1. (1 pt) A cart is being pushed as shown so that the acceleration is 4 ft/s². Neglect friction and air resistance. The force P on the cart is:
   a. 1.5 pounds
   b. 4 pounds
   c. 48 pounds
   d. 1545 pounds

2. What is the friction force between the box and the ground?
   a. 12 lb
   b. 15 lb
   c. 18 lb
   d. 30 lb

3. (1 pt) A tractor is accelerating at 4 ft/s² while pulling a trailer. The coupling force on the tractor is 600 pounds. The coupling force on the trailer is:
   a. < 600 lb
   b. = 600 lb
   c. > 600 lb
   d. cannot determine from given information

4. (1 pt) Butch Jones throws a football straight up. Considering air resistance, the magnitude of the acceleration of the football the instant after release is:
   a. greater than gravity
   b. equal to gravity
   c. less than gravity
   d. cannot determine from given information

5. (1 pt) The work done by the normal force when pushing the block is:
   a. negative
   b. 0
   c. positive
   d. cannot determine from given information

6. (1 pt) During which type of collision is mechanical energy conserved?
   a. perfectly elastic
   b. inelastic
   c. perfectly inelastic
   d. all of the above

7. (1 pt) A spring has a stiffness of 1200N/m. Determine the force required to stretch the spring 0.2 m:
   a. 24 N
   b. 48 N
   c. 120 N
   d. 240 N
8. (1 pt) During the ballistic pendulum experiment, a ball is shot into a catcher. After the ball is embedded in the catcher and the combination is swinging up, what is conserved?
   a. energy
   b. momentum
   c. both energy and momentum
   d. neither energy or momentum

9. (1 pt) The location of the center of mass of the object to the right is at point:
   A.        
   B.        
   C.        
   D.        

10. (1 pt) A car starts from rest. The tangential acceleration of the car is 4 ft/s², the normal acceleration is 3 ft/s², and the total acceleration is 5 ft/s². The speed of the car after 2 seconds is
    a. 6 ft/s
    b. 8 ft/s
    c. 10 ft/s

11. (1 pt) A car is going around a circle. What are the signs of the centripetal acceleration when the car is at point A?
    a. x: +  y: +
    b. x: -  y: +
    c. x: +  y: -
    d. x: -  y: -

12. (1 pt) A person stands on a rotating platform while holding a spinning bicycle wheel. When they turn the bicycle wheel over, the person starts to rotate. This is due to:
    a. Conservation of linear energy
    b. Conservation of angular energy
    c. Conservation of linear momentum
    d. Conservation of angular momentum

13. (4 pts) The screen in the AMB auditorium is 6 smoots wide by 4 meters high. How many rolls of wallpaper does it take to cover the screen? 1 smoot = 5 ft 7 inches; 1 roll of wallpaper covers 30 ft².

   | 4.6 rolls |
   |__________|

   6 smoots 5.583 ft = 33.498 ft
   1 smoot

   4 m 3.28 ft = 13.12 ft
   1 m

   Area = 33.498 ft² 13.12 ft = 439.49 ft²
   1 roll 30 ft² = 14.65 rolls

   3 pts 2.5 rolls 1.47 rolls 95 rolls didn't divide by 2.54 cm/in

   -1 for using 5 7/12 in, instead of 5 ft 7 in
   -1 either conv. example wrong (12 ft = 1 m)
   -1 for rounding down to 14
   -2 both conv. wrong
14. (7 pts) Andrew flies his drone 400 feet due north. He then flies the drone 500 feet at 30° south of west, followed by flying it 300 feet at 40° east of north. Determine the direction he needs to fly the drone to get back to the starting point.

\[ \theta = \tan^{-1} \left( \frac{379.81}{240.16} \right) = 57.7° \text{ or } 57.7° \text{ S of E} \]

15. (7 pts) Brandi is driving her car at 80 ft/sec. She slows down at a rate of 6 ft/s² for 4 seconds. She then slows down at a rate of 9 ft/s² until coming to a stop. Determine the total distance Brandi traveled from when she started to slow down until she came to a stop.

