PHYS 1901 – Physics 1A (Advanced)
Mechanics module

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Applying Newton's Laws

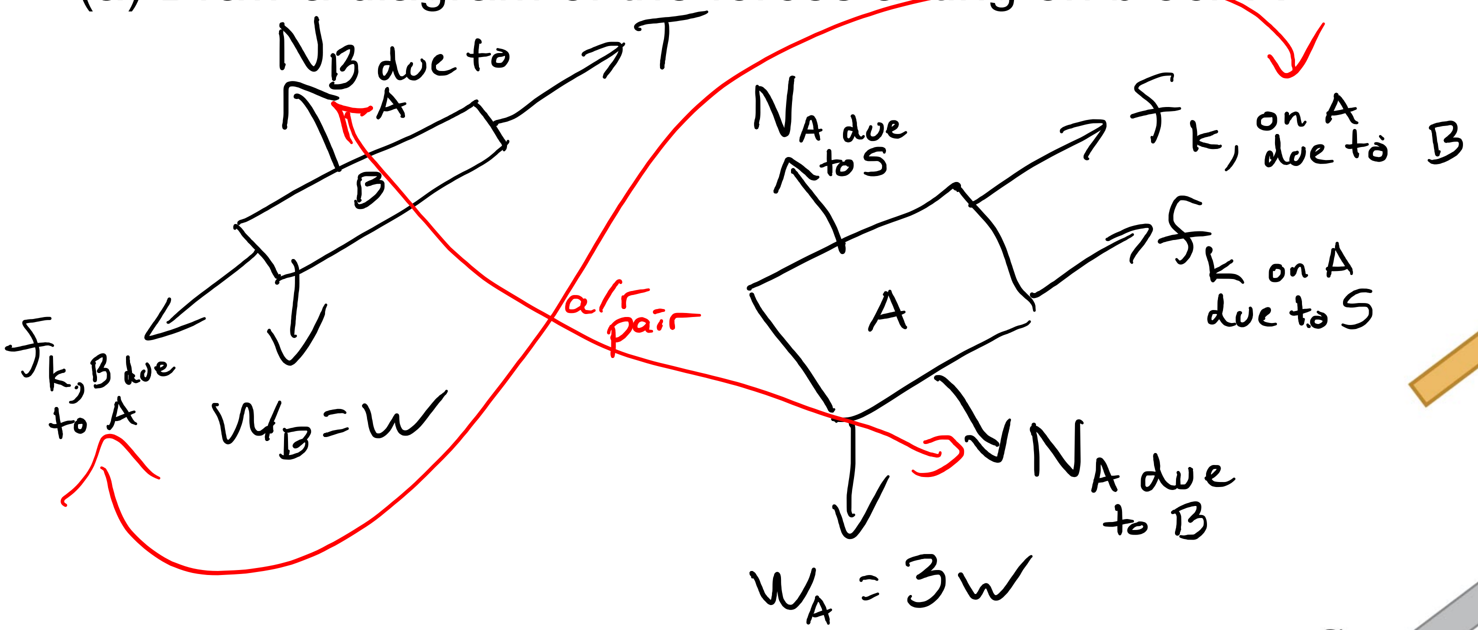
Chapter

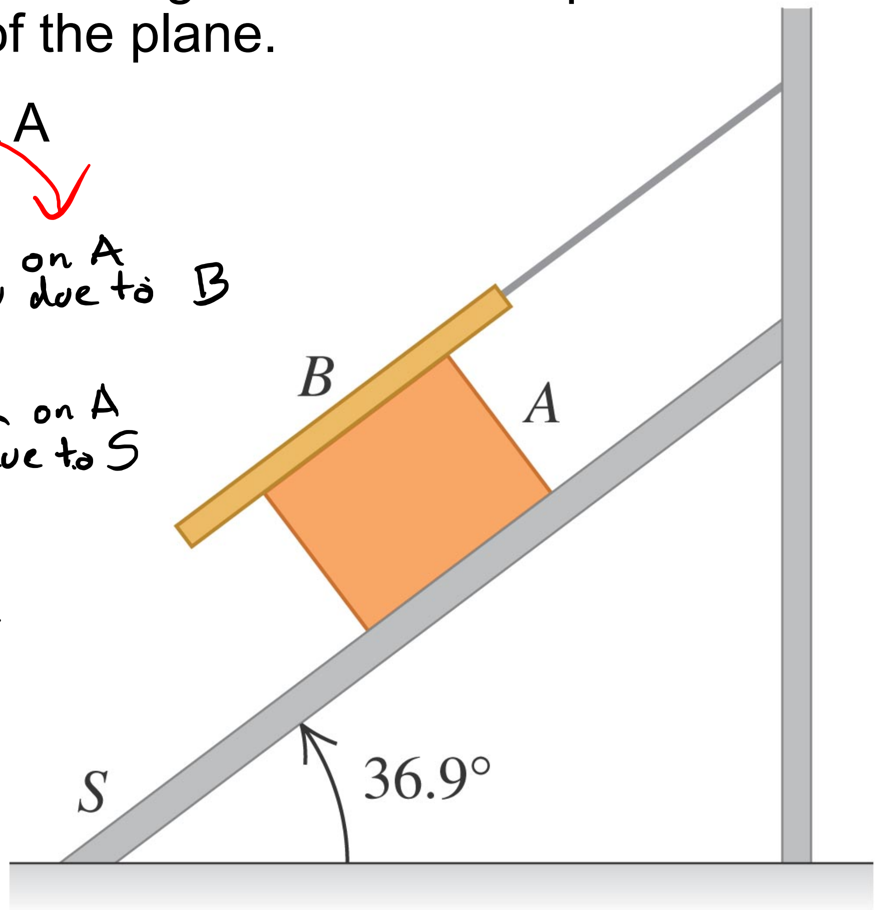
5

Worked Example (5.93)

Block A, with a weight of 3*w,* slides down an inclined plane S of slope angle 36.9° at a constant speed, while plank B