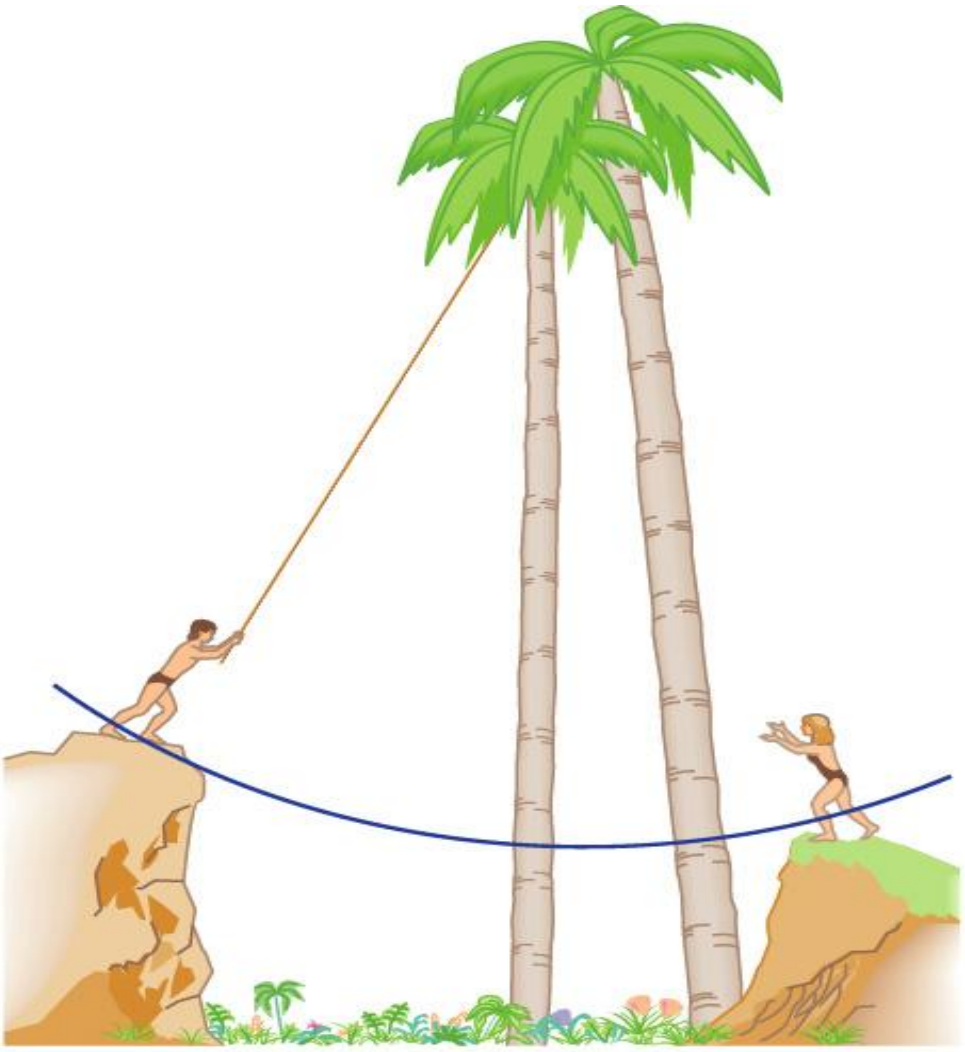
Yanbu University College

General Studies Department

PHSC001 Course

Chapter3 (work and Energy) Worksheet Solutions



Chapter 3 Worksheet

Part1: Sentence Completion

1. Work is ---**Force**-----times ---**distance**----.
2. Energy is the ---**ability to do work on an object by another object**----.
3. Gravitational potential energy is the ---**energy**--- of ---**position relative to the ground**-----.
4. Kinetic energy is the ---**energy**--- of --**motion**---.
5. Power is ---**work per unit time**---.
6. Mechanical advantage is ---**the resistance (or load)-force**---**divided by –effort force**-----.

Part 2: Multiple Choices

1. Work is done when

   A. A force is applied.
   B. A person tries unsuccessfully to move a box.
   C. **Force is applied and an object moved**.
   D. None of the above is correct

2. Kinetic energy is

   A. **Energy of motion**.
   B. Energy of position.
   C. Energy stored in fossil fuels.
   D. Electrical energy.

3. When you through a ball straight up in the air, its KE

   A. Is $1/2mv^2$.
   B. equals the work you did on the ball when you through it.
   C. Is converted into gravitational potential energy as it goes higher.
   D. **All of the above is correct**.

4. A ball falls off a window 10 m above the ground. Its KE as it hits the ground is

   A. The same as its GPE it had before falling.
   B. Equal to the work done in placing the ball on the window.
   C. Equal to the loss of GPE as a result of the fall.
   D. **All of the above is correct**.

5. The important variables in the GPE equation are the weight of an object and

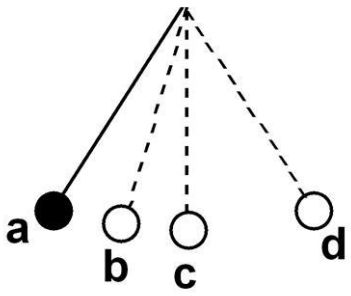
   A. **Its distance from the ground**.
   B. Its speed.
   C. Its mass.

