Kuwait University Physics Department

Physics 101
Second Midterm Examination
Monday, April 29, 2002
5-7 PM

حل نموذجي

Student's Name: ~~.........................~~ Student's Number: ....

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For use by instructors only

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

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

P1- The pilot of an airplane flies 39° north of east with a speed of 80 km/h relative to the ground in a wind blowing 40 km/h towards the east. What is the velocity (in unit vector notation) of his airplane relative to the wind?.

(a) $(40\hat{i}+80\hat{j})$ km/h (b) $(40\hat{i}-80\hat{j})$ km/h (c) $(50.34\hat{i}+22.17\hat{j})$ km/h

$\boxed{\text{(d) } (22.17\hat{i}+50.34\hat{j}) \text{ km/h}}$ (e) other

The General Equation $\vec{v}_{PW} = \vec{v}_{Pg} + \vec{v}_{gW}$

$\therefore v_{PW} = 80(\cos 39°)\hat{i} + 80(\sin 39°)\hat{j} + (-40)\hat{i}$ (where $\vec{v}_{gW} = -\vec{v}_{Wg}$)

$= 62.17\hat{i} - 40\hat{i} + 50.34\hat{j}$

$= [22.17\hat{i} + 50.34\hat{j}]$ m/s #

P2- A 0.2-kg pendulum bob is held at an angle θ from the vertical by a 2-N horizontal force $\vec{F}$ as shown. The tension in the string supporting the bob (in Newtons) is

(a) $\cos\theta$ $\boxed{\text{(b) } 2/\cos\theta}$ $\boxed{\text{(c) } 2\sqrt{2}}$ (d) 1 (e) other

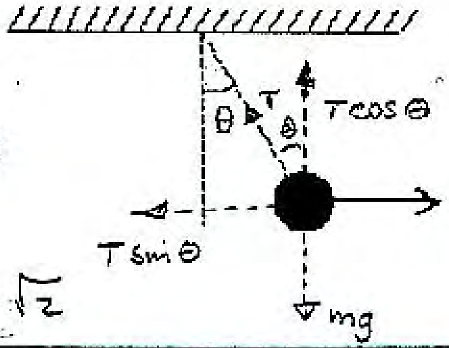
(x) $F - T\sin\theta = 0 \Rightarrow F = T\sin\theta$

(y) $T\cos\theta - mg = 0 \Rightarrow mg = T\cos\theta$

divide both equations: $\frac{T\sin\theta}{T\cos\theta} = \frac{F}{mg}$

$\Rightarrow \theta = \tan^{-1}\frac{F}{mg} = \tan^{-1} 1 = 45°$

$\therefore T\cos 45° = (.2)(10) \Rightarrow T = \frac{2}{\cos\theta} = 2\sqrt{2}$



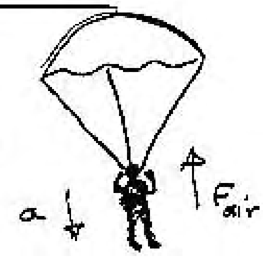
P3- An 80 kg person is parachuting and experiencing a downward acceleration of 2.5 m/s^2. The mass of the parachute is 5.0 kg. What is the upward force on the open parachute from the air?

$\boxed{\text{(a) } 637.5 \text{ N}}$ (b) 1062.5 (c) 850 N (d) 250 N (e) –850 N (f) other

- Total mass $80 + 5 = 85$ Kg
- Newton's Second Law $F_{net} = ma$

$\Rightarrow F_{air} - mg = ma$ where $a = -2.5$ (down)

$F_{air} = m(g-a) = 85(10-2.5) = 637.5$ N



P4- A pilot of mass 90 kg executes a looping-the-loop maneuver makes a vertical loop of 3000 m radius with a speed of 720 km/h. Determine the force (in Newtons) exerted by the seat on the pilot at the top of the loop.

(a) 900 N (b) 600 N $\boxed{\text{(c) } 300 \text{ N}}$ (d) 0 N (e) other

from the figure we see that N, mg and $\frac{v^2}{R}$ have minus sign because they are all inward

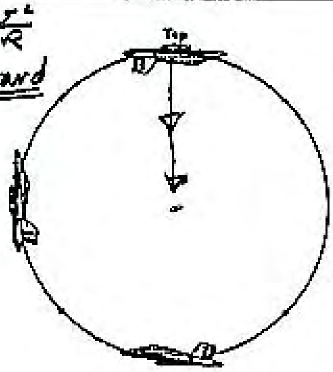
$\Rightarrow$ Newton's Second Law

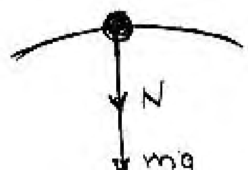
$-N - mg = m\left(\frac{-v^2}{R}\right)$ multiply by -1

