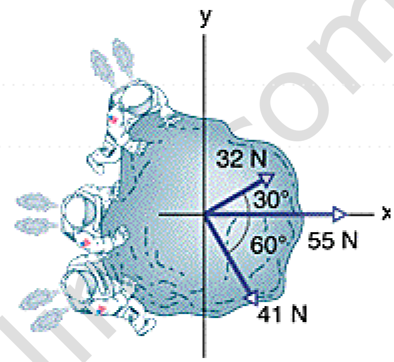
Q- Three astronauts, propelled by jet backpacks, push and guide a 195kg asteroid toward a processing dock. One astronaut exerts a force of 30N, 30^0 from positive x-axis towards positive y direction, second exerts a force of 55 N along the x-axis and third astronaut exerts a force of 41N 60^0 from the positive x-axis towards negative y direction.

(a) What is the asteroid's acceleration in unit-vector notation?

(b) What is the asteroid's acceleration as a magnitude and direction?



The first force is 32 N (30 N in question) making angle 30^0 with x axis hence in component form can be written as

$$\vec{F}_1 = 32*\cos30^0\hat{i} + 32*\sin30^0\hat{j}$$

Or $$\vec{F}_1 = 32*0.866*\hat{i} + 32*0.500*\hat{j}$$

Or $$\vec{F}_1 = 27.7*\hat{i} + 16.0*\hat{j} \qquad \text{-------------- (1)}$$

Second force is along x direction and hence its component in y direction will be zero and is given by

$$\vec{F}_2 = 55*\cos0^0\hat{i} + 55*\sin0^0\hat{j}$$

Or $$\vec{F}_2 = 55*1*\hat{i} + 55*0*\hat{j}$$

Or $$\vec{F}_2 = 55*\hat{i} \qquad \text{--------------- (2)}$$

And similarly, the third force is given by

$$\vec{F}_3 = 41*\cos(-60^0)*\hat{i} + 41*\sin(-60^0)*\hat{j}$$

Or $$\vec{F}_3 = 41*\cos(60^0)*\hat{i} - 41*\sin(60^0)*\hat{j}$$

Or $$\vec{F}_3 = 41*0.500*\hat{i} - 41*0.866*\hat{j}$$

Or $$\vec{F}_3 = 20.5*\hat{i} - 35.5*\hat{j}$$

The resultant of the three force is given by adding the three equations as

$$\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = (27.7*\hat{i} + 16.0*\hat{j}) + 55*\hat{i} + (20.5*\hat{i} - 35.5*\hat{j})$$

Or $$\vec{F} = (27.7 + 55 + 20.5)*\hat{i} + (16.0 + 0 - 35.5)*\hat{j}$$

Or $$\vec{F} = 103.2*\hat{i} - 19.5*\hat{j} \text{ N}$$

(a)

The acceleration of the asteroid is given by using Newton's second law of motion as

$$\vec{a} = \frac{\vec{F}}{m}$$

Or $\vec{a} = \frac{103.2 * \hat{i} - 19.5 * \hat{j}}{195} = 0.53 * \hat{i} - 0.10\hat{j}$

Or $\vec{a} = 0.53 * \hat{i} - 0.10\hat{j}$ m/s

(b)

The magnitude of the acceleration is given by

$$|\vec{a}| = a = \sqrt{a_x^2 + a_5^2} = (0.53)^2 + (-0.10)^2 = 0.539 \approx 0.54 \text{ m/s}$$

And the direction of the acceleration is given by the angle it makes with positive x direction and is given by

$$\tan\theta = \frac{a_y}{a_x} = \frac{-0.10}{0.53} = -0.1887$$

Gives $\theta = -10.68^0$

Hence the resultant acceleration is 0.54 m/s in the direction making angle -10.68^0 with positive x axis.