Q1.
Under a tension τ, it takes 2 s for a pulse to travel the length of a stretched wire. What tension is required for the pulse to take 6 s to travel the length of the wire?

A) $\tau/9$
B) $\tau/3$
C) τ
D) 3τ
E) 9τ

Q2.
A transverse sinusoidal wave, travelling on a stretched string, is described by the equation: $y(x,t) = y_m \sin(kx - \omega t + \phi)$. At time $t = 0$, the point on the string at $x = 0$ has positive displacement and is moving upward. Then:

A) $\pi/2 < \phi < \pi$
B) $0 < \phi < \pi/2$
C) $\pi < \phi < 3\pi/2$
D) $3\pi/2 < \phi < 2\pi$
E) All the other answers are possible.

Q3.
Two sinusoidal waves, identical except for phase, travel in the same direction along a stretched string, producing a resultant wave $y'(x,t) = 0.050 \sin(15x - 2.4t + 0.78)$, where x is in meters and t is in seconds. What is the amplitude of the interfering waves?

A) 0.035 m
B) 0.10 m
C) 0.025 m
D) 0.027 m
E) 0.050 m

Q4.
The speed of waves on a string fixed at both ends is 180 m/s. The string is vibrating in the third harmonic with a frequency of 240 Hz. The amplitude of the standing wave at an antinode is 0.48 cm. Calculate the amplitude of the standing wave at a point which is at a distance of 50 cm from the left end of the string.

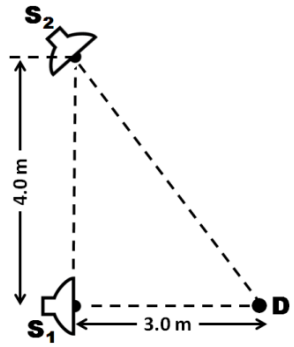
A) 0.42 cm
B) 0.37 cm
C) 0.15 cm
D) 0.48 cm
E) 0.24 cm

Q5.
If the intensity of a sound source is doubled, what will be the increase in sound level?

A) 3.0 dB
B) 2.0 dB
C) 4.0 dB
D) 1.4 dB
E) 100 dB

Q6.
Two sound sources (S1 and S2) are driven by the same generator, and emit sound waves in phase. The two sources and a detector (D) are arranged as shown in **FIGURE 1.**
What is the lowest frequency that results in destructive interference at the detector location? Take the speed of sound in air as 340 m/s.

Fig#



A) 85 Hz
B) 260 Hz
C) 170 Hz
D) 430 Hz
E) 236 Hz

Q7.
Standing sound waves are produced in a pipe that is open at both ends, and has a length of 1.2 m. For the third harmonic standing wave, at what distance from either end is the first pressure antinode?

A) 0.20 m
B) 0.40 m
C) 0.80 m
D) 0.30 m
E) 1.8 m

Q8.
An ambulance emits sound waves with frequency f_o. A stationary observer detects a frequency of 1.05 f_o as the ambulance approaches him, and a frequency of 0.950 f_o as the ambulance moves away. What is the speed of the ambulance? Take the speed of sound as 343 m/s.

A) 17.2 m/s
B) 36.1 m/s
C) 32.7 m/s
D) 28.7 m/s
E) 11.3 m/s

Q9.
A temperature scale (X) is defined so that its zero is the absolute zero. The size of one degree on the X scale is equal to the size of one degree on the Fahrenheit scale. What is the freezing point of water on the X scale?

A) 492
B) 524
C) 305
D) 440
E) 459

Q10.
A 6.00-kg piece of copper is placed in contact with 2.00 kg of water that was initially at 2.00 ^{o}C. The two objects are placed in an insulated container. If the final equilibrium temperature is 34.3 ^{o}C, what was the initial temperature of the copper piece? The specific heat of copper is 390 J/kg.K.

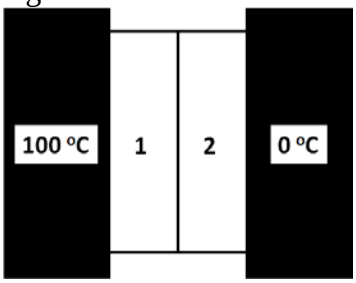
A) 150 ^{o}C
B) 209 ^{o}C
C) 37.9 ^{o}C
D) 114 ^{o}C
E) 129 ^{o}C

Q11.
A solid aluminum sphere is initially at 20.0 ^{o}C, and has a radius of 5.00 cm. What is the radius of the sphere when it is heated to 300 ^{o}C? The coefficient of linear expansion of aluminum is 23.0×10^{-6} $(^{o}C)^{-1}$.

