Q1.
The function y(x,t) = 15.0 cos (πx- 20 πt) with x and y in meters and t in seconds, describes a wave on a taut string. What is the mass of one meter of the string if the tension in the string is 40.0 N?

A) 100 g
B) 200 g
C) 20 g
D) 10 g
E) 50 g

Sec# Wave Motion - The Speed of Waves on Strings
Grade# 50

Q2.
What phase difference (in wavelength λ) between two identical traveling waves, moving in the same direction along a stretched string, results in the combined wave having an amplitude 1.75 times that of the common amplitude of the two combined waves?

A) 0.16 λ
B) 2.30 λ
C) 2.80 λ
D) 1.10 λ
E) 0.89 λ

Sec# Wave Motion - Superposition and Interference of Waves
Grade# 50

Q3.
What is the third lowest frequency for standing waves on a 10.0 m long wire with 2.0 g mass and stretched under a tension of 200 N?

A) 150 Hz
B) 185 Hz
C) 250 Hz
D) 50 Hz
E) 100 Hz

Sec# Wave Motion - Standing Waves and Resonance
Grade# 50

Q4.
Energy is transmitted at the rate of P_0 by a wave of frequency f_0 on a string under tension τ_0. What is the new energy transmission rate P in terms of P_0 if the tension is increased to $4\tau_0$ and frequency is decreased to $f_0/2$?

A) $P= P_0/2$
B) $P=4 P_0$

C) $P=2\ P_0$
D) $P= P_0/4$
E) $P= P_0$

Sec# Wave Motion - Energy and Power Transmitted by Sinusoidal Waves on Strings
Grade# 50

Q5.
What is the bulk modulus of nitrogen gas if the speed of sound in nitrogen is 310 m/s . Assume 28.0 g of nitrogen occupies 22.4 L volume ?

A) $1.20\text{x } 10^5$ N/m2
B) $3.84 \text{ x } 10^5$ N/m2
C) $2.20 \text{ x } 10^6$ N/m2
D) $1.20 \text{ x } 10^3$ N/m2
E) $3.84 \text{ x } 10^4$ N/m2

Sec# Sound Waves - Speed of Sound Waves
Grade# 50

Q6.
The form of a sound wave travelling through air is $S(x,t) = S_m \cos(kx+3000t+\phi)$, where x is in meters and t in seconds. What is the shortest time interval that any air molecule takes along the path to move between displacements $S = +S_m/3$ and $S = - S_m/3$?

A) 0.23 ms
B) 0.14 ms
C) 1.21 ms
D) 0.89 ms
E) 5.23 ms

Sec# Sound Waves - Speed of Sound Waves
Grade# 45

Q7.
A pipe, filled with air, is closed at one end. If the third lowest harmonic frequency of the pipe is 750 Hz, what is the fundamental frequency for the pipe?

A) 150 Hz
B) 250 Hz
C) 75 Hz
D) 375 Hz
E) 175 Hz

Sec# Sound Waves - Standing waves in Air Columns
Grade# 50

Q8.

A train approaches a mountain at a speed of 21.0 m/s. The train engineer sounds a whistle that emits a frequency of 420 Hz. What will be the sound frequency that the engineer hears reflected off the mountain? (speed of sound =340 m/s)

A) 475 Hz
B) 550 Hz
C) 350 Hz
D) 420 Hz
E) 385 Hz

Sec# Sound Waves - Doppler Effect
Grade# 45

Q9.
The outside temperature changes by 40°F during a day. What is this temperature change on the Kelvin scale?

A) 22 K
B) 86 K
C) 72 K
D) 110 K
E) 295 K

Sec# Temerature - Termometers and Temperature Scale
Grade# 50

Q10.
A bolt hole in a brass plate has a diameter of 1.200 cm at 20.00°C. What is the diameter of the hole when the plate is heated to 220.0°C? (The coefficient of linear thermal expansion for brass is 19.00×10^{-6} /C°).

A) 1.205 cm
B) 1.125 cm
C) 1.495 cm
D) 1.300 cm
E) 1.550 cm

Sec# Temerature - Thermal Expantion of Solids and Liquids
Grade# 50

Q11.
200 g of ice at 0°C is dropped into a calorimeter of negligible heat capacity containing 350 g of water at 20°C. What is the final temperature of the system when it reaches equilibrium?

