1. One mole of an ideal gas expands slowly and isothermally at temperature T until its volume is doubled. The change of entropy per molecule of this gas for this process is:

   A. ln(2) / T
   B. 2 k
   C. zero
   D. k ln(2)
   E. k T ln(2)

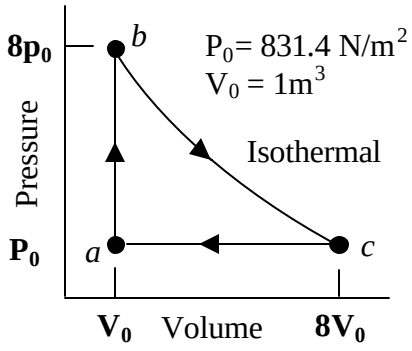
2. The heat capacity of object B is twice that of object A. Initially A is at 300K and B is at 450K. They are placed in thermal contact and the combination is isolated. The final temperature of both objects is:

   A. 400 K
   B. 300 K
   C. 600 K
   D. 200 K
   E. 450 K

3. A 10 g ice cube at -10°C is placed in a lake whose temperature is 15°C. Calculate the change in entropy of the ice cube as it becomes water and reaches the lake temperature.

   A. 15.2 J/K
   B. 3.8 J/K
   C. 3.1 J/K
   D. 2.0 J/K
   E. 0.8 J/K

4. The P-V diagram shows when one mole of He is taken through a reversible cycle. Process *ab* is constant volume, *bc* is isothermal and *ca* is constant pressure. Use R = 8.314 J/mol.K in the calculations. Calculate the work done by the gas during the isothermal process *bc*.



A. -8730 J
B. 0 J
C. -5814 J
D. +13831 J
E. +5820J

5. A Carnot heat engine uses 1 mole of an ideal monatomic gas and operates between two reservoirs at T = 600 K and T = 300 K. Calculate the work done by the gas during the adiabatic compression part of the Carnot cycle.

A. -3741 J
B. +5602 J
C. -5602 J
D. +3741 J
E. No work is done since the process is adiabatic.

6. An ideal monatomic gas expands isothermally to ten times its initial volume. Which of the following statements is correct in this situation?

A. The work done by the gas equals the heat absorbed by the gas.
B. There is no work done by the gas or on the gas.
C. There is no exchange of heat between the gas and its surroundings.
D. The internal energy of the gas increases tenfold.
E. The change in internal energy of the gas equals the heat absorbed by the gas.

7. A horizontal pipe 8 cm in diameter has a smooth reduction to a pipe of 6 cm in diameter. If the pressure of the water in the larger pipe is 8×10^4 Pa and the pressure in the smaller pipe is 6×10^4 Pa, at what rate does the water flow through the pipes?

   A. 21.6 kg/s
   B. 12.8 kg/s
   C. 216 kg/s
   D. 63.1 kg/s
   E. 6.3 kg/s

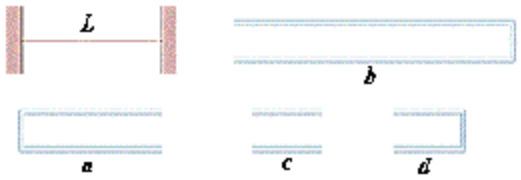
8. A heat engine operates between reservoir temperatures of 350 K and 500 K. The efficiency of this engine:

   A. can be any number between zero and one.
   B. must be less than the efficiency of a Carnot engine operating between the same two reservoir temperatures.
   C. must be less than the efficiency of a Stirling engine operating between the same two reservoir temperatures.
   D. must be greater than the coefficient of performance of a Carnot refrigerator operating between the same two reservoir temperatures.
   E. ***both*** of B. and C.

9. A certain wire stretches 1 cm when a force F is applied to it. The same force is applied to a wire of the same material but with twice the diameter and twice the length. The second wire stretches:

   A. 0.25 cm
   B. 1 cm
   C. 2 cm
   D. 4 cm
   E. 0.5 cm

10. The figure shows a stretched string of length L and pipes a, b, c, and d of lengths L, 2L, L/2, and L/2, respectively. The string's tension is adjusted until the speed of waves on the string equals the speed of sound waves in the air. The fundamental mode of oscillation is then set up on the string. In which pipe will the sound produced by the string cause resonance?



