Department of Mathematics and Natural Sciences

PHY111 - Principles of Physics-I (Spring 2022)

Assignment-1

Total Marks: 25

Answer all questions.

1. A tower guy wire is anchored by means of a bolt at *A* which is shown Fig. 1(a). The position of the bolt *A* in the negative *z* and positive *x* plane [*x*(-*z*) plane].

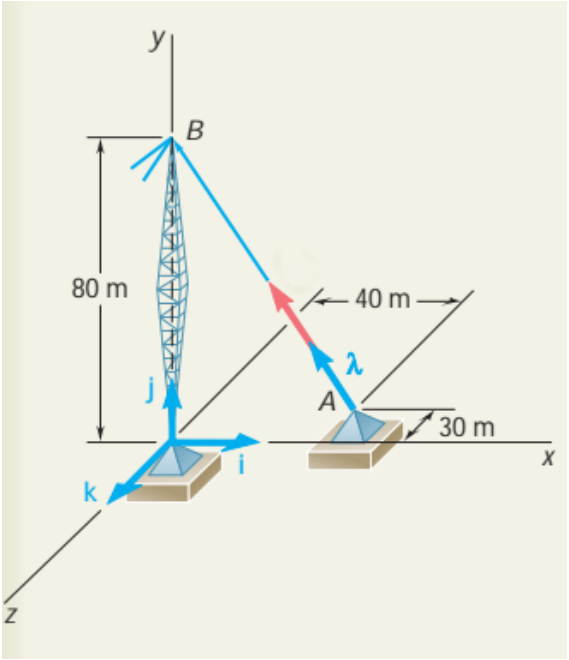

Fig. 1(a)

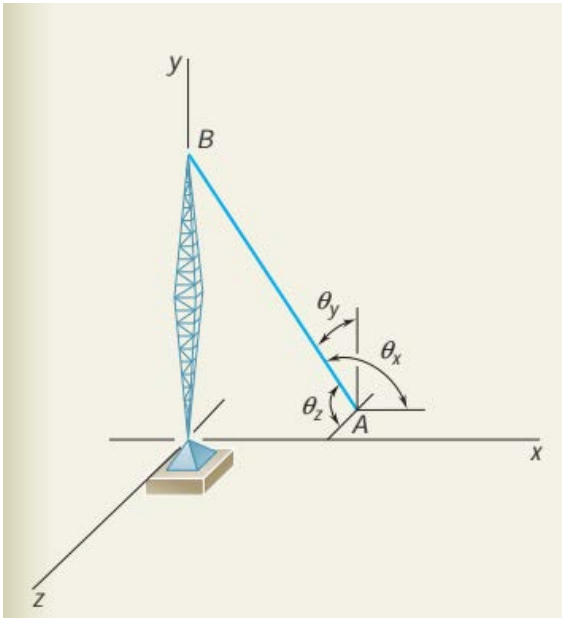

Fig. 1(b)

(a) (*2 marks*) Determine the vector $\overrightarrow{AB}$.

(b) (*2 marks*) Calculate the unit vector **λ** in the direction of $\overrightarrow{AB}$.

(c) (*4 marks*) Calculate θ_x, θ_y and θ_z as shown in Fig. 1(b).

2. A point particle moves in the *xy* plane with position vector $\vec{r} = 2t\hat{\imath} + 3t(1 - 5t)\hat{\jmath}$. Here $\hat{\imath}$ & $\hat{\jmath}$ are the unit vectors in the direction of *x* and *y* axis respectively and *t* is the time. The unit of the position vector is in meters and the time is in seconds. Now for the point particle, find:

(a) (*2 marks*) The trajectory equation, *y*(*x*).

(b) (*2 marks*) The average velocity and average acceleration for time interval t = 0 s to t =4 s.

(c) (*2 marks*) The velocity and the acceleration vectors and their magnitudes and directions at time t = 1 s.

(d) (*2 marks*) The moment when the velocity and acceleration are perpendicular to each other.

3. Fig. 2 illustrates a game of a circus show. James & Severus are standing on identical pillars made of metal, A & B respectively. When James throws a ball horizontally with a speed of 3 m/s, Severus dives horizontally exactly at the time of the throw to catch the ball. Just before the ball reaches the ground, Severus successfully catches it. The ground is covered with some soft material so that Severus does not get injured.

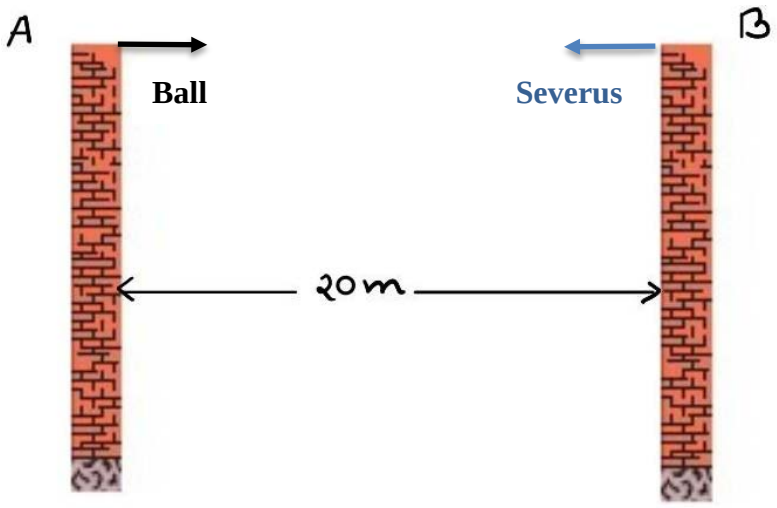

Fig. 2

(a) (*2 marks*) If the ball reaches the ground 3.0 s after the throw, calculate the speed at which Severus dives?

(b) (*1 marks*) Calculate the height of the metal pillars.

(c) (*3 marks*) Now the ball is thrown by James at an angle of 15º with a speed of 3 m/s, and Severus dives exactly at the time of the throw with the same velocity as before. Calculate the time taken by the ball to reach the ground. Will the ball reach the ground before Severus? (Assume, no collision happens between them during their flights.)

(d) (*3 marks*) Consider the situation in part (c) and Severus has just reached the ground. At that instant calculate the position vector from the ball to Severus.