ABRHS PHYSICS (H)

NAME: KEY

Test 4: *Newton's Laws II*

2011

Equations and Constants:

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

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

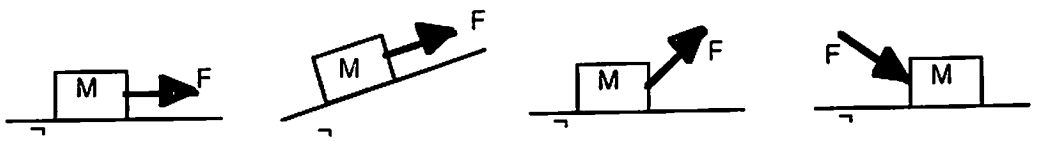
$\sum \vec{F} = m\vec{a}$ $\quad w = mg$ $\quad w_\perp = mg\cos\theta$ $\quad w_{||} = mg\sin\theta$ $\quad f = \mu N$

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

1. A A brick slides on a horizontal surface. Which of the following will increase the magnitude of the frictional force on it?
   a. Putting a second brick on top.
   b. Decreasing the surface area of contact.
   c. Increasing the surface area of contact.
   d. Decreasing the mass of the brick.
   e. None of the above.

2. C A 5 kg Jigglypuff is being pulled across the floor at a constant speed. The coefficient of friction between Jigglypuff and the floor is 0.3. What is the force of friction?
   a. 1.5 N. b. 5 N. c. 15 N. d. 35 N. e. 50 N.

3. D In which of the following diagrams would the force of friction be the most?



a. b. c. d.

4. B An elephant and a mouse decide to go cliff diving in Mexico. While they are falling, who experiences the greater force of air resistance?
   a. the mouse. b. the elephant. c. they are always the same.
   d. they are the same once they reach terminal speed.
   e. at first the mouse, but then the elephant.

5. A What is meant by term "terminal speed?"
   a. It is the fastest you fall if only gravity is pulling you down.
   b. It is the fastest you can ever travel through the air.
   c. It is the fastest you can travel in an airport.
   d. It is the speed that will kill you.

6. E The coefficient of kinetic friction:
   a. is in the direction of the frictional force
   b. is in the direction of the normal force
   c. is the ratio of force to area
   d. can have units of newtons
   e. is none of the above

7. B A forward horizontal force of 12 N is used to pull a 240-N crate at constant velocity across a horizontal floor. The coefficient of friction is:
   a. 0.5 b. 0.05 c. 2.0 d. 0.2 e. 20.0

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8. D An object moving in a circle at constant speed:
   a. must have only one force acting on it
   b. is not accelerating
   c. is held to its path by centrifugal force so that the net force is zero.
   d. has an acceleration of constant magnitude
   e. has an acceleration that is tangent to the circle

9. B Why do raindrops fall with constant speed during the later stages of their descent?
   a. The gravitational force is the same for all drops.
   b. Air resistance just balances the force of gravity.
   c. The drops all fall from the same height.
   d. The force of gravity is negligible for objects as small as raindrops.
   e. Gravity cannot increase the speed of a falling object to more than 9.8 m/s.

Questions 10 to 12 refer to the following:
A person of mass m is riding a Ferris Wheel that rotates with a constant speed. The centripetal acceleration of the person is g.

10. E When the person is at the highest point of the ride, what is the normal force acting on the person?
    a. mg (up). b. mg (down). c. 2mg (down). d. 2mg (up). e. 0.

11. A When the person is at the lowest point of the ride, what is the net force on the person?
    a. mg (up). b. mg (down). c. 2mg (down). d. 2mg (up). e. 0.

12. D What would happen if the ride somehow doubled in speed?
    a. The person would be killed by the massive centripetal forces.
    b. The ride would be a lot more "fun", but still certainly safe.
    c. The ride would be especially dangerous at its lowest points because the person would be flung out of the ride at high speed.
    d. There would not be enough gravity at the highest points of the ride to keep the person moving in a circle and so they would become a projectile.

13. A Pikachu (m = 3 kg) is asleep on the floor. Ash tries to pull Pikachu with a force of 7 N, but the Pokemon doesn't move. There is a coefficient of friction of 0.4. What is the force of friciton on Pikachu?
    a. 7 N. b. 12 N. c. 18 N. d. 23 N. e. 30 N.

14. B Imagine trying to push a large object across the floor. Why does it usually take more force to get the object initially moving than it does to keep it moving with a constant speed?
    a. Because you are weak.
    b. Because static friction can be stronger than kinetic friction.
    c. Because there is a lot of inertia in the large object.
    d. Because objects at rest want to stay at rest.
    e. Because of Newton's Third Law.

Connor Miss P Mrs. Quinn Ryan

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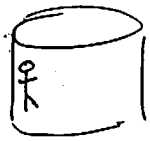
Problem Solving: Show all work, including a correct free-body diagram.

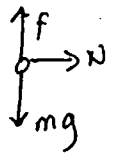
15. Someone want to design a "kinder and gentler" Turkish Twist ride. They would like it to have a 9 meter radius and rotate at only 4 rpm. What should be the minimum coefficient of friction on the walls so that the riders will stay suspended on the wall when the floor drops. Also make a brief comment on how feasible this ride is.