A. pipe a
B. pipe b
C. pipe c
D. pipe d
E. none of the above

11. For a system consisting of an ideal gas in a container of fixed volume, which of the following state functions is proportional to the average translational kinetic energy of the molecules in the gas?

A. the entropy
B. the pressure
C. the temperature
D. both A. and C.
E. each of A., B., and C.

12. A hollow sphere of inner radius 8.0 cm and outer radius 9.0 cm floats half-submerged in liquid of density 800 kg/m^3. What is the density of the material of which the sphere is made?

A. 1.3×10^3 kg/m^3
B. 0.6×10^3 kg/m^3
C. 0.4×10^3 kg/m^3
D. 2.7×10^3 kg/m^3
E. 0.7×10^3 kg/m^3

13. An air bubble of 20 cm^3 volume is at the bottom of a lake 40 m deep where the temperature is 4°C. The bubble rises to the surface, which is at a temperature of 20°C. Take the temperature of the bubble's air to be the same as that of the surrounding water, and assume no water molecules enter the air. Just as the bubble reaches the surface, what is its approximate volume? (You may treat the air in the bubble as an ideal gas.)

A. 20.0 cm^3
B. 100.0 cm^3
C. 21.1 cm^3
D. 80.0 cm^3
E. 74.0 cm^3

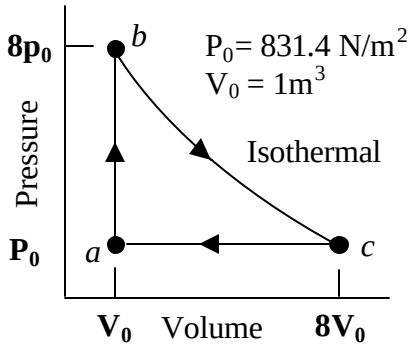
14. How much energy must be expended by an external agent to raise the temperature of one mole of an ideal diatomic gas by 100 K at constant pressure? (Note: R = ideal gas constant)

A. 100 R
B. 250 R
C. 350 R
D. 150 R
E. We need to know the pressure to answer this question

15. At 20°C, a rod is exactly 20.05 cm long on a steel ruler. Both the rod and the ruler are placed in an oven at 270°C, where the rod now measures 20.11 cm on the same ruler. The thermal expansion coefficient of steel is 11 x 10-6 /C°. What is the coefficient of thermal expansion for the rod material?

A. 46 x 10^{-6} /C°
B. 6 x 10^{-6} /C°
C. 23 x10^{-6} /C°
D. 11 x10^{-5} /C°
E. 12 x 10^{-6} /C°

16. The P-V diagram shows when one mole of He is taken through a reversible cycle. Process *ab* is constant volume, *bc* is isothermal and *ca* is constant pressure. Use R = 8.314 J/mol.K in the calculations. Calculate the heat absorbed by the gas during the isochoric process *ab*.



A. +13831 J
B. +5820 J
C. +8730 J
D. -5814 J
E. 0 J

17. An aluminum container of mass 68 g holds 150 g of water. Both the container and the water are at a temperature of 14°C when 90 g of ice at -6°C is dropped into the container. The container-water-ice system is then allowed to come to thermal equilibrium, and exchanges no heat with its environment as it does so. How much ice now remains?

A. 25.4 g
B. 12.1 g
C. 29.0 g
D. 61.0 g
E. 64.6 g

18. The heat capacity at constant volume of an ideal gas is dependent on:

A. the number of molecules
B. the temperature
C. the pressure
D. the volume
E. none of the above

19. Two transverse traveling waves with equations:
$y_1(x,t) = y_m \sin(kx - wt)$
$y_2(x,t) = y_m \sin(kx - wt + f)$
are allowed to interfere. For which *one* of the following values of the phase constant f does the wave resulting from the interference have amplitude y_m?

