Physics Unit 3 SG: Energy Name KEY

1. A bicycle has a momentum of 24 kg•m/s. What momentum would the bicycle have if it had … *use $p = m \cdot v$

a. … twice the mass and was moving at the same speed? 48 kg·m/s

b. … the same mass and was moving with twice the speed? 48 kg·m/s

c. … one-half the mass and was moving with twice the speed? 24 kg·m/s

d. … the same mass and was moving with one-half the speed? 12 kg·m/s

2. State the law of conservation of momentum

look @ slideshow

3. During an elastic collision, is KE conserved?

yes

4. During an inelastic collision, what happens to some/all of the kinetic energy?

It is transformed into sound, heat, etc.

5. How can the change in momentum (impulse) be determined when looking at a force vs. times graph? It is the area under the graph

3. An astronaut with a mass of 100 kg is floating at rest in deep space near her ship when she notices that the cord that's supposed to keep her connected to her ship has broken! She reaches into her pocket, finds a metal tool of mass 1 kg and throws it out into space with a velocity of 10 m/s, directly away from the ship. If she's 5 m away from the ship, how long will it take her to reach it?

$m_{ast.} = 100kg$ $V_1 = 0 m/s$ $x = 5m$

$m_{tool} = 1kg$ $V_2 = 0 m/s$ $V_2' = 10 m/s$ $t = ?$

$m_1 V_1 + m_2 V_2 = m_1 V_1' + m_2 V_2'$

$0 + 0 = 100kg V_1' + 1kg(-10\frac{m}{s})$

$10 kg\frac{m}{s} = 100 kg V_1'$

$V_1' = 0.1 m/s$

$V_1' = 0.1\frac{m}{s}$

$V = \frac{x}{t} \therefore t = \frac{x}{v}$

$t = \frac{5m}{0.1\frac{m}{s}} = \boxed{50s}$

4. Ball 1 rolls with velocity v1 = 5 m/s toward ball 2, which is initially at rest. Ball 1 has a mass of 1 kg, and ball 2 has a mass of 4 kg. After the collision, ball 2 is observed to move with a velocity of v2 = 2 m/s. A. What is the velocity of ball 1 after the collision? B. Was the collision elastic or inelastic?

1 (1kg) → 5 m/s 2 (4kg)

$V_1' = ?$ $V = 0 m/s$ $V_2' = 2 m/s$

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$1kg(5 m/s) + 4kg(0\frac{m}{s}) = 1kg(v_1') + 4kg(2\frac{m}{s})$

$5 kg\, m/s = 1kg v_1' + 8 kg\, m/s$

$-8 \quad -8$

$-3 kg\, m/s = 1kg\, v_1'$

$\frac{-3 kg\, m/s}{1kg} = \frac{1kg\, v_1'}{1kg}$ $v_1' = \boxed{-3 m/s}$

find KE before & KE after

Before: $KE = \frac{1}{2} \cdot 1kg \cdot 5\frac{m}{s}^2$

$= 12.5J$

After: $\frac{1}{2} \cdot 1kg(-3\frac{m}{s})^2 + \frac{1}{2}(4kg)(2\frac{m}{s})^2$

$4.5J + 8J$

$= 12.5J$

* NO KE lost = Elastic!

5. According to the Guinness Book of World Records, the fastest recorded baseball pitch was delivered by Nolan Ryan in 1974. The pitch was clocked at 100.9 mi/hr (45.0 m/s). Determine the impulse required to give a 0.145-kg baseball such a momentum.

$J = F\Delta t = \Delta P = m\Delta V = 0.145kg(45\frac{m}{s} - 0\frac{m}{s}) = \boxed{6.52 N\cdot s}$

6. A machine lifts a 35-kg object 20.0 m in 2.0 s. How much power is produced by the machine to lift the object?

↑ 20m, 35kg, $t = 2s$

$P = \frac{W}{t} = \frac{F\cdot d}{t} = \frac{m\cdot g\cdot h}{t} = \frac{35kg(9.8\frac{m}{s^2})(20m)}{2s} = \boxed{3{,}430 W}$

7. What is the maximum velocity at which a 25 W motor can lift a 8.5 kg object upward?

$P = 25W \quad m = 8.5kg \quad V = ? \quad P = \frac{W}{t} = \frac{F d}{t} = F\cdot V$

$25W = (8.5kg)(9.8\frac{m}{s^2})V$

$\boxed{V = 0.3 m/s}$

8. How much power is required to lift a 12-N box at 4.5 m/s?

$F = 12N \quad V = 4.5\frac{m}{s} \quad P = \frac{W}{t} = \frac{F\cdot d}{t} = F\cdot V = 12N \cdot 4.5\frac{m}{s} = \boxed{54W}$

9. A 290-N force is used to compress a spring. The spring constant of the spring is 5,880 N/m. How far is the spring compressed? $F = -Kx \quad 290N = -5880 N/m\, x \quad \boxed{x = 0.05 m}$

10. A student throws an object downward. The initial kinetic energy of the object is 360 J. When the object reaches the ground, the kinetic energy of the object is 3 times the initial kinetic energy of the object. What was the initial potential energy of the object?

$360J \times 3 = 1{,}080J$ * when it reaches the ground KE = max

∴ $ME = 1{,}080J$ ∴ initial $PE = 1{,}080J - 360J = \boxed{720J}$

11. A 588-N person carrying 294 N of equipment starts climbing a mountain that is 3,118 m high. What is the minimum energy required for the person to climb the mountain?

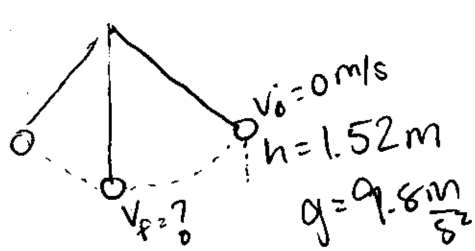
$588N + 294N = 882N \quad W = F\cdot d = 882N \cdot 3118m = \boxed{2.75\times10^6 J}$

12. A student drops a 0.45-kg ball that hits the floor with a speed of 5.3 m/s. If the velocity of the ball is 4.8 m/s when it hits the floor on the second bounce, how much mechanical energy is lost during the first bounce? @floor, KE is max ∴ ME = KE

$KE = \frac{1}{2}mv^2 \quad \frac{1}{2}0.45kg(5.3\frac{m}{s})^2 = 6.32J \quad \frac{1}{2}0.45kg(4.8\frac{m}{s})^2 = 5.18J$

$6.32J - 5.18J = \boxed{1.1J}$

13. A pendulum swings back and forth up to a maximum height of 1.52 m. Neglecting friction, what is the speed of the pendulum at the lowest position?



$V_f^2 = V_i^2 + 2a\Delta x$

$V_f^2 = 0 + 2(9.8\frac{m}{s^2})(1.52m)$

$\boxed{V_f = 5.5\frac{m}{s}}$