STUDENT NUMBER:

NAME:

SECTION NUMBER:

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KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

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COURSE: PH102

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EXAM: PH102 1ST MAJOR EXAM - 002

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TEST CODE NUMBER: XXX

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INSTRUCTIONS:

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1. PRINT YOUR STUDENT NUMBER, NAME, AND SECTION NUMBER ON THE EXAM.
2. PRINT YOUR STUDENT NUMBER, SECTION NUMBER, AND YOUR NAME ON THE EXAM ANSWER FORM. PRINT THE TEST CODE NUMBER, OR CHECK IT IF IT HAS ALREADY BEEN PRINTED ON YOUR ANSWER FORM.
3. CODE YOUR STUDENT NUMBER AND SECTION NUMBER ON THE EXAM ANSWER FORM. CODE THE TEST CODE NUMBER, OR CHECK IT IF IT IS ALREADY CODED.
4. CODE YOUR ANSWERS ON THE EXAM ANSWER FORM. YOU MUST NOT GIVE MORE THAN ONE ANSWER PER QUESTION.
5. RETURN THE EXAM AND ANSWER FORM TO THE INSTRUCTOR WHEN YOU HAVE FINISHED.

Dear respected student,

To get the most benefit form this old exam, I suggest the following,

(1) Solve it without seeing the answers.

(2) Time yourself. A question should not take more than 6 minutes.

(3) Compare your answers to the answers provided at the end of this exam.

(4) If your answer is wrong, study why you did not get it right. If you cannot know your mistake, ask your friends or come to me.

The formula sheet, figures and answers are provided at the end of the exam.

****
QUESTION NO: 1
****

If two successive frequencies of a pipe, closed at one end and filled by air, are 500 Hz and 700 Hz, the length of the pipe is: [speed of sound in air = 340 m/s].

A. 1.70 m.
B. 3.40 m.
C. 0.18 m.
D. 0.85 m.
E. 0.43 m.

****
QUESTION NO: 2
****

For an ideal gas, which of the following statements is FALSE:

A. In a constant volume process, the work done by the gas is zero.
B. In an adiabatic process, no heat enters or leaves the system.
C. In an isothermal process, the work done is equal to heat energy.
D. In an isothermal process, there is no change in the internal energy.
E. In any cyclic process, the work done by the gas is zero.

****
QUESTION NO: 3
****

An iron ball has a diameter of 6.0 cm and is 0.01 mm too large to pass through a hole in a brass ring when both are at a temperature of 30 degrees Celsius. To what temperature should the brass ring be heated so that the ball just passes through the hole? [The coefficient of volume expansion of iron = 3.6*10**(-5) K**-1 and of brass = 5.7*10**(-5) K**-1]

A. 52 degrees Celsius.
B. 47 degrees Celsius.
C. 59 degrees Celsius.
D. 39 degrees Celsius.
E. 32 degrees Celsius.

****
QUESTION NO: 4
****

The lowest resonant frequency, in a certain string clamped at both ends, is 50 Hz. When the string is clamped at its midpoint, the lowest resonant frequency is:

A. 150 Hz.
B. 250 Hz.
C. 100 Hz.
D. 50 Hz.
E. 200 Hz.

****
QUESTION NO: 5
****

A sinusoidal wave is described as:

y = (0.1 m) * sin[10*pi*(x/5 + t - 3/2)],

where x is in meters and t is in seconds. What are the values of its frequency(f), and its velocity(v)?

A. f=5 Hz, v = 1 m/s moving in -x-direction.
B. f=2 Hz, v = 5 m/s moving in -x-direction.
C. f=5 Hz, v = 5 m/s moving in +x-direction.
D. f=5 Hz, v = 1 m/s moving in +x-direction.
E. f=5 Hz, v = 5 m/s moving in -x-direction.

****
QUESTION NO: 6
****

A 100-Hz oscillator is used to generate a sinusoidal wave, on a string, of wavelength 10 cm. When the tension in the string is doubled, the oscillator produces a wave with a frequency and wavelength of:

A. 50 Hz and 14 cm.
B. 200 Hz and 20 cm.
C. 200 Hz and 14 cm.
D. 100 Hz and 20 cm.
E. 100 Hz and 14 cm.

****
QUESTION NO: 7
****

The power transmitted by a sinusoidal wave on a string does not depend on:

A. the wavelength of the wave.
B. the tension in the string.
C. the frequency of the wave.
D. the length of the string.
E. the amplitude of the wave.

