its rest frame is lying at an angle θ with respect to the x-axis. What is the length and orientation of this rod as measured by an observer moving along the x-axis with speed v?

4. Rest mass energy of the electron is 0.5 MeV, and of the proton is 938 MeV. Anti-particles have the same mass but opposite charge. In a particular nuclear reaction, an electron and its anti-particle positron collide to give a proton and its anti-particle anti-proton. What is the minimum kinetic energy of each particle to produce this reaction?