Kuwait University
Physics Department

Physics 101

Final Exam

Summer Semester
Saturday, July 30, 2005
2:00 p.m. – 4:00 p.m.

Student's Name: ....Solution........

Student's Number: ....

Choose your Instructor's Name :

- ◯ Dr. Adnan Al-Yaseen
- ◯ Dr. Hassan Raafat
- ◯ Dr. Abdulnasser Burezq
- ◯ Dr. Yaccob Makdisi
- ◯ Dr. Hala Al Jassar

Grades	Q1	Q2	Q3	Q4	Q5	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 and each **problem** 2 points.
3. The solution should be given explicitly for each problem.
4. No solution = no points.
5. Check the correct answer for each question.
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.

<u>Some Rotational Inertias</u>

Object (mass M)	Axis	Moment of Inertia I
Thin rod length L	Through center ⊥ rod	$\frac{1}{12}ML^2$
Solid sphere of radius R	Through center	$\frac{2}{5}MR^2$
Solid disk or cylinder of radius R	Through center	$\frac{1}{2}MR^2$

GOOD LUCK

PART I – QUESTIONS - ***Choose the correct answer***

Q1. If a particle decelerates, then its velocity and acceleration signs might be:

a) positive and positive
b) positive and zero
c) negative and negative
d) positive and negative

Q2. A particle of mass m moves with velocity v and has a momentum P. Suddenly its kinetic energy is doubled. The increase in its momentum will be:

$K = \frac{1}{2} m v^2$

$v^2 = \frac{2K}{m}$

$v = \sqrt{\frac{2K}{m}}$

a) 0.4 P $\therefore P = m\sqrt{\frac{2K}{m}}$
b) 1.4 P $= \sqrt{2Km}$
c) 2.4 P
d) 4 P

$P = \sqrt{2mK}$

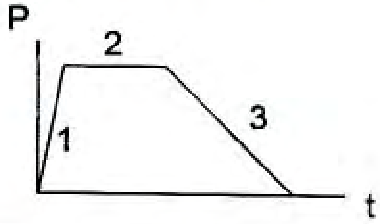
$P' = \sqrt{4mK}$

$P' - P = (\sqrt{2} - 1)P$

$= 0.4P$

Q3 The figure gives the linear momentum (P) versus time (t) for a particle moveing along an axis. A force directed along the axis acts on the particle. Rank the three regions shown according to the magnitude of the force, greatest first:

a) 1, 3, 2
b) 2, 3, 1
c) 3, 2, 1
d) 2, 1, 3

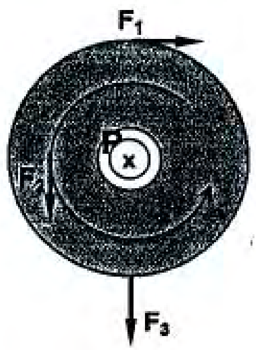


Q4. Three small balls $m_A = 2$ m, $m_B = m_C =$ m. They are arranged along a straight line as shown in the figure. m_A is given an initial speed v where m_B and m_C are initially at rest as shown. If all collisions are elastic, then which of the following statements is true?

a) m_A will collide with m_B and then rebound
b) m_B will exchange velocity with m_C
c) m_A will have the greatest velocity
d) $V_A = V_B = V_C$ after collisions.

Q5. Three equal forces on a disk which rotates around point P as shown. Rank the forces according to the magnitude of torque that they create on point P. Start with the greatest:

a) F3, F2, F1
b) F2, F1, F3
c) F1, F2, F3
d) F1, F3, F2



PART II – PROBLEMS - Solve the following problem

P1. A particle position is given by $x = 2 + 2t^2$ (x in meters and t in seconds). Its instantaneous velocity (in m/s) when the particle is midway between its position at t=0 s and t = 2.83 s is:

a) 4 b) 6 c) 8 d) 10 e) Others

$x(0) = 2\,m$, $x(2.83) = 18\,m$

$x_{mid} = \left(\frac{18-2}{2}\right) + 2 = 10\,m$

at $x = 10\,m \rightarrow 10 = 2 + 2t^2 \rightarrow t = \sqrt{4} = 2\,(s)$

$v = 4t = 4(2) = 8\,m/s$

P2. A particle is projected at an angle θ_o. After 4 s its velocity is found to be $30\,\hat{i}$ m/s. Then the angle of projection θ_o (in degrees) is:

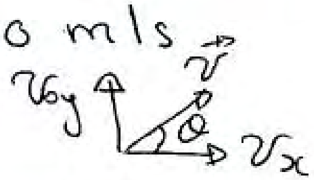
a) 60 b) 30 c) 37 d) 53 e) Others

as $\vec{v} = 30\hat{i} \rightarrow \therefore$ 4 (s) is the time for max. height

$v_y = v_{yo} - gt$

$0 = v_{yo} - (10)(4) \rightarrow v_{yo} = 40\,m/s$

$\therefore \theta = \tan^{-1}\frac{40}{30} = 53^\circ$



P3. A constant and continuous force acts on a 5 kg block initially at rest. The particle started to move according to the relation: $X = 8\,t + 3\,t^2$. Then the magnitude of this force (in N) is:

a) 4 b) 15 c) 30 d) 120 e) Other

$a = 6\,m/s^2$

$F = ma = (5)(6) = 30\,N$

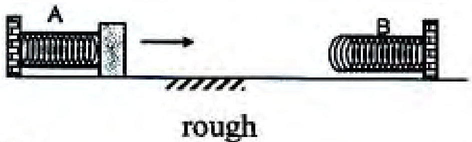
P4. A and B are two identical springs, each having a spring-constant of 1000 N/m. They are arranged horizontally on a smooth surface. A block of mass 8 kg compresses against spring A by 20 cm. The spring is released and the block runs towards spring B and passes the rough surface. If the block compresses spring B by 10 cm then the work (in Joules) done by friction is:

a) -50 b) -45 c) -15 d) -10 e) Other

$W_f = E_f - E_i$

$= \frac{1}{2}k\left[(0.1)^2 - (0.2)^2\right]$

$= \frac{1}{2}(1000)(-0.03) = -15\,J$



P5. Four equal particles m_1, m_2, m_3 and m_4 are arranged in xy plane so that their center of mass is located at origin. When one of those masses is removed from this group the new position of the center of mass becomes $3\hat{i}-2\hat{j}$. Therefore the original position of the removed mass was:

a) $-3\hat{i}+2\hat{j}$ b) $-9\hat{i}+6\hat{j}$ c) $-12\hat{i}+8\hat{j}$ d) $-6\hat{i}+4\hat{j}$ e) others

$$0 = \frac{m\vec{r}_1 + m\vec{r}_2 + m\vec{r}_3 + m\vec{r}_4}{4m} \Rightarrow r_4 = -(r_1+r_2+r_3) \quad (1)$$

$$3\hat{i}-2\hat{j} = \frac{m\vec{r}_1 + m\vec{r}_2 + m\vec{r}_3}{3m} \Rightarrow r_1+r_2+r_3 = 3(3\hat{i}-2\hat{j}) \quad (2)$$

sub. (1) in (2)

$$\Rightarrow r_4 = -9\hat{i}+6\hat{j}$$

P6. A ball of mass 2 kg is thrown upward by an initial velocity of 3 m/s. It returns back to the same position after 1 s. The impulse that acts on the ball (in N.s) between the initial and final positions is:

a) 0 b) 6 c) –6 d) –12 e) Others

$$\vec{J} = \Delta\vec{P} = \vec{P}_f - \vec{P}_i$$

$$= 2(-3) - 2(3)$$

$$= -12 \ (\text{N.s})$$

P7. A is a block of mass 1 kg and is moving east with constant speed of 3 m/s. Block B of mass 2 kg is moving north with a constant speed of 2 m/s. Blocks A and B collide at the interception and stick together. They continue their motion (together) on a rough surface for ½ m before coming to a stop. What is the coefficient of friction between the rough surface and both blocks?