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

But $v = \frac{720 \times 1000}{3600} = 200$ m/s

$\therefore N = 90\left(\frac{(200)^2}{3000} - 10\right) = +300$ N #

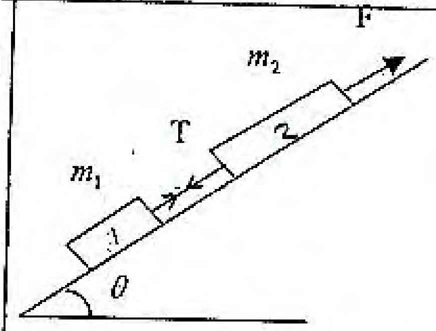




P5- Two blocks of masses $m_1 = 20$ kg and $m_2 = 40$ kg are pulled up along a rough incline with a force $\vec{F}$ as shown in the Figure. If $\mu_k = 0.3$, $\theta = 37°$ and T =168 N, then the magnitude of the force $\vec{F}$ is

(a) 336 N $\boxed{\text{(b) 504 N}}$ (c) 436 N (d) 240 N (e) 168 N (f) other

$\sin 37° \simeq .6 \qquad \cos 37° \simeq .8$



on m_1 (x) $T - m_1 g \sin\theta - f_k = m_1 a \qquad f_k = \mu_k N_1$

(y) $N_1 = m_1 g \cos\theta \simeq 160$ N

so $a = \dfrac{T - m_1 g \sin\theta - \mu_k N_1}{m_1}$

$a = \dfrac{168 - (20)(10)(.6) - (.3)(160)}{20} = 0$

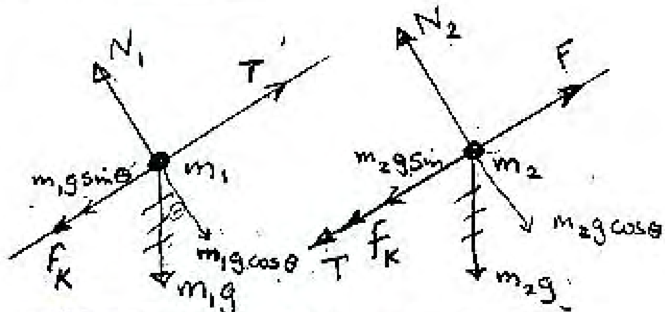
on m_2 (x) $F - m_2 g \sin\theta - f_k - T = \cancel{m_2 a}^{0}$

(y) $N_2 = m_2 g \cos\theta \simeq 320$ N

$\Rightarrow F = T + f_k + m_2 g \sin\theta$

$F = 168 + (.3)(320) + (40)(10)(.6)$

$= 504$ N #



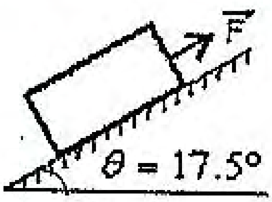
P6- What is the work W_F needed to push a 1000-kg box by a force F for 300 m up a smooth-incline ($\theta = 17.5°$) with constant speed of 5 m/s.

(a) $2.86 \times 10^6\ J$ $\boxed{\text{(b) } 9 \times 10^5\ J}$ (c) 0 J (d) 286 kJ (e) other

Speed is constant means $a = 0$

ΔK also is = zero

But $W_F = F \cdot d \cdot \cos\phi$ where $\phi = 0$

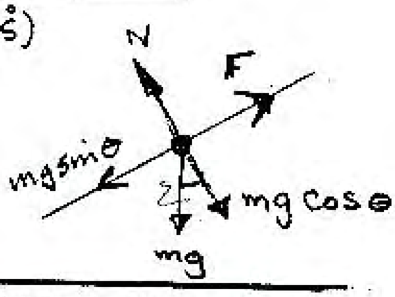


using newton's Law.

(x) $F - mg\sin\theta = 0 \Rightarrow F = (1000)(10)(\sin 17.5°)$

$F \simeq 3007$ N

$\therefore W_F = (3007)(300) = 9.02 \times 10^5\ J$ #



P7- A 2.0-kg body starts moving at x = 0 along the x axis with initial velocity $v_i = 5.0$ m/s. The only force acting on the body is $F_x = -(4x)$ N, where x is in m. For what value of x will this object first come (momentarily) to rest?

