Q1.
A stretched string has a length of 2.00 m and a mass of 3.40 g. A transverse sinusoidal wave is travelling on this string, and is given by $y(x, t) = 0.030 \sin(0.75x - 126t)$, where $x$ and $y$ are in meters, and $t$ is in seconds. What is the magnitude of the tension in this string?

A) 48 N
B) 60 N
C) 17 N
D) 29 N
E) 35 N

---

Q2.
The average power of a sinusoidal wave on a stretched string is P. If an identical wave is sent simultaneously along the same string in the same direction but with a phase difference of $90^o$ from the first wave, the new average power is

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

---

Q3.
For a standing wave on a string fixed at both ends

A) the midpoint is an antinode for odd harmonics.
B) the midpoint is an antinode for even harmonics.
C) the midpoint is a node for odd harmonics.
D) the shortest wavelength corresponds to the fundamental mode.
E) the amplitude of all points on the string is the same.

---

Q4.
A string that is stretched between fixed supports oscillates in a third-harmonic standing wave pattern. The displacement of the wave is given by $y(x,t) = (0.10) \sin(\pi x/5) \cos(12\pi t)$,
where $x$ and $y$ are in meters, and $t$ is in seconds. What is the length of the string?

A) 15 m
B) 6.7 m
C) 10 m
D) 60 m

E) 25 m

---

Q5.
A string that is stretched between fixed supports has resonant frequencies of 385 and 430 Hz, with no intermediate resonant frequencies. What is the frequency of the seventh harmonic?

A) 315 Hz
B) 45 Hz
C) 2700 Hz
D) 655 Hz
E) 3010 Hz

---

Q6.
If the intensity of a sound wave traveling in air with constant frequency is doubled, then

A) the wave speed remains the same.
B) the displacement amplitude remains the same.
C) the displacement amplitude is doubled.
D) the sound level is doubled.
E) the displacement amplitude is halved.

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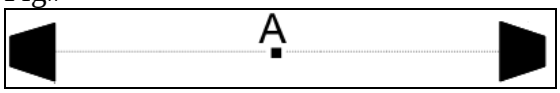
Q7.
Two speakers, separated by 2.00 m, face each other as shown in **Figure 1** . They are driven by the same generator, and emit sound waves with a frequency of 170 Hz, that are initially in phase. A listener is initially at point **A**, which is at the midpoint between the two speakers. What is the shortest distance he should move to find a point of destructive interference? [Take the speed of sound to be 340 m/s]

Fig#



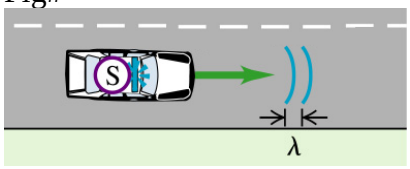

A) 0.500 m
B) 0.125 m
C) 0.250 m
D) 0.375 m
E) 0.625 m

Q8.
A tube open at both ends has length $L_A$. A tube open only at one end has length $L_B$. If the two tubes have the same fundamental frequency, then

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

Q9.
A police car, moving at 20.0 m/s, emits a sound wave with a frequency of 300 Hz. Find the wavelength of the sound wave in front of the car, as shown in **Figure 2**.
[Take the speed of sound in air to be 340 m/s]

Fig#




A) 1.07 m
B) 1.13 m
C) 1.20 m
D) 0.938 m
E) 0.833 m

Q10.
The melting point of sulfur is 444.6 °C and is 586.1 F° below its boiling point. Determine the boiling point of sulfur in degrees Celsius.

A) 770.2 $^{o}$C
B) 118.0 $^{o}$C
C) 1031 $^{o}$C
D) 1500 $^{o}$C
E) 214.2 $^{o}$C

Q11.
An iron tank is completely filled with 2.80 $m^3$ of water when both the tank and the water are at a temperature of 32.0 °C. When the tank and the water have cooled to 18.0 °C, what additional volume of water can be put into the tank? [$\alpha_{iron} = 12.0 \times 10^{-6}$/ C°, $\beta_{water} = 4.79 \times 10^{-4}$/ C°]

A) $17.4 \times 10^{-3}$ $m^3$
B) $1.41 \times 10^{-3}$ $m^3$
C) $18.8 \times 10^{-3}$ $m^3$
D) $0.470 \times 10^{-3}$ $m^3$
E) $18.3 \times 10^{-3}$ $m^3$

Q12.
A 100-g ice cube at 0.0 °C is placed in 650 g of water at 18 °C. If the system is isolated, what is the final temperature?

