Physics 50 Fall 2017 Final Exam

Name: _____

Dec 14, 2017

Please show your work! Answers are not complete without clear reasoning. When asked for an expression, you must give your answer in terms of the variables given in the question and/or fundamental constants, like g.

Answer as many questions as you can. Do not forget to include appropriate units when giving a number as an answer. Calculators are allowed. If you detach any pages from the test, please write your name on every loose page.

$g = 9.8\ \mathrm{m/s^2}$

Equations

$\mathbf{v}_f = \mathbf{v}_0 + \mathbf{a}t$

$\mathbf{v}_{\text{avg}} = \frac{\mathbf{v}_0 + \mathbf{v}_f}{2}$

$\boldsymbol{\Delta x} = \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$

$\boldsymbol{\Delta x} = \mathbf{v}_f t - \frac{1}{2}\mathbf{a}t^2$

$v_f^2 = v_0^2 + 2a\,\Delta x$

$\boldsymbol{\Delta x} = \mathbf{v}_{\text{avg}} t$

$\omega = \frac{2\pi}{T}$

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

$a_c = \frac{v^2}{r}$

$\mathbf{f}_k = \mu_k \mathbf{n}$

$\mathbf{f}_{s,\max} = \mu_s \mathbf{n}$

$\mathbf{F} = -k\mathbf{x}$

$K = \frac{1}{2}mv^2$

$U_g = mgy$

$U_s = \frac{1}{2}kx^2$

$W = \mathbf{F} \cdot \mathbf{d}$

$P = \frac{W}{\Delta t} = \mathbf{F} \cdot \mathbf{v}$

$\mathbf{p} = m\mathbf{v}$

Trigonometric Identities

$\sin^2\theta + \cos^2\theta = 1$

$\sin(2\theta) = 2\sin(\theta)\cos(\theta).$

$\cos(2\theta) = \cos^2\theta - \sin^2\theta$

$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$

$\cos(\alpha \pm \beta) = \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$

$\cos\alpha\cos\beta = \frac{1}{2}[\cos(\alpha-\beta) + \cos(\alpha+\beta)]$

$\sin\alpha\sin\beta = \frac{1}{2}[\cos(\alpha-\beta) - \cos(\alpha+\beta)]$

$\sin\alpha\cos\beta = \frac{1}{2}[\sin(\alpha+\beta) + \sin(\alpha-\beta)]$

$\sin\left(\theta + \frac{\pi}{2}\right) = \cos\theta$

$\cos\left(\theta + \frac{\pi}{2}\right) = -\sin\theta$

$\sec\theta := \frac{1}{\cos\theta}$

$\csc\theta := \frac{1}{\sin\theta}$

$\cot\theta := \frac{1}{\tan\theta}$

1. Starting from rest, a boat increases its speed to 6.22 m/s with constant acceleration. If it takes the boat 5.85 s to reach this speed, how far has it traveled?

   SKETCH: [2pts]

   HYPOTHESIS: [1 pt]

   SOLUTION: [4 pts]

   ANSWER REASONABLE / AGREE WITH HYPOTHESIS?: [1 pt]

2. The pilot of an airplane wishes to fly due north, but there is a 65 km/h wind blowing toward the north-east, making a 15° angle with due east.

   (a) In what direction should the pilot head her plane if its speed relative to the air is 350 km/h?

   (b) If the pilot decreases the air speed of the plane, but still wants to head due north, should the angle found in part (a) be increased or decreased? Explain.

HYPOTHESIS (just for part (a)): [1pt]

Part (a) VECTOR DIAGRAM and SOLUTION: [6 pts]

ANSWER REASONABLE / AGREES WITH HYPOTHESIS? (just for part (a)): [1 pt]

Part (b): [2 pts]

3. In a baseball game, a second baseman tosses the ball to the first baseman, who catches it at the same level from which it was thrown. The throw is made with an initial speed of 16.0 m/s at an angle of 32.5° above the horizontal.

   (a) What is the horizontal component of the ball's velocity just before it is caught? [3 pts]

   (b) How long is the ball in the air? [4 pts]

   (c) How far is the second baseman from the first baseman? [3pts]

   SKETCH: [2pts]

   HYPOTHESES for parts (a), (b), and (c): [3 pts]

   SOLUTION: [10 pts, total]

   ANSWERS REASONABLE / AGREE WITH HYPOTHESES?: [3 pts]

4. A 75-kg parent and a 20.0-kg child meet at the center of an ice rink. They place their hands together and push.

   (a) Is the magnitude of the force experienced by the child more than, less than, or the same as the force experienced by the parent?

