Name: _____

Class: _____

Due Date: _____

Physics Topic 17A – Power and Efficiency

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: Define power. Equation? Units?

2. E: Define efficiency. Equation? Units?

3. E: John, who has a mass of 72 kg, climbed from an elevation of 3,100 m to the summit of Torrey's Peak at 4,300 m. The hike required 4.8 hours. Calculate the average power supplied.

4. E: A windlass raises a 200 kg anchor at 3 m/s.

   a. Calculate the average power required.

   b. The motor is 40% efficient. Calculate the size of the engine.

5. E: In eight minutes, a conveyor belt, whose engine is 40.0% efficient, lifts 160 crates, each having a mass of 30.0 kg. The belt, inclined at 59.49°, results in an elevation increase of 112 m. The crates start and end at rest. Find the size of the engine required to run this belt.

6. E: Danny, who has a mass of 75.0 kg, is swimming at 2 m/s. The end is near. In four seconds, he accelerates to 14 m/s to win the gold medal.

    a. Calculate the work he did during the four second sprint.

    b. Calculate the average power during the sprint.

    c. Calculate his acceleration.

    d. Calculate his velocity at three seconds into the sprint.

    e. Calculate his instantaneous power at three seconds.

7. E: Paige cruises at a constant 65 m/s in her 1,500 kg BMW up Mt. Soledad which is inclined at $30.51°$.

   a. Calculate v_y.

   b. Calculate her instantaneous power.

8. E: Amber's 2,500 kg BMW accelerates from 8 m/s to 52 m/s in four seconds as it zooms up Pikes Peak whose elevation is 72 m and whose incline is $36.9°$.

   a. Calculate the total work done by the engine.

   b. Calculate the average power for the entire trip.

   c. Calculate v_y three seconds into the trip.

d. Calculate the instantaneous power three seconds after beginning to accelerate.

9. E: The takeoff thrust of an airplane engine is approximately 514,000 N. This airplane can reach a speed of approximately 247 m/s. Calculate the power generated by the engine.

10. E: The height of the Burj Khalifah is approximately 830 m. A man with a mass of 65.0 kg takes approximately 1490 s to walk to the top of the building. Calculate the average power output.

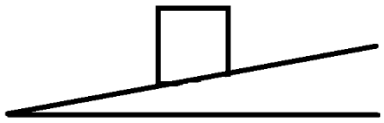
11. E: A truck with a mass of 1250 kg travels eastward on a horizontal road. There is a constant resistive force of 325 N.

    a. Calculate the power generated from the driving force when the truck has a speed of 12.0 m/s and an acceleration of $0.625\ \frac{\mathrm{m}}{\mathrm{s}^2}$.

    b. Calculate the power of the constant resistive force.

    c. Calculate the time rate of change of the kinetic energy of the car.

12.E: A 15.0 kg box is pushed up a rough incline with an angle of 12.0 degrees with a constant speed of 1.25 m/s.



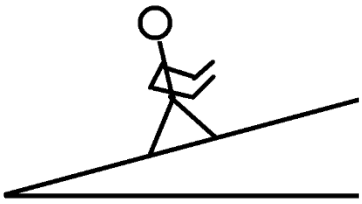
a. Calculate the input power of the push if the output power of the push is 255 W with an efficiency of 25.0%.

b. Calculate the rate of increase of the gravitational potential energy of the box.

c. Calculate the value of the resistive force acting on the box.

13.E: A 70.0 kg man runs up an incline with a constant speed of 3.50 m/s which is 20.0° above the horizontal. A constant resistive force acting on the man is 13.5 N.

a. Label the forces on the man.

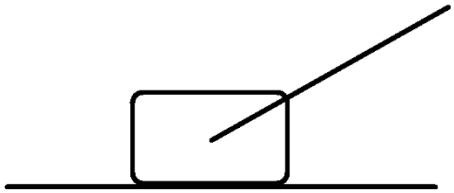


b. Calculate the power output of the man.

c. Calculate the power done against the gravitational force.

