Kuwait University
Physics Department

Physics 101

Final Exam
Spring Semester
Thursday, June 3, 2004
11:00 a.m. – 1:00 p.m.

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

Student's Number: ....

Choose your Instructor's Name :

Prof. Fekri El-Akkad
Dr. Ahmad Ali Al-Jassar
Dr. Abdulnasser Burezq
Dr. Abdul Muhsen Habib
Dr. Hala Khalid Al Jassar
Dr. Abdulmuhsen Habeeb
Dr. Adnan Al-Yaseen
Dr. Yaccob Makdisi
Dr. Majed Ali Fehmi

Grads:

Problem	1	2	3	4	5	6	7	8	9	10	11	12	Total
Points													

Important Notes:

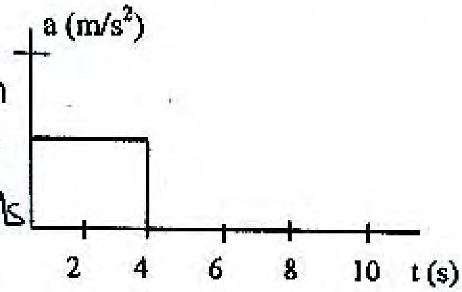
1. Answer all questions.
2. Each question will be assigned 2 points.
3. The solution should be given explicitly for each problem.
4. No solution = no points.
5. Check the correct answer for each question.
6. Take $g = 10\ m/s^2$.
7. Mobiles and Pagers are not allowed during the exam.
8. Programmable calculators which can store equations are not allowed.
9. Some Rotational Inertias

OBJECT (mass M)	AXIS	MOMENT OF INERTIA (I)
Thin rod of length L	Through center ⊥ rod	$1/12\ ML^2$
Solid sphere of radius R	Through center	$2/5\ MR^2$
Solid disk or cylinder of radius R	Through center	$½\ MR^2$

GOOD LUCK

1. A particle moves along the x-axis, its acceleration versus time is shown in the figure. If the particle starts from rest then it's displacement (in m) after 10 seconds is:

a) 8 b) 16 c) 48 (d) 64) e) 100 f) Other



for the first 4 seconds

$\Delta x_1 = v_0 t + \frac{1}{2} a t^2 = 0 + (\frac{1}{2})(2)(4)^2 = 16\ m$

v = Area under the curve $= (2)(4) = 8\ m/s$

$v = v_0 + at = (2)(4) = 8\ m/s$

from $t = 4\,(s) \to t = 10\,(s) \to a = 0$ so $\to v =$ const

$\Delta x_2 = vt = (8)(6) = 48\ m$

$\Delta x = \Delta x_1 + \Delta x_2 = 16 + 48 = 64\ m$

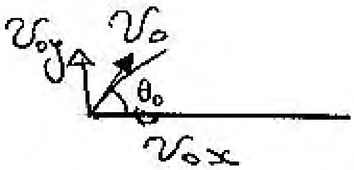
2. A particle is projected with an initial angle θ_o from a horizontal surface on the ground as shown. After 4 seconds its velocity is found to be $30i$ m/s. The angle θ_o (in degrees) is:

a) 0 b) 30° c) 37° d) 45° (e) 53°) f) Other

$v_y = 0$ after 4 seconds as $\vec{v} = 30\hat{i}$ m/s

$\therefore\ 0 = v_{oy} - (10)(4)$

$v_{oy} = 40\ m/s$



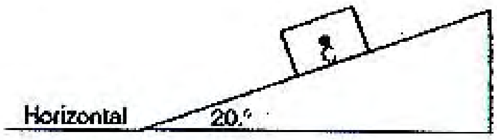
$\therefore\ \theta = \tan^{-1} \frac{v_{oy}}{v_{ox}}$

$= \tan^{-1} \frac{40}{30} \simeq 53°$

3. If a 10 kg block slides at constant speed down a plane inclined 20° to the horizontal, then the coefficient of kinetic friction between the block and the incline is:

a) 0.85 b) 0.56 c) 0.65 d) 0.54 (e) 0.36) f) Other

$mg \sin\theta = \mu_k mg \cos\theta$



$\mu_k = \tan\theta$

$= \tan 20°$

$= 0.36$

4. A roller-coaster car has a mass of 500 kg when fully loaded with passengers. The car passes over a hill of radius r =15 m, as shown. When the car has a speed of 8 m/s at the top of the hill, then the force (in k N) of the track on the car is:

a) 7 up b) 7 down c) 2.9 down (d) 2.9 up) e) 5.6 down f) Other

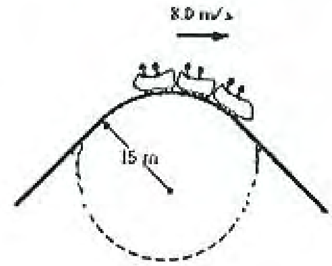
$$mg - N = \frac{mv^2}{r}$$

$$N = m\left(g - \frac{v^2}{r}\right)$$

$$= 500\left(10 - \frac{8^2}{15}\right)$$

$$\simeq 2.9 \text{ kN (up)}$$

with direction



5. A Force F = 79.2 N is used to raise a box of weigh 72 N from the ground, as shown. Assume that the pulley is massless and frictionless. At the instant the box is 5 meters above the ground its kinetic energy (in Joules) will be:

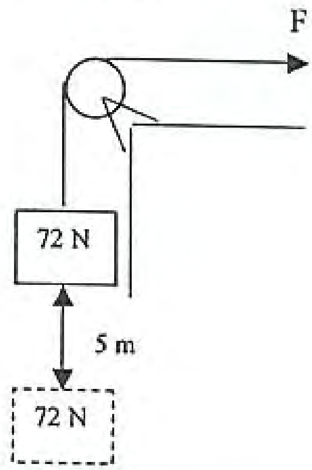
(a) 36) b) 58 c) 74 d) 756 e) 890 f) Other

$$W_{net} = \Delta K$$

$$W_T + W_g = \Delta K$$

$$(79.2)(5) - (72)(5) = K_f - K_i$$

$$K_f = 36 \text{ J}$$



6. Two identical blocks each of mass = 2 kg are projected with the same speed towards two identical springs (k = 400 N/m). The first block is moving along horizontal smooth surface and compresses the spring by 20 cm (as maximum compression), while the other moves along a rough surface with distance d = 70 cm before it stops after compressing the spring. If the coefficient of kinetic friction is $\mu_k = 0.25$, then the maximum compression of the spring (in cm) is:

a) 5 b) 7 c) 10 (d) 15) e) 18 f) Other

$$U_s = \frac{1}{2}kx^2 = \left(\frac{1}{2}\right)(400)(0.2)^2 = 8 \text{ Joules}$$

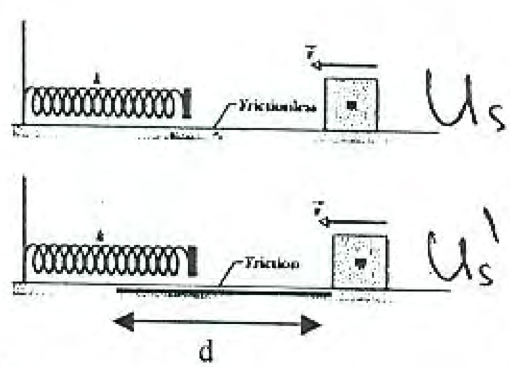
$$W_f = \mu_s mgd = (0.25)(2)(10)(0.7) = 3.5 \text{ Joules}$$

$$U_s' = \frac{1}{2}kx^2 - W_f = \frac{1}{2}kx'^2$$

$$\frac{1}{2}kx'^2 = 8 - 3.5 = 4.5 \text{ Joules}$$

$$x' = \sqrt{\frac{(2)(4.5)}{400}} = 0.15 \text{ m}$$

15 cm



7. Two particles, one of mass 50 g is moving with an acceleration of 80 m/s^2 in the positive x direction; the other of mass 75 g is moving with an acceleration of 40 m/s^2 in the positive y direction. The magnitude of the acceleration (in m/s^2) of their center of mass is:

a) 60 b) 56 c) 40 d) 50 e) 46 f) Other

$$\vec{a}_{cm} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2}{m_1+m_2} = \frac{(0.05)(80)\hat{i} + (0.075)(40)\hat{j}}{(0.05+0.075)}$$

$$= 32\hat{i} + 24\hat{j} \ (m/s^2)$$

$$a_{cm} = \sqrt{32^2+24^2} = \sqrt{1600} = 40 \ m/s^2$$

8. A particle of mass $m_1 = 2$ kg moving along the x axis and with a speed of 8 m/s collides with another particle of mass $m_2 = 4$ kg and is initially at rest. After the collision, if m_1 has a speed of 4 m/s at an angle 37°, then the speed (in m/s) of m_2 is:

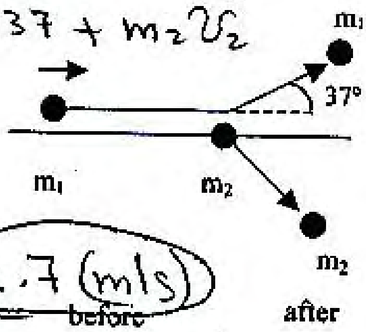
a) 2 b) 2.7 c) 4.9 d) 2.4 e) 3.6 f) Other

