Kuwait University
Physics Department

Physics 101

Second Midterm Exam
Fall 2007-2008
Saturday, December 8, 2007
9:00 a.m. – 10:30 a.m.

…………………………………………………………………………… Stu…'s Name:

…………………………………………………………………………… … Number:

…e y… Ins…tor's Name :

Prof. Fekri El-…ad.	D… Hasan Rafaat
Dr. Yacoub M…i	… Adnan Al-Yaseen
Dr. Ahmed Ali Al-Ja…	Dr. Ismail Sabbah
Dr. A…l Mohsen Ha…	Dr. Fatemah Al-Douseri
Dr. …rek Al Refaey	Dr. Tarek Ramadan

Grades:

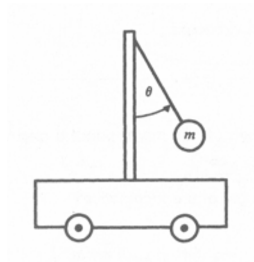
Problem	Q1	Q2	Q3	Q4	P1	P2	P3	P4	P5	P6	P7	P8	Total
Points													

Important Notes:

1. The exam contains **4 questions** and **8 problems** in **4 pages** plus the front page.
2. Answer all questions and problems.
3. Each question will be assigned 1 point.
4. Each problem will be assigned 2 points.
5. **No solution for problems = no points**.
6. Check the correct answer for each question.
7. **Take g = 10 m/s^2**
8. Mobiles and Pagers are not allowed during the exam.
9. Programmable calculators which can store equations are not allowed.

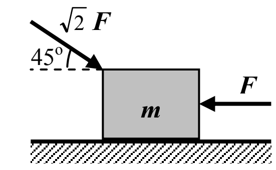
Part I: Questions ***Choose the correct answer***

1. A ball is attached to the vertical post of a cart by a string. If the cart is **moving to the left** at **constant speed** then the string makes an angle θ with the post, which is



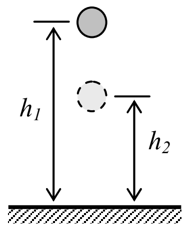
(a) zero (b) towards the right (c) towards the left
(d) changing as the mass moves

2. A box of mass m is held stationary on a **rough** horizontal surface by two applied forces, as shown in the figure. The static frictional force f_s on the box has magnitude



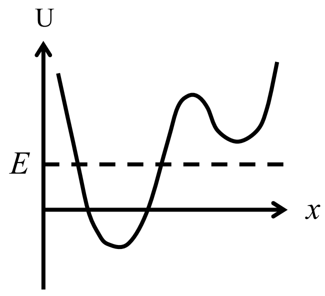
(a) $\mu_s\, mg$ (b) $\mu_s\,(mg + F)$ (c) F (d) zero

3. A ball is dropped from a height h_1. It strikes the floor and rebounds to a maximum height $h_2 < h_1$. The work done on the ball by the gravitational force W_g and the corresponding change in mechanical energy ΔE are



(a) $W_g > 0$ and $\Delta E = 0$ (b) $W_g < 0$ and $\Delta E = 0$ (c) $W_g > 0$ and $\Delta E < 0$
(d) $W_g < 0$ and $\Delta E < 0$

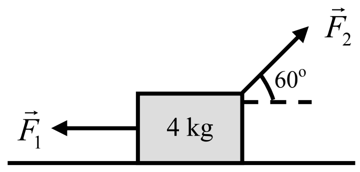
4. The potential energy U of a particle moving is the x-direction is shown. If the total mechanical energy of the particle is E, then the number of **stable-equilibrium** points the particle has is



(a) 2 (b) 3 (c) 1 (d) None

Part II: Problems ***Solve the following problems***

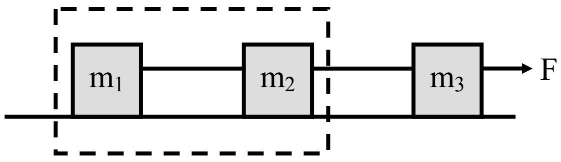
1. Two forces $\vec{F}_1$ and $\vec{F}_2$ act on a 4-kg mass placed on a frictionless horizontal surface, as shown in the figure. If the mass slides across the surface to the right with acceleration $a = 2$ m/s^2, and $F_1 = 10$ N, find the magnitude of $\vec{F}_2$ (in N).



$$F_2 \cos(60^o) - F_1 = ma$$

$$F_2 = \frac{F_1 + ma}{\cos(60^o)} = 2(10 + 4x2) = 36N$$

2. Three identical blocks m_1 = 6 kg, m_2 = 4 kg, and m_3 = 2 kg are pulled across a frictionless horizontal surface by a force F=24 N applied to m_3. Find the net force (in N) on the system that consists of m_1 and m_2 (enclosed by the dashed rectangle).



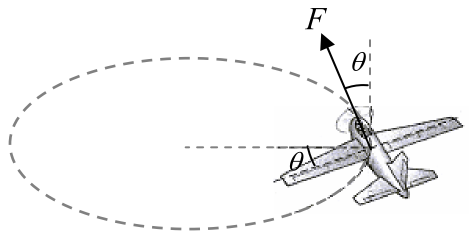
$$F = (m_1 + m_2 + m_3)a$$

$$a = \frac{F}{(m_1 + m_2 + m_3)} = \frac{24}{12} = 2 \text{ m/s}^2$$

$$F_{1,2} = (m_1 + m_2)a$$

$$F_{1,2} = (6+4)x2 = 20N$$

3. A plane is flying at a speed of 540 km/h. The lift force F on the wings due to the air is normal to the plane as shown in the figure. At what angle θ (in degrees) to the vertical must the plane be banked to fly in a horizontal circle of radius 4.5 km ?



