Q1.
The displacement of a string carrying a traveling sinusoidal wave is given by:
$y(x,t) = y_m \sin(kx - \omega t + \varphi)$. At time $t = 0$ the point at $x = 0$ has a displacement of zero and is moving in the positive y direction. Find the value of the phase constant φ.

A) 180 degrees
B) 90 degrees
C) 135 degrees
D) 0 degrees
E) 270 degrees

Q2.
A stretched string of mass 2.0 g and length 10 cm, carries a wave having the following displacement wave: $y(x,t) = 0.05\sin(2\pi x - 400\pi t)$, where x and y are in meters and t is in seconds. What is the tension in the string?

A) 800 N
B) 150 N
C) 55 N
D) 15 N
E) 100 N

Q3.
A harmonic wave in a string is described by the equation: $y(x,t) = 0.200 \sin(\pi x - 40.0t)$, where x and y are in m and t in s. If the mass per unit length of this string is 15.0 g/m, determine the power transmitted to the wave.

A) 6.11 W
B) 14.6 W
C) 9.80 W
D) 73.5 W
E) 0 W

Q4.
Two identical traveling waves of amplitude 10.0 cm, moving in the same direction, are out of phase by π/4 rad. Find the amplitude of the resultant wave.

A) 18.5 cm
B) 0.800 cm
C) 1.20 cm
D) 0.400 cm
E) 2.40 cm

Q5.

A pipe has two consecutive resonance frequencies of 600 Hz and 1000 Hz. One end of the pipe is closed. What is the fundamental frequency of the pipe?

A) 200 Hz
B) 500 Hz
C) 400 Hz
D) 700 Hz
E) 1600 Hz

Q6.
The intensity of sound emitted by a source is doubled. What is the change in intensity level of the sound?

A) 3.0 dB
B) 2.0 dB
C) 1.0 dB
D) 4.0 dB
E) 5.0 dB

Q7.
Two identical loudspeakers, facing each other, are in phase and each has a frequency of 85 Hz. A man at the midpoint between the two loudspeakers moves slowly toward one of them until he hears the first minimum in sound. How far did he move? (The speed of sound in air = 340 m/s)

A) 1.0 m
B) 2.0 m
C) 4.0 m
D) 0.50 m
E) 0.25 m

Q8.
If it were possible for a man to move with the speed of sound directly toward a stationary whistle emitting a sound of frequency f, he would hear

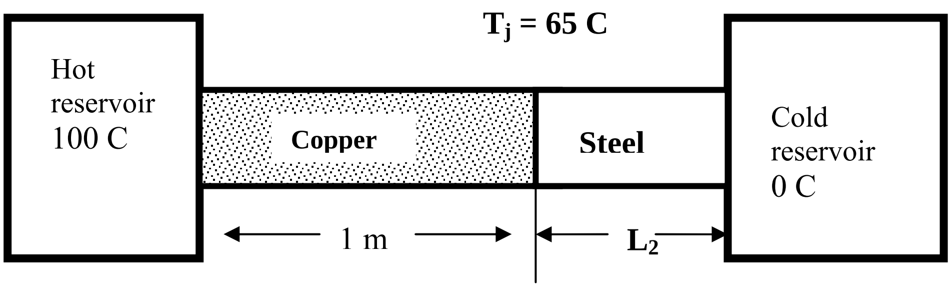
A) a sound of frequency $2f$
B) a sound of frequency $f/2$
C) no sound (zero frequency)
D) a sound of infinite frequency
E) a sound of the same frequency f

Q9.
The volume of 1.00 kg water is 958.38 mm^3 at a temperature of 10.0 °C and 999.73 mm^3 at temperature of 100.0 °C. Calculate coefficient of volume expansion for water in that range of temperature.

