Physics 2204
## Unit 3: Work, Power and Energy
Worksheet 9 : Efficiency

Student Name:_____

According to the law of conservation of energy, none of the energy is destroyed but energy is transferred from one form to another, However, some of it is transferred to a form that is not useful for its intended purpose. Energy that does not do useful work is called wasted energy. In a mechanical system where the loss is use to friction, the lost energy goes into heat.

Efficiency: a measure (usually expressed as a percent) of the amount of useful output energy from a machine, compared with the input energy needed to run a machine.

$$\text{Efficiency} = \frac{\text{Output Energy}}{\text{Input Energy}} \times 100\%$$
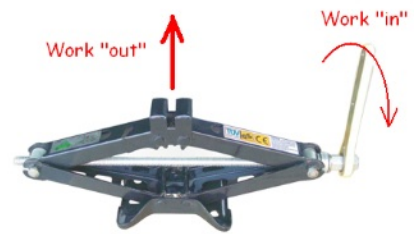
Input Energy (Work in)
(J) is the amount of energy going into a system

Output Energy (Workout) (J) is the amount of energy going out of a system.

Nothing is perfectly efficient, therefore, Work in is usually greater than work out.

Example 1:

What is the efficiency of a crane that uses 5.10 x10⁵ J of energy to lift 1000 kg a vertical height of
32.0 m?

Example 2

A quad with a weight of 2450 N needs to be raised to a height of 0.60 m so it can be placed in the pan of a pickup truck.

A)   Use the given information to calculate W_{out}.

B)   Several planks are used to make a ramp that is 2.5 m long. With the ramp, an applied force of 625 N can be used to move the quad into the truck. Use this information to calculate Win.

C)   What is the efficiency of the ramp?

Example 3:

The handle of a screw jack is 0.30 m long. An applied force of 50.0 N allows it to make one complete revolution. This raises a load of 800 kg by 1.0 cm. Use the given information to calculate the efficiency of the jack.

Example 4:

Suppose that it is estimated that a pulley arrangement is 95% efficient. It is to be used to raise a 3900 N engine block to a height of 1.3 m. What Win is required?

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1.   Which of the following would best describe B is the illustration below?

(A)   Work In
(B)   Work Out
(C)   Wasted Energy
(D)   Output Energy
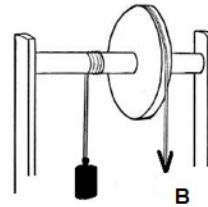
2.   Which of the following is true for mechanical devices?

(A)   Work in = Work out
(B)   Work in >Work out
(C)   Work in < Work out
(D)   Work out = 0

3.   What output energy do you want from a car?

(A)   Heat
(B)   Kinetic
(C)   Light
(D)   Sound

4.   What is the formula for efficiency?

(A)   (energy input / energy output) × 100
(B)   (energy input • energy output) × 100
(C)   (useful energy input / energy output) × 100
(D)   (useful energy output / total energy input) × 100

5.   How is efficiency of a machine measured?

        (A)   (Wasted Energy Output / Energy Input) × 100 %
        (B)   (Energy Input / Wasted Energy Output) × 100 %
        (C)   (Useful Energy Output / Energy Input) × 100 %
        (D)   (Energy Input / Useful Energy Output) × 100 %

6.   Which of the following is a TRUE statement?

        (A)   Machines can have an efficiency larger than 100%
        (B)   Machines can have an efficiency equal to100%
        (C)   Machines can have an efficiency less than 100%
        (D)   Machines can have any value for efficiency

7.   If a motor is 80% efficient, which statement regarding energy is true?

        (A)   Input > output
        (B)   Input < output
        (C)   Input = output
        (D)   Input = zero

8.   An engine that consumes 400 J of thermal energy while exhausting 300 J has an efficiency of

        (A)   25%
        (B)   33%
        (C)   66%
        (D)   75%

9.   A car uses total energy of 2500 J and output is 750 J. What is the efficiency of the car?

        (A)   25%
        (B)   30%
        (C)   50%
        (D)   80%

10.   Output of a truck is 4500 J and its efficiency is 50%, what input energy is provided to the truck?

        (A)   500 J
        (B)   900 J
        (C)   5000 J
        (D)   9000 J

11.   A wheel and axle system is estimated to be 85.0 % efficient. How much work needs to be done on the system if the wheel and axle is to do 125 J of work?

