P113 University of Rochester NAME Solnkey - SLM
S. Manly Fall 2004

Exam 1 (October 5, 2004)

Please read the problems carefully and answer them in the space provided. Write on the back of the page, if necessary. Show all your work. Partial credit will be given unless specified otherwise.

Problem 1 (10 pts, no partial credit, no need to justify):

The displacement of an object for a round trip between two locations

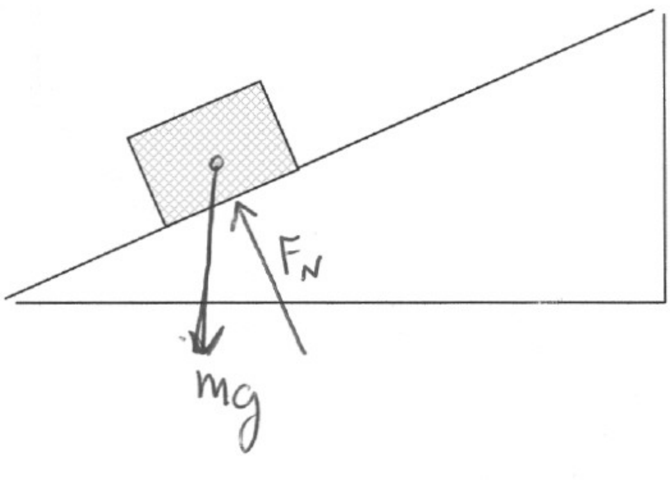
ANSWER IS "= zero"

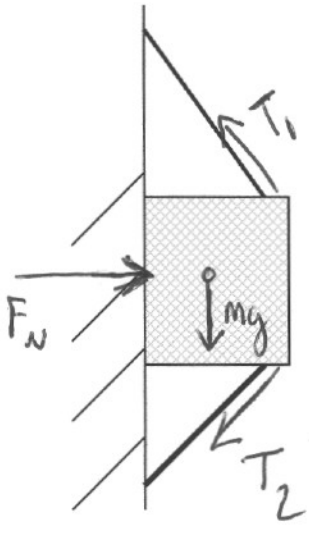
Different versions of exam might have this ANSWER in different locations

- **a) > zero.**
- **b) < zero.**
- **c) = zero.**
- **d) can be greater than or less than, but not equal to, zero.**
- **e) can have any value.**

Problem 2 (12 pts, no need to justify): 2 pts per force

In the left-hand drawing below, a block is sliding down a frictionless inclined plane. In the right-hand drawing below, a block is held up against a wall by two ropes as shown. In both cases, make a free body diagram for the block in the space provided. That is to say, draw (as vectors) all of the forces acting on each block.





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1)	/10
2)	/12
3)	/13
4)	/10
5)	/13
6)	/12
7)	/15
8)	/15
tot	/100

Problem 3 (13 pts, justify):

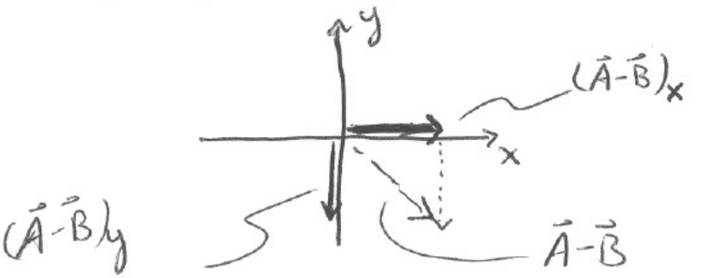
Vectors A and B have the following components: A_x=+5 m, A_y=2 m, B_x=3 m, B_y=4 m. The angle between the positive x axis and the vector A-B is