with weight *w* rests on top of A. The plank is attached by a cord to the top of the plane.

(a) Draw a diagram of the forces acting on block A





Worked Example (5.93)

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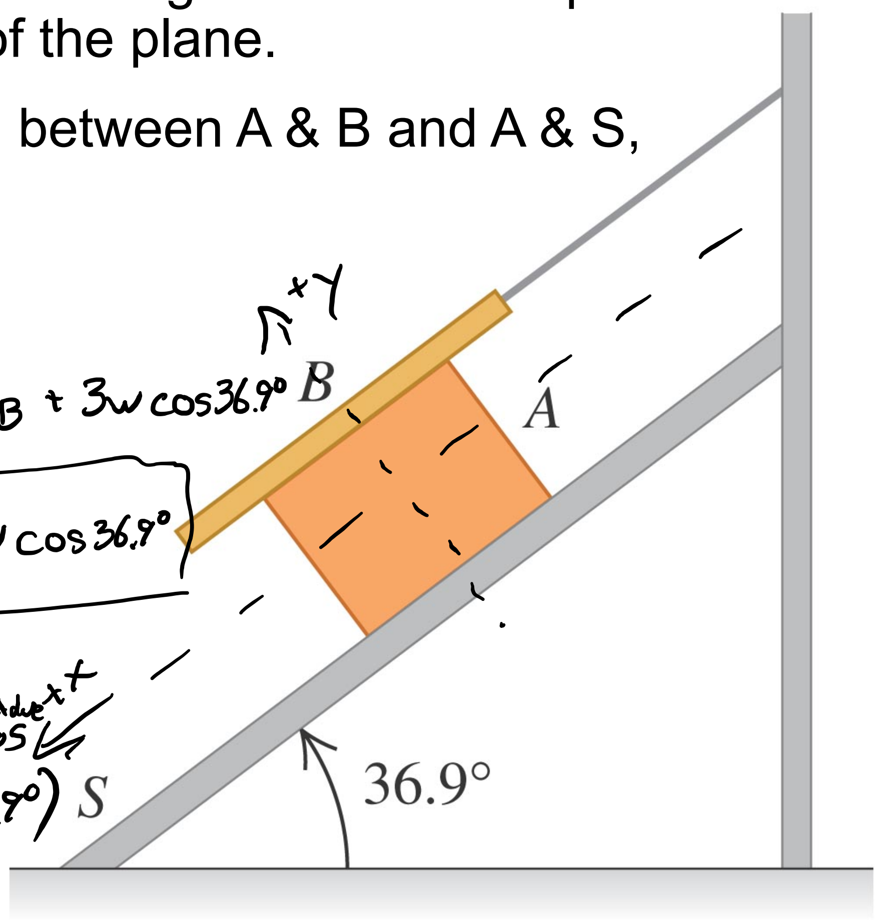
(b) If the coefficient of kinetic friction is the same between A & B and A & S, determine its value.