14.E: A 85.0 kg car engine is attached to a massless chain and pulled across a rough horizontal surface which has an average friction force of 125 N and is 40.0° above the horizontal. The car engine is pulled 625 m in five minutes.

a. Label the forces on the engine.



b. Determine the average value of the pulling force in which the engine moves at a constant speed.

c. Calculate the work done on the car engine.

d. Calculate the power used to move the car engine.

15.E: A car starts from rest and accelerates at a constant rate in a straight line. The car experiences no friction. Draw a *power vs. time* graph of the thrust force from the engine of the car.

16.E: A car starts from rest and accelerates at a constant rate in a straight line. The car experiences air friction. The magnitude of the air friction increases as the speed of the car increases. Draw a *power vs. time* graph of the thrust force from the engine of the car.

17.E: An object of mass 2.00 kg is pulled upward from rest with a constant acceleration to 6.00 m/s in 3.00 s. Calculate the average power output of the pulling force.

18.E: An electric motor has an input power of 400. W. When doing work on an object 250. W of power is dissipated. Calculate the efficiency of the electric motor.

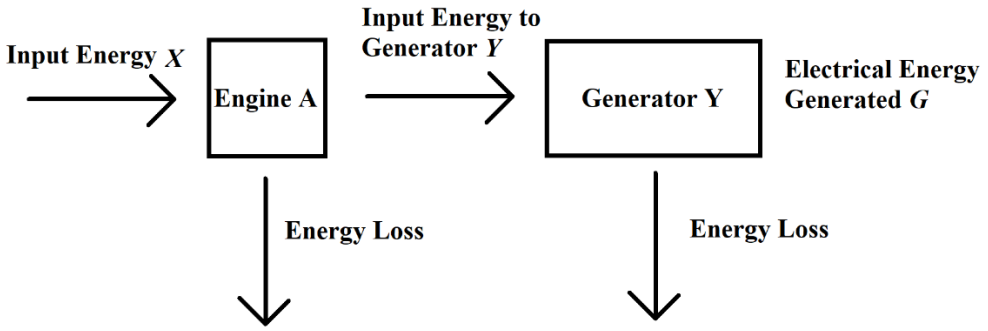
19.E: 500. J of energy is absorbed and 400. J of energy is ejected in one cycle of a heat engine. Calculate the efficiency of the heat engine.

20.E: 455 J of work is done in one cycle on a heat engine while 825 J of energy is wasted. Calculate the efficiency of the heat engine.

21.E: A machine is supplied an amount Q of energy. The amount of useful work done is in the amount W and the amount of energy wasted is R. State an equation for the efficiency of the machine in terms of Q, R, and W.

22.E: An elevator lifts a mass *m* up with a constant speed over a distance *y*. The efficiency of the machine is 20.0%. State an equation for the input energy of the elevator.

23.E: The figure below shows an energy flow chart. State an equation for the efficiency of the system.



24.E: An object is pulled up an incline with a constant speed by an electric motor. The efficiency of the electric motor is 0.655. The object gains 185 J in gravitational potential energy. Calculate the amount of energy dissipated.

25.E: A solar panel has a surface area of $1.65\ \mathrm{m}^2$ with an efficiency of 45.0%. The average intensity of radiation reaching the surface of the solar panel is $325\ \frac{\mathrm{W}}{\mathrm{m}^2}$. Calculate the average power output of 30 of these solar panels.

26.E: A first set of solar panels with an efficiency of 30.0% acquire an area of *A*. A second set of solar panels with an efficiency of 35.0% acquire an area of *B*. Calculate the area of the second solar panels so both panels produce the same power output in the same conditions.

27.E: Calculate the efficiency of an elevator motor with an input power of 1820 W which raises a mass of 355 kg vertically with a constant speed of 0.225 m/s.

28.E: The efficiency of an elevator motor is 35.0% and its input power is 255 W. Calculate the vertical height the elevator motor will raise a 25.0 kg object in 3.50 s.

29.E: A 70.0 kg runner runs up an incline with a vertical height of 60.0 m in 355 s with a constant speed. Calculate the efficiency of the runner if the power input of the runner is 175 W.