Virtual Learning

Physics

Fictitious Forces and The Coriolis Effect

May 7, 2020

Physics

Fictitious Forces and The Coriolis Effect: May 7,2020

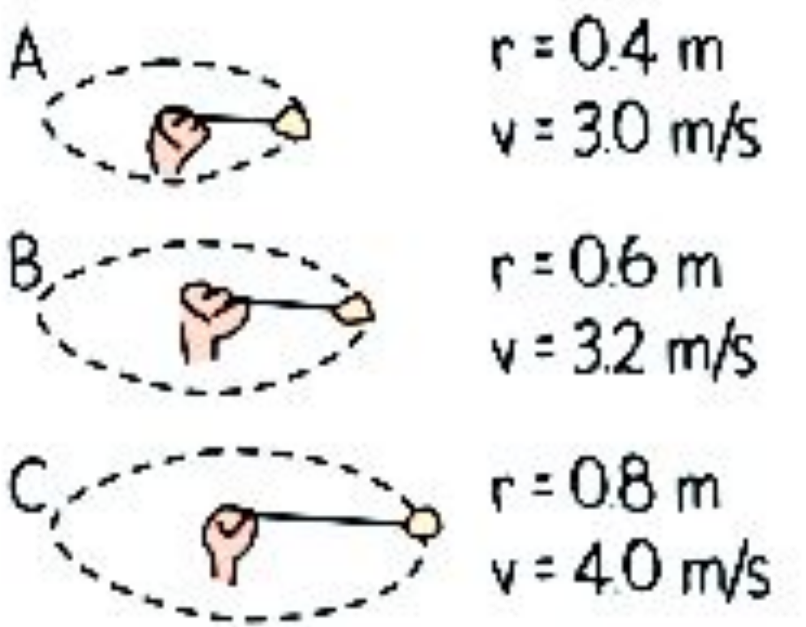
Objective/Learning Target:

Students will examine fictitious forces and then answer some questions about them.

Quick Review #1

A ball is swung in a horizontal circle as shown below. The ball swings from various lengths of rope at the speeds indicated.

Rank the tension in the ropes from greatest to least.



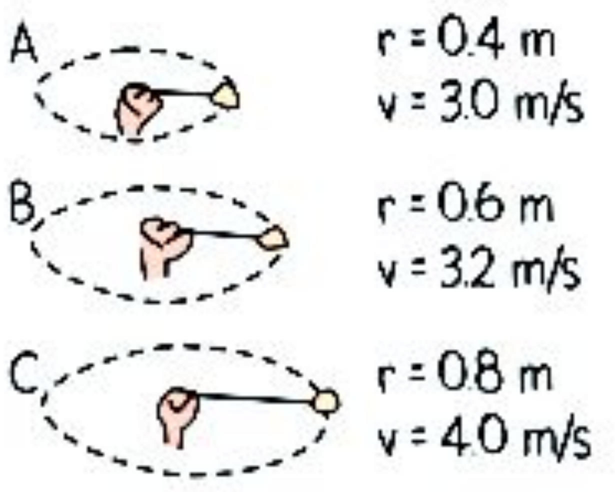
Quick Review #1 Answer

The tension in the ropes from greatest to least is:

$$F_c = \frac{mv^2}{r} = = \frac{1.0\text{ kg} \times (3.0\text{ m/s})^2}{0.4\text{ m}} = 22.5\text{ N}$$

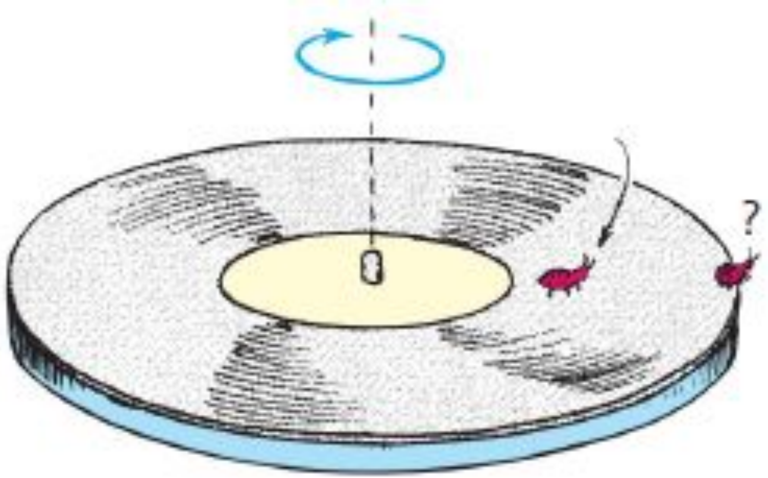
$$F_c = \frac{mv^2}{r} = = \frac{1.0\text{ kg} \times (3.2\text{ m/s})^2}{0.6\text{ m}} = 17.1\text{ N}$$

$$F_c = \frac{mv^2}{r} = = \frac{1.0\text{ kg} \times (4.0\text{ m/s})^2}{0.8\text{ m}} = 20.0\text{N}$$



