Kuwait University
Physics Department

I + II

Physics 101

Final Exam

Autumn Semester
Thursday, January 13, 2005
11:00 a.m. – 1:00 p.m.

Student's Name: .... 31 ....

Student's Number: ....

Choose your Instructor's Name :

○ Prof. Fekri El-Akkad
○ Dr. Ahmed Ali Al-Jassar
○ Dr. Abdulnasser Burezq
○ Dr. Abdulmuhsen Habib
○ Dr. Hala Khalid Al-Jassar
○ Dr. Afifa Bahbehani
○ Dr. Adnan Al-Yaseen
○ Dr. Yacoob Makdisi
○ Dr. Majed Fehmi
○ Dr. Tariq Ramadan

Grads:

Problem	Q1	Q2	Q3	Q4	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Total
Points															

Important Notes:

1. Answer all questions and problems.
2. Each question will be assigned 1 point.
3. Each problem will be assigned 2 points.
4. No solution for problems = no points.
5. Check the correct answer for each question and problem.
6. Take $g = 10$ m/s^2, $\sin(37°) = 0.6$ and $\cos(37°) = 0.8$.
7. Mobiles and Pagers are not allowed during the exam.
8. Programmable calculators which can store equations are not allowed.

GOOD LUCK

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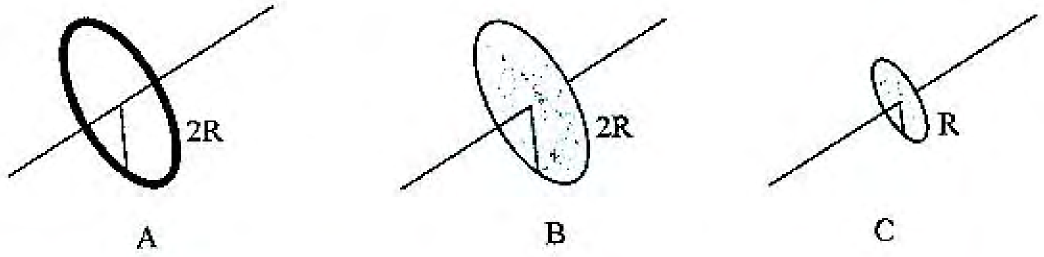
Part I: Questions *Choose the correct answer:*

Q1. Two objects of different masses A and B have the same linear momentum. B will have more kinetic energy than A if:

a) B weighs more than A ($mass_B > mass_A$)
b) B is moving faster than A ($v_B > v_A$)
c) B weighs the same as A ($mass_B = mass_A$)
d) B is moving slower than A ($v_B < v_A$)
e) B is moving at the same speed as A ($v_B = v_A$)

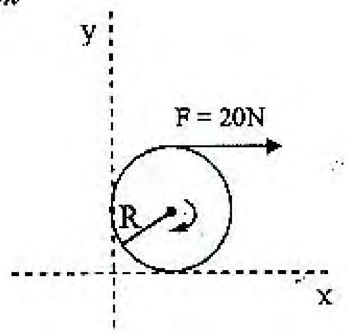
Q2. (A) is a ring, (B) and (C) are two disks; I_A, I_B and I_C are their moment of inertia about an axis passing through their center of mass, and perpendicular to their planes as shown. If their masses are equal and their thicknesses are uniform, then:

a) $I_A = I_B = I_C$
b) $I_A = I_B$ and $I_B > I_C$
c) $I_A > I_B > I_C$
d) $I_A < I_B < I_C$
e) $I_A = I_B$ and $I_B < I_C$



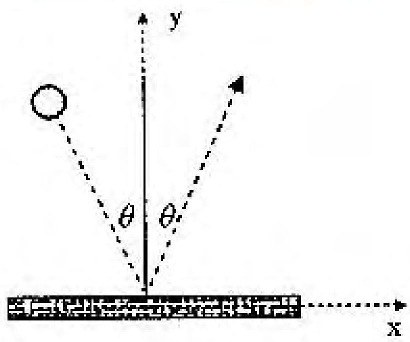
Q3. A disk of radius R = 2 m can rotate about a fixed axis perpendicular to it and passing through its center. A constant force F=20N is applied tangent to the disk edge, as shown, to rotate it, then the torque $\vec{\tau}$ (in Nm) on the disk is:

a) $40\hat{k}$
b) $-40\hat{k}$
c) $80\hat{k}$
d) $-80\hat{k}$
e) $40\hat{j}$
f) $-40\hat{j}$



