STUDENT NUMBER:

NAME:

SECTION NUMBER:

****

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

****

COURSE: PH102

****

EXAM: PH102 1ST MAJOR EXAM - 011

****

TEST CODE NUMBER: XXX

****

INSTRUCTIONS:

****

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.

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

Which of the following statements are CORRECT:

1. The first law of thermodynamics represents the conservation of energy.
2. Room temperature is about 20 degrees on the Kelvin scale.
3. A calorie is approximately 4.2 J.
4. Heat has the same units as work.
5. Heat is a temperature difference.

A. 1 and 5.
B. 1, 2 and 3.
C. 3 and 5.
D. 2 and 4.
E. 1, 3, and 4.

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

A tube 1.5 m long is closed at one end. A stretched wire is placed near the open end, see Fig. (1). The wire is 0.33 m long and has a mass of 9.8 g. It is fixed at both ends and vibrates in its fundamental mode. By resonance, it sets the air column in the tube into oscillation at that column's fundamental frequency. Find the tension in the wire.
[Speed of sound in air = 343 m/s].

A. 77 N.
B. 64 N.
C. 42 N.
D. 30 N.
E. 98 N.

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

A 1.5*10**(-6) W point source emits sound waves isotropically. What is the sound level 2.5 m from the source?

A. 43 dB.
B. 55 dB.
C. 30 dB.
D. 39 dB.
E. 16 dB.

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

Two identical containers, one has 2.0 moles of type 1 molecules, of mass m1, at 20 degrees Celsius. The other has 2.0 moles of type 2 molecules, of mass m2 = 2*m1, at 20 degrees Celsius. The ratio between the average translational kinetic energy of type 2 to that of type 1 is:

A. 4.
B. 16.
C. 1.
D. 2.
E. 8.

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

The resultant wave, of two interfering waves, moving in the same direction is given by:

y(x,t) = 10.0*cos(Pi/6)*sin(3.0*x + 20*Pi*t + Pi/6).

One of the two originally interfering waves could be:

A. y(x,t) = 10.0 sin(3.0*x + 20*Pi*t + Pi/3).
B. y(x,t) = 5.0 sin(3.0*x + 20*Pi*t + Pi/6).
C. y(x,t) = 5.0 sin(3.0*x + 20*Pi*t + Pi/3).
D. y(x,t) = 10.0 sin(3.0*x + 20*Pi*t).
E. y(x,t) = 10.0 sin(3.0*x - 20*Pi*t).

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

Standing waves are produced in a string at the two consecutive resonant frequencies 155 and 195 Hz. If the mass of the string is 5.00 g and its length is 0.80 m, then the tension applied to the string should be:

A. 28.5 N.
B. 19.0 N.
C. 25.6 N.
D. 17.2 N.
E. 6.4 N.

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

Two sound waves, from two different sources with the same frequency, 660 Hz, travel at a speed of 330 m/s. The sources are in phase. What is the phase difference of the waves at a point that is 5.0 m from one source and 4.0 m from the other? (The waves are traveling in the same direction.)

A. 1 Pi.
B. 4 Pi.
C. 2 Pi.
D. 5 Pi.
E. 3 Pi.

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

A thermometer, of mass 0.06 kg and specific heat 836 J/(kg K), reads 15 degrees Celsius. It is then completely immersed in 0.15 kg of water of specific heat 4180 J/(kg K). The final temperature reading of the thermometer in the water is 45 degrees Celsius. Assuming no heat losses from the system to the surrounding, the initial temperature of the water was:

A. 15.4 degrees Celsius.
B. 35.1 degrees Celsius.
C. 50.4 degrees Celsius.
D. 42.6 degrees Celsius.
E. 47.4 degrees Celsius.

