

# Physics 100 - fall 2007 - Recitation 4

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①



A kid twirls a rock attached to a string about his head. The rock moves along a circular path.

What happens if the string breaks?

Looking from above ...

what path will

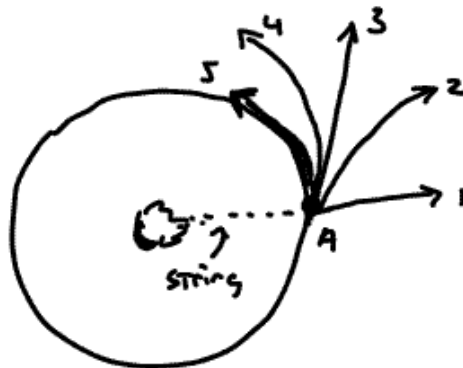
the rock

take if

the string

breaks at

Point A?



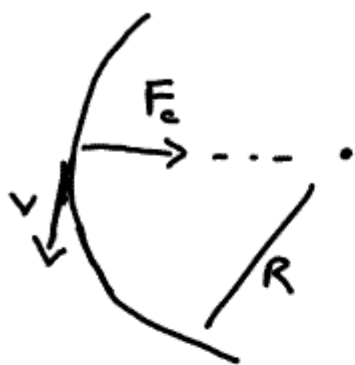
Defend your answer using Newton's Laws.

2

For an object to move on a circle there must be a net force toward the center of

circle,  $F_c = m \frac{v^2}{R}$ ,

called the "centripetal force".



The string supplies the centripetal force for the rock in the example above.

What supplies the centripetal force for a speed skater going around a curve?

What supplies the centripetal force for a car going around a curve?

For a given set of road conditions, what happens if you take a curve too fast?

if you take too sharp a curve?

defend your answers using the circular motion equation above.

③ In the Bohr model, what is the force that acts as the centripetal force?

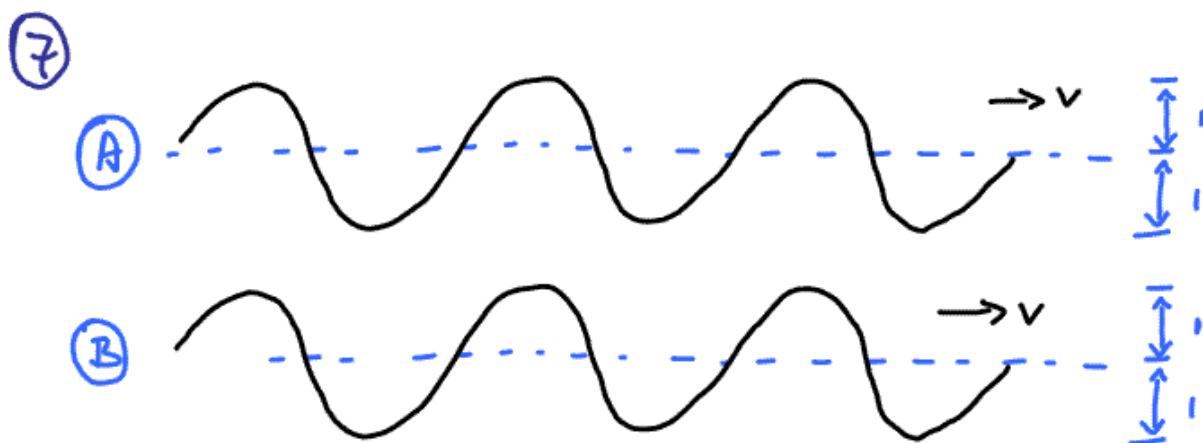
④ For the space shuttle in orbit, what force acts as the centripetal force?

Are the astronauts on the space shuttle in orbit weightless?

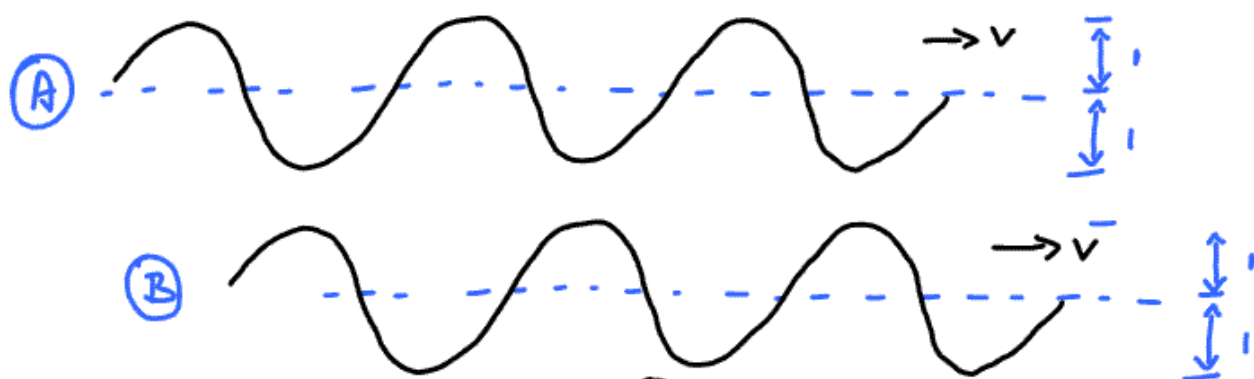
⑤ How much work is done by the centripetal force as an object moves around a circle one time?

