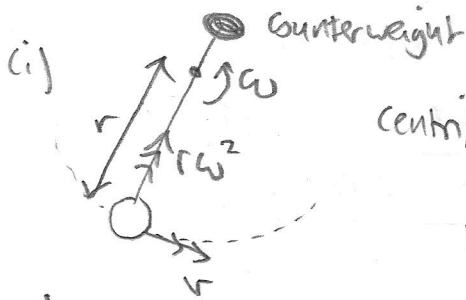


NON-UNIFORM CIRCULAR MOTION

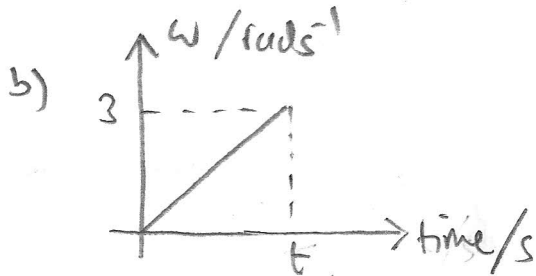


Centrifuge at NASA Ames

$$r\omega^2 = 12.5g$$

$$\omega = \sqrt{\frac{12.5g}{r}} = \frac{60}{2\pi} \sqrt{\frac{12.5 \times 9.81}{8.8}} \text{ RPM}$$

$$= \boxed{35.6 \text{ RPM}}$$



Tangential acceleration is $r\dot{\omega} = 0.5g$

$$\dot{\omega} = \frac{3}{t} \quad \text{and} \quad \dot{\omega} = \frac{0.5g}{r}$$

$$\therefore \frac{3}{t} = \frac{0.5g}{8.8}$$

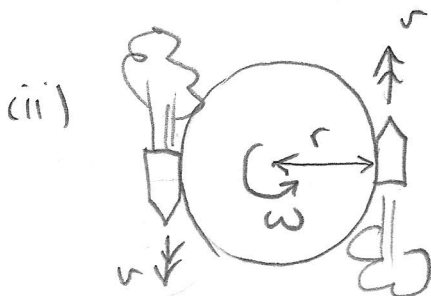
$$\therefore \frac{3 \times 8.8}{0.5 \times 9.81} = t$$

$$\therefore \boxed{5.38 \text{ s} = t}$$

c) $\theta = \int \omega dt$ i.e. area under $\omega(t)$ graph.

$$\text{So } \theta = \frac{1}{2}(3)(t) = \frac{1}{2}(3)(5.38) = 8.07 \text{ radians}$$

$$= \boxed{462.6^\circ} \quad (1.28 \text{ rotations})$$



$$r = 0.33 \text{ m}$$



$$a) \omega = \frac{600 \times 2\pi}{60 \times 5} \text{ rads}^{-2}$$

$$= 4\pi \text{ rads}^{-2}$$

$$\approx \boxed{12.6 \text{ rads}^{-2}}$$

$$b) \text{ At } 5.0 \text{ s, } v = r\omega = 0.33 \times \frac{600 \times 2\pi}{60}$$

$$= \boxed{20.7 \text{ m/s}}$$

c) Total angle of turn is $\theta = \int_0^7 \omega dt =$

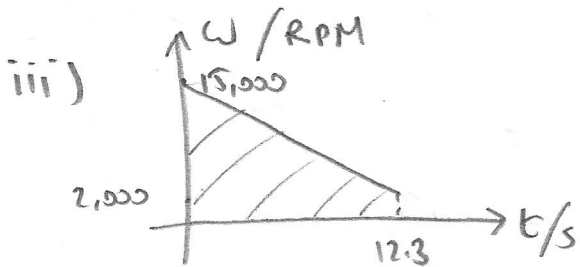
Since $\omega = \text{constant}$, $\theta = \frac{1}{2}(4\pi) \times (7)^2$
 $\Rightarrow \theta = \frac{1}{2}\omega t^2$
 $= 307.9 \text{ radians or } 17640^\circ$
 $= \boxed{49 \text{ rotations}}$

{ In our case, since $\dot{\omega} = 4\pi \text{ rads}^{-2}$

$\theta = \frac{1}{2}(4\pi)t^2$

$\frac{\theta}{2\pi} = t^2$

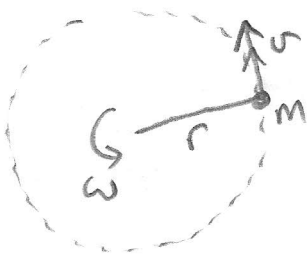
So $\boxed{\# \text{ rotations} = t^2}$



Total angle of turn is area under ω, t graph

$= \frac{1}{2}(12.3)(15,000 + 2,000) \times \frac{2\pi}{60} \text{ (rad)}$
 $= 1.09 \times 10^4 \text{ rad}$
 $= \boxed{627,300^\circ}$