A, C, B

Quick Review #2

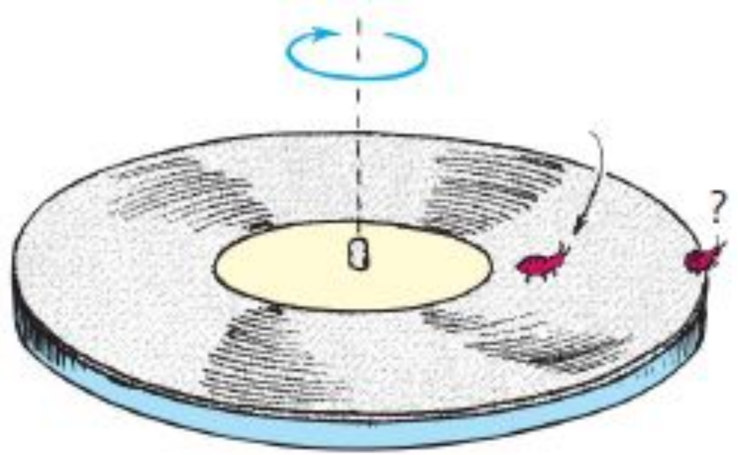


A ladybug is sitting halfway between the rotational axis and the outer edge of the turntable as in the Figure above. When the turntable has a rotational speed of 20 RPM and the bug has a tangential speed of 2 cm/s, what will be the rotational and tangential speeds of her friend who sits at the outer edge?

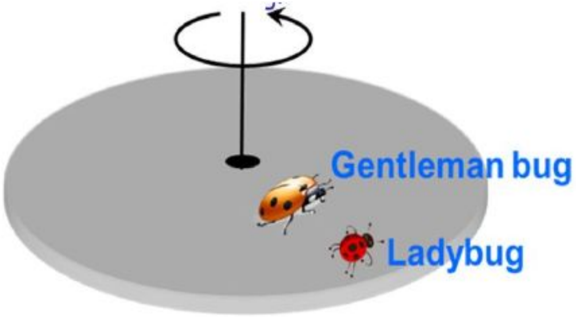
Quick Review #2 Answer

The rotational speed would be the same at 20 RPM. However the outer bug would have twice the tangential speed.

The outer bug covers twice the distance in the same amount of time as the inner bug.



Fictitious Forces



Link:[Fictitious Forces and the Coriolis Effect]

Directions:

- Read through Fictitious Forces.
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual questions and the problems and exercises in the table of contents for the online text linked above.

Practice Problem #1

A heavy iron ball is attached by a spring to a rotating platform, as shown in the sketch. Two observers, one in the rotating frame and one on the ground at rest, observe its motion.

a. Which observer sees the ball being pulled outward, stretching the spring?

b. Which sees the spring pulling the ball into circular motion?