a) -45 degrees
b) 194 degrees
c) 37 degrees
d) -54 degrees
e) 86 degrees

$(\vec{A}-\vec{B})_x = A_x - B_x = 5 - 3 = 2\,m$

$(\vec{A}-\vec{B})_y = A_y - B_y = 2 - 4 = -2\,m$

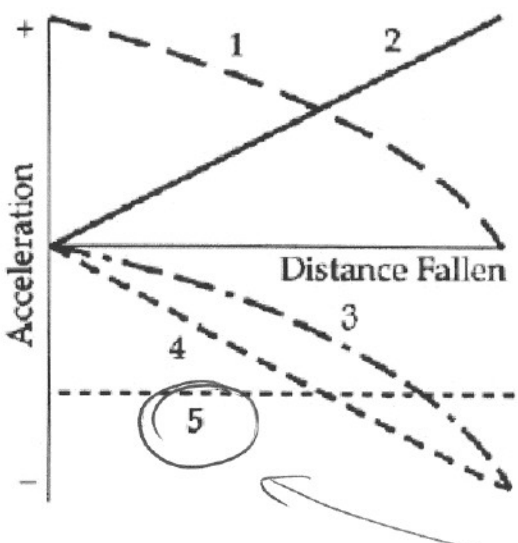
(a negative angle here is defined as the angle measured clockwise from the +x-axis, a positive angle is defined as the angle measured counter-clockwise from the +x-axis)



∴ Angle w/ + x-Axis is -45°

Problem 4 (10 pts, ~~no partial credit, no justification necessary~~):
justify

A ball is thrown horizontally from a cliff. A graph of the acceleration of the ball versus the distance fallen could be represented by curve



Acceleration due to grav is CONSTANT and in downward direction

⇒ only CONSTANT Accel. curve is 5

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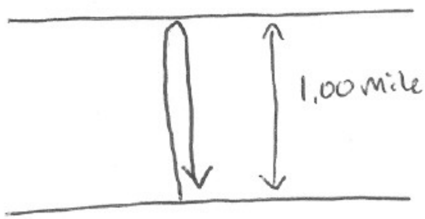
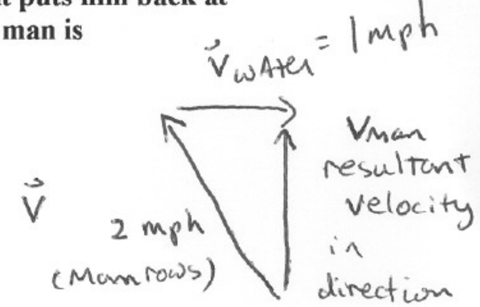
Problem 5 (13 pts):

A river 1.00 mile wide flows with a constant speed of 1.00 mile per hour. A man can row a boat at 2.00 mile per hour. He crosses the river in a direction that puts him directly across the river from the starting point, and then he returns in a direction that puts him back at the starting point in the shortest time possible. The travel time for the man is

a) 2.00 hours
b) 1.15 hours
c) 1.00 hours
d) 1.33 hours
e) 0.67 hours





For man to go straight across river, he must row upstream some because river flow pushes him downstream

$2^2 = 1^2 + V_{Man}^2$

$V_{Man} = \sqrt{3}$ mph

width of River

Travel Time $= \dfrac{(2)(1 \text{ mile})}{\sqrt{3} \text{ mph}} = 1.15$ hours

back and forth

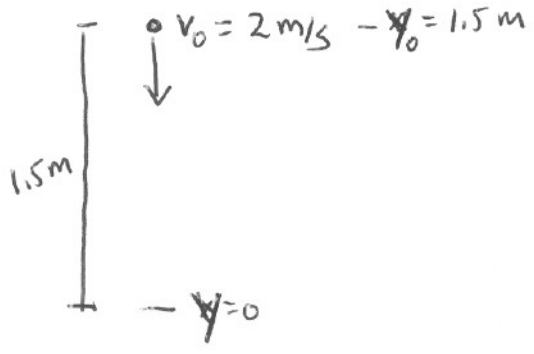
Speed directly Across River

Problem 6 (12 pts):

