Test 4: *Newton's Laws, Part 1*

Equations and Constants:

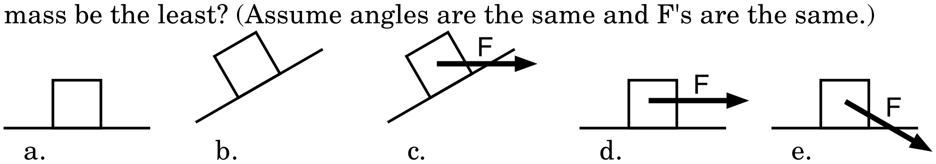
$\bar{v} = \dfrac{\Delta x}{\Delta t}$ $\quad v = \dfrac{dx}{dt}$ $\quad \bar{a} = \dfrac{\Delta v}{\Delta t}$ $\quad a = \dfrac{dv}{dt}$ $\quad \bar{v} = \tfrac{1}{2}(v_i + v_f)$ $\quad |g| = 10\ \text{m/s}^2$

$x = \tfrac{1}{2}at^2 + v_i t + x_i$ $\quad v = at + v_i$ $\quad v_f^2 = v_i^2 + 2a\Delta x$ $\quad R = \dfrac{v^2 \sin 2\theta}{g}$ $\quad a_c = \dfrac{v^2}{r}$

$\sum F = ma$ $\quad w = mg$ $\quad w_\perp = mg\cos\theta$ $\quad w_\parallel = mg\sin\theta$

Multiple Choice: *Choose the letter of the best answer. 3 points each.*

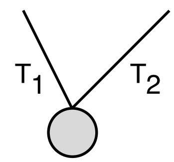
1. _____ A mass is on a frictionless surface. In which of the following situations would the normal force on the mass be the least? (Assume angles are the same and F's are the same.)



a. b. c. d. e.

2. _____ What does pulling a cloth out from under a plate have to do with physics?
   a. What?! You mean there was a point to that demonstration?
   b. It shows how talented physics students are.
   c. It demonstrates how an object at rest tends to remain at rest.
   d. It demonstrates that the plate has very little mass.

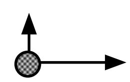
3. _____ An object is held at rest by 2 strings as shown in the diagram to the right. Which of the following statements has to be true?

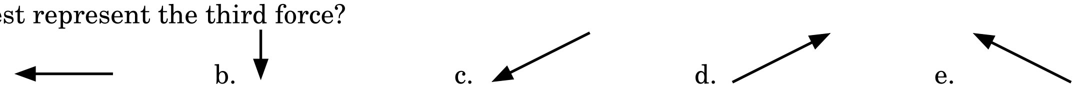


   a. The horizontal components of the tensions in the strings have to cancel out.
   b. The vertical components of the tensions in the strings add up to the mass of the object.
   c. The horizontal components of the tensions in the strings add up to the weight of the object.
   d. The magnitudes of the tensions of the strings have to cancel out the mass of the object.

4. _____ Inertia is the same thing as
   a. mass. b. weight. c. acceleration. d. normal force. e. resistance.

5. _____ Two of three forces acting on an object are shown in the diagram to the right. If the object had a constant velocity in the horizontal direction, which of the following would best represent the third force?

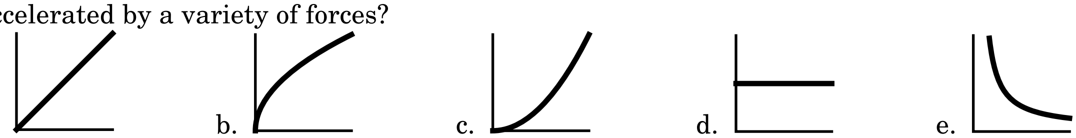




a. b. c. d. e.

6. _____ An object is somehow moving to the right, but accelerating to the left. Which of the following has to be true?
   a. The net force on the object is to the right.
   b. Huh? Impossible because an object can't move one way and accelerate another.
   c. The net force on the object is to left.
   d. The net force on the object could be left or right, depending on the magnitudes.
   e. There is no net force on the object because the left and right cancel.

7. _____ What would a graph of acceleration vs force look like for an object with a constant mass that is accelerated by a variety of forces?



a. b. c. d. e.

