1. The tension in a string with a linear mass density of 1.0×10^{-3} kg/m is 0.40 N. A sinusoidal wave with a wavelength of 20 cm on this string has a frequency of:
   A) 100 Hz
   B) 25 Hz
   C) 125 Hz
   D) 50 Hz
   E) 175 Hz

2. A wave is described by $y(x, t) = 0.1 \sin(3x - \omega t)$, where x and y are in meters. If the maximum transverse speed is 60 m/s, what is the speed of the wave?
   A) 200 m/s
   B) 300 m/s
   C) 600 m/s
   D) 180 m/s
   E) 100 m/s

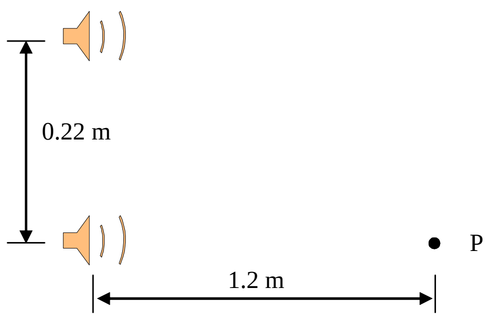
3. Two sinusoidal waves having wavelength of 5 m and amplitude of 10 cm, are traveling in opposite directions on a 20-m long stretched string fixed at both ends. Excluding the nodes at the ends of the string, how many nodes appear in the resulting standing wave?
   A) 7
   B) 4
   C) 5
   D) 3
   E) 8

4. Two stretched strings have the same linear density. The tension in the second string is half the tension in the first ($T_2=T_1/2$), and its length is only one third the first ($L_2=L_1/3$). Compare the fundamental frequencies for both strings (f1/f2).
   A) 0.47
   B) 0.24
   C) 0.34
   D) 0.62
   E) 0.12

5. The sound level at a distance of 5.0 m from a point source is 117 dB. The power output of the source is:
   A) 157 W
   B) 39 W
   C) 266 W
   D) 322 W
   E) 397 W

6. The maximum pressure amplitude ΔP_m that the human ear can tolerate is about 30 N/m^2. If the maximum displacement S_m is $1.3*10^{-5}$ m, find the frequency of the corresponding sound. (ρ =1.2 kg/m^3, the speed of sound =340 m/s).
   A) 900 Hz
   B) 820 Hz
   C) 300 Hz
   D) 1025 Hz
   E) 565 Hz

7. Two identical speakers are connected in phase to the same source. The speakers are 0.22 m apart and at ear level. An observer stands at distance of 1.2 m in front one speaker as shown in the figure. If the will hears maximum sound if the wavelength is:



   A) 2.0 cm
   B) 2.5 cm
   C) 1.1 cm
   D) 0.4 cm
   E) 3.6 cm

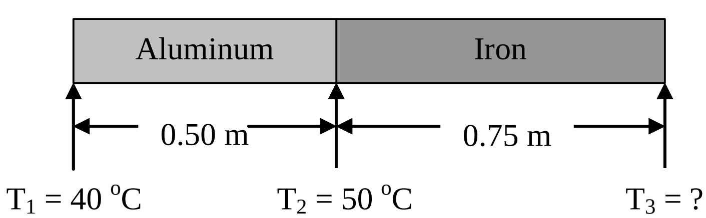
8. A police car is moving at speed of 30 m/s. Its siren emits a sound at frequency of 600 Hz. As the car approaches a large wall, what is the frequency of the sound heard by the driver of the police car?
   A) 716 Hz
   B) 651 Hz
   C) 517 Hz
   D) 828 Hz
   E) 932 Hz

9. 500 g of water at 100 °C is converted to steam at 100 °C by heating at constant pressure of 1.01×10^5 Pa. The volume of the water is 0.5×10^{-3} m^3 and the volume of steam is 0.83 m^3. Calculate the change in the internal energy of the system.
   A) 1044 kJ
   B) 828 kJ
   C) 523 kJ
   D) 1212 kJ
   E) 2352 kJ

10. What mass of steam initially at 100 °C that can be mixed with 160 g of ice at 0 °C in a thermally insulated container to produce liquid water at 40 °C.
   A) 32 g
   B) 316 g
   C) 9.4 g
   D) 42 g
   E) 160 g

11. Which statement is **incorrect**?
   A) In an adiabatic process, the internal energy of the system always decreases.
   B) In a cyclic process the change in internal energy of the system is zero.
   C) In an adiabatic process, transfer of energy as heat is zero.
   D) In an isochoric process (constant volume), the internal energy of the system increases if energy is added as heat Q.
   E) Heat energy can be transfered only between bodies having different temperatures.

