



## Midterm-1 Solution

1

We start with the particle under a net force model in the  $x$  and  $y$  directions:

$$\sum F_x = ma_x: \quad T \sin \theta = \frac{mv^2}{r}$$

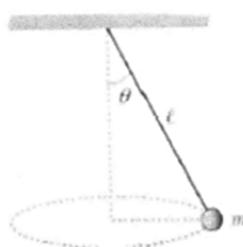
$$\sum F_y = ma_y: \quad T \cos \theta = mg$$

So  $\frac{\sin \theta}{\cos \theta} = \frac{v^2}{rg}$  and  $v = \sqrt{rg \frac{\sin \theta}{\cos \theta}}$

then  $L = rmv \sin 90.0^\circ = rm \sqrt{rg \frac{\sin \theta}{\cos \theta}} = \sqrt{m^2 gr^3 \frac{\sin \theta}{\cos \theta}}$

and since  $r = \ell \sin \theta$ ,

$$L = \boxed{\sqrt{m^2 g \ell^3 \frac{\sin^4 \theta}{\cos \theta}}}$$



ANS. FIG. P11.16

2. (a) A triangular sign to be hung from a single string. (b) Geometric construction for locating the center of mass.

Evaluate  $dm$ :

$$dm = \rho yt dx = \left( \frac{M}{\frac{1}{2}abt} \right) yt dx = \frac{2My}{ab} dx$$

Use Equation 9.32 to find

$$(1) \quad x_{CM} = \frac{1}{M} \int x dm = \frac{1}{M} \int_0^a x \frac{2My}{ab} dx = \frac{2}{ab} \int_0^a xy dx$$

the x coordinate of the

center of mass:

To proceed further and evaluate the integral, we must express  $y$  in terms of  $x$ . The line representing the hypotenuse of the triangle in Figure 9.20b has a slope of  $b/a$  and passes

through the origin, so the equation of this line is  $y = (b/a)x$ .

Substitute for  $y$  in Equation (1):

$$x_{CM} = \frac{2}{ab} \int_0^a x \left( \frac{b}{a} x \right) dx = \frac{2}{a^2} \int_0^a x^2 dx = \frac{2}{a^2} \left[ \frac{x^3}{3} \right]_0^a = \frac{2}{3} a$$

3.

$$\because V^2 = V_0^2 + 2aS \quad \therefore V^2 = 0 + 2 \cdot g \cdot 4 \text{ (floor), } (2V)^2 = 0 + 2 \cdot g \cdot K$$

Thus the algebra K is for 16

4. Assume  $g = 10 \text{ m/s}^2$ ,

$$\begin{aligned} - (5+3) \times a &= (5-3) \times 10, a = 2.5 \text{ m/s}^2 \\ V^2 &= V_0^2 + 2as \\ &= 0 + 2 \times 2.5 \times 4 \\ &= 20 \end{aligned}$$

$$V = 2\sqrt{5} \text{ m/s}$$

$$5. \frac{1}{2} M v'^2 = Mg \cdot 2l, v' = \sqrt{4gl}$$

$$mv = M \cdot \sqrt{4gl} + m \cdot \frac{1}{2} v$$

$$v = \frac{4M}{m} \sqrt{gl}$$