D. All of the above is correct.

6. The rate at which work is done is

A. Acceleration.
B. Potential energy.
C. Kinetic energy.
D. Power.

7. The pendulum shown in the drawing is being pulled up to position a, then released. Where is its KE maximum?



A. At a.
B. At b.
C. At c.
D. At d.

8. When you stop at the top after climbing a flight of stairs, you have

A. Lost energy.
B. Lost work.
C. Gained GPE.
D. Gained KE.

9. The KE of a moving object can be defined as

A. How much work was done putting the object into motion.
B. How much work is needed to bring the object to a stop.
C. ½ mv^2.
D. All of the above is correct.

10. Which of the following occurs when one rides a bicycle?

A. The bicycle has KE because of its motion.
B. The KE is obtained from the conversion of chemical energy stored in the rider's muscles.
C. The energy for riding the bicycle was originally generated in nuclear reactions in the sun.
D. All of the above is correct.

11. Which of the following is not a simple machine?

A. Lever.
B. Pulley.

C. Car.
D. System of pulleys.

12. The force applied to a simple machine is the

A. Effort.
B. Resistance.
C. Friction.
D. Normal.

13. A pulley system has eight strands holding the load or resistance. The mechanical advantage is

A. 4
B. 8
C. 16
D. 64

Part3: True/False. Explain if False

1. Work is the rate of doing energy.

A. True
B. False

2. The energy an object has because of its position is called GPE.

A. True
B. False

3. You do more work on yourself when you run up the stairs than when you walk slowly.

A. True
B. False (the force and distance are the same in both cases)

4. Energy is not conserved when an object slows to a stop.

A. True
B. False (energy is converted to another form with same magnitude. Therefore energy is conserved.)

5. The watt is a unit of work.

A. True
B. False (Watt is the unit of power not work. Joule is unit of work.)

6. The unit of power is Joule.

A. True
B. False (Joule is energy or work unit.)

7. A car at rest on ground possesses a large GPE.

A. True
B. False (distances are measured with respect to the ground. An object at rest on ground has no GPE.)

8. When there is no air resistance and no friction, a pendulum would swing forever.

A. True
B. False

9. Work is a vector quantity.

A. True
B. False (work is energy and it is a scalar not a vector.)

10. Work can be done by a moving object by itself.

A. True
B. False (work done on an object must be done by another object.)

11. The resistance (or load) is the name given to the force overcome by the simple machine.

A. True
B. False

12. The mechanical advantage of a pulley depends on the diameter of the pulley.

A. True
B. False (it does not.)

Part4: Questions

1. Equal forces acting on boxes A and B and move them across the floor. Box A has twice the mass of box B, but box B moves twice the distance moved by box A. Which box has the greater amount of work done on it? Explain.

$$W = F.d, \Rightarrow W_A = F.d, \;\; W_B = F.(2d) = 2W_A$$

2. A person pushes very hard for several seconds on a heavy table, but the table does not move. Has the person done any work on the table? Explain

No. The distance d=0, therefore the work done by the person on the table = F. 0 = 0

3. Can KE energy be negative? Explain

No. KE= ½ mv^2. Mass cannot be negative and velocity squared cannot be negative even if the velocity is negative.

4. When a rubber ball is dropped from 1m above the ground, can it rebound to a height greater than its original 1m height? Explain

No. The final KE is either equal to the initial KE (energy is conserved), or is less than the initial KE (energy is not conserved). Going to a height greater than 1m is impossible.

5. Where does the KE come from when a car accelerates uniformly from rest? How is the increase in KE is related to the friction force the road exerts on the tires?

The KE comes from the conversion of chemical energy of fuel into thermal energy (heat) inside the car's engine and then into KE for the wheels. The wheels push backward on ground and the friction pushes the car forward like when we walk on a ground level. The work done by the friction between increases car's KE.

6. At what point is the GPE of a swinging pendulum ball at a maximum?

At the swing (path) extremes.

7. Can an object possess both KE and PE at the same time? Explain

Yes. For example, a falling object has both GPE and KE before it hits the ground. The pendulum also at any point between its extremes.

8. Why is a person likely to be severely injured by a bolt (or a rock) falling from the fourth floor of a construction site than one falling the second floor? Explain

The bolt (or rock) falling from the fourth floor has more GPE (because of the height) than the one that falls from the second floor. When it hits a person, the more energy does more damage than the less energy.

9. What is the difference between a fixed pulley and a movable pulley?

The fixed pulley is not moving; it provides support and changes direction of force. The movable pulley is the one that moves to lift up a load.