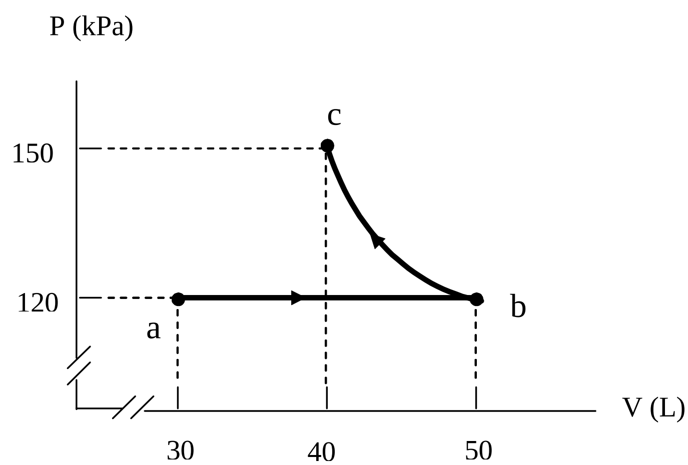
12. The figure below shows an aluminum and iron rods joint together. The rods have the same cross section and their sides are insulated. In the steady state, find the temperature T_3 at the far end of the iron rod. The thermal conductivity of aluminum is 235W/mK and for iron is 14 W/mK.



   A) 302 °C
   B) 259 °C
   C) 166 °C
   D) 204 °C
   E) 403 °C

13. A sample of an ideal gas is compressed by a piston from 10 m^3 to 5 m^3 and simultaneously cooled from 540 K to 270 K. As a result there is:
   A) No change in pressure.
   B) A decrease in pressure.
   C) A decrease in density.
   D) No change in density.
   E) No change in volume.

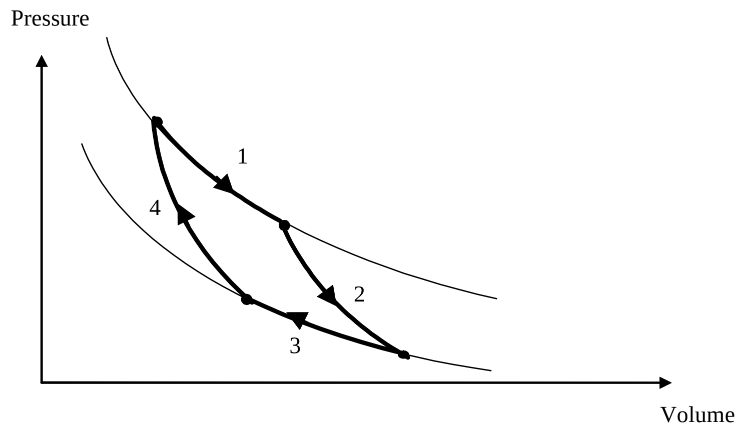
14. An ideal gas expands at constant pressure of 120 kPa from (a) to (b) as shown in the figure. It is then compressed isothermally to point (c) where the volume is is 40 L. Find the net work done during these two processes.



   A) 1060 J
   B) 2500 J
   C) 1500 J
   D) 1220 J
   E) 100 J

15. Two moles of ideal gas are at 20 ^oC and a pressure of 200 kPa. If the gas is heated to 40 ^oC, and its pressure is reduced by 30%, what is the new volume?
   A) 37 L
   B) 25 L
   C) 45 L
   D) 53 L
   E) 13 L

16. In the figure below, paths 1 and 3 are isotherms and paths 2 and 4 are adiabatic. Which path results in the highest heat transferred to the gas?

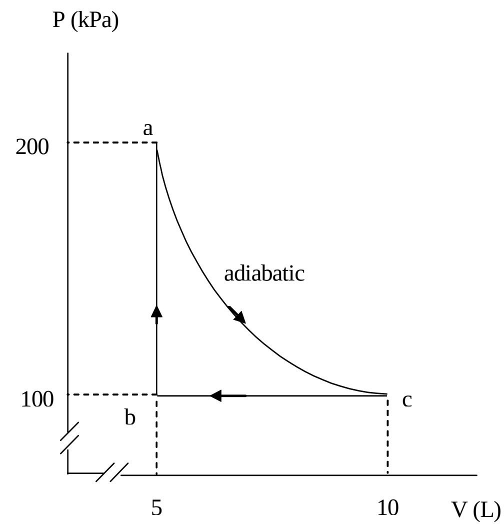


A) Path 1
B) Path 2
C) Path 3
D) Path 4
E) Paths 2 and 4

17. One mole of an ideal gas expands reversibly and isothermally at temperature T =27 ^{o}C until its volume is doubled. The change of entropy of this gas for this process is:
A) 5.8 J/K
B) 2.6 J/K
C) 4.4 J/K
D) 7.7 J/K
E) 9.3 J/K

18. A 300 g of lead melts at 327 C. The latent heat of fusion of lead is 24.5 kJ/kg. The change in entropy is
A) 12.3 J/K
B) 24.5 J/K
C) 16.4 J/K
D) 4.5 J/K
E) 8.4 J/K

19. Two moles of an ideal monatomic gas are taken around the cycle shown in the figure. If T_a= 60K, T_b=30K and T_c=38K, find the efficiency? (C_v=12.5 and C_p=20.75J/mol.K).