A) 4.79×10^{-4}/ C°
B) 1.72×10^{-4}/ C°
C) 2.38×10^{-4}/ C°
D) 5.00×10^{-4}/ C°
E) 8.35×10^{-4}/ C°

Q10.
An isolated rod is in thermal contact with hot reservoir at one end and with cold reservoir at other end (Fig. 1). The rod consists of a 1.00 m section of copper joined by a section of length L_2 of steel. Both rods have the same cross section area of 4.00 cm^2. The temperature of copper-steel junction Tj is 65 °C. Find L_2.
(k_{steel} = 14 W/m.K; k_{cu} = 401 W/m.K)

Fig#



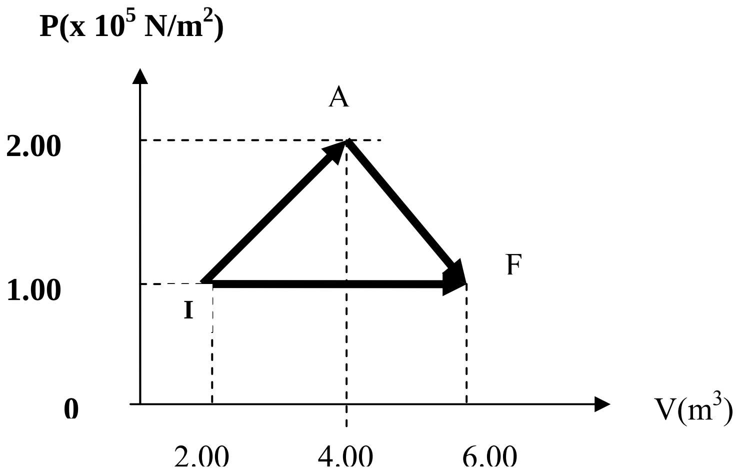
A) 0.065 m
B) 0.80 m
C) 0.74 m
D) 0.044 m
E) 0.54 m

Q11.
How much ice at -20.0 °C must be mixed with 0.25 kg of water, initially at 20.0 °C to obtain a final temperature of mixture of 0.0°C with all ice melted. (c_{ice} = 2220 J/kg K)

A) 56 g
B) 95 g
C) 15 g
D) 88 g
E) 30 g

Q12.
A gas expands from a volume of 2.00 m^3 to a volume of 6.00 m^3 along two different paths as shown in Fig 2. The heat added to the gas along path IAF equals 1.68×10^6 J. Find the heat added during path IF.

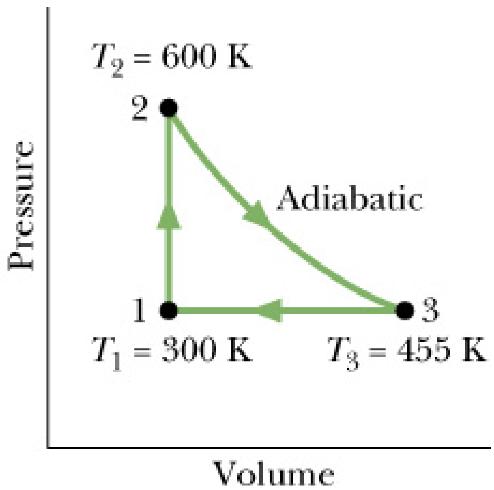
Fig#



A) 1.48×10^6 J
B) 9.47×10^6 J
C) 5.80×10^6 J
D) 0.83×10^6 J
E) 4.73×10^6 J

Q13.
Fig. 3. shows a cycle undergone by 1.0 mol of a monatomic ideal gas. What is the heat added to the gas during the whole cycle?

Fig#



A) 520 J
B) 3700 J
C) -3200 J
D) 0.0 J

E) 760 J

Q14.
What is the change in the internal energy of a 1.00 mole of a monatomic ideal gas that goes from point 1 (T1= 455K and pressure P1 = 1.00 atm) to point 2 (T2 = 300 K and pressure P2 = 1.00 atm.)?

