# Midterm #1

Physics 1A - Dr. Mostafa El Alaoui

Winter – January 28, 2014

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Signature [redacted]

Please do the following 4 problems. Show all work and reasoning. Use the back of the page if necessary and circle your final answer. **Write your name and student ID on your exam.**

| Problem | Points |
|---|---|
| 1 | 25 |
| 2 | 25 |
| 3 | 25 |
| 4 | 25 |
| TOTAL | |

Name

## Problem 1

A sports car is traveling down a straight road at 40.0 m/s (constant speed). It passes a police car waiting (stationary) by the side of the road. At the moment the sports car passes the police car, the police car starts to accelerate at a constant rate of 0.600 $m/s^2$.

(10 Points) a) How much time does it take for the police car to catch up with the sports car?

(8 Points) b) How far does the police car travel before it catches up with the sports car?

(7 Points) c) What is the speed of the police car at the time it catches up with the sports car? forward is the positive direction

sports car
$x = x_0 + v_0 t + \frac{1}{2}at^2$
$x = 40t$

police
$x = x_0 + v_0 t + \frac{1}{2}at^2$
$x = \frac{1}{2}(0.600)t^2$

a) $40t = \frac{1}{2}(0.600)t^2$

$0 = 0.3t^2 - 40t$

$0 = t(0.3t - 40)$

$t = 0, 133.33$ seconds

133 seconds 10

b) police

$x = \frac{1}{2}(0.600)t^2$

$x = \frac{1}{2}(0.600)(133.33)^2$

$x = 5333$

5330 m 6

c) police

$v_f = v_0 + at$

$v_f = 0 + 0.600(133.33)$

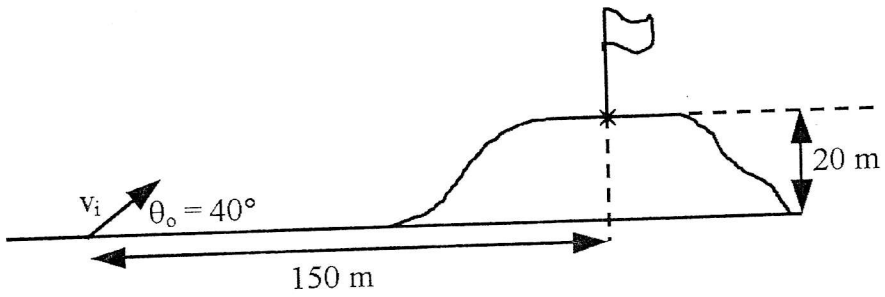
$v_f = 80.0$

80.0 m/s 7

Name

## Problem 2

A golfer is 150 m from the flag of an elevated green 20 m above his position (see figure). He hits a golf ball at an angle of 40° to the horizontal with an initial velocity $v_i$. The ball strikes the base of the flag stick.

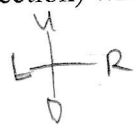



(12 Points) a) What is the magnitude of the initial velocity ($v_i$)?

(5 Points) b) How long is the ball in the air?

(8 Points) c) What is the velocity of the ball (magnitude and direction) when it strikes the flag stick?

