Kuwait University
Physics Department

Physics 101

2nd Midterm

Summer Semester
Saturday, August, 2, 2003
5 p.m. – 7 p.m.

Student's Name: .... اكل الخوفزمي ....

Student's Number: ....

Choose your Instructor's Name :

○ Dr. Adnan Al-Yaseen
○ Dr. Hala Al Jassar
○ Dr. Abdulnasser Burezq
○ Dr. Abdulmuhsen Habeeb
○ Dr. Yaccob Makdisi

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, 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.

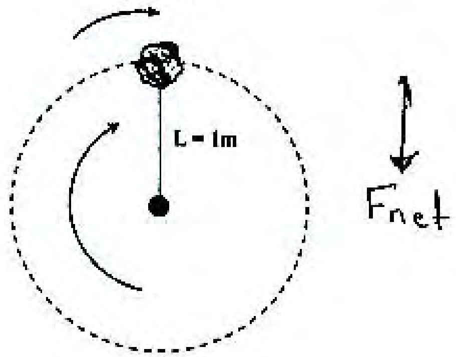
1. One end of a 1.0 m string is fixed; the other end is attached to a 2.0 kg stone. The stone swings in a vertical circle. Find the speed (in m/s) of the stone at the top point if the magnitude of the net force exerted there on the stone is 32 N.

a) 0 [✓ b) 4.0] c) 3.2 d) 2.4 e) 5 f) Other

$$F_{net} = \sum F = 32 = m\frac{v^2}{r}$$

$$v = \sqrt{\frac{(32)(1)}{2}}$$

$$= \sqrt{16} = 4 \text{ m/s}$$



2. A box with a weight of 55 N, rests on a horizontal rough surface. A person pulls horizontally on it with a force $F_1 = 10$ N and it does not move. To start it moving, a second person pulls vertically upward on the box with a minimum force $F_2 = 30$ N. Find the coefficient of static friction μ_s.

a) 0.1 b) 0.2 c) 0.3 [✓ d) 0.4] e) 0.6 f) Other

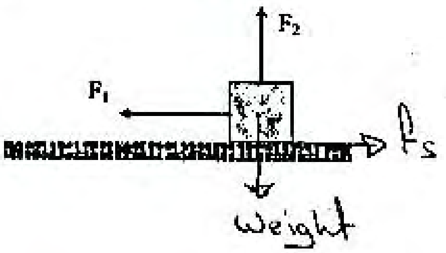
$$\underline{\underline{x}} \quad \sum F_x = f_s - F_1 = 0$$

$$\mu_s N = F_1$$

$$\underline{\underline{y}} \quad \sum F_y = F_2 + N = 55$$

$$\therefore N = 55 - 30 = 25 \text{ N}$$

$$\therefore \mu_s = \frac{F_1}{N} = \frac{10}{25} = 0.4$$



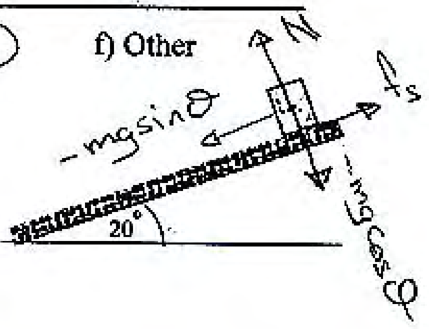
3. A block of 0.2 kg is initially at rest on inclined plane. If $\mu_s = 0.6$, and $\mu_k = 0.5$, then the acceleration (in m/s^2) of the block is:

a) 0.3 b) 1.3 c) 4.7 d) 2.3 [✓ e) 0] f) Other

$$f_s = \mu_s N = \mu_s mg\cos\theta$$

$$= (0.6)(0.2)(10)\cos 20$$

$$= 1.13$$

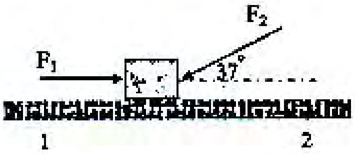


$$mg\sin\theta = (0.2)(10)(\sin 20) = 0.68$$

$$\text{as } f_s > mg\sin\theta \Rightarrow a = 0$$

4. A block slides on a rough surface from point 1 to point 2 as shown. How much work (in Joules) is done by friction force if the kinetic energy at points 1 and 2 are 6J and 2J respectively? Take $F_1 = 10$ N, $F_2 = 3$ N, and the distance between points 1 and 2 is 2m.

