1= 9   2= 10   3= 7   4= 9   9

Name: ____________   Physics 50 – Exam 2   October 26, 2011

- Keep the exam booklet closed until everyone has a copy.
- This exam has four pages; all of them are weighted equally.
- Please show all of your work, especially which equations you are using.
- No books, notes, smart phones, etc. are allowed during the exam – only calculators.
- Please keep your calculators flat on the desk during the exam.

Equations that you may find useful:

$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2 \qquad v_x = v_{0x} + a_x t$$

$$v_x^2 = v_{0x}^2 + 2a_x(x - x_0) \qquad x - x_0 = \left(\frac{v_{0x} + v_x}{2}\right)t \qquad a_{rad} = \frac{v^2}{r}$$

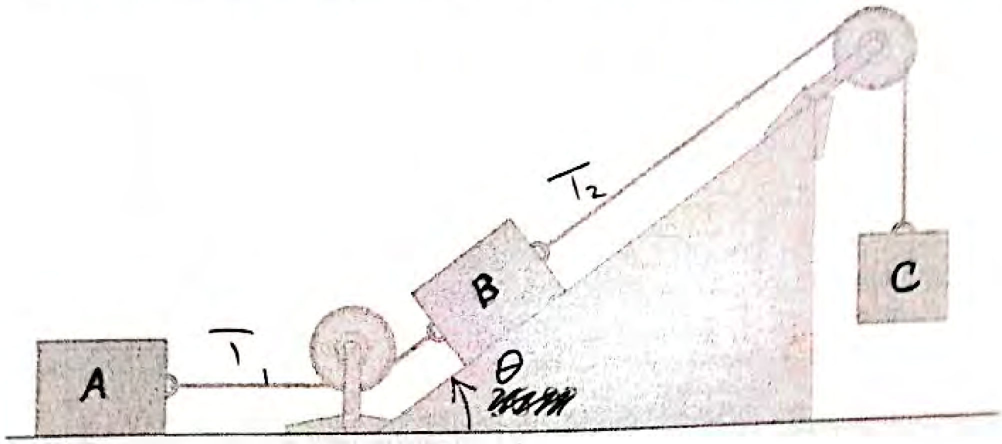
circumference of a circle $= 2\pi r$ area of a circle $= \pi r^2$ $f = \mu N$

$$\sum \vec{F} = m\vec{a} \qquad W = \vec{F}\cdot\vec{s} = Fs\cos\phi \qquad U_{el} = \frac{1}{2}kx^2$$

$$U_{gr} = mgh \qquad K = \frac{1}{2}mv^2 \qquad W_{tot} = \Delta K \qquad F = -kx$$

$$K_1 + U_{1,el} + U_{1,gr} + W_{other} = K_2 + U_{2,el} + U_{2,gr}$$

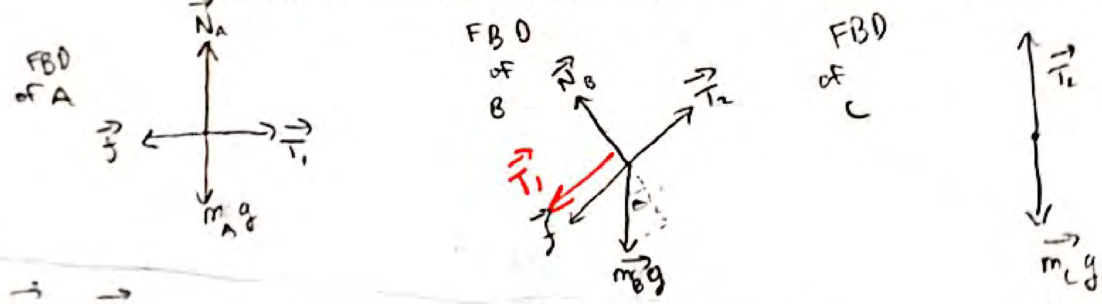
1. In this laboratory experiment, there is friction between the surface and the blocks. The coefficient of friction is the same on the slope and horizontal surface.