A. $2\pi/3$
B. $\pi/2$
C. $5\pi/6$
D. $\pi/6$
E. $\pi/3$

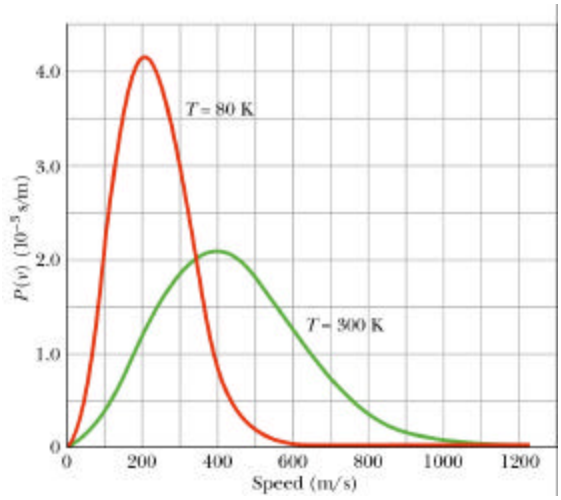
20. Which of the following variables represents a quantity that is not a state function?

A. V
B. W
C. T
D. S
E. P

21. Consider a source and detector which are each free to move. The source emits sound at a constant frequency. For which of the following situations does the detector observe the ***highest*** frequency? The speed of sound in air is 343 m/s.

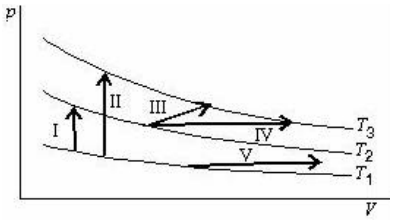
A. the source moves toward the detector at 100 m/s while the detector is stationary.
B. the source moves toward the detector at 50 m/s while the detector moves toward the source at 50 m/s.
C. the detector moves toward the source at 100 m/s while the source is stationary.
D. the situation with the highest observed frequency cannot be determined without knowing the frequency at which the source emits sound.
E. the detector observes the same frequency in all three of the above situations.

22. The figure shows the Maxwell probability distribution function P(v) for oxygen molecules at two different temperatures. Using the information in this figure, we conclude that the **average speed** of oxygen molecules at 300 K is:



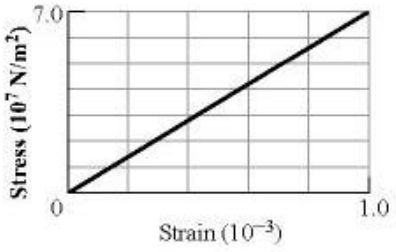
A. less than 400 m/s.
B. greater than 600 m/s.
C. exactly 400 m/s.
D. greater than 400 m/s.
E. We cannot estimate this without knowing the molecular mass of oxygen.

23. The diagram shows five thermodynamic processes carried out on an ideal gas. For which of these processes is the change in the internal energy of the gas the greatest? (T3>T2>T1)



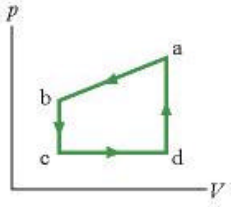
A. I
B. II
C. III
D. IV
E. V

24. The figure shows the stress versus strain plot for an aluminum wire ($E = 70 \times 10^9$ N/m^2) that is stretched by a machine pulling in opposite directions at the two ends of the wire. The wire has an initial length of 0.5 m and an initial cross-sectional area of 2.0×10^{-6} m^2. How much work does the force from the machine do on the wire to produce a strain of 1.00×10^{-3}?



A. 70 mJ
B. 140 mJ
C. 35 mJ
D. 17.5 mJ
E. 0 mJ

25. The figure shows a closed cycle for a gas (the figure is not drawn to scale). The change in the internal energy of the gas as it moves from *a* to *c* along the path *abc* is -215 J. As it moves from *c* to *d*, 185 J must be transferred to it as heat. An additional transfer of 70 J as heat is needed as it moves from *d* to *a*. How much work is done on the gas as it moves from *c* to *d*?



A. 0 J
B. 40 J
C. -40 J
D. 100 J
E. -100 J

Answer Key for Test "213FnlAFa04.tst", 10/19/2004

No. in Q-Bank		No. on Test	Correct Answer
60	2	1	D
44	3	2	A
60	11	3	A
51	12	4	D
62	3	5	A
51	5	6	A
16	9	7	A
62	2	8	B
6	14	9	E
28	3	10	D
60	3	11	C
13	17	12	A
51	16	13	B
56	6	14	C
42	11	15	C
56	8	16	C
44	5	17	E
44	12	18	A
25	3	19	A
45	1	20	B
36	3	21	A
55	4	22	D
56	3	23	B
6	12	24	C
46	2	25	C