up and right are positive





a) $x = 150m$ $y = 20m$

$v_{ox} = v_o \cos 40$ $v_{oy} = v_o \sin 40$

$a_x = 0$ $a_y = -9.8$

$x = x_o + v_{ox}t + \frac{1}{2}a_x t^2$

$150 = v_o \cos 40\, t$

$v_o = \frac{150}{\cos 40\, t}$ Sub in

$y = y_o + v_{oy}t + \frac{1}{2}a_y t^2$

$20 = v_o \sin 40\, t - 4.9t^2$

$20 = \frac{150 \sin 40\, t}{\cos 40 t} - 4.9t^2$

$20 = 150 \tan 40 - 4.9t^2$

$t = 4.648$

$v_o = \frac{150}{\cos 40 \cdot 4.648}$

$v_o = 42.13$

42.1 m/s

b) 4.65 seconds

c) x component

$v_{fx} = v_{ox} + at$

$v_{fx} = v_{ox}$

$v_{fx} = 42.1 \cos 40$

$= 32.25$ m/s right

y component

$v_{fy} = v_{oy} + at$

$v_{fy} = 42.1 \sin 40 - (9.8)(4.65)$

$= -18.51$ up

32.25, -18.51, θ

$v_f = \sqrt{v_{fx}^2 + v_{fy}^2}$

$= 37.18$ m/s

$\tan\theta = \left(\frac{-18.51}{32.25}\right)$

$\theta = -29.85°$

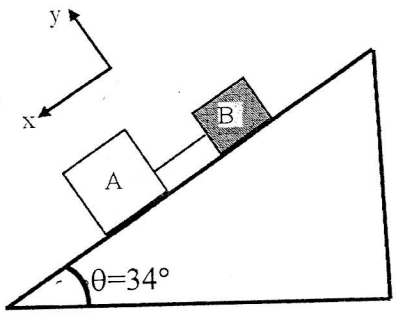
37.2 m/s 29.9° down at right

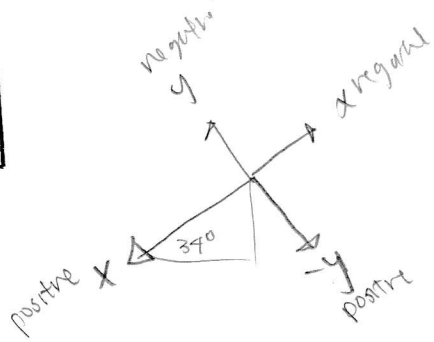
+25

Name: _____

## Problem 3

Two blocks A and B are sliding down an inclined plane. They are connected by a massless cord. Block A has a mass $m_A$=5.00 kg and a coefficient of kinetic friction with the plane $\mu_A$=0.20 while block B has a mass $m_B$=4.0 kg and a coefficient of kinetic friction with the inclined plane of $\mu_B$=0.35. The slope of the plane's inclination is. The acceleration of gravity is g=9.8 m/s$^2$.



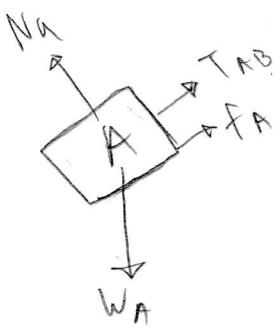

(8 Points) a) Draw free-body diagrams for both masses.

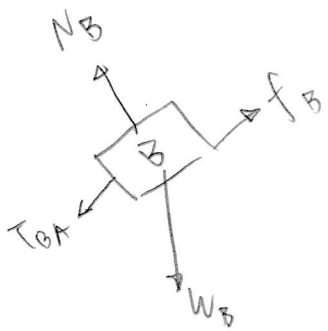
(10 Points) b) What is the acceleration of the blocks?

(7 Points) c) What is the tension in the string?

a)

positive in the x and y direction




c) $m_a a = mg\sin\theta - T_{AB} - 0.20(5)(9.8)\cos 34$

$5(3.31) = 19.2758 - T_{AB}$

$T_{AB} = 2.726\,N$

$T_{AB} = \boxed{2.73\,N}$

b) $\Sigma F = ma$

$m_a a = mg\sin\theta - T_{AB} - f_A$

$5(a) = 5(9.8)\sin 34 - T_{AB} - (0.20)(5)(9.8)\cos 34$

$5a = 19.2758 - T_{AB}$

$m_b a = mg\sin\theta + T_{BA} - f_B$

$4(a) = 4(9.8)\sin 34 + T_{BA} - (0.35)(4)(9.8)\cos 34$

$4a = 10.546 + T_{BA}$

adding the equations together →

$5a + 4a = 19.2758 + 10.546$

$9a = 29.821$

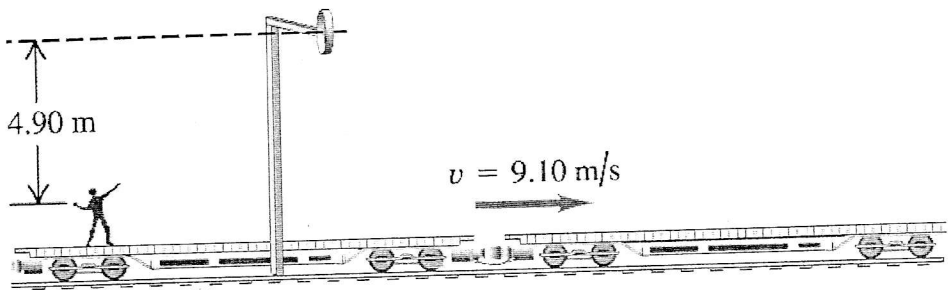
$a = 3.314$

$a = \boxed{3.31\,m/s^2}$

Nam

## Problem 4

A man is riding on a flatcar traveling at a constant speed of 9.10 m/s (see figure). He wishes to throw a ball through a stationary (on the ground) hoop 4.90 m above the height of his hands in such a manner that the ball will move horizontally as it passes through the hoop. He throws the ball with a speed of 10.8 m/s with respect to himself.




(8 Points) a) What must the vertical component of the initial velocity of the ball be?

(5 Points) b) How many seconds after he releases the ball will it pass through the hoop?

(12 Points) c) At what horizontal distance in front of the hoop must he release the ball?

→ 9.10 → $v_0 \cos\theta$

Up and right are positive

a) $v_f^2 = v_0^2 + 2ax$

$0 = (10.8\sin\theta)^2 + 2(-9.8)(4.9)$

$\theta = 65.15°$

$10.8 \sin 65.15 =$ **9.80 m/s up** 8

b) $y = y_0 + v_0 t + \frac{1}{2}at^2$

$4.9 = 10.8\sin 65\, t - 4.9t^2$

$4.9t^2 - 10.8\sin 65\, t + 4.9 = 0$

$4.9(t^2 - 2t + 1) = 0$

$4.9(t-1)^2 = 0$

$t = 1$

**1.00 seconds** 5

c) $x = x_0 + v_0 t + \frac{1}{2}at^2$

$x = 0 + (10.8\cos 65 + 9.10)(1) + 0$

$x = 13.66$

**13.7m before the hoop**

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