(a) 4.2 m (b) 3.5 m (c) 5.3 m (d) 6.4 m (e) 5.0 m (f) other

$\Rightarrow$ using variable force Law $\quad W = \int F(x)\,dx$

also we know $W = \Delta K = K_f - K_i$

$\Rightarrow \quad 0 - \frac{1}{2} m v_i^2 = \int_0^x (-4x)\,dx$

$-\frac{1}{2}(2)(5^2) = \left[-\frac{4x^2}{2}\right]_0^x$

$-25 = -2x^2$

$x^2 = \frac{25}{2} \Rightarrow x = 3.53$ m #

P8. The position of a 1-kg block moving in the xy plane is given by $\vec{r} = (t^3 - 2t^2)\hat{i} + 4t^2\hat{j}$, with r meters and t (>0) in seconds. Find the power delivered to the block by a single acting force $\vec{F}$ at t = 2s.

(a) 228 W (b) 200 W (c) 180 W (d) 160 W (e) other

Power $= \vec{F}\cdot\vec{v} = m\vec{a}\cdot\vec{v}$

$\Rightarrow \vec{v} = \frac{d\vec{r}}{dt} = (3t^2 - 4t)\hat{i} + 8t\hat{j}$ also $\vec{a} = \frac{d\vec{v}}{dt} = (6t-4)\hat{i} + 8\hat{j}$

$\Rightarrow$ Power at 2s $= 1\cdot\vec{a}(2)\cdot\vec{v}(2) = [(6(2)-4)\hat{i} + 8\hat{j}]\cdot[(3(2)^2 - 4(2))\hat{i} + 8(2)\hat{j}]$

$P = [8\hat{i} + 8\hat{j}]\cdot[4\hat{i} + 16\hat{j}] = (32) + (128) = 160\text{ W}$ #

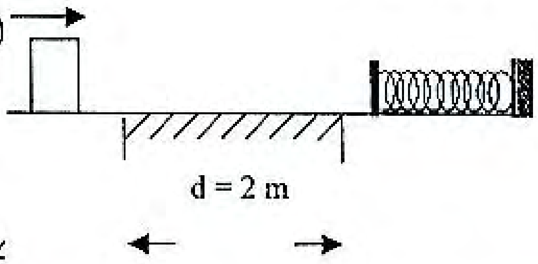
Scalar

P9- A block of mass m = 4-kg slides with a velocity $v_i = 5$ m/s over a frictionless surface towards a spring with spring constant K = 8000 N/m. During its journey it passes over 2 meters of a rough region with $\mu_k = 0.5$ as shown in the figure. The maximum compression of the spring is

(a) 2 cm (b) 5 cm (c) 4 cm (d) 10 cm (e) other

$\Delta E = W_f$

$E_f - E_i = -\mu_k N d$



$\frac{1}{2}Kx^2 - \frac{1}{2}mv_i^2 = -(.5)mg(2)$

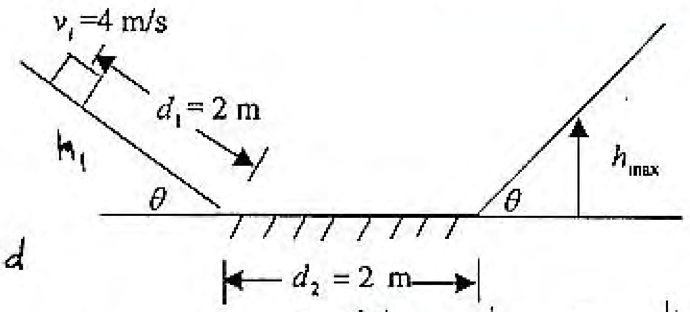
$\frac{1}{2}(8000)x^2 - 50 = -40$

$x^2 = \frac{10}{4000} = 2.5\times10^{-3}$

$x = .05\text{ m} = 5\text{ cm}$ #

P10 - A 2-kg block starts to slide down a smooth incline for a distance $d_1 = 2$ m with initial velocity of 4 m/s. The block continues motion on a rough horizontal surface whose coefficient of kinetic friction $\mu_k = 0.4$ for a distance $d_2 = 2$ m. Determine the maximum height (h_{max}) of the block as it travels along the second smooth incline [$\theta = 37°$ for both inclines].

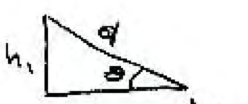
(a) 1.8 m (b) 1.2 m (c) 0 m (d) 1.53 m (e) 0.6 (f) other



$\Delta E = W_f$

$E_f - E_i = -\mu_k N d$

$[\cancel{m}gh_{max}]_f - [\frac{1}{2}\cancel{m}v_i^2 + \cancel{m}gh_1]_i = -(.4)(\cancel{2})(10)(2)$



$\sin\theta = \frac{h_1}{d}$

$h_1 = d\sin\theta$

$h_1 = 1.2$ m

$10\,h_{max} - \frac{1}{2}(4)^2 - 10(1.2) = -(.4)(1.2)(10)$

$10\,h_{max} - 8 - 12 = -8$

$h_{max} = \frac{20-8}{10} = \frac{12}{10} = 1.2$ m #