[✓ a) -19.2] b) -10.8 c) -21.4 d) -11.4 e) -8.4 f) Other



$$W_{net} = W_{F_1} + W_{F_2} + W_f = K_2 - K_1$$

$$(10)(2) - (3)(\cos 37^\circ)(2m) + W_f = 2 - 6$$

$$15.2 + W_f = -4$$

$$W_f = -19.2 \text{ J}$$

5. A variable force is acting on a particle and is given by $\vec{F} = x\hat{i} + 2\hat{j} + 3z^2\hat{k}$ N, where x, y, z are in meters. The work done (in Joules) by this force as the particle moves from position $\vec{r}_1 = 2\hat{i} + \hat{j} + \hat{k}$ to position $\vec{r}_2 = 4\hat{i} + 2\hat{j} + 3\hat{k}$ is:

a) 15 b) 39 c) 26 d) 40 [✓ e) 34] f) Other

$$W_x = \int_2^4 x\,dx = \left(\frac{x^2}{2}\right)_2^4 = \frac{1}{2}[16 - 4] = 6 \text{ J}$$

$$W_y = \int_1^2 2\,dy = [2y]_1^2 = 4 - 2 = 2 \text{ J}$$

$$W_z = \int_1^3 3z^2\,dz = [z^3]_1^3 = 27 - 1 = 26 \text{ J}$$

$$W = W_x + W_y + W_z = 6 + 2 + 26 = 34 \text{ J}$$

6. A constant force $\vec{F} = 4\hat{i} + 5\hat{j}$ is acting on a 5 kg object which has its position given by $\vec{r} = 4t^3\hat{i} + 6t\hat{j}$. The power (in W) at t = 3 is:

a) 6.4 b) 548 c) 30 d) 42.6 [✓ e) 462] f) Other

$$P = \vec{F} \cdot \vec{v}$$

$$\vec{v} = 12t^2\,\hat{i} + 6\hat{j}$$

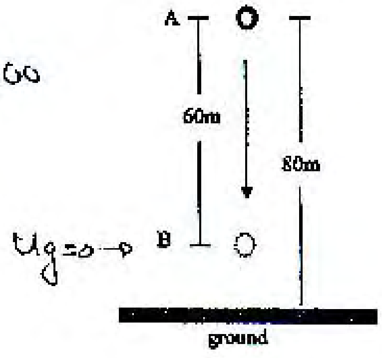
$$P = (4\hat{i} + 5\hat{j}) \cdot (12t^2\,\hat{i} + 6\hat{j})$$

$$= 48t^2 + 30 = (48)(3)^2 + 30$$

$$= 462 \text{ Watts}$$

7. A 6 kg ball is thrown vertically downward from point A with $v_o = 20$ m/s from 80 m above the ground as shown. If the work done by the air resistance is - 400 J, find the kinetic energy at point B in J is:

[✓ a) 4400] b) 3500 c) 1200 d) 2400 e) 40 f) Other



$\Delta K + \Delta U = W_f$

$[K_f - \frac{1}{2}(6)(20)^2] + [0 - mgh] = -400$

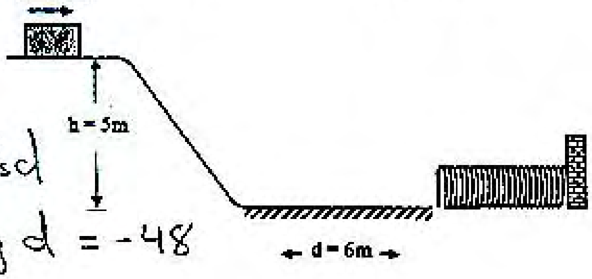
$K_f = 1200 + (6)(10)(60) - 400$

$= 1200 + 3600 - 400$

$= 4400$ J

8. A 2 kg block with initial velocity $v_i = 6$ m/s moves as shown down the slop. It hits a spring of K = 1100 N/m after it passes over a 6 meter long rough surface of $\mu_k = 0.4$. By how much the spring will be compressed (in m)?