Block B

$\Sigma F_y = 0$

$N_{B\text{ due to }A} = w\cos 36.9°$

Block A

$\Sigma F_y = 0$

$N_{A\text{ due to }S} = N_{A\text{ due to }B} + 3w\cos 36.9°$

equal (a/r pair)

$\Rightarrow \boxed{N_{A\text{ due to }S} = 4w\cos 36.9°}$

Block A

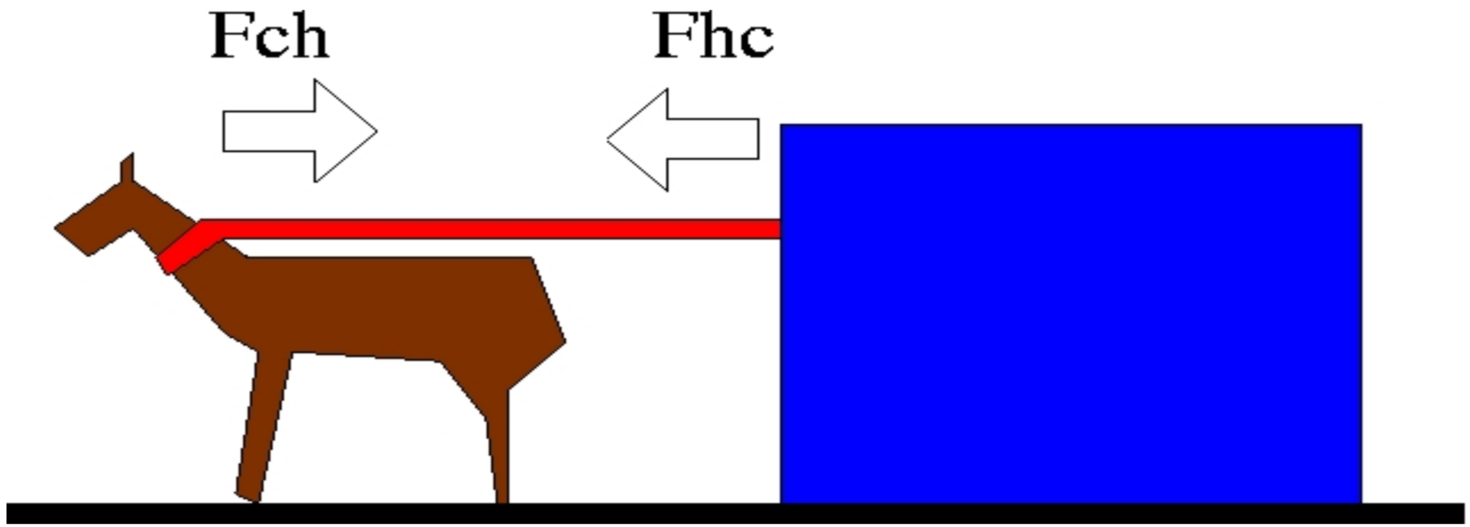
$\Sigma F_x = 0$

$3w\sin 36.9° = \mu_K N_{A\text{ due to }B} + \mu_K N_{A\text{ due to }S}$

$3w\sin 36.9° = \mu_K(w\cos 36.9° + 4w\cos 36.9°)$

$\mu_K = \frac{3}{5}\tan 36.9° = \frac{9}{20}$

Complaining horse

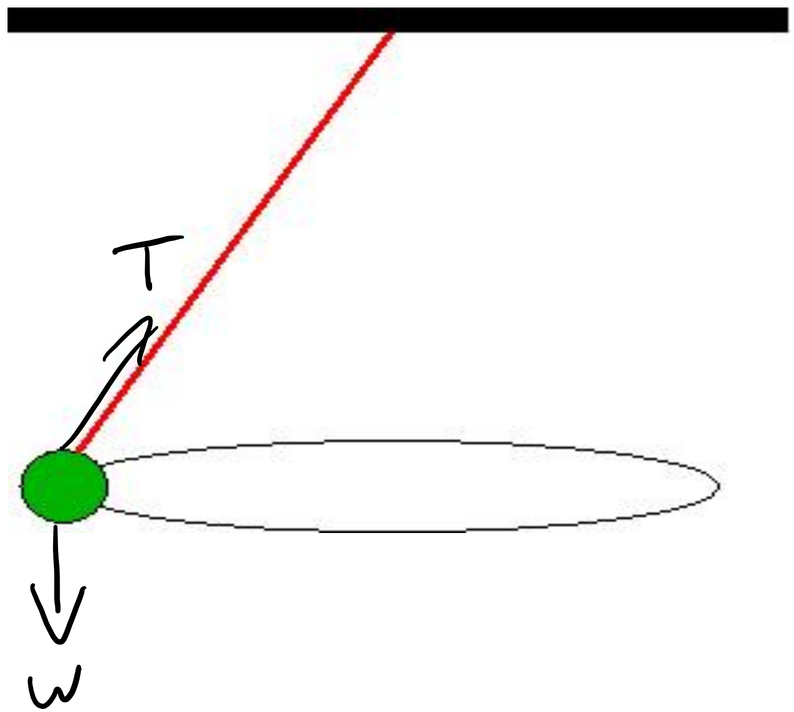


The horse claims that “due to Newton’s third law, no matter how hard I pull on the cart, the cart pulls back on me with the same force. How can I ever move the cart!”

