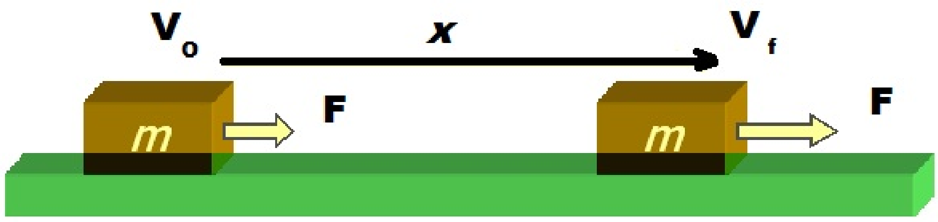
Physics 2204

Unit 3: Work, Power and Energy

Worksheet 7: Work-Energy Theorem

Student Name:___________________________________

Work- Energy Theorem : A resultant force changes the velocity of an object and does work on that object. When work is done on a perfectly frictionless horizontal surface all the work is transformed into kinetic energy of the object.



$$W = \Delta KE$$

$$W = KE_2 - KE_1$$

$$W = \frac{1}{2}m\vec{v}_f^{\,2} - \frac{1}{2}m\vec{v}_i^{\,2}$$

$$\vec{F}_{\parallel} \bullet \vec{d} = \frac{1}{2}m\vec{v}_f^{\,2} - \frac{1}{2}m\vec{v}_i^{\,2}$$

TWO conditions of the Work-Energy Theorem**:**

(1) There is assumed to be no friction. If there were friction, not all of the applied force would be translated into motion and thus KE, some would be wasted overcoming friction

(2) The motion is assumed to be horizontal. That is, the object was not raised or lowered.

Example 1:

Student wearing frictionless roller skates on a horizontal surface is pushed by a friend with a constant force of 45 N. How far must the student be pushed, starting from rest, so that her final kinetic energy is 352 J?

Example 2:

A plane is taxiing at 22 m/s when the pilot opens the throttle. The effective force on the plane is 5.2×10^3 N, which is applied for a distance of 1.1 km. What will be the final speed of the plane if its mass is 1.2×10^4 kg?

Example 3:

During a braking sequence, the wheels of 1200 kg car lock and the car slows from 98 km/hr to 43 km/hr. The skid mark is 17 m long. What is the effective braking force on the car?

PART A: MULTIPLE CHOICE

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

1. What is the ability to do work called?

(A) Energy
(B) Force
(C) Momentum
(D) Power

2. The Work-Energy Theorem states that the

(A) Work done equals the change in the net force
(B) Work done equals the change in kinetic energy
(C) Work done equals the net force divided by the net kinetic energy
(D) Work done equals the product of the net force and the net kinetic energy

3. Which of the following equations expresses the work-kinetic energy theorem?

(A) $ME_i = ME_f$
(B) $ME_i = W$
(C) $W = \Delta PE$
(D) $W = \Delta KE$

4. An applied force F accelerates an object from rest to a velocity v. How much work is done by the applied force F?

(A) $\frac{1}{2} mv^2$
(B) mgh
(C) $\frac{1}{2} kx^2$
(D) mFd

5. What can the SI unit of work be expressed as?

(A) kg m/s
(B) kg m/s^2
(C) kg/m/s^2
(D) kg m^2/s^2

6. A person uses 2.5×10^4 J of energy in moving a car across a frictionless horizontal surface. What was the change in kinetic energy for the car?

(A) Exactly 2.5×10^4 J
(B) Less than 2.5×10^4 J
(C) More than 2.5×10^4 J
(D) Not enough information is give to determine the answer

7. A 950 kg car accelerates from rest to 7.0 m/s. How much work is done on the car?

(A) 3300 J
(B) 6700 J
(C) 23000 J
(D) 47000 J

8. How much energy is required to stop a car of mass 100.0 kg moving at a speed of 25.0 m/s?

(A) 1150J
(B) 21,150 J
(C) 31,250 J
(D) 32,250 J

9. A 500 kg car is moving at 28 m/s. The driver sees a barrier ahead . If the car takes 95 m to come to rest, What is the magnitude of the minium average force necessary to stop?

(A) 47.5 N
(B) 1400 N
(C) 2060 N
(D) 19 600 N

10. A javelin with a mass of 1.2 kg is thrown at a speed of 28 m/s. How much force does the athlete exert over a throwing distance of 1.5 m?

(A) 1.2 N
(B) 11 N
(C) 392 N
(D) 627 N

11. What average net force need be exerted on a 2.0 kg object traveling at 6.0 m/s to bring it to rest (i.e. stop it) in a distance of 3.0 m?

(A) 1.0 N
(B) 2.0 N
(C) 6.0 N
(D) 12 N

12. A car moving at 50 km/hr skids 20 m with locked brakes. How far will the car skid with locked brakes if it is travelling at 150 km/hr?

(A) 40 m
(B) 60 m
(C) 90 m
(D) 180 m

13. A bullet with a kinetic energy of 400 J strikes a wooden block where a 8.00×10^3 N resistive force stops the bullet. What is the penetration of the bullet in the block?

(A) 0.050 m
(B) 0.500 m
(C) 0.200 m
(D) 2.00 m

14. A friend slides a glass of milk with a mass of 500 g along the top of a table. The coefficient of kinetic friction between the glass and the bar is $\mu_k = 0.10$. When the glass leaves your friend's hand, it is moving at a speed of $v_0 = 2$ m/s. How far does the glass travel before coming to a stop? Take g= 9.81 m/s^2.

(A) 1.0 m
(B) 1.8 m
(C) 2.0 m
(D) 2.2 m

PART B: WRITTEN RESPONSE

1. Calculate the amount of work done when an 1150 kg car accelerates from 2.00 m/s to 6.00 m/s.

2. A 605 kg race car accelerates from 20.0 m/s to 60.0 m/s.

   i) Calculate the work done during the acceleration

   ii) If the car generates 582 kW of power, calculate the time it took to accelerate.

3. How much work is done by a cyclist who accelerates himself on his bicycle (a combined mass of 105 kg) from 5.0 m/s to 10.0 m/s?

4. A 80.0 kg sled is initially at rest on a frictionless, horizontal ice surface. An applied force of 220.0 N acts on the sled over a distance of 5.2 m.

   i) Calculate the work done on the object.
   ii) Find the change in the kinetic energy object of the object.
   iii) Calculate the final speed of the object.

5. A car has stalled and stopped. To get it started again, one person pushes the 1300.0 kg vehicle with a combined force of 800.0 N over a distance of 1.60 m. What will be the speed of the car when the driver "pops the clutch" to try and restart the car?

6. A 1300.0 kg car is moving to the right at 30.0 m/s when the driver applies the brakes, which apply a stopping force of 8.1 x 103 N. If the brakes are applied over a distance of 68.0 m, what will be the final speed of the car once the brake is released?

7. An 8000.0 kg aircraft is taxiing for takeoff and moving at 20.0 m/s when the pilot notices that there is only 100.0 m of runway space left. She increases the engine's thrust. What minimum thrust will be required to allow the jet to reach its take-off speed of 70.0 m/s ?