Q1.
An 8.00 m long wire with a mass of 10.0 g is under a tension of 25.0 N. A transverse wave for which the wavelength is 0.100 m, and the amplitude is 3.70 mm is propagating on the wire. The magnitude of the maximum transverse acceleration of a point on the wire is:

A) 29.2×10^4 m/s^2
B) 41.0×10^4 m/s^2
C) 35.0×10^3 m/s^2
D) 39.0×10^3 m/s^2
E) 52.5×10^2 m/s^2

Sec# Wave - I - The speed of a Traveling Wave
Grade# 53

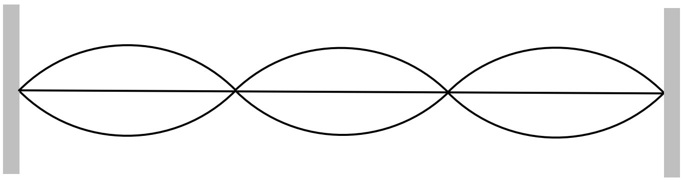
Q2.
A sinusoidal transverse wave travels with a speed of 30.0 m/s on a string of length 8.00 m and mass 6.00 g. The average power of the wave is 50.0 W. What is the average power of the wave if the tension is increased such that the wave speed is doubled while keeping both the wavelength and the amplitude fixed.

A) 400 W
B) 300 W
C) 200 W
D) 600 W
E) 700 W

Sec# Wave - I - Energy and Power of a Traveling String Wave
Grade# 49

Q3.
Figure 1 shows a standing wave on a string under a fixed tension and oscillating at a frequency f. How many antinodes will there be if the frequency is doubled?

Fig#



A) 6
B) 8
C) 10
D) 4
E) 5

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

Q4.
Two identical waves having a phase difference of 0.127 λ and moving in the same direction along a stretched string. They interfere with each other and the amplitude of the resultant wave is 14.0 mm. What is the amplitude of each wave?

A) 7.60 mm
B) 3.28 mm
C) 5.01 mm
D) 8.20 mm
E) 2.88 mm

Sec# Wave - I - Interference of Waves
Grade# 53

Q5.
A standing sound wave in a pipe has five nodes and five antinodes. Find the harmonic number n for this standing wave.

A) 9
B) 8
C) 7
D) 12
E) 10

Sec# Wave - II - Source of Musical Sound
Grade# 46

Q6.
The pressure in a travelling sound wave is given by the equation

$\Delta p = (1.00 \text{ Pa}) \sin \pi [(0.900 \text{ m}^{-1}) x - (315 \text{ s}^{-1})t]$

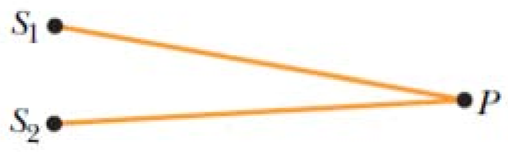
Find the sound level of the wave (Take the density of air $\rho_{air} = 1.21 \text{ kg/m}^3$).

A) 90.7 dB
B) 100 dB
C) 85.0 dB
D) 75.0 dB
E) 120 dB

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

Q7.
Figure 2 shows two point sources S_1 and S_2, which are in phase and emit identical waves of wavelength λ. Initially, the sources are at equal distances from point P. Then S_1 is moved directly toward P by a distance equal to $\lambda/4$ and S_2 is moved directly away from P by a distance equal to $\lambda/4$. Now the waves at P:

Fig#



A) Are exactly out of phase.
B) Are exactly in phase.
C) Have some intermediate phase.
D) Have path difference equal to $\lambda/4$.
E) Have phase difference equal to $\pi/4$.

