Physics 1303.001 **Fall 2011**

Exam 1 **Instructions**

All students at SMU are under the jurisdiction of the Honor Code, which you have already signed a pledge to uphold upon entering the University. For this particular exam, you may not give help to nor receive help from any other student. You are bound by the Honor Code to report any infractions to me or to the Honor Council.

Part I is multiple choice. Write your name and mark your responses both on the exam and on the Scantron form. Be sure to use a No. 2 pencil.

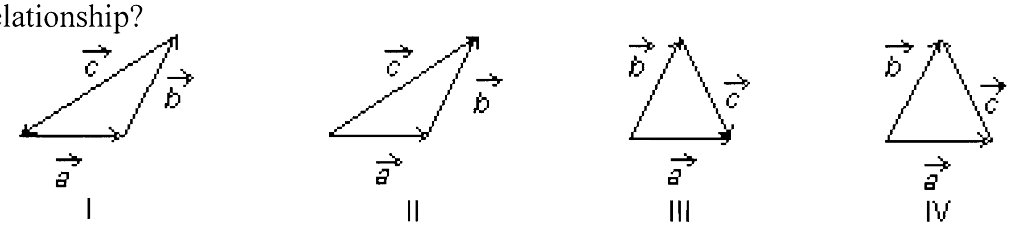
Part II consists of three free response problems. Show your work on the following pages to receive partial credit. Box final answers. Pen or pencil is fine. All exams are closed book. You may use one formula sheet written on both sides and a calculator. Cell phones, iPads, laptops, etc. must be switched off.

Name: Key **Date:** ____________________

1. The average speed of a moving object during a given interval of time is always:
A) the magnitude of its average velocity over the interval
(B) the distance covered during the time interval divided by the time interval
C) one-half its speed at the end of the interval
D) its acceleration multiplied by the time interval
E) one-half its acceleration multiplied by the time interval.

2. Two automobiles are 150 kilometers apart and traveling toward each other. One automobile is moving at 60 km/h and the other is moving at 40 km/h. In how many hours will they meet?
A) 2.5
B) 2.0
C) 1.75
(D) 1.5
E) 1.25

3. The vectors $\vec{a}$, $\vec{b}$, and $\vec{c}$ are related by $\vec{c} = \vec{a} - \vec{b}$. Which diagram below illustrates this relationship?

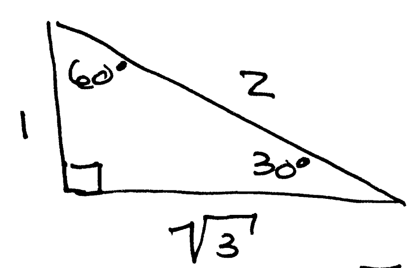


A) I.
B) II.
(C) III.
D) IV.
E) None of these

4. 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 $\vec{A} \cdot \vec{B}$ is:
A) zero
B) L^2
C) $\sqrt{3L^2/2}$
D) $2L^2$
(E) none of these

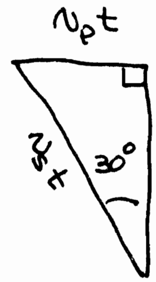
$\vec{A}\cdot\vec{B} = L \times L \cos 30°$

$= L^2 \frac{\sqrt{3}}{2}$



$\cos 30° = \frac{\sqrt{3}}{2}$

5. A jet plane in straight horizontal flight passes over your head. When it is directly above you, the sound seems to come from a point behind the plane in a direction 30° from the vertical. The speed of the plane is:
A) the same as the speed of sound
B) half the speed of sound
C) three-fifths the speed of sound
D) 0.866 times the speed of sound
E) twice the speed of sound

