

Sample Test for Unit IV

Potentially useful equations:

$$F_s = -k(\Delta x) \quad |W_s| = \frac{1}{2}k(\Delta x)^2 \quad K = \frac{1}{2}mv^2 \quad P = \frac{W}{\Delta t}$$

$$\vec{p} = m\vec{v} \quad W_{\text{net}} = K_f - K_i \quad W_{\text{n.c.}} = E_f - E_i \quad \varepsilon = \frac{W_{\text{out}}}{W_{\text{in}}}$$

$$W = FD \cos \theta \quad W_{\text{cons.}} = U_f - U_i \quad \vec{F}_{\text{ave}}(\Delta t) = \Delta \vec{p} \quad E_{\text{tot}} = U_{\text{tot}} + K_{\text{tot}}$$

- Determine the work done
 - by a 240-N force that displaces a block 5.0 m, acting parallel to the displacement.
 - by a force of $\vec{F} = (100\hat{x} + 70\hat{y})$ N with a displacement of $\vec{D} = (9.0\hat{x} - 2.0\hat{y})$ m.
- How much work is done:
 - by the frictional force when a 40-kg block is pushed 36 m horizontally at constant velocity ($\mu_k = 0.22$)?
 - by a force that extends a spring from $x = 0$ to $x = 4$ cm? It was previously found that a force of 70 N extended the same spring from $x = 0$ to $x = 2$ cm.
- What is the Law of Conservation of Energy?
 - An electric stovetop burner uses 180,000 J of energy to increase the heat energy of a pot of water by 70,000 J. What is the efficiency of the energy transfer?
- A spring with a force constant of 1600 N/m is held vertically and compressed 4.0 cm. A ball of mass 0.12 kg is placed on top of the spring. The spring is released and the ball flies upward. Use the work-energy theorem to find the following:
 - The speed (m/s) of the ball as it leaves the spring (find the work done by the spring and by gravity) Note that the ball leaves the spring at 4 cm above its starting point.
 - the maximum height (above the initial release point) reached by the ball. (Hint: you don't need to know the answer to part A, just use the theorem to go from the starting point to the highest point.)
- What is the power output of a fork lift when it lifts a 400-kg crate by 3.0 m straight upward in a time of 5.0 s at constant velocity?
- A 0.25-kg baseball moves toward a batter with a velocity of 14 m/s. It is struck with a bat, causing it to move in the opposite direction at 28 m/s. Find the magnitude of the average force exerted on the ball if the bat and ball are in contact for 0.010 s.
- A bullet of mass 0.010 kg is fired with a muzzle velocity of 900 m/s from a 2.0-kg rifle. If the rifle is "loosely held," find its recoil speed. (i.e., assume that the net external force on the rifle is zero.)
- A 1500-kg automobile moving at 24 m/s collides completely inelastically with a 3000-kg truck traveling at 10 m/s in the same direction. Find the velocity of the two-vehicle combination immediately after the collision. (Assume zero friction with the road.)

Answers:

1. a.) $W = 1.2 \times 10^3 \text{ J}$, b.) $7.6 \times 10^2 \text{ J}$
2. a.) $-3.1 \times 10^3 \text{ J}$, b.) 2.8 J ($k = 3.5 \times 10^3 \text{ N/m}$)
3. a.) Energy cannot be created or destroyed. The total energy of the universe (or any “closed” system) is constant. (The total energy can change in an “open” system smaller than the universe whereby energy enters or leaves the system.); b.) $\varepsilon = 0.39$
4. a.) 4.5 m/s , b.) $h = 1.09 \text{ m}$
5. $P = 2.4 \times 10^3 \text{ W}$ (2352 W before rounding)
6. $1.05 \times 10^3 \text{ N}$
7. 4.5 m/s
8. 14.7 m/s .