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# Unit 4F
# Work-Energy Theorem
## *Practice Problems TEACHER*

**Work each of the following problems. SHOW ALL WORK.**

1. **A 2 kg toy car moves at a speed of 5 m/s.**

   **a. What is the kinetic energy of the car?**

$$KE = \frac{1}{2}mv^2$$
$$KE = \frac{1}{2}(2\,kg)(5\,{}^{m}\!/_{s})^2$$
$$KE = 25\,J$$

   **b. If a child applies a 3 N force for 2 m in the same direction the car is already moving, how much work is done on the car?**

$$W = Fd$$
$$W = (3\,N)(2\,m)$$
$$W = 6\,J$$

   **c. What is the change in the car's kinetic energy from the applied force?**

*The change in the car's kinetic energy is equal to the work done on the car, so the car gains 6 J of kinetic energy.*

   **d. What is the final kinetic energy of the car?**

$$W = \Delta KE$$
$$W = KE_f - KE_i$$
$$6\,J = KE_f - 25\,J$$
$$KE_f = 31\,J$$

   **e. What is the velocity of the car after the child applies the 3 N force?**

$$KE_f = \frac{1}{2}mv_f^2$$
$$31\,J = \frac{1}{2}(2\,kg)v_f^2$$
$$31\,{}^{m^2}\!/_{s^2} = v_f^2$$
$$v_f = 5.57\,{}^{m}\!/_{s}$$

**questions continued on next page**

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**Work each of the following problems. SHOW ALL WORK.**

**2. A 3 kg ball is thrown downward at 4 m/s from a height of 1.5 m.**

**a. What is the kinetic energy of the ball as it leaves the thrower's hand?**

$$KE = \frac{1}{2}mv^2$$
$$KE = \frac{1}{2}(3\ kg)(4\ {}^{m}\!/_{s})^2$$
$$KE = 24\ J$$

**b. What force is doing work on the ball as it falls?**

*force of gravity*

**c. How much work is done on the ball as it falls?**

$$W_G = F_G d$$
$$W_G = (mg)d$$
$$W_G = (3\ kg)(9.8\ {}^{m}\!/_{s^2})(1.5\ m)$$
$$W_G = 44.1\ J$$

**d. What is the final kinetic energy of the ball?**

$$W_G = \Delta KE$$
$$W_G = KE_f - KE_i$$
$$44.1\ J = KE_f - 24\ J$$
$$KE_f = 68.1\ J$$

**e. What is the velocity of the ball as it strikes the ground?**

$$KE_f = \frac{1}{2}mv_f^2$$
$$68.1\ J = \frac{1}{2}(3\ kg)v_f^2$$
$$45.4\ {}^{m^2}\!/_{s^2} = v_f^2$$
$$v_f = 6.74\ {}^{m}\!/_{s}$$

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**Work each of the following problems. SHOW ALL WORK.**

**3. A 75 kg baseball player runs at a velocity of 6 m/s before sliding to a stop at second base.**

**a. What is the kinetic energy of the runner before he begins his slide?**

$$KE = \frac{1}{2}mv^2$$
$$KE = \frac{1}{2}(75\ kg)(6\ {}^{m}\!/_{s})^2$$
$$KE = 1350\ J$$

**b. What is the kinetic energy of the runner once he reaches the base?**

*If the runner stops, his final kinetic energy is zero.*

**c. What is the change in the kinetic energy of the runner?**

$$\Delta KE = KE_f - KE_i$$
$$\Delta KE = 0 - 1350\ J$$
$$\Delta KE = -1350\ J$$

**d. How much work is done by friction in stopping the runner?**

*The work done by friction is equal to the change in kinetic energy, so the work done is -1,350 J.*

**e. If the runner slides for 2 m, what is the force of friction that acts upon him?**

$$W_f = F_f d$$
$$-1350\ J = F_f(2\ m)$$
$$F_f = -675\ N$$

**4. Runaway truck ramps are common on mountainous highways in case the brakes fail on large trucks. If a runaway 60,000 kg truck is moving at 27 m/s, how much work must be done to stop the truck?**

$$W = \Delta KE$$
$$W = KE_f - KE_i$$
$$W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$
$$W = \frac{1}{2}(60{,}000\ kg)(0)^2 - \frac{1}{2}(60{,}000\ kg)(27\ {}^{m}\!/_{s})^2$$
$$W = 0 - 21870000\ J$$
$$W = -21870000\ J$$

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**Work each of the following problems. SHOW ALL WORK.**

5. **If the net force applied by the truck ramp in the previous question is -300,000 N, how far along the ramp will the truck move as it stops?**

$$W = Fd$$
$$-21870000\,J = (-300000\,N)d$$
$$d = 72.9\,m$$

6. **A 40 kg gymnast somersaults into a foam ball pit at a speed of 7 m/s. If the foam applies an average resistive force of 1,000 N, how far into the pit will the gymnast sink before she stops?**

$$W = \Delta KE$$
$$W = KE_f - KE_i$$
$$W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$
$$W = \frac{1}{2}(40\,kg)(0)^2 - \frac{1}{2}(40\,kg)(7\,{}^{m}\!/_{s})^2$$
$$W = 0 - 980\,J$$
$$W = -980\,J$$

$$W = Fd$$
$$-980\,J = (-1000\,N)d$$
$$d = 0.98\,m$$

7. **A 1.5 kg ball is thrown upward at 10 m/s. What is its velocity when it is 2 m above the release point?**

$$W_G = F_G d$$
$$W_G = (mg)d$$
$$W_G = (1.5\,kg)(9.8\,{}^{m}\!/_{s^2})(-2\,m)$$
$$W_G = -29.4\,J$$

$$W_G = \Delta KE$$
$$W_G = KE_f - KE_i$$
$$W_G = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$
$$-29.4\,J = \frac{1}{2}(1.5\,kg)v_f^2 - \frac{1}{2}(1.5\,kg)(10\,{}^{m}\!/_{s})^2$$
$$-29.4\,J = \frac{1}{2}(1.5\,kg)v_f^2 - 75\,J$$
$$45.6\,J = \frac{1}{2}(1.5\,kg)v_f^2$$
$$v_f^2 = 60.8\,{}^{m^2}\!/_{s^2}$$
$$v_f = 7.80\,{}^{m}\!/_{s}$$