Exam 3 Review

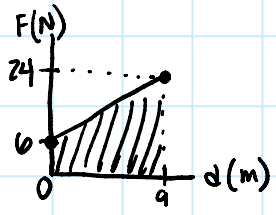
1. Rock Subjected to a Variable Force

$m_{rock} = 12\ kg \quad F(x) = 6.0\ N + (2.0\ \frac{N}{m})x$

Find v at $x = 9.0\ m$.

$F(0\ m) = 6.0\ N + (2.0\ \frac{N}{m})(0\ m) = 6.0\ N$

$F(9\ m) = 6.0\ N + (2.0\ \frac{N}{m})(9\ m) = 24.0\ N$



W_{in} = area under F·d curve $= (\frac{1}{2})(6N + 24N)(9\ m) = 135\ J$

$K_i^{\nearrow 0} + U_{gi}^{\nearrow 0} + U_{ei}^{\nearrow 0} + W_{in} = K_f + U_{gf}^{\nearrow 0} + U_{ef}^{\nearrow 0} + E_{loss}^{\nearrow 0}$

$W_{in} = \frac{1}{2}mv_f^2$

$135\ J = (\frac{1}{2})(12\ kg)v_f^2$

$\underline{\underline{v_f = 4.74\ m/s}}$

2. Dr. Bennett Throwing a Brick

$m_{brick} = 2.7\ kg \quad v_i = 15.0\ m/s\ \uparrow \quad E_{loss} = 15\ J$

Find d when speed is half of initial

$K_i + U_{gi}^{\nearrow 0} + U_{ei}^{\nearrow 0} + W_{in}^{\nearrow 0} = K_f + U_{gf} + U_{ef}^{\nearrow 0} + E_{loss}$

$\frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 + mgH + E_{loss}$

$(\frac{1}{2})(2.7\ kg)(15\ m/s)^2 = (\frac{1}{2})(2.7\ kg)(\frac{15\ m/s}{2})^2 + (2.7\ kg)(9.81\ m/s^2)H + 15\ J$

$\underline{\underline{H = 8.03\ m}}$

3. Block Hitting a Spring

$m_{block} = 5\ kg \quad v_{block} = 7\ m/s \quad \Delta x_{spring} = 0.68\ m$

$m_{block} = 5\ kg$ $v_{block} = 7\ m/s$ $\Delta x_{spring} = 0.68\ m$

Find speed when spring is half compressed.

$$K_i + U_{gi}^{0} + U_{ei}^{0} + W_{in}^{0} = K_f + U_{gf}^{0} + U_{ef} + E_{loss}^{0}$$

$$\frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 + \frac{1}{2}k(\Delta x)^2$$

At full compression: $\frac{1}{2}mv_i^2 = \frac{1}{2}k(\Delta x)^2$

$$\frac{1}{2}(5\ kg)(7\ m/s)^2 = \frac{1}{2}k(0.68\ m)^2$$

$$k = 529.8\ N/m$$

Half compression: $\frac{1}{2}(5\ kg)(7\ m/s)^2 = \frac{1}{2}(5\ kg)v_f^2 + \frac{1}{2}(529.8\ N/m)\left(\frac{0.68\ m}{2}\right)^2$

$$\underline{\underline{v_f = 6.06\ m/s}}$$

4. Crane Lifting a Crate

$m_{crate} = 89\ kg$ $P_{in} = 2500\ W$ $\eta = 65\% = 0.65$ $d = 18.7\ m$

Find time to lift crate.

$$t = \frac{E}{P_{use}} = \frac{W}{\eta P_{in}} = \frac{mgH}{\eta P_{in}} = \frac{(89\ kg)(9.81\ m/s^2)(18.7\ m)}{(0.65)(2500\ W)} = \underline{\underline{10.05\ s}}$$

5. Roller Coaster

$m_{rc} = 1000\ kg$ $H = 35\ m$ $v_i = 0\ m/s$ $v_{max} = 9\ m/s$ $v_{actual} = 2\ m/s$

Find W_{in} + E_{loss}.

