

PROBLEM 2.9

KNOWN: Vehicle crumple zone absorbs energy during impact.

FIND: Change in kinetic energy, in Btu, of 3000-lb vehicle decelerating from 10 mph to 0 mph.

SCHEMATIC AND GIVEN DATA:



ENGINEERING MODEL:

1. The automobile is the system.
2. Crumple zone absorbs all kinetic energy of vehicle upon impact.
3. Weight of occupants can be neglected.

ANALYSIS:

Change in kinetic energy (ΔKE) is determined by

$$\Delta KE = \frac{1}{2} m(V_2^2 - V_1^2)$$

where m is mass of the vehicle and V is velocity of the vehicle relative to the roadway.

Substituting and applying appropriate conversion factors yield

$$\Delta KE = \frac{1}{2} (3000 \text{ lb}) \left(\left(0 \frac{\text{mi}}{\text{h}} \right)^2 - \left(10 \frac{\text{mi}}{\text{h}} \right)^2 \right) \left(\frac{(5280 \text{ ft})^2}{(\text{mi})^2} \right) \left(\frac{1 \text{ lbf}}{32.2 \frac{\text{lb} \cdot \text{ft}}{\text{s}^2}} \right) \left(\frac{\text{h}^2}{(3600 \text{ s})^2} \right) \left(\frac{1 \text{ Btu}}{778 \text{ ft} \cdot \text{lbf}} \right)$$

$$\Delta KE = \underline{-12.9 \text{ Btu}}$$

The negative sign indicates the energy of the moving vehicle is reduced and must be absorbed by the crumple zone to protect the occupants.