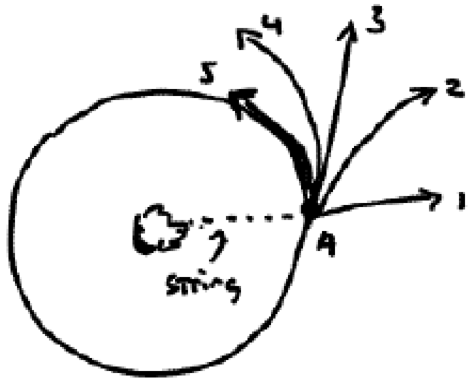
PHY100 — Recitation #4

1) A kid swirls a rock attached to a string about his head. The rock moves along a circular path. What happens if the string breaks?

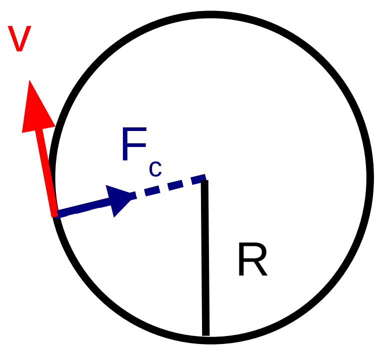


Looking from above, what path will the rock take if the string breaks at point A?

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 the circle called the "centripetal force" F_c.

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



In the example above, the string supplies the centripetal force to the rock in the sling.

What supplies the centripetal force for a speedskater 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:

- a) you take the curve too fast
- b) you take too sharp a curve

Defend your answers using the equation on the left

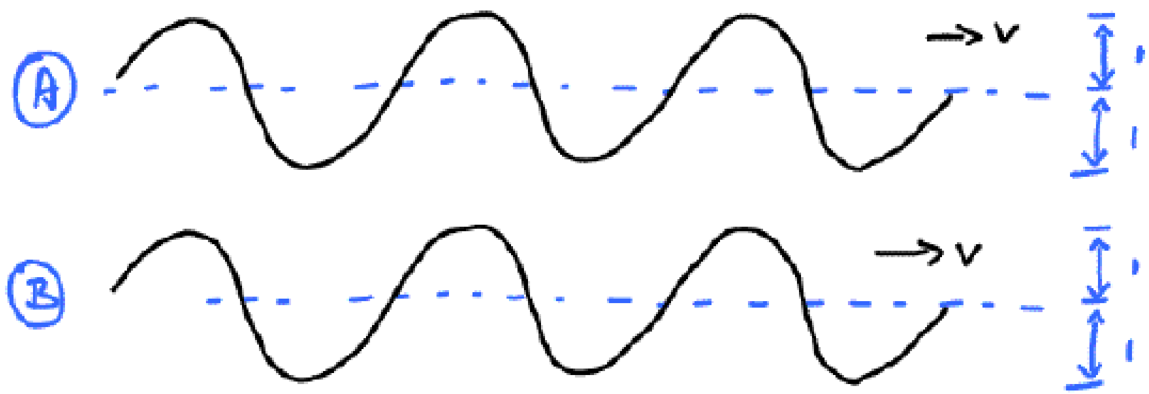
3) In the Bohr model, what is the force that acts as the centripetal force?

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?

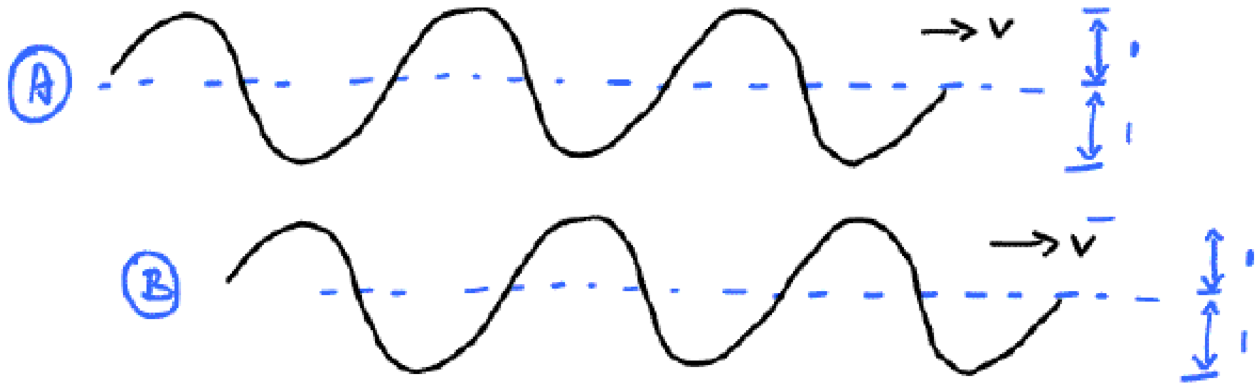
6) If you were a captain in the space shuttle, how would you move to a higher orbit if asked to do so by NASA? In what direction would you fire your rockets?

7)



Suppose waves A and B travel in space together. How would the wave resulting from A and B interfering appear?

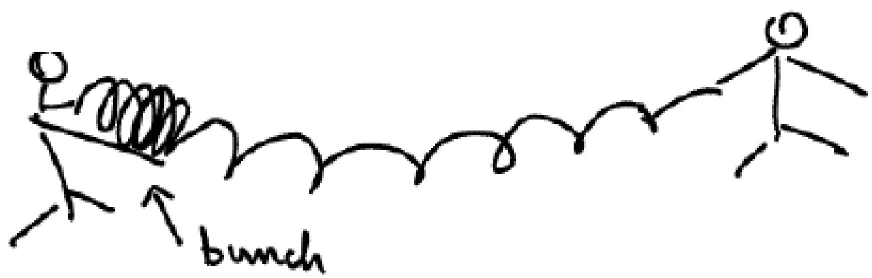
8)



How would the wave resulting from A and B interfering appear?

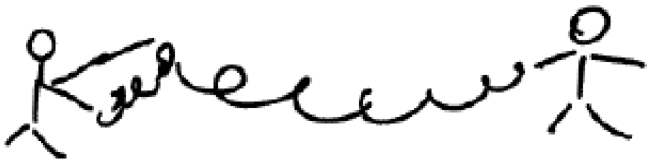
9) Two members of your group should lightly stretch a slinky a distance about 3 or 4 meters. CAUTION: DO NOT STRETCH THE SLINKY TOO MUCH OR IT WILL NOT RECOIL PROPERLY EVER AGAIN

a) The person at one end of the slinky should bunch up 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 of the slinky should displace the slinky transversely (to direction of stretched slinky) and let go



Observe the trasnverse wave travel along the slinky. You might want to make this displacement in the horizontal direction if the slinky is touching the floor.

c) What waves in nature are longitudinal? And 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”?

This is called the “fundamental” mode

One node? “First harmonic”

Two nodes? “Second harmonic”

Don't try more than 2 nodes.

For a string or slinky of length L, what frequencies (or periods) give standing waves?
Theoretical analysis follows:

v=speed of wave
ν=frequency
λ=wavelength

0 nodes

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

$v = \lambda\nu$

$\lambda = v/\nu$

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

1 node

$L = \lambda$

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

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

2 nodes

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

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

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

⋮

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

n = 1, 2, 3...

Frequencies that will resonate on a string or slinky of length L n=1 corresponds to the fundamental frequency

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

n=2 corresponds to the 1st harmonic

n=2 corresponds to the 2nd harmonic

etc...

v is the speed of wave propagation on string: it depends on tension and mass of string

This is why pitch changes when you tighten or loosen a string

→ you are changing v in the equation 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.