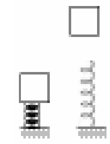
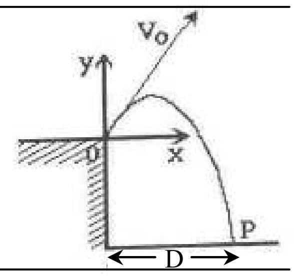
Part I: Questions (Choose the correct answer)

1. A mass m is placed on a vertical spring of spring constant k compressed a distance x. When the spring is released the mass is projected upward . The acceleration of this mass at maximum height is

a. zero b. g (c.) −g d. $\frac{kx}{m}$



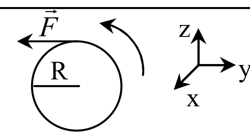
2. A Projectile is fired from point 0 at the edge of a cliff, with initial velocity components of v_{ox} and v_{oy} . The projectile rises, then falls into the sea at point P. If the time of flight of the projectile is T. then the horizontal distance D (see the figure) is



a. v_0T b. $v_{oy}T$ c. ½ g T^2 (d.) v_{ox} T

3. The torque exerted on the disk about an axis passing by the center is (see figure)

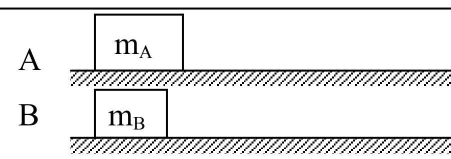
a. $-FR\hat{i}$ b. $FR\hat{j}$ (c.) $FR\hat{i}$ d. $FR\hat{k}$



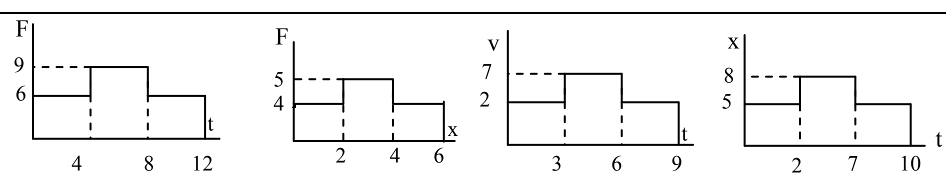
4. The surfaces A and B are rough and $\mu_A = 4\ \mu_B$. If $m_A = 2m_B$, and both blocks come to a stop after covering the same distance then their initial velocities are related by.

a. $V_A = V_B$ (b.) $V_A = 2V_B$

c. $V_A = \frac{1}{2}V_B$ d. $V_A = 4V_B$



5. Let F be in Newton, v in meter per second, x in meter and t in seconds. The impulse is the area under which curve?



(a) (b) (c) (d)

Part II: Problems (solve the following problems)

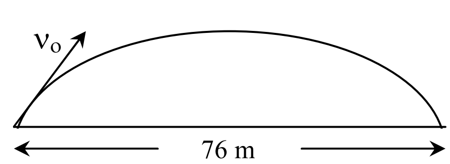
1. A projectile is projected with speed v_o from the ground level. It returns to the ground after 4.0 seconds. It travels 76 meters horizontally. If air resistance is neglected, what is the initial speed v_o?

$v_{ox} = \frac{76}{4} = 19\,m/s$

$\Delta y = v_{oy}\,t - \frac{1}{2}g t^2 \Rightarrow 0 = v_{oy}(4) - \frac{1}{2}(10)(4)^2$

$v_{oy} = 20\,m/s$

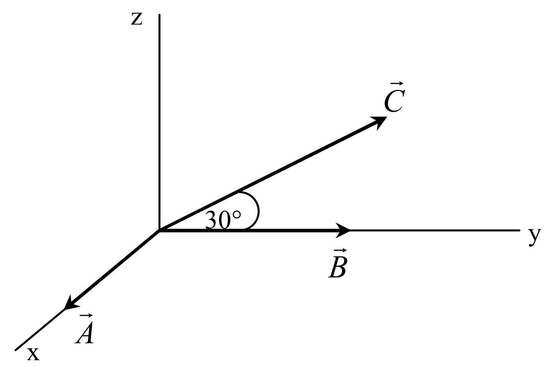
$v_o = \sqrt{(19)^2 + (20)^2} = 27.6 \approx 28\,m/s$



2. $\vec{A}, \vec{B}$ and $\vec{C}$ are three vectors of equal magnitude A=B=C= 4 units. $\vec{A}$ points to the positive x-direction and $\vec{B}$ points to the positive y directions. Vector $\vec{C}$ is perpendicular to vector $\vec{A}$ and makes an angle 30° with $\vec{B}$ as shown in the figure.