Q4. A ball hits a floor (ground) and rebounds with the same speed, as shown below. The changes in the components of the momentum of the ball are:

a) $\Delta p_x > 0$, $\Delta p_y > 0$
b) $\Delta p_x < 0$, $\Delta p_y > 0$
c) $\Delta p_x = 0$, $\Delta p_y > 0$
d) $\Delta p_x = 0$, $\Delta p_y < 0$
e) $\Delta p_x > 0$, $\Delta p_y < 0$



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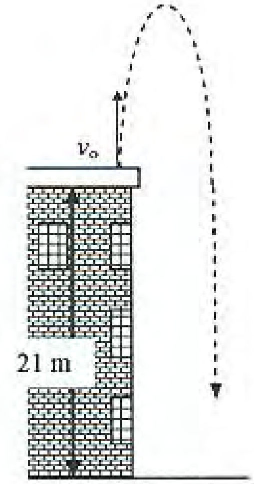
Part II: Problems *Solve then choose the correct answer:*

P1. A ball is thrown vertically upward with speed $v_o = 9\,m/s$, from a roof 21m above the ground. The average velocity (in m/s) of the ball, after 3 seconds will be:

a) -3 b) 4.5 c) -6 d) 7.5 e) -8.5 f) Other



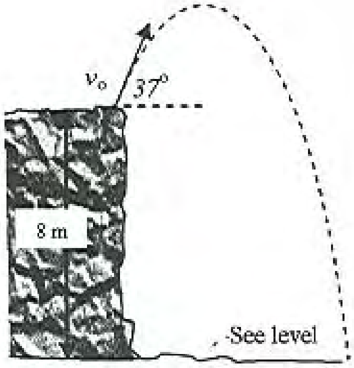
$\bar{v} = \frac{\Delta y}{\Delta t}$

$\because \Delta y = v_o t - \frac{1}{2} g t^2 = -18\,m$

$\therefore \bar{v} = \frac{-18}{3} = -6\,m/s$

P2. A ball is projected, at an angle 37° above horizontal, from the edge of a cliff 8m above the see level. If the ball strikes the see surface after 2 seconds, then the velocity (in m/s) of the ball when it strikes the water will be:

a) $6\hat{i} - 20\hat{j}$ b) $10\hat{i} + 8\hat{j}$ c) $6\hat{i} + 8\hat{j}$ d) $14\hat{i} - 8\hat{j}$ e) $8\hat{i} - 14\hat{j}$ f) Other



We need to calculate v_x and v_y at see level.

$\because \Delta y = v_{oy} t - \frac{1}{2} g t^2$

$-8 = v_{oy}(2) - \frac{1}{2}(10)(4) \Rightarrow v_{oy} = 6\,m/s$

$\because v_y = v_{oy} - gt = 6 - 20 = -14\,m/s$

$v_{oy} = v_o \sin\theta \Rightarrow v_o = \frac{6}{.6} = 10\,m/s$

$\therefore v_x = v_{ox} = v_o \cos\theta = 10(.8) = 8\,m/s$

$\therefore \vec{v} = 8\hat{i} - 14\hat{j}$

P3. A 4.0 kg block is pushed up a 37° rough incline by a force $\vec{F}$ applied parallel to the incline. When F is 31 N the block moves up the incline with a constant speed. The value of **F** (in N) needed to let the block move down the incline at a constant speed is:

a) 27 b) 31 c) 8 d) 17 e) Other

* when moving upward (direction of f_k is downward)

$F - f_k - mg \sin\theta = 0$

$31 - f_k - 4(10) \cdot 6 = 0$

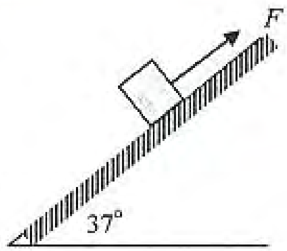
$f_k = 31 - 24 = 7\,N$

* when moving downward (direction of f_k is upward)