Max: $K_i^{0} + U_{gi}^{0} + U_{ei}^{0} + W_{in} = K_f + U_{gf} + U_{ef}^{0} + E_{loss}^{0}$

$$W_{in} = \frac{1}{2}mv_{max}^2 + mgH$$

$$W_{in} = (1/2)(1000\ kg)(9\ m/s)^2 + (1000\ kg)(9.81\ m/s^2)(35\ m)$$

$$W_{in} = (\tfrac{1}{2})(1000\ kg)(9\ m/s)^2 + (1000\ kg)(9.81\ m/s^2)(35\ m)$$
$$\underline{W_{in} = 383\,850\ J = 383.9\ kJ}$$

Actual: $\cancel{K_i}^{0} + \cancel{U_{gi}}^{0} + \cancel{U_{ei}}^{0} + W_{in} = K_f + U_{gf} + \cancel{U_{ef}}^{0} + E_{loss}$

$$W_{in} = \tfrac{1}{2} m v_{actual}^2 + mgH + E_{loss}$$
$$383\,850\ J = \tfrac{1}{2}(1000\ kg)(2\ m/s)^2 + (1000\ kg)(9.81\ m/s)(35\ m) + E_{loss}$$
$$\underline{E_{loss} = 38\,500\ J = 38.5\ kJ}$$

6. Truck Crashing into a Slow Car

$m_{truck} = 2200\ kg$ $v_{truck} = 22\ m/s$ $v_{car} = 8\ m/s$ $v' = 17\ m/s$

Find mass of car.

$$m_t v_t + m_c v_c = (m_t + m_c)v'$$
$$(2200\ kg)(22\ m/s) + m_c(8\ m/s) = (2200\ kg + m_c)(17\ m/s)$$
$$\underline{m_c = 1222\ kg}$$

7. Shane's Sliding Disc

$m_{disc\,1} = 14\ kg$ $v_{disc\,1} = 6\ m/s$ $e = 1$

$m_{disc\,2} = 8\ kg$ $v_{disc\,2} = 0\ m/s$

$$m_1 v_1 + \cancel{m_2 v_2}^{0} = m_1 v_1' + m_2 v_2'$$
$$(14\ kg)(6\ m/s) = (14\ kg)v_1' + (8\ kg)v_2'$$

$$v_1 - \cancel{v_2}^{0} = -(v_1' - v_2')$$
$$6\ m/s = -v_1' + v_2'$$
$$v_2' = 6\ m/s + v_1'$$

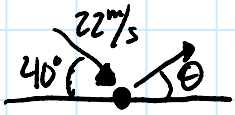
$$(14\text{ kg})(6\text{ m/s}) = (14\text{ kg})v_1' + (8\text{ kg})(6\text{ m/s} + v_1')$$

$$v_1' = 1.64\text{ m/s}$$

$$v_2' = 6\text{ m/s} + v_1' = 6\text{ m/s} + 1.64\text{ m/s} = \underline{\underline{7.64\text{ m/s}}}$$

8. Abby Throwing a Ball

$W_{ball} = 0.80$ lb $V = 22$ m/s @ 40° $e = 0.64$



Find the angle after hitting the ground.

POC (x): $v_x' = v_x = 22\text{ m/s}\cos(40°) = 16.85\text{ m/s}$

LOI (y): $e = \dfrac{-(v_{1y}' - \cancel{v_{2x}}^{0})}{v_{1y} - \cancel{v_{2y}}^{0}} \rightarrow e = \dfrac{-v_{1y}'}{v_{1y}}$

$$v_{1y}' = -v_{1y}e = -(-22\text{ m/s}\sin(40))(0.64) = 9.05\text{ m/s}$$

$$\theta = \tan^{-1}\left(\frac{v_y'}{v_x'}\right) = \tan^{-1}\left(\frac{9.05\text{ m/s}}{16.85\text{ m/s}}\right) = \underline{\underline{28.24°}}$$