Q1.
The maximum transverse speed for a particle on a string carrying a sinusoidal wave is v_s. When the displacement of a point on the string is half its maximum, the speed of the point is:

A) $\sqrt{3}v_s/2$
B) $v_s/2$
C) $v_s/4$
D) $3v_s/4$
E) $v_s/3$

Q2.
A transverse sinusoidal travelling wave on a stretched string is given by:

$$y\,(x,t) = 0.00230\,sin\,(6.98\,x + 742\,t),$$

where x and y are in meters, and t is in seconds. The length of the string is 1.35 m and its mass is 3.38 g. What is the average power carried by the wave?

A) 0.387 W
B) 0.774 W
C) 0.194 W
D) 0.457 W
E) 0.513 W

Q3.
Two identical sinusoidal waves travel simultaneously in the same direction along the same string. Each wave has an amplitude of y_m. If the amplitude of the resultant wave is $y_m/2$, what is the phase difference between the two waves?

A) 151°
B) 75.5°
C) 120°
D) 60.0°
E) 110°

Q4.
Standing waves are produced by the interference of two traveling sinusoidal waves, each of frequency 100 Hz. The distance from the 2nd node to the 5th node is 60 cm. The wavelength of each of the two original waves is:

A) 40 cm
B) 50 cm
C) 15 cm
D) 20 cm
E) 30 cm

Q5.
Two sinusoidal waves, each of wavelength 5 m and amplitude 10 cm, travel in opposite directions on a 20-m stretched string which is clamped at each end. Excluding the nodes at the ends of the string, how many nodes appear in the resulting standing wave?

A) 7
B) 8

C) 9
D) 4
E) 5

Q6.
Two identical strings (same mass and length), each fixed at both ends, are arranged near each other. If string A starts oscillating in its fundamental mode, it is observed that string B will begin vibrating in its third normal mode (n = 3). What is the ratio of the tension in string B to that in string A?

A) 1/9
B) 9
C) 1/3
D) 3
E) 1

Q7.
The displacement of a sound wave in air is given by:

$$s(x,t) = (7.00 \times 10^{-6})\,[\cos(5.23x - 1800\,t)],$$

where x and s are in meters and t is in seconds. What is the pressure amplitude of this wave?
[The density of air is 1.21 kg/m^3]

A) 5.25 Pa
B) 4.31 Pa
C) 8.62 Pa
D) 9.54 Pa
E) 1.32 Pa

Q8.
Two sound sources are driven by the same generator and emit sound waves with frequency 688 Hz. An observer is at a point on the line joining the two sources, and is at a point of destructive interference. What is the shortest distance the observer should walk on the line joining the sources to move to a point of constructive interference?
[The speed of sound in air is 343 m/s]

A) 0.125 m
B) 0.250 m
C) 0.375 m
D) 0.500 m
E) 0.675 m

Q9.
An observer is 50 m from a sound source. If he moves to a distance of 100 m from the source, the change in sound level (in dB) is:

A) – 6.0
B) + 6.0
C) + 1.7
D) – 1.7
E) + 20

Q10.

A tube of length L is open at both ends. The second harmonic frequency of this tube is *F*. The tube is then closed at one end, and its length is adjusted so that its fundamental frequency is equal to *F*. What is the new length?

A) L/4
B) L/2
C) 2L
D) 4L
E) L

Q11.
A stationary source emits a sound wave of frequency *f*. A man travels toward the source at half the speed of sound. The frequency as detected by the man is:

A) 3f/2
B) 2f/3
C) f
D) 2f
E) 3f

Q12.
Two containers A and B, each having 1.0 kg of water, are initially at 20 ^oC. Container A is heated by 10 K, while container B is heated by 10 F^o. Then, they are mixed. What is the final temperature?

A) 27.8 °C
B) 25.0 °C
C) 22.2 °C
D) 32.2 °C
E) 17.8 °C

Q13.
A steel gas tank of volume 0.0700 m^3 is filled completely with gasoline. The temperature of the tank increased from 20.0 to 50.0 ^oC. How much gasoline has spilled out of the tank? For steel, the coefficient of linear expansion is 12.0×10^{-6} $(^oC)^{-1}$. For gasoline, the coefficient of volume expansion is 9.50×10^{-4} $(^oC)^{-1}$.

