Phys 111.01 – Fall 2009 – Midterm 1 Solutions

A. MULTIPLE-CHOICE QUESTIONS. **CIRCLE THE BEST ANSWER** (7 Pts. each): (White Version)

1. An airplane is flying at 40 m/s due East relative to the air. The air is moving at 30 m/s due North and carries the plane with it. How fast is the plane moving relative to the ground?

a) 70 m/s
b) 50 m/s
c) 40 m/s
d) 30 m/s
e) 10 m/s

$\vec{V}_{pg} = (40\ m/s)\hat{x} + (30\ m/s)\hat{y}$

$V_{pg} = \sqrt{(40\ m/s)^2 + (30\ m/s)^2} = 50\ m/s$

2. In the above problem 1, what is the direction angle of the airplane's velocity?

a) 90° North of East
b) 53° North of East
c) 37° North of East
d) 30° North of East
e) 0° North of East

$\theta = \arctan\left(\frac{V_y}{V_x}\right) = \arctan\left(\frac{30}{40}\right) = 37°$ (N of E)

3. A car of mass 1000 kg is traveling at constant speed around a circular track of radius R= 200 m. If the friction between the tires and the road is exerting a force of 2000 N toward the center of the circle, what is the speed of the car?

a) 500 m/s
b) 200 m/s
c) 100 m/s
d) 20 m/s
e) 10 m/s

$F_{cp} = 2000N = mv^2/r$

$v^2 = \frac{(200m)(2000N)}{1000\ kg} = 400\ m^2/s^2$

$v = 20\ m/s$

4. You place a mass of 10 kg on one end of a spring of original length 1.0 m whose other end is hanging from the ceiling. The spring constant is 300 N/m. What will be the length of the spring after you hang the mass ?

a) 1.43 m
b) 1.33 m
c) 1.23 m
d) 1.13 m
e) 1.03 m
f) 0.33 m

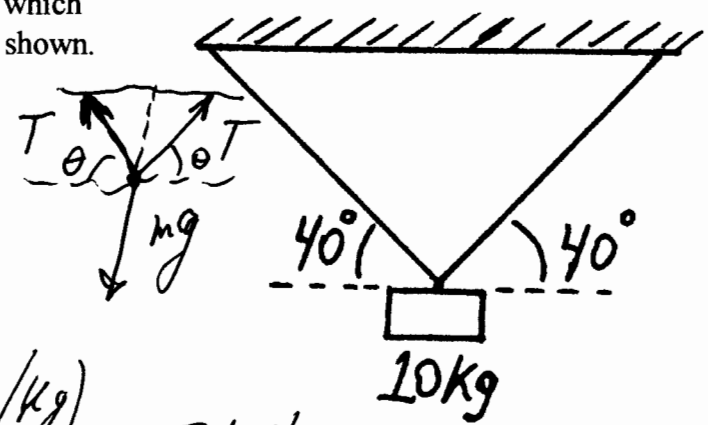
$F_{sp} = mg = k\,x_{str}$

$x_{str} = \frac{(10kg)(9.8N/kg)}{300N/m} = 0.33\ m$

$\ell = 1.0m + 0.33m = 1.33\ m$

5. A box of mass 10 kg is supported by two ropes which each make an angle of 40° with the horizontal, as shown. What is the tension in each of the ropes?

a) 152N
b) 128 N
c) 76 N
d) 64 N
e) 49 N
f) 38 N



$2T\sin\theta = mg$

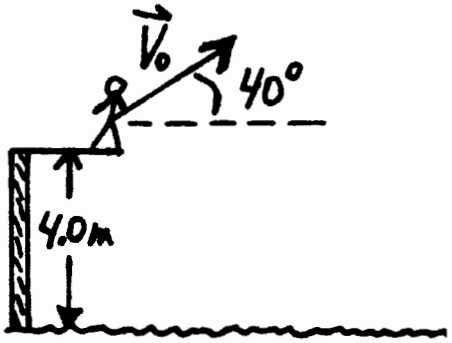
$T = \frac{mg}{2\sin\theta}$

$= \frac{(10kg)(9.8N/kg)}{2\sin(40°)} = 76\ N$

PROBLEMS. BE SURE TO **SHOW YOUR METHOD CLEARLY**. (6 points for each problem part.)

1. A diver of mass 70 kg jumps off a diving board at a speed of 12 m/s at an angle of 40° above the horizontal. The diving board is 4.0 m above the water. Neglect air resistance.

a) What is the acceleration of the diver at the highest point in her motion?



$-g$

$-9.80\ m/s^2$

a = $-9.8\ m/s^2$; $9.8\ m/s^2$ down

b) What is the vertical component of the diver's initial velocity?

$V_{oy} = V_o \sin(40°) = (12\ m/s)\sin(40°) = 7.71\ m/s$

v_y = 7.71 m/s

c) How long does it take for the diver to reach the highest point of the motion?

At high pt., $V_y = 0 = V_{yo} - gt$

$t = \frac{V_{yo}}{g} = \frac{7.71\ m/s}{9.8\ m/s^2} = 0.79\ s$

t = 0.79 s

d) What will be the diver's horizontal component of velocity at the highest point of the motion, **assuming it takes 5.0 s to reach the highest point**?

$V_x = V_{xo} = V_o \cos(40°) = (12\ m/s)\cos(40°) = 9.19\ m/s$

v_x = 9.19 m/s

e) What is the speed of the diver as she hits the water, **assuming it takes 2.0 seconds to reach the water after reaching the high point.**?

