Name: ____________

Date: ____________

Circular Motion Practice 2

Solutions are posted

p.105 #13

a. They all move through the same $\Delta\theta$ in time Δt, and $\omega = \frac{\Delta\theta}{\Delta t}$, so they all have same ω. $\boxed{\omega_1 = \omega_2 = \omega_3}$

b. $V_t = \omega r$, and ω is the same for all of them. Since 1 and 2 have the same smaller r, $V_1 = V_2 < V_3$, so from largest to smallest: $\boxed{V_3 > V_2 = V_1}$

p.106 #24. Include a statement about how you used the graph to get your answers.

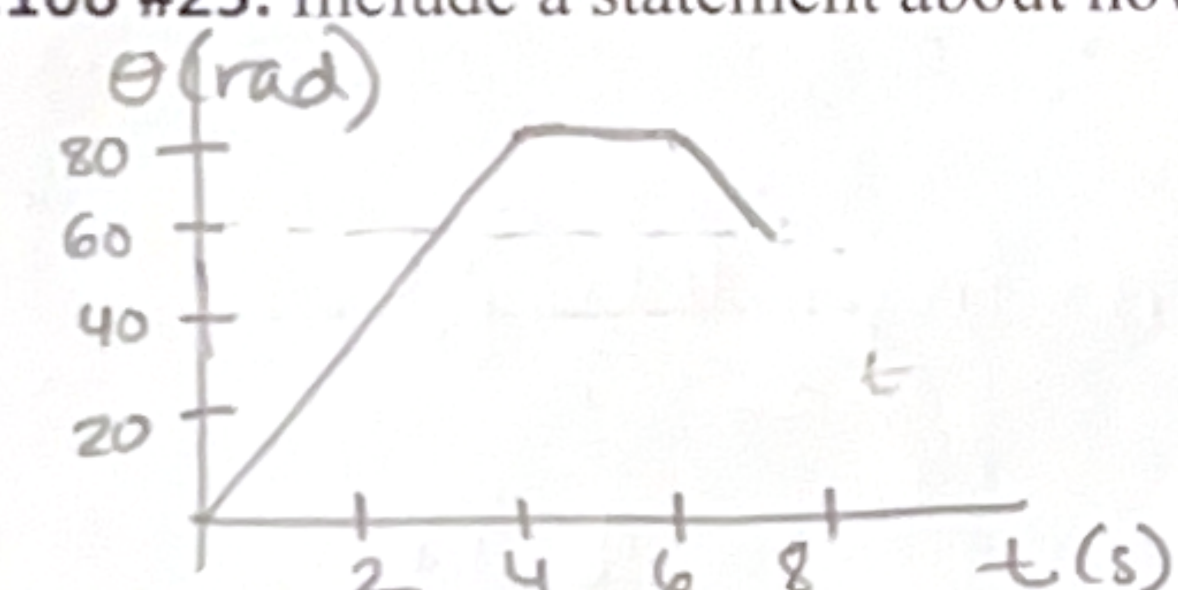
Angular velocity is the slope of a θ vs. t graph, since $\omega = \Delta\theta/\Delta t$

a) At $t = 1s$, $\omega = \frac{\Delta\theta}{\Delta t} = \frac{4\pi \text{ rad}}{2s} = \boxed{2\pi \text{ rad/s}}$

b) $\boxed{\omega = 0}$

c) $\omega = \frac{\Delta\theta}{\Delta t} = \frac{-6\pi \text{ rad}}{3s} = \boxed{-2\pi \text{ rad/s}}$

p.106 #25. Include a statement about how you used the graph to get your answers: Area is $\Delta\theta$



From 0→4s, $\Delta\theta$ = area = (20 rad/s)(4s) = 80 rad

From 4→6s, $\Delta\theta$ = 0

From 6→8s, $\Delta\theta$ = -20 rad

p.106 #27. Provide support for your answers.