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

The coefficient of linear expansion of gold is 14.20*10**(-6)/K. If the density of gold is 19.30 g/cm**3 at 20 degrees Celsius, the density of gold at 90 degrees Celsius will be:

A. 19.00 g/cm**3.
B. 19.38 g/cm**3.
C. 19.34 g/cm**3.
D. 19.28 g/cm**3.
E. 19.24 g/cm**3.

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

A wave on a string is reflected from a fixed end. The reflected wave:

A. has a larger speed than the original wave.
B. has a larger amplitude than the original wave.
C. is 180 degrees out of phase with the original wave at the fixed end.
D. is in phase with the original wave at the fixed end.
E. cannot be transverse.

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

The maximum pressure amplitude that the human ear can tolerate in loud sounds is 28 Pa. What is the displacement amplitude for such a sound in air of density 1.21 kg/m**3 at a frequency of 5.0*10**3 Hz?
[speed of sound in air = 343 m/s].

A. 2.15*10**(-6) m.
B. 50.5*10**(-6) m.
C. 8.30*10**(-6) m.
D. 11.0*10**(-6) m.
E. 4.15*10**(-6) m.

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

A traveling wave is given by:

y(x,t) = 6.0*cos[0.63*x + 25.1*t)],

where x and y are in cm and t is in seconds. It interferes with a similar wave propagating in the opposite direction to produce a standing wave. The distance between the node and the consecutive antinode is:

A. 5.0 cm.
B. 2.5 cm.
C. 1.0 cm.
D. 7.9 cm.
E. 0.5 cm.

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

A closed cubical box (60 cm on edge and 5 cm on thickness) contains ice at zero degrees Celsius. When the outside temperature is 20 degrees Celsius, it is found that 250 grams of ice melt each hour. What is the value of the thermal conductivity of the walls of the box?

A. 0.03 Watts/(m*K).
B. 0.07 Watts/(m*K).
C. 0.01 Watts/(m*K).
D. 1.02 Watts/(m*K).
E. 3.21 Watts/(m*K).

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

A diatomic ideal gas, at a pressure of 1.0 atm, expands isobarically from a volume of 2.0 Liters to a volume of 5.0 Liters. Calculate the change in internal energy of the gas during the process.

A. 1.1*10**3 J.
B. -3.1*10**2 J.
C. 1.7*10**3 J.
D. 7.6*10**2 J.
E. -9.0*10**3 J.

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

A string under a tension of 15 N, is set into vibration to produce a wave of speed 20 m/s, and a maximum transverse speed of 8 m/s. For this wave, the average power is:

A. 30 W.
B. 15 W.
C. 11 W.
D. 24 W.
E. 44 W.

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

Which of the following statements is CORRECT for a gas undergoing an adiabatic process:

A. The temperature of the gas remains constant.
B. The pressure of the gas remains constant.
C. There is no heat exchange between the gas and its environment.
D. The volume of the gas remains constant.
E. The internal energy of the gas is always zero.

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

One mole of an ideal gas is taken through the cyclic process ABCA as shown in Fig. (2). What is the net heat transfer during the cycle?

A. -1.0*10*3 J.
B. 2.0*10*3 J.
C. 5.0*10*3 J.
D. -2.0*10*3 J.
E. 1.0*10*3 J.

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

By what factor does the rate of radiant emission of heat, from a heating element, increases when the temperature of a heating element increases from 27 degrees Celsius to 327 degrees Celsius?

A. 4.
B. 64.
C. 16.
D. 8.
E. 2.

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

Sound waves

A. are mechanical waves.
B. are transverse waves.
C. are electromagnetic waves.
D. are matter waves.
E. travel at the same speed in all media.

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

A police car is approaching a stationary observer at 34.0 m/s with its siren emitting a frequency of 450 Hz. What is the frequency heard by the observer?
[Speed of sound in air = 343 m/s].