****
QUESTION NO: 8
****

In a constant-volume gas thermometer, the pressure is 0.019 atm at 100 degrees Celsius. Find the temperature when the pressure is 0.027 atm.

A. 531 degrees Celsius.
B. 340 degrees Celsius.
C. 321 degrees Celsius.
D. 132 degrees Celsius.
E. 257 degrees Celsius.

****
QUESTION NO: 9
****

A solid aluminum rod, of length 1.60 m and cross-sectional area of 3.14*10**(-4) m**2, has one end in boiling water and the other end in ice. How much ice melts in one minute?
[The thermal conductivity of aluminum is 205 Watts/(m*K) and the heat of fusion of water is 3.35*10**5 J/kg.]
(neglect any heat loss, by the system, to the surrounding)

A. 5.8*10**(-4) kg.
B. 7.9*10**(-2) kg.
C. 3.2*10**(-3) kg.
D. 7.2*10**(-4) kg.
E. 6.3*10**(-4) kg.

****
QUESTION NO: 10
****

Two transmitters, S1 and S2 in figure (1), emit sound waves of wavelength lambda. The transmitters are separated by a distance lambda. Consider a big circle of radius R with center halfway between these transmitters. How many interference minima (i.e. completely silent positions) are there on this big circle?

A. 4.
B. 2.
C. 6.
D. 5.
E. 1.

****
QUESTION NO: 11
****

Two moles of helium (monatomic) gas are heated from 100 degrees Celsius to 250 degrees Celsius. How much heat is transferred to the gas if the process is isobaric?

A. 3.11 kJ.
B. 8.52 kJ.
C. 2.63 kJ.
D. 1.51 kJ.
E. 6.23 kJ.

****
QUESTION NO: 12
****

One mole of an ideal gas undergoes the thermodynamic process shown in figure (2). If the process BC is an isothermal, how much work is done by the gas in this isothermal process?

A. 0.56*10**3 J.
B. 5.29*10**4 J.
C. 1.69*10**3 J.
D. 0.92*10**3 J.
E. 1.30*10**3 J.

****
QUESTION NO: 13
****

The equation for a standing wave is given by:
y = 4.00*10**(-3) sin(2.09 x) cos(60.0 t) (SI units).
What is the distance between two consecutive antinodes?

A. 5.00 m.
B. 2.20 m.
C. 3.00 m.
D. 1.50 m.
E. 0.56 m.

****
QUESTION NO: 14
****

5 moles of hydrogen gas occupy a balloon that is inflated to a volume of 0.3 m**3 and at 1.0 atmospheric pressure. What is the root-mean square velocity of the molecules inside the balloon? [The mass of hydrogen atom is 1.66*10**(-27) kg].

A. 3.4*10**2 m/s.
B. 2.2*10**3 m/s.
C. 1.3*10**3 m/s.
D. 3.0*10**9 m/s.
E. 4.3*10**3 m/s.

****
QUESTION NO: 15
****

A 100 g of water at 100 degrees Celsius is added to a 20-g aluminum cup containing 50 g of water at 20 degrees Celsius. What is the equilibrium temperature of the system? The specific heat of aluminum is 900 J/(kg*K) and the specific heat of water is 4186 J/(kg*K).

A. 72 degrees Celsius.
B. 55 degrees Celsius.
C. 14 degrees Celsius.
D. 95 degrees Celsius.
E. 63 degrees Celsius.

****
QUESTION NO: 16
****

Helium gas is heated at constant pressure from 32 degrees Fahrenheit to 212 degrees Fahrenheit. If the gas does 20.0 Joules of work during the process, what is the number of moles?

A. 0.013 moles.
B. 0.200 moles.
C. 0.050 moles.
D. 0.111 moles.
E. 0.024 moles.

****
QUESTION NO: 17
****

An ambulance siren emits a sound of frequency 1.60 kHz. A person running with a speed of 2.50 m/s hears a frequency of 1.70 kHz as the ambulance approaches him from the back. How fast is the ambulance moving? (speed of sound is 340 m/s).

