Q1.

A string has a mass of 0.20 g and a length of 1.6 m. A sinusoidal wave is travelling on this string, and is given by: $y(x,t) = 0.030 \sin(0.30x - 80t + 3\pi/2)$ (SI units). What is the magnitude of the tension in the string?

A) 8.9 N
B) 3.3 N
C) 4.7 N
D) 9.2 N
E) 5.4 N

Sec# Wave - I - The speed of a Traveling Wave
Grade# 58

Q2.

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

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

Sec# Wave - I - Energy and Power of a Traveling String Wave
Grade# 53

Q3.

A standing wave is established on a 3.0 m long string fixed at both ends. The string vibrates in three loops with an amplitude of 1.0 cm. If the wave speed is 100 m/s, what is the frequency?

A) 50 Hz
B) 100 Hz
C) 33 Hz
D) 25 Hz
E) 10 Hz

Sec# Wave - I - Standing Waves and Resonance
Grade# 58

Q4.

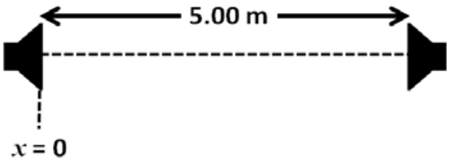
A string of length 2.5 m is fixed at both ends. A standing wave of frequency 100 Hz is set up on the string. The distance between two adjacent nodes is 0.50 m. What is the fundamental frequency of the string?

A) 20 Hz
B) 100 Hz
C) 40 Hz
D) 500 Hz
E) 60 Hz

Sec# Wave - I - Standing Waves
Grade# 53

Q5.
Two speakers, facing each other and separated by a distance of 5.00 m, are driven by the same oscillator, as shown in **Figure 1**. A listener starts walking from the left speaker toward the right one, along the line joining them. He hears the fist minimum at *x* = 1.00 m. Find the frequency of the oscillator. Speed of sound = 343 m/s.

Fig#



A) 57.2 Hz
B) 114 Hz
C) 42.9 Hz
D) 85.8 Hz
E) 34.3 Hz

Sec# Wave - II - Interference
Grade# 48

Q6.
A point source uniformly emits 440 W of sound in all directions. How far from the source will the sound level be 106 dB?

A) 29.7 m
B) 21.8 m
C) 32.5 m
D) 38.1 m
E) 52.5 m

Sec# Wave - II - Intensity and Sound Level
Grade# 48

Q7.
A train approaches a mountain at a speed of 20.8 m/s. The train’s engineer sounds a whistle that emits sound with a frequency of 420 Hz. What will be the frequency of the sound reflected from the mountain, as heard by the engineer? Speed of sound = 343 m/s.

A) 474 Hz
B) 430 Hz
C) 446 Hz
D) 420 Hz
E) 400 Hz

Sec# Wave - II - The Doppler Effect
Grade# 43

Q8.
Tube A has length L_A and is open at both ends. Tube B has length L_B and is closed at one end. If the fundamental frequencies of the two tubes match then:

A) $L_B = L_A/2$
B) $L_B = L_A$
C) $L_B = L_A/4$
D) $L_B = 2\,L_A$
E) $L_B = 4\,L_A$

Sec# Wave - II - Source of Musical Sound
Grade# 55

Q9.
A bridge is made of segments of concrete, each of length L = 50 m, that are placed end to end. Every two adjacent segments are separated by a spacing ΔL to allow for thermal expansion, without the two segments touching. If the temperature changes by 150 F^o, what should be the minimum value of ΔL? The coefficient of linear expansion of concrete is 12×10^{-6} $(^oC)^{-1}$.

A) 5.0 cm
B) 7.5 cm
C) 10 cm
D) 2.5 cm
E) 9.5 cm

Sec# Temerature, Heat, and the First Law of Thermodynamics - Thermal Expansion
Grade# 58

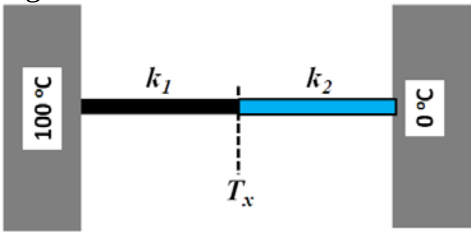
Q10.
A 4.0 kg block of ice at 0.0 ^oC is mixed with 4.0 kg of steam at 100 ^oC. What is the final equilibrium temperature of the system?

A) 100 ^oC
B) 0.0 ^oC
C) 50 ^oC
D) 85 ^oC
E) 22 ^oC

Sec# Temerature, Heat, and the First Law of Thermodynamics - The Absorption of Heat by Solids and Liquids
Grade# 48

Q11.
Two rods, made of different materials but having the same length and diameter, are welded end to end between two thermal reservoirs, as shown in **Figure 3**. In steady state, what is the temperature (T_x) at the junction between the two rods?

