STUDENT: **SCHOOL:**

5. Two forces, $\mathbf{F_1} = 2\,\mathbf{i} - 5\,\mathbf{j}$ and $\mathbf{F_2} = \mathbf{i} + \mathbf{j}$, are exerted on an object with a mass of 5 kg starting at $t = 0$. t is time, and **i** and **j** are the unit vectors in a rectangular coordinate system. If the object has an initial velocity (at $t = 0$) of 2.5 m/s in the positive x direction, what is the speed of the object after 4 seconds (in m/s)?

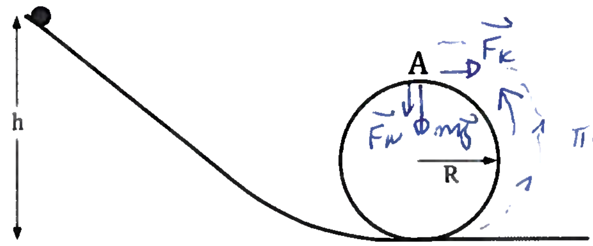
(a) $\mathbf{v} = 4.9\,\mathbf{i} - 3.2\,\mathbf{j}$ *
(b) $\mathbf{v} = 7.0\,\mathbf{i} + 4.0\,\mathbf{j}$
(c) $\mathbf{v} = 8.6\,\mathbf{i} + 1.3\,\mathbf{j}$
(d) $\mathbf{v} = 3.0\,\mathbf{i} - 4.0\,\mathbf{j}$
(e) $\mathbf{v} = 2.5\,\mathbf{i} - 3.2\,\mathbf{j}$

$\vec F = \vec F_1 + \vec F_2 = 3\hat i - 4\hat j$. $\vec a = \vec F/m = \frac{3}{5}\hat i - \frac{4}{5}\hat j$ = const.

$\Rightarrow \vec v = \vec v_0 + \vec a t \Rightarrow \vec v = 2.5\hat i + \left(\frac{3}{5}\hat i - \frac{4}{5}\hat j\right)\times 4 \Rightarrow$

$\vec v = 2.5\hat i + \frac{12}{5}\hat i - \frac{16}{5}\hat j = 4.9\hat i - 3.2\hat j$.

6. A small object of mass $m = 2$ kg, initially at rest, is released from a height $h = 4.5$ m and slides down a frictionless inclined plane until it reaches a vertical circular track. As the object slides without rolling along the interior surface of the circle, it experiences a constant kinetic friction force of 5.0 N. The radius of the circle is $R = 1.2$ m.



(i) What is the normal force on the ball due to the track at point A? (5)

(ii) What is the minimum height from which the ball needs to be released in order to stay on the track at A and continue moving on the circle? (5)

(a) (i) 4.70 N (ii) 5.12 m
(b) (i) 17.6 N (ii) 3.96 m *
(c) (i) 4.70 N (ii) 3.96 m
(d) (i) 17.6 N (ii) 4.50 m
(e) (i) 49.0 N (ii) 3.00 m

(i) $mgh = 2mgR + \frac{1}{2}mv^2 + F_K \pi R$ (at A)

$\frac{1}{2}mv^2 = mgh - 2mgR - F_K\pi R \Rightarrow$

$v^2 = 2(mgh - 2mgR - F_K \pi R)/m$

$\Rightarrow v^2 = 22.31\ m^2/s^2 \Rightarrow v = 4.72$ m/s.

$m\frac{v^2}{R} = mg + F_N \Rightarrow F_N = \frac{mv^2}{R} - mg \Rightarrow$ $\boxed{F_N = 17.6\,N}$ 5

(ii) For $h = min \Rightarrow v = min$

$\Rightarrow F_N = 0 \Rightarrow mv^2/R = mg \Rightarrow v^2 = Rg$

Then: $mgh = 2mgR + \frac{1}{2}mv^2 + F_K\pi R \Rightarrow mgh = 2mgR + \frac{1}{2}mgR + F_K\pi R \Rightarrow$

$h = \frac{2mgR + \frac{1}{2}mgR + F_K\pi R}{mg} \Rightarrow h = \frac{2.5mgR + F_K\pi R}{mg} \Rightarrow \boxed{h = 3.96\,m}$