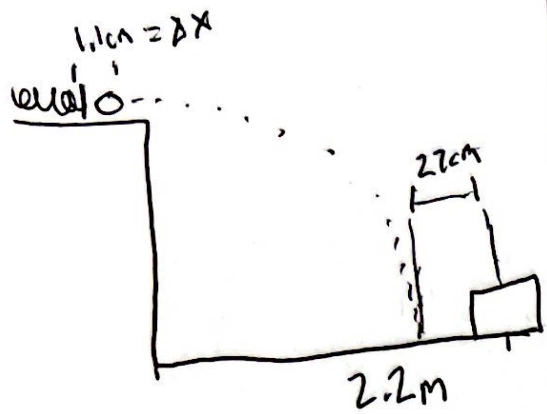
9. $f = -k\Delta x$



$$V_f - V_i = a\Delta t$$
$$\Delta x = \left(\frac{V_2 + V_1}{2}\right)\Delta t$$
$$\Delta x = V_i\Delta t + \frac{1}{2}a(\Delta t)^2$$
$$V_f^2 - V_i^2 = 2a\Delta x$$

$g = -10 m/s^2$

$PE_{spring} = \frac{1}{2}k\Delta x^2$

$a = -k/m \cdot \Delta x \qquad \omega = \sqrt{k/m}$

* when referring to Δx I refer to the compression of spring, not distance travelled

conservation of energy

$PE_{spring} = KE_{ball}$

$\frac{1}{2}k\Delta x^2 = \frac{1}{2}m_b v_b^2$

$220 - 27 = 193$

$\frac{193}{220} = 0.87$

$\frac{1.1cm}{0.87} = 1.254cm$

Rhonda should compress spring 1.254cm to hit the center of the box

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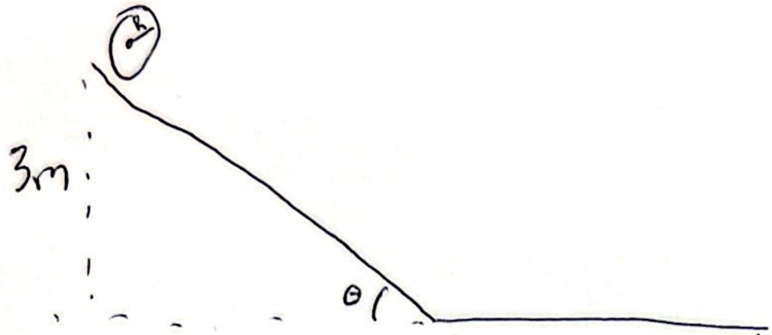
(10.) $R = 0.2\,m$ $M = 2\,kg$ $h = 3\,m$ $I = \frac{1}{2}mr^2$

$\theta = 30°$



a) find linear accel

$mg\sin\theta - f = ma$

$\tau = fr = I\alpha = I\frac{a}{r}$ so $f = \frac{Ia}{r^2}$

$\cancel{m}g\sin\theta - \frac{(\frac{1}{2}\cancel{m}\cancel{r^2})a}{\cancel{r^2}} = \cancel{m}a$

$g\sin\theta - \frac{a}{2} = a$

$g\sin\theta = \frac{3a}{2}$

$\frac{10\sin 30}{1.5} = a$

$a = 3.\overline{3}\,m/s^2$

(linear acceleration

b) find rotational KE at Bottom

$KE_{rot} = \frac{1}{2}I\omega^2$

find v

$mgh = \frac{1}{2}mv_f^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}mv_f^2 + \frac{1}{2}(\frac{1}{2}m\cancel{r^2})(\frac{V_f^2}{\cancel{r^2}})$

$2(10)(3) = \frac{1}{2}(2)v^2 + \frac{1}{4}(2)v^2$

$60 = v^2 + \frac{1}{2}v^2$

$V_f = 6.325\,m/s \longrightarrow KE_{rot} = \frac{1}{2}(\frac{1}{2}m\cancel{r^2})(\frac{V_f^2}{\cancel{r^2}}) = \frac{1}{4}mV_f^2 = 20J$

$\boxed{KE_{rot} = 20J}$

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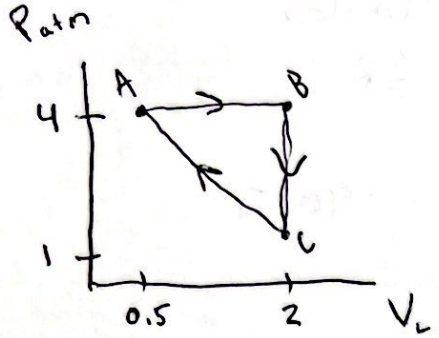
11. Monoatomic heat engine



$T_c = 300K$

$1atm = 10^5 \, N/m^2$

$1L = 10^{-3} \, m^3$

AB = isobaric

BC = isovolumetric

a) find T_a & T_b

$$\frac{P_b}{P_c} = \frac{T_b}{T_c}$$

$$\frac{4}{1} = \frac{T_b}{300K} \quad \text{so} \quad \boxed{T_b = 1200K}$$

$$\frac{V_A}{V_B} = \frac{T_A}{T_B} \rightarrow \frac{0.5}{2} = \frac{T_a}{1200} \quad \text{so} \quad \boxed{T_a = 300K}$$

b) find W in each process

$AB \rightarrow W = -P\Delta V = -(4 \cdot 10^5)(2 \times 10^{-3} - 0.5 \times 10^{-3}) = -600J$