A. 2.50 m/s.
B. 25.6 m/s.
C. 22.4 m/s.
D. 12.2 m/s.
E. 17.7 m/s.

****
QUESTION NO: 18
****

A man strikes a long steel rod at one end. Another man, at the other end with his ear close to the rod, hears the sound of the of the blow twice (one through air and once through the rod), with a 0.1 seconds interval between. How long is the rod? [For the steel, the bulk modulus = 2.1*10**11 Pa, and the density = 7.0*10**3 kg/m**3. Speed of sound in air = 340 m/s.]

A. 36 m.
B. 34 m.
C. 44 m.
D. 42 m.
E. 40 m.

****
QUESTION NO: 19
****

If the distance from a source of sound increases by 1 meter, the sound level is decreased by 2 dB. Assume the loudspeaker that is emitting this sound emits sound in all directions. The original distance from the sound source is:

A. 1.93 m.
B. 12.0 m.
C. 7.72 m.
D. 3.86 m.
E. 9.93 m.

****
QUESTION NO: 20
****

An ideal diatomic gas, initially at a pressure Pi = 1.0 atm and volume Vi, is allowed to expand isothermally until its volume doubles. The gas is then compressed adiabatically until it reaches its original volume. The final pressure of the gas will be:

A. 0.5 atm.
B. 2.0 atm.
C. 1.3 atm.
D. 0.4 atm.
E. 1.7 atm.

Physics 102 Major1
Formula sheet
Spring Semester 2000-2001 (Term 002)

$v = \lambda f$ $\qquad v = \sqrt{\dfrac{Y}{\rho}}$

$v = \sqrt{\dfrac{F}{\mu}}$ $\qquad v = \sqrt{\dfrac{B}{\rho}}$

$y = y_m \sin(kx - \omega t - \varphi)$

$P = \dfrac{1}{2}\mu\omega^2 A^2 v$

$S = S_m \cos(kx - \omega t)$

$\Delta P = \Delta P_m \sin(kx - \omega t)$

$\Delta P_m = \rho v \omega S_m$

$I = \dfrac{1}{2}\rho(\omega S_m)^2 v$

$\beta = 10\log\left(\dfrac{I}{I_o}\right)$

$I = \dfrac{\text{Power}}{\text{Area}}$

$f' = f\left(\dfrac{v \pm v_D}{v \mp v_s}\right)$

$y = \left(2y_m \cos\dfrac{\varphi}{2}\right)\sin\left(kx - \omega t - \dfrac{\varphi}{2}\right)$

$y = (2y_m \sin kx)\cos\omega t$

$f_n = \dfrac{nv}{2L}, \qquad n = 1,2,3,\ldots$

$f_n = \dfrac{nv}{4L}, \qquad n = 1,3,5\ldots$

$\Delta L = \alpha L \Delta T$

$PV = nRT = NkT$

$\Delta L = \dfrac{\lambda}{2\pi}\varphi$

$\Delta L = n\dfrac{\lambda}{2} \qquad n = 0, 2, 4, \ldots$

$\Delta L = n\dfrac{\lambda}{2}, \qquad n = 1, 3, 5, \ldots$

$\Delta L = m\lambda \qquad m = 0,1,2,\ldots.$

$\Delta L = \left(m + \dfrac{1}{2}\right)\lambda, \qquad m = 0,1,2,\ldots..$

$PV^{\gamma} = \text{constant}$

$TV^{\gamma-1} = \text{constant}$

$T_F = \dfrac{9}{5}T_C + 32$

$Q = mL$

$Q = mc\Delta T$

$Q = nc\Delta T$

$\Delta E_{int} = Q - W$

$\Delta E_{int} = nC_V \Delta T$

$C_p - C_v = R$

$W = \int P\,dV$

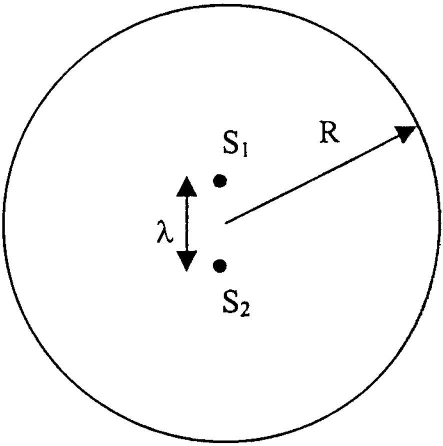
$H = \dfrac{Q}{t} = \kappa A \dfrac{T_H - T_C}{L}$

