Lab: AP Review Sheets

AP Physics

Ch.6: Circular Motion and more

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Background and Summary: With the use of Newton's 2nd law we can analyze circular motion and resistive forces like friction

A. Sliding Friction

a. *Friction*: a force that opposes the relative motion of a body

b. $\mu = \frac{F_{friction}}{F_{Normal}}$, coefficient of friction

c. $F_{static} \leq \mu_s F_{Normal}$

d. $F_{kinetic} = \mu_{kinetic} F_{Normal}$

e.

f. $\mu_s > \mu_k$

g. $F_{friction} = \mu F_{Normal}$

A box with a mass of 7.0kg is pulled across a table with a constant force of 30N and it slides across the surface with constant velocity. What is the acceleration of the box? What is the coefficient of friction between the box and the table?

Solution:

$$\mu_k = \frac{F_{friction}}{F_{Normal}}$$

Horizontally:

$$F_{net-x} = ma_x = 0$$
$$F_{applied} - F_{friction} = 0$$
$$F_{applied} = F_{friction}$$
$$F_{friction} = 30N$$

Vertically:

$$F_{net-y} = ma_x = 0$$
$$F_{Normal} - F_{gravity} = 0$$

$$F_{normal} = mg = (7.0kg)(9.8m/s^2)$$
$$F_N = 69N$$

Final Calculation:

$$\mu = \frac{30N}{69N} = 0.43$$

B. Centripidal Force

a. $a_c = \frac{v^2}{r}$

b. $\sum F_c = ma_c = m\frac{v^2}{r}$

C. Horizontal and Vertical Circular Motion

A 300kg rollercoaster travels inverted through a vertically-oriented circular loop of radius 40m. At what velocity would the car travel through the top of the loop if the track is not to supply any force on the car?

Solution:

$$\sum F_c = ma_c$$

$$+F_g = + m\frac{v^2}{r} = mg$$

$$g = \frac{v^2}{r}$$

$v = \sqrt{rg} = \sqrt{(40m)(9.8m/s^2)} = 20m/s$

D. Non-uniform circular motion

a. "Hat-theta," "hat-r" $\hat{\theta}, \hat{r}$

$a_{net} = a_{tangential} + a_{radial}$

$F_{net} = F_{tangential} + F_{radial}$

b. Ex. a car speeding up (or slowing down) as it travels around a curved road

The ball shown is suspended by a long wire from the ceiling, pulled back a small angel, and released so that it oscillates back and forth.

1. Draw a free-body diagram of the pendulum when teh wire makes a non-zero angle with the vertical. Tilt your axes?
2. Calculate the force of tension in the wire at this moment
3. Calculate the tangential acceleraiotn of the ball at this moment
4. Calculate the radial acceleration of hte ball at this moment
5. Express the net acceleration of the ball using unit vector notation
6. Express the net Force acting on the ball using unit vector notation

Solutions:

1. Only forces acting on the ball are gravity and tension in the wire. Bc the ball is accelerating radially and tangentially, we're going to tilt the axes so they are aligned
2. $F_{net-radial} = ma_{radial}$

$F_{Tension} - F_{g-radial} = m\frac{v^2}{r}$

$F_{Tension} - mg\cos\theta = m\frac{v^2}{r}$

$F_{Tension} = m\frac{v^2}{r} + mgcos\theta$

3. $F_{net-tangential} = ma_{tangential}$
   $F_{g-tangential} = mgsin\theta$
   $mgsin\theta = ma_{tangential}$
   $a_{tangential} = gsin\theta$
4. $a_c = \frac{v^2}{r}$
   $a_{radial} =- (\frac{v^2}{r})\ \hat{r}$
5. $a_{net} =- (gsin\theta)\ \hat{\theta} +- (\frac{v^2}{r})\ \hat{r}$
6. $F_{net} = ma =- (mgsin\theta)\ \hat{\theta} +- (\frac{mv^2}{r})\ \hat{r}$

E. Centrifugal Force… that doesnt exist

a. An “apparent” force that we mistakenly think pulls an object away from the center of hte circle. There is no force pulling a rotating object outward!

F. Resistive (Drag) Forces

a. $R =- bv$
   Where b is a constant
b. $R = \frac{1}{2}D\rho Av^2$
   Where
   D = an experimentally-determined drag coefficient
   p = the density of the fluid
   A = the cross-sectional area of the moving object