Show work #1 (9)

target box = 2.2m from edge table

spring compress 1.1 cm

center marble falls 27 cm short

How far should spring be compressed to hit box?

$$\frac{1}{2} mg = \frac{1}{2}(10)(0.27)$$

$$= \boxed{1.35}$$

Show work #2 (#10)

cyclinder : $R = 0.2m$

$m = 2kg$ @ height 3m

rolls down ramp w/o friction

$g = 10\ m/s^2$

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

a. find linear acceleration of cyclinder rolling down ramp?

$I = \frac{1}{2}mR^2$ for cylinder

$mg\sin\theta - f = ma$

$fR = I\alpha = I\frac{a}{R}$

$f = \frac{I}{R^2}a$

$mg\sin - \frac{I}{R^2}a = a$

$a = \frac{g\sin\theta}{1 + \left(\frac{I}{mR^2}\right)} \Rightarrow a = \frac{g\sin\theta}{\left(1 + \frac{1}{2}\right)}$

$= \frac{10\sin(30)}{1.5} = \boxed{3.333\ m/s^2}$

b. Find rotational KE of cyclinder when reaches bottom of ramp.

$K_i + V_i = K_f + V_f$

$K_f = \frac{1}{2}mgR$

$= \frac{1}{2}(2)(10)(0.2)$

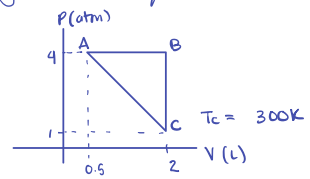
$= \boxed{2}$

Show work #3 (#11)

Heat engine w/ monoatomic gas reverse goes through cycle in 3 processes

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

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



a. Determine T_A and T_B

$$\frac{P_i}{T_i} = \frac{P_f}{T_f} \qquad \frac{V_i}{T_i} = \frac{V_f}{T_f}$$

$$\frac{1}{300} = \frac{4}{T_B}$$

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

$$T_B = \frac{4}{1/300} = \frac{4}{1}\cdot\frac{300}{1} = \boxed{1200\ K}$$

$$\frac{1}{300} = \frac{4}{T_A}$$

$$\frac{T_A}{300} = 4$$

$$T_A = 4(300) = \boxed{1200\ K}$$

B. Determine work done on gas in each process.

A → B :

$$W = -P\Delta V$$
$$= -4(1.5)$$
$$= \boxed{-6}$$

B → C : $\boxed{W = 0}$

C → A : $nRT\ln\left(\frac{V_i}{V_f}\right)$

$$(1)(8.314)(900)\ln\left(\frac{2}{0.5}\right)$$
$$7482.6$$
$$= \boxed{10373.08619}$$

C. Determine change of internal energy in each process.

A → B : isobaric
B → C : isovolumetric
C → A : isothermal

A → B :

$$\Delta E_{int} = Q + W$$
$$= 0 + (-6)$$
$$= \boxed{-6}$$

$Q = nC_p\Delta T$
$= (1)(20.785)(0)$
$= \boxed{0}$

$C_v = C_p + R$
$= 12.471 + 8.314$
$= 20.785$

B → C :

$$\Delta E_{int} = nC_v\Delta T$$
$$= (1)(20.785)(900)$$
$$= \boxed{18706.5}$$

C → A : $\boxed{\Delta E_{int} = 0}$

D. Determine heat transferred to gas in each process.

A → B : $Q = nC_p\Delta T$
$= (1)(12.471)(0)$
$= \boxed{0}$

$C_p = \frac{5}{2}(8.314)$
$= 12.471$

B → C : $Q = nC_v\Delta T$
$= (1)(12.471)(900)$
$= \boxed{11223.9}$

C → A : $-nRT\ln\left(\frac{V_i}{V_f}\right)$
$-(1)(8.314)(900)\ln\left(\frac{2}{0.5}\right) = \boxed{-10373.086}$

E. determine efficency

$$e = \frac{Q_H - Q_c}{Q_H} = 1 - \frac{Q_c}{Q_H}$$

$$= 1 - \frac{10373.086}{11223.9}$$

$$= 1 - 0.92419$$

$$= 0.0758 = \boxed{7.58\%}$$

Show Work #4 (# 12)

Star 10.8 light years from Earth

Probe @ velocity 0.3c

$c = 3.00 \times 10^8$ m/s

a. How long does journey take when measured in Earth's frame?

Earth = S

$t_p = \frac{2d}{c}$

$= \frac{2(0.3)}{3 \times 10^8}$

$= \boxed{2 \times 10^{-9}}$

b. How long measured from probes frame?

$t - \frac{V}{c^2} x$

$10.8 - \frac{2 \times 10^{-9}}{c^2}$

$= \boxed{10.8}$

c. probe velocity = $-0.7c$

what's velocity of interceptor seen by probe?

$u' = \frac{u - v}{1 - uv/c^2}$

$= \frac{(2 \times 10^{-9}) - (10.8)}{1 - \frac{(2 \times 10^{-9})(10.8)}{c^2}}$

$= 1 - \frac{-10.8}{9 \times 10^{16}}$

$= \boxed{1}$