Circular motion

Consider a ball on a string, moving in a circle with uniform speed.

What are the forces acting on the ball?

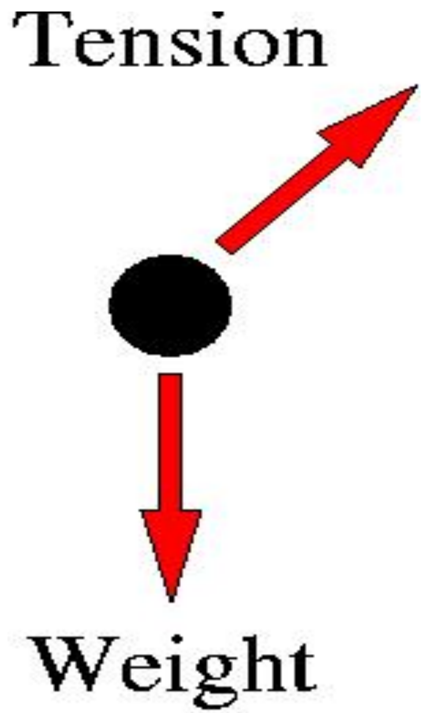


Circular motion

The forces are not in equilibrium, and hence the ball **must** be accelerating!

The acceleration points towards the centre of the circle.

DO NOT add fictitious forces! (more on that in a moment)

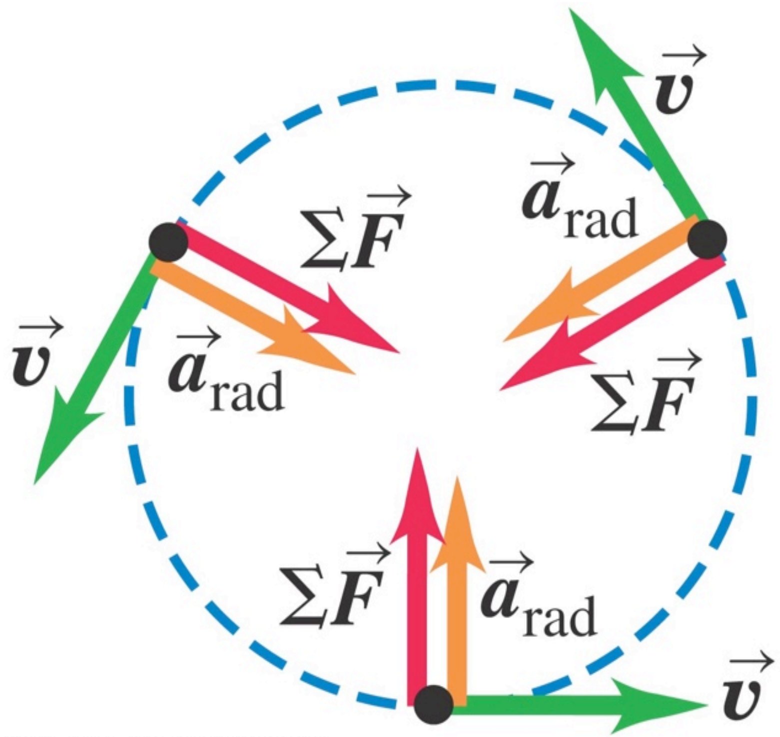


Circular motion

The length of the velocity vector remains constant, and so the acceleration is changing its direction.

