Kuwait University **Physics Department**

Physics 101
Final Examination
January 10, 2002
Thursday, 11:00 AM – 1:00 PM

Name:……………………………… Student Number:…………………

Instructor's Name:

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For use by Instructors only

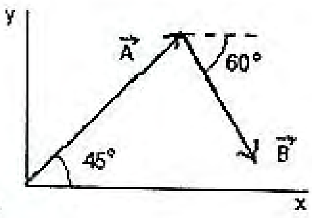
Problem	1	2	3	4	5	6	7	8	9	Total
Marks										

1- Answer all questions
2- The solution should be given explicitly for each problem
3- No. solution = no grade.
4- Check the correct answer for each question.
5- Take g=10 m/s^2.

P1 In the diagram, $\vec{A}$ has magnitude 12 and $\vec{B}$ has magnitude 8. The y component of $\vec{A} + \vec{B}$ is

A) 15.60 B) 12.50 $\boxed{\text{C) 1.56}}$ D) –12.5 E) other

We need to calculate the y- component only of $\vec{A}+\vec{B}$.



So we need $A_y + B_y$ only

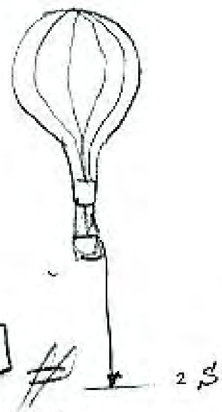
$$A_y = A\sin 45° = (12)(.707) = 8.48$$

$$B_y = -B\sin 60° = (8)(.866) = -6.93$$

$$\therefore A_y + B_y = 8.48 - 6.93 = \boxed{1.55} \quad \#$$

P2 A stone is released from a balloon that is descending at a constant speed of 10 m/s. Neglecting air resistance, after 2 s the speed of the stone is:

A) 10 m/s $\boxed{\text{B) 30 m/s}}$ C) 20 m/s D) 19 m/s E) other



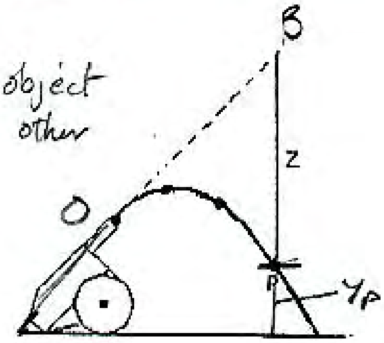
Solution The movement of the balloon will effect the initial motion of the stone. Therefore we solve this problem as if we through a stone from a clif with initial velocity $v_0 = 10\,m/s$. So we can use the free-fall equation:

$$\Rightarrow v = v_0 - gt = -10 - (10)(2) = -30\ m/s \text{ downward}$$

But we want the speed and not the velocity $\Rightarrow \boxed{30\ m/s}$ #

P3 A cannon fires a projectile as shown. After 3 seconds the particle reaches point P. The dashed line shows the trajectory of the particle in the absence of gravity. The height Z is:

A) 15m $\boxed{\text{B) 45m}}$ C) 90m D) 30m E) other



we slove this problem as if we project two object in the same time one will go straight and the other will flow the path as shown due to gravity

– Both will have the same time.

$\Rightarrow$ for first object from O to B

$$Z + Y_P = v_{oy}t \quad ---- \ (1)$$

for the second objet from O to P

$$Y_P = v_{oy}t - \tfrac{1}{2}gt^2 \quad --- \ (2)$$

from (1) and (2)

$$Y_P = Z + Y_P - \tfrac{1}{2}gt^2$$

$$-Z = -\tfrac{1}{2}gt^2 \Rightarrow Z = \tfrac{1}{2}gt^2$$

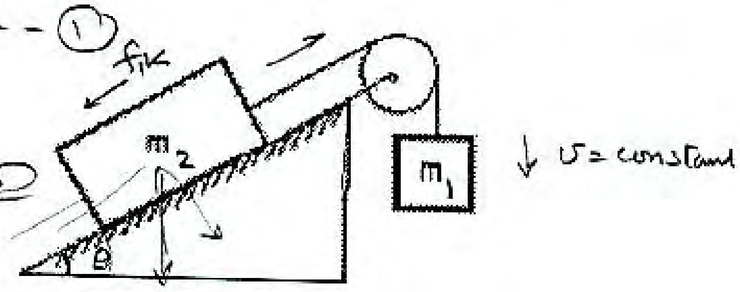
$$= \tfrac{1}{2}(10)(3)^2 = \boxed{45\,m}$$

P4 In the system shown, the mass m is 0.5 kg and the plane is inclined at an angle $\theta = 37^{\circ}$. Thee force of friction between the upper block and the plane is:

A) 1 N B) 2 N C) 3 N D) 4 N E) 5 N

Solution

for $m_1 \Rightarrow m_1 g - T = m \cancel{a}$ (zero) ---- ①



and for $m_2 \Rightarrow$

$T - m_2 g \sin 37° - f_K = m_2 a$ ---- ②

We know that

$m_1 = m_2$ and $a = $ zero

$\therefore$ from equation ① $T = mg$

and from equation ② $mg - mg \sin 37° - f_K =$ zero

$\therefore f_K = mg - mg \sin 37° = mg(1 - \sin 37°)$

$= (.5)(10)[1 - .6] = \boxed{2\,N}$ #

P5 A man pulls a 2-kg box up a frictionless 30° slope 15 m high from the bottom as shown. If the box moves at constant speed, then the work done by the man is:

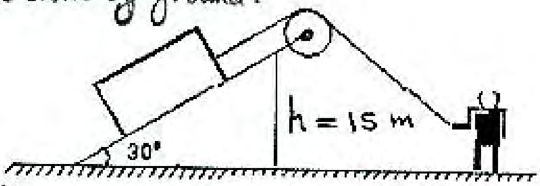
$\boxed{\text{A) } 300}$ B) 150 C) zero D) -150 E) -300

Work done by the man = − work done by ground.

$W_{man} = -W_g$

$W_g = mgh$

$= (2)(10)(-15) = -300\,N.m$



$\therefore W_m = -(-300)\,N.m = \boxed{+300\,N.m}$ #

P6 When a certain rubber band is stretched a distance x, it exerts a restoring force $F = ax + bx^2$, where a and b are constants. The work done in stretching this rubber band from x = 0 to x = L is:

A) $aL^2 + bLx^3$
B) $aL + 2bL^2$
C) $a + 2bL$
D) bL
$\boxed{\text{E) } aL^2/2 + bL^3/3}$

Solution

$F = ax + bx^2$

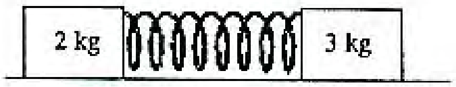
$\therefore W_F = \int F.dx = \int_0^L ax + bx^2 = \left[\frac{ax^2}{2} + \frac{b}{3}x^3\right]_0^L$

$= \boxed{\frac{aL^2}{2} + \frac{bL^3}{3}}$ #

P7 Two blocks with masses 2.0 kg and 3.0 kg are placed on horizontal frictionless surface. The blocks are compressed against a light spring and brought to rest. The blocks are then released and the spring reached its relaxation state. At this state, the 3.0 kg mass has a speed of 2.0 m/s. How much potential energy was initially stored in the spring?.

A) 15 J B) 3.0 J C) 6.0 J D) 12 J E) 9.0 J

Solution



$$\vec{P}_i = \vec{P}_f$$

$$0 + 0 = m_1 v_{1f} + m_2 v_{2f}$$

$$0 = 2 v_{1f} + 3(-2)$$

$$\boxed{v_{1f} = -3\ m/s}$$

$$E_i = E_f \Rightarrow K_i + U_{si} = K_f + U_{sf}$$

$$0 + U_{si} = K_f + 0$$

$$\therefore U_{si} = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

$$= \frac{1}{2}(2)(-3)^2 + \frac{1}{2}(3)(-2)^2$$

$$= 9 + 6 = \boxed{15\ J}$$

P8 A billiard ball with speed $v_i = 1.8\hat{i}$ m/s strikes a stationary billiard ball of the same mass. After collision, the first ball has velocity of $(1.44\hat{i} + 0.7\hat{j})$, is the collision elastic?

Solution

$$\vec{P}_i = \vec{P}_f$$

$$\therefore \cancel{m}(1.8)\hat{i} + \cancel{m}(0) = \cancel{m}(1.44\hat{i} + .70\hat{j}) + \cancel{m}\vec{v}_{2f}$$

divide both sides by m.

$$\Rightarrow \vec{v}_{2f} = (1.8 - 1.44)\hat{i} - .70\hat{j} = .36\hat{i} - .70\hat{j}$$

To prove that the collision is elastic or not we have to compare Kinetic energy befor and after collision K_i and K_f

$$K_i = \frac{1}{2} m v_{1i}^2 = \frac{1}{2} m (1.8)^2 = \boxed{1.62\ m}$$

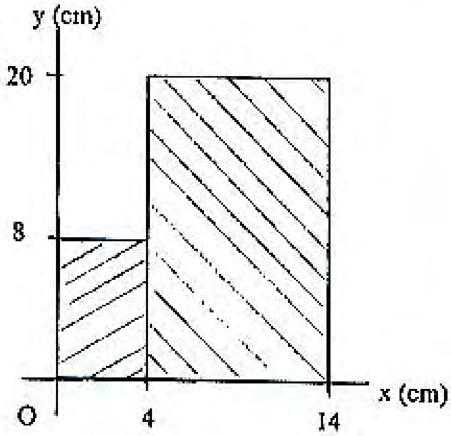
$$K_f = \frac{1}{2} m v_{1f}^2 + \frac{1}{2} m v_{2f}^2 = \frac{1}{2} m \sqrt{(1.44)^2 + (.70)^2}^{\,2} + \frac{1}{2} m \sqrt{(.36)^2 + (.70)^2}^{\,2}$$