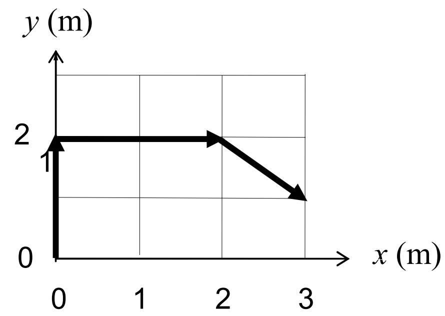
$$F\sin(\theta) = \frac{mV^2}{R}$$

$$F\cos(\theta) = mg$$

$$\tan(\theta) = \frac{V^2}{Rg}$$

$$\theta = \tan^{-1}\left(\frac{V^2}{Rg}\right) = \tan^{-1}\left(\frac{(540/3.6)^2}{4500x10}\right) \approx 26.6^o$$

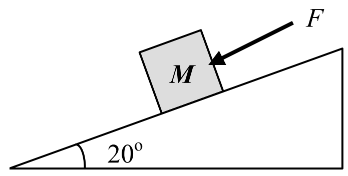
4. A particle moves in the x-y plane between the points (0,0) and (3,1) along the path shown by the arrows. Find the work done (in Joules) by a constant force $\vec{F} = 2\hat{i} + 4\hat{j}$ N along this path.



$$\vec{d} = 2\hat{j} + 2\hat{i} + (\hat{i} - \hat{j}) = 3\hat{i} + \hat{j} \text{ m}$$

$$W_F = \vec{F} \bullet \vec{d} = (2\hat{i} + 4\hat{j}) \bullet (3\hat{i} + \hat{j}) = 6 + 4 = 10J$$

5. A mass M=5 kg is initially at rest on a rough 20^o incline (μ_s = 0.6). Then, a force F is applied on the mass in the direction shown. Find the minimum value of F (in N) required to slide the mass down the incline (i.e. at which the mass is on the verge of slipping down).



$$F + Mg\sin(\theta) - \mu_s Mg\cos(\theta) = 0$$

$$F = \mu_s Mg\cos(\theta) - Mg\sin(\theta)$$

$$F = 0.6x5x10x\cos(20^o) - 5x10x\sin(20^o) \approx 11N$$

6. A 2 kg mass starts moving from rest at t=0 under the action of a **conservative force.** The potential energy (in Joules) associated with this force is given by $U(x) = -4x$, where x is in meters. Find the power (in Watt) delivered by this force to the 2 kg mass at t =2s.

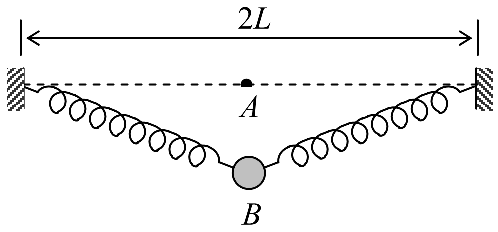
$$F = -\frac{dU}{dx} = 4N$$

$$a = \frac{F}{m} = \frac{4}{2} = 2m/s^2$$

$$V = V_0 + at = 0 + 2x2 = 4m/s$$

$$P_F = FV = 4x4 = 16W$$

7. A particle is suspended by two identical springs each of unstreched length L=0.8 m and spring constant k=300 N/m. It is released from rest at point A when both strings are unstreched. If it momentarily stops at point B which is 0.6 m below A, find the mass (in kg) of the particle.



$$E_B = E_A$$

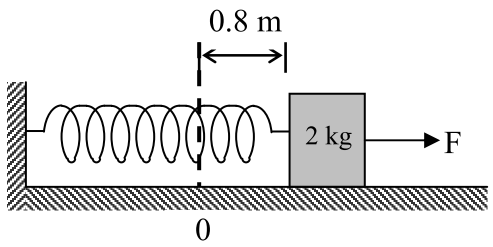
$$K_B + U_{gB} + U_{eB} = K_A + U_{gA} + U_{eA}$$

$$0 + 0 + 2\left(\frac{1}{2}kx^2\right) = 0 + mgh + 0$$

$$k(L' - L)^2 = mgh \quad L' = \sqrt{L^2 + h^2}$$

$$m = \frac{k(L' - L)^2}{gh} = \frac{300x(0.2)^2}{6} = 2kg$$

8. A 2-kg block is attached to a spring (k = 100 N/m) on a horizontal rough surface. Initially the block is at rest while the spring is in the relaxed position. A force F=120 N is then applied to the block causing it to move with a speed of 4 m/s when the spring is stretched by 0.8 m. How much thermal energy (in Joules) due to friction has been released during this motion?



$$W_F = Fx = 120x0.8 = 96J$$

$$W_s = -\frac{1}{2}kx^2 = -0.5x100x(0.8)^2 = -32J$$

$$\Delta K = \frac{1}{2}mV^2 = 0.5x2x(4)^2 = 16J$$

$$W_f = \Delta K - W_s - W_F = -48J$$

$$\Delta E_{th} = -W_f = 48J$$