Physics 2210
Spring Semester 2008
Anthony Pantziris

EXAM 2

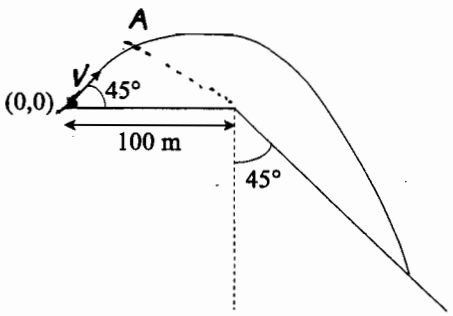
1

Name: _____ unid: u _ _ _ _ _ _ _ _

Discussion TA (circle): Aaron Yuan (Xiao)

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

A projectile is launched from the point (x = 0, y = 0) at an angle of 45.0° and a speed of 50.0 m/s. The ground is level for 100 m and then drops at a 45.0° slope.



(a) Find the maximum height of the projectile.
(b) Find the speed of the projectile 3.00 s after launch.
(c) Find the x and y coordinates of the point of impact of the projectile.
(d) Find the speed of the projectile at the time of impact.
(e) Find the time of flight of the projectile.

Sol: (a) $\frac{v\sin\theta+0}{2}\cdot\frac{v\sin\theta}{g}=\frac{v^2\sin^2\theta}{2g}=\frac{50^2\times\sin^2 45^\circ}{2\times9.8}=63.8\ m$

(b) $V_x = V\cos\theta$

$V_y = V\sin\theta - gt$

$v=\sqrt{V_x^2+V_y^2}=\sqrt{(50\times\cos45^\circ)^2+(50\times\sin45^\circ-9.8\times3)^2}=35.9\ m/s$

c) The trajectory of the projectile is

$$\begin{cases} x = V\cos\theta\, t \quad (*) \\ y = V\sin\theta\, t - \frac{1}{2}gt^2 \end{cases} \Rightarrow y = \tan\theta\cdot x - \frac{g}{2V^2\cos^2\theta}x^2 = x - \frac{g}{V^2}x^2 \quad (1)$$
$$= x - 3.92\times10^{-3}x^2$$

The slope can be described by $y = -(x-100) = -x+100$ (2)

combine eq① and eq②, we get

$X_1 = 454\ m$, $Y_1 = -354\ m$

$X_2 = 56.1\ m$, $Y_2 = +43.9\ m$

X_2 & is the point A on the diagram. so it is not the point we want. Only (X_1, Y_1) is resonable.

d) From eq (*), we get $t = \frac{x}{V\cos\theta} = \frac{454}{50\times\cos45^\circ} = 12.8\ s$

$V = \sqrt{(V\cos\theta)^2+(V\sin\theta-gt)^2} = \sqrt{(50\times\frac{\sqrt{2}}{2})^2+(50\times\frac{\sqrt{2}}{2}-9.8\times12.8)^2} = 97.8\ m/s$

e) · we have solved it in d). $t = 12.8\ s$.

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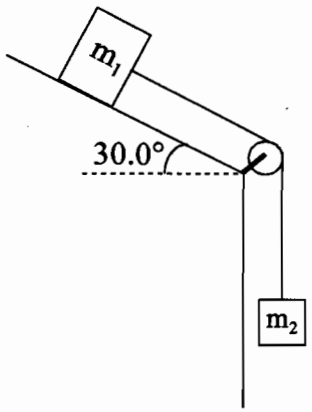
Discussion TA (circle): Aaron Yuan Xiao

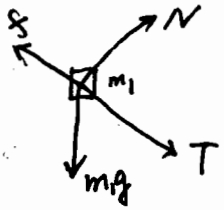
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Two blocks, $m_1 = 200$ kg and $m_2 = 100$ kg, are connected by a lightweight cord over a lightweight frictionless pulley as shown in the drawing. The coefficient of kinetic friction between the block and the incline is 0.300.



(a) Draw free body diagrams for each block.
(b) Find the acceleration of the blocks.
(c) Find the tension of the cord.
(d) Find the minimum coefficient of static friction between the block (m_1) and the incline such that the blocks do not move.