   (b) What law helped you answer part (a)? Give the name of the law, and its full statement.

   (c) Is the acceleration of the child more than, less than, or the same as the acceleration of the parent? Explain.

   (d) If the acceleration of the child is 2.5 m/s^2 in magnitude, what is the magnitude of the parents acceleration?

   (e) What is the total momentum of the child and parent together after they push off? If the child's final speed is 3 m/s, what is the parent's final speed?

   SKETCH: [3pts]

   Part (a) ANSWER: [1 pt]

   Part (b) ANSWER: [4 pts]

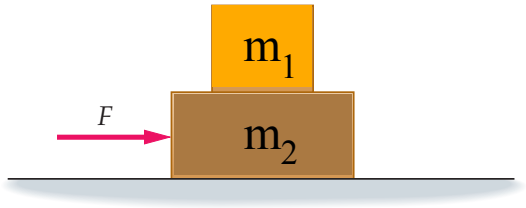
   Part (c) ANSWER: [3 pts]

SOLUTION for part (d): [3 pts]

SOLUTION for part (e): [3 pts]

5. What Newton's second law? If you use an equation, define all variable(s) in it. [4 pts]

6. Two blocks, stacked one on top of the other, can move without friction on the horizontal surface shown. The surface between the two blocks is rough, however, with a coefficient of static friction μ_s.



(a) If a horizontal force F is applied to the bottom block, find an expression for the maximum value F can have before the top block begins to slip.

(b) If the mass of the top block is increased, does the maximum value of F increase, decrease, or stay the same? Does the maximum possible acceleration of the block m_1 increase, decrease, or stay the same? For each, explain.

SKETCH (free body diagrams): [4pts]

Part (a) SOLUTION: [8 pts]

Part (b) ANSWERS: [4pts]

7. Consider riding a Ferris wheel.

   (a) As you ride, your apparent weight is different at the top than at the bottom of the wheel. Explain why.

   (b) Calculate your apparent weight at the top and bottom of a Ferris wheel, given that the radius of the wheel is 8.0 m, it completes one revolution every 30 s, and your mass is 60.0 kg.

Part (a) ANSWER: [2 pts]

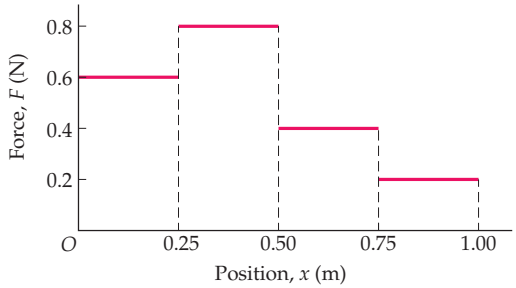
SKETCH free body diagrams for top and bottom: [4 pts]

HYPOTHESES for (b), top and bottom: [2 pts]

Part (b) SOLUTION: [8 pts]

ANSWERS REASONABLE / AGREE WITH HYPOTHESES?: [2 pts]

8. The force shown moves an object from $x = 0$ to $x = 1.00$ m.



(a) How much work is done by the force? [3 pts]

(b) What is the average power delivered if the object moves from from $x = 0$ to $x = 1.00$ m in 5 seconds? [3 pts]

(c) If the power delivered by the force is constant while moving the object, what is the time taken for the object to be moved from $x = 0$ to $x = 0.25$ m? [4 pts]

SOLUTIONS for parts (a), (b), and (c): [10 pts, total]

9. A 45.0-kg seal at an amusement park slides from rest down a ramp into the pool below. The top of the ramp is 1.80 m higher than the surface of the water and the ramp is inclined at an angle of 30.0° above the horizontal. If the seal reaches the water with a speed of 4.50 m/s, what is

   (a) the work done by kinetic friction and [4 pts]

   (b) the coefficient of kinetic friction between the seal and the ramp? [6 pts]

   SKETCH + free body diagram of seal: [4 pts]

   SOLUTIONS for parts (a) and (b): [10 pts, total]

10. A 15.0-g marble is dropped from rest onto the floor 1.60 m below.

    (a) If the marble bounces straight upward to a height of 0.700 m, what is the magnitude and direction of the impulse delivered to the marble by the floor?

    (b) If the marble had bounced to a greater height, would the impulse delivered to it have been greater or less than the impulse found in part (a)? Explain.

SKETCH: [2 pts]

Part (a) SOLUTION: [6 pts]

Part (b) ANSWER: [2 pts]