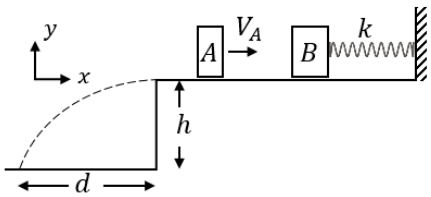
Group Number		Name		Type
List Number		Surname		A
Student ID		Signature		
e-mail				

ATTENTION: There is normally only one correct answer for each question and each correct answer is equal to 1 point. Only the answers on your answer sheet form will be evaluated. Please be sure that you have marked all of your answers on the answer sheet form by using a pencil (*not* pen).

Questions 1-5

Block A of mass 0.20 kg sliding to the right over a frictionless elevated surface at a speed of 8.0 m/s. It undergoes an elastic collision with stationary block B, which is attached to a spring of spring constant 2160 N/m. (Assume that the spring does not affect the collision.) After the collision, block B oscillates in SHM with a period of 0.1 s, and block A slides off the opposite end of the elevated surface, landing a distance d from the base of that surface after falling a height $h = 5.0$ m. ($\pi = 3$, g=10 m/s^2)



1. What is the mass of block B?
(a) 0.7 kg (b) 0.4 kg (c) 0.6 kg (d) 0.5 kg (e) 1.0 kg

2. What are the velocities V_{Af} and V_{Bf} of the blocks in m/s, immediately after the collision? (Again, assume that the spring does not affect the collision and the collison is elastic.)
(a) V_{Af}=$-1.5\hat{\imath}$, V_{Bf}=$0.5\hat{\imath}$ (b) V_{Af}=$-4.0\hat{\imath}$, V_{Bf}=$4.0\hat{\imath}$ (c) V_{Af}=$4.0\hat{\imath}$, V_{Bf}=$1.5\hat{\imath}$ (d) V_{Af}=$-4.0\hat{\imath}$, V_{Bf}=$1.0\hat{\imath}$ (e) V_{Af}=$0.5\hat{\imath}$, V_{Bf}=$4.0\hat{\imath}$

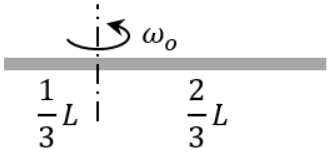
3. What is the value of d?
(a) 5.0 m (b) 1.5 m (c) 2.5 m (d) 4.0 m (e) 0.5 m

4. What is the maximum acceleration of block B?
(a) 240 m/s^2 (b) 120 m/s^2 (c) 160 m/s^2 (d) 100 m/s^2 (e) 80 m/s^2

5. Now, consider a different situation. Block B is replaced by a 0.2 kg mass and the spring is replaced by a spring with k= 40 N/m. Assume that the collision is completely inelastic, so that after the collision the two blocks stick together. What is the amplitude of the new oscillation?
(a) 0.15 m (b) 0.2 m (c) 0.4 m (d) 0.3 m (e) 0.1 m

Questions 6-10

A homogeneous rod with a length L =3 m and mass m = 2 kg rotates on a flat, frictionless surface with an angular velocity ω_0=3 rad/s around a vertical axis at a distance $L/3$ from one side, as shown in figure. $I_{cm} = \frac{1}{12}ML^2$



6. What is the moment of inertia of the rod with respect to the rotation axis?
(a) 1/2 kg m^2 (b) 2/3 kg m^2 (c) 2 kg m^2 (d) 3/2 kg m^2 (e) 1/4 kg m^2

7. What is the magnitude of the angular momentum of the rod?
(a) 6 m^2/s (b) 2 m^2/s (c) 2/3 m^2/s (d) 3 m^2/s (e) 1/6 m^2/s

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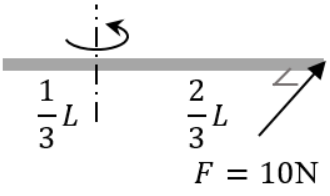
If a force F=10 N is applied, during 3 s, perpendicular to the far end of the long leg of the rod, as in the second figure, so as to increase the angular velocity of the rod.



8. What will be the final angular momentum of the rod?
(a) 36 m^2/s (b) 60 m^2/s (c) 16 m^2/s (d) 30 m^2/s (e) 66 m^2/s

9. What is the angular velocity of the rod after 3 s?
(a) 18 rad/s (b) 33 rad/s (c) 8 rad/s (d) 30 rad/s (e) 15 rad/s

10. What is the linear velocity of the end point of the short edge of the rod after 3 s?
(a) 8 m/s (b) 30 m/s (c) 15 m/s (d) 33 m/s (e) 18 m/s

Questions 11-13

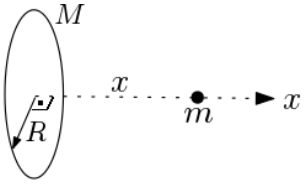
A solid sphere of radius R and mass M starts from rest and rolls without slipping down a θ incline that has a length of l . ($I_{cm} = \frac{2}{5}MR^2$ $g = 10$ m/s^2)

