I included more than 35 problems only for practice purposes. In the final you will have 35 problems, as I stated during the last class meeting on Thursday, December 7, 2006.

Practice Final

Name__________________________

1) In a Young’s double slit experiment, a 5th order maximum occurs at an angle of 1.422°. If the screen is 3.90 m from the slits and the slit separation is 0.135 mm, what wavelength is being used?
   a) 3350 nm
   b) 670 nm
   c) 335 nm
   d) 589 nm
   e) 690 nm
   Ans: b

2) A small hole is cut in the bottom of a tank of water storage tank. The initial depth of the water is 8.0 m. If the diameter of the small hole in the bottom of the tank is 1.0 cm, then what is the flow rate of the water leaving the tank?
   a) 9.83 x 10^-4 m^3/s
   b) 8.75 x 10^-4 m^3/s
   c) 8.21 x 10^-4 m^3/s
   d) 7.45 x 10^-4 m^3/s
   e) 7.21 x 10^-4 m^3/s
   Ans: a

3). A sound source radiates sound uniformly in all directions. The intensity of the sound at a distance of 100 m is 1.0 x 10^-4 W/m^2. The power of the sound source is,
   A) 12.6 W
   B) 16.2 W
   C) 20.4 W
   D) 24.5 W
   E) 30.6 W
   Ans: A
4). A sound source of 100 watts radiates sound uniformly in all directions. The intensity of the sound at a distance of 4.0 m is,
   A) 0.301 W/m²
   B) 0.353 W/m²
   C) 0.497 W/m²
   D) 0.535 W/m²
   E) 0.621 W/m²
   Ans: C

5). A string with a mass/length of 0.002 kg/m is stretched between two points with a tension of 120 N. If the fundamental frequency is 440 Hz, then what is the distance between the two points?
   A) 17.5 cm
   B) 20.3 cm
   C) 27.8 cm
   D) 30.0 cm
   E) 35.0 cm
   Ans: C

6). A longitudinal wave travels on a slinky or any long spring. The wave is represented by the equation \( x(x,t) = 2.1\text{cm} \cos(2000 \text{ rad/s} t - 40 \text{ m}^{-1} x) \). What is the direction of the velocity of the wave?
   A) The \(-x\) direction
   B) The \(+x\) direction
   C) The \(-y\) direction
   D) The \(+y\) direction
   Ans: B

7). A string on a violin is stretched between two points 20 cm apart with a tension of 120 N. The mass/length of the string is 0.002 kg/m. The frequency of the mode next higher than the fundamental mode is,
   A) 758 Hz
   B) 980 Hz
   C) 1,225 Hz
   D) 1,558 Hz
   E) 2,120 Hz
   Ans: C
8). A transverse periodic wave is represented by the equation \( z(y,t) = 1.5 \text{ cm} \sin(1250 \text{ rad/s} \ t + 10.0 \text{ m}^{-1} \ y) \). What is the direction of the vibration of the wave?

A) The x direction
B) The y direction
C) The z direction

Ans: C

9). A transverse periodic wave is represented by the equation \( y(x,t) = 2.5 \text{ cm} \cos(2500 \text{ rad/s} \ t - 15.0 \text{ m}^{-1} \ x) \). What is the direction of the velocity of the wave?

A) The + z direction
B) The + y direction
C) The + x direction
D) The – z direction
E) The – y direction
F) The – x direction

Ans: C

10) An organ pipe is open at both ends. The frequency of the fourth mode is 316 Hz higher than the frequency of the third mode. If the speed of sound is 340 m/s, then what is the length of the organ pipe?

a) 53.8 cm
b) 59.8 cm
c) 60.3 cm
d) 62.8 cm
e) 64.7 cm

Ans: a

11) An organ pipe is open at both ends. The frequency of the third mode is 320 Hz higher than the frequency of the second mode. If the speed of sound is 345 m/s, then what is the length of the organ pipe?

a) 64.0 cm
b) 62.6 cm
c) 57.9 cm
d) 53.9 cm
e) 50.3 cm

Ans: d

12) A 25.0 cm long organ pipe is filled with air and is open at one end and closed at the other. The velocity of sound in air at 0 °C is 331 m/s. What is the frequency of the fifth mode?

a) 1,550 Hz
b) 1,750 Hz
c) 2,320 Hz
d) 2,720 Hz
e) 3,170 Hz
Ans: c

13) A 30.0 cm long organ pipe is filled with air and is open at one end and closed at the other. The velocity of sound in air at 0 °C is 331 m/s. What is the wavelength of the fifth mode?
   a) 30.3 cm
   b) 26.7 cm
   c) 21.2 cm
   d) 17.1 cm
   e) 12.3 cm
Ans: d

