

Q1.

A transverse traveling wave is described by  $y = 0.15 \sin \left[ \frac{\pi}{16} (2x - 64t) \right]$ , where  $y$  and  $x$  are in meter and  $t$  is in second. Determine the first positive  $x$ -coordinate where  $y$  is maximum and when  $t = 0$ .

- A) 4.0 m
- B) 8.0 m
- C) 16 m
- D) 2.0 m
- E) 13 m

Q2.

A resultant traveling wave can be produced by an interference between two sinusoidal waves of the same frequency and amplitude. This interference is fully destructive only if the two waves:

- A) travel in the same direction and are  $180^\circ$  out of phase
- B) travel in opposite directions and are  $180^\circ$  out of phase
- C) travel in the same direction and are in phase
- D) travel in opposite directions and are in phase
- E) travel in the same direction and are  $90^\circ$  out of phase

Q3.

A traveling sinusoidal wave is generated on a stretched string. The string has a linear mass density  $\mu = 0.20$  kg/m and is stretched under a tension of 400 N. If the traveling wave has an amplitude of 30 cm and a period of 1.4 s, how much average power is transmitted by this wave?

- A) 8.1 W
- B) 1.5 W
- C) 33 W
- D) 40 W
- E) 2.4 W

Q4.

A string with a linear mass density of 0.0350 kg/m and a mass of 0.0140 kg is clamped at both ends. Under what tension in the string will it have a standing wave with a fundamental frequency of 110 Hz?

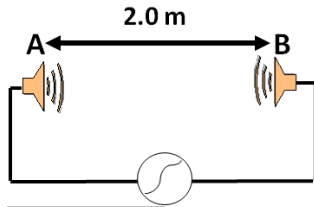
- A) 271 N
- B) 312 N
- C) 455 N
- D) 583 N
- E) 691 N

Q5.

In Figure 1, two identical speakers, separated by 2.00 m, are connected (in phase) to the same sound source. An observer, initially at the midpoint between the two speakers, moves slowly

toward B along the line joining the two speakers. He hears the first minimum in sound after moving a distance of 0.100 m. Find the frequency of the sound waves. [The speed of sound in air = 344 m/s]

Fig#



- A) 860 Hz
- B) 116 Hz
- C) 1720 Hz
- D) 581 Hz
- E) 172 Hz

Q6.

A jet plane has a sound level  $\beta_{\text{jet}} = 120$  dB while the sound level of a child is  $\beta_{\text{child}} = 20$  dB. Their corresponding sound intensities ratio ( $I_{\text{jet}}/I_{\text{child}}$ ) is:

- A)  $10^{10}$
- B)  $10^8$
- C)  $10^6$
- D)  $10^{12}$
- E)  $10^{11}$

Q7.

Standing waves with the seventh harmonic are produced in a long pipe closed at one end. The number of antinodes in the standing wave pattern is:

- A) 4
- B) 3
- C) 2
- D) 5
- E) 6

Q8.

As you stand by the side of the road, a car approaches you at constant speed, sounding its horn, and you hear a frequency of 120 Hz. After the car has passed, you hear a frequency of 100 Hz. What is the speed of the car? Assume that the speed of sound in air is 341 m/s.

- A) 31.0 m/s
- B) 25.0 m/s
- C) 23.0 m/s
- D) 41.0 m/s
- E) 47.0 m/s

Q9.

Given two metal rods A and B. The length of rod A is twice that of rod B, whereas the coefficient of linear thermal expansion for rod B is three times that of rod A. If rod A undergoes a change of temperature that is three times larger than that of rod B, which of the following statements is TRUE?

- A) The change in the length of rod A is twice that of rod B.
- B) The change in the length of rod B is twice that of rod A.
- C) The change in the length of rod A is six times larger than that of rod B.
- D) The change in the length of rod B is six times larger than that of rod A.
- E) The change in the length of rod A is the same as that of rod B.

Q10.

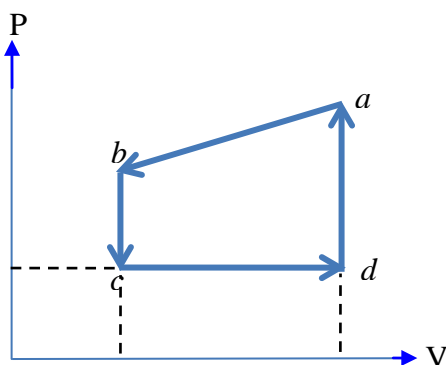
The specific heat of object B is twice that of object A, and the mass of object A is three times the mass of object B. Initially A is at 300 K and B is at 450 K. They are placed in thermal contact with each other and the combination is isolated. The final temperature of both objects is:

- A) 360 K
- B) 340 K
- C) 250 K
- D) 420 K
- E) 460 K

Q11.