A) 5.03 cm
B) 5.10 cm
C) 5.01 cm
D) 5.07 cm
E) 5.12 cm

Q12.
Two slabs, of equal area and thickness, are placed side-by-side to form a composite slab between two thermal reservoirs, as shown in **FIGURE 2**. Their thermal conductivities are: k_1 = 0.0800 W/m.K and k_2 = 0.0100 W/m.K. At steady state, what is the temperature at the junction between the two slabs?

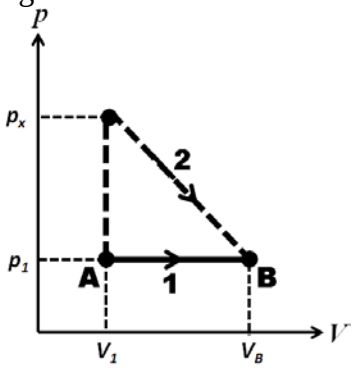
Fig#



A) 88.9 °C
B) 50.0 °C
C) 11.2 °C
D) 34.3 °C
E) 65.7 °C

Q13.
The *p*-*V* diagram in **FIGURE 3** shows two paths along which a sample of an ideal gas can be taken from state ***A*** to state ***B***, where $V_B = 2.0V_1$. Note that path 2 consists of two steps, and that the figure is not to scale. Along path 1, a heat of 5.0 p_1V_1 is added to the gas. Along path 2, a heat of 6.0 p_1V_1 is added to the gas. What is the ratio p_x/p_1?

Fig#



A) 3.0
B) 1.5
C) 1.2
D) 2.4
E) 2.0

Q14.
A quantity of 0.0560 moles of an ideal gas occupies a volume of 1.45 L. If the rms speed of the gas molecules is 185 m/s, what is the pressure of the gas? The molar mass of the gas is 4.00×10^{-3} kg/mole.

A) 1.76 kPa
B) 5.31 kPa
C) 3.50 kPa
D) 10.5 kPa
E) 11.7 kPa

Q15.
In an isobaric process, an ideal monatomic gas absorbs 130 J of heat. What is the change in the internal energy of the gas in this process?

A) 78 J
B) 65 J
C) 220 J
D) 95 J
E) 180 J

Q16.
Two moles of an ideal diatomic gas, initially at a temperature of – 55.0 ^{o}C, are compressed adiabatically to one half the initial volume. What is the change in the internal energy of the gas?

A) + 2.90 kJ
B) – 2.90 kJ
C) – 7.30 kJ
D) + 7.30 kJ
E) – 5.30 kJ

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Q17.
1.00 kg of copper, initially at 20.0 ^{o}C, absorbs 5.00 kJ of heat. What is the change of entropy of copper? The specific heat of copper is 390 J/kg.K.

A) 16.7 J/K
B) 19.1 J/K
C) 250 J/K
D) 12.8 J/K
E) zero

Q18.
In a large room, 0.250 kg of water is cooled from 85.0 ^{o}C to the room temperature of 20.0 ^{o}C. The cooling process is isothermal for the air in the room. What is the entropy change of the air?

A) 232 J/K
B) 340 J/K
C) 210 J/K
D) 314 J/K
E) 147 J/K

Q19.
A Carnot heat engine has an efficiency of 0.590 and performs 250 kJ of work per cycle. If the low temperature reservoir is at 20.0 ^{o}C, what is the temperature of the hot reservoir?

A) 442 ^{o}C
B) 48.8 ^{o}C
C) 224 ^{o}C
D) 33.9 ^{o}C
E) 149 ^{o}C

Q20.
An ideal refrigerator is placed in a room and operates between 0 ^{o}C and 25.0 ^{o}C. How much heat is exhausted into the room when 10.0 kg of liquid water at 0 ^{o}C is converted to ice at 0 ^{o}C?

A) 3.63 MJ
B) 1.09 MJ
C) 5.33 MJ
D) 9.04 MJ
E) 6.23 MJ
