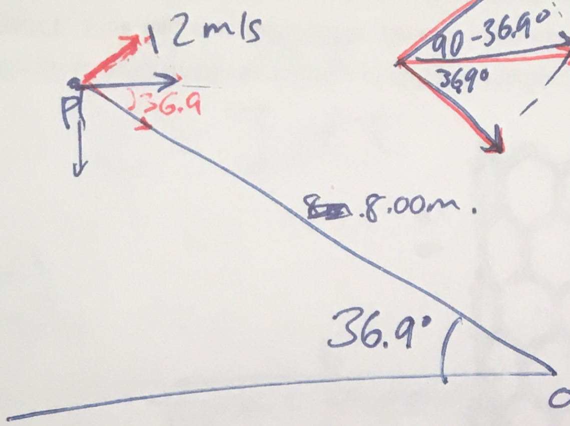
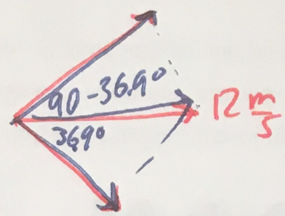
21 A)

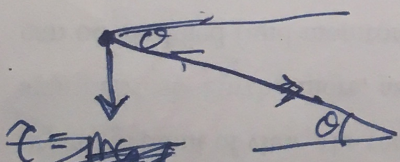




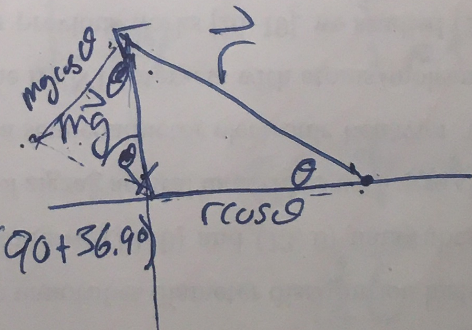
$$L = I\omega$$
$$= mr^2 \frac{v}{r}\sin\theta$$
$$= \frac{mvr}{\cancel{r}}$$
$$= \frac{2.40\,kg \;\; 12.0\,\frac{m}{s}\;\; 8.00m}{\cancel{8.00m}} \times \sin\theta$$
$$\frac{kg\,m^2}{s}$$

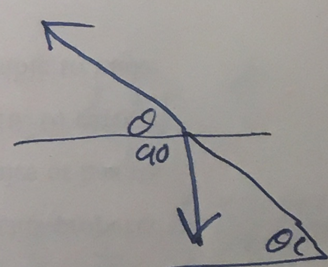
B) momentum is into the page by Right-hand rule.

C) $|\vec{\tau}| = \left|\frac{d\vec{L}}{dt}\right| = |mg\vec{r}|$



$\tau = \cancel{mg}$

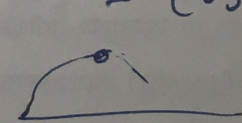




$\tau = m\vec{g} \times \vec{r} = mgr\sin(90+36.9°)$

$= \cancel{\quad} = 151.$

$\sin(90+\theta)$
$= \cos(\theta)$



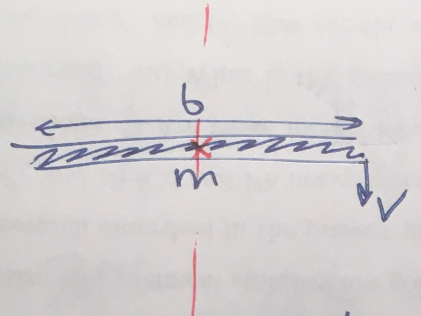
D) out of the page. (opposite to $\vec{L}$ since P is left of O).

22) B). $\alpha = \frac{\omega_f - \cancel{\omega_i}^{\to 0}}{t} = \frac{\omega}{t}$ A) $kg\frac{m}{s^2}$

$\omega = \alpha t$

$L = I\alpha t$

C).

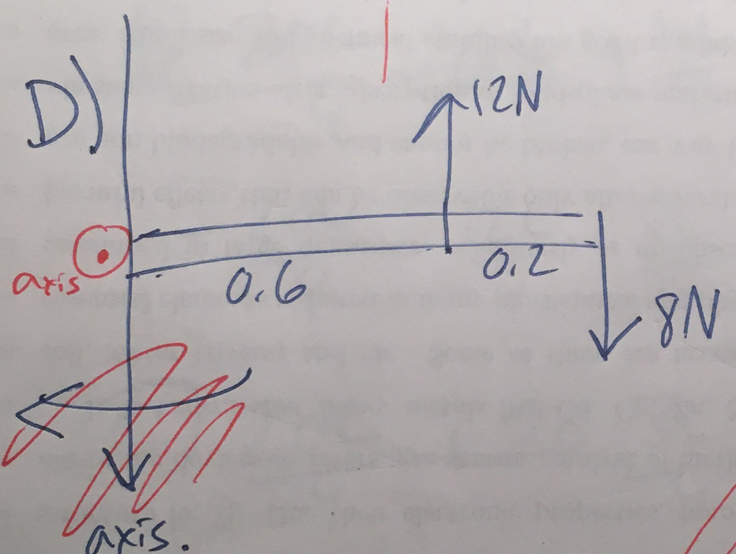


$\omega = \frac{v}{r}$

$L = I\omega = I\frac{v}{(b/2)} = \frac{2}{12} m b^2 \frac{v}{b}$

$= \frac{mbv}{6}$

D)



$F_{net} = 4N \uparrow$.

