Kuwait University
Physics Department

Physics 101

Second Midterm Exam
Spring Semester
Thursday, May 13, 2004
11:30 p.m. – 1:30 p.m.

Student's Name: .... key

Student's Number: ....

Choose your Instructor's Name :

- Prof. Fekri El-Akkad.
- Dr. Ahmed Ali Al-Jassar
- Dr. Ismail Sabbah
- Dr. Abdel Muhsen Habib
- Dr. Hala Khalid Al-Jassar
- Dr. Afifa Bahbehani
- 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													

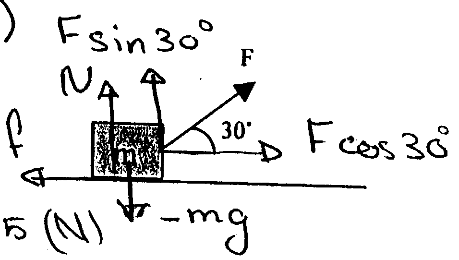
Important Notes:

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.

GOOD LUCK

1. A force F = 30 N is applied to a block of mass 5 kg on a rough surface as shown. The block is initially at rest. If $\mu_s = 0.7$, $\mu_k = 0.6$, then the frictional force (in N) on the block is:

a) 10 b) 21 c) 24.5 d) 26 e) 30 f) Other



$F\cos 30^\circ = (30\,N)\cos 30^\circ = 25.98(N)$

$N + 30\sin 30 = mg$

$N = 50 - 15 = 35\,(N)$

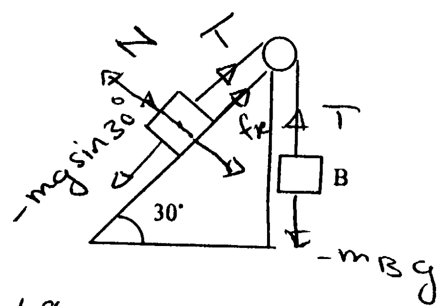
$f_{s,max} = \mu_s N = (0.7)(35) = 24.5\,(N)$

As $F\cos 30 > f_{s,max}$ → There will be motion

→ $f_k = (\mu_k)(N) = (0.6)(35) = 21\,N$

2. A block A slides down a rough inclined plane at constant speed as shown in the figure. If m_A = 10kg and μ_k= 0.2 , then the mass of block B (in kg) is:

a) 3.3 b) 6.7 c) 5.3 d) 10.7 e) 20.3 f) Other



$T + f_k - m_A g\sin\theta = 0$

$T = (10)(10)\sin 30 - (0.2)(10)(10)\cos 30^\circ$

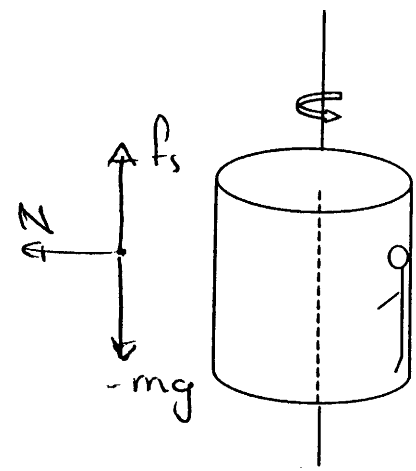
$= 50 - 17.32 = 32.68\,N$

$T = m_B g$ → $m_B = \dfrac{32.68}{10}$

$= 3.3\,kg$

3. A vertical cylinder of radius R that spins about it's axis is shown in the figure. If the coefficient of static friction between the person and the wall is μ_s, then the maximum period of rotation T required to keep the person from falling is:

a) $2\pi\sqrt{R/g}$ b) $2\pi\sqrt{\mu_s Rg}$ c) $2\pi\sqrt{\mu_s R/g}$ d) $2\pi\sqrt{g/R}$ e) $2\pi/\sqrt{\mu_s Rg}$ f) Other



$f_{s,max} = \cancel{m}g = \mu_s N = \mu_s \dfrac{\cancel{m}v^2}{R}$

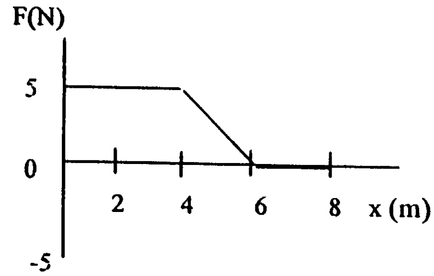
$\therefore v^2 = \dfrac{Rg}{\mu_s}$

$T = \dfrac{2\pi R}{v} = \dfrac{2\pi R}{\sqrt{\dfrac{Rg}{\mu_s}}} \times \dfrac{\sqrt{R}}{\sqrt{R}}$

