Unit #4: Energy & Momentum Review Sheet

- Work done on an object = Force x distance where force is the component of force acting in the direction of motion only.
- If there is no net force on an object, there can be no net work done on the object.
- Energy: either a transfer or storage. Work is energy transfer.
- $KE = \frac{1}{2} mv^2$
- GPE = mgh (only worry about this when vertical heights change in a problem)
- $EPE = \frac{1}{2} kx^2$
- Work energy theorem: net work done on an object = change in PE plus change in KE of the object.
- This can be expanded when the work done by the conservative forces of gravity and springs is taken into account. We can use CLEE (the Crazy Long Energy Equation):

$$KE_o + GPE_o + EPE_0 + W_{nc} = KE_f + GPE_f + EPE_f$$

- Energy is always conserved.
- Power = Work / time = Energy / time
- ONLY when a constant force is applied with a constant velocity, does Power = F x v
- Momentum = p = mv
- $\Sigma F = \Delta p / \Delta t$
- When $\Sigma F = 0$, momentum is conserved. System must be isolated – no outside forces acting on the system as a whole. All forces must be internal to the system.
- Impulse = $\Sigma F \Delta t$ = the change in momentum of an object.
- Elastic collisions: both momentum and KE are conserved.
- Inelastic collisions: only momentum is conserved.

1. What work is required to slide a 58 lb block 6 ft along a level surface whose coefficient of friction is 0.3? [104 ft-lb]

2. How much work is required to slide a 4.0 kg block 6.0 m up a 31-degree incline whose coefficient of friction is 0.1? [141 J]

3. What is the KE of a 15-kg mass traveling at 4.7 m/sec? [166 J]

4. A 6-kg bowl of spaghetti is dropped from a 7.0-meter high shelf. Find the speed at which the bowl hits the ground. [11.7 m/sec]

5. A 7-lb frictionless shoe (that is initially at rest) is pushed along a table top with a steady force of 2.0 lb. Find its speed after traveling 5.4 ft. [9.95 ft/sec]

6. A 20 lb elf is traveling across a frictionless surface at 15 ft/sec. Suddenly, the mass encounters a surface with a coefficient of friction of 0.1. If the mass travels over this new surface for 6 feet, what will the final velocity of the mass be? [13.7 ft/sec]

7. A 6 kg mass is traveling along a frictionless surface at 13 m/sec. If the surface over which the mass travels first slopes up for a net rise of 4.0 vertical meters followed by a 5.3 meter horizontal section in which the coefficient of friction is .2, what will the final velocity of the mass be? [8.36 m/sec]

8. How much energy is stored in a spring compressed 0.4 m, whose stiffness constant is 49 N/m? [3.92 J]

9. A spring whose constant is 26 N/cm is compressed 6.3 cm and a 40 gram ball is placed on it. How high will the ball fly up when the spring is released? (Height is measured from the starting position of the ball.) [13.2 m]

10. A 5 kg mass traveling to the right at 4 m/sec collides with an 8 kg mass traveling to the left at 12 m/sec. If the collision is completely inelastic, how much KE is lost? [394 J]

11. A 220 lb football player runs full-tilt (24 ft/sec) at a spring. If the spring compresses 0.42 ft, what is its stiffness constant? [2.24×10^4 lb/ft]

12. A 50-gram bullet collides with a 1.8 kg block, sliding it 2.4 meters along a table having a coefficient of friction of 0.3. What was the initial speed of the bullet? (Remember, a considerable amount of KE will be lost at the moment of impact.) [139 m/sec]

13. If a car encounters a combined wind and road drag of 800 N when traveling at 20 m/sec, what power must the engine deliver to the car? [1.60×10^4 W]

14. Two roller skaters (one with a mass of 48 kg, the other with a mass of 66 kg) face each other and are stationary. If they push off of one another, and the 48 kg skater rolls backward at 3.7 m/sec, how fast is the 66 kg skater going? [2.69 m/sec in the opposite direction from the other skater]

15. An 8 kg mass explodes into two parts, one traveling to the left at 11 m/sec, the other to the right at 4 m/sec. What are the masses of each part? [2.13 kg, 5.87 kg]

16. One blob of clay with a mass m moves to the left at 15.8 m/sec. A second blob of clay of mass 1.9 kg moves to the right at 9.7 m/sec. If the two blobs form one larger blob that moves to the left at 1.6 m/sec after the collision, what is the mass m? [1.51 kg]

17. An 11-slug mass traveling at 140 ft/sec collides with a 28-slug mass traveling at 30 ft/sec. (Both masses are traveling in the same direction). If the 11 slug mass is traveling at 17.9 ft/sec in the opposite direction after the collision, what is the final velocity of the 28 slug mass? What impulse is received by the 28 slug mass? [92.1 ft/sec; 1.74×10^3 lb-sec]

18. A 40-gram bullet slows from 600 to 500 m/sec as it penetrates a can of anchovies. A) What impulse is received by the bullet? ...the can? B) If the can is 12 cm in diameter, how long is the bullet in the can? (Think – what is the average velocity during penetration?) C) What force is exerted on the bullet during this time? [-4.00 N-sec, 4.00 N-sec; 2.18×10^{-4} sec; -1.83×10^4 N]

19. A 615-gram ball strikes a wall at 14.6 m/sec and rebounds at 11.2 m/sec. The ball is in contact with the wall for 0.042 sec. What force acted on the ball during the collision? [-378 N]