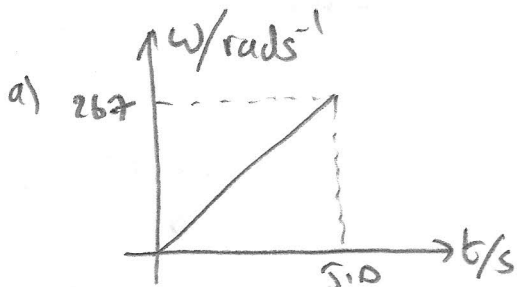
iv)



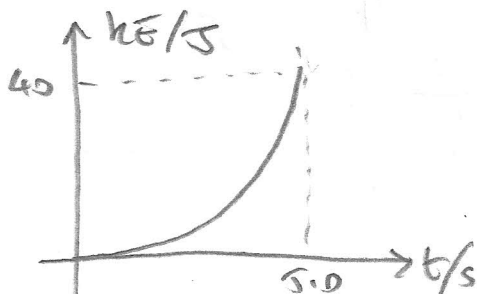
radius of ball $r = 0.75 \text{ m}$, $m = 0.20 \text{ kg}$

$v = r\omega \quad \therefore \omega = \frac{v}{r}$

when $v = 20 \text{ m/s}$, $\omega = \frac{20}{0.75} = \boxed{26.7 \text{ rads}^{-1}}$



b) $KE = \frac{1}{2} M v^2$
 $KE = \frac{1}{2} M r^2 \omega^2$



At 5.0 s , $KE = \frac{1}{2}(0.2)(0.75)^2(26.7)^2$
 $= \boxed{40 \text{ J}}$

2)

c) Angle of turn $\theta = \frac{1}{2} \left(\frac{20}{0.75} \right) (5)$

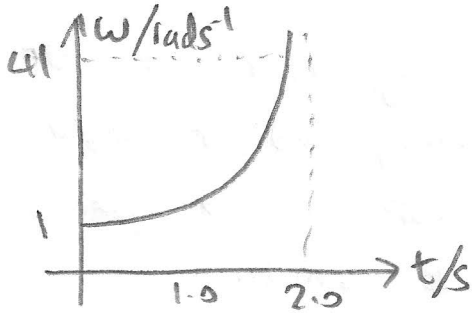
\approx area under (t, ω) graph = 66.7 radians

= 10.6 rotations.

So

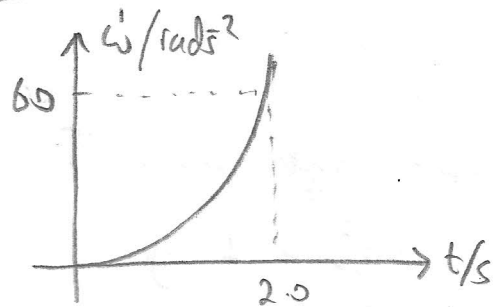
$\boxed{10 \text{ complete rotations}}$

(v) a) $\boxed{\omega = 1 + 5t^3}$ for ice-skater.



when $t = 2.0\text{s}$, $\omega = 41 \text{ rad/s}$

$\boxed{\dot{\omega} = 15t^2}$ ($\approx \frac{d\omega}{dt}$)

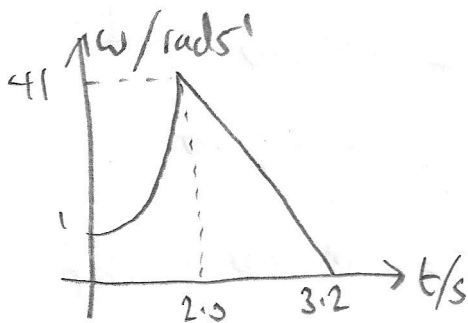


b) $\theta = \int_0^2 \omega dt = \left[t + \frac{5}{4} t^4 \right]_0^2 = 2 + \left(\frac{5}{4} \right) (16) = \boxed{22 \text{ rad}}$

\approx 3.50 rotations. (She lands backwards!)

c) After 2.0s she brakes at constant angular acceleration $\dot{\omega}$

At 2.0s, $\omega = 41 \text{ rad/s}$



$\dot{\omega} = -\frac{41}{1.2} = \boxed{-34.2 \text{ rad/s}^2}$

