Momentum, Work + Energy Review

① No. Momentum is a vector. Since their directions are not the same, their momentum is not the same.

② The initial momentum of Superman + the villain is 0. Conservation says that it should still be 0 after Superman throws the villain. For this to be true, if the villain moves forward, Superman should move backwards with an equal amount of momentum.

③ $m = 15g = 0.015\ Kg$

$p = mv$

$= (0.015)(12)$

$p = \boxed{0.18\ Kg \cdot m/s}$

④ $F\Delta t = m\Delta v$

$(272)\Delta t = (0.058)(62 - 0)$

$\Delta t = \boxed{0.013\ s}$

⑤ a) $\Delta p = F\Delta t$

$= (186)(0.4)$

$\Delta p = \boxed{74.4\ N \cdot s}$

b) $\Delta p = m\Delta v$

$74.4 = 7.3\Delta v$

$\Delta v = \boxed{10.2\ m/s}$

⑥ a) $\Delta p = m \Delta v$

$= (5500)(7.8 - 4.2)$

$\Delta p = \boxed{19\,800 \text{ Kg.m/s}}$

b) $F \Delta t = \Delta p$

$F(15) = 19\,800$

$F = \boxed{1320 \text{ N}}$

⑦ a) $\Delta p = m \Delta v$

$= (0.145)(-58 - 42)$

$\Delta p = \boxed{-14.5 \text{ Kg.m/s}}$

b) $F \Delta t = \Delta p$

$F(4.6 \times 10^{-4}) = -14.5$

$F = \boxed{-31\,522 \text{ N}}$

⑧ a) $p = mv$

$= (550)(24)$

$p = \boxed{13\,200 \text{ Kg.m/s}}$

b) $\Delta p = p_f - p_i$

$= 0 - 13\,200$

$\Delta p = \boxed{-13\,200 \text{ Kg.m/s}}$

(8) c) $\Delta p_{truck} = -\Delta p_{car}$

$= -(-13\,200)$

$\Delta p = \boxed{+13\,200 \text{ kg} \cdot \text{m/s}}$

d) $\Delta p = mv_f - mv_i$

$13\,200 = 0 - 680 v_i$

$v = \boxed{-19.4 \text{ m/s}}$

(9) $(m_1 + m_2) v = m_1 v_1' + m_2 v_2'$

$(0.05 + 4.65)(2) = (0.05)(647) + (4.65) v_2'$

$9.4 = 32.35 + 4.65 v_2'$

$v_2' = \boxed{-4.94 \text{ m/s}}$

(10) $(m_1 + m_2) v = m_1 v_1' + m_2 v_2'$

$0 = (5)(0.12) + (2) v_2'$

$v_2' = \boxed{-0.3 \text{ m/s}}$

(11) $m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$(0.012)(150) + 0 = (0.012)(-100) + 8.5 v_2'$

$1.8 = -1.2 + 8.5 v_2'$

$v_2' = \boxed{0.35 \text{ m/s}}$

(12) $W = Fd$

$220\,000 = F(8)$

$F = \boxed{27\,500\ N}$

(13) $W = F_g \cdot d$

$= mgd$

$W = (180)(9.8)(1.95)$

$W = \boxed{3440\ J}$

(14) d = circumference

$= 2\pi r$

$= 2\pi(25)$

$d = 157.08\ m$

$W = Fd\cos\theta$

$= (38)(157.08)\cos 42$

$W = \boxed{4436\ J}$

(15)

$h = 10\sin 11$

$W = \Delta E_g$

$= mgh$

$= (185)(9.8)(10\sin 11)$

$W = \boxed{3459\ J}$

(16) W = area

$= (1)(0.6\times10^2) + \frac{1}{2}(1)(0.6\times10^2)$

$W = 60 + 30 = 90$ J

$W = \Delta E_K$

$90 = \frac{1}{2} m v_f^2$

$90 = \frac{1}{2}(0.005) v_f^2$

$v_f = \boxed{189.7 \text{ m/s}}$

(17) a) $W = Fd$

$= (30)(2.8)$

$W = \boxed{84 \text{ J}}$

b) $W = \Delta E_K$

$\Delta E_K = \boxed{84 \text{ J}}$

c) $\Delta E_K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$84 = \frac{1}{2}(1.5) v_f^2 - 0$

$v_f = \boxed{10.6 \text{ m/s}}$

(18) $W = \Delta E_K$

$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$-140d = 0 - \frac{1}{2}(82)(4.2)^2$

$d = \boxed{5.2 \text{ m}}$

(19) a) $\Delta E_K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= \frac{1}{2}(7.12)(10.2)^2 - \frac{1}{2}(7.12)(5.6)^2$