A) 1.92×10^{-3} m^3
B) 2.52×10^{-3} m^3
C) 1.69×10^{-3} m^3
D) 4.21×10^{-3} m^3
E) 7.56×10^{-3} m^3

Q14.
You take a block of ice at 0 °C and add heat to it at a steady rate. It takes time ***t*** to completely convert the block of ice to steam at 100 °C. What do you have at time ***t/2***?

A) A mixture of water and steam at 100 °C.
B) All ice at 0 °C.
C) Water at a temperature between 0 °C and 100 °C.
D) A mixture of ice and water at 0 °C.
E) All steam at 100 °C.

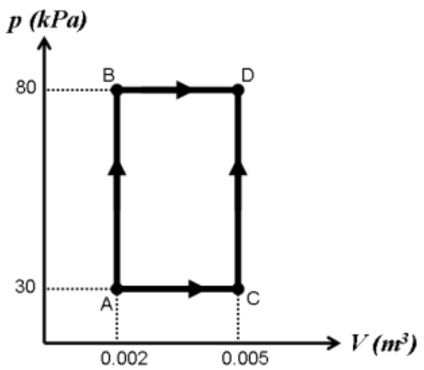
Q15.
One end of an insulated metal rod is maintained at 100 ^{o}C, and the other end is maintained at 0.00 ^{o}C by an ice-water mixture. The rod is 60.0 cm long and has a cross sectional area of 1.25 cm^2. The heat conducted by the rod melts 8.50 g of ice in 10.0 min. What is the thermal conductivity of the rod?

A) 226 W/m.K
B) 377 W/m.K
C) 136 W/m.K
D) 181 W/m.K
E) 339 W/m.K

Q16.
In the p-V diagram shown in **Figure 1**, 150 J of heat is added to the system in process AB, and 600 J of heat is added to the system in process BD. What is the total heat added in process ACD?

Fig#

#:



A) 600 J
B) 900 J
C) 750 J
D) 690 J
E) 810 J

Q17.
Five moles of an ideal monatomic gas with an initial temperature of 127 ^{o}C expand, and in the process absorb 1200 J as heat and do 2100 J of work. What is the final temperature of the gas?

A) 113 °C
B) 141 °C
C) 180 °C
D) 74 °C
E) 127 °C

Q18.
In an adiabatic process for an ideal gas, the pressure decreases. Which of the following statements is CORRECT?

A) The internal energy decreases.
B) The internal energy increases.

C) The internal energy remains constant.
D) The work done is zero.
E) The work is done on the system.

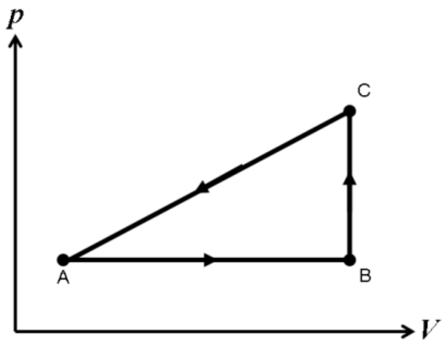
Q19.
Heat flows into a monatomic gas, and the volume increases while the pressure is kept constant. What fraction of the heat energy is used to do the expansion work of the gas?

A) 2/5
B) 1/2
C) 5/3
D) 3/5
E) 4/5

Q20.
Two moles of an ideal monatomic gas go through the cycle shown in the *p*-*V* diagram in **Figure 2**. For the complete cycle, 800 J of heat flows out of the gas. States A and B have temperatures T_A = 200 K and T_B = 300 K. What is the work during process C→A?

Fig#

#:



A) – 2462 J
B) + 2462 J
C) + 862 J
D) – 862 J
E) – 1662 J

Physics 102 Major1
Formula sheet

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$PV = nRT = NkT$$

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

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

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

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

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

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

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

$$Q = mL$$

$$Q = mc\Delta T$$

$$Q = nc\Delta T$$

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

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

$$C_p - C_v = R$$

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

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

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

$$W = Q_H - Q_L$$

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

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

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

<u>Constants:</u>

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:

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

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