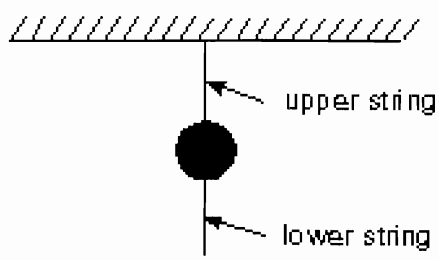


$\sin 30° = \frac{v_p t}{v_s t} = \frac{1}{2}$

$v_p = \frac{1}{2} v_s$

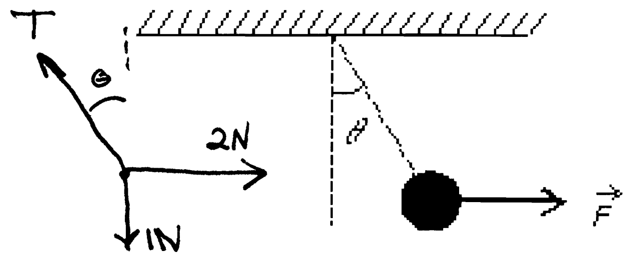
6. Identical guns fire identical bullets horizontally at the same speed from the same height above level planes, one on the Earth and one on the Moon. Which of the following three statements is/are true?
I. The horizontal distance traveled by the bullet is greater for the Moon. T
II. The flight time is less for the bullet on the Earth. T
III. The velocities of the bullets at impact are the same. F
A) III only
B) I and II only
C) I and III only
D) II and III only
E) I, II, III

7. A heavy ball is suspended as shown. A quick jerk on the lower string will break that string but a slow pull on the lower string will break the upper string. The first result occurs because:



A) the force is too small to move the ball
B) action and reaction is operating
C) the ball has inertia
D) air friction holds the ball back
E) the ball has too much energy

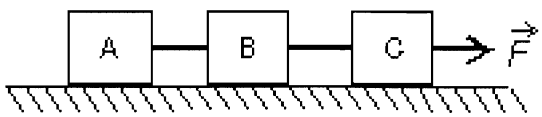
8. A 1-N pendulum bob is held at an angle θ from the vertical by a 2-N horizontal force F as shown. The tension in the string supporting the pendulum bob (in newtons) is:



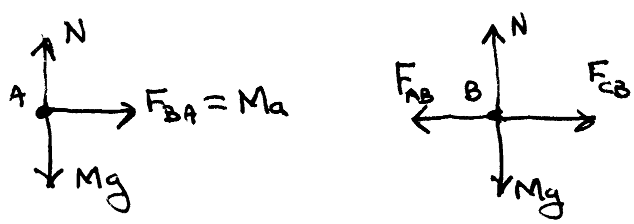
$\Sigma F_y: T\cos\theta = 1N$
$\Sigma F_x: T\sin\theta = 2N$
$T^2\cos^2\theta + T^2\sin^2\theta = 1N^2 + 4N^2$
$T^2(\cos^2\theta + \sin^2\theta) = 5N^2$
$T = \sqrt{5}$

A) cos θ
B) 2/cos θ
(C) $\sqrt{5}$
D) 1
E) none of these

9. Three blocks (A,B,C), each having mass M, are connected by strings as shown. Block C is pulled to the right by a force $\vec{F}$ that causes the entire system to accelerate. Neglecting friction, the net force acting on block B is:



$F = 3Ma$

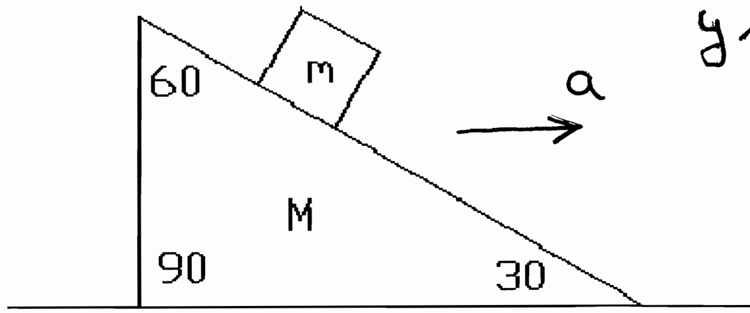


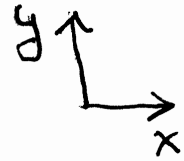
A) zero
(B) $\vec{F}/3$
C) $\vec{F}/2$
D) $2\vec{F}/3$
E) $\vec{F}$

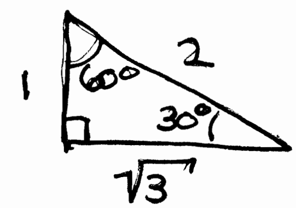
$F_{B\,Net} = F_{CB} - F_{AB} = Ma = \frac{F}{3}$