A. 475 Hz.
B. 525 Hz.
C. 405 Hz.
D. 500 Hz.
E. 485 Hz.

Physics 102 Major1

Formula sheet

<u>Spring Semester 2000-2001 (Term 011)</u>

$$v = \lambda f = \frac{\omega}{k}$$

$$v = \sqrt{\frac{\tau}{\mu}} \qquad v = \sqrt{\frac{B}{\rho}}$$

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

$$P = \frac{1}{2}\mu\omega^2\, y_m{}^2\, v$$

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

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

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

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

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

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

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

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

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

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

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

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

$$PV = nRT = NkT$$

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

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

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

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

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

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

$$Q = mL$$

$$Q = mc\Delta T$$

$$Q = nc\Delta T$$

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

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

$$C_p - C_v = R$$

$$W = \int P\,dV$$

$$H = \frac{Q}{t} = \kappa A\frac{T_H - T}{L}$$

$$P = \sigma\varepsilon A T^4$$

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

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

Constants:

Pi = π

1 Liter = 10^{-3} m^3

R = 8.31 J/mol K

$N_A = 6.02 \times 10^{23}$ molecules/mole

1 atm = 1.01×10^5 N/m^2

k = 1.38×10^{-23} J/K

$I_o = 10^{-12}$ W/m^2

1 calorie = 4.186 Joule

$\sigma = 5.67 x 10^{-8}\, W/(m^2K^4)$

micro = 10^{-6}

for water: L_f = 80 cal/g

L_v = 540 cal/g

c = 1 cal/g.K

$a * b ** c = a\, b^c$

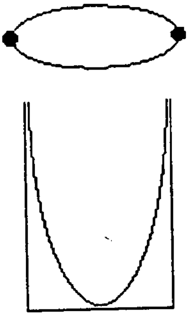


fig.(1)

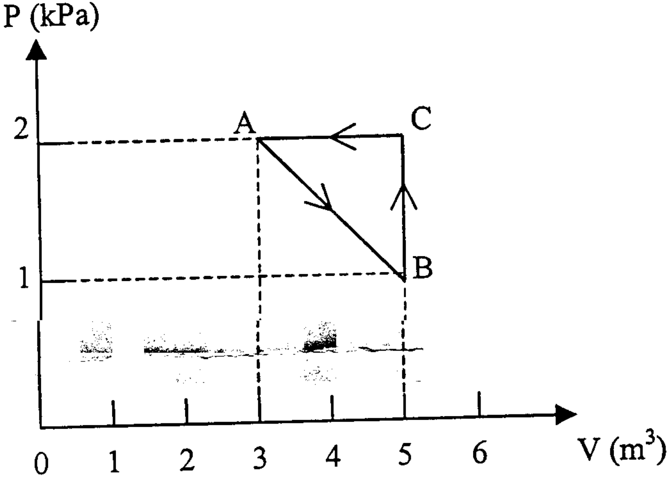


fig.(2)

Q1

E

2. is wrong

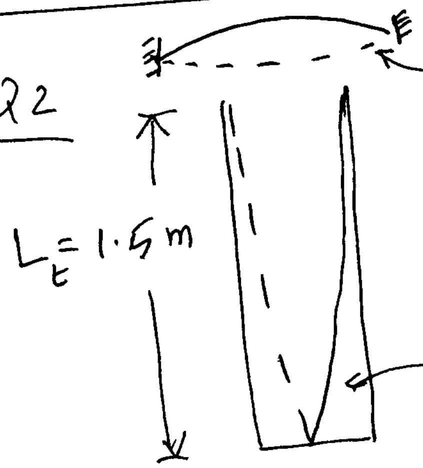
5. is wrong

$T_{room} \approx 300\,K$

$Q = \underset{\uparrow}{C}\,(T_f - T_i)$

heat capacity

Q2



$m_w = 9.8g$

$L_w = 0.33m$

$\tau = ?$

speed of sound 343 m/s

Fundamental mode for wire

$$f = 1\,\frac{v_w}{2L_w}$$

$n=1$

length of wire

speed of wave on the wire $= \sqrt{\frac{\tau}{\mu}}$ ← tension

linear density $= \frac{\text{mass of wire}}{\text{length of wire}} = \frac{m_w}{L_w}$