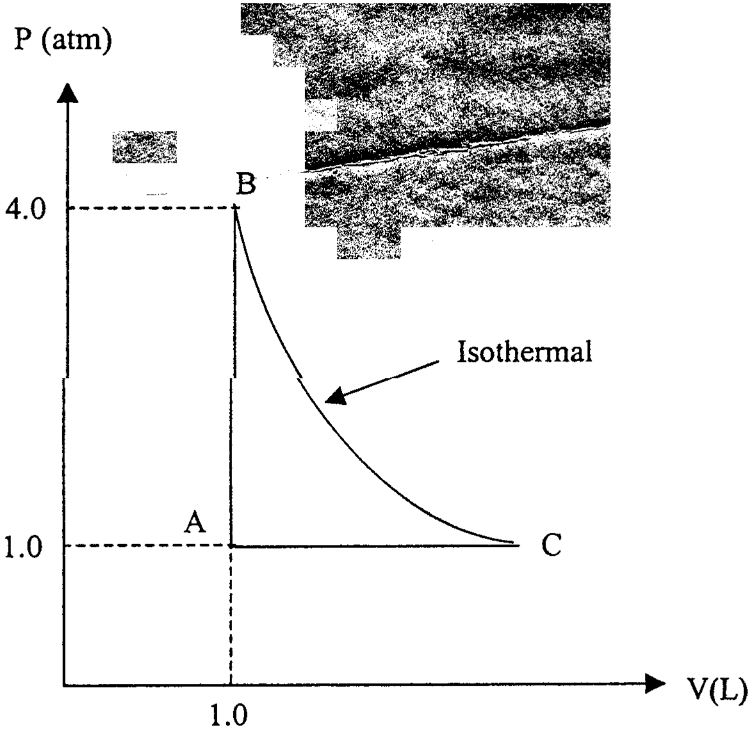
$\dfrac{m\overline{v^2}}{2} = (3/2)kT$

$v_{rms} = \sqrt{\dfrac{3RT}{M}}$

Constants:

$R = 8.31$ J/mol K
$N_A = 6.02 \times 10^{23}$ molecules/mole
1 atm $= 1.01 \times 10^5$ N/m^2
$k = 1.38 \times 10^{-23}$ J/K
$I_o = 10^{-12}$ W/m^2
1 calorie = 4.186 Joule
micro = 10^{-6}


S1
R
λ
S2


P (atm)
B
4.0
Isothermal
A
1.0
C
1.0
V(L)

Q1

$$f_n = n\frac{v}{4L} \qquad \underline{n = \text{odd}}$$

frequency of the n^{th} harmonic

let 500 Hz corresponds to the n' harmonic. the next harmonic will be $n'+2$, since n should be odd.

$$\left.\begin{aligned} 500 &= n'\frac{v}{4L} \\ 700 &= (n'+2)\frac{v}{4L} \end{aligned}\right\}$$

take the difference

$$700 - 500 = n'\frac{v}{4L} - (n'+2)\frac{v}{4L} = 2\frac{v}{4L}$$

$$\Rightarrow 200 = \frac{v}{2L}$$

$$\Rightarrow L = \frac{v}{2(200)} = \frac{340}{400} = 0.85\,m$$

Q2 False: In any cyclic process, the work done by the gas is zero

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Q3. We need to raise the temperature of brass ring such that its diameter becomes larger by 0.01 mm.

$\alpha = \frac{\beta}{3}$ coefficient of volume expansion

$$\Delta L = \alpha L \Delta T$$

$$0.01\,\cancel{mm} = \left(\frac{5.7\times10^{-5}}{3}\frac{1}{K}\right)\underbrace{(60 - 0.01)}_{\text{original diameter of the ring}}\cancel{mm}\,(T_f - 30^\circ C)$$

$$T_f = \frac{(0.01)(3)}{5.7\times10^{-5}(59.99)} + 30 = 39\,^\circ C$$

Q4

$$f_1^{old} = 1\,\frac{v}{2L} \rightarrow \text{change length to } \frac{L}{2}$$

$$\Rightarrow f_1^{new} = 1\,\frac{v}{2\frac{L}{2}} = 2\left(1\,\frac{v}{2L}\right) = 2 f_1^{old} = 100\ \text{Hz}$$