9/10
good!

a) Draw a free body diagram for each of the three blocks.
b) Write out three vector equations that describe how Newton's Laws apply to each block
c) Write out a set of equations that relate the masses, coefficient of friction, tension in the strings, the angle of the incline, the acceleration and g.

a)



b) $\sum \vec{F} = m_A \vec{a}$

$\vec{N}_A + \vec{T}_1 + \vec{f} + m_A \vec{g} = m_A \vec{a}$

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

$\vec{N}_B + \vec{f} + \vec{T}_2 + m_B \vec{g} = m_B \vec{a}$

$\sum \vec{F} = m_C \vec{a}$

$\vec{T}_2 + m_C \vec{g} = m_C \vec{a}$

c) x: $T_1 - f = m_A a$

so, $T_1 - \mu N_A = m_A a$

y: $N_A - m_A g = m_A a$

x: $T_2 - f = m_B a$

so, $T_2 - \mu N_B = m_B a$

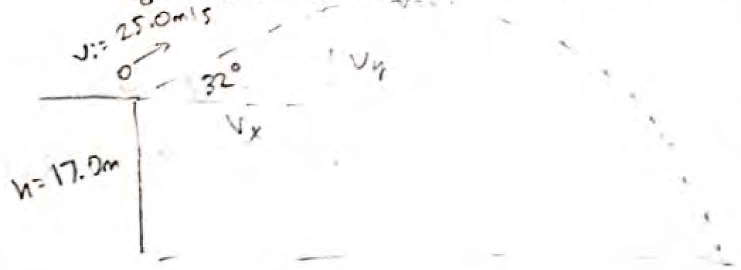
y: $N_B - m_B g \cos\theta = m_B a$

good.

x: none

y: $T_2 - m_C g = m_C a$

2. A man stands on the roof of a building of height 17.0 m and throws a rock with a velocity of magnitude 25.0 m/s at an angle of 32.0° above the horizontal. You can ignore air resistance. What is the speed of the rock when it strikes the ground?



$V_x = 25 \cos 32$
$= 21.20$ m/s

$K_1 + \cancel{U_{1el}} + U_{1gr} + \cancel{W_{other}} = K_2 + \cancel{U_{2el}} + \cancel{U_{2gr}}$

$\frac{1}{2} m v_i^2 + mgh = \frac{1}{2} m v_F^2$

$\frac{1}{2} v_i^2 + gh = \frac{1}{2} v_F^2$

$\frac{1}{2}(25.0 m/s)^2 + (9.8)(17.0m) = \frac{1}{2}(v_F)^2$

$312.5 m/s + 166.6 = \frac{1}{2} v_F^2$

$479.1 = \frac{1}{2} v_F^2$

$\sqrt{958.2} = \sqrt{v_F^2}$

$\boxed{v_F = 30.9 \text{ m/s}}$ yes.

In terms of v_x

$K_1 + \cancel{U_{1el}} + U_{1gr} + \cancel{W_{other}} = K_2 + \cancel{U_{2el}} + \cancel{U_{2gr}}$

$\frac{1}{2} m v_{x_i}^2 + mgh = \frac{1}{2} m v_{xF}^2$

$\frac{1}{2} v_{x_i}^2 + gh = \frac{1}{2} v_{xF}^2$

$\frac{1}{2}(21.20)^2 + (9.8)(17) = \frac{1}{2}(v_{xF})^2$

$224.72 + 166.6 = \frac{1}{2}(v_{xF})^2$

$\sqrt{782.64} = \sqrt{v_{xF}^2}$

$v_{xF} = 27.97$ m/s

then find v_y also and $v = \sqrt{v_x^2 + v_y^2}$

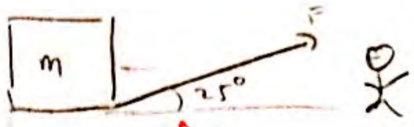
10

3. A person is pulling 30.0-kg crate to the right along a rough horizontal surface. He pulls with a force of 200.0 N at an angle of 25.0 degrees from horizontal. The friction force is 80.0 N. Find the total force on this crate.

