Name:_____ ID:_____ Lab (day/time)_____

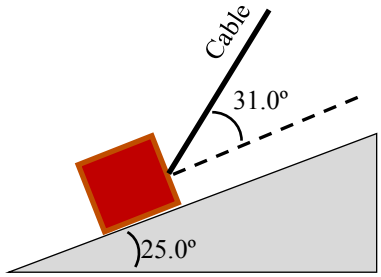
Physics 201

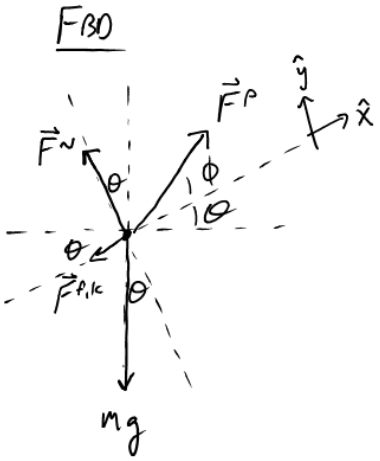
Midterm Exam 2

7/8/2015

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 60 minutes to complete this exam.

1. (10 points) A 15-kg-box is being pulled up an incline at a constant speed of 4 m/s by a cable, as shown in the figure. If the coefficient of kinetic friction between the incline and the box is 0.2, what is the tension in the cable?





$$\Sigma F_y \Rightarrow \quad F^N + F^P \sin\phi - mg\cos\theta = m\cancel{a_y}^{\,0}$$

$$F^N = mg\cos\theta - F^P \sin\phi$$

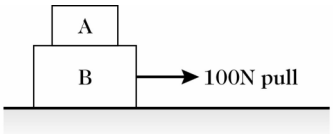
$$\Sigma F_x \Rightarrow \quad F^P\cos\phi - F^{P,k} - mg\sin\theta = m\cancel{a_x}^{\,0}$$

$$F^P\cos\phi - \mu_k\left(mg\cos\theta - F^P\sin\phi\right) - mg\sin\theta = 0$$

$$F^P = \frac{mg\left(\mu_k\cos\theta + \sin\theta\right)}{\left(\cos\phi + \mu_k\sin\phi\right)} = \boxed{92.5\,N}$$

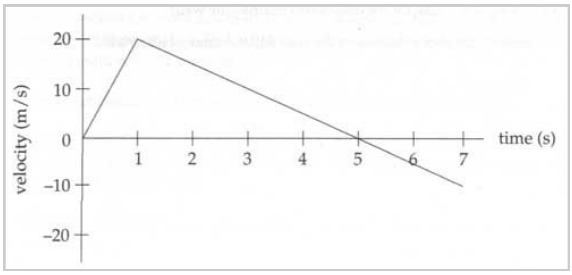
For questions 2 through 4 circle all correct answers, a given problem may have more than one correct answer. Each correctly circled answer will receive two points. There are **5** correct answers in this section and only the first **5** circled answers will be graded. There is no partial credit.

2. Block **A** is on top of block **B** and a 100 N force is pulling on the bottom block, as shown in the figure. Assume the two do not slide relative to each other and the surface between the bottom block and the ground is frictionless. Which of the following statements regarding this situation are necessarily true?



[T] (a) There is friction present between block **A** and **B**.
[?] (b) The blocks are moving to the right
[T] (c) The acceleration of block **A** is equal to that of **B**.
[?] (d) Friction, if present, is in the opposite direction of motion.
[F] (e) Block **A** would slide off of block **B** if the pulling force was removed.

3. The velocity as a function of time for a 2-kg-object, moving along a straight line, is plotted in the figure. Which of the following statements are necessarily true regarding this situation.



[F] (a) The acceleration at 5 s is zero.
[T] (b) The magnitude of the net force at 2 s is 10 N.
[T] (c) The net force is in the positive direction at 0.5 s.
[?] (d) The object has a force in the opposite direction as the acceleration at t = 6 s.
[?] (e) The object is located at x = 0 at 5 s.

