Physics Work, Power and Energy Study Guide

Vocabulary
1. Elastic Potential Energy
2. Energy
3. Fulcrum
4. Gravitational Potential Energy
5. Inclined Plane
6. Joule
7. Kinetic Energy
8. Law of Conservation of Energy
9. Lever
10. Mechanical Energy
11. Newton-Meter
12. Power
13. Pulley
14. Screw
15. Simple Machine
16. Watt
17. Wedge
18. Wheel & Axle
19. Work
20. Work energy theorem

Concept Questions
1. What are the requirements for work to be done on an object? \( \text{Force} \times \text{Displacement} \)

2. Work is a \( \text{vector} \). A + or – sign on a work value indicates information about
   a. Vector; direction of work
   b. Scalar; the direction of work

3. What is the unit(s) for work? \( \text{N} \times \text{m} \) or \( \text{Joule} \)

4. Indicate whether there is positive or negative work being done:
   a. \( + \) An eastward moving car skids to a stop.
   b. \( + \) At Six Flags, a roller coaster is lifted to the peak of the first hill.
   c. \( - \) A catcher pits his hand in the mitt and catches a baseball.
   d. \( + \) You pick up your book bag from the floor and put it in your locker.

5. What is power and how is it measured? \( \text{rate of doing work} \), \( \text{Watt} \)

6. For the following 3 scenarios, explain why work is or is not done:
   - A woman preparing for a trip lifts her suitcase from the floor to the bed so that she may pack more easily. \( \text{Yes, Ft Same Direction} \)
   - A man spends 5 minutes holding a present before hiding it on a closet shelf. \( \text{No, no displacement} \)
   - A student carries his book bag down the hallway. \( \text{Ft Displacement at 90°} \)

7. Identify which of the pairs in each scenario illustrates more work being done:
   - A boy helps a teacher by lifting a 200-N box of books 1.5 meters from the floor to the desktop.
     \( \text{Yes, more force} \)
   - The same boy lifts a 500-N box of books to the same height.
     \( \text{Explain your choice: more force} \)
   - A girl throws a 1-kg softball with a force of 50 N a distance of 25 meters.
     \( \text{Explain your choice: more distance} \)
   - The same girl throws the softball with the same force a distance of 17 meters.
8. Identify which of the pairs in each scenario illustrates less power being generated:
   • A woman pushes a cart with 95 N of force 3 m in 10 seconds.
   • A man pushes a cart with 95 N of force 3 m in 15 seconds.
   Explain your choice:

   • (A 340 N student climbs the stairs in 14 seconds.
   • A 420 N student climbs the stairs in 14 seconds.
   Explain your choice:

9. The relationship between power, force and velocity is \( P = Fv \).

10. The 2 simple machines that are a modified version of the inclined plane are
    screw and wedge.

11. Is energy a vector or scalar? What does this indicate? What about work? Power?
    Scalar, no direction Vector

12. How can a person become more powerful?
    Same work, less time or more work, less time

13. What two conditions must be met in order for work to be done?
    Force applied, displacement in same direction of force

14. Explain why the change in gravitational potential energy is path independent.

15. If a car’s speed is doubled, its kinetic energy will \( x \frac{4}{x} \).

16. If a car’s speed is doubled, its momentum will \( x \frac{2}{x} \).

17. Does the speed at which an object is lifted change the amount of work done on the object? Amount of GPE? No

18. What is meant by an isolated system? No external forces like friction

19. Identify and label the different simple machines in the diagram below:
20. Fill in the blanks and color the bar charts below. Mass of the bob is 2.0 kg.

Problems:
1. A rope is used to pull a wagon. If the rope makes a 55° to the ground, how much work is done to pull the wagon? If the rope is horizontal to the ground, will the amount of work increase, decrease or stay the same? Explain your answer.

\[ W = Fd \cos \theta \]

We more if pulled horizontal &c
\[ F \text{ is at a maximum} \]

2. How much gravitational potential energy does a 3kg mass have after it has been lifted 10m?

\[ PE = mgh = 294 \text{ J} \]

3. How much kinetic energy is there in a 70kg skateboarder moving 3m/s?

\[ KE = \frac{1}{2} (70)(3)^2 = 315 \text{ J} \]

4. A 2kg book falls off a bookshelf 3m high. What is the books speed just before it hits the ground? (Solve the problem 2 different ways)

\[ PE = 2(9.8)(3) = 58.8 \text{ J} \]
\[ KE = 58.8 \text{ J} = \frac{1}{2} (2)(u^2) \quad u = 7.6 \text{ m/s} \]

5. A 100kg bungee jumper jumps off a bridge 50m high. His bungee (stretched) is 20 m long.

a. Before he jumps:
   i. How much Gravitational Potential Energy does he have?

\[ PE = 100 \times (9.8)(50) = 49,000 \text{ J} \]

ii. How much Kinetic energy does he have?

\[ KE = 0 \text{ J} \]

iii. What is his total mechanical energy?

\[ mE = 49,000 \text{ J} \]

b. After he has fallen 20m

iv. What is his total mechanical energy?

\[ mE = 49,000 \text{ J} \]

v. How much Gravitational Potential Energy does he have?

\[ PE = 100(9.8)(30) = 29,400 \text{ J} \]

vi. How much Kinetic energy does he have?

\[ KE = 19,600 \text{ J} \]

\[ mE = KE + PE \]