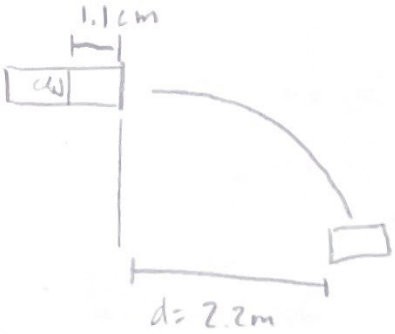
Q9



27 cm = .27 m

Which means when compressed 0.011 m, the ball goes 2.2 - 0.27 m = 1.93 m

$F = -kx$ $k = -\frac{F}{x}$ $F = ma$

$x = 1.1$

k = spring constant

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Q10

(a) $a = ?$

$mgsin\theta - I\omega = ma$

$I = \frac{1}{2}mr^2$

$mgsin\theta - \frac{1}{2}mr^2(a/r) = ma$

$gsin\theta - \frac{1}{2}ra = a$

$gsin\theta = a + \frac{1}{2}ra$

$gsin\theta = a(1 + \frac{1}{2}r)$

$$a = \frac{gsin\theta}{1+\frac{1}{2}r} = \frac{(9.8)sin(30)}{1+\frac{1}{2}(0.2)} = \frac{4.9}{1.1} = 4.454\ m/s^2$$

(b) $KE_{rotational} = \frac{1}{2}I\omega^2$

$PE = KE_{rot} + W_f$

$mgh = \frac{1}{2}I\omega^2 + W_f$

$(2)(10)(3) = \frac{1}{2}\left(\frac{1}{2}(2)(0.2)^2\right)\cdot\left(\frac{0.2}{4.454}\right)^2 + W_f$

$60 = 4.032641\cdot10^{-5} + W_f$

$W_f = 59.99995967$

$mgh = KE_{rot} + 59.9999567$

$KE_{rot} = 4.032641\cdot10^{-5}$

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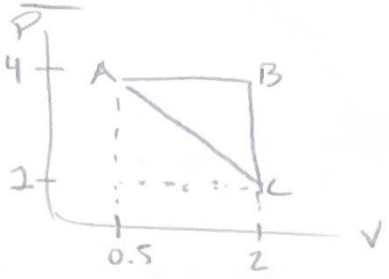
Q11



(a). $T_C = 300\ K$

$P_C = 1$

$V_C = 2$

$\frac{P_C V_C}{T_C} = \frac{P_B V_B}{T_B}$

$\frac{1(2)}{300} = \frac{4(2)}{T_B}$

$\frac{2}{300} = \frac{8}{T_B}$

$\frac{2T_B}{300} = 8$

$T_B = 1200\ K$

$\frac{2}{300} = \frac{(4)(0.5)}{T_A}$

$\frac{2}{300} = \frac{2}{T_A}$

$2T_A = 600$

$T_A = 300$

$PV = nRT$

$(1)(2) = n(8.314)(300K)$ $\quad n = 72.167$

(b,c,d) $B \to C$ Isovolumetric ($\Delta V = 0$)

$W = 0$

$Q = nC_v\Delta T = (72.167)(3/2 \cdot 8.314)(300 - 1200)$

$= -809995.1913$

$E_{int} = Q = -809995.1913$

$C \to A$ $-\int P dV$

$W = -(1 \cdot 2 - 0.5) + (1/2(1.5) \cdot 3)$

$= -(1.5 + 0.75)$

$W = -2.25$

$Q = nC_p\Delta T = (72.167)(5/3(8.314))(0) = 0$

$E_{int} = W = -2.25$

$A \to B$ Isobaric ($\Delta P = 0$)

$W = nRT\ln(V_i/V_f) = (72.167)(8.314)(1200)\ln\left(\frac{0.5}{2}\right) = -998126$

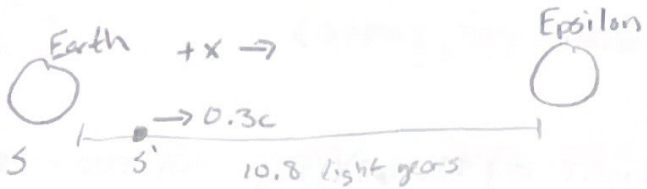
$Q = nC_p\Delta T = (72.167)(5/2(8.314))(1200 - 300)$

$= 134991.986$

$E_{int} = Q + W = 134991.986 - 998126 = -863134.014$

(c) $e = 1 - \frac{|Q_C|}{|Q_H|}$

Q12



time on earth (t)
proper time on probe (tp)

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{1}{\sqrt{1-\frac{0.3c}{3.00\cdot10^8}}} = \frac{1}{0.1} = 10$$

(a) : $t = (10)tp$

$t = 10tp$

(b) $tp = (t/10)$

$tp = t/10$

(c)

u' = ? Speed of inceptor measured by probe

$u = 0.3c$ Speed probe measured by spectator

$v = -0.7c$ Speed of inceptor by spectator

$$u' = \frac{u - v}{\sqrt{1-\frac{uv}{c^2}}} = \frac{0.3c + 0.7c}{\sqrt{1-\frac{(0.3c)(-0.7c)}{c^2}}} = \frac{1.0c}{\sqrt{1+0.21}} = \frac{1.0}{1.1} = \boxed{0.909c}$$