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

Equations and Constants:

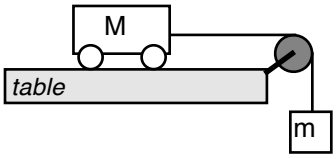
$\bar{v} = \frac{\Delta x}{\Delta t}$ $v = \frac{dx}{dt}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $a = \frac{dv}{dt}$ $\bar{v} = \frac{1}{2}(v_i + v_f)$ $|g| = 10\ m/s^2$

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

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

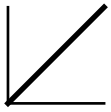
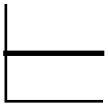
Multiple Choice: *Choose the letter of the best answer. 3 points each.*

Problems 1 and 2 refer to the following:
A cart of mass M is on a horizontal frictionless table and attached via a string and a pulley to a mass m as shown in the diagram.



1. _____ If M = 2 kg and m = 1 kg What is the acceleration of the system?
a. 0 m/s^2. b. 3.3 m/s^2. c. 6.7 m/s^2. d. 10 m/s^2. e. 13.3 m/s^2.

2. _____ Imagine doing an experiment in which you varied the mass M of the cart without changing the mass m that was hanging over the edge and measured the resulting accelerations. What would a graph of acceleration vs M look like?

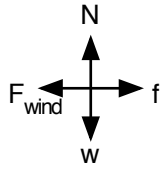
a.  b.  c.  d.  e. 

3. _____ Imagine you weigh 500 N and are sitting in a chair taking a test. What is the reaction to your weight?
a. The chair pushing up on you.
b. You pulling up on the earth.
c. You pushing down on the chair.
d. OMG! You look so skinny - eat something!
e. What does "taking a test" have to do with this question?

4. _____ A 2 kg object is being accelerated up at 3 m/s^2 by a string. What must be the tension in the string?
a. 6 N. b. 8 N. c. 14 N. d. 26 N. e. 34 N.

5. _____ When you decide to walk forwards, where does the force come from that causes your body to accelerate forwards?
a. the ground pushing you forward. b. your legs pushing you forward.
c. your feet pushing you forward. d. your mind.
e. the force that binds the galaxy together.

6. _____ A cow is at rest in the middle of a windy field. The free-body diagram is shown in the diagram. Which of the forces are a Newton's 3rd Law action/reaction pair?
a. F_{wind} & f. b. N & w. c. N & f. d. F_{wind} & w.
e. None of those are correct.



7. _____ Object A weighs 200 N on the earth. Object B weighs 200 N on the moon. Which would be harder to pick up, object A on the earth or object B on the moon?
a. object A. b. object B. c. the same difficulty.
d. it could be either one, depending on the masses.

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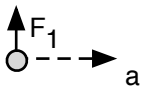
8. _____ Two forces act on an object. One of the forces is shown in the diagram. The acceleration of the object is also shown. Which of the following would best represent the second force?



a.  b.  c.  d.  e. 

Problems 9 and 10 refer to the following:
It takes a net force of 50 N to accelerate an object at 2 m/s^2 on the earth.

9. _____ What is the mass of the object?
a. 5 kg. b. 20 kg. c. 25 kg. d. 100 kg. e. 500 kg.

10. _____ If the object were on a planet where the acceleration due to gravity was 20 m/s^2, what net force would be needed to accelerate it at 2 m/s^2?
a. 25 N. b. 50 N. c. 75 N. d. 100 N. e. 200 N.

11. _____ Upset at the election results, you angrily kick a huge boulder that you happen to be standing next to. Naturally, this hurts your toes. Wishing you lived somewhere else, like the moon, you wonder: if kicking the same boulder on the moon would hurt more or less than her on earth? [Disclaimer! I wrote this before the election!]
a. It would hurt just as much on the moon because the mass of the boulder wouldn't change.
b. It would hurt less on the moon because the weight of the boulder would be less.
c. It would hurt just as much on the moon because the weight of the boulder wouldn't change.
d. It would hurt less on the moon because the mass of the boulder would be less.
e. None of the above are correct.

12. _____ What are the units of inertia?
a. N. b. m/s. c. kg.
d. Huh? You can't measure inertia because it is an idea!

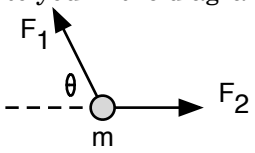
13. _____ If for every action there is an equal and opposite reaction, why don't those forces cancel out?
a. This question makes no sense as they cancel out all the time.
b. Because the masses of the objects could be very different.
c. They only cancel out when the net force is zero.
d. The forces are acting on different objects.
e. None of the above are correct.

14. _____ How much applied force is needed to keep a 25 N rock sliding across level, frictionless ice?
a. 0 N. b. 2.5 N. c. 15 N. d. 25 N. e. 35 N.

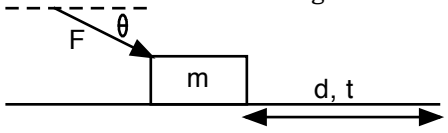
Test 4: *Newton's Laws, Part 1*

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

15. Two constant forces are acting on a 5 kg mass as shown in the diagram. F_1 is 30 N and the angle shown is 50°. F_2 is 20 N and is directed to the right. If the object has an initial velocity of 3.5 m/s to the right, what is its velocity (in unit-vector notation) after 15 seconds? (You do not need a FBD for this one, as I gave it to you in the diagram.)



16. A 12 kg box is on a horizontal table, initially at rest. It is then pushed down with a force F at an angle of 20° below the horizontal. There is also a frictional force of 15 N acting on the box. It travels 30 meters in 5 seconds. What is the magnitude of the force F?



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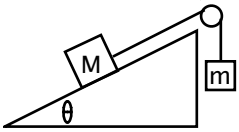
17. A 3 kg box is on an inclined plane with a base angle of 35°. It is also attached via a string and a pulley to a mass of 1 kg. There is a frictional force of 5 N acting on the larger mass. What is the acceleration of the smaller mass? (Give the magnitude and direction.)



18. A mass m is hanging at rest from 2 strings, as shown in the diagram. The tension in the first string is 100 N at angle of 20°. The second string makes an angle of 40° with the vertical. What is the mass?