Name:________________ ID:________________ Lab (day/time)____________

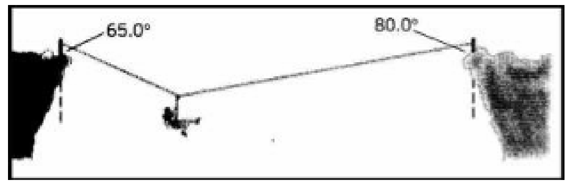
# Physics 201

## **Midterm Exam 2**

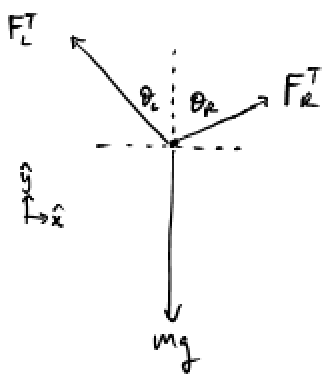
11/18/2015

Collaboration is not allowed. Allowed on your desk are: up to ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating/graphing scientific calculator, 1 page of scratch paper, writing utensils, and the exam. You will have 80 minutes to complete this exam.

1. (10 points) A mountain climber, in the process of crossing between two cliffs by a rope, pauses to rest. She weighs 585 N. As the drawing shows, she is closer to the left cliff than to the right cliff, with the result that the tensions in the left and right side of the rope are not the same. Find the tension in the rope to the left and to the right of the mountain climber.




FBD (climber)



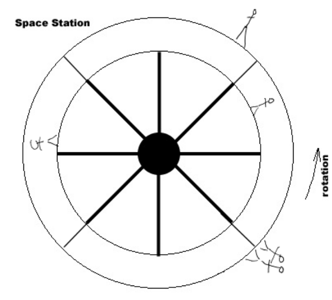

$$\Sigma F_x \Rightarrow |\vec{F}_R^T| \sin\theta_R - |\vec{F}_L^T| \sin\theta_L = m a_x \rightarrow 0$$

$$\Sigma F_y \Rightarrow |\vec{F}_R^T| \cos\theta_R + |\vec{F}_L^T| \cos\theta_L - mg = m a_y \rightarrow 0$$

$$|\vec{F}_L^T| = \frac{mg}{\left(\frac{\sin\theta_L}{\sin\theta_R}\cos\theta_R + \cos\theta_L\right)} = \boxed{1004\,N}$$

$$|\vec{F}_R^T| = \frac{mg}{\left(\frac{\sin\theta_R}{\sin\theta_L}\cos\theta_L + \cos\theta_R\right)} = \boxed{924\,N}$$

For questions 2 through 5 circle all correct answers, a given problem may have more than one correct answer. Each correctly circled answer will receive two points. There are **7** correct answers in this section and only the first **7** circled answers will be graded. There is no partial credit.




2. Three students are discussing the possibility for a two level rotating space station, far from any gravitational bodies. One of them finds this drawing on the internet and the following conversation occurs. Which student do you agree with the least? Ignore oxygen issues.

[Y] (a) "A rotating space station uses a normal force acting on the people to simulate gravity yo"

[Y] (b) "Yeah but this station is drawn wrong, those on the inside level would float towards the ceiling and those on the outside would float away from the station"

[N] (c) "Nah, the station is drawn correctly, just think about what you look like standing on Earth, it's just like this"

3. You throw a stone vertically upward, and it feels no air resistance. Once it is free of your hand and flying through the air, which of the following statements are true.

[F] (a) The two forces acting on it are the downward pull of gravity and the upward force due to its motion.

[F] (b) The net force acting on it switches directions at the top of the stone's flight.

[F] (c) The net force acting on it is zero at the top of the stones flight.

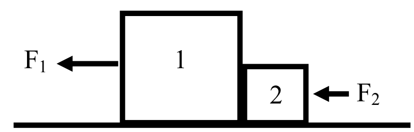
[T] (d) The only force acting on it during the entire flight is gravity.

4. Two cubic blocks are made of identical material but block 2 is half the length in every dimension as block 1. Which of the following are true regarding the two blocks?

[F] (a) The mass of block 1 is twice that of block 2.

[F] (b) The mass of block 1 is four times that of block 2.

[T] (c) The mass of block 1 is eight times that of block 2.




The two blocks lie at rest on a frictionless surface and two forces, $F_1$ and $F_2$ begin acting in the same direction on each, as shown in the figure. Which of the following statements are true regarding their subsequent motion?

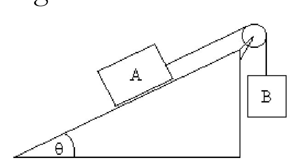
[T] (d) If $F_1$ is equal to $F_2$ the two blocks will not separate from each other.