10. A professor holds an eraser against a vertical chalkboard by pushing horizontally on it. He pushes with a force that is much greater than is required to hold the eraser. The force of friction exerted by the board on the eraser increases if he:
A) pushes with slightly greater force
B) pushes with slightly less force
C) stops pushing
(D) pushes so his force is slightly downward but has the same magnitude
E) pushes so his force is slightly upward but has the same magnitude

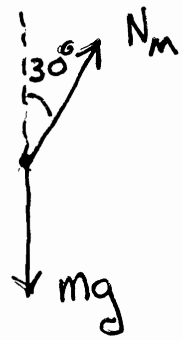
11.) A triangular block of mass M with angles 30°, 60° and 90° rests with its 30°- 60° side on a horizontal table. A cubical block of mass m rests on the 60°-30° side. (a) What horizontal acceleration, *a*, must M have relative to the table to keep m stationary relative to the triangular block, assuming frictionless contacts? (b) What horizontal force **F** must be applied to the system to achieve this result, assuming a frictionless tabletop?







m:



$\sum F_x$: $N_M \sin 30° = ma$

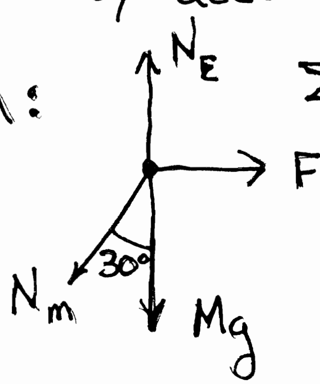
$\sum F_y$: $N_M \cos 30° - mg = 0$ $N_M = \frac{mg}{\cos 30°}$

$\tan 30° = \frac{a}{g}$ but $\tan 30° = \frac{1}{\sqrt{3}}$

a) $\boxed{a = g/\sqrt{3}}$ $g = 9.8\,\frac{m}{s^2} \Rightarrow \boxed{a = 5.7\,\frac{m}{s^2}}$

b.) By inspection m+M move as a combined mass w/ acceleration a so $\boxed{F = (m+M)\,a}$ or,

M:



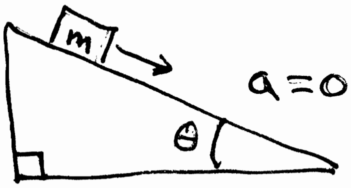
$\sum F_x$: $F - N_m \sin 30° = Ma$ $N_m = N_M = \frac{mg}{\cos 30°}$

$F - mg\frac{\sin 30°}{\cos 30°} = Ma$

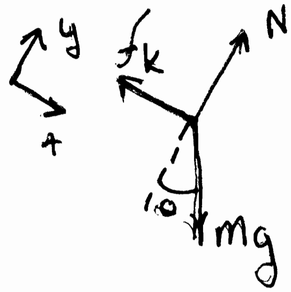
$F = mg\tan 30° + Ma$ but $a = g\tan 30°$

b.) $\boxed{F = (m+M)a}$

12.) A block slides down an inclined plane of slope θ with constant velocity. It is then projected up the same plane with an initial speed v_0. How far up the incline will it move before coming to rest? Will it slide down again? Explain.



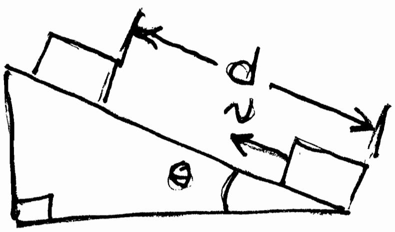
Downhill slide



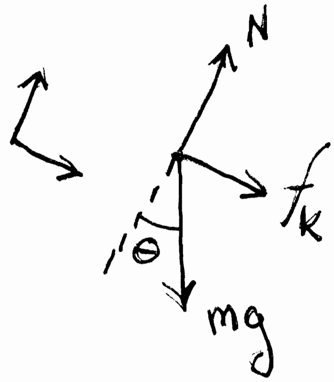
ΣF_y: $N = mg\cos\theta$

ΣF_x: $f_k = mg\sin\theta$

$\Rightarrow$ $\boxed{\mu_k = \tan\theta}$



Uphill Slide



To find $d = (x - x_0)$, determine acceleration up incline and use $V^2 = V_0^2 + 2a(x - x_0)$