Q5

$$y = 0.1 \sin\left[\underbrace{\frac{10\pi}{5}}_{k} x + \underbrace{10\pi}_{\omega} t - \frac{3}{2}10\pi\right]$$

moving in the negative x-direction

$$f = \frac{\omega}{2\pi} = \frac{10\pi}{2\pi} = 5\ \text{Hz}$$

$$v = \frac{\omega}{k} = \frac{10\pi}{\frac{10\pi}{5}} = 5\ \text{m/s}$$

Q6 Frequency does not change and is determined by the oscillator = 100 Hz.

$$\lambda^{old} = \frac{v^{old}}{f} = \sqrt{\frac{\tau^{old}}{\mu}}\,\frac{1}{f} = 10\ \text{cm}$$

from question

$$\lambda^{new} = \sqrt{\frac{\tau^{new}}{\mu}}\,\frac{1}{f} = \sqrt{\frac{2\tau^{old}}{\mu}}\,\frac{1}{f}$$

$$= \sqrt{2}\,\lambda^{old} = 14\ \text{cm}$$

Q7 the length of the string.

Q8

$$\left.\begin{matrix} P_i V = nRT_i \\ P_f V = nRT_f \end{matrix}\right\} \xrightarrow{\text{divide}} \frac{P_i}{P_f} = \frac{T_i}{T_f} \Rightarrow T_f = \frac{P_f T_i}{P_i} = \frac{0.027}{0.019}\,(100+273)$$