[F] (e) If $F_1$ is twice as large as $F_2$, the two blocks will separate from each other.

[F] (f) If $F_1$ is four times as large as $F_2$, the two blocks will separate from each other.

[T] (g) If $F_1$ is greater than eight times as large as $F_2$, the two blocks will separate from each other.

5. Block **A** and **B** are connect across a massless frictionless pulley as shown in the figure. Which of the following statements regarding this situation are necessarily true?




[?] (a) The tension in the cable is equal to $M_B$ g.

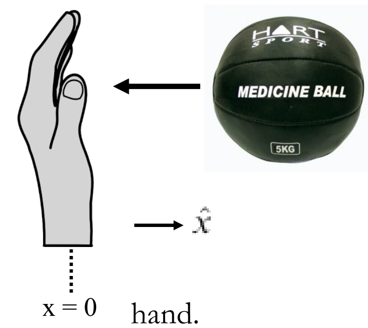
[T] (b) There must be a ratio of the masses, angle of incline, and coefficient of friction that allows this system to be in equilibrium.

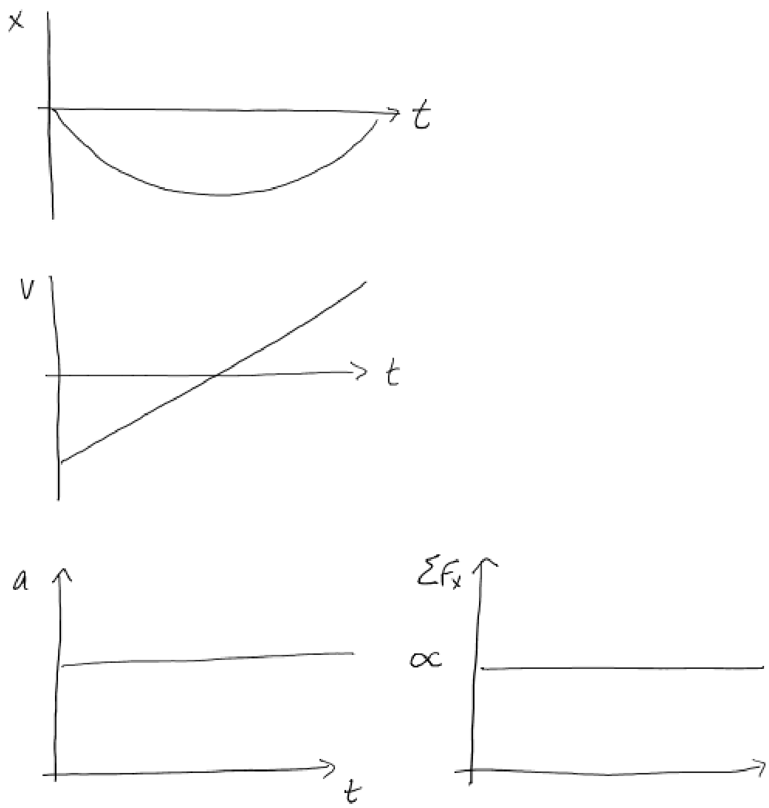
[F] (c) If the mass of **B** is large enough to cause **A** to accelerate up the incline then the tension in the cable must be greater than $M_B$ g.

[T] (d) If the mass of **A** is large enough to cause it to accelerate down the incline then the tension in the cable must be greater than $M_B$ g.

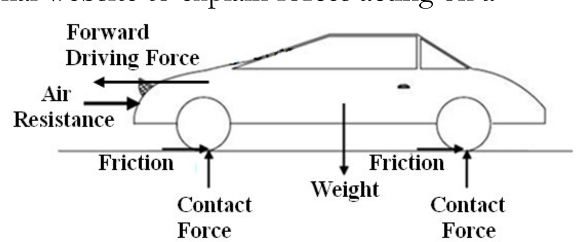
[?] (e) Friction must be present between the incline and block **A** for the system to be in equilibrium.

6. (6 points) Two people are tossing a medicine ball back and forth. When the ball comes in contact with the hand of one of the people they push on it with a constant force, absorbing its momentum and sending it back to the other in one fluid motion. Assume all of this happens along a horizontal line, only regarding horizontal forces. Sketch separate plots for the ball's: (a) net force, (b) velocity, and (c) position, all as a function of time. Assume the time starts when the ball contacts the hand and stops when the ball loses contact with the hand.