Fig#

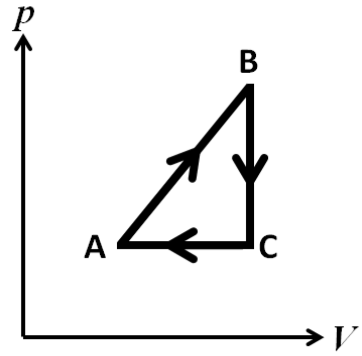


A) 100 k_1/(k_1 + k_2)
B) 100 k_2/(k_1 + k_2)
C) 100 k_1 k_2/(k_1 + k_2)
D) 50 k_1/(k_1 + k_2)
E) 50 k_2/(k_1 + k_2)

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

Q12.
An ideal gas undergoes the cyclic process shown in **Figure 2**. What are the signs of the heats Q_{AB}, Q_{BC}, Q_{CA}, respectively?

Fig#



A) positive, negative, negative
B) positive, negative, positive
C) positive, positive, negative
D) negative, positive, positive
E) negative, positive, negative

Sec# Temerature, Heat, and the First Law of Thermodynamics - The First Law of Thermodynamics
Grade# 45

Q13.
Two moles of a monatomic ideal gas are initially at 27.0 ^{o}C and occupy a volume of 20.0 L. The gas is expanded at constant pressure until the volume is doubled. Find the change in the internal energy of the gas.

A) 7.48 kJ
B) 12.5 kJ
C) 0.673 kJ

D) 1.12 kJ
E) 5.44 kJ

Sec# The kinetic Theory of Gases - The Molar Specific Heats of an Ideal Gas
Grade# 48

Q14.
An ideal diatomic gas, initially at 20.0 ^{o}C, is compressed adiabatically from 1.00 L to 0.500 L. What is the final temperature of the gas?

A) 387 K
B) 299 K
C) 465 K
D) 305 K
E) 117 K

Sec# The kinetic Theory of Gases - The Adiabatic Expansion of an Ideal Gas
Grade# 53

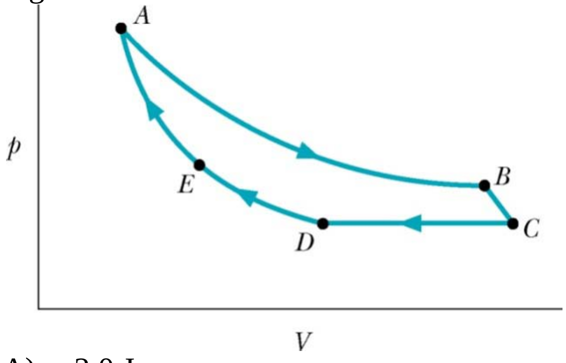
Q15.
The speeds of four particles are as follows: v_1 = 1.0 m/s, v_2 = 2.0 m/s, v_3 = 3.0 m/s and v_4 = 4.0 m/s. What is their root mean square speed?

A) 2.7 m/s
B) 2.5 m/s
C) 1.9 m/s
D) 5.5 m/s
E) 3.2 m/s

Sec# The kinetic Theory of Gases - Pressure, Temperature and RMS Speed
Grade# 43

Q16.
Figure 4 shows a cycle consisting of five paths: *AB* is isothermal at 300 K, *BC* is adiabatic with work = 8.0 J, *CD* is isobaric at 5.0 atm, *DE* is isothermal, and *EA* is adiabatic with a change of internal energy of 10 J. What is the change in the internal energy of the gas along path *CD*?

Fig#



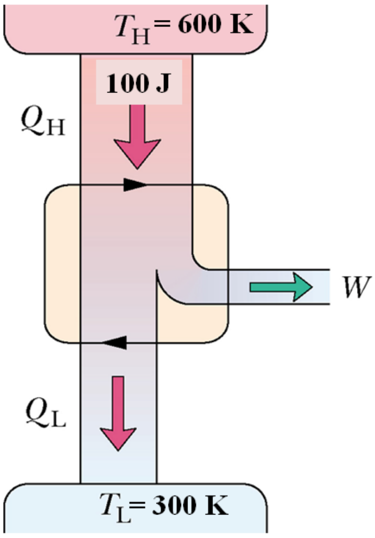
A) – 2.0 J
B) + 2.0 J

C) – 12 J
D) + 12 J
E) – 18 J

Sec# The kinetic Theory of Gases - Translational Kinetic Energy
Grade# 48

Q17.
A real heat engine is represented by the diagram shown in **Figure 5**. The heat expelled to the low-temperature reservoir can be