very important

$$T_f = 530\ \text{K} = 257\ ^\circ\text{C}$$

Q9

$$P_{cond} = kA\frac{T_f - T_i}{L}$$

$$= (205)\,3.14\times10^{-4}\,\frac{100-0}{1.6} = 4.02\ W$$

$P_{cond} = \frac{\Delta Q}{\Delta t}$ is heat ΔQ conducted in Δt

ΔQ is used to melt ice, so

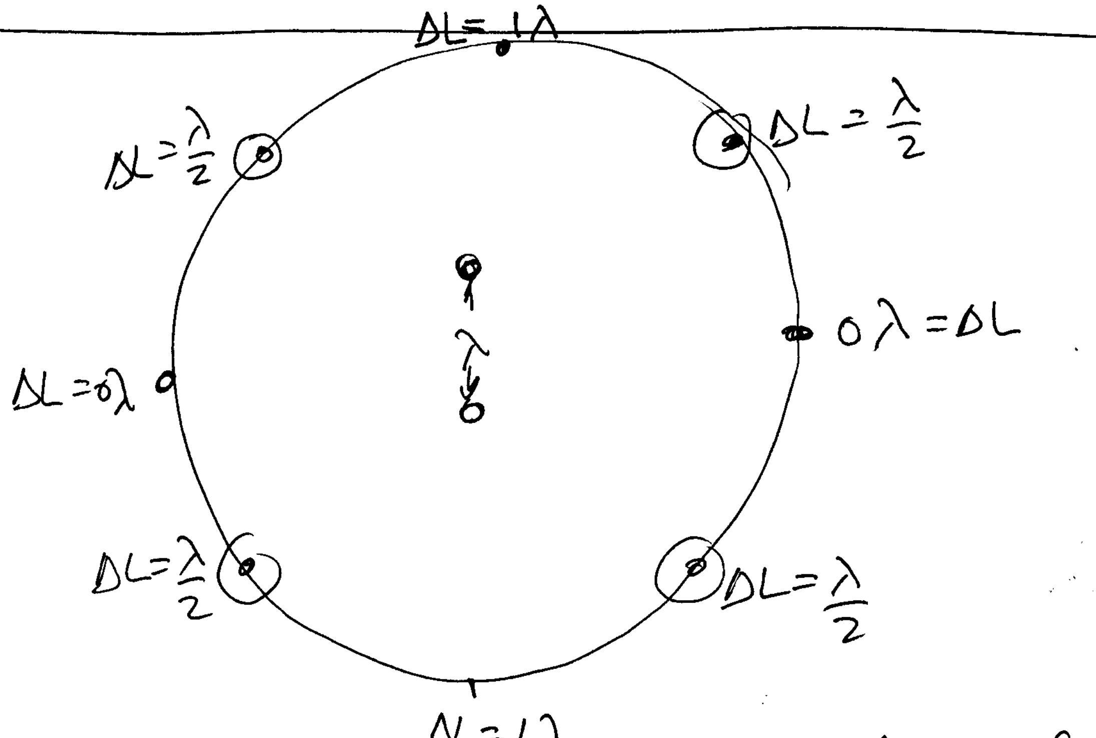
$\Delta Q = L_F \Delta m$ ← ice melted

$P_{cond} = L_F \frac{\Delta m}{\Delta t}$ ← rate of melting

$$\frac{\Delta m}{\Delta t} = \frac{P_{cond}}{L_F} = \frac{4.02}{3.35\times10^{5}} = 1.2\times10^{-5}\ kg/s$$

in one minute $\Delta m = (1.2\times10^{-5})(60) = 7.2\times10^{-4}\ kg$

Q10



minima occurs when ΔL is multiple of half wavelength ($\frac{\lambda}{2}, \frac{3}{2}\lambda, \ldots$). From figure we have 4 interference minima.

Q11

$$Q = n C_p \Delta T$$

$$= 2 \, \frac{5}{2} \underset{\uparrow \, 8.31}{R} (250-100) = 6.23 \text{ KJ}$$

Q12

For isothermal process (ideal gas)

$$W = nRT \ln \frac{V_f}{V_i}$$

since for an ideal gas $PV = nRT$,

$$W = PV \ln \left(\frac{P_i}{P_f} \right)$$

For isothemal process,

$PV = \text{constant}$

$\Rightarrow P_f V_f = P_i V_i$

$\Rightarrow \frac{V_f}{V_i} = \frac{P_i}{P_f}$

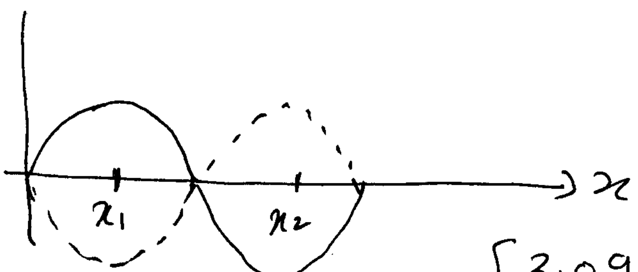
$$W = (4 \cancel{atm}) \left(\frac{1.01 \times 10^5 \text{ Pa}}{1 \cancel{atm}} \right) (1.0 \cancel{L}) \left(\frac{10^{-3} \text{ m}^3}{1.0 \cancel{L}} \right) \ln \frac{(4 \cancel{atm})}{(1 \cancel{atm})}$$

$$= 0.56 \times 10^3 \text{ J}$$

Q13

$$y = 4.00 \times 10^{-3} \underbrace{\sin(2.09x)} \cos(60.0t)$$

oscillating term



$$\begin{cases} 2.09 x_1 = \frac{\pi}{2} \\ 2.09 x_2 = \frac{3\pi}{2} \end{cases}$$

difference

$$2.09 (x_2 - x_1) = \pi$$

$$x_2 - x_1 = \frac{\pi}{2.09} = 1.50 \text{ m}$$

Mar 14, 02

Phys102 - 1st major - 002

PS

Q14

$$PV = nRT$$

$$v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3\,\frac{PV}{n}}{m N_A}}$$

