Announcements

- HW 9 is posted and due on Monday!!
- Sign-up slots for final chapter topics went out in an email!
  - If you haven't signed up for something, try to do so by the end of the week, as I'd like to get questions out this weekend.
- Responses: `rembold-class.ddns.net`

Today's Objectives

- Build intuition and skills with working with rotation vectors
- Understand where the rotational correction terms for spinning reference frames come from
- Be able to determine the direction and magnitude of the Coriolis and Centrifugal forces
- Understand how these forces affect our classic kinematic equations here on Earth

Q1

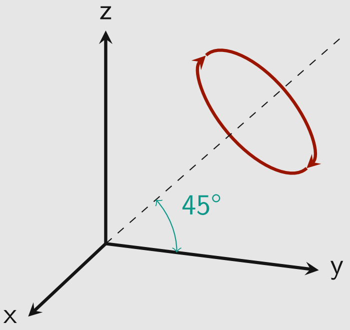
The object to the right completes one revolution every 6 seconds as it orbits with radius 1 m about the axis shown. How would you describe its angular velocity vector?

A) $\langle 1.47,\ 0,\ -0.71 \rangle$ rad/s

B) $\langle 0,\ -0.74,\ -0.74 \rangle$ rad/s

C) $\langle 0,\ 0.74,\ 0.74 \rangle$ rad/s

D) $\langle 0,\ 0.71,\ 0.71 \rangle$ rad/s



Q2

I take a black pen and draw a small dot on a baseball (r=3.65 cm) before tossing it into the air. One second later, the ball is traveling at a velocity given by (1,-1,3) m/s and is spinning about its center with $\vec{\omega} = (0, -100, 10)$ rad/s. At this point it time, the black dot is precisely on the top of the baseball. I took the z-direction to be upwards in this case.

What is the total linear velocity of the black dot with respect to the ground at this point in time?

A) (3.65, 2.65, 3) m/s
B) (-2.65, -1, 3) m/s
C) (4.65, -1.65, 2.43) m/s
D) None of the above

Q3

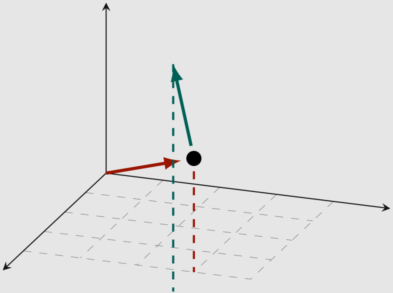
Suppose you have a ball which is located at the point (4,3,2) m which is traveling with velocity (1,0,2) m/s. A person is located at the origin and spins about the z-axis at 1 rad/s. From the spinning person's point of view, how fast is the ball traveling?

A) 2.24 m/s

B) 4.9 m/s

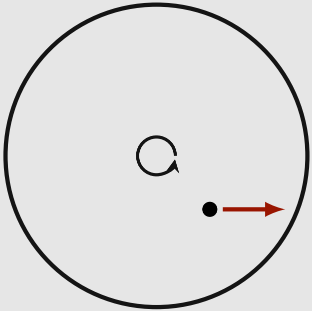
C) 6 m/s

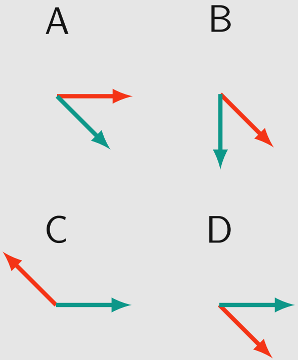
D) None of the above



Q4

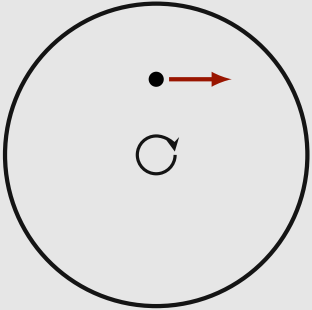
In the figure below, a large turntable is turning counter-clockwise. On that table is an object at a particular position which is traveling in the indicated direction. Which of the diagrams to the right correctly shows the direction of $\vec{F}_{cf}$ and $\vec{F}_{cor}$?

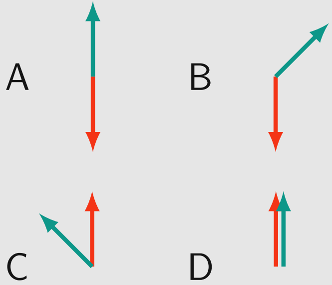




Q5

In the figure below, a large turntable is now turning clockwise. On that table is an object at a particular position which is traveling in the indicated direction. Which of the diagrams to the right correctly shows the direction of $\vec{F}_{cf}$ and $\vec{F}_{cor}$?





Q6

Suppose you went outside (a novel idea!) and fired a bullet straight up into the air (a terrible idea! Do not do this!) in Salem (latitude=45°N). Assuming only gravity acted on the bullet, in what direction would the bullet have moved a split second later, as seen by yourself in the rotating reference frame? Earth rotates counter-clockwise as viewed from above the North Pole.

A) To the East and to the North
B) To the West and to the South
C) To the East and to the South
D) To the West and to the North

Q7

In general you will have to solve a set of coupled differential equations when looking at motion in 3D, so numerical solutions may be your best bet. But the book showcases a nice method of successive approximations that you can do. In the book they did it for an object falling freely toward the Earth, but let's take the example we just had, where we fire a bullet vertically at speed v_0. What would the 1st order approximation for x look like?

A) $\frac{1}{3}\Omega g t^3 \sin(\theta)$

B) $\frac{1}{3}\Omega g t^3 \sin(\theta) - \Omega v_0 t^2 \sin(\theta)$

C) $\frac{1}{3}\Omega g t^3 \sin(\theta) + \Omega v_0 t^2 \sin(\theta)$

D) $\Omega v_0 t^2 \sin(\theta)$