$\Delta E_K = \boxed{25\,874 \text{ J}}$

b) $d = \left(\frac{v_f + v_i}{2}\right)t$

$= \left(\frac{10.2 + 5.6}{2}\right)8.4$

$d = \boxed{66.4 \text{ m}}$

c) $W = \Delta E_K$

$Fd = \Delta E_K$

$F(66.4) = 25\,874$

$F = \boxed{390 \text{ N}}$

(20) Book 1 $W = \Delta E_g = 0 - 0 = 0$

Book 2 $W = \Delta E_g = mgh_1 - 0 = mgh$

Book 3 $W = \Delta E_g = mgh_2 - 0 = mg(2h) = 2mgh$

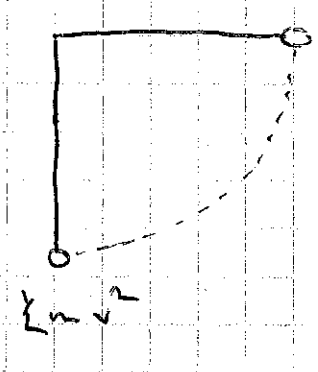
Book 4 $W = \Delta E_g = mgh_3 - 0 = mg(3h) = 3mgh$

Book 5 $W = \Delta E_g = mgh_4 - 0 = mg(4h) = 4mgh$

Total $mgh + 2mgh + 3mgh + 4mgh = 10mgh$

$\therefore W = 10(0.8\vec{i})(9.8)(0.02\vec{i}) = \boxed{2.1\ \text{J}}$

(21) a)



$mgh = \frac{1}{2}mv^2$

$(9.8)(5) = \frac{1}{2}v^2$

$v = \boxed{9.9\ \text{m/s}}$

b)

$\Sigma\vec{F} = \vec{F}_T - \vec{F}_g$

$\frac{mv^2}{r} = F_T - mg$

$F_T = \frac{mv^2}{r} + mg$

$= \frac{(1)(9.9)^2}{5} + (1)(9.8)$

$F_T = \boxed{29.4\ \text{N}}$

(22) $F = kx$

$5 = k(0.1)$

$k = 50 \text{ N/m}$

$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\frac{1}{2}(4.5)(2)^2 = \frac{1}{2}(50)x^2$

$x = \boxed{0.6 \text{ m}}$

(23) a) $E_K = \frac{1}{2}mv^2$

$= \frac{1}{2}(15)(12.5)^2$

$E_K = \boxed{1172 \text{ J}}$

b) $\Delta E_g = mg\Delta h$

$= (15)(9.8)(-20.4)$

$\Delta E_g = \boxed{-2999 \text{ J}}$

c) $\Delta E_K = -\Delta E_g$

$= -(-2999)$

$\Delta E_K = \boxed{+2999 \text{ J}}$

d) $E_K' = E_K + \Delta E_K$

$= 1172 + 2999$

$E_K' = \boxed{4171 \text{ J}}$

e) $E_K' = \frac{1}{2}m(v')^2$

$4171 = \frac{1}{2}(15)(v')^2$

$v' = \boxed{23.6 \text{ m/s}}$

(24) $72\ km/h = 20\ m/s$

a) $\Sigma W = \Delta E_K$

$= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$= \frac{1}{2}(1200)(20)^2 - 0$

$\Sigma W = \boxed{240\,000\ J}$

b) $d = \left(\frac{v_f + v_i}{2}\right) t$

$= \left(\frac{20+0}{2}\right) 20$

$d = \boxed{200\ m}$

c) $\Sigma W = \Sigma F \cdot d$

$240\,000 = \Sigma F\,(200)$

$\Sigma F = \boxed{1200\ N}$

d) $\Sigma F = F_A - F_f$

$1200 = F_A - 450$

$F_A = \boxed{1650\ N}$

(25) Point B

$$\tfrac{1}{2}mv_A^2 + mgh_A = \tfrac{1}{2}mv_B^2 + mgh_B$$

$$\tfrac{1}{2}(1.8)^2 + (9.8)(30) = \tfrac{1}{2}v_B^2 + (9.8)(0)$$

$$295.62 = \tfrac{1}{2}v_B^2$$

$$v_B = \boxed{24.3 \text{ m/s}}$$

Point C

$$\tfrac{1}{2}mv_A^2 + mgh_A = \tfrac{1}{2}mv_C^2 + mgh_C$$

$$295.62 = \tfrac{1}{2}v_C^2 + (9.8)(25)$$

$$295.62 = \tfrac{1}{2}v_C^2 + 245$$

$$v_C = \boxed{10.1 \text{ m/s}}$$

Point D

$$\tfrac{1}{2}mv_A^2 + mgh_A = \tfrac{1}{2}mv_D^2 + mgh_D$$

$$295.62 = \tfrac{1}{2}v_D^2 + (9.8)(12)$$

$$295.62 = \tfrac{1}{2}v_D^2 + 117.6$$

$$v_D = \boxed{18.9 \text{ m/s}}$$