PHY 2048-S4, Fall 2009

Examination #1
September 24, 2009
Instructor: Beatriz Roldan Cuenya

Name_______________________________________ID______________

Please answer all questions.

#1______________

#2______________

#3______________

#4______________

#5______________

Total: ___________

Show all work and enter answers in boxes, if provided.

1. An object moves along the x-axis according to the equation:
   $x(t) = (2\,t^2 + t - 1)$ m, where t is in seconds. Determine: *(20 points)*

   (a) the average speed between t = 1 s and t = 4 s,
   (b) the instantaneous speed at t = 3 s
   (c) the average acceleration between t = 1 s and t = 4 s,
   (d) the instantaneous acceleration at t = 3 s

(a) v_{avg} = m/s	(b) v = m/s	(c) a_{avg} = m/s^2	(d) v_{avg} = m/s^2

2. A car (initially at rest) starts moving with a constant acceleration of 2 m/s^2 until it reaches a speed of 8 m/s. He then keeps that speed constant for some time. If the total distance traveled is 250 m, how much time does it take for the total trip of the car? *(20 points)*

t =	s

3. A particle undergoes three consecutive displacements: *(20 points)*

$\overrightarrow{\Delta r_1} = (10\,\hat{i} - 2\,\hat{j})$ m

$\overrightarrow{\Delta r_2} = (13\,\hat{i} + 11\,\hat{j})$ m

$\overrightarrow{\Delta r_3} = (-9\,\hat{i} + 5\,\hat{j})$ m

(a) Find the components of the resultant displacement.
(b) Find the magnitude and the direction (angle) of the resultant displacement.

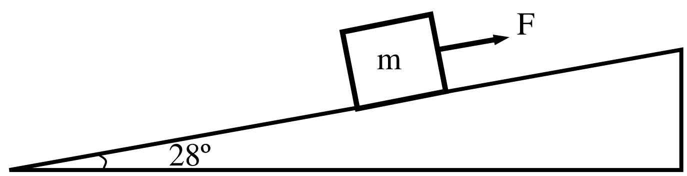
(a) $\overrightarrow{\Delta r}$ =	(b) Δr = θ =

4. A football player kicks a ball from a point at ground level located 30 m horizontally away from the goal, and he tries to hit the crossbar which is 4 m high. When kicked, the ball leaves the ground at an angle of 47° to the horizontal. What initial speed must the football have in order to hit the crossbar? (Neglect air friction). *(20 points)*

$V_0 =$ m/s

5. The object in the figure ($m = 2$ kg) is being pulled up by the external force F and moves with a constant acceleration of 3 m/s^2. The coefficient of kinetic friction between the object and the incline is 0.2, and the angle θ of the incline is 28º. *(20 points)*

(a) Calculate the magnitude of the force F.
(b) Calculate the magnitude of the normal force and indicate its direction in the figure below.



(a) F = N	(b) N = N

Formula sheet **PHY 2048**

$$\vec{v} = \vec{v}_0 + \vec{a}t$$

$$\vec{r} = \vec{r}_0 + \vec{v}_0 t + 0.5\vec{a}t^2$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

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

$$F_s = -kx$$

$$a_c = \frac{v^2}{r}$$

$$E_{mec} = K + U$$

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

$$W_{net} = -\Delta U$$

$$\Delta E = \Delta K + \Delta U$$

$$\Delta E = \Delta K + \Delta U + \Delta E_{th}$$

$$\Delta E_{th} = f_k d$$

$$U(y) = mgy$$

$$U(x) = \frac{1}{2}kx^2$$

$$K = \frac{1}{2}mv^2$$

$$\vec{p} = m\vec{v}$$

$$\vec{F}_{ext} = \frac{d\vec{p}}{dt}$$

$$\vec{F}_{ext} = M\vec{a}_{COM}$$

$$\vec{a}_{COM} = \frac{d^2\vec{R}_{COM}}{dt^2}$$

$$\vec{R}_{COM} = \frac{1}{M_{tot}}\sum_i m_i \vec{r}_i$$

$$\vec{R}_{COM} = \frac{1}{M_{tot}}\int_V \vec{r}\, dm$$

$$\tau = I\alpha = r_\perp F = rF_\perp$$

$$s = \theta \cdot r$$

$$\omega = \omega_0 + \alpha \cdot t$$

$$a_t = \alpha \cdot r$$

$$K_{rot} = \frac{1}{2}I\omega^2$$

$$K_{tot} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$I = \sum_i m_i r^2$$