$\boxed{W_{AB} = -600J}$

$BC \rightarrow \boxed{W_{BC} = 0J}$ cuz $\Delta V = 0$

$CA \rightarrow W_{CA}$ = area under curve so

$$W_{CA} = (1 \times 10^5)(1.5 \times 10^{-3}) + \frac{1}{2}(3 \times 10^5)(1.5 \times 10^{-3})$$

$|W_{CA}| = 375 \quad 150 + 225$

find sign $\quad W = - \cdot \Delta V = - \cdot - = +$

$$\boxed{W_{CA} = 375J}$$

11. pt 2

c) find ΔE_{int}

$P_A V_A = nRT_a$

$(4\times10^5)(0.5\times10^{-3}) = 8.314 n \cdot 300$

$n = 0.0801$ moles

$C_v = \frac{3}{2}R$

$AB \rightarrow nC_v\Delta T$

$\Delta E_{int} = 0.0801(\frac{3}{2})(8.314)(1200-300)$

$\boxed{\Delta E_{int} \text{ for } AB = 900J}$

$BC \rightarrow nC_v\Delta T = 0.0801(\frac{3}{2})(8.314)(300-1200) = -900J$

$\boxed{\Delta E_{int} \text{ for } BC = -900J}$

$CA \rightarrow$ same temp so $\Delta E_{int} = 0$

$\boxed{\Delta E_{int} \text{ for } CA = 0J}$

d) find Q

$AB \rightarrow Q = \Delta E_{int} - W = 900J - (-600J) = 1500J$

$\boxed{Q_{AB} = 1500J}$

$BC \rightarrow Q_{BC} = \Delta E_{int}$ BC cuz $W = 0$

$\boxed{Q_{BC} = -900J}$

$CA \rightarrow Q_{CA} = -W_{CA} = -(375)$

$\boxed{Q_{CA} = -375J}$

e) find efficiency

$e = 1 - \frac{Q_c}{Q_H} = 1 - \frac{1275J}{1500J} = 0.15$

$\boxed{e_{HE} = 0.15 \text{ or } 15\%}$

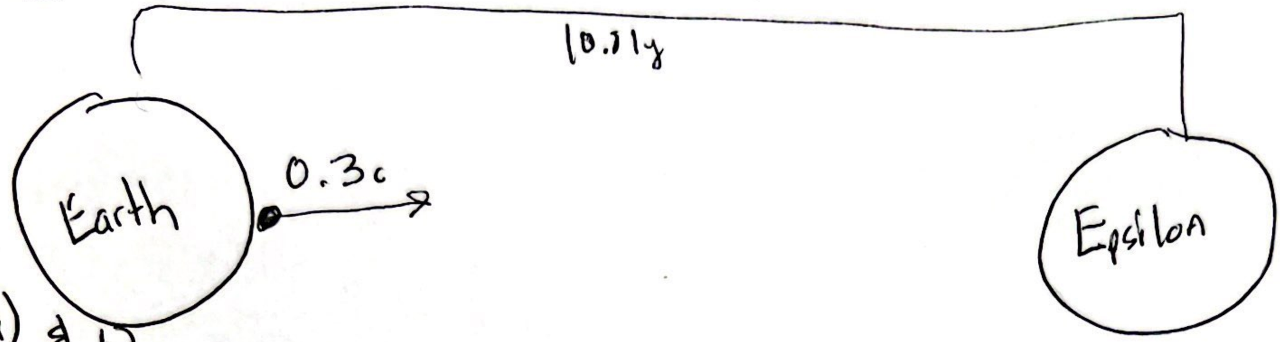
$Q_H = 1500J$

$Q_c = 900 + 375 = 1275$

Michael Gorman

$c = 3 \times 10^8$ m/s

(12.) distance = 10.8 light years   probe = 0.3c



a) & b)

$t_p = \frac{10.8}{0.3}\ ly = 36y$

$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{1}{\sqrt{1-\frac{0.3^2\cancel{c^2}}{\cancel{c^2}}}} = 1.048$

$t = \gamma \cdot t_p$

$t = 1.048 \cdot 36 = 37.738$ years

$\boxed{t_{Earth} = 36 \text{ years}}$

$\boxed{t_{probe} = 37.738 \text{ years}}$

c)

s   find u'

$u' = \frac{u - v}{1 - \frac{uv}{c^2}} = \frac{-0.7c - 0.3c}{1 - \frac{-0.7\cancel{c} \cdot 0.3\cancel{c}}{\cancel{c^2}}} = \frac{-c}{1-} = \frac{-1c}{1.21} = -0.826c$

$\boxed{u' = -0.826c}$ or, to the probe, the interceptor is travelling at them at 0.826c, but due ~~do~~ to our coordinates, we say -0.826c