$F + f_k - mg \sin\theta = 0$

$F + 7 - 24 = 0$

$F = 17\,N$



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P4. The only variable force acting on a 2 kg body as it moves along the x axis is given by F(x)= - 4x where force is in N and x is in m. If the velocity of the body at x = 0 is v_o= +9 m/s, then the value of x (in m) when the body have a velocity of +3 m/s is:

a) 6 b) 72 c) 81 d) 2 f) Other

$\because \quad W = \int F(x)\,dx = \Delta K$

$\therefore \quad W = \int_0^x -4x\,dx = \left[-2x^2\right]_0^x = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$-2x^2 = \frac{1}{2}(2)(3)^2 - \frac{1}{2}(2)(9)^2 = 9 - 81$

$-2x^2 = -72$

$x = \sqrt{36} = 6\ m$

P5. A box of mass m = 30 kg is placed on a rough incline as shown. At the moment the box is released from rest, a force F = 30 N is applied on the box as shown. The box slides down and hits the spring (k = 2000 N/m) and compresses it 50 cm before stopping. The increase in thermal energy ΔE_{th} (in J) is:

a) 111 b) 250 c) 50 d) 361 e) 171 f) Other

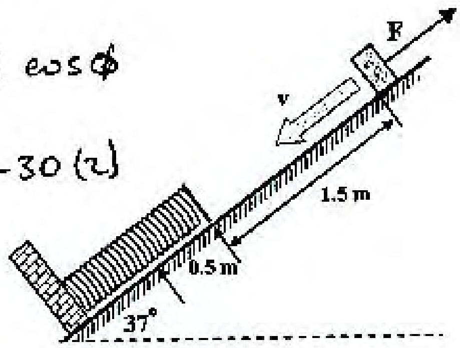
$\because \quad \Delta E + \Delta E_{th} = W \Rightarrow E_f - E_i + \Delta E_{th} = W$

$\therefore \quad \left(\frac{1}{2} k x^2\right)_f - \left(mgd\sin\theta\right)_i + \Delta E_{th} = F d \cos\phi$

$\left[\frac{1}{2}(2000)(.5)^2\right]_f - \left[30(10)(1.5+.5)(.6)\right]_i + \Delta E_{th} = -30(2)$

$250 - 360 + \Delta E_{th} = -60$

$\Delta E_{th} = 50\ J$



P6. Three objects are made of the same material and have the same uniform thickness. They are positioned as shown in the figure. The distance between the center of mass of the system and origin (in m) is:

a) 1.2 b) 4.8 c) 5.3 d) 7.1 e) Other

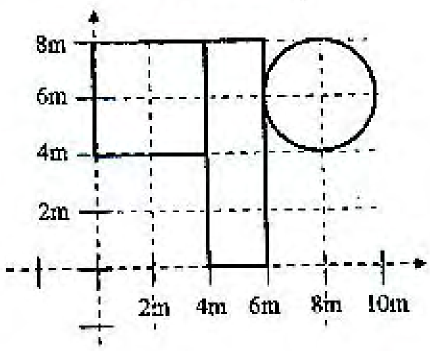
$x_{cm} = \dfrac{Area_1(x_1) + Area_2(x_2) + Area_3(x_3)}{Total\ Areas}$

$= \dfrac{16(2) + 16(5) + \pi(2)^2(8)}{16 + 16 + 12.57} = \dfrac{212.63}{44.57} = \underline{\underline{4.77}}$

Same for y_{cm}

$y_{cm} = \dfrac{16(6) + 16(4) + \pi(2)^2(6)}{44.57} = \underline{\underline{5.3}}$

$\therefore \quad r_{cm} = \sqrt{x_{cm}^2 + y_{cm}^2} = \underline{\underline{7.1}}$



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P7. A force $F(t) = 3t^2$ (where F is in N and t is in seconds) is exerted on an object during the time interval 3 to 7 seconds. The average force F_{avg} (in N) within the same interval is:

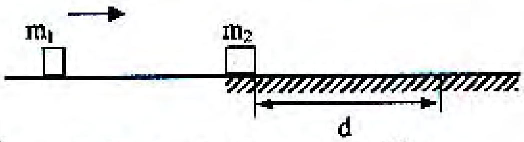
a) 316 b) 27 c) 79 d) 215 e) 370 f) Other

$$J = \int_3^7 F(t)\,dt = \left[t^3\right]_3^7 = 343 - 27 = 316 = F_{avg}\,\Delta t$$

$$\therefore F_{avg} = \frac{316}{4} = \underline{\underline{79\ N}}$$

P8. A box of mass $m_1 = 2$ kg and a velocity of $v_{1i} = 5$ m/s collides with another box at rest of mass $m_2 = 3$kg by an elastic head-on collision as shown. After collision m_1 rebounds with speed 1 m/s while m_2 slides over a rough area of $\mu_k = 0.4$. The distance d (in m) that box m_2 will cover to stop is:

a) 24 b) 9 c) 40 d) 20 e) 2 f) Other



$$\therefore v_{2f} = \frac{2m_1}{m_1+m_2} v_{1i} = 4\ m/s$$

$$\Delta K = W_f \Rightarrow \tfrac{1}{2}\cancel{m_2} v_{2f}^2 - \tfrac{1}{2} m_2 v_i^2 = W_f$$

$$-\tfrac{1}{2}\cancel{m_2} v_i^2 = -\mu_k \cancel{m_2} g\, d$$

$$d = \frac{16}{2(.4)(10)} = \underline{2\ m}$$

OR

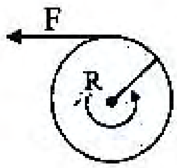
$$m_1 v_{1i} = m_1 v_{1f} + m_2 v_{2f}$$

$$2(5) = 2(-1) + m_2 v_{2f}$$

$$v_{2f} = \frac{12}{3} = 4\ m/s$$

P9. A disk of radius R = 2m and mass M = 100kg can rotate about a fixed axis normal to it and passes through its center. The moment of inertia of the disk is $I_{com} = \frac{1}{2} MR^2$. A force F is applied tangent to the disk edge, as shown, to rotate it from rest. If the disk completes 40 revolutions in 4 seconds, then the applied force F (in N) is:

a) 200 b) 1960 c) 3141 d) 6283 e) 13.41 f) Other



$\tau = I\alpha$ and $\tau = RF\sin\theta$ where $\theta = 90°$

$$\therefore F = \frac{I\alpha}{R}$$

$$\therefore I = \tfrac{1}{2}MR^2 \Rightarrow I = \tfrac{1}{2}(100)(2)^2 = 200\ kg \cdot m^2$$

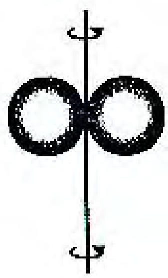
$$\therefore \Delta\theta = \omega_0 t + \tfrac{1}{2}\alpha t^2 \Rightarrow 40(2\pi) = \tfrac{1}{2}\alpha (4)^2$$

$$\therefore \alpha = 10\pi\ rad/s^2$$

$$\therefore F = \frac{200(10\pi)}{2} = 1000\pi = \underline{3141\ N}$$

P10. A system of two identical solid spheres, each of mass 10 kg and radius 50 cm. They are rotating with angular speed $w = 30$ rev/min about an axis touching the two spheres as shown. If the moment of inertia of the sphere is $I_{com} = {}^2/_5 MR^2$, then the kinetic energy (in J) of the system approximately is.

a) 35 b) 16 c) 5 d) 50 e) other



I_t is inertia for the two spheres

$$I_t = 2\left[\tfrac{2}{5}MR^2 + MR^2\right] = 2\left[\tfrac{7}{5}MR^2\right] = \tfrac{14}{5}MR^2$$

$$K = \tfrac{1}{2} I\omega^2 = \tfrac{1}{2}\left[\tfrac{14}{5}MR^2\right]\left[30\left(\tfrac{2\pi}{60}\right)\right]^2$$

$$= 3.5\pi^2 \simeq \underline{\underline{35\ J}}$$

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