KEY!

Conceptual Physics Review (Chapters 7 & 8) Ms. Bush

Chapter 7

- Define momentum, in words.
- Be able to compare the momentums of two objects, given information about their relative masses and/or relative velocities.
- Be able to calculate the momentum of an object, including the proper units.
- Define impulse, in words, and describe how it affects momentum.
- Be able to calculate impulse, including the proper units.
- Explain why an impulse is greater when an object bounces than when the same object comes to a sudden stop.
- State the law of conservation of momentum.
- Do calculations using the law of conservation of momentum, for both elastic and inelastic collisions.

Chapter 8

- Define work, in words.
- Be able to calculate the work done on one object by another object, including the proper units.
- Define power, in words.
- Be able to calculate power, including the proper units.
- Define potential energy, and more specifically, gravitational potential energy.
- Be able to calculate the potential energy of an object, given the work required to raise it above the earth or given the mass of the object and the distance it is raised above the earth.
- Define kinetic energy, and give an equation for how to calculate it given the mass and velocity of an object.
- Describe the work-energy theorem.
- State the law of conservation of energy.
- Explain how the potential energy and kinetic energy of an object change when it falls from some height above the earth down to the surface of the earth.

Labs

- Review Lab #19: Go Cart.
- Review Lab #22: Muscle Up. (This will be returned to you on Monday)
- Review Lab #23: Cut Short (did together in class)

Sample Calculations

1. Tiger Woods hits a 0.050-kg golf ball, giving it a speed of 75 m/s.

   a) What change in momentum does the golf ball undergo?

   Ball was at rest, so $\Delta V = (V_F - V_i) = (75 m/s - 0) = 75 m/s$

   $\Delta p = m\Delta V = (.050 kg)(75 m/s) = 3.75 kg\cdot m/s$

   b) What impulse does Tiger impart to the ball?

   $Ft = m\Delta V$ (Impulse) — Impulse is change in momentum! $= 3.75 kg\cdot m/s$

   c) Why is it impossible to determine what impact force Tiger exerts on the ball?

   We don't know how long (time) the hit took.

2. Compare the momentums of the following pairs of objects, stating whether their momentums are the same, or stating which one has greater momentum, or stating that it is impossible to tell from the information given.

   a) A jogging elephant and a sprinting elephant, each with the same mass.

   Sprinting elephant has greater momentum (Because of greater velocity)

   b) A jogging elephant and a sprinting gazelle.

   Impossible to tell.

   c) A mouse and an elephant traveling at the same speed.

   Elephant has greater momentum (because of its greater mass)

   d) A 5-kg dog running at 3 m/s and a 7.5-kg dog running at 2 m/s.

   $p = mv \rightarrow$ $Dog_1 = 5 \cdot 3 = 15 kg\cdot m/s$, $Dog_2 = 7.5 kg \cdot 2 m/s = 15 kg\cdot m/s$ → Same momentum.

3. A 0.060-kg tennis ball is traveling at 10.0 m/s toward Venus Williams's tennis racket. She hits the ball and sends it in the opposite direction with a speed of 36.0 m/s.

   a) What change in momentum does the tennis ball undergo? (Don't forget that it changes direction,)

   $\Delta V = (V_F - V_i) = -36 - 10 = -46 m/s$

   $V_i = 10 m/s$ →, $V_F = -36 m/s$ ←

   $\Delta p = m\Delta V = (0.060 kg)(-46 m/s) = -2.76 kg\cdot m/s$ (− optional)

   b) If the ball is in contact with the racket for 0.020 seconds, with what average force of impact has Venus hit the ball?

   $Ft = m\Delta V$

   $F(0.020 s) = (2.76 kg\cdot m/s)$

   $F = \frac{2.76 kg\cdot m/s}{.020 s} = 138 kg\cdot m/s^2 = 138 N$

4. **If a 1000.0-kg car is sent toward a cement wall (in a crash test) with a speed of 14 m/s and the impact brings it to a stop in 8.00×10^{-2} s, with what average force is it brought to rest?**

$$F = \frac{m \Delta v}{t} = \frac{m(v_f - v_i)}{t} = \frac{(1000\,kg)(0 - 14\,m/s)}{8 \times 10^{-2}}$$

$$= \boxed{175,000\ N}$$

What could you do differently to decrease the average force of impact?