$\tau = F_{net}\, r = \underline{4N\, 0.6m}$

$\frac{d\vec{L}}{dt} = 4N \cdot 0.6m$.

$\frac{L}{t} = 4 \cdot 0.6\ Nm$.

$L = 4 \cdot 0.6 \cdot 6.0s\ Nm$.

$\frac{kgm}{s^2}\ m.s$ ✓

$\frac{L_2 - L_1}{t} = \frac{dL}{dt}$

22 D) $\tau_{net} = \tau_1 + \tau_2$

$$= (12N \cdot 0.6m - 8N \cdot 0.8m).$$

$$L = \tau_{net} t = (12 \cdot 0.6 - 8 \cdot 0.8) 6.0 \frac{Nm}{s}$$

E) A $\frac{8L}{4} - \frac{1.3L}{4} - \frac{7.4L}{4} \neq 0.$

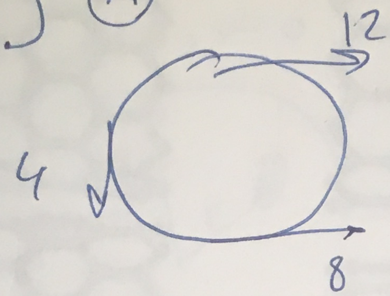
B $-\frac{20L}{4} - 6\frac{L}{2} + \frac{4L}{2} + \frac{6L2}{2}$

$$-\frac{20L}{4} - \frac{12L}{4} + \frac{8L}{4} + \frac{24L}{4} = 0.$$

C $\frac{20L}{4} + 20 \cdot \frac{3L}{4} - \frac{20.4L}{4} = 0.$

D. $-\frac{6L}{4} + \frac{24L}{4} - \frac{12L}{4} - \frac{8L}{4} \neq 0.$

22G) A



$-12+8+4=0.$

B

$$-8-4+\frac{4}{2}$$
$$-12+2\neq 0.$$

C $-4+8+\frac{12}{2}=-4+8+6.\neq 0.$

D $-8-6-4+\frac{36}{2}=-18+18=0.$

H) $(I,w),(2I,3w),(4I,-\frac{w}{2})$

$$L_i=-Iw+6Iw-\frac{4}{2}Iw \qquad I_f=I+2I+4I=7I$$

$$=-Iw-2Iw+6Iw$$

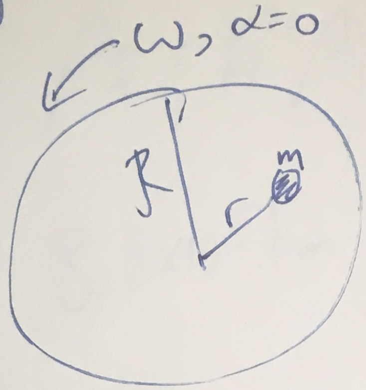
$$=-3Iw+6Iw$$

$$=\underline{3Iw}$$

$$L_f=7\cancel{I}\,w_{net}=3\cancel{I}w$$

$$w_{net}=\frac{3w}{7}$$

23A)



$$L_i = I\omega$$

$$L_f = (I + mr^2)\,\omega_f$$

$$I\omega = (I + mr^2)\,\omega_f$$

$$\omega_f = \frac{I\omega}{I + \underbrace{mr^2}}$$

$mr^2 \Rightarrow$ bigger = smaller ω_f

A $10 \cdot 0.5^2$, B $40 \cdot 0.25^2$, C $20 \cdot \cancel{0.25}\ 0.0625$, D $10 \cdot 0.0625$

2.5 $= 40 \cdot \cancel{0.25}\ 0.0625$ $= \cancel{10} = \cancel{5}$ $= \cancel{7.5}\ 2.5$, $= 1.25$, 0.625 ,

E 10 , F $15 \cdot 0.75^2 = 8.4375$

D C ~~B~~ A F E

B

2(1). $\rho_f = 10^{-14}\rho_i$ $\qquad \rho_f = \frac{m}{\frac{4}{3}\pi r_f^3}$

r_i 8.0×10^5 km, $r_f = 17$ km.

$$f_i = \frac{1\text{ cycle}}{35\text{ days}}$$

$$\omega_i = \frac{1\ \cancel{\text{cycle}}}{35\ \cancel{\text{days}}} \times \frac{2\pi r\ \text{m}}{\text{cycle}} \times \frac{1\ \text{days}}{24\cdot3600\ \text{s}}$$

$$\omega_i = \frac{\cancel{2\pi\ 8\times10^5\ 10^3}\quad 2\pi\,8\times10^5\,10^3}{35\cdot24\cdot3600}$$

$$I = \frac{2}{5}mr^2 \qquad \rho_f = \frac{3m_f}{4\pi r_f^3} \qquad \frac{\rho_f}{\rho_i} = 10^{14}$$

$$\rho_i = \frac{3m_i}{4\pi r_i^3} \qquad 10^{14} = \frac{m_f r_i^3}{m_i r_f^3}$$

$$\frac{\cancel{2}}{\cancel{5}} m_f r_f^2 \omega_f = \frac{\cancel{2}}{\cancel{5}} m_i r_i^2 \omega_i \qquad m_f = \frac{m_i r_f^3\, 10^{14}}{r_i^3}$$

$$\omega_f = \frac{m_i r_i^2 \omega_i}{m_f r_f^2} \quad \left[\frac{m_i}{m_f} = \frac{r_i^3}{r_f^3}10^{-14}\right] \Rightarrow \omega_f = \frac{r_i^5}{r_f^5}10^{-14}\omega_i$$