        (A)   40.0 J
        (B)   106 J
        (C)   125 J
        (D)   147 J

12.   A crane is 78% efficient when lifting a load. If the crane does 1500 J of work, what is the output energy?

        (A)   19 J
        (B)   1200 J
        (C)   1900 J
        (D)   12000 J

13.   A force of 1100 N is applied over a distance of 10.0 m on a ramp. What is the efficiency of the ramp if 5100 J of work is done?

(A)   0.46 %
(B)   2.2 %
(C)   46 %
(D)   216 %

PART B: WRITTEN RESPONSE

1.   A quad runner with a weight of 2450 N needs to be raised to a height of 0.60 m so it can be placed in the pan of a pickup truck.

A.   Use the given information to calculate W_{out}.   ANSWER IS 1470 J
B.   Several planks are used to make a ramp that is 2.5 m long. With the ramp an applied force of 625 N can be used to move the Quad into the truck. Use this information to calculate Win.   ANSWER IS1563 J
C.   Use parts (a) and (b) to help you to calculate efficiency. ANSWER IS 94%

2.   With a block and tackle arrangement a relatively small force applied over a large distance can be used to apply a large force over a smaller distance.

A.   An long-liner needs to be moved for a distance of 15.0 m using an average applied force of 9500 N. Calculate W_{out}. ANSWER IS 142500 J
B.   A block and tackle is able to move the vessel using an input force of 1500 N. The user must, however, haul in 100.0 m of rope to move the vessel the required distance. Calculate Win. ANSWER IS 150000 J
C.   Use parts (a) and (b) to help you calculate efficiency. ANSWER IS 95%

3.   The handle of a jackscrew is 0.30 m long. An applied force of 50.0 N allows it to make one complete revolution. This raises a load of 800 kg by 1.0 cm. Use the given information to calculate the efficiency. Hints: first realize that the circumference allows you to calculate the distance through which the applied force acts then, second, calculate W_{in} and W_{out}. ANSWER IS 83%

4.   Suppose that it is estimated that a pulley arrangement is 95% efficient. It is to be used to raise a 3900 N engine block to a height of 1.3 m. What Win is required? ANSWER IS 5300 J

5.   A wheel and axle system is estimated to be 75% efficient. What Wout   is obtained if a force of 250 N is used to move the outer part of the wheel through a distance of 0.82 m? ANSWER IS 154 J

6.   On a ramp an input of 500 J results in an output of 400 J. Calculate the efficiency. ANSWER IS 80%

7.   The efficiency of a ramp is 75%. If 100 J of work are done on the ramp, what will be the work output? ANSWER IS 75 J

8.   The efficiency of a ramp is 75%. What value of Win will result in an output of 200 J? ANSWER IS 267 J

9.   An applied force of 200 N, when applied along a ramp for a distance of 1.8 m   results in 3000 N object being lifted by 0.10 m. What is the efficiency? ANSWER IS 83.3%

10.   A pulley system is estimated to be 90% efficient. An engine with a weight of 2000 N is to be lifted to a height of 1.0 m. A force of 100 N is required. Over what distance must it be applied? ANSWER IS 22.2 m

11.   A 45 kg child bounces on a trampoline with a spring constant of 10800 N/m. If the trampoline is compressed 0.35 m and is 75% efficient, how high will the child bounce above the uncompressed trampoline? **June 11**

12.   A light bulb has a power input of 40 W and is only 4.0% efficient. What is the light energy output from the light bulb in a time of 3600s? **June 2012**