11. What is the speed of its center of mass (v_{cm}) when it reaches the bottom of the inclined?
(a) $\sqrt{\frac{9}{5}gl\sin\theta}$ (b) $\sqrt{\frac{2}{5}gl\sin\theta}$ (c) $\sqrt{\frac{10}{7}gl\sin\theta}$ (d) $\sqrt{\frac{2}{7}gl\sin\theta}$ (e) $\sqrt{\frac{5}{7}gl\sin\theta}$

12. What is the acceleration of the center of mass (a_{cm}) of the sphere?
(a) $\frac{5}{7}g\sin\theta$ (b) $\frac{7}{9}g\sin\theta$ (c) $\frac{2}{7}g\sin\theta$ (d) $\frac{5}{9}g\sin\theta$ (e) $\frac{2}{5}g\sin\theta$

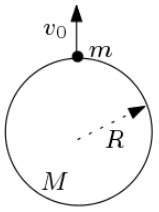
13. What is the friction force acting on the sphere?
(a) $\frac{2}{5}mg\sin\theta$ (b) $\frac{5}{7}mg\sin\theta$ (c) $\frac{9}{7}mg\sin\theta$ (d) $\frac{2}{7}mg\sin\theta$ (e) $\frac{5}{9}mg\sin\theta$

14. Which of the following is the gravitational potential energy of the system, shown in the figure? The circular wire has a uniform density.
(a) $-\frac{GMm}{\sqrt{R^2+x^2}}$ (b) $-\frac{3GMm}{2\sqrt{R^2+x^2}}$ (c) $\frac{GMm}{2\sqrt{R^2+x^2}}$ (d) $\frac{GMm}{\sqrt{R^2+x^2}}$ (e) $-\frac{GMm}{2\sqrt{R^2+x^2}}$



15. Which of the following is the force on the point mass m?
(a) $-\frac{2GMmx}{5(R^2+x^2)^{3/2}}\hat{i}$ (b) $-\frac{GMmx}{(R^2+x^2)^{3/2}}\hat{i}$ (c) $-\frac{2GMmx}{3(R^2+x^2)^{3/2}}\hat{i}$ (d) $-\frac{GMmx}{2(R^2+x^2)^{3/2}}\hat{i}$
(e) $-\frac{GMmx}{3(R^2+x^2)^{3/2}}\hat{i}$

16. An object of mass m is thrown in the upward direction with a speed $v_0 = \sqrt{\frac{3GM}{2R}}$ on a planet of mass M and radius R, as shown in the figure. Assume that the density of the planet is constant, it is a perfect sphere, and it is not rotating. What is the speed of the object at an altitude R?
(a) $\sqrt{\frac{GM}{3R}}$ (b) $\sqrt{\frac{GM}{2R}}$ (c) $\sqrt{\frac{2GM}{3R}}$ (d) $\sqrt{\frac{3GM}{4R}}$ (e) $\sqrt{\frac{GM}{4R}}$



17. Which of the following is the expression giving the time to reach for this object to the altitude R?
(a) $\int_R^{2R}\frac{dr}{\sqrt{2Gm\left(\frac{1}{r}-\frac{1}{4R}\right)}}$ (b) $\int_0^{2R}\frac{dr}{\sqrt{2GM\left(\frac{1}{r}-\frac{1}{4R}\right)}}$ (c) $\int_R^{2R}\frac{dr}{\sqrt{2Gm\left(\frac{1}{r}-\frac{1}{2R}\right)}}$
(d) $\int_0^{2R}\frac{dr}{\sqrt{2GM\left(\frac{1}{r}-\frac{1}{2R}\right)}}$ (e) $\int_R^{2R}\frac{dr}{\sqrt{2GM\left(\frac{1}{r}-\frac{1}{4R}\right)}}$

Questions 18-20

A physical pendulum of 3 kg oscillates at small angle around an axis at a distant of h=0.8 m to it center of gravity. It's moment of inertia is I=1.2 kg m^2 with respect to the oscillation axis. (g=10 m/s^2)

18. What is the length of a 1.5 kg simple pendulum that has the same period for small amplitude oscillations?
(a) 1 m (b) $\sqrt{5}/2$ m (c) 0.2 $\sqrt{2}$ m (d) 0.5 m (e) 2 $\sqrt{2}$ m

19. Find the maximum value of the angular acceleration if the amplitude of the oscillation is 0.5 rad.
(a) 1/10 rad/s^2 (b) $2\sqrt{5}$ rad/s^2 (c) 2 rad/s^2 (d) 1/20 rad/s^2 (e) 10 rad/s^2

20. What is the angular acceleration as the pendulum passed through the equilibrium position?
(a) 1/10 rad/s^2 (b) 10 rad/s^2 (c) 20 $\sqrt{2}$ rad/s^2 (d) 1/10 $\sqrt{5}$ rad/s^2 (e) 0 rad/s^2