\[ \Delta t = \frac{272}{\frac{1}{2} \times 6 - \frac{1}{2} \times 9} = \frac{272 \times 2}{-1.5} = 446 \text{ ft} \]

\[ \Delta s = \frac{\Delta v \times t}{2} = \frac{(80 + 56) \times 4}{2} = 272 \text{ ft} \]

\[ v_2 = \frac{\Delta s - \frac{1}{2} \times 9 \times (4)^2}{4} = \frac{446 - 72}{4} = 91.5 \text{ ft/sec} \]

\[ a_3 = -\frac{9}{4} \text{ ft/sec}^2 \]

\[ \Delta s = \frac{(446 - (56))^2}{2 \times (4)} = 174.2 \text{ ft} \]

\[ \text{Total: } 272 + 174.2 = 446.2 \text{ ft} \]
16. (7 pts) Tyler throws a football from a height above the ground of 5 ft and at a 20° angle from the horizontal. The football hits the ground 1.2 seconds later. Determine the horizontal distance the football travelled.

\[ y = y_0 + v_{y0} t - \frac{1}{2} g t^2 \]

\[ 0 = 5 + v_{y0} (1.2 \text{ sec}) - \frac{1}{2} (32.2 \text{ ft/s}^2)(1.2 \text{ s})^2 \]

\[ v_{y0} = 15.15 \text{ ft/s} \]

\[ 15.15 = v_0 \sin(20) \]

\[ v_0 = 44.3 \text{ ft/s} \]

**Automatic adjustment +2 if you received a 1, 2, or 3**

17. (7 pts) Sarah is flying her airplane at 320 mph due south with respect to the ground. The wind is blowing at 20° north of east. Sarah's speed with respect to the air is 360 mph. Determine the wind speed.

\[ v_{W茉} = v_{W/A} + v_{A/茉} \]

\[ \frac{\sin A}{A} = \frac{\sin C}{C} = \frac{\sin 110}{360} = \frac{\sin C}{220} \]

\[ C = 56.6° \]

\[ \frac{\sin A}{A} = \frac{\sin C}{C} = \frac{\sin 110}{360} = \frac{\sin 13.4}{B} \]

\[ B = 88.7 \text{ mph} \]

-3 triangle drawn incorrectly
-2 couldn't find correct angle C or B or 110°
-2 switched \( v_{W茉} \) \& \( v_{W/A} \)
18. (7 pts) Jason is pushing a 40 lb cart up a ramp with a 19 lb force. Determine the magnitude of the acceleration. Neglect friction and drag. \( F\text{BD} = K\text{D required} \)

\[
\begin{align*}
2.48 \text{ ft/s}^2
\end{align*}
\]

19. (7 pts) Daniel is pushing on a 50 pound box of his fraudulent tax returns with a force of 45 pounds. Determine the minimum additional force \( P \) to keep the box from sliding. \( F\text{BD required} \)

\[
\begin{align*}
14.3 \text{ lb}
\end{align*}
\]
20. (7 pts) Rachel is riding a roller coaster with a total weight (coaster and riders) of 6000 pounds, as shown. The speed at point A is 20 ft/s, and the speed at point B is 45 ft/s. The distance along the track between points A and B is 210 ft. Determine the average retarding force between points A and B.

\[ \text{PE}_{\text{gA}} + \text{PE}_{\text{fA}} + \text{KE}_{\text{fA}} + \text{WK} = \text{PE}_{\text{gB}} + \text{PE}_{\text{fB}} + \text{KE}_{\text{fB}} + E_{\text{loss}} \]

\[ mg(80) + \frac{1}{2}m(20)^2 = \frac{1}{2}m(45)^2 + F_d \]

\[ 6000\text{lb}(30\text{ft}) + \frac{1}{2}( \frac{600}{32.2})(20^2) = \frac{1}{2}( \frac{600}{32.2})(45^2) + F(210\text{ft}) \]

-1 # filled in wrong up to #

\[ F = 136.2\text{ lb} \]

-1 math err.