A) -1930 J
B) -3220 J
C) 520 J
D) -3740 J
E) 0 J

Q15.
The mass of an oxygen molecule is 16 times that of a hydrogen molecule. At room temperature, the ratio of the rms speed of an oxygen molecule to that of a hydrogen molecule is:

A) 1/4
B) 16
C) 1/16
D) 1
E) 4

Q16.
A 0.825 mol of an ideal gas undergoes an isothermal process. The initial volume is 0.20 m^3 and the final volume is 0.30 m^3. If the heat added to the gas is 1000 J, find the temperature of the gas.

A) 360 K
B) 300 K
C) 600 K
D) 150 K
E) 180 K

Q17.
The efficiency of a car engine is 20% when the engine does 1.2 kJ of work per cycle. What is the energy $|Q_L|$ the engine loses per cycle as heat?

A) 4.8 kJ
B) 1.2 kJ
C) 6.1 kJ
D) 3.1 kJ
E) 7.0 kJ

Q18.
The freezing compartment of a Carnot refrigerator is at 269 K while outside air in the room is at 298 K. If the power of refrigerator motor is 150 W, what is maximum amount of energy that can be extracted as heat from the freezing compartment in 10.0 min?

A) 8.35×10^5 J
B) 4.72×10^5 J
C) 2.16×10^5 J
D) 5.04×10^5 J
E) 3.51×10^5 J

Q19.
Calculate the change in entropy of 1.0 kg of ice at 0.0 °C when its temperature is increased to 20.0 °C [$L_{fusion\text{-}ice}$= 333 kJ/kg; c_{water}= 4190 J/kg.K]

A) 1.5×10^3 J/K
B) 2.9×10^3 J/K
C) 5.2×10^3 J/K
D) 4.1×10^3 J/K
E) 3.2×10^3 J/K

Q20.
A 5.00 mol sample of an ideal gas expands reversibly and isothermally at 355 K until its volume doubled. What is the change in entropy of the gas?

A) 28.8 J/K
B) 80.0 J/K
C) 11.0 J/K
D) 70.5 J/K
E) 50.9 J/K

Physics 102 Major1
Formula sheet

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

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

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

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

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

$$\Delta P = \Delta P_m \sin(kx - \omega t); \qquad \text{where } \Delta P_m = \rho\, v\, \omega S_m$$

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

$$\beta = 10 \log\left(\frac{I}{I_o}\right), \qquad I_o = 10^{-12}\ \text{W/m}^2$$

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

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

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

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

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

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

$$\Delta L = \alpha L \Delta T \qquad \Delta V = \beta V \Delta T$$

$$PV = nRT = NkT$$

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

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

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

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

$C_V = \frac{3}{2}R$ for monatomic gases,

$= \frac{5}{2}R$ for diatomic gases.

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

$$Q = mL$$

$$Q = mc\Delta T$$

$$Q = nc\Delta T$$

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

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

$$C_p - C_v = R$$

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

$$P_{cond} = \frac{Q}{t} = kA\frac{T_H - T_C}{L}$$

$$\frac{m\overline{v^2}}{2} = (3/2)kT, \qquad v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$W = Q_H - Q_L$$

$$\varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$$

$$K = \frac{Q_L}{W}$$

$$\frac{Q_L}{Q_H} = \frac{T_L}{T_H}, \qquad \Delta S = \int\frac{dQ}{T}$$

Constants:

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

R = 8.31 J/mol K

N_A = 6.02 x 10^{23} molecules/mole

1 atm = 1.01 x 10^5 N/m^2

k = 1.38 x 10^{-23} J/K

1 calorie = 4.186 Joule

g = 9.8 m/s^2

for water:

$$c_w = 4190\frac{J}{kg.K}; \qquad c_{ice} = 2220\frac{J}{kg.K}$$

$$L_F = 3.33\times10^5\frac{J}{kg}, \quad L_V = 2.256\times10^6\frac{J}{kg}$$