Name: _____

Show all work to receive full credit.

For each question:

- draw a diagram
- identify the quantities given and the quantities to find
- identify the principle that applies
- write the equation(s) you need to solve the problem
- rewrite the equation(s) in a form that isolates the unknown quantity
- solve for the unknown quantity
- make sure you have the correct units and significant figures

1. A skier starts from rest at the top of a hill that is inclined at 10.5° with the horizontal. The hillside is 50.0 m long and the coefficient of friction between the snow and the skis is 0.125. At the bottom of the hill, the snow is level and the coefficient of friction is unchanged. How far does the skier glide along the horizontal portion of the snow before coming to rest?

2. A 1.50 g mass is attached to a 15.0 cm long string that is free to swing. The mass is hanging vertically with no initial velocity. A spring with a spring constant, k, equal to 85 N/m is compressed 0.250 cm and brought into contact with the mass. The spring is then released, causing the mass to swing upwards. How high does the mass rise?

3. A pitcher throws a baseball of mass 0.250 kg horizontally at a speed of 35.0 m/s towards a batter. The batter swings and hits the ball. The ball is in contact with the bat for 0.0250 s and the ball leaves the bat with a speed of 43.0 m/s at an angle of 30.0° to the horizontal. What is the average force (magnitude and direction) exerted by the bat on the baseball? (Hint: Break the velocity vectors into horizontal and vertical components.)

4. A car of mass 1250 kg traveling at 31.5 m/s rear ends a truck of mass 33,200 kg traveling at 20.5 m/s. After the collision the car and truck move together as one object.

   (a) What is the final velocity of the car/truck system?

   (b) How much kinetic energy is lost during the collision?

5. A father and his daughter are riding bumber cars at the state fair. The combined mass of the father and his car is 168 kg and the combined mass of the daughter and her car is 136 kg. They drive towards each other in a head on collision with the father traveling at +2.23 m/s and the daughter traveling at −1.45 m/s. The father's final velocity is 0.450 m/s.

   (a) What is the daughter's final velocity after the collision?

   (b) How much kinetic energy is lost during the collision?

Equations

Pythagorean Theorem and Trigonometry

$$r^2 = x^2 + y^2$$

$$\sin\theta = \frac{y}{r} \qquad \cos\theta = \frac{x}{r} \qquad \tan\theta = \frac{y}{x}$$

Quadratic Formula

$$\text{For: } Ax^2 + Bx + C = 0$$

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

Vectors

$$A_x = A\cos\theta \qquad A_y = A\sin\theta$$

$$\tan\theta = \frac{A_y}{A_x} \qquad A^2 = A_x^2 + A_y^2$$

Kinematics – Uniform Acceleration

$$\Delta x = v_{0x}t + \frac{1}{2}a_x t^2 \quad \Delta y = v_{0y}t + \frac{1}{2}a_y t^2$$

$$v_x = v_{0x} + a_x t \quad v_y = v_{0y} + a_y t$$

$$v_x^2 = v_{0x}^2 + 2a_x(\Delta x) \quad v_y^2 = v_{0y}^2 + 2a_y(\Delta y)$$

Newton's Laws

$$\sum \vec{F} = m\vec{a} \qquad \vec{F}_{12} = -\vec{F}_{21}$$

$$\sum F_x = ma_x \qquad \sum F_y = ma_y$$

Universal Gravitation

$$F = G\frac{m_1 m_2}{r^2}$$

Friction

$$f_s \leq \mu_s N \qquad f_k = \mu_k N$$

Spring Force

$$F_s = -kx$$

Work and Energy

$$W = F\cos\theta\Delta x$$

$$KE = \frac{1}{2}mv^2 \quad PE_g = mgy \quad PE_s = \frac{1}{2}kx^2$$

$$E = PE + KE$$

$$W_{nc} = \Delta E$$

Power

$$\bar{P} = \frac{\Delta W}{\Delta t} = \frac{F\Delta x}{\Delta t} = F\bar{v}$$

Impulse and Momentum

$$\vec{I} \equiv \vec{F}\Delta t$$

$$\vec{p} = m\vec{v} \quad \vec{F}\Delta t = \Delta\vec{p}$$

Conservation of Momentum

$$\sum \vec{p}_i = \sum \vec{p}_f$$

$$\sum p_{ix} = \sum p_{fx} \quad \sum p_{iy} = \sum p_{fy}$$

Collisions

$$\sum \vec{p}_i = \sum \vec{p}_f$$

$$\underbrace{KE_i = KE_f}_{\text{elastic}} \qquad \underbrace{KE_i \neq KE_f}_{\text{inelastic}}$$

Constants

$$g = G\frac{M_E}{R_E^2} = 9.80\ \text{m/s}^2$$

$$G = 6.67 \times 10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2$$