$$I = \int r^2\, dm$$

$$I = I_{COM} + Mh^2$$

$$a_r = \frac{v^2}{r} = r\omega^2$$

$$I_{disk} = \frac{1}{2}mR^2 = I_{cylinder}$$

$$I_{ring} = mR^2$$

$$I_{sphere} = \frac{2}{5}mR^2$$

$$Rv_{rel} = Ma$$

$$v_f - v_i = v_{rel}\ln\frac{M_i}{M_f}$$

MIDTERM 1

(1) $x(t) = 2t^2 + t - 1$

(a) $V_{avg} = \frac{x(4) - x(1)}{4-1} = \frac{35m - 2m}{3s} = \frac{33m}{3s} =$

$x(4) = 32 + 4 - 1 = 35m$

$x(1) = 2 + 1 - 1 = 2m$

(b) $v = \frac{dx}{dt} = 4t + 1$

$v(3) = 12 + 1 = \boxed{13 m/s}$

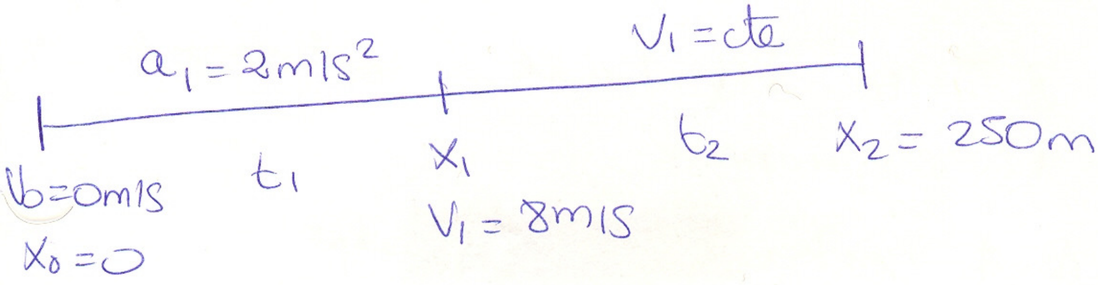
(c) $a_{avg} = \frac{v(4) - v(1)}{4-1} = \frac{17 - 5 \, m/s}{3s} = \boxed{4 m/s^2}$

$v(4) = 4 * 4 + 1 = 17$

$v(1) = 5$

(d) $a = \frac{dv}{dt} = \frac{dx^2}{dt^2} = \boxed{4 m/s^2}$

$\boxed{2}$



$$\boxed{t_T = t_1 + t_2} \rightarrow t_2$$

(1) $x_1 - \cancel{x_0} = \frac{1}{2} a_1 t_1^2 \rightarrow \boxed{x_1 = \frac{1}{2}\left(2\frac{m}{s^2}\right) \cdot t_1^2 = t_1^2}$

(2) $x_2 - x_1 = v_1 \cdot t_2 \rightarrow \boxed{250 - x_1 = 8 \cdot t_2}$

(2) $250 - t_1^2 = 8 t_2$

(3) $a_1 = \frac{v_1 - \cancel{v_0}}{t_1} \Rightarrow v_1 = a_1 \cdot t_1 = \left(2\frac{m}{s^2}\right) \cdot t_1 = 8 m/s$

$\Rightarrow t_1 = \frac{v_1}{a_1} = \frac{8 \cancel{m}/\cancel{s}}{2 \cancel{m}/s^{\cancel{2}}} = \boxed{4 s}$