Eggburt Lowder is a film studies major with issues. He often gets confused between reality and movies. On a good day, Eggburt thinks Jodie Foster is in love with him. On a bad day, he thinks he is Spiderman. On one of his "Spiderman" days, Eggburt braids a bungee cord out of rubber bands lifted from the copy center and takes a dive off the back of Fauver Stadium. Eggburt's makeshift bungee cord snaps when he is a height of 1.5 meters above the ground moving downward with a speed of 2 m/s. How fast is Eggburt going when he strikes the ground? Ignore air resistance throughout this problem.

$$V_y^2 = V_{0_y}^2 + 2a(y - y_0)$$

$$V_y^2 = (-2\,m/s)^2 - 2(9.8\,m/s^2)(0 - 1.5)$$



$V_y = 5.8$ m/s downward

He is going 5.8 m/s when he hits the ground.

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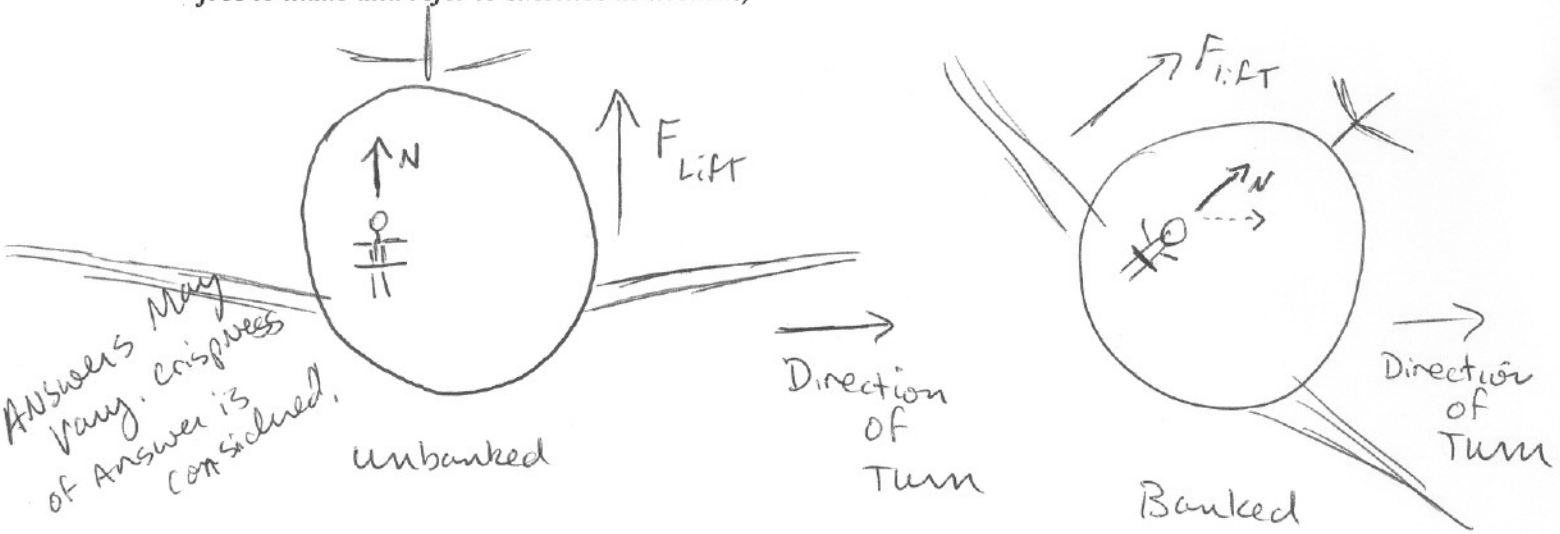
Problem 7 (15 pts):

If you have ever flown on an airplane, you probably noticed that they bank when they turn. That is to say, during the turn the plane rotates about the central forward-backward axis so that the top of the plane is pointing somewhat in the direction they are turning. Briefly discuss why you think they do this. (*Refer to physics concepts we have studied recently. Feel free to make and refer to sketches as needed.*)

Answers may vary. crispness of Answer is considered.