Sec# Wave - II - Interference
Grade# 53

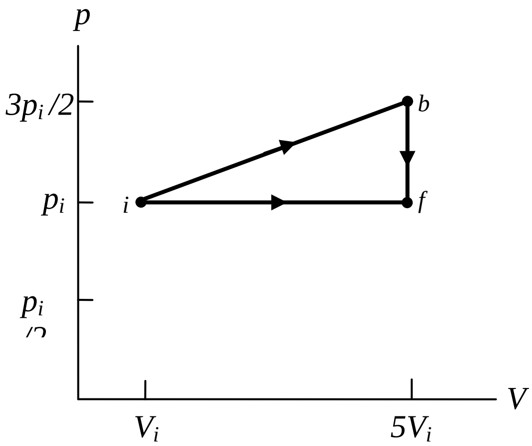
Q8.
A sound source and a truck are approaching each other with speeds of 50.0 m/s and 30.0 m/s respectively. The source emits sound waves at a frequency of 0.150 MHz. Find the wavelength of the sound waves reflected back to the source.
(The speed of sound in air is 340 m/s)

A) 0.141 cm
B) 1.20 cm
C) 0.213 cm
D) 0.532 cm
E) 0.921 cm

Sec# Wave - II - The Doppler Effect
Grade# 42

Q9.
A sample of a gas undergoes a transition from an initial state *i* to a final state *f* by two different paths, *if* and *ibf*, as shown in Figure 3. The energy transferred to the gas as heat along the path *if* is 10 p_iV_i. Find the change in internal energy of the gas for the path *ibf*.

Fig#



A) $6\ p_iV_i$
B) p_iV_i
C) $(3/2)\ p_iV_i$
D) $10\ p_iV_i$
E) $(5/2)\ p_iV_i$

Sec# Temerature, Heat, and the First Law of Thermodynamics - The First Law of Thermodynamics
Grade# 55

Q10.
A cubic tank filled with 5.0 kg of water is insulated from all sides except its top which is covered with a square glass sheet of length 2.0 m and thickness 3.0 cm. The water is initially at 20 ^oC. It is exposed for 20 seconds to the outside environment where the temperature is 55 ^oC. Find the change in the temperature of water (assume that heat is distributed uniformly in the water).(K_{glass} = 1.0 W/m.K)

A) 4.5 ^oC
B) 2.5 ^oC
C) 0.6 ^oC
D) 1.5 ^oC
E) 8.5 ^oC

Sec# Temerature, Heat, and the First Law of Thermodynamics - Heat Transfer Mechanisms
Grade# 43

Q11.
Water at 90.0 ^{o}C fills a Pyrex tube (radius=2.00 cm, height=12.0 cm) to the rim. If we ignore the expansion of the Pyrex tube, what will be the height of water if it is cooled to 10.0 ^{o}C. (The coefficient of volume expansion of water is 207×10^{-6} /C^{o})

A) 11.8 cm
B) 10. 4 cm
C) 10. 9 cm
D) 9.00 cm
E) 9.70 cm

Sec# Temerature, Heat, and the First Law of Thermodynamics - Thermal Expansion
Grade# 46

Q12.
Two different solid objects have the same mass and temperature. Equal quantities of energy are absorbed as heat by each. Their final temperatures may be different because the samples have different:

A) Specific heats
B) Coefficients of thermal expansion
C) Latent heat of fusion
D) volumes
E) thermal conductivities

Sec# Temerature, Heat, and the First Law of Thermodynamics - The Absorption of Heat by Solids and Liquids
Grade# 63

Q13.
An ideal gas initially at a pressure of 1.2 atm and temperature 74 ^{o}C undergoes an isothermal expansion to twice its original volume. During the expansion, the gas absorbs 20 kJ of heat. Find the number of moles for this gas?

A) 10
B) 12
C) 15
D) 18
E) 20

Sec# The kinetic Theory of Gases - Ideal Gases
Grade# 55

Q14.
An ideal gas with a volume V_0 and a pressure P_0 undergoes a free expansion to volume V_1 and pressure P_1 where $V_1=32V_0$. The gas is then compressed adiabatically to the original volume V_0 and pressure $4P_0$. The ratio of specific heats, γ, of the ideal gas is:

A) 7/5
B) 2/5
C) 3/5
D) 1/5
E) 9/5

Sec# The kinetic Theory of Gases - The Adiabatic Expansion of an Ideal Gas
Grade# 45