$= 2\pi\sqrt{\dfrac{R\mu_s}{g}}$

4. A 2 kg block moves in a straight line on a horizontal frictionless surface under the influence of a force that varies with position as shown in the figure. If the block is moved 8 meters during the first 5 seconds, then the average power (in watts) due to this force is:

a) 2 b) 5 c) 11 d) 13 e) 15 f) Other



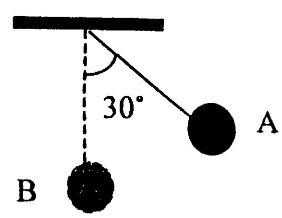
$$W = (4)(5) + \frac{1}{2}(2)(5)$$

$$= 20 + 5 = 25 \text{ Joules}$$

$$\bar{P} = \frac{W}{\Delta t} = \frac{25}{5} = 5 \text{ watts}$$

5. A pendulum has a cord of length L = 3m. If the speed of it's bob at point A is 1.5 m/s, then it's speed at point B will be: (in m/s)

a) 0 b) 1.5 c) 3.2 d) 5.2 e) 6.2 f) Other



$$E_A = E_B$$

$$K_A + U_A = K_B + U_B$$

$$\frac{1}{2} \cancel{m} V_A^2 - \cancel{m} g L \cos\theta = \frac{1}{2} \cancel{m} V_B^2 - \cancel{m} g L$$

$$\frac{(1.5)^2}{2} - (10)(3)\cos 30 = \frac{v_B^2}{2} - (10)(3)$$

$$1.125 - 25.98 = \frac{v_B^2}{2} - 30$$

$$v_B^2 = 10.29 \rightarrow 3.2 \text{ m/s} = v_B$$

correction

6. The force **F** = ($3x^2$ **i** + 2y **j**) N, where x and y are in meters, is applied on an object. Then the work (in Joules) that is done to move the object from point (2,1) m to point (3, - 4) m is:

a) 4 b) 8 c) 18 d) 34 e) 52 f) Other

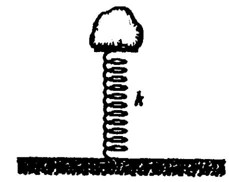
$$W = \int_2^3 F_x\,dx + \int_1^{-4} F_y\,dy = \int_2^3 3x^2\,dx + \int_1^{-4} 2y\,dy$$

$$= x^3\Big]_2^3 + y^2\Big]_1^{-4} = (27 - 8) + (16 - 1)$$

$$= 34 \text{ J}$$

7. The figure shows an 8 kg stone resting on a spring. The spring is compressed 10 cm by the stone. The stone is pushed down an additional 30 cm and released. The potential (in Jouls) is stored in the spring just before the stone is released is

a) 64 b) 128 c) 36 d) 18 e) 5 f) Other



$mg = kx_0$ (equilibrium)

$k = \frac{mg}{x_0} = \frac{(8)(10)}{(0.1)} = 800$ N/m

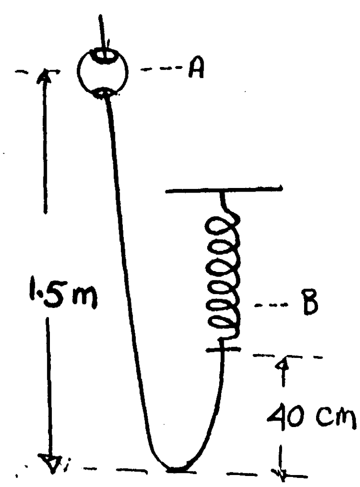
$U_s = \frac{1}{2}kx^2$

$= \frac{1}{2}(800)(0.4)^2 = 64$ J

8. A 300 g bead slides on a frictionless wire as in figure. The bead starts from rest at A and is stopped momentarily at B after colliding and compressing the spring. If the spring is compressed a distance of 10 cm by the bead, then the force constant of the spring k (N/m) is:

a) 300 b) 660 c) 600 d) 450 e) 150 f) Other

$E_A = E_B$ & $K_A = K_B = 0$



$U_A = U_B + U_s$

$(0.3)(10)(1.5) = (0.3)(10)(0.5) + \frac{1}{2}k(0.1)^2$

$4.5 = 1.5 + \frac{1}{2}k(0.1)^2$

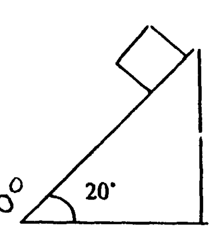
$k = 600$ N/m

9. A 2 kg mass is released from rest at the top of an inclined plane. The coefficient of kinetic friction between the mass and the plane is 0.2. Then the speed (in m/s) of mass after sliding 4 m along the plane is:

a) 2.2 b) 3.0 c) 3.5 d) 5.2 e) 0 f) Other

$W_f = \Delta K + \Delta U_g$

$-\mu_k N d = \frac{1}{2}mv^2 - mgx\sin 20^\circ$



$-(0.2)(2)(10)\cos 20^\circ(4) = \frac{2}{2}v^2 - (2)(10)(4)\sin 20^\circ$

$-15.04 = v^2 - 27.36$

$v^2 = 12.32 \rightarrow v = 3.5$ m/s

10. Three particles are placed in the x-y plane so that the center of mass of their system is at the origin (0,0). If m_1 = 50 g is located at (2, 4) and m_2 = 20 g is located at (-1, -4) then m_3 = 40 g must be located at:

a) (-2, -3) b) (3, -4) c) (2, 2) d) (2, 1) e) (1, -2) f) Other

$$x_{cm} = 0 = \frac{(50)(2) + (20)(-1) + (40)(x)}{50 + 20 + 40}$$

$$80 = -40x \longrightarrow x = -\frac{80}{40} = -2\ \text{m}$$

$$y_{cm} = 0 = \frac{(50)(4) + (20)(-4) + (40)(y)}{50 + 20 + 40}$$

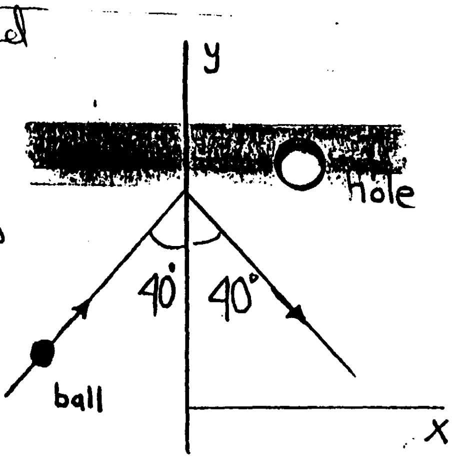
$$120 = -40y \longrightarrow y = \frac{-120}{4} = -3\ \text{m}$$

11. A 170 g ball with an initial speed of 3 m/s bounces off a rail of horizontal table with the same speed as shown in the figure. If x and y axes are located as shown, then the change in the ball's linear momentum (in kg.m/s) in unit-vector notation is:

a) -0.78 j b) 0.78 i c) 0.39 i d) 0.26 j e) –0.26 j f) Other

As $P_{xi} = P_{xf} \rightarrow P_x$ is conserved

P_y only



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

$$= -mv\cos 40\hat{j} - mv\cos 40\hat{j}$$

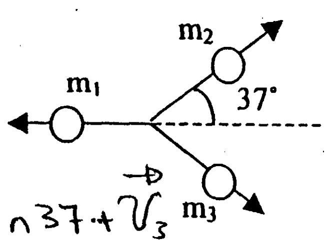
$$= -2mv\cos 40\,\hat{j}$$

$$= (-2)(0.17)(3)\cos 40^\circ\,\hat{j}$$

$$= -0.78\,\hat{j}$$

12. A vessel at rest explodes into three equal pieces as shown in the figure. If m_1 moves with speed of 3m/s while m_2 moves with speed of 4 m/s, then the speed (in m/s) of m_3 is:

a) 1 b) 2.4 c) 3.2 d) 6.7 e) 7 f) Other



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

$$0 = \cancel{m}\vec{v}_1 + \cancel{m}\vec{v}_2 + \cancel{m}\vec{v}_3$$

$$0 = -3\hat{i} + 4\cos 37\,\hat{i} + 4\sin 37 + \vec{v}_3$$

$$0 = -3\hat{i} + 3.2\hat{i} + 2.4\hat{j} + \vec{v}_3$$

$$\vec{v}_3 = -0.2\hat{i} - 2.4\hat{j}$$

$$v_3 = \sqrt{(-0.2)^2 + (-2.4)^2} = 2.4\ \text{m/s}$$