Physics 2101: General Physics I
Exam 2, Saturday, November 10, 2007
5:30-6:40pm

Name:____

ID:____

Section or instructor name:____________________________

ALL multiple choice questions have 2 pts

Solve ALL 6 multiple choice questions

Solve ALL 6 problems

MC________/12

P1________/4

P2________/6

P3________/8

P4________/7

P5________/4

P6________/9

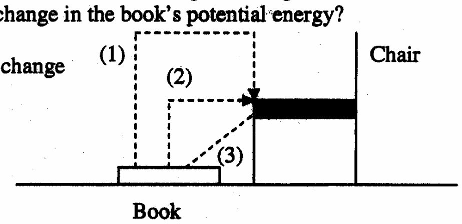
Total________/50

IMPORANT NOTICE
All numerical answers must have **proper units** otherwise there will be a **penalty of 1 point (2%)**.

All questions must have **ONE AND ONLY ONE** answer.

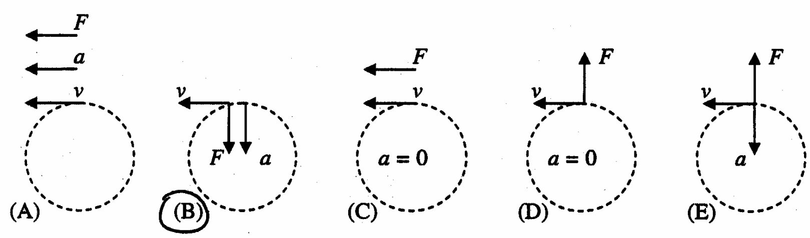
(M1: 2pts) You take a book from the floor and put it on a chair (see figure) using one of the paths shown. Which path gives the maximum change in the book's potential energy?

(A) Path (1) (B) Path (2)
(C) Path (3) (D) All paths give the same change



$\Delta PE = PE_f - PE_i$, ∴ it depends only on the final and initial points, not on the path.

(M2: 2pts) A cup is on the edge of a horizontal plate rotating at a constant velocity. If v is the cup's velocity, a is its centripetal acceleration and F is the centripetal force acting on it, which picture is correct?



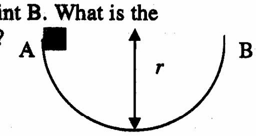
(M3: 2pts) A ball of mass m is thrown to the right with speed v. It hits a wall and then bounces back of the wall to the left with speed v. The impulse the wall gives the ball is

(A) zero (B) mv to the right (C) mv to the left
(D) $2mv$ to the right (E) $2mv$ to the left

mv →, $-mv$ ← ∴ $\Delta p = mv - (-mv) = 2mv$, left (Newton's 3rd law)

(M4: 2pts) A block of mass m is released from rest at point A on the track shown in the figure. The track is a half circle whose radius is r. The block goes to point B. What is the total work done by the normal force, F_N, on the block when it reaches B?

(A) $+F_N \times \pi r$ (B) $-F_N \times \pi r$ (C) zero (D) $F_N \times 2r$



F_N is ⊥ path, ∴ $W_{F_N} = 0$.

(M5: 2pts) Box A moves to the right with momentum p and hits box B (initially at rest). Box A then bounces back to the left. The momentum of box B after the collision is

(A) greater than p (B) less than p (C) equal to p (D) impossible to know

(M6: 2pts) Every one in SQU jumps up at the same time. Which of the following is correct about Earth's momentum when every one is in the air?

(A) Earth does not gain momentum because its mass is so large its motion cannot be seen.
(B) Earth gains momentum, but its momentum is much smaller than that of all the jumping people because of its very, very large mass.
(C) Earth's momentum is equal and opposite to that of all the jumping people.
(D) It depends.

conservation of momentum:
mom. before jumping = 0
" after " $= P_{people} + P_{Earth}$
$0 = P_{people} + P_{Earth} \Rightarrow P_{Earth} = -P_{people}$

before mom. $= P$, bounce back
after mom. $= -P_A + P_B$
∴ $P = -P_A + P_B$ ∴ $P_B = P + P_A > P$

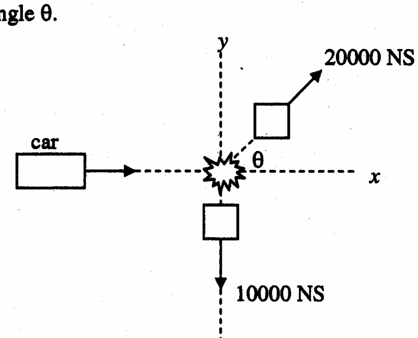
(P1: 4pts) Box A is moving to the right with momentum p. Box B is moving to the left with momentum $2p$. The boxes collide in a completely (perfect) inelastic collision. What are the magnitude **AND** direction of the momentum of the system (box A + box B) after collision?

befor mom. $= p + -2p = -p$

after mom. $= p'$

cons. of mom. $p' = -p$, $\therefore$ p to the left

(P2) The figure shows a car moving with a certain momentum in the $+x$ direction. It explodes into two pieces. One piece moves in the $-y$ direction with momentum 10000 Ns and the other piece moves with momentum 20000 Ns at angle θ.



(A: **3pts**) Calculate the angle θ.

$P_{ix} = P_{fx} \rightarrow P_{car} = 20000 \cos\theta$

$P_{iy} = P_{fy} \rightarrow 0 = 20000 \sin\theta - 10000$

$\therefore \sin\theta = \frac{10000}{20000} = \frac{1}{2}$

$\therefore \theta = 30^\circ$

(B: **3pts**) Calculate the momentum of the car before it exploded.