4. Consider what happens when you jump up in the air. Which one of the following is the most accurate statement?

[F] (a) It is the upward force exerted by the ground that pushes you up, but this force can never exceed your weight.
[F] (b) You are able to spring up because the earth exerts a force upward on you which is stronger than the downward force you exert on the earth.
[F] (c) Since the ground is stationary, it cannot exert the upward force necessary to propel you into the air. Instead, it is the internal forces of your muscles acting on your body itself which propels the body into the air.
[T] (d) When you push down on the earth with a force greater than your weight, the earth will push back with the same magnitude force and thus propel you into the air.

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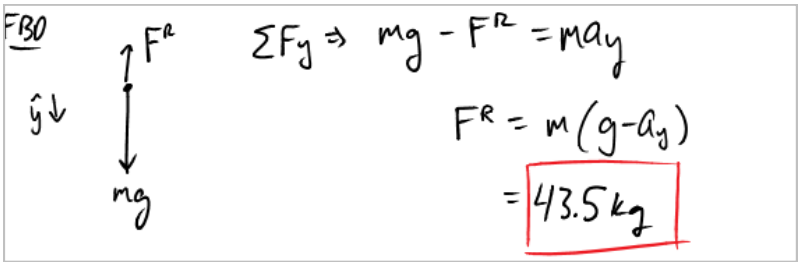
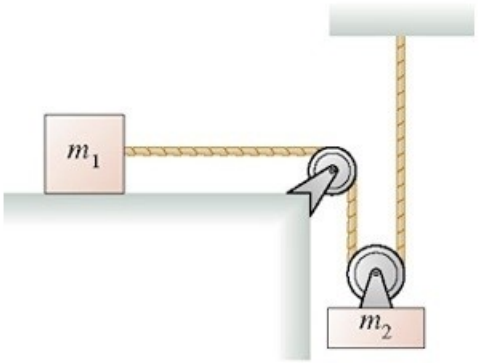
5. (2 points) Last year's midterm had the following problem: A 15.0-kg package is dropped from a high tower and is "tracked" by a radar system. At one point the radar tracking indicates that its acceleration is 6.90 m/s² downward. Determine the force of air resistance on the package at this point.

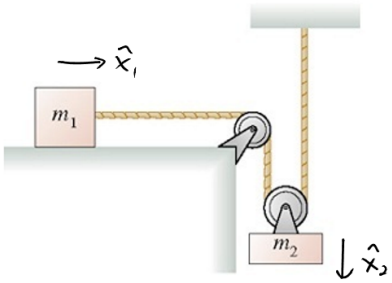
To the right is the (slightly incorrect) solution to that problem. Identify the error in the solution.



Answer: The question asked for a force and although the value is correct (43.5), the units are not. Force should be in Newton's, not kg.

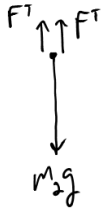
6. (12 points) Two equal masses are connected by a light string via a massless, frictionless set of pulleys, as shown in the figure. (a) What is the acceleration of m_1? (b) If both start from rest, how far has m_2 traveled after 3 s? Assume all surfaces are frictionless.





FBD(1)

FBD(2)



Connections/constraints

$\vec{a}_1 = 2\vec{a}_2 \equiv \vec{a}$

$\vec{v}_1 = 2\vec{v}_2 \equiv \vec{v}$

$|\vec{F}_1^T| = |\vec{F}_2^T| \equiv F^T$

$m_1 = m_2 \equiv m$

(a)

[1] $\sum F_x \Rightarrow F^T = m a_x$

[2] $\sum F_x \Rightarrow mg - 2F^T = m\frac{a_x}{2}$

$mg - 2(m a_x) = m\frac{a_x}{2}$

$a_x\left(\frac{1}{2} + 2\right) = g \Rightarrow \boxed{a_x = \frac{2g}{5}}$

(b) [2] $\Delta x_2 = \cancel{v_{ix}}^{0}\Delta t + \frac{1}{2}a_x \Delta t^2$

$= \frac{1}{2}\left(\frac{a_x}{2}\right)\Delta t^2$, if $\Delta t = 3s$ $\boxed{\Delta x_2 = \frac{9g}{10}}$ units in meters

Scores:

Problems

1	2-4	5	6

Exam Total