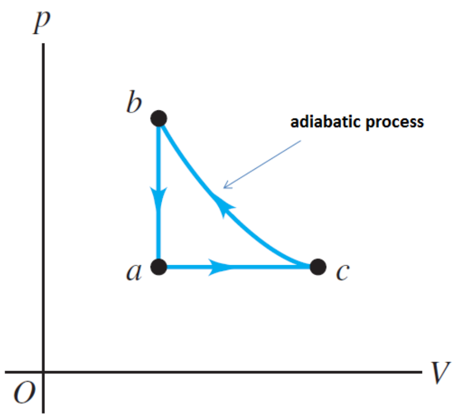
Q15.
The pressure of a monatomic ideal gas is doubled, while its volume is reduced by a factor of four. What is the ratio of the new rms speed of the atoms to the initial rms speed?

A) 0.71
B) 1.0
C) 0.47
D) 0.28
E) 0.87

Sec# The kinetic Theory of Gases - Pressure, Temperature and RMS Speed
Grade# 58

Q16.
Three moles of an ideal diatomic gas are taken through the cycle *acba* as shown in Figure 4, where *cb* is an adiabatic process. The temperature of the gas in states a, c, and b are T_a = 300 K, T_c = 492 K, and T_b = 600 K respectively. Calculate the net work for the cycle.

Fig#



A) −1.95 kJ
B) +1.95 kJ
C) +3.84 kJ
D) −3.84 kJ
E) 0

Sec# The kinetic Theory of Gases - The Molar Specific Heats of an Ideal Gas
Grade# 46

Q17.
An ideal refrigerator has a coefficient of performance of 5.0. If the temperature in the room is 31 ^oC, what is the temperature inside the refrigerator?

A) −20 ^oC
B) –5.0 ^oC
C) −10 ^oC
D) −30 ^oC
E) Zero

Sec# Entropy and the Second Law of Thermodynamics - Entropy in the Real World: Refrigerators
Grade# 61

Q18.
Consider an ideal engine that operates between two reservoirs at 300 K and 600 K and absorbs 1.44×10^6 J per cycle. What is the power output of this engine if it completes 10 cycles per minute?

A) 120 kW
B) 100 kW
C) 350 kW
D) 440 kW
E) 500 kW

Sec# Entropy and the Second Law of Thermodynamics - Entropy in the Real World: Engines
Grade# 47

Q19.
An ideal monatomic gas of volume of 6.00 L, originally at 127 ^oC and a pressure of 3.00 atm undergoes an isothermal expansion to 4 times the original volume. What is the change in entropy of the gas for this process?

A) 6.3 J/K
B) 5.0 J/K
C) 3.4 J/K
D) 4.0 J/K
E) 7.1 J/K

Sec# Entropy and the Second Law of Thermodynamics - Change in Entropy
Grade# 57

Q20.
A piece of iron of mass 2.00 kg at a temperature of 880 K is thrown into a large lake whose temperature is 280 K. Assume the lake is so large that its temperature change can be ignored. If the change in entropy of the **iron-lake system** is 898 J/K, calculate the specific heat of iron.

A) 450 J/kg K
B) 350 J/kg K
C) 230 J/kg K
D) 190 J/kg K
E) 580 J/kg K

Sec# Entropy and the Second Law of Thermodynamics - The Second Law of Thermodynamics
Grade# 47

Test Expected Average = 51

$v = \sqrt{\frac{\tau}{\mu}}$

$v = \sqrt{\frac{B}{\rho}}$

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

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

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

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

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

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

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

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

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

$y = 2 y_m \cos(\phi/2) \sin(kx - \omega t + \phi/2)$

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

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

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

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

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

$PV = nRT = NkT$

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

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

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

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

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

$T_F = \frac{9}{5} T_C + 32$, $T_c = T - 273$

$Q = mL \quad Q = mc\Delta T$

$Q = n C_V \Delta T$

$Q = n C_P \Delta T$

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

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

$C_p - C_v = R$

$W = \int PdV$

$W = nRT \ln(V_f/V_i)$

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

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

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

$W = Q_H - Q_L$

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

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

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

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