Question 8.1

A particle P is free to slide on a smooth, lightweight bar. The bar is free to rotate in a horizontal plane about a vertical axis passing through end O of the bar. A spring of stiffness k and unstretched length R_0 is connected between P and O. The spring is compressed to half of its unstretched length and released when the bar has a rotational speed of ω_1. After release, P reaches a position when the spring is unstretched. At this position, the rotational speed of the bar is ω_2.

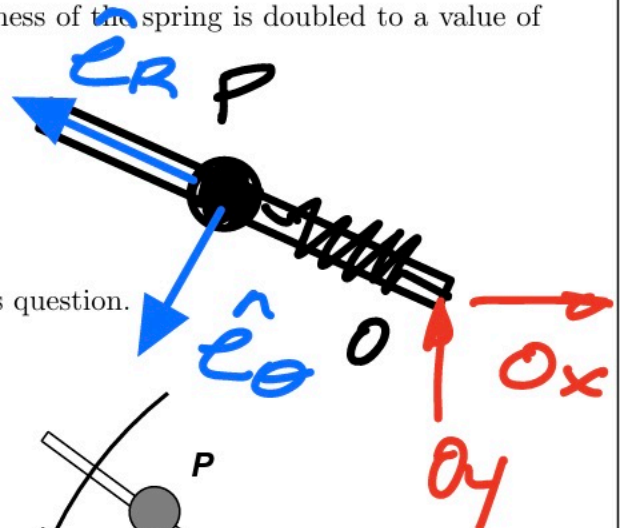
Suppose now the experiment is repeated except the stiffness of the spring is doubled to a value of $2k$. As a result of this change, the value of ω_2 is now:

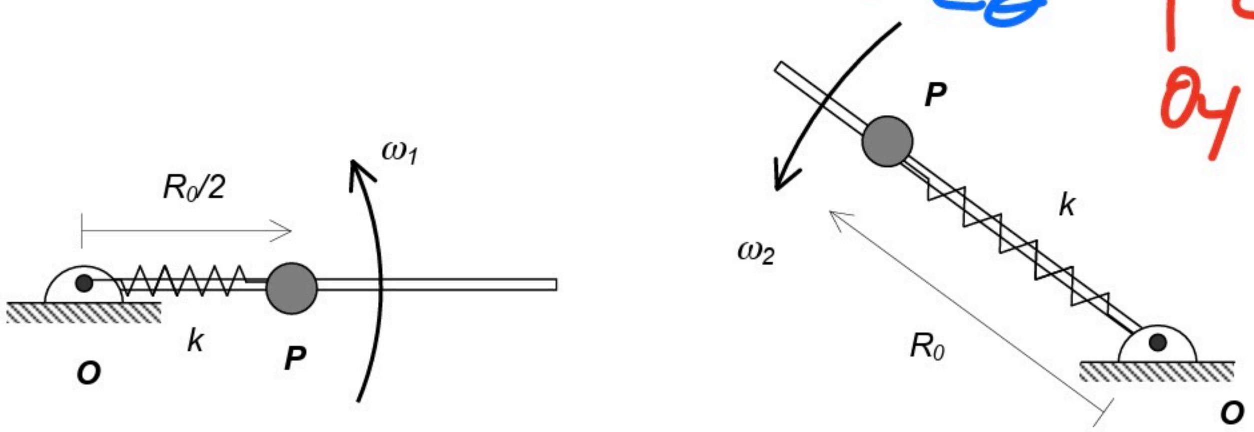
(a) Decreased

(b) The same

(c) Increased

(d) More information is needed in order to answer this question.





$$\sum \vec{M}_O = \vec{0} \Rightarrow \vec{H}_{O_1} = \vec{H}_{O_2}$$

w/ $\vec{H}_{O_1} = m\left(\frac{R_0}{2}\hat{e}_R\right)\times\left(\frac{R_0}{2}\omega_1\hat{e}_\theta\right)$

$= \frac{1}{4} m R_0^2 \omega_1 \hat{k}$

$\vec{H}_{O_2} = m(R_0\hat{e}_R)\times(\dot{R}_2\hat{e}_R + R_0\omega_2\hat{e}_\theta)$

$= m R_0^2 \omega_2 \hat{k}$

↳ $\frac{1}{4} m R_0^2 \omega_1 = m R_0^2 \omega_2$

↳ $\omega_2 = \frac{1}{4}\omega_1$ (ind. of k)

Question 8.2

Particle P (of mass m) is traveling on a smooth horizontal surface with a speed of v_1 and angle θ when it strikes a smooth wall. The coefficient of restitution between the wall and the particle is $0 < e < 1$. Circle the answer below that most accurately describes the angle ϕ at which the particle rebounds from the wall.