⑥ If you were captain of the space shuttle, how would you move to a higher orbit if asked to do so by NASA?

(i.e., in what direction would you fire your rockets?)



Suppose waves ④ and ③ Travel in space together. How would the wave resulting from wave ④ and ③ interfering appear?



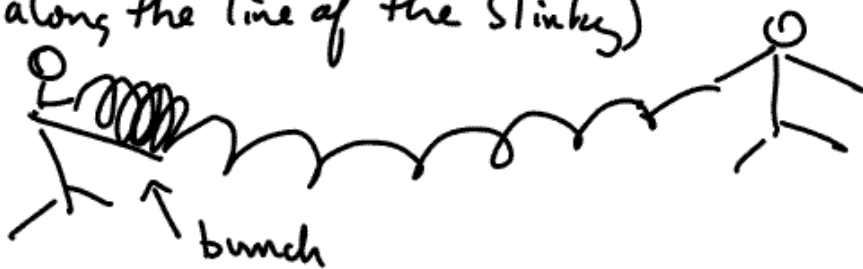
Suppose waves ④ and ③ Travel in space together. How would the wave resulting from wave ④ and ③ interfering appear?

8

2 Members of your group should lightly stretch a Slinky a distance of about 3 or 4 meters.

Caution: Do NOT stretch the slinky too much or it will NOT recoil properly ... ever again.

(a) The person at one end of the slinky should "bunch up" some of the slinky longitudinally (along the line of the slinky)



Now let the slinky go.

Observe the longitudinal wave travel along the slinky.

(b) Now the person at one end of the slinky should displace the slinky transversely (to direction of stretched slinky) and let go



Observe the TRANSVERSE wave travel along the Slinky. (might want to make this displacement in the horizontal direction if the Slinky is touching the floor.

(c) What waves in nature are longitudinal?  
TRANSVERSE?

(d) Have the person at one end of the Slinky move their end up and down smoothly at a fixed frequency.

Can you form STANDING waves  
with zero "nodes"?



one node?



"1<sup>ST</sup> harmonic"

Two nodes?



"2<sup>ND</sup> harmonic"

Don't try more than 2 nodes.

for string (or slinky) of length  $L$ , what frequencies (or periods) give STANDING waves? ... A Theoretical analysis



0 nodes

$$v = \lambda \nu$$

$$L = \frac{1}{2} \lambda$$

$$\lambda = \frac{v}{\nu}$$

$$L = \frac{1}{2} \frac{v}{\nu} \quad \rightsquigarrow \quad \nu = \frac{1}{2} \frac{v}{L}$$

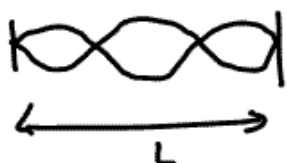


1 node

$$L = \lambda$$

$$\nu = \frac{2}{2} \frac{v}{L}$$

$$L = \frac{v}{\nu}$$



2 nodes

$$L = \frac{3\lambda}{2}$$

$$\nu = \frac{3}{2} \frac{v}{L}$$

$$L = \frac{3}{2} \frac{v}{\nu}$$

⋮

$$\boxed{\nu_n = \frac{n}{2} \frac{v}{L}}$$

frequencies that will resonate on  
String (or Slinky) of length  $L$   
 $n = 1, 2, 3 \dots$

$n=1$  corresponds to the fundamental frequency  
 $n=2$  " " " 1<sup>ST</sup> harmonic  
 $n=3$  " " " 2<sup>ND</sup> "  
⋮

$v$  is speed of wave propagation on string  
This depends on tension and mass of string.  
This is why pitch changes when you tighten  
or loosen a string  $\rightarrow$  you change  $v$  in the  
eqn above.

With the materials you have at hand,  
design an experiment to  
see if the relationship I derived above  
seems to work for waves on a Slinky.

After discussing your idea with your TA,  
carry out your experiment.