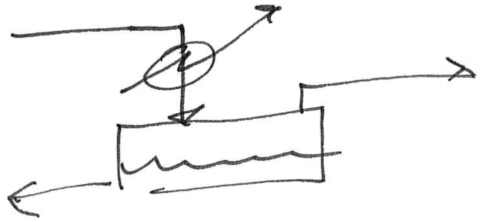

Concepts

1. Total energy is conserved
2. Energy can transform from one form to another

Forms

1. Kinetic $E_k = \frac{1}{2} m v^2$
2. Potential $E_p = mgh$

$\left.\begin{array}{l} E_k \\ E_p \end{array}\right\}$ force x distance

3. Internal energy $U = f(T)$

   ~~Mat~~ may also be $f(P, V)$

Closed Systems

no mass crosses the boundary

1. Heat (energy flow caused by ΔT)

   Q = positive when heat is transferred <u>to</u> the system from surroundings

2. Work

   W = positive when work is done by the system on the surroundings

   Types

   - PV (mechanical)
   - friction
   - shaft
   - flow
   - electrical

open

in + ~~gen~~ = out + accum + ~~cons~~

$$\Delta U + \Delta E_k + \Delta E_p = Q - W$$

SI: J or KJ

cgs ergs

kcal 1 kg H_2O 1°C

American: Btu 1 Btu = $1 lb_m H_2O(l)$ 1°F

Correct the ppt

7.5 (7.6 in 4th Ed)

Air at 300°C and 130 kPa flows through a horizontal 7-cm ID pipe at a velocity of 42.0 m/s.

a) Calculate $\dot{E}_k$ in Watts, assuming ideal gas behavior.
b) If the air is heated to 400°C at constant pressure, what is $\Delta\dot{E}_k$ ($=\dot{E}_k(400°C) - \dot{E}_k(300°C)$)?
c) Why would it be <u>incorrect</u> to say that the rate of transfer of heat to the gas in part (b) must equal the rate of change of kinetic energy?

Air → 300°C, 130 kPa

$d = 7\text{ cm}$

$V = 42\text{ m/s}$

$\dot{E}_k = \frac{1}{2}\dot{m}v^2$

$\dot{m} = \rho A v$

$$\rho_{air} = \frac{P\,MW}{RT} = \frac{(130\times10^3\text{ Pa})(29\text{ g/mol})}{\left(8.314\ \frac{\text{Pa m}^3}{\text{gmol K}}\right)(573\text{ K})} = 791\ \frac{\text{g}}{\text{m}^3}$$

$$\dot{m} = \rho A v = \left(791\ \frac{\text{g}}{\text{m}^3}\right)\left(\frac{\pi(.07\text{ m})^2}{4}\right)\left(42\ \frac{\text{m}}{\text{s}}\right) \qquad A = 3.85\times10^{-3}\text{ m}^2$$

$$= 128\text{ g/s}$$

$$\dot{E}_k = \frac{1}{2}\dot{m}v^2 = \left(\frac{1}{2}\right)\left(.128\ \frac{\text{kg}}{\text{s}}\right)\left(42\ \frac{\text{m}}{\text{s}}\right)^2 = 113\ \frac{\text{kg-m}^2}{\text{s}^3}$$

$$= 113\text{ W}$$

(b) 300°C → 400°C

$$\rho = 791\left(\frac{573}{673}\right) = 674\ \frac{\text{g}}{\text{m}^3}$$

$$V_{new} = ? = \frac{\dot{m}}{\rho A} = \frac{128\text{ g/s}}{\left(674\ \frac{\text{g}}{\text{m}^3}\right)(3.85\times10^{-3}\text{ m}^2)} = 49.3\ \frac{\text{m}}{\text{s}}$$

$$\Delta\dot{E}_k = \frac{1}{2}(\dot{m})(V_{400}^2 - V_{300}^2) \qquad 42.6\text{ W}$$

7.6 (7.7 in 4th Ed)

Suppose you pour a gallon of water on a yowling cat 10 ft below your bedroom window.

a) How much potential energy (in ft-lb_f) does the water have?
b) How fast is the water traveling (in ft/s) just before impact?
c) True or false: Energy must be conserved, therefore the kinetic energy of the water before impact must equal the kinetic energy of the cat after impact.

$$\cancel{\Delta U} + \Delta E_p + \Delta E_k = \cancel{Q} - \cancel{W}$$

$$\Delta E_p = m g \Delta h$$

$$m = V\rho$$

$$= (1\ gal)\left(\frac{ft^3}{7.4805\ gal}\right)\left(\frac{62.43\ lb_m}{ft^3}\right)$$

$$= 8.346\ lb_m$$

$$\Delta E_p = \frac{(8.346\ lb_m)\left(32.2\ \frac{ft}{s^2}\right)(-10\ ft)}{32.2\ \frac{lb_m\text{-}ft}{lb_f\ s^2}}$$

$$= -83.46\ ft\text{-}lb_f = -\Delta E_k$$

$$\Delta E_k = \frac{1}{2} m \left(v_2^2 - \cancel{v_1^2}^{\,0}\right)$$