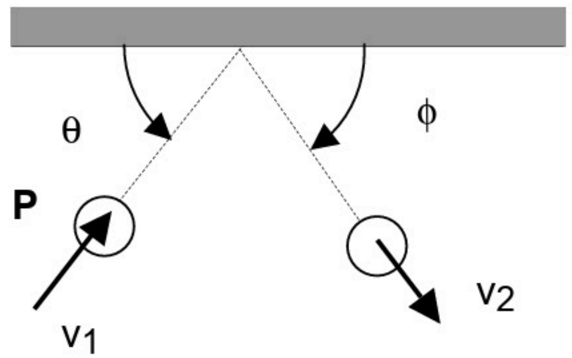
(a) $\phi < \theta$

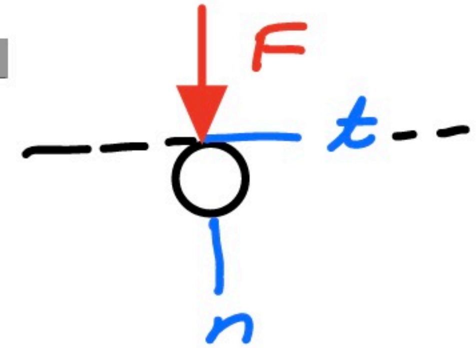
(b) $\phi = \theta$

(c) $\phi > \theta$

(d) $\phi = 0$

(e) $\phi = 90°$





$\sum F_t = 0 \Rightarrow v_{2t} = v_{1t} = v_1\cos\theta$

$e = -\frac{v_{2n}}{v_{1n}} = -\frac{v_{2n}}{-v_1\sin\theta} \Rightarrow v_{2n} = (e\sin\theta)v_1$

$\tan\phi = \frac{v_{2n}}{v_{2t}} = \frac{(e\sin\theta)v_1}{(\cos\theta)v_1}$

$= e\tan\theta$ ($e < 1$)

Question 8.3

Particles A and B are attached to a rigid bar with the bar being pinned to ground at point O. A bullet b strikes particle A and sticks. Consider a system made up of b, A, B and the rod. Circle all answers below that correctly describe this system during impact.

(a) linear momentum is conserved

(b) angular momentum about A is conserved

(c) angular momentum about O is conserved

(d) energy is conserved

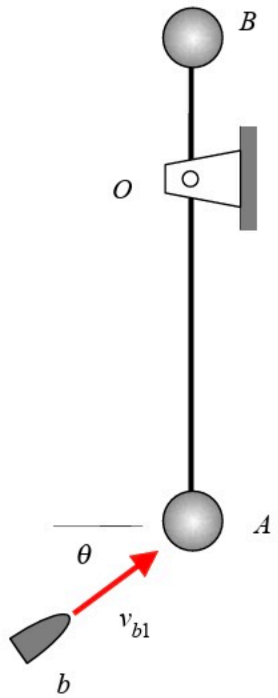
(e) none of the above

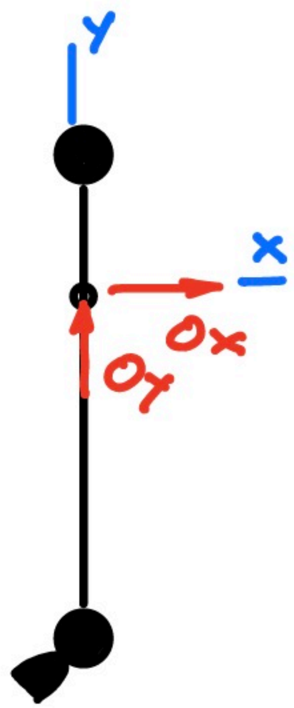
(a) $\Sigma F_x \neq 0$
$\Sigma F_y \neq 0$

(b) $\Sigma M_A \neq 0$

(c) $\Sigma M_O = 0$

(d) $e = 0$ $(e \neq 1)$





Question 8.4

In System A shown below on the left, particle P is connected to a pin joint at O with a lightweight, rigid bar of length L. Bullet b impacts the stationary particle P with a speed of v_1, and after impact the bullet sticks to P. System B is identical to System A except the rigid bar is replaced by an inextensible string of length L. Let $(v_{1,min})_A$ represent the minimum value of v_1 that is required for particle P in System A to reach position 2, a position where P is at a distance of L immediately above O. Let $(v_{1,min})_B$ represent the minimum value of v_1 that is required for P in System B to reach position 2. Circle the response below that most accurately describes the relative magnitudes of $(v_{1,min})_A$ and $(v_{1,min})_B$:

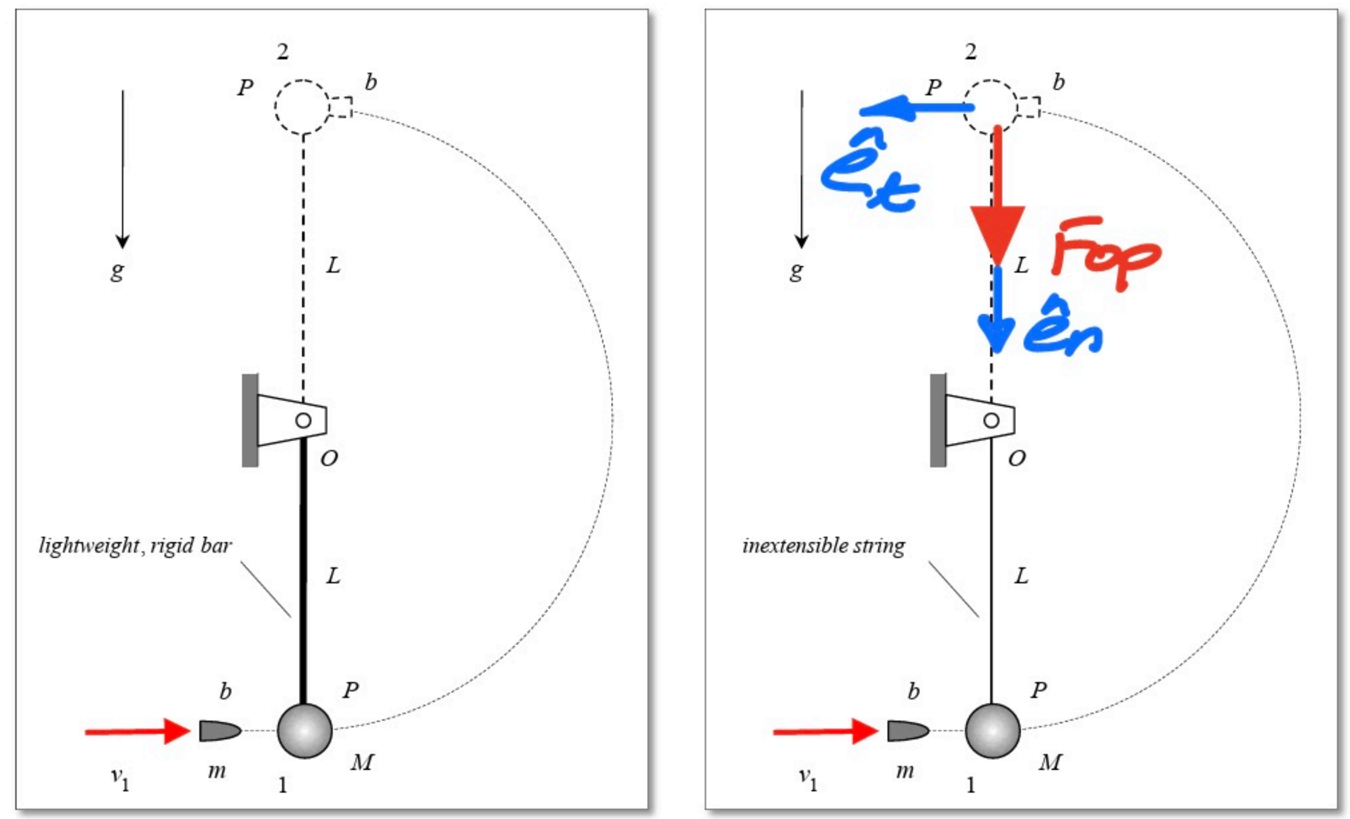
(a) $(v_{1,min})_A > (v_{1,min})_B$

(b) $(v_{1,min})_A = (v_{1,min})_B$

(c) $(v_{1,min})_A < (v_{1,min})_B$

Justify your response with equations and/or words.

$\Sigma F_n = F_{op} + mg$
$= m \frac{v_2^2}{\rho}$
$\rightarrow V_{2min} = \sqrt{Lg}$



System A System B

A: Minimum speed at top $= 0$

B: Minimum speed at top $= \sqrt{Lg}$