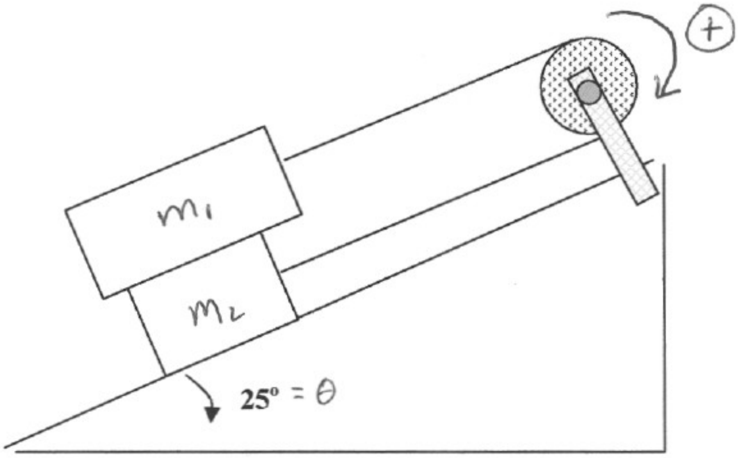
In order to Turn (can think of as moving on a circle) there Must be a centripetal force to accelerate the plane and everything in it toward the center of the circle/Turn. The plane MUST be supported against gravity by some lift force. The passenger is supported against gravity by Normal force of seat on them.

If the plane banks then both $\vec{N}$ and $\vec{F}_{lift}$ have components in the direction toward the center of the circle/Turn. So, rather than being pushed by the side of the plane as it turns, passengers feel the centripetal force in their seat. It is more comfortable.

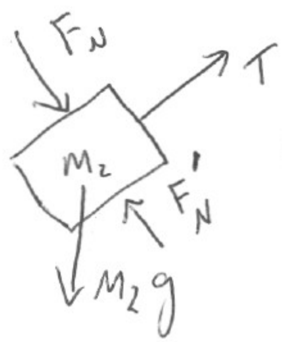
Also by banking the lift force ~~is harnessed as~~ contributes to the needed centripetal force on the plane.

Problem 8 (15 pts):

The figure below shows a 10 kg block (mass m_1) sliding on a 5 kg block (mass m_2) supported on a inclined plane. All surfaces are frictionless. Find the acceleration of each block and the tension in the rope that connects the two blocks. Assume the rope is massless and that the pulley is massless and frictionless.



choose this motion as defining the + direction for variables



$$\Sigma F_{\parallel_{①}} = \boxed{m_1 a_\parallel = T - m_1 g \sin\theta}$$

$$\Sigma F_{\parallel_{②}} = \boxed{m_2 a_\parallel = m_2 g \sin\theta - T}$$

Eliminate T

$$m_1 a_\parallel = -m_2 a_\parallel + m_2 g \sin\theta - m_1 g \sin\theta$$

$$(m_1 + m_2) a_\parallel = (m_2 - m_1) g \sin\theta$$

$$\boxed{a_\parallel = \left(\frac{m_2 - m_1}{m_1 + m_2}\right) g \sin\theta}$$

units both m/s^2 ✓

$m_2 \to$ large $a_\parallel \to$ ⊕ ✓

$m_1 \to$ large $a_\parallel \to$ ⊖ ✓

Mag goes to $g \sin\theta$ ✓

$-1.4\ m/s^2$

Direction ↺

$$m_2 \left(\frac{m_2 - m_1}{m_1 + m_2}\right) g \sin\theta = m_2 g \sin\theta - T$$

$$(m_1 + m_2) T = (m_1 + m_2) m_2 g \sin\theta - m_2 (m_2 - m_1) g \sin\theta$$

$$\boxed{T = \frac{2 m_1 m_2 g \sin\theta}{(m_1 + m_2)}}$$

$$T = 27.6\ N$$