same frequencies

Fundamental mode for tube

$$f = 1\,\frac{v}{4L_t}$$

$n=1$

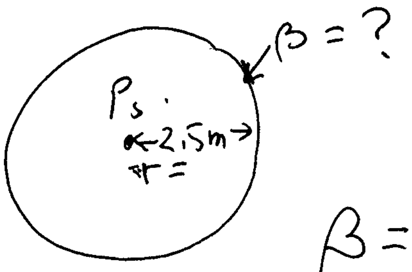
speed of sound in the tube

length of tube

$$\frac{v_w}{\cancel{2}L_w} = \frac{v}{\cancel{4}^{\,2}L_t} \Rightarrow \frac{\sqrt{\frac{\tau}{\mu}}}{L_w} = \frac{v}{2L_t} \Rightarrow \frac{\tau}{\mu L_w^2} = \frac{v^2}{4L_t^2}$$

$$\tau = \frac{v^2 \mu L_w^2}{4L_t^2} = \frac{(343)^2\left(\frac{0.0098}{0.33}\right)(0.33)^2}{4(1.5)^2} = 42.3\,N$$

Q3



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

$$\beta = 10 \operatorname{Log} \frac{I}{I_0}, \quad I_0 = 10^{-12}\ \mathrm{W/m^2}$$

$$= 10 \log \frac{\frac{1.5\times10^{-6}}{4\pi(2.5)^2}}{10^{-12}} = 42.8$$

Q4

$n = 2$ moles $m = m_1$ $T = 20°C$	$n = 2$ moles $m = 2m_1$ $T = 20°C$

$$\frac{(K_{avg})_1}{(K_{avg})_2} = \frac{\frac{3}{2}kT}{\frac{3}{2}kT} = 1$$

Q5

$$y_1 = y_m \sin(kx + \omega t)$$

$$y_2 = y_m \sin(kx + \omega t + \phi)$$

$$y' = \left[2y_m \cos\frac{\phi}{2}\right] \sin\left(kx + \omega t + \frac{\phi}{2}\right)$$

$$= \left(10 \cos\frac{Pi}{6}\right] \sin\left(3.0x + 20\pi t + \frac{Pi}{6}\right)$$

$$\Rightarrow y_m = 5 \ ; \ \frac{\phi}{2} = \frac{Pi}{6} \Rightarrow \phi = \frac{Pi}{3}$$

$$\Rightarrow y_2 = 5.0 \sin\left(3.0x + 20Pi\,t + \frac{Pi}{3}\right)$$

Q6

$$f_n = n\frac{v}{2L}$$

two consecutive resonance frequencies
$\Rightarrow$ if one has $n = n'$ the next will
have $n = n'+1$

take the difference

$$f_{n'+1} = (n'+1)\frac{v}{2L}$$

$$f_{n'} = n'\frac{v}{2L}$$

$$f_{n'+1} - f_{n'} = \frac{v}{2L}$$

195 Hz 155 Hz 0.8 m

$= 64$

$$v = 2(0.8)(195-155) = \sqrt{\frac{\tau}{\mu}}$$

tension

linear density

$$\frac{\text{mass}}{\text{length}} = \frac{0.005}{0.8}\ \frac{\text{kg}}{\text{m}}$$

$$\tau = (64)^2\mu$$

$$= (64)^2\frac{0.005}{0.8}$$

$$= 25.6\ \text{N}$$

Q7

$$s = s_m \sin(\underbrace{kx - \omega t + \phi}_{\text{phase}})$$

phase constant

phase 1 $= kx_1 - \omega t + \phi_1$

we measure at the same time

phase 2 $= kx_2 - \omega t + \phi_2$

$\phi_1 = \phi_2$ since sources are in phase.

