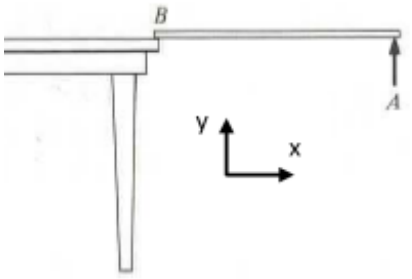
Group Number		Name		Type
List Number		Surname		A
Student ID		Signature		
e-mail				

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 1-4

A uniform stick of mass m and length l is suspended horizontally with end B at the edge of a table and the other end A is held by hand. Point A is suddenly released. At the instant after release:



1. What is the torque about the end B on the table?
(a) $\frac{l}{2}mg(\hat{i}+\hat{j})$ (b) 0 (c) $lmg\hat{k}$ (d) $-\frac{3}{2}mg\hat{k}$ (e) $-\frac{l}{2}mg\hat{k}$

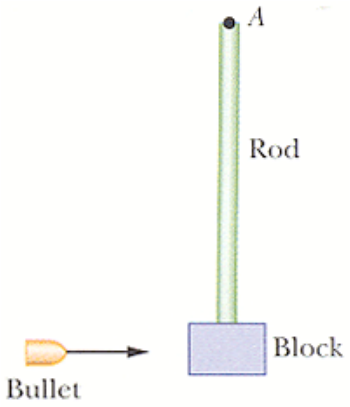
2. What is the angular acceleration about the end B on the table? (For a uniform rod of mass m and length l, $I_{cm}=\frac{1}{12}ml^2$.)
(a) $\frac{2g}{3l}$ (b) $\frac{g}{l}$ (c) $\frac{2g}{l}$ (d) $\frac{3g}{2l}$ (e) $\frac{g}{2l}$

3. What is the vertical acceleration of the center of mass?
(a) g (b) $\frac{4g}{3}$ (c) $\frac{3g}{4}$ (d) $\frac{3g}{2}$ (e) $\frac{2g}{3}$

4. What is the vertical component of the hinge force at B?
(a) $\frac{mg}{3}$ (b) mg (c) $\frac{2mg}{3}$ (d) $\frac{mg}{2}$ (e) $\frac{mg}{4}$

Questions 5-7

A bullet of mass m is fired into a block of mass M_b that is mounted on the end of a nonuniform rod of total mass M and length l. Linear mass density of the rod is $\lambda = c\,y$ where c is a constant and y is the distance from the point A.



5. Find the constant c in terms of M and length l.
(a) $\frac{M}{l}$ (b) $\frac{2\,M}{l^2}$ (c) $\frac{3\,M}{2\,l^2}$ (d) $\frac{M}{l^2}$ (e) $\frac{2\,M}{3\,l^2}$

6. The block-rod-bullet system then rotates about a fixed axis at point A. Assume the block is small enough to treat as a particle on the end of the rod. What is the rotational inertia of the block-rod-bullet system about point A?
(a) $(3M/2+m+M_b)l^2$ (b) $(2M/3+m+M_b)l^2$ (c) $(M/2+m+M_b)l^2$
(d) $(M/3+m+M_b)l^2$ (e) $(2M+m+M_b)l^2$

7. Now assume that the rod has a constant density and total mass M. If the velocity of the bullet before collision is v, find the angular speed of the rod-bullet-block system about point A after collisin. (For a uniform rod of mass m and length l, $I_{cm}=\frac{1}{12}ml^2$.)
(a) $\frac{mv}{(M+m+M_b)l/12}$ (b) $\frac{mv}{(M+m+M_b)l/3}$ (c) $\frac{mv}{(M/2+m+M_b)l}$ (d) $\frac{mv}{(M/12+m+M_b)l}$ (e) $\frac{mv}{(M/3+m+M_b)l}$

8. Find the ratio of final kinetic energy of the rod-bullet-block system just after the collision to the initial kinetic energy of the bullet just before the collision.
(a) $\frac{m}{M+m+M_b}$ (b) $\frac{m}{M/3+m+M_b}$ (c) $\frac{3m}{M+m+M_b}$ (d) $\frac{m}{M/12+m+M_b}$ (e) $\frac{12m}{M+m+M_b}$

Questions 9-10

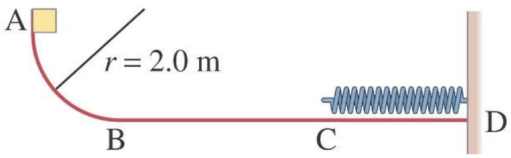
A body of mass 10.0 kg makes an elastic collision with another body at rest and continues to move in the original direction but one-third of its original speed.