$P_{car} = 20000 \cos\theta = 20000 \cos 30^\circ =$

(P3) A ball of mass $m = 1$ kg is pushed against a horizontal spring of spring constant $k =$ 100 N/m. The spring is compressed by 20 cm. The ball is then released from rest.

(A: **4pts**) Calculate the speed of the ball just after it leaves the spring.

$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$ by cons. of energy

$\therefore v^2 = \frac{kx^2}{m} = \frac{(100)(0.2)^2}{1} = 100 \times 0.04 = 4$

$\therefore v = 2\,m/s$

(B: **4pts**) **After leaving the spring**, the ball moves on a horizontal surface with coefficient of kinetic friction $\mu_k = 0.1$. How far does the ball travel on the surface before it stops? Friction is a non-conservative force,

$\therefore \Delta KE = W_{net}$

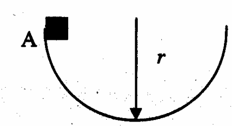
$KE_f - KE_i = F_{fr}\, d \cos\theta$; $\theta = 180°$ $\therefore \cos\theta = -1$

KE_f = 0 (stops) ; $F_{fr} = mg\mu$ $(F_N = mg)$

$\therefore -KE_i = -mg\mu d \Rightarrow KE_i = mg\mu d$

$\Rightarrow \frac{1}{2}mv^2 = mg\mu d \Rightarrow d = \frac{v^2}{g\mu} = \frac{4}{2(9.8)(0.1)} \simeq 2.04\,m$

(P4: 7pts) In the figure, the track is a half circle and is frictionless. The radius is $r = 10$ cm. A block of mass 1 kg is released from rest at point A. Calculate the normal force on the block at the bottom of the circle.



~~F_N~~ $F_N - mg = \frac{mv^2}{r}$

need v, use conservation of energy

$\therefore mgr = \frac{1}{2}mv^2$ (I am using the bottom of the circle as my reference)

$\therefore v^2 = 2gr$

$\therefore F_N - mg = \frac{m(2gr)}{r}$ (where $2gr = v^2$)

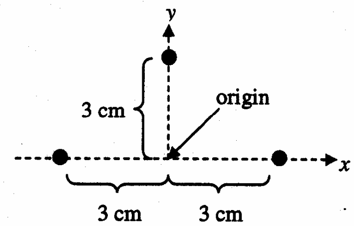
$= 2mg$ (independent of r!!)

$\therefore F_N = 3mg = (3)(1)(9.8) = 29.4\,N$

(P5: 4pts) A system is made of three objects, which are located as shown below. All have the same mass m. Find the location of the center of mass of the system **with respect to the origin shown in the figure.**

$$x_{CM} = \frac{3m + 0(m) - 3m}{m + m + m} = 0 \text{ cm}$$

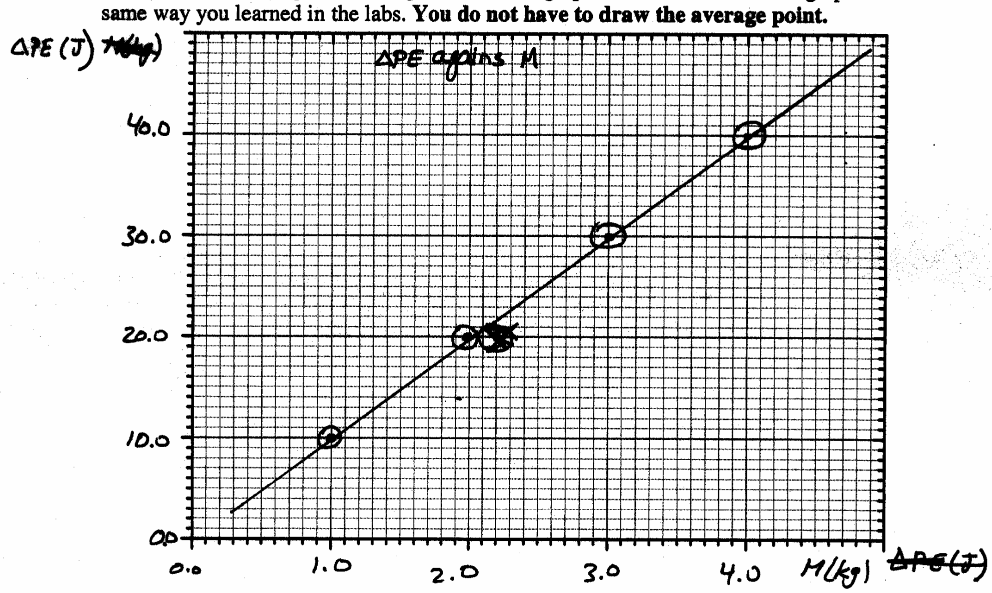
$$y_{CM} = \frac{0(m) + 0(m) + 3m}{m + m + m} = 1 \text{ cm}$$



(P6) In an experiment you lift up different masses to a height of h = 1.0 m. For each mass you measure the change in its potential energy, ΔPE. You obtain the following table.

M (kg)	ΔPE (J)
1.0	10.0
2.0	20.0
3.0	30.0
4.0	40.0

(A: **6pts**) Make a graph of ΔPE against m in the graph area below. Make the graph in the same way you learned in the labs. **You do not have to draw the average point.**



(B: **3pts**) Use the graph to find the acceleration due to gravity. *Hint*: ΔPE = mgh. **Make sure your final answer has the correct number of significant figures.**

Slope of the graph $= gh = \frac{40.0 - 10.0}{4.0 - 1.0} = 10. \frac{J}{kg}$

$h = 1.0$ m for all $\therefore g = \frac{10.}{1.0} = 10 \text{ m/s}^2$