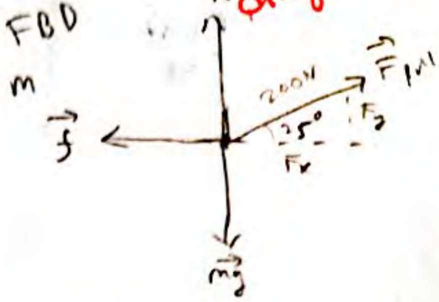
m: 30.0kg

μ = 80.0N

pulling force F 200.0N



good diagram



$\Sigma \vec{F} = m\vec{a}$ good

$\vec{N} + \vec{f} + \vec{F} + \vec{mg} = m\vec{a}$

294N + 80N + 200N + 294N = ma

Total Force = 868 N

$\Sigma F_x = ma_x$

$\Sigma F_y = 0$

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

$\vec{N} + \vec{f} + \vec{F} + \vec{mg} = m\vec{a}$

x: $F_x - f = \cancel{0} = ma$

so, $F\cos 25 = f$

y: $N - mg + F_y = 0$

so, $N = mg + F_y$

ok.

$F_x - f$ = Force in x direction

181.26N − 80N = $\boxed{101.26\text{N}}$ to the right.

Force in y direction = 0

N = mg
= 9.8 · 30
= 294

f = F_x
= 200 cos 25
= 181.26

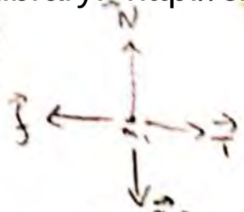
F_y
= 200 sin 25
= 84.52

$F_x + F_y = F$
181.26 + 84.52
F = 200N

$K_1 + U_{1el} + U_{1gr} + W_{other} = K_2 + U_{2el} + U_{2gr}$

7

FBD m_1



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

$\vec{N} + \vec{T} + \vec{f} + m\vec{g} = m\vec{a}$

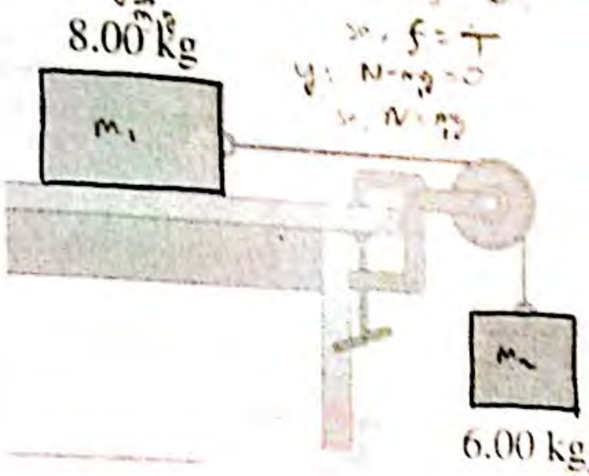
$x: T - f = 0$

so, $f = T$

$y: N - mg = 0$

so, $N = mg$

4. Two blocks are connected by a thin string through a pulley. The pulley's mass is very small compared to the blocks. There is friction between the 8.00-kg block and the table. The two blocks to move at a constant speed of 0.500 m/s over a distance of 1.80 m.



$f = \mu N$

$s = 1.80\text{m}$

FBD m_2

$\Sigma F = ma$

$\vec{T} + m\vec{g} = m\vec{a}$

$x:$ none

$y: T - mg = 0$

so, $T = mg$

$T = mg$

$T = (6.00\text{kg})(9.8)$

$T = 58.8\text{N}$

$N = mg$

a) Find the work done by gravity on the 8.00 kg block.

