Phys 2107 Physics for Engineers I

Test I 03/03/2008 5:30-6:30 p.m.

ID:	Name:	Sec:	Score:

Please check that you have 5 multiple-choice questions and 2 classical problems. **Total Score 50**

1. Multiple –choice questions (15 points)

1a. A projectile is shot vertically upward with a given initial velocity. It reaches a maximum height of 100 m. If, on a second shot, the initial velocity is doubled then the projectile will reach a maximum height of:

A) 70.7 m B) 141.4 m C) 200 m D) 241 m E) 400 m

1b. At a location where $g = 9.8 m/s^2$, an object is thrown vertically down with an initial speed of 1.00 m/s. After 5.00 s the object will have traveled:

A) 125 m B) 127.5 m C) 245 m D) 250 m E) 255 m

1c. Vectors $\vec{A}$ and $\vec{B}$ each have magnitude L. When drawn with their tails at the same point, the angle between them is 30°. The value of scalar product $\vec{A} \bullet \vec{B}$ is:

A) zero B) L^2 C) $\frac{\sqrt{3}L^2}{2}$ D) $2L^2$ E) none of these

1d. A projectile is fired over level ground with an initial velocity that has a vertical component of 20 m/s and a horizontal component of 30 m/s. Using g = 10 m/s2, the distance from launching to landing points (range) is:

A) 40 m B) 60 m C) 80 m D) 120 m E) 180 m

1e. A 70-kg man stands in an elevator that has a downward acceleration of $1.8 m/s^2$. The force exerted by him on the floor is about:

A) zero B) 90 N C) 560 N D) 880 N E) 1010 N

2. Let $\vec{r} = x(t)\hat{i} + y(t)\hat{j}$ represents the position vector of a particle where $x(t) = 2 - 3t + 2t^2$ and $y(t) = 2t - t^2$ are measured in meters and time in second.

(a) Calculate the average velocity in unit vector notation between $t = 2s$ and $t = 3s$.

(b) Find the position vector in unit vector notation when the particle reaches its maximum y coordinate.

(c) Find the velocity in unit vector notation when $x = 1m$.

(d) When is the velocity perpendicular to the acceleration? **(17points)**

(a) $\vec{r}(3) = (2-9+18)\hat{i} + (6-9)\hat{j} = 11\hat{i} - 3\hat{j}$

3 $\vec{r}(2) = (2-6+8)\hat{i} + (4-4)\hat{j} = 4\hat{i}$

$\Delta\vec{r} = \vec{r}(3) - \vec{r}(1) = 7\hat{i} - 3\hat{j}, \quad \Delta t = 3-2 = 1$

$\vec{V}_{avg} = \frac{\Delta\vec{r}}{\Delta t} = 7\hat{i} - 3\hat{j}$ m/s

(b) $V_y = \frac{dy}{dt} = 0 \Rightarrow 2 - 2t = 0, \quad t = 1s$

4 $\vec{r}(1) = (2-3+2)\hat{i} + (2-1)\hat{j}$

$\boxed{\vec{r}(1) = \hat{i} + \hat{j}}$

(c) $\vec{V} = (-3+4t)\hat{i} + (2-2t)\hat{j}$

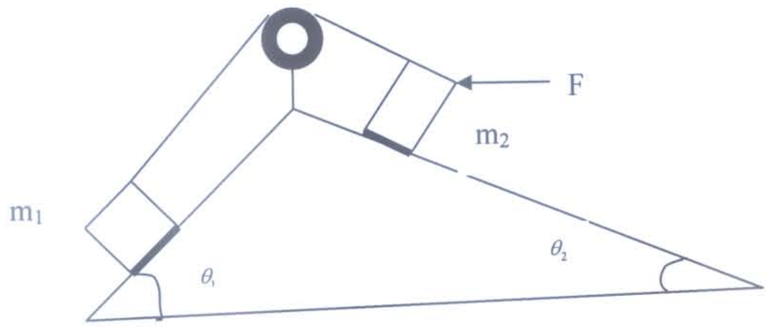
$x = 1 \Rightarrow 2t^2 - 3t + 1 = 0 \Rightarrow t_1 = 1s, \quad t_2 = 0.5s$

3 $\boxed{\vec{V}(1) = \hat{i}}$ 3 $\boxed{\vec{V}(0.5) = -\hat{i} + \hat{j}}$

(d) $\vec{a} = 4\hat{i} - 2\hat{j}$

4 $\vec{a} \cdot \vec{V} = 0 \Rightarrow -12 + 16t - 4 + 4t = 0$

$20t = 16 \Rightarrow \boxed{t = 0.8\,s}$



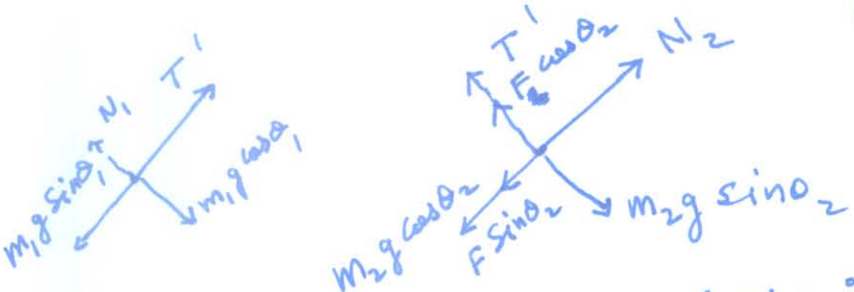
3. Two blocks of masses $m_1 = 2kg$, $m_2 = 4kg$ are connected to each other by a cord over a massless pulley as shown in the figure where the angles of the inclined planes with horizontal plane are $\theta_1 = 53^\circ, \theta_2 = 30^\circ$. A horizontal force $\vec{F}$ is applied to the block of mass $4kg$ to keep the system at rest. The system is released from rest by removing the force $\vec{F}$ when the block of mass $4kg$ is $1.5m$ from the ground.

(a) Find the magnitude of the force $\vec{F}$ and the normal force on block of mass m_2.

(b) Calculate the magnitude of the acceleration of the system and the tension T after the force $\vec{F}$ is removed

(c) Find the speeds of the blocks just before the $4kg$ block hits the ground. **(18 points)**

Free-body diagrams:



(a) $T' = m_1 g \sin\theta_1$, $N_1 = m_1 g \cos\theta_1$

$T' = m_2 g \sin\theta_2 - F\cos\theta_2$

$N_2 = F\sin\theta_2 + m_2 g \cos\theta_2$

$$F = \frac{(m_2\sin\theta_2 - m_1\sin\theta_1)g}{\cos\theta_2} = \frac{(4\sin 30^\circ - 2\sin 53^\circ)\,9.8}{\cos 30^\circ} = \underline{4.6\ N = F}$$

4

$\boxed{N_2 = 36.2\ N}$ 4

(b) When F is removed

$$\left.\begin{aligned} T - m_1 g\sin\theta_1 &= m_1 a \\ m_2 g \sin\theta_2 - T &= m_2 a \end{aligned}\right\} \Rightarrow a = \frac{(m_2\sin\theta_2 - m_1\sin\theta_1)g}{m_1 + m_2} = 0.66\ m/s^2$$

4

$T = m_1(g\sin\theta_1 + a) = 2(9.8\sin 53^\circ + 0.66)$

4 $\boxed{T = 17\ N}$

(c) $V^2 = 2a\Delta x$, $V = \sqrt{2\times 0.66\times 1.5}$

$\boxed{V = 1.4\ m/s}$ 2