For an object traveling with speed *v* to move in a circle of radius *r* the centripetal acceleration must be

$$|a| = \frac{v^2}{r}$$



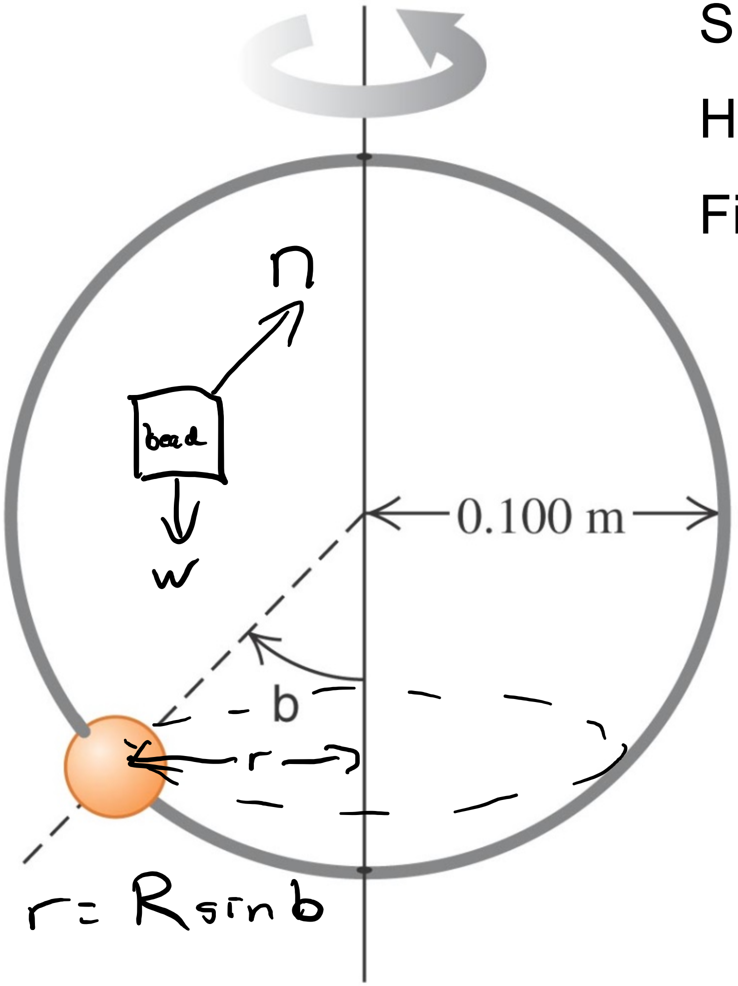
(review chapter 3)

Problem 5.115

Small bead can slide without friction on a circular hoop

Hoop rotates at a constant 4.00 rev/s

Find the angle at which the bead is in vertical equilibrium



$$\Sigma F_y = 0 \Rightarrow mg = n\cos b \Rightarrow n = \frac{mg}{\cos b}$$

$$\Sigma F_x = F_c = ma_c$$

$$n\sin b = m\left(v^2/r\right)$$

Eliminate n

$$\cancel{m}g\frac{\sin b}{\cos b} = \cancel{m}v^2/r \quad \Leftarrow \quad v = \omega r$$

$$g\tan b = \omega^2 r \quad \leftarrow \quad r = R\sin b$$

$$g\tan b = \omega^2 R\sin b$$

$$\frac{g}{\omega^2 R} = \cos b \qquad \omega = 2\pi \cdot 4.00 \text{ rad/s}$$

$$\cos b = \frac{9.80\text{ m/s}^2}{4\pi^2(4.00)^2(0.100\text{ m})} = 0.155 \qquad b = 81^\circ$$

rad/s