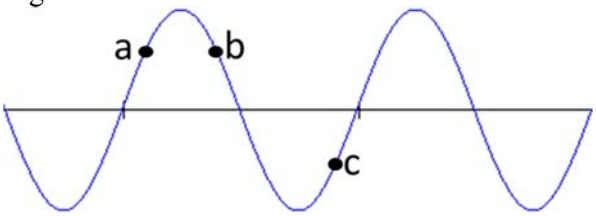
Q1.

A sinusoidal travelling wave in a string is given by equation $y = y_m \sin(kx + \omega t)$ and its snap shot at an instant is shown in **FIGURE 1**. Three string elements are indicated by the lettered points. Which of the following is correct about the direction of motion of the string elements **a**, **b**, and **c** at the instant of the snap shot.

Fig#



A) a-up, b-down, c-up
B) a-up, b-up, c-down
C) a-down, b-down, c- up
D) a-down, b-up, c-down
E) a-up, b-down, c-down

Q2.

Two sinusoidal waves, identical except for phase, travel in the same direction along a string are given by

$y_1 = 0.025\sin(15.0x - 90.0t)$

$y_2 = 0.025\sin(15.0x - 90.0t + \pi/3)$

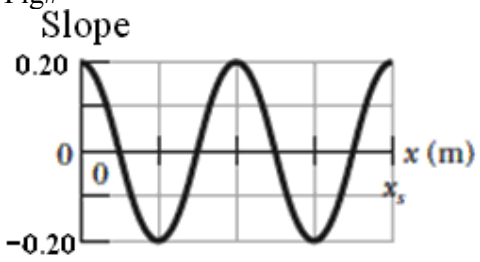
Where x, y are in m and t is in s. At what average rate does the resultant wave transport the energy? (μ = 500 g/m for the string)

A) 22.8 W
B) 17.5 W
C) 12.3 W
D) 7.58 W
E) 9.37 W

Q3.

A sinusoidal wave travels along a string under tension. **FIGURE 2** gives the slopes (of string elements) along the string at time t = 0. The scale of the x-axis is set by x_s = 0.80 m. what is the amplitude of the wave?

Fig#



A) 1.3 cm
B) 0.20 cm
C) 0.40 cm
D) 2.1 cm
E) 1.8 cm

Q4.
A rope, under a tension of 200 N and fixed at both ends, oscillates in a second-harmonic standing wave pattern. The displacement of the rope is given by:
$y = (0.10\text{ m})(\sin \pi x/2)(\cos 12\pi t)$
where $x = 0$ at one end of the rope, x is in meters, and t is in seconds. What is the speed of the waves on the rope?

A) 24 m/s
B) 12 m/s
C) 6.0 m/s
D) 36 m/s
E) 18 m/s

Q5.
In an experiment on standing waves, a string 90 cm long is attached to an oscillator that oscillates at a frequency of 80 Hz. The mass of the string is 0.044 kg. Find the tension in the string if it is oscillating in four loops.

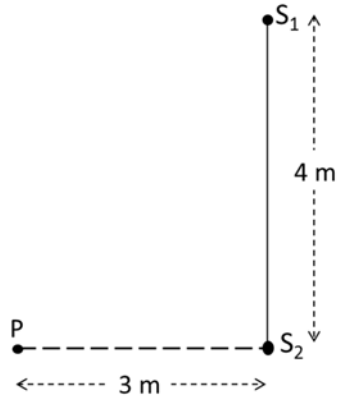
A) 63 N
B) 1.8 N
C) 34 N
D) 27 N
E) 51 N

Q6.
A man strikes one end of a rod with a hammer. The speed of sound in the rod is 15.0 times the speed of sound in air. A man, at the other end with his ear close to the rod, hears the sound of the blow twice with a 0.120 s interval between them; one sound comes through the rod and the other comes through the air along-side of the rod. If the speed of sound in air is 343 m/s, what is the length of the rod?

