Chapter5&8 problems

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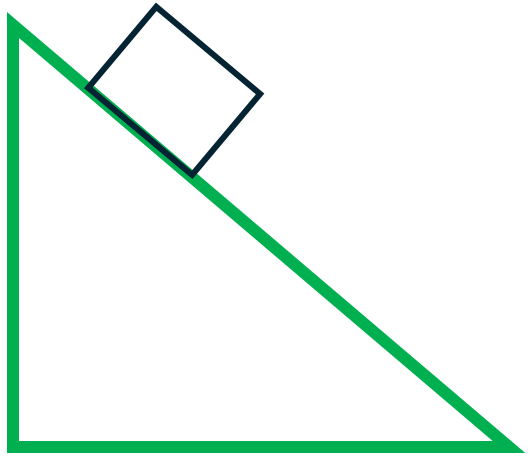
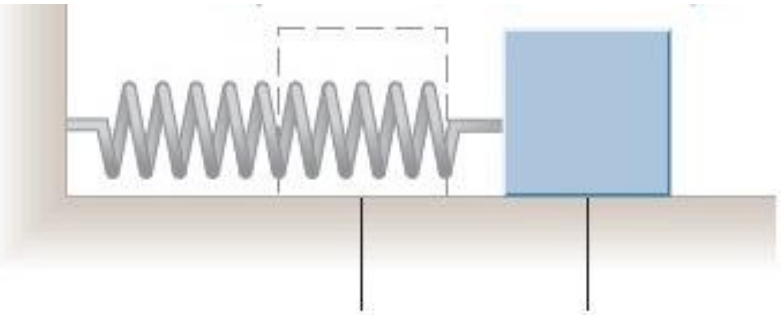
33. A child and sled with a combined mass of 50.0 kg slide down a frictionless hill that is 7.34 m high. If the sled starts from rest, what is its speed at the bottom of the hill?



- M = 50kg, h = 7.34m, Vi = 0
- From conservation of energy law:
- ---> K.Ei + P.Ei = K.Ef + P.Ef
- $0.5\ m\ Vi^2 + m\ g\ h1 = 0.5\ m\ Vf^2 + m\ g\ h2$
- $0.5\ (50)\ (0)^2 + (50)\ (10)\ (7.34) = 0.5\ (50)\ (Vf)^2 + (50)\ (10)\ (0)$
- $3670 = 25\ Vf^2$ ---> $Vf^2 = 146.8$ ---> $Vf = 12.1$ m/s

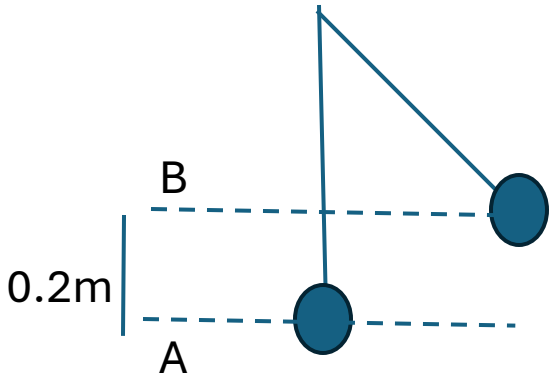
Problem

- An object of mass 2 kg compresses a horizontal spring for 0.1 m on a horizontal track.
- What is the spring constant if the velocity the object moves with at the beginning of the motion is 1 m/s?
- Solution:
- From conservation of energy law:
- ---> K.Ei + P.Ei = K.Ef + P.Ef
- ---> 0.5 m v_i^2 + 0.5 k x_i^2 = 0.5 m v_f^2 + 0.5 k x_f^2 .
- ---> 0.5 (2) $(0)^2$ + 0.5 k $(0.1)^2$ = 0.5 (2) $(1)^2$ + 0.5 k $(0)^2$.
- 0.005 k = 1 ---> k = 1/0.005 = 200 N/m



Problem

- A pendulum swings as shown in the figure. The mass of the ball is 0.1 kg.
- What is the velocity of the object at the bottom of the pendulum if it starts from rest?
- Vi = 0,
- Assume point A to be the reference
- ---> $y_A = 0$, $y_B = 0.2m$
- From conservation of energy law:
- ---> K.Ei + P.Ei = K.Ef + P.Ef
- $0.5\ m\ Vi^2 + m\ g\ y_A = 0.5\ m\ Vf^2 + m\ g\ y_B$
- ---> $0.5\ (0.1)\ (0)^2 + (0.1)\ (10)\ (0.2) = 0.5\ (0.1)\ (Vf)^2 + (0.1)\ (10)\ (0)$
- $0 + 0.2 = 0.05\ Vf^2 + 0$
- $0.2 = 0.05\ Vf^2$ ---> $Vf^2 = 4$ ---> $Vf = 2$ m/s



20. An engineer weighs a sample of mercury ($\rho = 13.6 \times 10^3$ kg/m^3) and finds that the weight of the sample is 4.5 N. What is the sample's volume?

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- $\rho = 13.6 \times 10^3$ kg/m^3.$= 13600$ kg/m^3.
- W = 4.5N, V = ?
- W = m g
- 4.5 = m (10) ---> m = 0.45 kg
- ρ = m / V ---> V = m / ρ
- ---> V = 0.45 / 13600 = 3.3×10^{-5} m^3.

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9. A sample of an unknown material weighs 300.0 N in air and 200.0 N when submerged in an alcohol solution with a density of 0.70×10^3 kg/m^3. What is the density of the material?

- $F_g = W = 300N$, $Fnet = 200N$, $\rho(liquid) = 0.7 \times 10^3$ kg/m^3= 700 kg/m^3
- Vo = V(liquid)
- $F_{net} = F_B - F_g$
- ---> -200 = FB – 300 ---> FB = 300 – 200 = 100 N
- $F_B = \rho_w \times V_w \times g$, $Fg = \rho_o \times V_o \times g$
- When submerged ---> $FB / Fg = \rho_w \times V_w \times g / \rho_o \times V_o \times g$
- ---> **$FB / Fg = \rho_w / \rho_o$.**
- $100/300 = 700 / \rho_o$ ---> $1/3 = 700 / \rho_o$ ---> $0.333 = 700 / \rho_o$
- ---> $\rho_o = 700/0.333$ ---> $\rho_o = 2100$ kg/m^3.