A) 56%
B) 34%
C) 25%
D) 66%
E) 75%

20. Find the **wrong** statement:
A) The entropy of an isolated system can decrease.
B) Perfect heat engines are not possible.
C) Perfect refrigerators are not possible.
D) Entropy is not conserved quantity.
E) A refrigerator requires work as input to make heat flow from cold reservoir to hot reservoir.

Physics 102 Major1
Formula sheet
Fall Semester 2005-2006)Term 051)

$$v = \lambda f = \frac{\omega}{k}$$

$$v = \sqrt{\frac{\tau}{\mu}} \qquad v = \sqrt{\frac{B}{\rho}}$$

$$y = y_m \sin(kx - \omega t + \varphi)$$

$$P = \frac{1}{2}\mu\omega^2\, y_m^{\ 2}\, v$$

$$S = S_m \cos(kx - \omega t)$$

$$\Delta P = \Delta P_m \sin(kx - \omega t), \Delta P_m = \rho v \omega S_m$$

$$I = \frac{1}{2}\rho(\omega S_m)^2 v$$

$$\beta = 10\log\left(\frac{I}{I_o}\right)$$

$$I = \frac{\text{Power}}{\text{Area}}$$

$$f' = f\left(\frac{v \pm v_D}{v \mp v_s}\right)$$

$$y = \left(2y_m \cos\frac{\varphi}{2}\right)\sin\left(kx - \omega t + \frac{\varphi}{2}\right)$$

$$y = (2y_m \sin kx)\cos\omega t$$

$$f_n = \frac{nv}{2L}, \quad n = 1,2,3,...$$

$$f_n = \frac{nv}{4L}, \quad n = 1,3,5...$$

$$\Delta L = \alpha L \Delta T$$

$$PV = nRT = NkT$$

$$\Delta L = \frac{\lambda}{2\pi}\varphi$$

$$\Delta L = m\lambda \qquad m = 0,1,2,....$$

$$\Delta L = \left(m + \frac{1}{2}\right)\lambda, \qquad m = 0,1,2,.....$$

PV^{γ} = constant; $TV^{\gamma - 1}$ = constant

$C_V = \frac{3}{2}$ R for monatomic gases,

$= \frac{5}{2}$ R for diatomic gases.

$$T_F = \frac{9}{5}T_C + 32$$

$$Q = mL, \; Q = mc\Delta T$$

$$\Delta E_{int} = Q - W$$

$$\Delta E_{int} = nC_V \Delta T$$

$$C_p - C_V = R$$

$$W = \int P dV$$

$$H = \frac{Q}{t} = \kappa A \frac{T_H - T_C}{L}$$

$$P = \sigma\varepsilon A T^4$$

$$\frac{m\overline{v^2}}{2} = (3/2)kT$$

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$Q = nc_p\Delta T, \qquad Q = nc_v\Delta T$$

$$W = Q_h - Q_c$$

$$\varepsilon = \frac{W}{Q_h} = 1 - \frac{Q_c}{Q_h}, \quad K = \frac{Q_c}{W}$$

$$\frac{Q_c}{Q_h} = \frac{T_c}{T_h}, \quad \Delta S = \int \frac{dQ}{T}$$

Constants:

Pi = π, lambda = λ

1 Liter = 10^{-3} m^3

R = 8.31 J/mol K

N_A = 6.02 x 10^{23} molecules/mole

1 atm = 1.01 x 10^5 N/m^2

k = 1.38 x 10^{-23} J/K

I_o = 10^{-12} W/m^2

1 calorie = 4.186 Joule

$\sigma = 5.67x10^{-8}\, W/(m^2K^4)$

micro = 10^{-6}

for water: L_f = 80 cal/g

L_v = 540 cal/g

c = 1 cal/g.K

speed of sound in air = 340m/s

a * b ** c = a b^c

Answer Key

1. A
2. A
3. A
4. A
5. A
6. A
7. A
8. A
9. A
10. A
11. A
12. A
13. A
14. A
15. A
16. A
17. A
18. A
19. A
20. A