A) 44.1 m
B) 617 m
C) 41.2 m
D) 246 m
E) 17.3 m

Q7.
Two sound sources S_1 and S_2, shown in **FIGURE 3** are driven by the same oscillator whose frequency is 686 Hz. They are located at distance of 4.0 m on a vertical line. If you slide a microphone from point P to S_2 along the horizontal line PS_2, how many time(s) the microphone will detect minimum in sound intensity along this line. (speed of sound 343 m/s)

Fig#



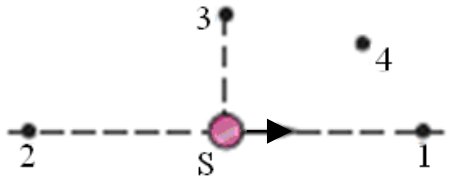
A) Four
B) One
C) Three
D) None
E) Two

Q8.
Suppose that the sound level of a sound is initially at 70.0 dB and then drops to 50.0 dB. Assuming that the frequency of the sound is 600 Hz, determine the ratio between initial sound wave amplitude S_{m1} to final sound wave amplitude S_{m2} (i.e. S_{m1}/S_{m2}).

A) 10.0
B) 100
C) 1.40
D) 1.96
E) 0.0150

Q9.
FIGURE 4 shows a moving sound source S that emits at a certain frequency, and four stationary sound detectors (located at points 1, 2, 3, and 4). Rank the detectors according the frequency of the sound they detect from the source, **GREATEST FIRST**.(The source is moving towards the detector **1**).

Fig#



A) 1, 4, 3, 2
B) 1 and 2 tie, 3, 4
C) 3, 4, then 1 and 2 tie
D) 3, 4, 1, 2
E) 4, 3, 2, 1

Q10.
Suppose that on a linear temperature scale X, water boils at – 53.5 ^{o}X and freezes at – 170 ^{o}X. What is a temperature of 340 K on the X scale?(0 ^{o}C = 273 K)

A) −91.9 ^{o}X
B) −211 ^{o}X
C) −58.7 ^{o}X
D) +50.2 ^{o}X
E) +83.7 ^{o}X

Q11.
What is the change in density of an aluminum cube of mass 200 g and of edge length 5.0 cm when heated from 10 ^{o}C to 80^{o}C (coefficient of linear expansion of aluminum 23 × 10^{-6} /^{o}C).

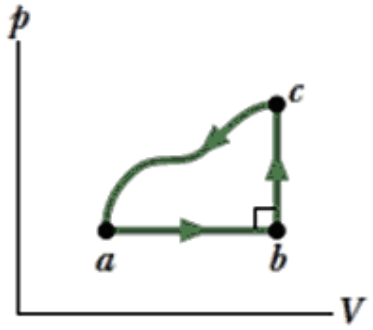
A) 7.7 × 10^{-3} g/cm^3
B) 5.0 × 10^{-1} g/cm^3
C) 3.3 g/cm^3
D) 2.4 × 10^{-3} g/cm^3
E) 9.7 × 10^{-2} g/cm^3

Q12.
Materials A, B, and C are solids that are at their melting temperatures. Material A requires 200 J to melt 4 kg, material B requires 300 J to melt 5 kg, and material C requires 300 J to melt 6 kg. Rank the materials according to their heats of fusion, **GREATEST FIRST**.

A) B, then A and C tie
B) B and C tie, A
C) C, B, A
D) A, B, C
E) A, B and C all tie

Q13.
FIGURE 5 displays a closed cycle for a gas. The change in internal energy along path **ca** is −160 J. The energy transferred to the gas as heat is 200 J along **ab**, and 40.0 J along path **bc**. How much work is done by the gas along path **abc**?

Fig#



A) 80.0 J
B) 400 J
C) 0.00 J
D) 200 J
E) 40.0 J

Q14.
Suppose 1.80 mol of an ideal gas is taken from a volume of 3.00 cm^3 to a volume of 1.50 cm^3 via an isothermal compression at 30.0 ^oC. How much energy is transferred as heat during the compression.