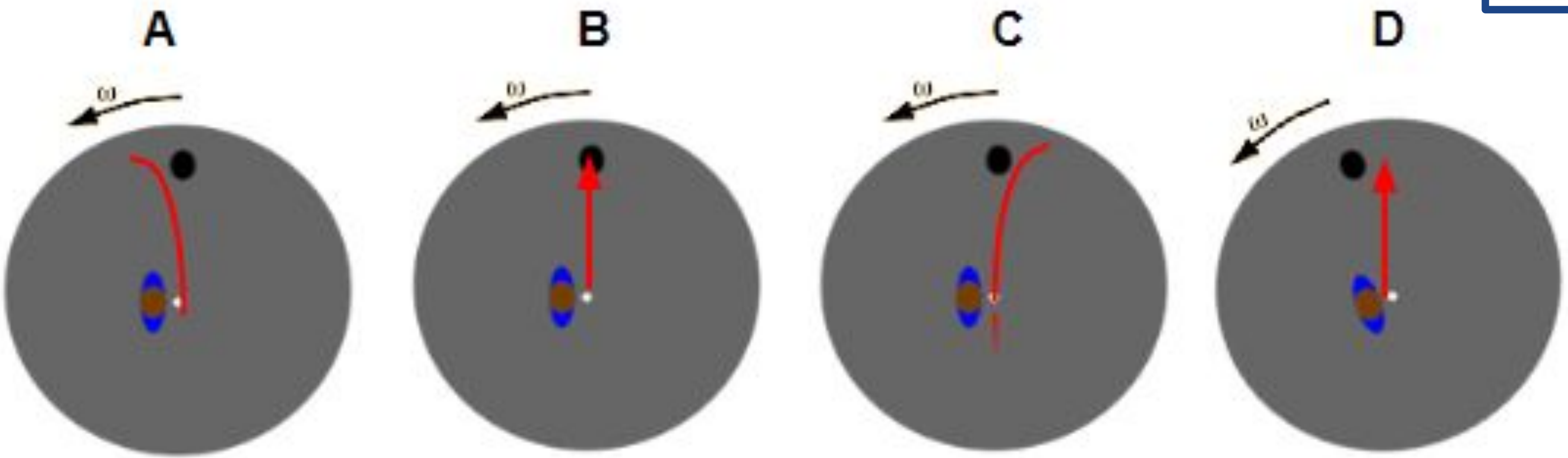
Practice Problem #1

a. The observer in the reference frame of the rotating platform states that a centrifugal force pulls radially outward on the ball, which stretches the spring.

b. The observer in the rest frame states that a centripetal force supplied by the stretched spring pulls the ball into circular motion.

Only the observer in the rest frame can identify an action–reaction pair of forces; where action is spring on ball, reaction is ball on spring. The rotating observer can't identify a reaction counterpart to the centrifugal force because there isn't any!

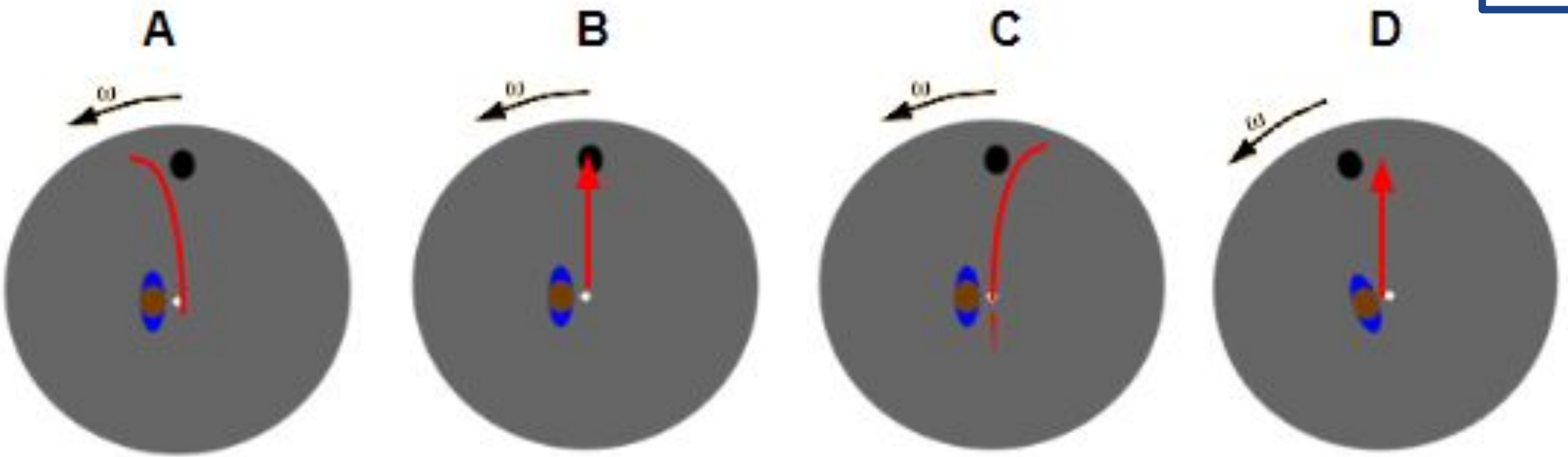
Practice Problem #2



A golfer puts directly at the whole on a rotating platform.

a. From his perspective what path does the ball follow?
b. From an observer on the ground, what path does the ball follow?

Practice Problem #2



a. Path C from the golfer perspective

b. Path D from someone not on the rotating platform

The rightward miss could be blamed on the Coriolis effect and the overshoot on the centrifugal (centrifical force), both only observable to the rotating observer.

Practice Problem #3

Watch the following video explanation of artificial gravity and then answer the question below.

Artificial Gravity Explained.

A 2 km in diameter space station slowly rotates to achieve a simulated gravity that is the same as earth's gravity here on earth. How long would it take for the space station to make one full rotation?

To equal earth the a_c would need to equal 9.8 m/s². The station has a radius of 1 km.

$a_c = r\omega^2$

Rearrange for ω

$\omega = \sqrt{(a_c / r)} = \sqrt{(9.80\ m/s^2 / 1000\ m)} = 0.0098\ rad/s$

Now convert to rev/min

$$0.0098\ \frac{rad}{s} \times \frac{60\ sec}{1\ min} \times \frac{1\ rev}{2\pi\ rad} = 0.093583\ rev/min \rightarrow 10.7\ min/rev$$

10 min 42 sec/rev

Additional Practice

For additional practice check out the conceptual questions and the problems and exercises in the table of contents from the online text linked above.