ΣF_y: $N = mg\cos\theta$

negative

ΣF_x: $f_k + mg\sin\theta = -ma$

$\mu_k mg\cos\theta + mg\sin\theta = -ma$ but $\mu_k = \tan\theta$ from above

$2mg\sin\theta = -ma$ $\Rightarrow$ $\boxed{a = -2g\sin\theta}$

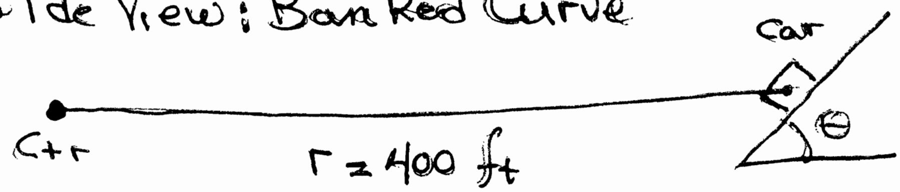
Find d: $0^2 = v^2 + 2(-2g\sin\theta)d$ $\Rightarrow$ $\boxed{d = \dfrac{v^2}{4g\sin\theta}}$

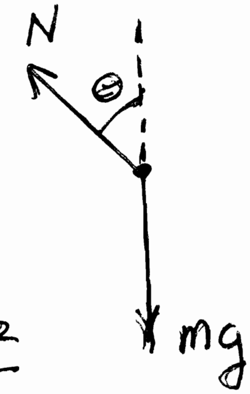
Because $\mu_k = \tan\theta$ & $\theta < \theta_s$

then $f_s < f_{s\,max}$ and the block remains at rest.

13.) A circular curve of highway is designed for traffic moving at 40 miles /hr. (a) If the radius of the curve is 400 ft, what is the correct angle of banking of the road? (b) If the curve is not banked, what is the minimum coefficient of friction between the tires and the road that would keep traffic from skidding at this speed? (1 mile = 5280 ft, g = 32 ft/s^2)

Side View: Banked Curve



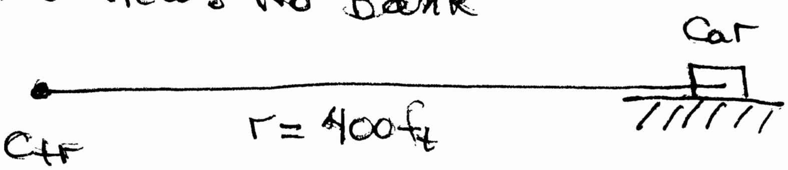


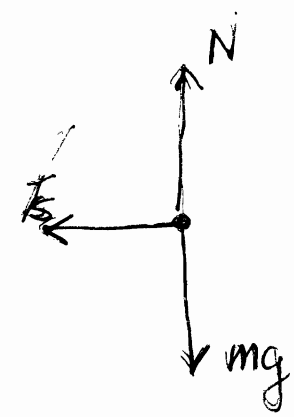
$$\left.\begin{aligned} \Sigma F_y:&\quad N\cos\theta = mg \\ \Sigma F_x:&\quad N\sin\theta = \frac{mv^2}{r} \end{aligned}\right\} \Rightarrow \tan\theta = \frac{v^2}{gr}$$

$$\theta = \tan^{-1}\left\{\left(40\,\frac{\text{miles}}{\text{hr}} * \frac{5280\,\text{ft}}{\text{mile}} * \frac{1\,\text{hr}}{3600\,\text{s}}\right)^2 \div \left(32\,\frac{\text{ft}}{\text{s}^2} * 400\,\text{ft}\right)\right\}$$

$$\boxed{\theta = 15^\circ}$$

Side View: No Bank





$$\Sigma F_y: \quad N = mg$$

$$\Sigma F_x: \quad f_s = \frac{mv^2}{r} \qquad f_s = \mu_s N$$

$$\mu_s mg = \frac{mv^2}{r}$$

$$\mu_s = \frac{v^2}{gr} = \tan(15^\circ)$$

$$\boxed{\mu_s = 0.27}$$