Sol: a):



b) $\begin{cases} T - \mu m_1 g\cos\theta + m_1 g\sin\theta = m_1 a & ① \\ m_2 g - T = m_2 a & ② \end{cases}$

① + ② $\Rightarrow$ $m_2 g - \mu m_1 g\cos\theta + m_1 g\sin\theta = (m_1 + m_2)\, a$

$\Rightarrow$ $a = \dfrac{m_2 g - \mu m_1 g\cos\theta + m_1 g\sin\theta}{m_1 + m_2}$ (*) $= \dfrac{100\times 9.8 - 0.3\times 200\times 9.8\times\cos 30^\circ + 200\times 9.8\times\sin 30^\circ}{200 + 100}$

$= 4.84\ m/s^2$

c) $T = mg - m_2 a = 100\times 9.8 - 100\times 4.84 = 496\ N$

d) It means that the eq.(*) for a can be rewritten as

$0 = a = \dfrac{m_2 g - \mu m_1 g\cos\theta + m_1 g\sin\theta}{m_1 + m_2}$

$\Rightarrow$ $\mu = \dfrac{m_2 g + m_1 g\sin\theta}{m_1 g\cos\theta} = \dfrac{100 + 200\times\sin 30^\circ}{200\times\frac{\sqrt{3}}{2}} = 1.15$

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EXAM 2

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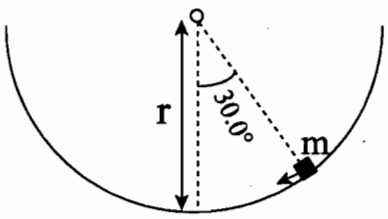
Name: Solution unid: u _ _ _ _ _ _ _ _

Discussion TA (circle): Aaron Yuan Xiao

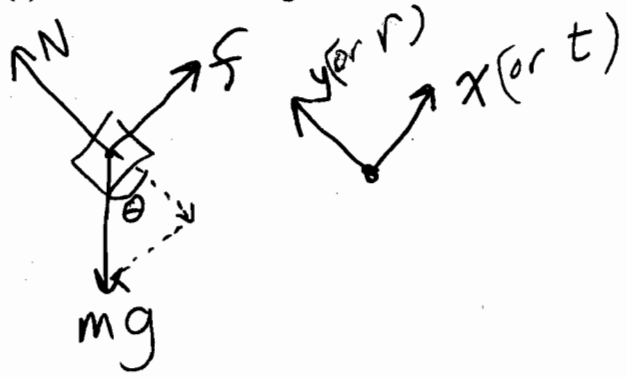
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

A block of mass m = 2.00 kg slides inside a semicircular surface of radius r = 0.500 m as in the figure. When the block is located at an angle of 30.0° from the vertical, its speed is 0.500 m/s and is sliding downward. The coefficient of kinetic friction between the block and the surface is 0.250.



(a) Draw a free body diagram for the block at that point.
(b) Calculate the centripetal acceleration of the block at that point.
(c) Calculate the normal force on the block at that point.
(d) Calculate the tangential acceleration of the block at that point.
(e) What is the magnitude of the net force on the block at that point?

a)



e) $|\vec{a}| = \sqrt{a_t^2 + a_c^2}$
$= 2.697\ m/s^2$
$|\vec{F}| = m|\vec{a}| = 5.39\ N$

b) $a_c = \frac{v^2}{r} = \frac{(.500\ m/s)^2}{.500\ m} = .500\ m/s^2$

c) $\Sigma F_y = N - mg\cos\theta = \frac{mv^2}{r}$
$\Rightarrow N = mg\cos\theta + \frac{mv^2}{r}$
$= 16.97\ N + 1.00\ N = 18.0\ N$

d) $\Sigma F_x = f - mg\sin\theta = -ma_t \Rightarrow a_t = g\sin\theta - \frac{\mu N}{m} = 2.65\ m/s^2$
(4.90, .250, 18.0; $\mu N \to 2.00$)