a) 0.16 b) 0.04 [✓ c) 0.4] d) 0.02 e) 0.06



$\Delta K + \Delta U_g + \Delta U_s = -f_k d$

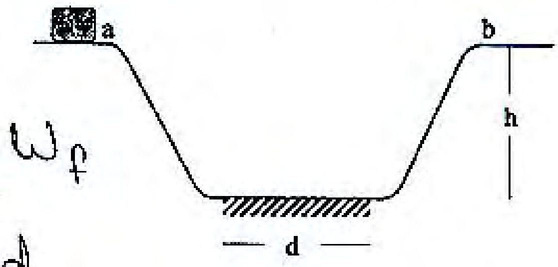
$(0 - \frac{1}{2}mv_i^2) + (0 - mgh) + (\frac{1}{2}kx^2 - 0) = -f_s d$

$-36 - 100 + 550x^2 = -\mu_s mgd = -48$

$x^2 = 0.16 \Rightarrow x = 0.4$ m

9. In the figure: $\mu_k = 0.3$, h = 5 m, mass of the block = 4 kg and the length of the rough region d = 5 m. What is the minimum initial velocity for the block at location **a** to be able to reach location **b** of the same level (in m/s):

a) 0.67 [✓ b) 5.48] c) 30 d) 43.6 e) 68.8



$\Delta K + \Delta U = W_f$

$[(mgh) - (mgh)] + [0 - \frac{1}{2}mv_i^2] = W_f$

$\frac{1}{2}\cancel{m}v_i^2 = \mu_k \cancel{m}gd$

$v_i^2 = 30 \Rightarrow v = 5.48$ m/s

10. Three masses are located as follows: 3 kg at (0,8), 1 kg at (12, 0), 4 kg at (x, y) and all are in meters. Find x, and y (in m) if the center of mass of the system is at the origin (0,0).

[✓ a) (-3, -6)] b) (-12, -8) c) (3,6) d) (-6,-3) e) Other

$$x_{cm} = \frac{m_1x_1+m_2x_2+m_3x_3}{m_1+m_2+m_3} \Rightarrow 0 = \frac{(3)(0)+(1)(12)+4x}{8}$$

$$0 = 12+4x \Rightarrow x = \frac{-12}{4} = -3 \text{ m}$$

$$y_{cm} = \frac{m_1y_1+m_2y_2+m_3y_3}{m_1+m_2+m_3} \Rightarrow 0 = \frac{(3)(8)+(1)(0)+4y}{8}$$

$$0 = 24+4y \Rightarrow y = \frac{-24}{4} = -6 \text{ m}$$

11. A 4.2 kg object, initially at rest, explodes into three objects of equal mass. Two of these are determined to have velocities of equal magnitudes 5 m/s with directions that differ by 90°. What is the total kinetic energy (in J) that is released in the explosion?

[✓ a) 70] b) 53 c) 60 d) 64 e) 35 f) Other

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

$$(4.2)(0) = m(5\hat{i}) + m(5\hat{j}) + m\vec{v}_f$$

$$\vec{v}_f = -5\hat{i} - 5\hat{j}$$

$$\Rightarrow v_f = \sqrt{50}$$ and as $m = \left(\frac{4.2}{3}\right)$ kg

$$K_f = \frac{1}{2}\left(\frac{4.2}{3}\right)\left[v_1^2+v_2^2+v_3^2\right] = (0.7)[25+25+50]$$

$$= (0.7)(100) = 70 \text{ J}$$

12. Two particles have masses $m_1 = 2$ kg and $m_2 = 4$kg, and velocities $\vec{v}_1 = 3\hat{i}+3\hat{j}$ (m/s) and $\vec{v}_2 = 6\hat{j}$ (m/s), respectively. Calculate the speed of their center of mass (in m/s).

a) 1 b) 4.2 c) 6 d) 30.6 [✓ e) 5.6] f) Other

$$\vec{v}_{cm} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1+m_2} = \frac{(2)(3\hat{i}+3\hat{j})+(4)(6\hat{j})}{2+4}$$

$$= \frac{6\hat{i}+6\hat{j}+24\hat{j}}{6}$$

$$\vec{v}_{cm} = \hat{i}+5\hat{j} \Rightarrow v_{cm} = \sqrt{1+25}$$

$$= 5.6 \text{ m/s}$$