Fig#

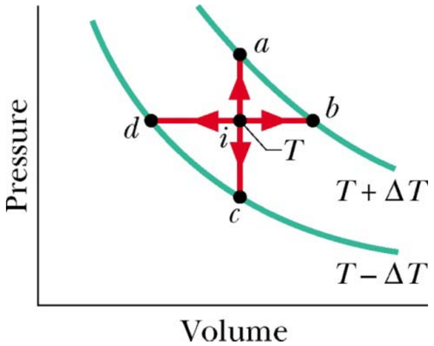


A) 60 J
B) 40 J
C) 20 J
D) 10 J
E) zero

Sec# Entropy and the Second Law of Thermodynamics - Entropy in the Real World: Engines
Grade# 43

Q18.
Point ***i*** in **Figure 6** represents the initial state of an ideal gas at temperature *T*. Rank the entropy changes that the gas undergoes as it moves reversibly from point ***i*** to points *a*, *b*, *c*, and *d*, greatest first.

Fig#



A) *b*, *a*, *c*, *d*
B) *a*, *b*, *c*, *d*
C) *b*, *d*, *a*, *c*
D) (*b* and *d* tie), (*a* and *c* tie)
E) (*b* and *d* tie), *a*, *c*

Sec# Entropy and the Second Law of Thermodynamics - Change in Entropy
Grade# 45

Q19.
In an experiment, 200 g of aluminum at 100 ^oC is mixed with 200 g of water at 20 ^oC. The final equilibrium temperature is 34 ^oC. What is the change in entropy of the aluminum-water system? The specific heat of aluminum is 900 J/kg.K.

A) + 4.1 J/K
B) + 74 J/K
C) – 74 J/K
D) – 4.1 J/K
E) zero

Sec# Entropy and the Second Law of Thermodynamics - Change in Entropy
Grade# 50

Q20.
A Carnot refrigerator operates between two reservoirs at – 3.0 ^oC and 27 ^oC. How long should the refrigerator be operated, with a 500 W power input, in order for it to absorb 4500 J of heat from the cold reservoir?

A) 1.0 s
B) 5.0 s
C) 2.7 s
D) 6.3 s
E) 1.6 s

Sec# Entropy and the Second Law of Thermodynamics - Entropy in the Real World: Refrigerators
Grade# 53

Test Expected Average = 50

$v = \sqrt{\frac{\tau}{\mu}}$ $v = \sqrt{\frac{B}{\rho}}$ $y = y_m \sin(kx - \omega t)$ $P = \frac{1}{2}\mu\omega^2 y_m^2 v$ $S = S_m \cos(kx - \omega t)$ $\Delta P = \Delta P_m \sin(kx - \omega t)$ $\Delta P_m = \rho v \omega S_m$ $I = ½ \rho (\omega S_m)^2 v$ $\beta = 10 \log\left(\frac{I}{I_o}\right)$ $I = \frac{P_s}{4\pi r^2}$ $f' = f\left(\frac{v \pm v_D}{v \mp v_s}\right)$ $y = 2 y_m \cos(\phi/2) \sin(kx - \omega t + \phi/2)$ $y = 2 y_m \sin kx \cos \omega t$ $f_n = \frac{nv}{2L}, \quad n = 1,2,3,...$ $f_n = \frac{nv}{4L}, \quad n = 1,3,5...$ $\Delta L = \frac{\lambda}{2\pi} \varphi$ $\Delta L = m\lambda \qquad m = 0,1,2,\ldots.$ $\Delta L = \left(m + \frac{1}{2}\right)\lambda, \qquad m = 0,1,2,\ldots.$ $T_c = T - 273$ $T_F = \frac{9}{5} T_C + 32$ $\Delta L = \alpha L \Delta T$ $\Delta V = \beta V \Delta T$	$PV = nRT = NkT$ $PV^{\gamma} = \text{constant}$ $TV^{\gamma - 1} = \text{constant}$ $Q = mL$ $Q = mc\Delta T$ $Q = n\, C_V\, \Delta T$ $Q = n\, C_P\, \Delta T$ $\Delta E_{int} = Q - W$ $\Delta E_{int} = nC_V \Delta T$ $C_p - C_v = R$ $W = \int PdV$ $W = nRT \ln(V_f/V_i)$ $P_{cond} = \frac{Q}{t} = \frac{kA(T_H - T_C)}{L}$ $\frac{m\overline{v^2}}{2} = (3/2)kT$ $v_{rms} = \sqrt{\frac{3RT}{M}}$ $W = Q_H - Q_L$ $\varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$ $K = \frac{Q_L}{W}$ $\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$, $\Delta S = \int \frac{dQ}{T}$ **Constants:** 1 Liter = 10^{-3} m^3 1 atm = 1.01 x 10^5 N/m^2 R = 8.31 J/mol K N_A = 6.02 x 10^{23} molecules/mole k = 1.38 x 10^{-23} J/K $I_o = 10^{-12}$ W/m^2 **For water:** c = 4190 J/kg.K L_F = 333 kJ/K L_V = 2256 kJ/K