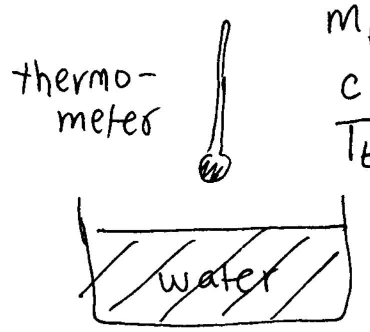
phase 2 - phase 1 $= k(x_2 - x_1)$

$$= \frac{2\pi}{\lambda}(x_2 - x_1) = \frac{2\pi f}{v}(x_2 - x_1)$$

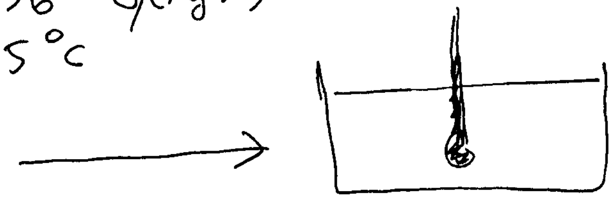
$\frac{v}{f} \rightarrow \lambda$

$$= \frac{2\pi(660)}{330}(5-4) = 4\pi.$$

Q8



$m_t = 0.06\,Kg$
$c = 836\ J/(Kg\,K)$
$T_{ti} = 15\,°c$



$T_f = 45\,°c$

$m_w = 0.15\ Kg$
$T_w = \ ?$
$c = 4180\ J/(kg\,k)$

Hear transferred to the thermometer + heat transferred to water = 0

$$c_t\, m_t\, (T_f - T_{ti}) + c_w\, m_w\, (T_f - T_{wi}) = 0$$

$$(836)(.06)(45-15)+(4180)(.15)(45 - T_{wi}) = 0$$

$$T_{wi} = 47.4\ {}^0C$$

Q9 at $T_1 = 20\,°c$, the density $\rho_1 = \frac{m}{V_1} = 19.30\ g/cm^3$

at $T_2 = 90\,°c$, the density $\rho_2 = \frac{m}{V_2}$

$$\Delta V = V \beta \Delta T$$

$$V_2 - V_1 = V_1 \beta (T_2 - T_1)$$

$$V_2 = V_1 + V_1 (3\alpha)(T_2 - T_1)$$

$\beta = 3\alpha$

$$\rho_2 = \frac{m}{V_1 (1 + 3\alpha (T_2 - T_1))} = \frac{m}{V_1} \cdot \frac{1}{1+3(14.20\times10^{-6})\,70}$$

$$= 19.24\ g/cm^3$$

Q10 is 180 degrees out of phase with the original wave at the fixed end.

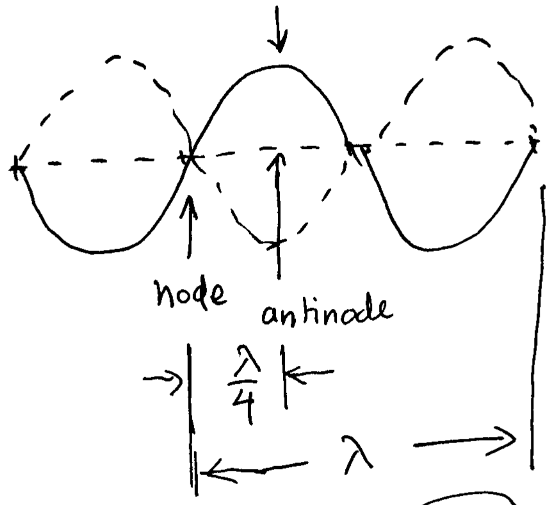
Q11

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

$$28 \text{ pa} = (1.21 \text{ kg/m}^3)(343 \text{ m/s})(2\pi\, 5000 \text{ Hz}) S_m$$

$$S_m = \frac{28}{(1.21)(343)(2\pi)(5000)} = 2.15 \times 10^{-6} \text{ m}$$

Q12



$$y(x,t) = 6.0 \cos(0.63\, x + 25.1\, t)$$

k

$$k = \frac{2\pi}{\lambda} \Rightarrow \lambda = \frac{2\pi}{0.63}$$

$$\frac{\lambda}{4} = \frac{2\pi}{4(0.63)} = 2.5 \text{ cm}$$

Q13

$$\underset{\uparrow \text{ Conduction rate}}{P_{cond}} = kA \frac{T_H - T_C}{L}$$