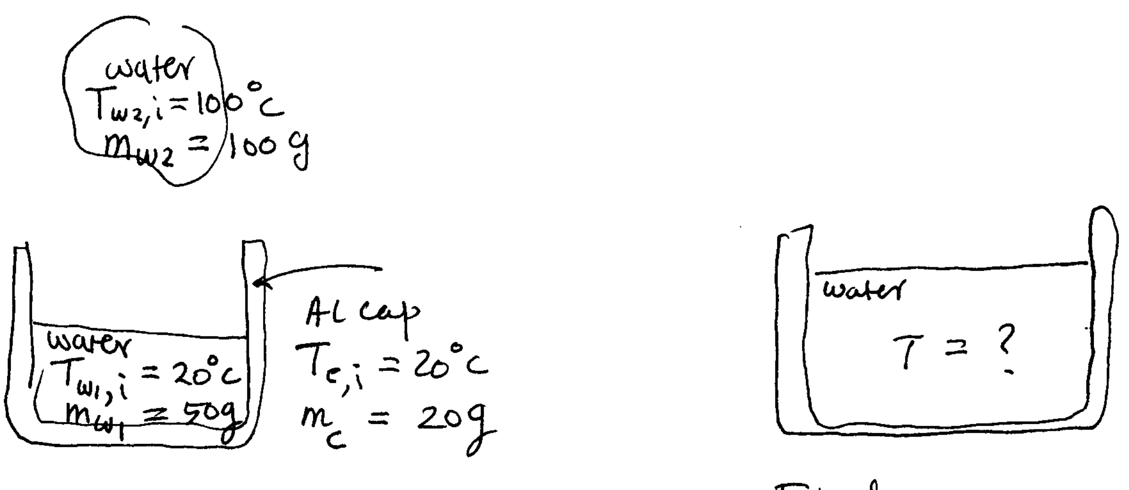
mass of one molecule.

$$= \sqrt{\frac{3(1.0\,\cancel{atm})\left(\frac{1.01\times10^{5}\,Pa}{1.0\,\cancel{atm}}\right)\left(\frac{0.3\,m^3}{5\,\cancel{moles}}\right)}{\underbrace{\left[(2)(1.66\times10^{-27}\,kg)\right]}_{}\left(6.022\times10^{23}\,\frac{1}{\cancel{mole}}\right)}}$$

This is the mass of one Hydrogen molecules which consists of two Hydrogen atom: H_2.

$$= \underline{3.0\times10^{3}\ m/s}$$

Q15



$$\underset{w2 \to c, w1}{Q} + \underset{c, w1 \to w2}{Q} = 0$$

Hot water cup cold water

$$c_{Al} m_c (T_f - T_{c,i}) + c_w m_{w1} (T_f - T_{w1,i})$$

same

$$+ c_w m_{w2} (T_f - T_{w2,i}) = 0$$

$$T_f \left[c_{Al} m_c + c_w m_{w1} + c_w m_{w2} \right] =$$

$$(c_{Al} m_c + c_w m_{w1}) T_{c,i} + c_w m_{w2} T_{w2,i}$$

$$T_f = \frac{\left[(900)(0.02) + 4186(0.05)\right](20) + 4186(0.1)(100)}{(900)(0.02) + 4186(0.05) + 4186(0.1)}$$

$$= 72\,^\circ C$$

Q16

$$W = P(V_f - V_i)$$ use $PV = nRT$

$$= P\left(\frac{nRT_f}{P} - \frac{nRT_i}{P} \right)$$

$$= nR(T_f - T_i)$$

$$n = \frac{W}{R(T_f - T_i)} = \frac{20}{8.31(100)}$$

$$= 0.024 \text{ mole}$$

$$= (212 - 32)\,F^\circ$$

$$= 180\,F^\circ \left(\frac{5C^\circ}{9F^\circ} \right)$$

$$= 100\,C^\circ = 100\,K$$

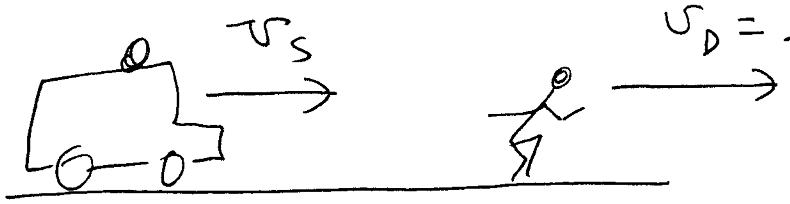
F° temperature difference measured in Fahrenheit

$$5C^\circ = 9F^\circ$$

$$5^\circ C \neq 9^\circ F$$

note C° stands for temperature difference measured in Celsius

Q17



$$f' = f\,\frac{v \pm v_D}{v \pm v_S}$$

Since the detector is moving away from the source, we make f' smaller by choosing $v - v_D$. Since the source is moving toward the detecter, we make f' larger by choosing $v - v_S$.

