Problem 1

A spring gun with k = 90.0 N/m is compressed by 5 cm. What is the exit speed of a 2.10-g projectile?

Solution

$$\begin{aligned} W &= \int_{min}^{max} F(x)\ dx = \int_{-0.05}^{0} -kx\ dx = \left(-\frac{1}{2}kx^2\right)|_{-0.05}^{0} \\ &= \frac{1}{2}k * 0.05^2 = 45\text{N/m} * 0.0025\text{m}^2 = 0.1\text{J} \\ W &= \Delta K = K_f - K_i \end{aligned}$$

Since the spring on the block is unmoving at the start, then $v_i = 0$, so $K_i = \frac{1}{2}mv_i^2$ is also equal to zero. From there, we can determine the final kinetic energy and determine the velocity at the end.

$$\begin{aligned} K_f = W = 0.1\text{J} &= \frac{1}{2}mv_f^2 \\ \frac{2K_f}{m} &= v_f^2 \\ v_f = \sqrt{\frac{2K_f}{m}} = \sqrt{\frac{2 * 0.1\text{J}}{0.0021\text{kg}}} &= \sqrt{\frac{2 * 1000}{21}} \\ &= \boxed{\frac{20\sqrt{105}}{21}\text{m/s} \approx 9.759\text{m/s}} \end{aligned}$$

Problem 2

(a) The United States, with a population of 2.2×10^8 people, consumes 5×10^{19} J per year. What is the per capita consumption in watts? (b) The sun's radiation provides the earth with 1000 W/m^2. Assuming solar energy can be converted to electrical energy with a 20% efficiency, how much area is needed to serve the energy needs of each U.S. citizen?

Solution

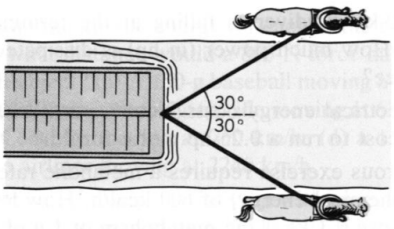
Problem 3

A 0.595-kg object is released from a height of 3.60 m and lands on the ground. Find: (a) the work done by gravity; (b) the change in kinetic energy of the ball; (c) the speed just before it lands using energy methods. Ignore air resistance.

Solution

Problem 4

Two horses pull a barge along a canal at a steady 5.00 km/h, as shown in the figure. The tension in each rope is 420 N and each is at 300 to the direction of motion. What is the horsepower provided by the horses?



Solution