$$= .8 m + .4 = \boxed{1.2\ m}$$

Since $K_i > K_f$ this means that collision is $\boxed{\text{inelastic}}$ #

P9 Two plates of the same material are arranged as shown in Figure. The whole system is pivoted about the origin. A force $\vec{F} = (8.03\,\hat{i} + 9.17\,\hat{j})N$ acts on the system at its center of mass. Does the system rotate about O? Why?

first we have to determine the center of mass.



$$x_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} =$$

$$= \frac{(4\times8)(2) + (10\times20)(4+5)}{32+200} = \frac{64+1800}{232}$$

$$\boxed{= 8.03\ cm}$$

$$y_{com} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2}$$

$$= \frac{(4\times8)(4) + (10\times20)(10)}{32+200} = \frac{128+2000}{232}$$

$$\boxed{= 9.17\ cm}$$

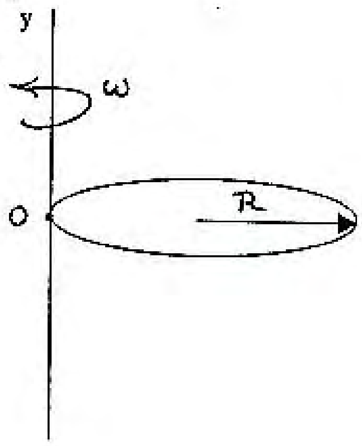
$$r_{com} = 8.03\,\hat{i} + 9.17\,\hat{j}$$

Since $\vec{F}$ acts along the line connecting the pivot and the center of mass, the system will not rotate.

P10 A 3 kg disk of radius R=0.5 m is rotating about the y-axis with angular velocity ω=40 rad/s. The moment of inertia of the disk about its center of mass is $I = \frac{MR^2}{2}$. The kinetic energy of the disk is

$\boxed{\text{A) 900 J}}$ B) 600 J C) 5400 J D) 300 J E) other

Solution



using Parallel-axis theorem at point O

$$I_o = I_{com} + Mh^2$$

$$I = \frac{MR^2}{2} + MR^2 = \frac{3}{2}MR^2$$

$$= 1.125\ kg\cdot m^2$$

$$K = \frac{1}{2} I \omega^2 = (\tfrac{1}{2})(1.125)(40)^2$$

$$\boxed{= 900\ J}$$ #

P11 A 2 kg block is attached to a cord that is wrapped around the rim of a flywheel of radius R =2 m. When the block is falling downward with a rate of 5 m/s^2, the moment of inertia I of the flywheel is in $Kg.m^2$

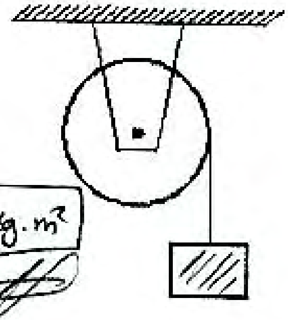
A) 2 B) 6 $\boxed{\text{C) 8}}$ D) 16 E) other

$mg - T = ma$

$T = mg - ma = 20 - 2(5) = 10\,N$

$\tau = I\alpha \Rightarrow TR = I\alpha$

$I = \frac{TR}{\alpha} = \frac{TR}{a/R} = \frac{TR^2}{a} = \frac{(10)(2)^2}{5} = \boxed{8\ Kg.m^2}$ #

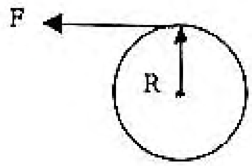


Solution

P12 A uniform disk of radius R = 0.25 m and rotational inertia $I_o = 5.0\ kg.m^2$ rotates about a frictionless fixed axis normal to it and passing through its center O. A constant force F = 2.0 N is applied tangential to disk edge as shown. If the disk starts at rest, then after it has turned through half a revolution its angular velocity is

A) 0.57 rad/s B) 0.64 rad/s $\boxed{\text{C) 0.8 rad/s}}$ D) 1.6 rad/s E) other

Solution



$\omega_0 = 0$

$\tau = I\alpha$

$F_t R = I\alpha$

$2(.25) = 5\alpha$

$\alpha = .1\ rad/s^2$

$\omega_f^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\Delta\theta = \text{half rev.} = \pi = 3.14$

$= 0 + 2(.1)(3.14)$

$\omega_f = \boxed{.8\ rad/s}$ #