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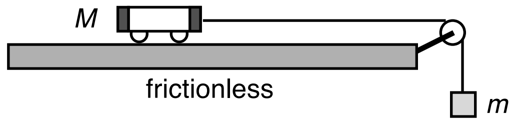
Questions 8 and 9 refer to the following:

Some students do a series of labs involving a cart of mass *M* and a hanger of mass *m* that are on a frictionless, level track, as shown in the diagram below:



8. _____ One time, they kept the mass of the hanger constant at 150 grams, but varied the mass of the cart several times, going from 500 grams to 1500 grams. Each time, they measured the acceleration. They made a graph of acceleration vs inverse mass and got a straight line. What was the slope of their line? (Using standard SI units.)
a. 10 b. 3.5 c. 5 d. 1.5 e. 15

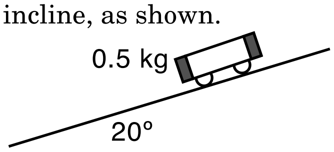
9. _____ How could they do an investigation into the relationship between force and acceleration for an object that has a constant mass using this setup?
a. Just keep adding mass to the hanger for each trial, keeping the cart constant.
b. Add mass to the hanger and to the cart at the same time for each trial.
c. Move mass from the cart to the hanger for each trial.
d. It can't be done and is the stupidest thing I have ever heard.

10. _____ Imagine you are standing in a hallway. If the acceleration due to gravity were to suddenly double, what would change?
I. Your mass would also double.
II. Your weight would also double.
III. The normal force on you would also have to double.
a. I only. b. II only. c. I & II only. d. I & III only. e. II & III only.

11. _____ What is the mass of something that weighs 500 N?
a. 500 kg. b. 50 kg. c. 5000 kg. d. 10 kg. e. 0 kg.

Questions 12 and 13 refer to the following:

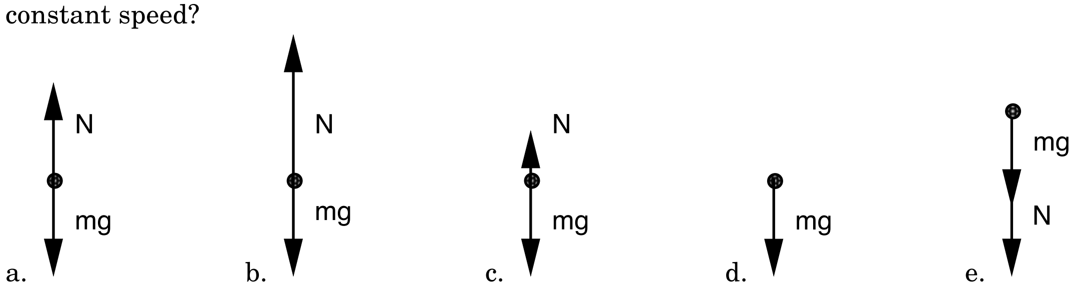
A 0.5 kg cart is on a frictionless incline, as shown.



12. _____ What is the acceleration of the cart on the incline?
a. 0.34 m/s^2. b. 0.17 m/s^2. c. 3.4 m/s^2. d. 1.7 m/s^2. e. 10 m/s^2.

13. _____ What is the normal force on the cart?
a. 10 N. b. 4.7 N. c. 9.4 N. d. 0.47 N. e. 0.94 N.

14. _____ Which of the following would be the best free-body diagram for an object going up in an elevator at a constant speed?



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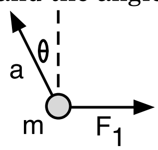
Problem Solving: *Show all work. 10 points each. Include appropriate Free-Body Diagrams!*

15. One of two forces acting on a 3.5 kg object are shown in the diagram. The resulting acceleration is also shown. What is the second force? The first force has a magnitude of 11 N and the acceleration is 3.2 m/s^2 and the angle shown is 40°. *(Note: you don't need a free-body diagram in this one.)*



16. A 5 kg rock is dropped into some sand from a height of 9 meters. When the rock hits the sand, it buries itself 15 cm into the sand. What was the (assumed constant) force of the sand on the rock while it was stopping? (If you would like to call the force of the sand a normal force, that would be fine.)

17. A normal force of 500 N is acting on Isaac who has a mass of 70 kg. If he starts from rest, how long would it take him to reach a speed of 5 m/s?

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18. A box is pulled across a frictionless floor with a force that is always directed up at an angle of ø, as shown in the diagram. What is the maximum possible acceleration of the box, assuming that it (just barely) stays on the floor?