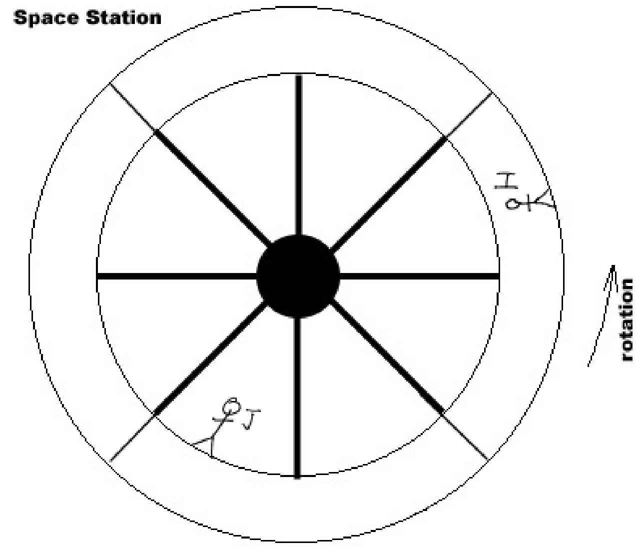




7. (4 points) This diagram was found on a major educational website to explain forces acting on a car in motion. What about this diagram is physically incorrect?

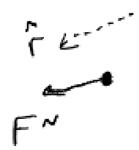



1. I don't know what a Forward Driving Force is, it is not a real force.
2. Friction is in the wrong direction. If the Forward Driving Force is not present, there is nothing to push it forward with friction going against the cars motion. The friction is what propels a car forward.

8. (10 points) Irene (I) and Justine (J) are on two different levels of a rotating space station, far from any gravitational bodies. Both floors of the station travel the same revolutions per time. Irene is 500 m from the center of the station while Justine is 400 m. (a) If Irene's apparent weight is equal to her normal weight on earth, how much time does it take for her to complete one revolution? (b) Will Justine's apparent weight be greater, equal to, or less than Irene's? Justify your answer.




a) FBD (I)




$\Sigma F_r \Rightarrow F^N = m\, a_r$

$m g = m \frac{V^2}{r}$

Normal Weight

$V = \frac{\text{dist}}{\text{time}} = \frac{2\pi r}{T}$

So, $g = \frac{4\pi^2 r^2}{T^2 r}$ (i)

$T^2 = \frac{4\pi^2 r}{g}$

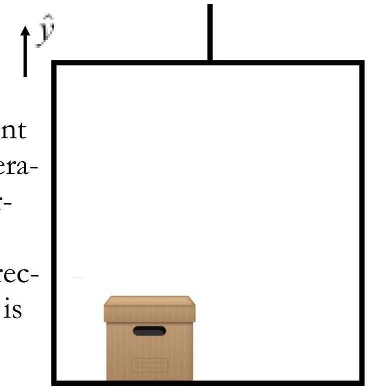
$T = 45\ s$

b) $M_I = M_J = M$, $F^N = mg$

w/ (i), $g \propto r$

$r_I > r_J$ so $F^N_I > F^N_J$

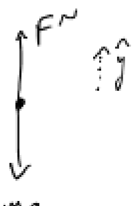
9. (10 points) A box is in an elevator as shown in the figure. The coefficient of static and kinetic friction are 0.4 and 0.3 respectively. (a) What acceleration in the vertical direction must the elevator have in order for the normal force between the box and elevator to go to zero? Explain. (b) If a horizontal force pushes on the box, what acceleration in the vertical direction must the elevator have if the push required to start sliding the box is equal to its weight?




FBD (Box) [10]

$$\Sigma F_y \Rightarrow F^N - mg = m a_y \quad (i)$$

In general




if $F^N \to 0$

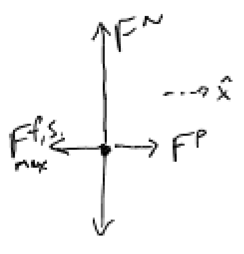
$$-mg = m a_y$$

$$a_y = -g$$

(a) Constraint $\vec{a}_B = \vec{a}_e$

so $\vec{a}_e = \langle 0, -g, 0 \rangle$

(b) FBD (Box)




from (i) $F^N = m(a_y + g)$

$$\Sigma F_x \Rightarrow F^P - F^{f,s}_{max} = m a_x^{\nearrow 0}$$

$$F^P = \mu_s F^N$$

$$mg = \mu_s m (a_y + g)$$

$$a_y = g\left(\frac{1}{\mu_s} - 1\right)$$

$$a_y = \frac{3}{2} g = 14.7 \text{ m/s}^2$$

extra space if needed

Scores:

Problems

| 1 | 2 | 3-5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|
| | | | | | | |

Exam Total