A) 5.0 °C
B) 0.0 °C
C) 22 °C
D) 28 °C
E) 12 °C

Q13.
A copper rod has a length of 60 cm. One end is maintained at 80 °C and the other end is at 20 °C. In steady state, what is the temperature of the rod at a point which is 20 cm from the hot end?
[$k_{copper}$ = 401 W/m.K]

A) 60 $^oC$
B) 40 $^oC$
C) 35 $^oC$
D) 25 $^oC$
E) 50 $^oC$

Q14.
A 5 moles of an ideal gas expand isobarically from $T_i$ = 25 °C to $T_f$ = 75 °C. Calculate the work done by the gas during this process.

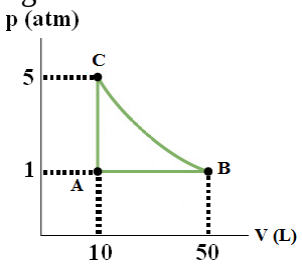
A) 2.1 x $10^3$ J
B) 4.5 x $10^3$ J
C) 1.2 x $10^3$ J
D) 5.4 x $10^3$ J
E) zero

Q15.
An ideal gas has a density of 3.75 kg/$m^3$ and is at a pressure of 1.00 atm. Determine the rms speed of the molecules of this gas.

A) 284 m/s
B) 94.9 m/s
C) 164 m/s
D) 1070 m/s
E) 616 m/s

Q16.
An ideal monatomic gas is taken through cycle A→B→C→A, shown in the *p*-*V* diagram of **Figure 3**, where process B→C is isothermal. Calculate the net work done in one cycle.

Fig#




A) 4088 J, on the gas
B) 4088 J, by the gas
C) 8152 J, by the gas
D) 8152 J, on the gas
E) 4000 J, by the gas

Q17.
One mole of an ideal monatomic gas is initially at a pressure of $1.01 \times 10^5$ Pa, a temperature of 300 K, and has a volume of 1.00 L. It is compressed adiabatically to a volume of 0.0667 L. Calculate the magnitude of the work done during this process.

A) 19.0 kJ
B) 6.75 kJ
C) 94.3 kJ
D) 2.49 kJ
E) Zero

Q18.
A system consists of two large thermal reservoirs in contact with each other, one at a temperature of 300 °C and the other at a temperature 200 °C. If 600 J of heat is transferred from the 300 °C reservoir to the 200 °C reservoir, what is the change in entropy of this system?

A) 0.221 J/K
B) 1.00 J/K
C) 5.00 J/K
D) -1.00 J/K
E) 2.31 J/K

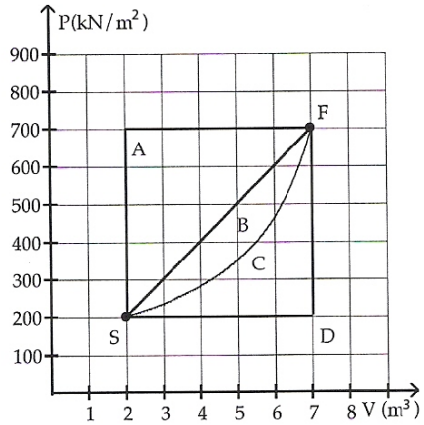
Q19.
A Carnot refrigerator is operated between two heat reservoirs at temperatures of 320 K and 270 K. In each cycle, the refrigerator extracts 415 J of heat from the cold reservoir. If the refrigerator completes 165 cycles each minute, what is the power input required to operate it?

A) 211 W
B) 178 W
C) 815 W
D) 224 W
E) 317 W

Q20.

Which of the processes on an ideal gas shown in **Figure 4** results in the minimum change in entropy of the gas in changing the gas from state S to State F?

Fig#




A) All processes
B) Only process A
C) Only process B
D) Only process C
E) Only process D