-1 units

21. (7 pts) Tayler is sliding a Rube-Goldberg device across a floor. The device is moving at 4 m/s when it hits a spring. Determine the maximum distance the spring compresses.

\[ \text{PE}_{\text{gA}} + \text{PE}_{\text{fA}} + \text{KE}_{\text{fA}} + \text{WK} = \text{PE}_{\text{gB}} + \text{PE}_{\text{fB}} + \text{KE}_{\text{fB}} + E_{\text{loss}} \]

\[ \frac{1}{2}mv^2 = \frac{1}{2}kx^2 + F_kx \]

\[ \frac{1}{2}(120)(4)^2 = \frac{1}{2}(2400)x^2 + (0.3)(120)x \]

Solve quadratic

\[ x = 0.270 \pm 0.305 \]
22. (7 pts) Professors McCord and Schleter are driving their Priuses as shown in the figure. Professor McCord rear ends Prof. Schleter and after the collision, Prof. Schleter is traveling at 55 ft/s.
Determine the coefficient of restitution between the Priuses. Assume both Priuses have the same mass.

\[ V_1 = 60 \text{ ft/s} \]
\[ V_2 = 40 \text{ ft/s} \]
\[ V'_1 = ? \]
\[ V'_2 = 55 \text{ ft/s} \]

\[ e = \frac{-(V'_1 - V'_2)}{V_1 - V_2} \]
\[ = \frac{-(45 - 55)}{60 - 40} \]
\[ e = 0.5 \]

23. (7 pts) Nate builds a bracket as shown. Determine the moment about point A. Give the magnitude of the moment and direction as clockwise or counterclockwise.

\[ \sum \text{MA} = 9 \text{ lbf ft} \quad \text{CCW} \]

\[ (+) 16 \text{ lb}(3 \text{ ft}) \]
\[ (+) (31 \text{ lb \cos 50})(4 \text{ ft}) \]
\[ (-)(31 \text{ lb \sin 50})(5 \text{ ft}) = +9 \text{ lbf ft} \]

\[ -119 \text{ lbf ft} \]

\[ \sqrt{2} \]

\[ \sqrt{79^2 + 70^2} = 107 \]

\[ 31 \left( 6.40 \text{ sin 50} \right) \]

\[ -39 \]
24. (7 pts) Prof. Jelde (weight of 150 lb) is riding a 70 ft radius Ferris Wheel that is spinning at a constant rate 5 rpm. Determine the normal force on Prof. Jelde when he is at the location shown. (FBD = KD required)

\[ a_n = \omega^2 r = \left( \frac{5 \text{ rev}}{\text{min}} \cdot \frac{1 \text{ min}}{60 \text{ s}} \cdot \frac{2\pi \text{ rad}}{1 \text{ rev}} \right)^2 (70 \text{ ft}) \]

\[ a_n = 19.19 \text{ ft/s}^2 \]

\[ a_{ny} = 19.19 \cos 30 = 16.62 \text{ ft/s}^2 \]

\[ \Sigma F_y = \text{ma}_y \]

\[ -150 + N = \left( \frac{150}{32.2} \right) (16.62) \]

\[ N = 227.4 \text{ lb} \]

25. (7 pts) Prof. Bennett releases from rest a 14 pound bowling ball and it rolls down the incline as shown. The radius of the bowling ball is 4.25 inches. Determine the speed of the bowling ball at the bottom of the incline. \([I_{\text{solid sphere}} = \frac{2}{5}mr^2]\)

\[ I = \frac{2}{5} \left( \frac{14}{32.2} \right) \left( \frac{4.25}{12} \right)^2 = 0.0218 \text{ slug ft}^2 \]

\[ \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh \]

\[ v = 21.9 \text{ ft/s} \]