45 rpm is angular speed $= 45 \frac{\text{rev}}{\text{min}}$

a) $45 \frac{\text{rev}}{\text{min}} \left(\frac{2\pi \text{ rad}}{1 \text{ rev}}\right)\left(\frac{1 \text{ min}}{60 s}\right) = \boxed{4.7 \text{ rad/s}}$

b) Period is time for 1 rev $\frac{1}{45 \text{ rev/min}} = .022 \frac{\text{min}}{\text{rev}} \left(\frac{60 s}{1 \text{ min}}\right) = \boxed{1.32 \text{ s per rev.}}$

Read: On p.188, read the section in the middle of the page, study the force diagrams in Figure 8.8, and answer these questions:

a. If a car is going slower than the "just-right" speed that would allow it to go around a banked curve without relying on friction, will it tend to slide down the incline or up the incline? down. What direction does static friction point in this case? Up the incline

b. If a car is going faster than the "just-right" speed that would allow it to go around a banked curve without relying on friction, will it tend to slide down the incline or up the incline? Up. What direction does static friction point in this case? down the incline

Read: "Centrifugal Force?" on p.191

a. Is there a force throwing you against the door when your car turns a corner quickly? no

b. What direction is your body trying to travel, when the turning of the car causes the door to get in the way and exert a force on you? Straight!

Read: "Circular Orbits" on pp. 189-190, up to equation 8.9. and study Figure 8.10

a. When is the flat-earth approximation valid? When v_0 is very small

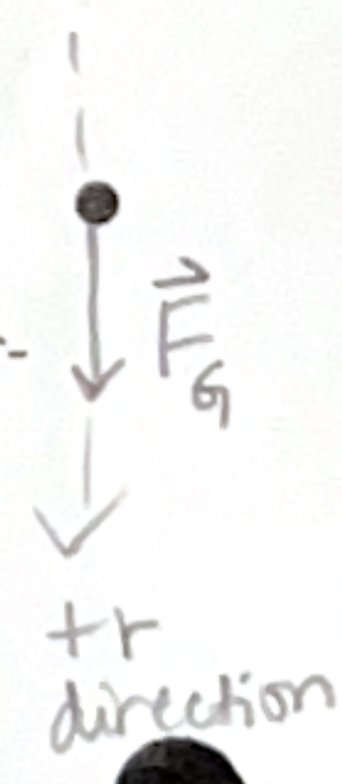
b. In Figure 8.10, explain why projectile D orbits the planet instead of hitting the ground.
As projectile D falls, the earth curves away below it the same amount, so it never gets any closer to the ground. This results in its orbit at a constant radius.

Read: "Why does water stay in the Bucket?" on p.192-193, and study Figures 8.14 and 8.15. For a roller-coaster car going around a loop-the-loop…

1. At the very bottom of the loop:
   a. What is the direction of the normal force on the car at this point? up.
   b. Does the normal force or the gravitational force have a greater magnitude? normal force
   c. After applying Newton's second law in the radial direction ($a_{Sr} = \frac{\Sigma F_{on\,Sr}}{m_S}$), what equation was obtained for the normal force at this point? $n = mg + \frac{m(v_{bot})^2}{r}$

2. At the very top of the loop:
   a. What is the direction of the normal force on the car at this point? down.
   b. What two forces add together to create the sum of the forces pointing toward the center when the car is at this point? n and F_G
   c. After applying Newton's second law in the radial direction ($a_{Sr} = \frac{\Sigma F_{on\,Sr}}{m_S}$), what equation was obtained for the normal force at this point? $n = \frac{m(v_{top})^2}{r} - mg$
   d. If v_{top} increases, does the normal force on the car at this point increase or decrease? increase
   e. If v_{top} decreases, does the normal force on the car at this point increase or decrease? decrease

   f. When the car is traveling at the critical speed at the top of the loop,
   - What is the normal force equal to? 0
   - Is the car in contact with the track? no
   - What is the only force pointing toward the center of the circle? F_G
   - Draw the force diagram on the dot for the roller-coaster car:



   g. Apply Newton's second law in the radial direction ($a_{Sr} = \frac{\Sigma F_{on\,Sr}}{m_S}$) for the instant when a roller-coaster car of mass m is traveling at the critical speed v_c at the top of a loop of radius R, and solve for the critical speed v_c in terms of given variables and fundamental constants.

$$a_{Sr} = \frac{\Sigma F_{on\,Sr}}{m_S}$$

$$\frac{v_c^2}{R} = \frac{+F_G}{m}$$

$$\frac{v_c^2}{R} = \frac{+mg}{m} \longrightarrow \boxed{v_c = \sqrt{gR}}$$