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}$$

$$(2)(8)\hat{i} + (4)(0) = (2)(4)\cos 37\,\hat{i} + (2)(4)\sin 37 + m_2\vec{v}_2$$

$$\vec{v}_2 = \frac{9.6\hat{i} - 4.8\hat{j}}{4} = 2.4\hat{i} - 1.2\hat{j}$$

$$v_2 = \sqrt{(2.4)^2+(-1.2)^2} = \sqrt{7.2} \simeq 2.7 \ (m/s)$$

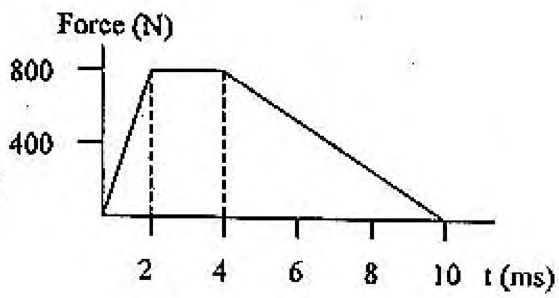


9. The figure shows a plot of force versus time during the collision of a ball with a bat. The average force F_{avg} (in N) on the ball by the bat is:

a) zero b) 400 c) 480 d) 800 e) 900 f) Other

$$J = F_{avg}\,\Delta t$$

$$\Delta t = 10 \text{ ms} = \frac{10}{1000} = 0.01 \text{ (s)} = 10^{-2} \text{ (s)}$$



J = Area under the curve

$$= (800 + 1600 + 2400)\,10^{-3} = 4.8 \ (N.s)$$

$$F_{avg} = \frac{J}{\Delta t} = \frac{4.8}{10^{-2}} = 480 \ (N)$$

10. A wheel of radius 30 cm starts from rest to rotate about a fixed axis with constant angular acceleration of 2 rad/s^2. When the outer edge of the wheel has a speed of 3 m/s then the number of revolutions is approximately:

a) 2   b) 4   c) 5   d) 8   e) 9   f) Other

$v = \omega r \rightarrow \omega = \frac{v}{r} = \frac{3}{0.3} = 10$ rad/s

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

$\Delta\theta = \frac{10^2 - 0}{(2)(2)} = 25$ rad

no. of rev. $= \frac{25}{2\pi} = 3.97 \simeq 4$ (rev)

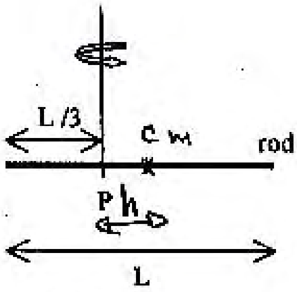
11. A uniform rod with mass M = 4 kg and length L = 3m is rotating about an axis that is passing through point P as shown in the figure. The work (in Joules) that is required to take the body from rest to an angular speed of 6 rad/s is:

a) 15   b) 32   c) 54   d) 72   e) 90   f) Other

$h = \frac{L}{2} - \frac{L}{3} = \frac{3L}{6} - \frac{2L}{6} = \frac{L}{6}$

$I = I_{cm} + Mh^2 = \frac{1}{12}ML^2 + M\left(\frac{L}{6}\right)^2$

$= \frac{4ML^2}{36} = \frac{ML^2}{9}$



$I = \frac{(4)(3)^2}{9} = 4$ kg.m^2

$W = \Delta K = \frac{1}{2} I \omega^2 = \frac{1}{2}(4)(6)^2 = 72$ (Jouls)

12. A mass (M1 = 5 kg) is connected by a light cord to a mass (M2 = 4 kg) which slides on a smooth surface, as shown in the figure. The pulley (radius = 0.2 m) rotates about a frictionless axle. If the acceleration of M2 is 3.5 m/s^2, then the inertia (in kg.m^2) of the pulley is:

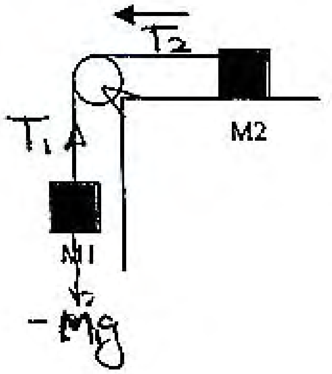
a) 0.29   b) 0.42   c) 0.2   d) 0.62   e) 0.6   f) Other

$T_2 = M_2 a = (4)(3.5) = 14$ (N)

$M_1 g - T_1 = M_1 a$

$T_1 = M_1 g - M_1 a = 50 - (5)(3.5)$

$= 32.5$ (N)



$I\alpha = (T_1 - T_2) r$

$I a = (T_1 - T_2) r^2$ as $a = \alpha r$

$I = \left(\frac{32.5 - 14}{3.5}\right)(0.2)^2 = 0.21 \simeq 0.2$ (kg.m^2)