Increase the time that the Force is applied, by having a big bumper on the car, & airbags in the car.

5. **Tubby and his twin brother Chubby have a combined mass of 200.0 kg and are zooming along in a 100.0-kg amusement park bumper car at 10.0 m/s. They bump Melinda's car (also 100.0 kg), which is sitting still. Melinda has a mass of 25.0 kg. After the elastic collision, the twins continue ahead with a speed of 4.12 m/s. How fast is Melinda's car bumped across the floor (She moves in the same direction as the twins)?**

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

$$(200 + 100\,kg)(10\,m/s) + 0 = (200 + 100\,kg)(4.12) + (100 + 25\,kg)\,v_2'$$

$$3000\,kg\,m/s = 1236\,kg\,m/s + 125\,v_2'$$

$$v_2' = \boxed{14.1\,m/s}$$ in the same direction as the twins.

6. **If an 800.0-kg sports car slows to 13.0 m/s to check out an accident scene and the 1200.0 -kg pickup truck behind him continues traveling at 25.0 m/s, with what velocity will the two move if they lock bumpers after a rear-end collision?**

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_{12}'$$

$$(800\,kg)(13\,m/s) + (1200)(25) = (800 + 1200)\,v_{12}'$$

$$v_{12}' = \boxed{20.2\,m/s}$$

7. **Charlotte, a 65.0-kg skin diver, shoots a 2.0-kg spear with a speed of 15 m/s at a fish who darts away quickly without getting hit. How fast does Charlotte move backwards when the spear is shot?**

$$(m_1 + m_2) v = m_1 v_1' + m_2 v_2'$$

$$\emptyset = (65\,kg)\,v_1' + (2\,kg)(15\,m/s)$$

$$\frac{-30\,kg\,m/s}{65} = \frac{65\,kg\,v_1'}{65}$$

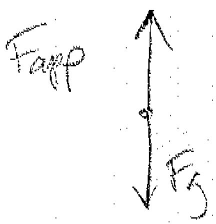
in the opposite direction of the spear! → $\boxed{-0.462\,m/s} = v_1'$

8. Bud, a very large man of mass 130 kg, stands on a pogo stick. How much work does he do on the pogo stick when he compresses the spring 0.50 m?

$F_g = mg = (130\,kg)(9.8\,m/s^2) = 1274\,kg\,m/s^2 = 1274\,N$

$W = Fd = (1274\,N)(0.50\,m) = 637\,N \cdot m = \boxed{637\,J}$

9. After finishing her physics homework, Sherita pulls her 50.0-kg body out of the living room chair and climbs up the 5.0-m-high flight of stairs to her bedroom.



a) How much work does Sherita do in ascending the stairs?

$F_g = (50)(9.8) = 490\,N$

$W = Fd = 490\,N \cdot 5\,m = \boxed{2450\,J}$

b) What is Sherita's potential energy relative to the living room floor once she is upstairs?

$GPE = mgh = (50\,kg)(9.8\,m/s^2)(5\,m) = \boxed{2450\,J}$

You can calculate GPE, or you can just explain that the work she did against the force of gravity gives her that much GPE.

c) If it took her 10 seconds to climb the flight of stairs, how much power did she generate?

$P = \frac{W}{t} = \frac{2450\,J}{10\,s} = 245\,J/s = \boxed{245\,Watts}$

d) The next night, she runs up the same flight of stairs in 3 seconds. Is the amount of work done by her less than, the same as, or greater than the night before? What about the amount of power she generates?