$\Sigma F_x = \frac{mv^2}{r}$ $\quad \Sigma F_y = 0$

$\left(4 \frac{rev}{min}\right)\left(\frac{1\ min}{60\ s}\right)\left(\frac{2\pi(9)\ m}{1\ rev}\right) = 3.77\ m/s$

$N = \frac{mv^2}{r}$ $\quad f - mg = 0$



$\& \quad f = \mu N$

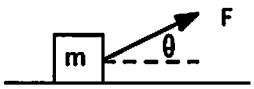
$\therefore \mu\left(\frac{mv^2}{r}\right) = mg \Rightarrow \boxed{\mu = \frac{rg}{v^2}}$

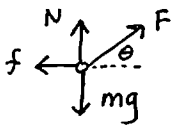
$\therefore \mu = \frac{(9)(10)}{(3.77)^2}$

$\boxed{\mu = 6.3}$

Hey! That's HUGE so won't work.

16. Starting from rest, a 7.5 kg mass is being dragged across a floor by a force of 40 N at an angle of 65° above the horizontal. The coefficient of friction is 0.4. How long will it take to drag the mass 6 meters?





$\Sigma F_x = ma$ $\quad \Sigma F_y = 0$

$F\cos\theta - f = ma$ $\quad N + F\sin\theta - mg = 0$

$\therefore N = mg - F\sin\theta$

$F\cos\theta - \mu(mg - F\sin\theta) = ma$

$a = \frac{F\cos\theta - \mu(mg - F\sin\theta)}{m}$

$a = \frac{40\cos 65 - 0.4[(7.5)(10) - (40\sin 65)]}{7.5} = 0.187\ m/s^2$

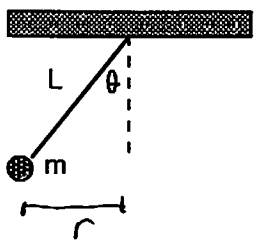
$d = \frac{1}{2}at^2$

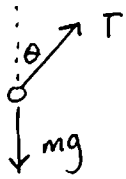
$6 = \frac{1}{2}(.187)t^2$

$t^2 = 64$

$\boxed{t = 8\ s}$

17. A conical pendulum is made from a mass of 150 grams connected to a string of length 1.2 meters. It is spinning such that the string makes a 35° angle from the vertical. What is the period of the motion?





$\Sigma F_x = \frac{mv^2}{r}$ $\quad \Sigma F_y = 0$

$T\sin\theta = \frac{mv^2}{r}$ $\quad T\cos\theta - mg = 0$

$r = L\sin\theta$

$\frac{T\sin\theta}{T\cos\theta} = \frac{\frac{mv^2}{r}}{mg}$

$\tan\theta = \frac{v^2}{rg}$

$v^2 = rg\tan\theta = L\sin\theta\, g\tan\theta$

$= (1.2)(\sin 35)(10)(\tan 35)$

$v^2 = 4.82 \rightarrow v = 2.2\ m/s$

$v = \frac{2\pi r}{t}$

$t = \frac{2\pi r}{v} = \frac{2\pi(1.2)\sin 35}{2.2}$

$\boxed{t = 1.97\ s}$

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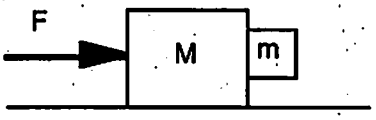
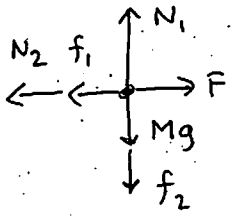
18. A mass M is on a table with a coefficient of friction of μ_1. It is being pushed by a horizontal force F. What must F be so that a mass m will stay suspended in front of M (as shown) if the coefficient of friction between the masses is μ_2?





$\Sigma F_x = Ma$ $\quad \Sigma F_y = 0$

$F - f_1 - N_2 = Ma$ $\quad N_1 - Mg - f_2 = 0$

$f_1 = \mu_1 N_1$

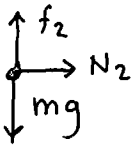
System:

$F - f_1 = (M+m)a$

$F - \mu_1(M+m)g = (M+m)a$

$F = \mu_1(M+m)g + (M+m)a$

$F = \mu_1(M+m)g + \frac{1}{\mu_2}(M+m)g$



$\Sigma F_x = ma$ $\quad \Sigma F_y = 0$

$N_2 = ma$ $\quad f_2 - mg = 0$

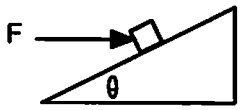
$f_2 = \mu_2 N_2$

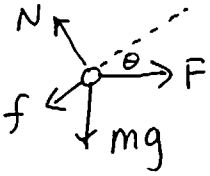
$\therefore f_2 = mg = \mu_2 N_2 = \mu_2 ma$

$\therefore a = \frac{g}{\mu_2}$

$$F = \left(\mu_1 + \frac{1}{\mu_2}\right)(M+m)g$$

19. An object of mass m is pushed up a hill at constant speed. The base angle of the hill is θ and the minimum force needed to keep it moving up the hill is F (directed horizontally, as shown.) What is the coefficient of friction?





$\Sigma \vec{F} = 0$

$\Sigma F_{\parallel} = 0$ $\quad \Sigma F_{\perp} = 0$

~~$F\cos\theta - f = 0$~~

$N - mg\cos\theta - F\sin\theta = 0$

$F\cos\theta - f - mg\sin\theta = 0$ $\quad \hookrightarrow N = mg\cos\theta + F\sin\theta$

$f = \mu N$

$F\cos\theta - \mu(mg\cos\theta + F\sin\theta) - mg\sin\theta = 0$

$\mu(mg\cos\theta + F\sin\theta) = F\cos\theta - mg\sin\theta$

$$\mu = \frac{F\cos\theta - mg\sin\theta}{mg\cos\theta + F\sin\theta}$$