T_H: 20°C, T_C: 0

$L \leftarrow$ thickness $= 0.05$ m

A: total area of the cube $= (0.6)^2 6$ — cube has six faces

Conduction rate

$$= \frac{\Delta Q}{\Delta t} = \frac{\Delta (L_F m)}{\Delta t} = L_F \left(\frac{\Delta m}{\Delta t}\right)$$

All heat is used to melt ice.

$$\frac{\Delta m}{\Delta t} = \frac{250\,g}{h} = \frac{0.250\text{ kg}}{3600\text{ s}}$$

L_F from formula sheet

$$L_F = 80\text{ cal/g} = \frac{80\text{ Cal}}{g}\left(\frac{4.186\,J}{1\text{ Cal}}\right)\left(\frac{1000\,g}{1\text{ kg}}\right) = 334\text{ kJ/kg}$$

$$k = \frac{P_{cond} L}{A(T_H - T_C)} = \frac{L_F \frac{\Delta m}{\Delta t} L}{A(T_H - T_C)} = \frac{334 \times 10^3 \left(\frac{0.250}{3600}\right)(0.05)}{(0.6)^2 6\ (20-0)}$$

$$= 0.027 \frac{W}{mK}$$

Q14

$$\Delta E_{int} = n C_v \Delta T$$

$C_v = \frac{5}{2} R$ ← diatomic

$$\Delta E_{int} = \frac{5}{2} nR\Delta T$$

$$\left.\begin{aligned} PV_i &= nRT_i \\ PV_f &= nRT_f \end{aligned}\right\} \quad P(V_f - V_i) = nR(T_f - T_i) = nR\Delta T$$

$$\Delta E_{int} = \frac{5}{2} P(V_f - V_i)$$

$$= \frac{5}{2}\, 1\text{ atm}\ \frac{1.01 \times 10^{+5}\text{ Pa}}{1\text{ atm}}\ (5\,\ell - 2\,\ell)\ \frac{m^3}{10^3\,\ell}$$

$$= 7.6 \times 10^{6}\ J$$

Q15 $P = \frac{1}{2} \mu \omega^2 \underbrace{y_m^2}_{} v^{\cancel{2}}$

$v = \sqrt{\frac{\tau}{\mu}} \Rightarrow \mu = \frac{\tau}{v^2}$

maximum transverse speed $= \omega y_m$

$P = \frac{1}{2} \frac{\tau}{v^{\cancel{2}}} (\omega y_m)^2 \cancel{v}$

$= \frac{1}{2} \frac{15}{20} (8)^2 = 24\,W$

Q16 C. There is no heat exchange between the gas and its enviroment.

Q17 $\Delta E_{int} = Q - W$

cyclic process

0

$\Rightarrow Q = W$

area enclose within the cycle.

$= -\ 1\times10^3 J$

counter-clock-wise direction

$Q = -1\times10^3 J$

Q18 $P_{rad} = \sigma \varepsilon A T^4$

Convert to Kelvins

$P_{rad,i} = \sigma \varepsilon A (27 + 273)^4$

$P_{rad,f} = \sigma \varepsilon A (327 + 273)^4$

$\frac{P_{rad,f}}{P_{rad,i}} = \frac{\cancel{\sigma \varepsilon A}(327+273)^4}{\cancel{\sigma \varepsilon A}(27+273)^4} = 16.$

Mar 13, 02

Phys 102 – 1st major – 011
R-8

Q19 Sound waves are mechanical waves

Q20

$$f' = f \frac{v+0}{v-v_s}$$

$$= (450)\frac{343}{343-34}$$

$$= 499.5 \text{ Hz}$$