Work is the same ($W = Fd = 2450\,J$), but

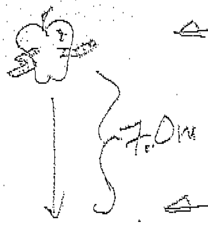
Power is more ($P = \frac{W}{t} = \frac{2450\,J}{3\,s} = \boxed{817\,W}$)

10. Marissa does 3.2 J of work to lower the window shade in her bedroom a distance of 0.8 m. How much force must Marissa exert on the window shade?

$W = Fd$, so $F = \frac{W}{d}$

$F = \frac{3.2\,J}{0.8\,m} = \boxed{4\,N}$

11. Legend has it that Isaac Newton "discovered" gravity when an apple fell from a tree and hit him on the head. If a 0.20-kg apple fell 7.0 m before hitting Newton, what was its *change* in PE during the fall?



$\leftarrow GPE_i = mgh = (0.2\,kg)(9.8\,m/s^2)(7\,m) = 13.7\,J$

$\leftarrow GPE_f = 0\,J$

$\Delta GPE = GPE_f - GPE_i$

$= 0 - 13.7\,J$

$= \boxed{-13.7\,J}$

Must hav minus sign because GPE was lo in the fi

12. A greyhound at a racetrack can run at a speed of 16.0 m/s. What is the KE of a 20.0-kg greyhound as it crosses the finish line, traveling at that speed?

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

$KE = \frac{1}{2}(20.0\,kg)(16.0\,m/s)^2 = \boxed{2560\,J}$

13. In a wild shot, Bo flings a pool ball of mass 0.50 kg off a 0.68-m-high pool table, and the ball hits the floor with a speed of 6.0 m/s.

a) What is the kinetic energy of the pool ball when it hits the floor?

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(0.50\,kg)(6\,m/s)^2 = \boxed{9\,J}$

b) How much potential energy did the pool ball have (relative to the floor) when it was on the table?

$GPE = mgh$

$= (0.50\,kg)(9.8\,m/s^2)(0.68\,m) = \boxed{3.33\,J}$

c) How much kinetic energy did the pool ball have when it left the table?

$GPE_i + KE_i = GPE_f + KE_f$

$3.33\,J + KE_i = 0\,J + 9\,J$

$KE_i = \boxed{5.67\,J}$

d) How fast was it going when it left the table?

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

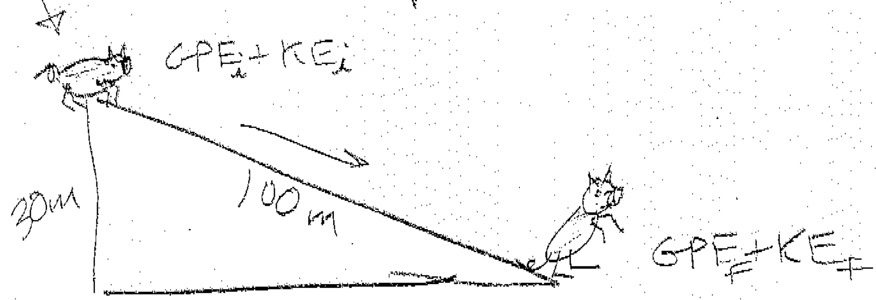
$5.67\,J = \frac{1}{2}(0.50\,kg)v^2$

$v = \boxed{4.76\,m/s}$

14. A 500.0-kg pig is standing on the top of a muddy hill on a rainy day. The hill is 100.0 m long with a vertical drop of 30.0 m. The pig slips and begins to slide down the hill. What is the pig's speed at the bottom of the hill? (Hint: Use the law of conservation of energy, meaning the total of the potential energy and kinetic energy for the pig is the same, whether the pig is at the top of the hill or at the bottom.)

Bacon

Who makes up these problems ?!?/



Pig isn't moving

Height at bottom is 0 m.

$$GPE_i + KE_i = GPE_f + KE_f$$

$$mgh + 0 = 0 + \frac{1}{2}mv^2$$

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

$$v = \sqrt{2gh}$$

$$v = \sqrt{2 \cdot 9.8 \cdot 30\text{ m}}$$

$$v = \boxed{24.2\text{ m/s}}$$