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General Physics I, Midterm1
PHYS1000AA, Class year102
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SN:________________, Name:_________________

Midterm1 Solution

Chapter 01-11, Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1.

(a) $\sum F_y = T - f - Mg = 0$ for the elevator to lift

$\therefore T$ = lift of the elevator $= Mg + f$

M = Total mass

$P \equiv$ Power $= T \cdot v = (Mg + f)\cdot v$

$= \left[(1800\,kg)(9.8\,m/s^2) + 4000\,N\right]\cdot 3.00\,m/s = 6.49\times10^4\,W$

(b) $\sum F_y = T - f - Mg = Ma$

$T = M(a+g) + f$

$P = Tv = [M(a+g) + f]\,v$

$= \left[1800\,kg\,(1.00\,m/s^2 + 9.8\,m/s^2) + 4000\,N\right] v$

$= 2.34\times10^4\, v$

(c) $v = 3\,m/s$ then $P = 2.34\times10^4 \cdot 3 = 7.02\times10^4\,W$

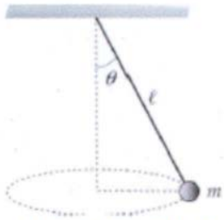
(d) Comparing (a) and (c). We found the (c) is longer than (a).
This is because (a) is a constant (average) speed.
(c) is the instant speed. To start an object, due to its mass (also called moment of inertia), one needs longer force. Therefore larger power at the same speed.

2.

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

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

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



ANS. FIG. P11.16

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

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

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

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

3.

$L = r\times p = mvr \quad , \omega = \frac{2\pi}{T} \quad . T = \text{period}$

$v = \omega r$

$\therefore L = mr^2\omega = m\left(\frac{2\pi}{T}\right)(r^2)$

$= (9.11\times10^{-31}\,\text{kg})\left(\frac{2\times3.14}{1.51\times10^{-6}\,\text{sec}}\right)\cdot(0.53\times10^{-10}\,\text{m})^2$

$= 1.06\times10^{-44}\ \text{kg}\cdot\text{m}^2/\text{sec}$

4.

$$I = \int_0^{\pi} r^2\,dm$$

$$= \int_0^{\pi} R^2 \sin^2\theta \cdot 2\pi R^2 \sin\theta\, d\theta$$

$$= 2\pi R^4 \int_0^{\pi} \sin^2\theta \sin\theta\, d\theta$$

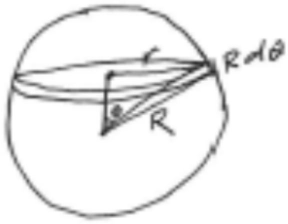
$$= 2\pi R^4 \int_{+1}^{-1} (1-\cos^2\theta)\, d(-\cos\theta)$$

$$= 2\pi R^4 \int_{-1}^{+1} (1-\cos^2\theta)\, d(\cos\theta)$$

$$= 2\pi R^4 \left[x - \tfrac{1}{3}x^3 \right]_{-1}^{1}$$

$$= 2\pi R^4 \cdot \frac{4}{3}$$

$$= \frac{8}{3}\pi R^4 = \frac{2}{3} M R^2$$



$r = R\sin\theta$

$$dm = 2\pi r\, R\, d\theta$$
$$= 2\pi R \sin\theta\, R\, d\theta$$
$$= 2\pi R^2 \sin\theta\, d\theta$$

$M = 4\pi R^2$

5.

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

Evaluate *dm*:

$$dm = \rho y t\, dx = \left(\frac{M}{\frac{1}{2} a b t} \right) y t\, dx = \frac{2My}{ab}\, dx$$

Use Equation 9.32 to find the x coordinate of the center of mass:

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

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):

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

$$= \tfrac{2}{3}a$$