Problem Set 3
Physics, summer 2020/21

1) **(2p.)** A carnival ride starts at rest and is accelerated from an initial angle of zero to a final angle of 6.3rad by a counterclockwise angular acceleration of 20rad/s^2. What is the angular velocity at 6.3rad?

Answer:
We know that initial angular velocity is equal 0rad/s. Also initial displacement is equal 0rad so

$\theta = \frac{\alpha}{2}t^2 + \omega_0 t + \theta_0 = \frac{\alpha}{2}t^2$ *and therefore we achieve at* $\theta = 6.3\ rad$ *at time*

$t = \sqrt{\frac{2\theta}{\alpha}} = \sqrt{\frac{2*6.3\ rad}{20\ rad/s^2}} = 0.79s$ *and then we can calculate angular velocity at* $\theta = 6.3\ rad.$

$$\omega = \omega_0 + \alpha t = \alpha t = 20\frac{rad}{s^2} * 0.79s = 15.87\ rad/s$$

2) **(3p.)** What is the angular velocity vector of the earth? Assume that period T is equal one day. Give answer in rad/s.

Answer:
The angular velocity equals the number of radians/time, so
$\omega = \frac{2\pi\ radians}{one\ day} = \frac{2\pi}{24(3600)\ s} \approx 7.27 \times 10^{-5} rad/s$
This is the magnitude of the angular velocity, but what is the direction? Since the sun sets in the west, the direction of ω is from the south to the north pole.

3) **(3p.)** Bugsy spins the lottery wheel counter-clockwise until it is rotating at 2 revolutions/sec. The wheel is a clockface with 12 equal divisions labeled 1 → 12 going clockwise. When the 12 is at the top, rotating at 2 revolutions/sec, he lets it slow down on its own. It takes 44.2 seconds to slow down. Assuming that the angular acceleration is constant, what two numbers does it land between?

Answer:
The initial angular velocity is $\omega_0 = 2(2\pi) = 4\pi$ *rad/s. Since it takes 44.2 seconds to slow down, the angular acceleration is* $\alpha = 4\pi/44.2 = \pi/11.05 \approx 0.284$ *rad/s^2. If the angular acceleration is constant, then the angle that is swept out is*

$$\theta = \frac{\alpha}{2}t^2 + \omega_0 t + \theta_0 = \frac{\pi}{22.1}44.2^2 + 4\pi(44.2) = (256.2)\pi\ rad$$

The number of revolutions that the wheel turns before it stops is
$(265.2)\pi/(2\pi) = 132.6$ revolutions.
So the wheel only completes the last 0.6 of a revolution. Multiplying by 12 gives 0.6(12) = 7.2. Thus, the wheel stops between 7 and 8.

4) **(2p.)** An object, attached to a 0,5m string, does 4 rotation in one second. Find
   a) Period
   b) Tangential velocity
   c) Angular velocity of the object.

<u>*Answer:*</u>

a) If the object does 4 rotation in one second, its frequency becomes;
$f=4s^{-1}$
$T=1/f=1/4s \Rightarrow T = 0.25s$

b) Tangential velocity of the object;
$V=2\pi r/T = 2\pi rf$
$V=2*3*4*0,5$
$V=12m/s$

c) Angular velocity of the object
$\omega=2*\pi*f=2*3*4=24radian/s$

Sylwia Majchrowska
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