(1) $x_1 = t_1^2 = 16 m$

(2) $t_2 = \frac{250 - x_1}{8} = \frac{250 m - 16 m}{8 m/s} = \boxed{29.25 s}$

$t_T = 29.25 s + 4 s = \boxed{33.25 s}$

(3) $\vec{\Delta r_1} = 10\hat{i} - 2\hat{j}$

$\vec{\Delta r_2} = 13\hat{i} + 11\hat{j}$

$\vec{\Delta r_3} = -9\hat{i} + 5\hat{j}$

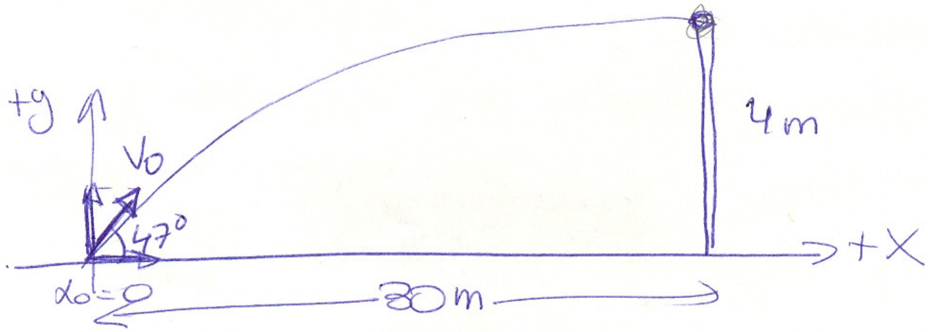
(a) $\vec{\Delta r_T} = 14\hat{i} + 14\hat{j}$

(b) $|\vec{\Delta r}| = \sqrt{14^2 + 14^2} = \boxed{19.80\ m}$

(c) $\tan\theta = \frac{14}{14} \rightarrow \boxed{\theta = 45°}$

4

4



$$x - \cancel{x_0} = (V_0 \cos 47^\circ) \cdot t$$
$$y - \cancel{y_0} = (V_0 \sin 47^\circ) t - \frac{1}{2} g t^2$$

$$30\ m = 0.682\ V_0 \cdot t \rightarrow V_0 = \frac{44}{t} = \boxed{18.35\ m/s}$$
$$4\ m = V_0 (0.731) t - 4.9 t^2$$

$$4 = \left(\frac{44}{\cancel{t}}\right) \cdot \cancel{t} (0.731) - 4.9 t^2 \rightarrow 4 = 32.16 - 4.9 t^2$$

$$\boxed{t = 2.397\ s}$$

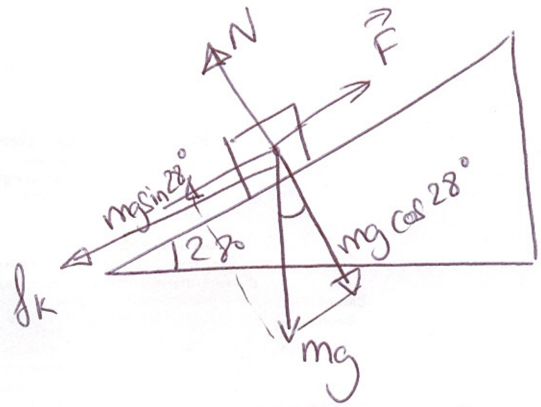
5 $m = 2\,kg$

$a = 3\,m/s^2$

$\mu_k = 0.2$

a) F?

b) N?



$f_k = \mu_k \cdot N = \mu_k \cdot mg\cos 28° = (0.2)(2\,kg)(9.8\,m/s^2)\cdot\cos 28° = 3.46\,N$

(a) $F - mg\sin 28° - f_k = ma$

$F - 3.46\,N - 9.20\,N = 2a = 6\,N \Rightarrow \boxed{F = 18.66\,N}$

(b) $N = mg\cos 28° = \boxed{17.3\,N}$