V_{y_0} = 0 at high pt.

$$V_y = V_{y_0} - gt = (-9.8\ m/s^2)(2.0\ s) = -19.6\ m/s$$

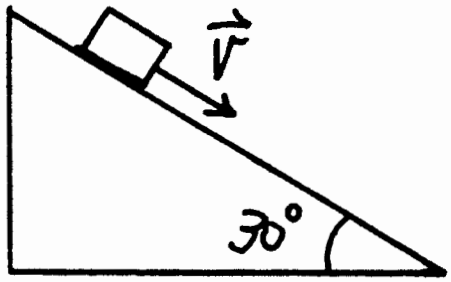
$$V_x = V_{x_0} = 9.19\ m/s$$

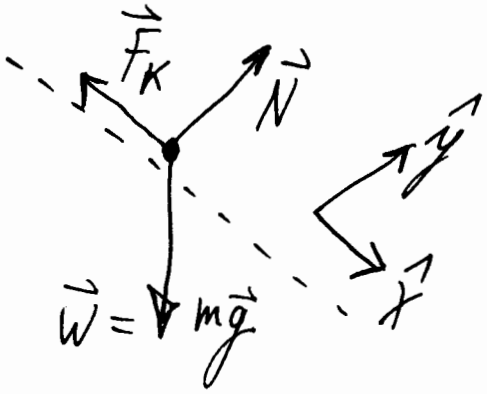
$$v = \sqrt{V_x^2 + V_y^2} = 21.6\ m/s$$

$v_f =$ 21.6 m/s

2. A box of mass 3.0 kg is sliding down an inclined plane of angle 30°, as shown. The friction coefficients between the box and the plane are $\mu_s = 0.35$ and $\mu_k = 0.25$.

a) Draw a free body diagram for the box, showing all forces that act on it.





b) What is the magnitude of the normal force exerted by the plane on the box?

$$N = mg\cos 30° = (3.0\ kg)(9.8\ N/kg)\cos 30°$$

$F_{normal} =$ 25.5 N

c) What is the size of the friction force acting on the box during the motion, **assuming the normal force is 20N**?

$$F_K = \mu_K N = (0,25)(20N) = 5,0N$$

$F_{friction}$ =	5,0 N

d) What is the size of the component of gravitational force that acts parallel to the inclined plane?

$$W_x = mg \sin 30° = (3,0\,kg)(9,8\,N/kg)\sin(30°)$$

$F_{parallel}$ =	14,7 N

e) What is the size of the net force on the box (based on your answers to parts c and d)?

$$\Sigma \vec{F} = (\Sigma F_x)\hat{x}$$

$$\Sigma F_x = 14,7N - 5,0N = 9,7N$$

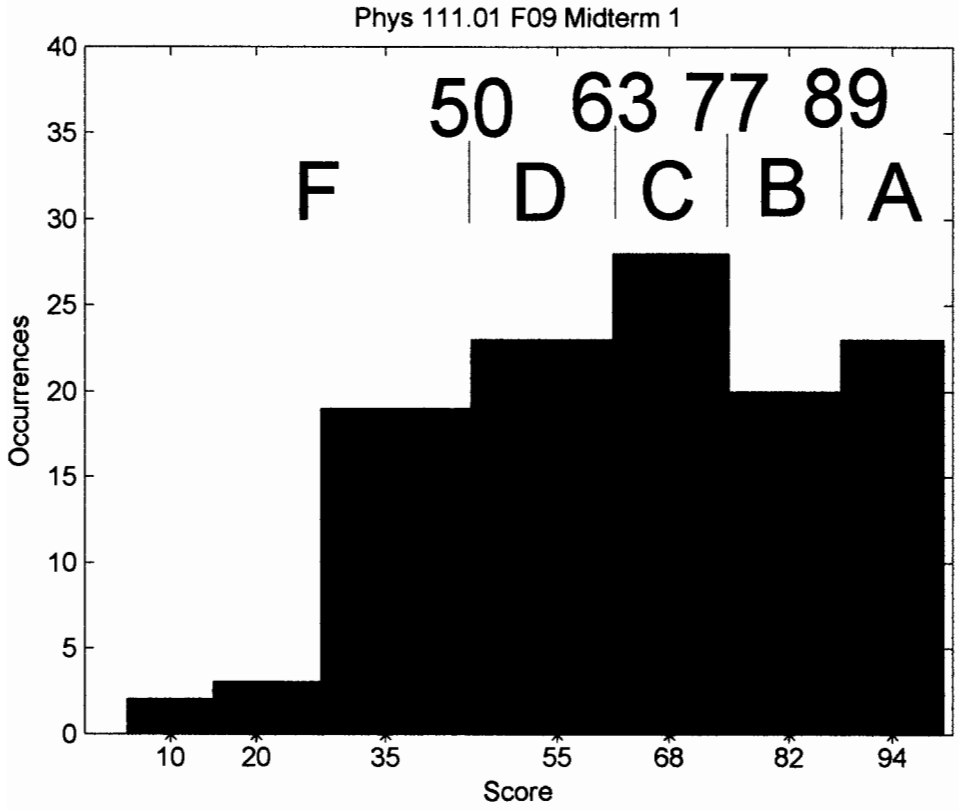
F_{net} =	9,7 N

f) What is the magnitude of the acceleration of the box, **assuming the size of the net force on the box is 15.0 N**?

$$F_{net} = ma$$

$$a = \frac{15N}{3,0kg} = 5,0\ m/s^2$$

a=	5,0 m/s^2


Phys 111.01 F09 Midterm 1
50 63 77 89
F D C B A
Occurrences
Score
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