$$f' = f\,\frac{v - v_D}{v - v_S}$$

$$1.70k = 1.60k\,\frac{340 - 2.5}{340 - v_S}$$

$$340 - v_S = \frac{1.6}{1.7}(340 - 2.5)$$

$$v_S = 340 - \frac{1.6}{1.7}(340 - 2.5)$$

$$= 22.4 \text{ m/s}.$$

Q18

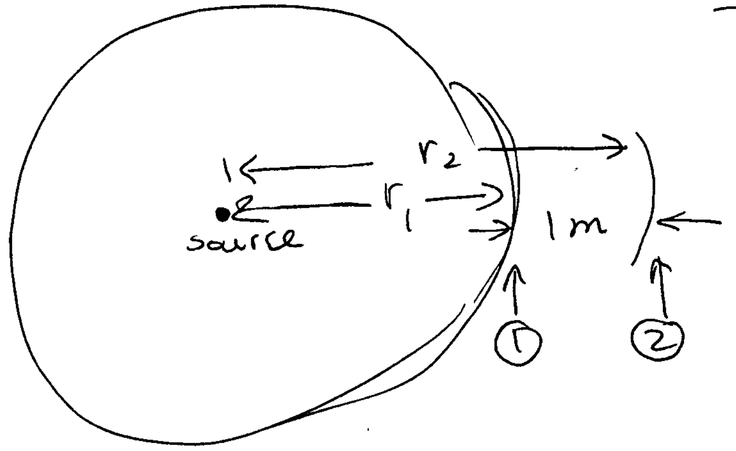
$$t_A = \frac{L}{v_A} \; ; \; t_s = \frac{L}{v_s}$$

air steel

$$0.1\text{s} \rightarrow (t_A - t_s) = L\left(\frac{1}{v_A} - \frac{1}{v_s}\right) \qquad v_s = \sqrt{\frac{B}{\rho}} = \sqrt{\frac{2.1\times10^{11}}{7\times10^{3}}}$$

$$L = \frac{0.1}{\frac{1}{340} - \sqrt{\frac{7\times10^{3}}{2.1\times10^{11}}}} = 36 \text{ m}$$

Q 19



$r_2 = r_1 + 1\ m$

$$\beta_1 = 10 \log \frac{I_1}{I_0}$$

$$\beta_2 = 10 \log \frac{I_2}{I_0}$$

$$\beta_1 - \beta_2 = 10 \left[\log \frac{I_1}{I_0} - \log \frac{I_2}{I_0} \right]$$

$$2 = 10 \log \frac{I_1}{I_2}$$

$$I = \frac{P_s}{4\pi r^2}$$

$$\frac{I_1}{I_2} = \frac{\frac{P_s}{4\pi r_1^2}}{\frac{P_s}{4\pi r_2^2}} = \left(\frac{r_2}{r_1}\right)^2$$

$$2 = 10 \log \left(\frac{r_2}{r_1}\right)^2$$

$$2 = 20 \log \frac{r_2}{r_1}$$

$$\frac{r_2}{r_1} = 10^{\left(\frac{2}{20}\right)} = 10^{0.1}$$

$$\frac{r_1 + 1}{r_1} = 10^{0.1} \Rightarrow r_1 + 1 = 10^{0.1} r_1$$

$$1 = (10^{0.1} - 1) r_1$$

$$r_1 = \frac{1}{10^{0.1} - 1} = 3.86\ m$$

Q20

$$\boxed{\begin{matrix} P_i \\ V_i \end{matrix}} \xrightarrow[T = \text{constant}]{\text{isothermal}} \boxed{\begin{matrix} P_2 \\ V_2 = 2V_i \end{matrix}} \xrightarrow{\text{adiabatic}} \boxed{\begin{matrix} P_f = ? \\ V_f = V_i \end{matrix}}$$

$$\gamma = \frac{c_p}{c_v} \qquad \gamma = \frac{7/2}{5/2} \qquad \gamma = 7/5$$

$$P_i V_i = P_2 V_2$$

$$P_2 = \frac{P_i V_i}{2V_i} = \frac{P_i}{2}$$

$$P_2 V_2^\gamma = P_f V_f^\gamma$$

$$\frac{P_i}{2}(2V_i)^\gamma = P_f V_i^\gamma$$

$$P_f = P_i\, 2^{\gamma - 1} = (1\ \text{atm})\, 2^{7/5 - 1} = 1.3\ \text{atm}$$