A) 0°C
B) 24°C
C) -13°C
D) 13°C
E) -24°C

Sec# Heat and the First Law of Thermodynamics - Latent Heat
Grade# 45

Q12.
What is the outside temperature if 16.8 x 10^6 J of heat is lost through a 4.0 m^2 area of 0.30 cm thick window glass in one hour from a house kept at 20°C (Thermal conductivity of window glass k = 0.84 W/m.K)

A) 16°C
B) 4°C
C) 0°C
D) 18°C
E) 24°C

Sec# Heat and the First Law of Thermodynamics - Heat Transfer
Grade# 50

Q13.
A quantity of an ideal gas is expanded to twice its initial volume. The process may be isothermal, isobaric or free expansion. Rank those three processes in order of the work done by the gas, **Least to Greatest**.

A) Free expansion, isothermal, isobaric
B) Isobaric, free expansion , isothermal
C) Isothermal, isobaric, free expansion
D) Isobaric, isothermal, free expansion
E) Free expansion , isobaric, isothermal

Sec# Heat and the First Law of Thermodynamics - The First Law of Thermodynamics
Grade# 45

Q14.
PV diagram for 4.3 g sample of an ideal gas contained in a container is shown in Fig. 1. The temperature T_1 of state 1 is 21°C. What is the temperature T_3 of state 3?

A) -53°C
B) 220°C
C) 16°C
D) -32°C
E) 390°C

Sec# The kinetic Theory of Gases - Molecular Model of an Ideal Gas
Grade# 50

Q15.
There is 0.0405 mol of air molecules contained in a cylinder at an initial temperature of 300K. Then the air molecules are compressed adiabatically to 1/15 of its initial volume. How much work does the air do ?
(Take gamma= 1.40 and C_V = 20.8 J/mol.K).

A) –494 J
B) +494 J
C) –234 J
D) +234 J
E) 0 J

Sec# The kinetic Theory of Gases - Adiabatic Processes for Ideal Gas
Grade# 45

Q16.
The temperature of a gas is increased by 110 K. As result, the rms velocity of the molecules increases from 400 m/s to 480 m/s. The molecular mass of the gas, in g/mol, is:

A) 39
B) 47
C) 45
D) 41
E) 43

Sec# The kinetic Theory of Gases - Molecular Model of an Ideal Gas
Grade# 50

Q17.
1.0 kg of water freezes at 0 °C. What is the change in entropy of water during this freezing process?

A) -1.22×10^{3} J/K
B) $+1.22\times10^{3}$ J/K
C) $+8.19\times10^{3}$ J/K
D) -8.19×10^{3} J/K
E) $+9.11\times10^{3}$ J/K

Sec# Heat engines, entropy and the 2nd law - Entropy
Grade# 50

Q18.
A 3.47 mol sample of an ideal gas expands reversibly and isothermally at 400 K until its volume doubled. What is increase in entropy of the gas?

A) 20.0 J/K
B) 15.0 J/K
C) 10.0 J/K
D) 30.0 J/K
E) 25.0 J/K

Sec# Heat engines, entropy and the 2nd law - Entropy
Grade# 50

Q19.

Fig. 2 shows a cycle for a heat engine for which Q_H = 35 J. The thermal efficiency of the engine is :

A) 29 %
B) 14 %
C) 23 %
D) 57 %
E) 19 %

Sec# Heat engines, entropy and the 2nd law - Heat Engine, Pump and Refrigerators
Grade# 50

Q20.
A heat pump delivers heat to a room at the rate of 34 kJ per second and maintains the room at a temperature of 293 K when the outside temperature is 229 K. The power requirement for the heat pump under these operating conditions is :

A) 7.4 k W
B) 13 k W
C) 6.0 k W
D) 15 k W
E) 5.6 k W

Sec# Heat engines, entropy and the 2nd law - Heat Engine, Pump and Refrigerators
Grade# 45