The change in the internal energy of a gas as it moves from *a* to *c* along the path *abc* is -300 J (Figure 2). As it moves from *c* to *d*, 280 J is transferred to it as heat. And as the gas moves from *d* to *a* it absorbs 110 J as heat. How much work is done on the gas as it moves from *c* to *d*?

Fig#

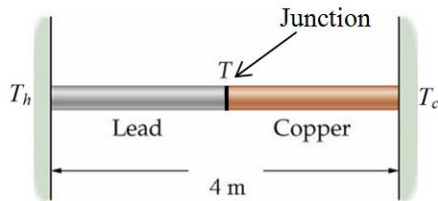


- A) + 90 J
- B) - 90 J
- C) + 260 J
- D) - 260 J
- E) 0 J

Q12.

Two rods, made of lead and copper, of equal lengths and diameters are attached to each other as shown in Figure 3. The rods are placed between hot and cold reservoirs with temperatures  $T_h = 350\text{ }^\circ\text{C}$  and  $T_c = 10.0\text{ }^\circ\text{C}$ . Find the temperature  $T$  at the junction between the two rods. (Given  $k_{\text{lead}} = 35.0\text{ W/m.K}$ , and  $k_{\text{copper}} = 401\text{ W/m.K}$ )

Fig#



- A) 37.3  $^\circ\text{C}$
- B) 63.4  $^\circ\text{C}$
- C) 21.2  $^\circ\text{C}$
- D) 42.1  $^\circ\text{C}$
- E) 73.5  $^\circ\text{C}$

Q13.

If the pressure of an ideal gas is tripled in an isothermal process, the root-mean-square speed of the molecules:

- A) does not change
- B) increases by a factor of  $\sqrt{3}$
- C) decreases by a factor of  $\sqrt{3}$
- D) increases by a factor of 2
- E) decreases by a factor of 2

Q14.

The temperature of 5.00 moles of an ideal monatomic gas is raised by 25.0 K in an adiabatic process. The work done in this process is:

- A) -1.56 kJ
- B) +3.45 kJ
- C) -2.53 kJ
- D) +5.53 kJ
- E) +12.0 J

Q15.

A 4.50 moles of an ideal gas undergoes isothermal compression from an initial volume of  $5.00\text{ m}^3$  to a final volume of  $2.00\text{ m}^3$ . The amount of heat transferred from the gas to its environment during this process is 9.83 kJ. Find the temperature of the gas.

- A) 287 K
- B) 201 K
- C) 154 K
- D) 305 K

E) 273 K

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Q16.

An ideal gas has an initial temperature of 200 K, and a volume of 2.0 liters. If the volume of the gas is reduced to 1.0 liter at constant pressure, find the new average kinetic energy per molecule.

- A)  $2.1 \times 10^{-21}$  J
- B)  $4.2 \times 10^{-21}$  J
- C)  $1.1 \times 10^{-21}$  J
- D)  $3.6 \times 10^{-21}$  J
- E)  $8.7 \times 10^{-21}$  J

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Q17.

An ideal heat engine absorbs heat from a reservoir at 527 °C and rejects heat to a reservoir at 127 °C. What is the power produced by the engine if the rate at which heat is absorbed is 1500 W?

- A) 750 W
- B) 680 W
- C) 450 W
- D) 940 W
- E) 230 W

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Q18.

When ice, initially at 0.00 °C, is heated to 40.0 °C, its entropy is increased by 1.18 kJ/K. Find the mass of ice.

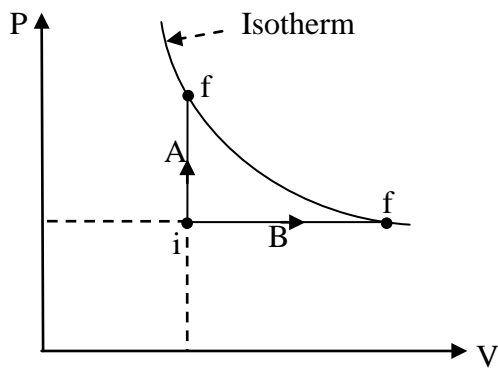
- A) 658 g
- B) 472 g
- C) 234 g
- D) 961 g
- E) 501 g

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Q19.

A monatomic gas can be taken through one of the two thermodynamical processes A or B. Process A is at constant volume and process B is at constant pressure. Both processes are shown in a PV diagram in Figure 4. The change in entropy:

Fig#



- A) is greater for process B than for process A
- B) is greater for process A than for process B
- C) is the same for both processes A and B
- D) is greater for process A than for process B only if the initial temperature is low
- E) is greater for process A than for process B only if the initial temperature is high

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Q20.

A refrigerator rejects 35.0 kJ of heat to the room during each cycle and operates with coefficient of performance of 4.60. What is the work done per cycle?

- A) 6.25 kJ
  - B) 7.61 kJ
  - C) 0.131 kJ
  - D) 10.2 kJ
  - E) 161 kJ
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