2

$W_{grav} = \vec{F} \cdot \vec{S}$

$= Fs\cos\phi$

$= mgs\cos 90$

$W_{grav} = 0\text{J}$

b) Find the work done by friction on the 8.00 kg block.

4

$W_{friction} = \vec{F} \cdot \vec{S}$

$f = T$

$= Fs\cos\phi$

$= Ts\cos 180$

$= 58.8(1.80\text{m})\cos 180$

$W_f = -105.8\text{J}$

c) Find the total work done on the 8.00 kg block.

1

$W_{total} = \Delta K = 0$

$= \frac{1}{2}m_1 v_f^2 - \frac{1}{2}m_1 v_i^2$

$W_{total} = \frac{1}{2}(8\text{kg})(.500\text{m/s})^2$

$W_{total} = 1\text{J}$

d) Find the work done by gravity on the 6.00 kg block.

2

$W_{grav} = \vec{F} \cdot \vec{S}$

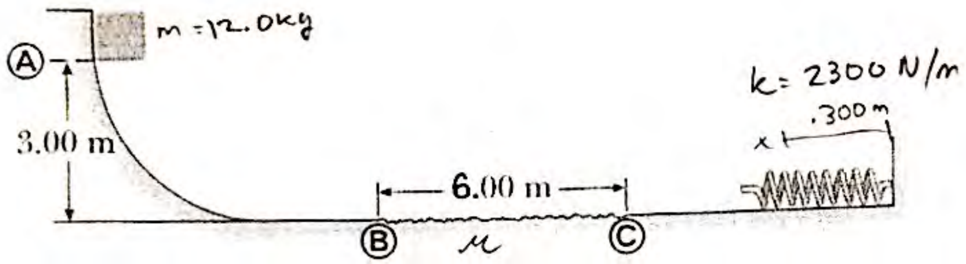
$= mgs\cos 0$

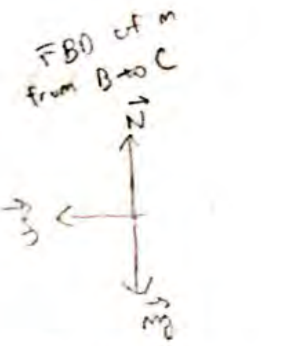
$= (6\text{kg})(9.8)(1.8\text{m})\cos 0$

$W_{grav} = 105.8\text{J}$

9

5. A 12.0-kg block is released from point A in the image below. The track is frictionless except between points B and C, which has a length of 6.00 m. The block travels down the track, hits a spring with a force constant of 2300 N/m, compresses the spring a maximum distance of 0.300 m, comes to rest for an instant before being pushed back the other way. Find the coefficient of friction on the horizontal segment between points B and C.





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

$\vec{N} + \vec{f} + m\vec{g} = m\vec{a}$

$x: \; -f = ma$

$y: \; N - mg = 0$

$N = mg$

$$\cancel{K_1} + U_{1gr} + \cancel{U_{1el}} + W_{other} = \cancel{K_2} + U_{2el} + \cancel{U_{2gr}}$$

$$U_{1gr} + W_{Friction} = U_{2el}$$

$$mgh + W_f = \frac{1}{2}kx^2$$

yes

$$mgh - \mu(mg)s = \frac{1}{2}kx^2$$

$$\boxed{(12.0\,kg)(9.8)(3.00\,m) - \mu(12\,kg)(9.8)(6.00\,m) = \frac{1}{2}(2300\,N/m)(.300\,m)^2}$$

$$352.8 - 648\mu = 103.5$$

$$-352.8 \qquad\qquad -352.8$$

$$-648\mu = -249.3$$

$$\mu = .3847$$

$$\boxed{\mu = .385}$$

Should be $\mu = 0.353$

$W_f = \vec{F} \cdot \vec{s}$

$= Fs\cos\phi$

$= \mu N s \cos 180$

$= \mu (mg) s \cos 180$

$= -\mu mg s$