10. State the law of simple machines.

Work input = work output

11. State the law of mechanical advantage.

$$MA = \frac{F_r}{F_e} = \frac{d_e}{d_r}$$

Part5: Exercises

1. How high can a 10 kg mass be lifted by a 1000 J of work?

$$\because W = F.d \Rightarrow \therefore 1000J = (10kg)(9.8m/\sec^2).d \Rightarrow \therefore d = \frac{1000J}{98m/\sec^2} = 10.20m$$

or

$$\because W = \Delta GPE = (GPE)_f - (GPE)_i = (GPE)_f - 0 = mgd, \Rightarrow \therefore d = \frac{W}{mg} = \frac{1000J}{(10kg)(9.8m/\sec^2)} = 10.20m$$

2. A 20 kg box is carried up a 2500 m high mountain in 5 h. (a) how much work is done and (b) how much is power in kilowatt.

$$\because W = F.d, \Rightarrow \therefore W = (20kg)(9.8m/\sec^2).2500m = 4.9\times10^5 J$$

$$\because P = \frac{W}{t}, \Rightarrow \therefore \ P = \frac{4.9\times10^5 J}{5\times3600\sec} = 27.2Watt$$

3. At what speed does a 10 kg mass have a KE of 100 J?

$$\because KE = \frac{1}{2}mv^2, \Rightarrow \therefore v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2\times100J}{10kg}} = 4.5m/\sec$$

4. The GPE of a 50 kg mass after being lifted to the top of a building is 5000J. How high is the building?

$$\because GPE = mgd, \Rightarrow \therefore d = \frac{GPE}{mg} = \frac{5000J}{(50kg)(9.8m/\sec^2)} = 10.02m$$

5. A man uses a lever to lift a box. The box has a resistance of 300N while the man exerts an effort force of 100 N. What is the mechanical advantage of the lever?

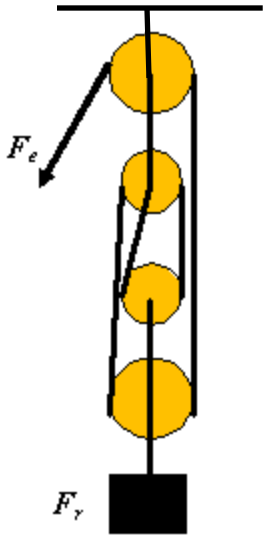
$$\because MA = \frac{F_r}{F_e}, \Rightarrow \therefore MA = \frac{300N}{100N} = 3$$ The lever triple the force (100N) in order to lift the box

6. A pulley system has a mechanical advantage of 6. What is the resistance force if an effort of 135 N is applied?

$$\because MA = \frac{F_r}{F_e}, \Rightarrow \therefore F_r = (MA).(F_e) = 6\times135N = 810N$$

Part 6: Challenge Exercises

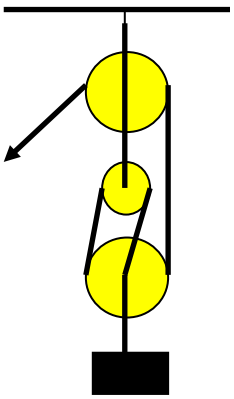
1. A system of two fixed pulleys and two movable pulleys ha a mechanical advantage of 4. (a) If a force of 88 N is applied, what weight (load or resistance) is raised? (b) If the weight is raised 10.5 m, what length of rope is pulled?



$$(a) \because MA = \frac{F_r}{F_e}, \Rightarrow \therefore F_r = (MA)(F_e) = 4 \times 88N = 352N$$

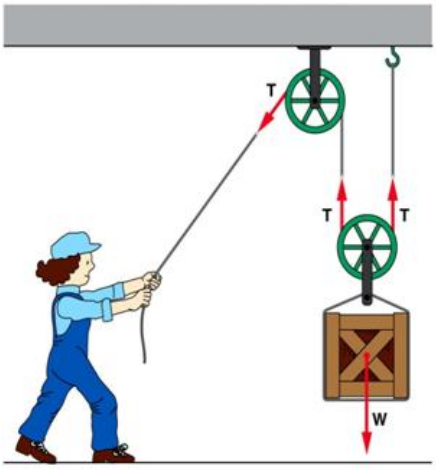
$$(b) \because MA = \frac{d_e}{d_r}, \Rightarrow \therefore d_e = (MA) \times (d_r) = 4 \times 10.5 = 42m$$

2. Find the mechanical advantage of the following pulley system



because there were three rope segments that support the movable pulley, therefore, MA=3

3. What is the mechanical advantage of this system of pulleys?



Because two rope segments were supporting the movable pulley, therefore MA=2

4. (a)How much work is done in lifting the 200 N block of ice shown below a vertical distance of 2.5 m? (b) how much work is done in pushing the same block of ice up the 5 m long ramp? The force needed is only 100 N, and (c) what is the increase in the block's gravitational potential energy in each case?

$(a) \because W = F \times d, \Rightarrow \therefore W = mg \times d = (200N)(2.5m) = 500J$

$(b) \because W = \Delta GPE = (GPE)_f - (GPE)_i = GPE - 0$

$\therefore W = mgd = 500J$

Fcredit: P.G. Hewitt, J.Suchocki, and L.A. Hewitt, "*Conceptual Physical Science-Explorations*".

(c) $500J$