9. What is the mass of the other body which is initially at rest?
(a) $5.0kg$ (b) $8.0kg$ (c) $15.0kg$ (d) $10.0kg$ (e) $3.0kg$

10. What is the speed of the two-body center of mass if the initial speed of the 10.0 kg body was 4.5 m/s?
(a) $4.5m/s$ (b) $3.0m/s$ (c) $2.5m/s$ (d) $3.5m/s$ (e) $4.0m/s$

Questions 11-14

Consider the track shown in the figure. The section AB is one quadrant of a circle of radius 2.0 m and is frictionless. B to C is a horizontal span that is 3.0 m long with a coefficient of kinetic friction $\mu_k = 0.25$. The section CD under the spring is frictionless. A block of mass 1.0 kg is released from rest at A. After sliding on the track, it compresses the spring by 0.20 m. Take the gravitational acceleration as $g = 10 m/s^2$



11. What is the velocity of the block at point B?

(a) $2\sqrt{10}$ m/s (b) $2\sqrt{5}$ m/s (c) $4\sqrt{5}$ m/s (d) $\sqrt{10}$ m/s (e) $3\sqrt{10}$ m/s

12. What is the thermal energy produced as the block slides from B to C?

(a) 2.5 J (b) 0 J (c) 3 J (d) 5 J (e) 7.5 J

13. What is the the velocity of the block at point C?

(a) 10 m/s (b) 5 m/s (c) 4 m/s (d) 2 m/s (e) 6 m/s

14. What is the stiffness constant k for the spring?

(a) 625 N/m (b) 250 N/m (c) 750 N/m (d) 25 N/m (e) 500 N/m

Questions 15-16

A mass m is on a platform of mass M and height H. A spring with spring constant k, with one end fixed to the platform is used to launch the small mass horizontally. The platform is on a frictionless table, and the friction between the mass and the platform is also negligible. Initially the spring is compressed by an amount d from its natural length, and both the mass and the platform are at rest. Then the system is released.

15. What are the velocities of the mass m, $\vec{v}_m$ and of the platform, $\vec{v}_P$ at the instant the mass leaves the platform.

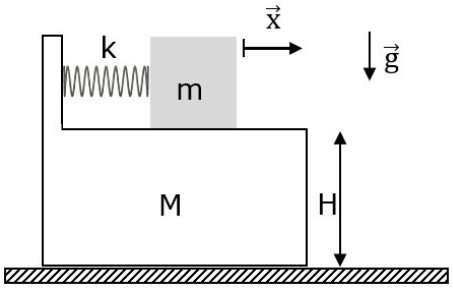
(a) $\vec{v}_m = d\sqrt{\frac{2Mk}{m(m+M)}}\hat{i}\,, \qquad \vec{v}_P = -d\sqrt{\frac{2mk}{M(m+M)}}\hat{i}$

(b) $\vec{v}_m = d\sqrt{\frac{mk}{M(m+M)}}\hat{i}\,, \qquad \vec{v}_P = -d\sqrt{\frac{Mk}{m(m+M)}}\hat{i}$

(c) $\vec{v}_m = d\sqrt{\frac{mk}{2M(m+M)}}\hat{i}\,, \qquad \vec{v}_P = -d\sqrt{\frac{2Mk}{m(m+M)}}\hat{i}$

(d) $\vec{v}_m = d\sqrt{\frac{Mk}{m(m+M)}}\hat{i}\,, \qquad \vec{v}_P = -d\sqrt{\frac{mk}{M(m+M)}}\hat{i}$

(e) $\vec{v}_m = d\sqrt{\frac{k}{m+M}}\hat{i}\,, \qquad \vec{v}_P = -d\sqrt{\frac{k}{m+M}}\hat{i}$



16. What is the distance between the mass and the platform when the mass hits the floor.

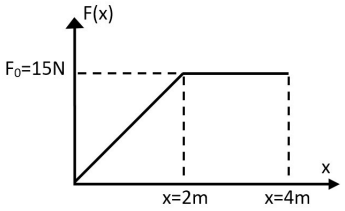
(a) $d\sqrt{\frac{2Hk(m+M)}{mMg}}$ (b) $d\sqrt{\frac{2MHk}{m(m+M)g}}$ (c) $d\sqrt{\frac{4Hk(m+M)}{mMg}}$ (d) $d\sqrt{\frac{Hk}{Mg}}$ (e) $d\sqrt{\frac{2mHk}{M(m+M)g}}$

Questions 17-20

A block of mass $m = 2\ kg$ is moving under the effect of a 1-dimensional force F(x) between $x = 0$ and $x = 4\ m$. The graph of the force as a function of position is given in the figure.

17. What is the work done by F between $x = 0$ and $x = 4\ m$.

(a) 40 J (b) 42 J (c) 50 J (d) 45 J (e) 35 J



18. If $F(x)$ is a conservative force, which of the following is the potential energy function between $x = 0$ and $x = 2\ m$ in units of joules, taking $U(0) = 2\ J$?

(a) $2 + \frac{15}{2}x^2$ (b) $2 + \frac{15}{2}x$ (c) $2 - \frac{15}{4}x$ (d) $2 - \frac{15}{4}x^2$ (e) $2 + \frac{15}{4}x^2$

19. If the block is initially at rest at $x = 0$, what is the speed of the block at $x = 2\ m$ in units of m/s?

(a) $2\sqrt{15}$ (b) $2\sqrt{30}$ (c) $\sqrt{15}$ (d) $\sqrt{30}$ (e) $3\sqrt{15}$

20. If there is friction between $x = 2\ m$ and $x = 4\ m$ with coefficient of kinetic friction $\mu_k = 0.2$, what is the speed of the block at $x = 4\ m$ in units of m/s?

(a) $\sqrt{39}$ (b) 7 (c) $\sqrt{37}$ (d) $\sqrt{41}$ (e) 6