a) 0.7 b) 0.5 c) 0.4 d) 0.3 e) Other

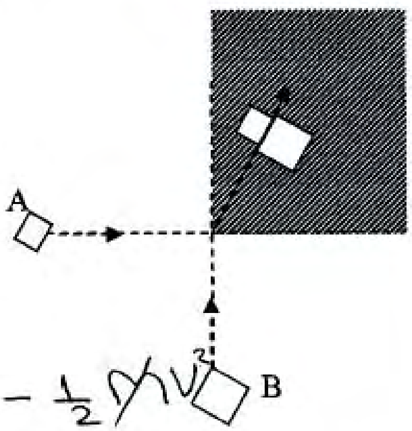
$$m_A\vec{V}_A + m_B\vec{V}_B = (m_A+m_B)\vec{V}$$

$$\vec{V} = \frac{(1)(3)\hat{i} + (2)(2)\hat{j}}{3}$$

$$\vec{V} = (\hat{i} + \tfrac{4}{3}\hat{j}) \text{ m/s}$$

$$W_f = \Delta K \longrightarrow -\mu_k Mgd = 0 - \tfrac{1}{2}MV^2$$

$$\therefore \mu_k = \frac{V^2}{2gd} = \frac{2.78}{(2)(10)(0.5)} = 0.27 \simeq 0.3$$



P8. A thin uniform rod of length 1 m and mass 1 kg is pivoted from one end. At the far end there is a particle of mass 1kg. The system (rod and particle) is released from rest from horizontal position. Their kinetic energy (in Joules) as they pass the lowest position is:

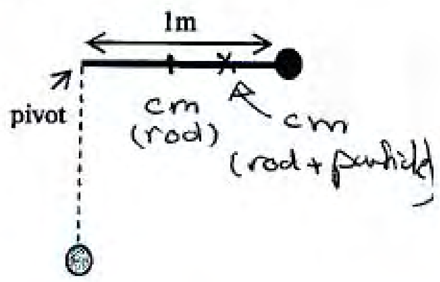
a) 7.5 b) 10 c) 29 d) 15 e) Others

$x_{cm} = 0.75 \text{ m}$

$K = U$

$= mgh$

$= (2)(10)(0.75) = 15 \text{ J}$



P9. A rotating uniform disk of radius 10 cm and mass 320 g is brought to rest in 1 s after two complete revolutions. The torque (in m.N) of friction is:

a) -0.01 b) -0.02 c) -0.03 d) -0.04 e) Others

$\Delta\theta = \omega - \frac{1}{2}\alpha t^2 \Rightarrow 4\pi = 0 - \frac{1}{2}\alpha t^2$

$\therefore \alpha = -8\pi \text{ rad}$

$\tau = I\alpha$

$= (\frac{1}{2}MR^2)(-8\pi)$

$= \underbrace{(\tfrac{1}{2})(0.32)(0.1)^2}_{1.6\times10^{-3}}\underbrace{(-8\pi)}_{-25.13} = -0.04 \text{ N.m}$

P10. A uniform disk of radius R = 1m and mass M = 2kg rotates around an axis that is parallel to the axis that goes through the centre as shown in the figure. When the kinetic energy of the disk = 96 J, then the speed (in m/s) of a point P on the rim of the disk is:

a) 8 b) 16 c) 24 d) 32 e) Others

$I = \frac{1}{2}MR^2 + MR^2$

$= (\frac{1}{2})(2)(1)^2 + (2)(1)^2 = 3 \text{ kg.m}^2$

$K = \frac{1}{2}I\omega^2$

$96 = (0.5)(3)(\omega^2)$

$\omega = \sqrt{\frac{96}{1.5}} = \sqrt{64} = 8 \text{ rad/s}$