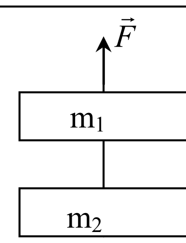
Find $\left(\vec{B}\,\mathrm{X}\vec{C}\right)\cdot\vec{A}$. Hint C_x= 0.

$$\vec{A}=4\hat{i},\quad \vec{B}=4\hat{j},\quad \vec{C}=4\cos 30\,\hat{j}+4\sin 30\,\hat{k}$$
$$\vec{B}\times\vec{C}=8\,\hat{j}\times\hat{k}=8\,\hat{i}$$
$$\left(\vec{B}\times\vec{C}\right)\cdot\vec{A}=8(4)=32$$



3. Two blocks m_1 =0.30 kg and m_2 =0.20 kg are connected by a string, as shown In the figure , and the upper block is pulled upward by a force $\vec{F}$ of magnitude 10 N. Find the tension (in N) in the string between the two blocks

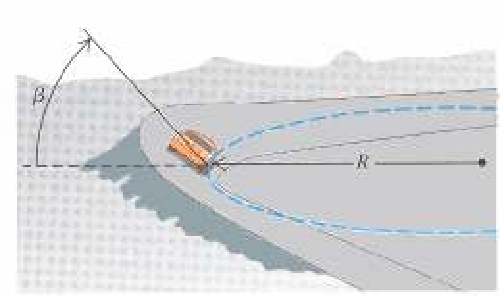
$$a=\frac{F-(m_1+m_2)g}{m_1+m_2}=\frac{10-(0.3+0.2)10}{(0.3+0.2)}$$
$$a=10\,m/s^2$$
$$T-m_2g=m_2\,a$$
$$T=m_2\,(g+a)=0.2(10+10)=4\,N$$



4. A road way is designed for traffic moving, at a speed of 72 km/h. A curved section of the roadway is a circular arc of 120 m radius. The roadway is banked – so that a vehicle can go around the curve. Find the angle β (in degree) at which the roadway is banked (ignore friction)

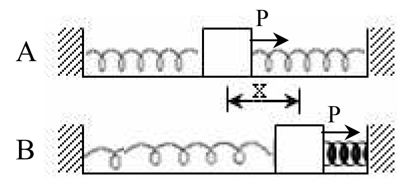
$$N\sin\theta=\frac{mv^2}{r}$$
$$N\cos\theta=mg$$
dividing

$$\tan\theta=\frac{v^2}{gr}\ \Rightarrow \theta=\tan^{-1}\frac{\left(\frac{72}{3.6}\right)^2}{10(120)}=18°$$



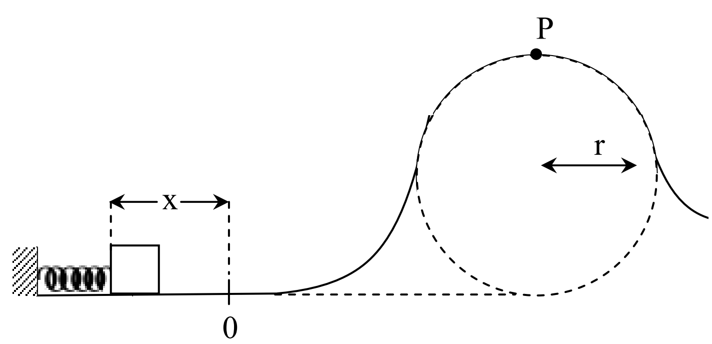
5. Two identical springs have force constants of 600 N/m. The springs are attached to a small cube as in figure A. An external force P pulls the cube a distance x = 0.20 m to the right and holds it there. (see fig.B) Find the work done(in J) by the external force P in pulling the cube 0.2 m:

$$W_P = 2\left(\frac{1}{2}kx^2\right)$$
$$W_P = 600(0.2)^2$$
$$W_P = 24\,J$$



6. A block of mass 0.50 kg is compressed a distance 0.40 m against a spring of force constant 400 N/m. When the spring is released the block moves up a frictionless circular surface of radius 2.9m (see figure). Find the apparent weight (in N) of the block at the top of the circular path. (point P)

$$E_1 = E_F$$
$$\frac{1}{2}kx^2 = mg(2r) + \frac{1}{2}mv^2 \Rightarrow mv^2 = kx^2 - 4mgr$$
$$mv^2 = (400)(0.4)^2 - 4(0.5)(10)(2.9)$$
$$mv^2 = 6$$
$$mg - N = \frac{mv^2}{r}$$
$$0.5(10) - N = \frac{6}{2.9}$$
$$N = 2.93\,N$$



7. A ball m_1= 0.4 kg moving with a speed of 2 m/s undergoes a head on elastic collision with another ball m_2= 1.6 kg moving in the opposite direction with a speed 3 m/s. Find the final velocity of ball m_1 (in m/s)

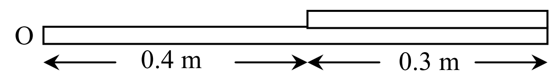
$$v_{1i} - v_{2i} = -(v_{1f} - v_{2f})$$
$$2 + 3 = v_{2f} - v_{1f} \Rightarrow v_{2f} = (5 + v_{1f})$$
$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$
$$(0.4)(2) + (1.6)(-3) = 0.4v_{1f} + 1.6v_{2f}$$
$$.8 - 4.8 = 0.4v_{1f} + 1.6(5 + v_{1f})$$
$$-4 = 0.4v_{1f} + 8 + 1.6v_{1f}$$
$$-4 - 8 = 2v_{1f}$$
$$v_{if} = -6\,m/s$$

Another Solution

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2}v_{1i} + \frac{2m_2}{m_1 + m_2}v_{2i}$$
$$v_{1f} = \frac{0.4 - 1.2}{2}\,2 + \frac{2(1.6)}{2}(-3)$$
$$v_{1f} = -6\,m/s$$

8. A uniform thin rod of length 1 m is folded at one end as shown in figure. Find the distance of the center of mass measured from point O. (in m)

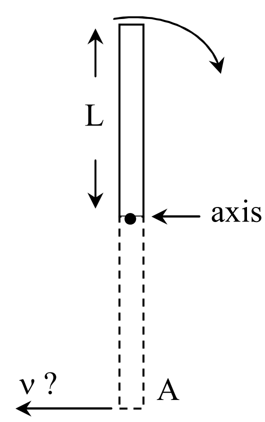
$$(m_1+m_2)x_{CM}=m_1x_1+m_2x_2$$
$$(0.4+0.6)x_{CM}=0.4(0.2)+0.6(0.55)$$
$$x_{CM}=0.42\,m$$



9. A rod of length 60 cm and mass of 1.2 kg rotates from rest about one end as shown in the figure. Find the linear speed (in m/s) of the far end (A) at the lowest position.

($I_{CM}=\frac{1}{12}ML^2$)

$$I=\frac{1}{12}ML^2+M\left(\frac{L}{2}\right)^2=\frac{1}{3}ML^2$$
$$W=\Delta K$$
$$MgL=\frac{1}{2}I\omega^2$$
$$MgL=\frac{1}{2}\left(\frac{1}{3}ML^2\right)\frac{v^2}{L^2}\Rightarrow v=\sqrt{6gL}=\sqrt{6(10)(0.6)}$$
$$v=6\,m/s$$



10. A block m_1=2.0 kg is placed on a frictionless 30° incline and connected to another block m_2 = 6 kg by a light string as shown in the figures. The pulley has a moment of inertia 0.40 kg m^2 and radius 0.2 m It rotates as the block m_2 falls down. Find the acceleration of m_1. (in m/s^2)

$$T_1-m_1g\sin\theta=m_1a$$
$$m_2g-T_2=m_2a$$
$$T_2-T_1=\frac{I}{R^2}a$$
adding
$$m_2g-m_1g\sin\theta=\left(m_1+m_2+\frac{I}{R^2}\right)a$$
$$6(10)-2(10)(0.5)=\left[2+6+\frac{0.40}{(2)^2}\right]a$$
$$a=2.78\,m/s^2$$