Test Expected Average = 49

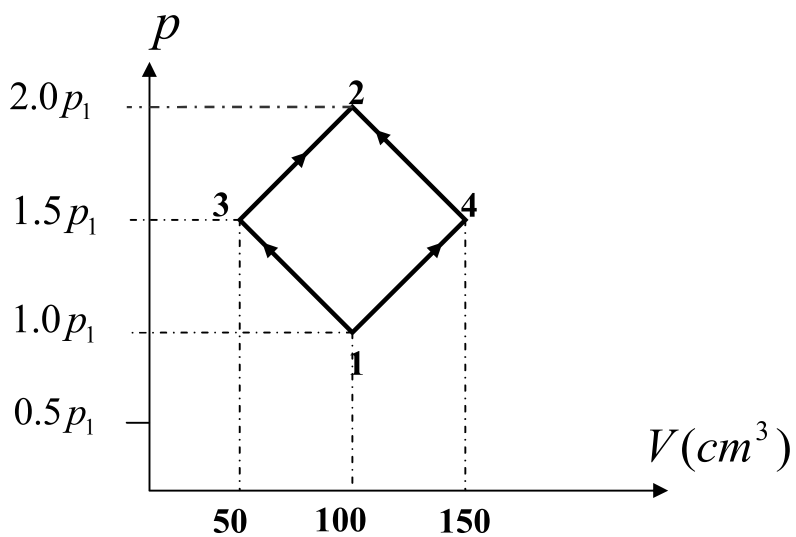

Figure 1

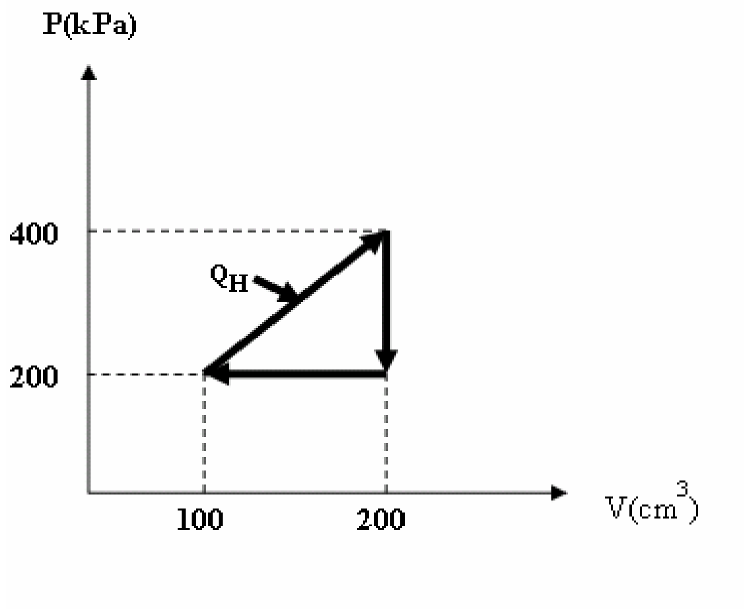

Figure 2

Physics 102 Major 1
Formula sheet

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

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

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

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

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

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

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

$\beta = 10 \log\left(\frac{I}{I_o}\right)$, $\quad I_o = 10^{-12}\ W/m^2$

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

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

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

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

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

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

$\Delta L = \alpha L \Delta T$ $\quad \Delta V = \beta V \Delta T$

$PV = nRT = NkT$

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

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

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

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

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

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

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

$Q = mL$

$Q = mc\Delta T$

$Q = nc\Delta T$

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

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

$C_p - C_v = R$

$W = \int P dV$

$P_{cond} = \frac{Q}{t} = kA\frac{T_H - T_C}{L}$

$\frac{m\overline{v^2}}{2} = (3/2)kT$, $\quad v_{rms} = \sqrt{\frac{3RT}{M}}$

$W = Q_H - Q_L$

$\varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$

$K = \frac{Q_L}{W}$

$\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$, $\quad \Delta S = \int \frac{dQ}{T}$

Constants:

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

R = 8.31 J/mol K

$N_A = 6.02 \times 10^{23}$ molecules/mole

1 atm = $1.01 \times 10^5\ N/m^2$

k = 1.38×10^{-23} J/K

1 calorie = 4.187 Joule

g = 9.8 m/s^2

for water:

$c_w = 4190\ \frac{J}{kg.K}$; $\quad c_{ice} = 2220\ \frac{J}{kg.K}$

$L_F = 3.33 \times 10^5\ \frac{J}{kg}$, $\quad L_V = 2.256 \times 10^6\ \frac{J}{kg}$