Name_____

Nov. 10, 2009

Phys 2112, Fall 2009
Quiz #2

1. An object undergoes uniform circular motion according to the formula

$$x = (1.4\,\mathrm{m})\cos((4.0\,\mathrm{s}^{-1})t) \qquad y = (1.4\,\mathrm{m})\sin((4.0\,\mathrm{s}^{-1})t)$$

a) What is period of motion for the object?

From the form of the equations of motion, $\omega = 4.0\,\mathrm{s}^{-1}$, so since $\omega = \frac{2\pi}{T}$, we have

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{(4.0\,\mathrm{s}^{-1})} = 1.57\,\mathrm{s}$$

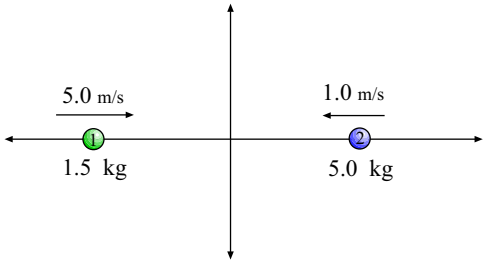
b) What is the (constant) speed of the object?

The speed of the mass is $v = \omega R$; here, $R = 1.4\,\mathrm{m}$, so

$$v = (4.0\,\mathrm{s}^{-1})(1.4\,\mathrm{m}) = 5.6\,\tfrac{\mathrm{m}}{\mathrm{s}}$$

2. Two masses are moving toward each other on the x axis, as shown at the right.

Consider a reference frame which moves at $0.385\,\frac{\mathrm{m}}{\mathrm{s}}$ in the $+x$ direction. Find the velocities of the masses in that frame.

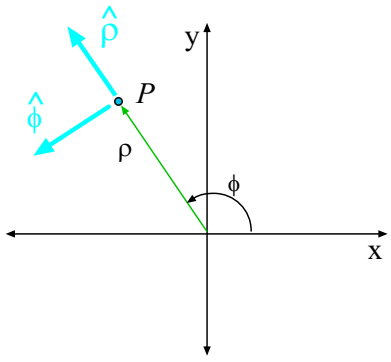


With $V = +0.385\,\frac{\mathrm{m}}{\mathrm{s}}$, use $v_x = v'_x + V$ to get

$$v'_{x1} = v_{x1} - V = 5.0\,\tfrac{\mathrm{m}}{\mathrm{s}} - 0.385\,\tfrac{\mathrm{m}}{\mathrm{s}} = 4.62\,\tfrac{\mathrm{m}}{\mathrm{s}} \qquad v'_{x2} = v_{x2} - V = -1.0\,\tfrac{\mathrm{m}}{\mathrm{s}} - 0.385\,\tfrac{\mathrm{m}}{\mathrm{s}} = -1.38\,\tfrac{\mathrm{m}}{\mathrm{s}}$$

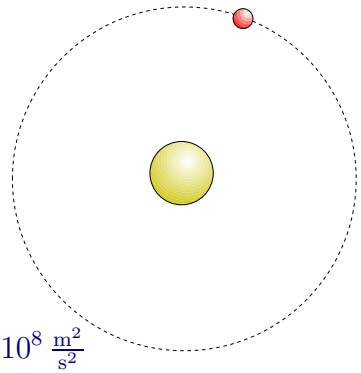
(The *speeds* of the masses are $4.62\,\frac{\mathrm{m}}{\mathrm{s}}$ and $1.38\,\frac{\mathrm{m}}{\mathrm{s}}$.)

3. For the point P shown here, show (on the graph) the directions of the unit vectors $\hat{\boldsymbol{\rho}}$ and $\hat{\boldsymbol{\phi}}$.



Shown on the (revised) figure.

4. The planet Jupiter has a mass of 1.90×10^{27} kg. It has a moon Io which orbits in a nearly circular orbit of radius 4.22×10^8 m.



a) Find the speed of Io as it orbits.

$$F_c = G\frac{Mm}{r^2} = \frac{mv^2}{r} \qquad \Longrightarrow \qquad v^2 = \frac{GM}{r}$$

Plug in numbers:

$$v^2 = \frac{(6.67 \times 10^{-11})(1.90 \times 10^{27})}{(4.22 \times 10^8)} \frac{\text{m}^2}{\text{s}^2} = 3.00 \times 10^8 \frac{\text{m}^2}{\text{s}^2}$$

This gives

$$v = 1.73 \times 10^4 \frac{\text{m}}{\text{s}}$$

b) Find the period of the orbit of Io.

Use $v = \frac{2\pi R}{T}$, then

$$T = \frac{2\pi R}{v} = \frac{2\pi(4.22 \times 10^8)}{(1.73 \times 10^4)} = 1.52 \times 10^5 \,\text{s} = 42.5 \,\text{hr}$$

Show work for all problems and include the right units!

$$x = R\cos(\omega t) \qquad y = R\sin(\omega t) \qquad v = \frac{2\pi R}{T} \qquad \omega = \frac{2\pi}{T}$$

$$F = G\frac{m_1 m_2}{r^2} \qquad G = 6.67 \times 10^{-11} \frac{\text{N}\cdot\text{m}^2}{\text{kg}^2} \qquad a_c = \frac{v^2}{r} \qquad F_c = \frac{mv^2}{r}$$