1. (14 pts) Paul's skateboard is moving at 12 m/s when the force shown is applied. The combined mass of Paul and his skateboard is 82 kg. Determine the speed of the skateboard after it has traveled 8 m.

\[ \text{Work} = \Delta KE \]
\[ \Delta KE = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 \]

\[ -1440 \text{ nm} = \frac{1}{2} \cdot 82 \text{ kg} \cdot v_2^2 - \frac{1}{2} \cdot 82 \text{ kg} \cdot (12 \text{ m/s})^2 \Rightarrow v_f = 10.43 \text{ m/s} \]

2. (14 pts) Dean is still pushing the cart with band equipment down a hill. The cart starts from at rest when Dean starts pushing. He pushes for 9 ft with a force of 36 lb. There is 90 ft-lb of energy loss due to friction. Determine the speed after the cart has gone 9 ft down the hill.

\[ \text{Datum} \]

\[ mgh_1 + kE_1 + W_{in} = mgh_2 + kE_2 + E_{loss} \]
\[ 87 \text{ lb} \cdot 9 \text{ ft} \cdot \sin 8^\circ + 9 \text{ ft} \cdot 36 \text{ lb} = \frac{1}{2} \cdot 87 \text{ lb} \cdot v_2^2 + 90 \text{ ft-lb} \]

\[ \Rightarrow v_2^2 = 15.9 \text{ ft/sec} \]
3. (14 pts) Nate is testing his bungee cord before jumping off a bridge. He ties a 74 kg sack of rocks to a 32 m long bungee cord and gently nudges it off the bridge. The bungee cord has a stiffness of 128 N/m. Unfortunately, Nate has miscalculated and the sack of rocks hits the ground, which is 45 m below the bridge. Determine the speed with which the sack of rocks hits the ground.

\[ v_a = 24.3 \text{ m/s} \]

- Energy equation wrong - 6
- Wrong "x" - 4
- Calc error - 2
- Not enough work - 4
- Forgot to square x term - 32 m
- Had same equation - 2

\[ mgh_1 = \frac{1}{2}m v_2^2 + U_e \]

\[ 74 \text{ kg} \cdot 9.81 \text{ m/s}^2 \cdot 45 \text{ m} = \frac{1}{2} \cdot 74 \text{ kg} \cdot v_2^2 \]

Wrong \( h_1 = -4 \)

\[ + \frac{3}{2} \cdot 128 \text{ N/m} \cdot (45 - 32)^2 \]

\[ = 45 \text{ m} - 32 \text{ m} \]

4. (14 pts) A 2200 kg truck traveling at 22 m/s rear crashes into a slow car in front of it that is traveling in the same direction at 8 m/s. After the crash, the car and truck move together at 17 m/s. Determine the mass of the car.

\[ m_1 = 1200 \text{ kg} \]

\[ m_1 v_1 + m_2 v_2 = (m_1 + m_2) v \]

\[ 2200 \text{ kg} \cdot 22 \text{ m/s} + 8m_2 = (2200 \text{ kg} + m_2) \cdot 17 \text{ m/s} \]

\[ \Rightarrow m_2 = 1228 \text{ kg} \]

-8 used energy eqs. incorrectly

-6 right eq., wrong idea

5 sig figs or 228 kg here!
5. (14 pts) Shane slides a 14 kg disc down the ice at a speed of 6 m/s. The disc directly collides with an 8 kg disc that is initially at rest. The collision is a perfectly elastic collision. Determine the speed of the 8 kg disc after the collision.

\[ m_1 v_{i1} + m_2 v_{i2} = m_1 v'_{i1} + m_2 v'_{i2} \]

\[ v_{1f} - v_{2f} = -(v'_{1f} - v'_{2f}) \]

\[ 14 \text{ kg} \cdot 6 \text{ m/sec} + 0 = 14 \text{ kg} \cdot v'_{1f} + 8 \text{ kg} \cdot v'_{2f} \]

\[ 6 \text{ m/sec} - 0 = -(v'_{1f} - v'_{2f}) \]

\[ 6 = v'_{2f} - v'_{1f} \]

\[ v'_{1f} = 7.63 \text{ m/sec} \]

\[ v'_{2f} = 1.63 \text{ m/sec} \]

6. (14 pts) Abby throws a 0.80 lb ball such that it strikes the floor with a speed of 22 ft/s at an angle of 40°. If the coefficient of restitution between the ball and the floor is 0.64, what is the angle \( \theta \) with which the ball leaves the floor?

\[ \theta = \tan^{-1} \left( \frac{9.05}{16.85} \right) \]

\[ \theta = 28.2° \]

\[ v_x = 22 \cos 40° = 16.85 \text{ ft/sec} = v_x' \]

\[ v_y = -22 \sin 40° = -14.14 \text{ ft/sec} \]

\[ v_y' = -e \cdot v_y = -0.64 \cdot (-14.14) \text{ ft/sec} = 8.05 \text{ ft/sec} \]
7. (8 pts) A force of \((12\hat{i} - 5\hat{j})N\) acts through a displacement of \((-4\hat{i} - 6\hat{j})m\). Determine the amount of work done by the force.

\[
\mathbf{W} = \mathbf{F} \cdot \Delta \mathbf{d} \quad \text{(dot product)}
\]

\[
\text{Work} = (12\hat{i} - 5\hat{j})N \cdot (-4\hat{i} - 6\hat{j})m = -48 + 30 = -18 \text{ J m}
\]

8. (4 pts) Dr. Bennett has to do 138 J of work. Dr. Bennett is only 18% efficient. Determine the amount of energy that Dr. Bennett burns in performing the work.

\[
767 \text{ J}
\]

9. (4 pts) A field goal attempt is kicked at an angle of \(12^\circ\) from the horizontal. Is the kinetic energy of the football:

(A) a scalar

(B) a vector

Please remain seated if there are less than 5 minutes to go in the exam so as not to disturb those still trying to finish. If you finish early you should go back and check your work.