Q1. For a given medium, the wavelength of a wave is:

A) inversely proportional to the frequency
B) independent of the frequency
C) proportional to the frequency
D) proportional to the amplitude
E) inversely proportional to the amplitude

Q2. A stretched string has a length of 2.0 m and a mass of 2.5 g. A sinusoidal transverse wave traveling on the string is described by the equation: $y(x,t) = 0.010 \sin(3.0x - 75t)$, where x and y are in meters and t is in seconds. What is the tension in the string?

A) 0.78 N
B) 0.31 N
C) 0.39 N
D) 0.47 N
E) 0.53 N

Q3. A transverse sinusoidal wave with an amplitude of 2.5 cm is traveling on a stretched string. The speed of the wave on the string is 35 cm/s, and the maximum transverse speed of a particle on the sting is 7.5 cm/s. What is the wavelength of the wave?

A) 73 cm
B) 54 cm
C) 66 cm
D) 47 cm
E) 31 cm

Q4. The displacement of a string carrying a traveling sinusoidal wave is given by: $y(x,t) = y_m \sin(kx - \omega t - \phi)$.
At time $t = 0$ the point at $x = 0$ has a displacement of 0 and is moving in the positive y direction.
The phase constant ϕ is:

A) 180^o
B) zero
C) 45^o
D) 90^o
E) 135^o

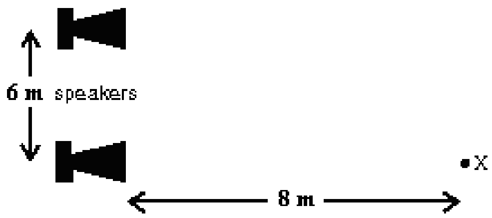
Q5. Standing waves are produced by the interference of two traveling sinusoidal waves, each of frequency 100 Hz. The distance from the second node to the fifth node is 60 cm. The wavelength of each of the two original waves is:

A) 40 cm
B) 50 cm

C) 30 cm
D) 20 cm
E) 15 cm

Q6. Two small identical speakers are connected (in phase) to the same source. The speakers are 6 m apart and are at ear level. An observer stands at X=8 m in front of one speaker as shown in Fig. 1. The sound he hears will be least intense if the wavelength is:

Fig#



A) 4 m
B) 9 m
C) 3 m
D) 2 m
E) 5 m

Q7. The intensity of sound wave A is 100 times that of sound wave B. By how many decibels is the sound level of A higher than that of B?

A) 20 dB
B) 100 dB
C) 40 dB
D) 2 dB
E) 10 dB

Q8. A tuning fork with a frequency of 510 Hz is placed at the open end of an air column that is closed at the other end. What is the shortest length of the air column that will resonate with the tuning fork? The speed of sound in air is 345 m/s.

A) 17 cm
B) 4.2 cm
C) 9.4 cm
D) 33 cm
E) 66 cm

Q9. A source emits sound with a frequency of 1000 Hz. The source and an observer are moving toward each other, each with a speed of 100 m/s. If the speed of sound is 340 m/s, the observer hears sound with a frequency of:

A) 1833 Hz

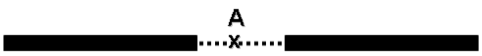
B) 1000 Hz
C) 294 Hz
D) 545 Hz
E) 3400 Hz

Q10. Which one of the following statements is TRUE?

A) Temperatures which differ by 10° on the Celsius scale must differ by 18° on the Fahrenheit scale
B) Temperatures differing by 25° on the Fahrenheit scale must differ by 45° on the Celsius scale
C) 40 K corresponds to –40 °C
D) water at 96 °C is warmer than water at 212 °F
E) 0 °F corresponds to –32 °C

Q11. Two steel rods are each 1.000 m long at 20.0 °C. Their ends are 1.00 mm apart as shown in Fig. 2. To what common temperature should they be heated so that their ends touch at point A? The coefficient of linear expansion of steel is 11.0 × 10^{-6} (°C)$^{-1}$.

Fig#



A) 111 °C
B) 131 °C
C) 160 °C
D) 23.0 °C
E) 91.5 °C

Q12. Fifty grams of ice at 0 °C is placed in a thermos bottle containing 100 g of water at 6.0 °C. What quantity of ice will melt? The heat of fusion of water is 333 kJ/kg and the specific heat of water is 4190 J/kg · K.