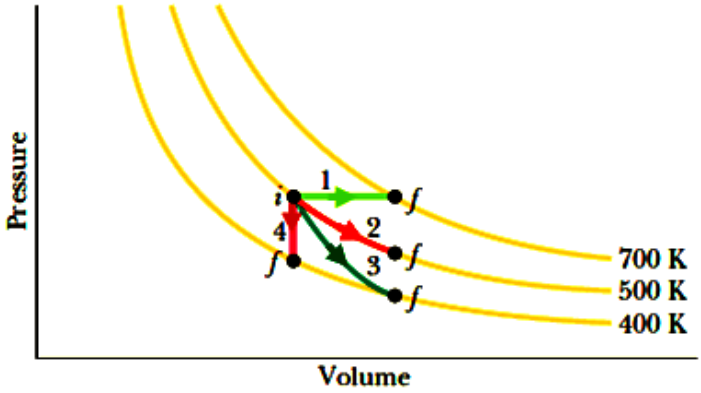
A) -3.14×10^3 J
B) $+3.14 \times 10^3$ J
C) $+2.95 \times 10^2$ J
D) -2.95×10^2 J
E) $+5.63 \times 10^3$ J

Q15.
A cylinder contains a mixture of helium (He) and argon (Ar) gas in equilibrium at 150 ^oC. Find the ratio of root-mean-square speed of helium to that of argon (V_{He}:V_{Ar}). (molar masses of helium and argon are 4.00 g/mole and 40.0 g/mole, respecticvely).

A) 3.16
B) 0.172
C) 4.00
D) 0.250
E) 6.32

Q16.
Rank the four paths of **FIGURE 6** according to the change in the internal energy of the gas, **MOST POSITIVE FIRST** and most negative last.

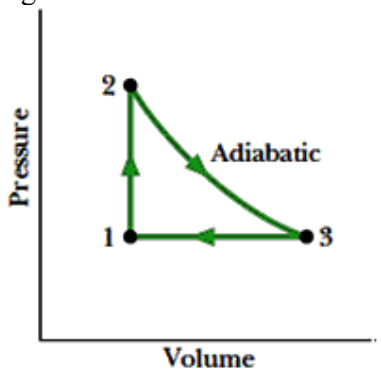
Fig#



A) 1, 2, then 3 and 4 tie
B) 1 and 2 tie, then 3 and 4 tie
C) 2,1, 3, 4
D) 1 and 4 tie, 2, 3
E) 4, 3, 2, 1

Q17.
One mole of an ideal monoatomic gas passes through a cycle as shown in **FIGURE 7**. The temperatures $T_1 = 300.0$ K, $T_2 = 600.0$ K, and $T_3 = 455.0$ K. What is the work done for path 2 $\rightarrow$3?

Fig#



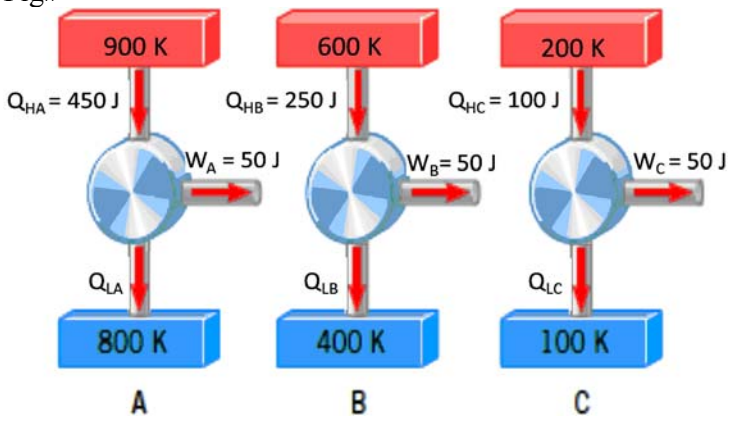
A) +1807 J
B) –1807 J
C) +1353 J
D) –1353 J
E) +9752 J

Q18.
0.300 kg of water at 90.0 °C and 0.700 kg of water at 10.0 °C are mixed together in an isolated container and come to equilibrium. Determine the change in entropy of the system of 1.00 kg of water.

A) +28.1 J/K
B) +239 J/K
C) −210 J/K
D) −13.2 J/K
E) +550 J/K

Q19.
Which one is/are **NOT** a Carnot heat engine in **FIGURE 8**?

Fig#



A) B only
B) C only
C) A and B
D) A and C
E) B and C

Q20.
An ideal refrigerator utilizes a Carnot cycle operating between 0 °C and 25 °C. To turn 10 kg of liquid water at 0 °C into 10 kg of ice at 0 °C how much energy must be supplied to the refrigerator?

A) 3.0×10^5 J
B) 3.6×10^6 J
C) 4.3×10^6 J
D) 1.7×10^5 J
E) 5.9×10^5 J