Questions (WG, 2nd ed.)

Q 18

Yes. The work done comes to the potential energy of the stretched bow.

Q 23

(a) elastic potential energy of the string
(b) at the points of the maximum compression (initial point) and stretching of the string. (p.p. A and C of the diagram)
(c) When the string has its normal (unstretched, non-compressed) length. (p. B)

Q 25

The gravitational potential energy of the mass is smaller than in p. 1, but potential elastic energy of the string is greater in p. 2 than in p. 1.

Total potential energy of the spring-mass system is greater in p. 2 than in p. 1.
7.13
\[ m = 0.002 \, \text{kg} \]
\[ \theta = 0.4 \, \text{m/s} \]
\[ E_k = \frac{m \cdot v^2}{2} = 1.6 \cdot 10^{-4} \, \text{J} = 16 \, \text{mJ} \]

7.16
\[ m = 7 \, \text{kg} \]
\[ S = 18 \, \text{m} \]
\[ E_{\text{kin}} = ? \]

To reach the target (at \( S = 18 \, \text{m} \)) with minimum initial speed (or kinetic energy) the angle \( \theta \) of the cannon must be 45°.

If so,
\[ S = \frac{v_0^2}{g} \cdot \sin 2\theta = \frac{v_0^2}{g} \]

\[ E_{\text{kin}} = \frac{m \cdot v_0^2}{2} = \]

\[ \frac{m}{2} \cdot (g \cdot S) = \frac{7}{2} \cdot (10.18) \]

\[ 630 \, \text{J} \approx 0.6 \, \text{kJ} \]
7.17

\[ M_c = 800 \text{ kg} \]

\[ m_1 = m_2 = m = 75 \text{ kg} \]

\[ P_{\text{out}} = 30 \text{ kW} \]

\[ v_o = 70 \text{ km/h} = 19.4 \text{ m/s} \]

\[ v_f = 110 \text{ km/h} = 30.5 \text{ m/s} \]

\[ t = ? \]

\[ W_f = P_{\text{out}} \cdot t = \Delta E_k \]

\[ \Delta E_k = \frac{M v_f^2}{2} - \frac{M v_o^2}{2} = \frac{M l^2}{2} \]

\[ M = M_c + 2m \]

\[ P_{\text{out}} \cdot t = \frac{(M_c + 2m)(v_f^2 - v_o^2)}{a^2} \]

\[ t = \frac{(M_c + 2m)(v_f^2 - v_o^2)}{P_{\text{out}}} = \frac{950 \text{ kg} \cdot (30.5^2 - 19.4^2)}{30 \cdot 10^3 \cdot 2} \approx 9.8 \text{ s} \]

7.20

\[ m = 10 \text{ g} = 10^{-2} \text{ kg} \]

\[ v = 600 \text{ m/s} \]

\[ l = 0.6 \text{ m} \]

\[ F_r = ? \]

\[ F_r \cdot l = \Delta E_k = \frac{m v^2}{2} \]

\[ F_r = \frac{m v^2}{2l} = \frac{10^{-2} \text{ kg} \cdot (600 \text{ m/s})^2}{2 \cdot 0.6 \text{ m}} \approx 3 \text{ kN} \]
\[ m = 800 \text{ kg} \]
\[ \theta_0 = 6 \text{ m/s} \]
\[ h = 40 \text{ m} \]
\[ \theta_f = 20 \text{ m/s} \]

\[ \Delta E \text{ cor} - ? \]

\[ E_0 = E_{k0} + E_{p0} = mgh + \frac{m \theta_0^2}{2} \]
\[ E_f = E_{k} = \frac{m \theta_f^2}{2} \]

\[ E_0 = 800 \left(9.8 \cdot 40 + \frac{36}{2} \right) \approx 328.8 \text{ kJ} \]
\[ E_f = \frac{800 \cdot (20)^2}{2} = 160 \cdot 10^3 \text{ J} = 160 \text{ kJ} \]

\[ \Delta E = E_f - E_0 = -168 \text{ kJ} \]

\[ E = 12 \text{ MJ} \]
\[ m = 1 \text{ kg} \]

\[ \Delta m = \frac{E}{c^2} = \frac{12 \cdot 10^6 \text{ J} \cdot \text{s}^2}{(3 \cdot 10^8)^2 \text{ m}^2} = 1.3 \cdot 10^{-10} \text{ kg} \]

\[ \frac{\Delta m}{m} = \frac{1.3 \cdot 10^{-10}}{1 \text{ kg}} \times 100\% = 1.3 \cdot 10^{-8} \% \]