A) 7.5 g
B) 2.0 g
C) 30 g
D) 17 g
E) 50 g

Q13. In a certain process a gas ends in its original thermodynamic state. Of the following, which is possible as the net result of the process?

A) The gas absorbs 50 J of energy as heat and does 50 J of work.
B) It is adiabatic and the gas does 50 J of work.

C) The gas does no work but absorbs 50 J of energy as heat.
D) The gas does no work but rejects 50 J of energy as heat.
E) The gas rejects 50 J of heat and does 50 J of work.

Q14. Heat flows through a slab. It takes 1.0 minute to transfer 600 J of thermal energy across the slab. If the slab thickness is doubled, its cross-sectional area is halved, and the temperature difference across it is doubled, how long will it take to transfer the same amount of thermal energy?

A) 120 s
B) 60 s
C) 30 s
D) 480 s
E) 7.5 s

Sec# Temerature, Heat, and the First Law of Thermodynamics - Heat Transfer Mechanisms
Grade# 50

Q15.
An ideal gas undergoes a constant-pressure process. The RMS speed :

A) Increases as the volume increases.
B) Decreases as the volume increases.
C) Decreases as the temperature increases.
D) Doubles if the temperature is doubled.
E) Decreases by one-half if the temperature is doubled.

Sec# The kinetic Theory of Gases - Pressure, Temperature and RMS Speed
Grade# 50

Q16.
An ideal gas occupies a volume of 1.5 m^3 at 20 °C and under a pressure of 0.10 atm. The gas is heated at constant pressure to 50 °C. What is the work done by the gas?

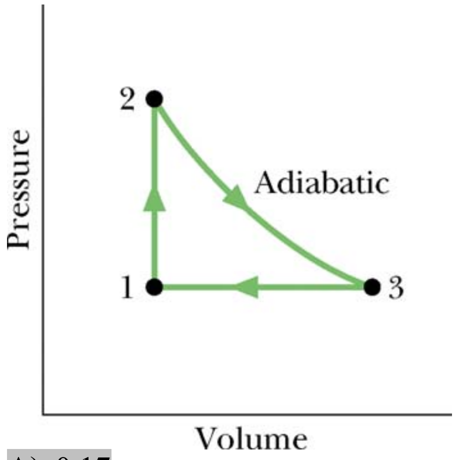
A) 1.6 kJ
B) 3.9 kJ
C) 2.3 kJ
D) 0.25 kJ
E) 6.2 kJ

Q17. An ideal monatomic gas, initially at 300 K, occupies a volume of 1.50 m^3. It expands adiabatically to twice its original volume. What is the final temperature of the gas?

A) 190 K
B) 600 K
C) 150 K
D) 476 K
E) 94.5 K

Q18. A heat engine has 1.5 moles of an ideal monatomic gas as the working substance. The working cycle of the engine is represented by the p-V diagram shown in Fig. 3, where T_1 = 300 K, T_2 = 600 K, T_3 = 450 K. What is the efficiency of the cycle?

Fig#



A) 0.17
B) 0.52
C) 0.83
D) 1.2
E) 0.21

Q19. An ideal refrigerator operates between 230 K and 300 K. In every cycle, the motor does 210 J of work. How much heat is rejected to the room?

A) 900 J
B) 64 J
C) 690 J
D) 49 J
E) 750 J

Q20. A 1.0 kg of water at 90 °C is mixed with 1.0 kg of water at 30 °C. What is the total entropy change in the process? The specific heat of water is 4190 J/kg.K.

A) + 35 J/K
B) – 361 J/K
C) + 396 J/K
D) Zero
E) 1200 J/K

Physics 102 Major1
Formula sheet

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$PV = nRT = NkT$

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

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

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

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

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

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

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

$Q = mL$

$Q = mc\Delta T$

$Q = nc\Delta T$

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

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

$C_p - C_v = R$

$W = \int P dV$

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

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

$W = Q_H - Q_L$

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

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

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

Constants:

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

1 calorie = 4.186 Joule

g = 9.8 m/s^2

for water:

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

$L_F = 3.33 \times 10^5 \frac{J}{kg},$ $\quad L_V = 2.256 \times 10^6 \frac{J}{kg}$