14) A sample of an ideal gas has a volume of 0.001 m³, a pressure of 4.5 atmospheres and $2.0 \times 10^{23}$ particles. What is the temperature of the gas?
   a) 154 K
   b) 165 K
   c) 173 K
   d) 186 K
   e) 194 K
Ans: b

15) An ideal gas at a temperature of 39 °C has a pressure of 2.0 atmospheres and a volume of 2.1 liters. What is the temperature if the pressure is halved and the volume is tripled?
   a) 155 °C
   b) 175 °C
   c) 188 °C
   d) 195 °C
   e) 204 °C
Ans: d

16) What is the total internal energy of one mole of an ideal gas at 100 °C?
   a) 5,230 J
   b) 4,650 J
   c) 4,040 J
   d) 3,950 J
   e) 3,750 J
Ans: b

17) An aluminum rod is 20.0 cm in length, has a diameter of 10.0 mm and is at a temperature of 20 °C. The coefficient of linear expansion of aluminum is $23.0 \times 10^{-6} \text{ °C}^{-1}$. If the temperature changes to 50 °C, then the increase in diameter of the aluminum rod is,
   a) $4.0 \times 10^{-3}$ mm
   b) $4.9 \times 10^{-3}$ mm
c) \(5.6 \times 10^{-3}\) mm  
d) \(6.0 \times 10^{-3}\) mm  
e) \(6.9 \times 10^{-3}\) mm  

Ans: e

18) The pupil of a cat’s eye narrows to a slit width of 0.5 mm in daylight. What is the angular resolution of the cat’s eye in daylight (\(\lambda = 500\) nm)?

a. 0.01 rads  
b. \(10^{-5}\) rads  
c. \(10^{-3}\) rads  
d. \(10^{-4}\) rads  
e. 0.1 rads

ans b

19). A ruby laser beam (\(\lambda = 694.3\) nm) is sent outwards from a 2.7-m diameter telescope to the moon, 384,000 km away. What is the radius of the big red spot on the moon?

a. 500 m  
b. 250 m  
c. 120 m  
d. 1.0 km  
e. 2.7 km

ans c

20). A radar installation operates at 9000 MHz with an antenna (dish) that is 15 meters across. Determine the maximum distance (in kilometers) for which this system can distinguish two aircraft 100 meters apart.

a. 7.4 km  
b. 370 km  
c. 3700 m  
d. 37 km  
e. 740 km

ans d

21). Two spectral lines in a mixture of hydrogen and deuterium gas have wavelengths of 656.30 nm and 656.48 nm, respectively. Determine the number of lines a diffraction grating must have to resolve these two wavelengths in first order.

a. 1825  
b. 3650  
c. 5475  
d. 7300  
e. 2740
If the interplanar spacing of NaCl is $2.814 \times 10^{-10}$ m, what is the predicted angle at which X-rays of wavelength 0.140 nm will be diffracted in a first-order maximum?

a. $31.3^\circ$

b. $7.20^\circ$

c. $20.5^\circ$

d. $14.4^\circ$

e. $29.8^\circ$

Photons of energy 4.20 eV bombard a surface, which emits photoelectrons with kinetic energies for 0 to 1.80 eV. What is the threshold frequency for this surface?

a) $1.35 \times 10^{14}$ Hz

b) $5.81 \times 10^{14}$ Hz

c) $1.35 \times 10^{15}$ Hz

d) $7.74 \times 10^{14}$ Hz

e) $7.74 \times 10^{15}$ Hz

Ans: b

Two converging lenses, the first with focal length 10.0 cm and the second with focal length 20.0 cm, are separated by 40.0 cm. An object, 3.0 cm in height, is placed 30.0 cm in front of the first lens. What is the height of the final image?

a) 3.0 cm

b) 1.5 cm

c) 6.0 cm

d) 12.0 cm

e) 24.0 cm

Ans: c

A 6.0 cm tall object is placed 20 cm in front of a convex mirror with focal −100 cm focal length. Where is the image formed?

a) 80 cm behind the mirror

b) 25 cm behind the mirror

c) 17 cm behind the mirror

d) 17 cm in front of the mirror

e) 25 cm in front of the mirror

Ans: c

A concave mirror has a 12-cm tall object placed 40 cm in front of it. An image forms 60 cm in front of the mirror. What is the size and orientation of the image?

a) 8.0 cm, inverted

b) 8.0 cm, upright
c) 18 cm, inverted  
d) 18 cm, upright  
e) 24 cm, upright  
Ans: c

27) A 25-cm focal length mirror has a 3.0-cm tall object placed 20 cm in front of it. What is the size of the image and is it upright or inverted?  
a) 1.0 cm, upright  
b) 3.8 cm, inverted  
c) 2.4 cm, inverted  
d) 15 cm, upright  
e) 12 cm, upright  
Ans: d

28) A thin lens of focal length 12.5 cm has a 5.0-cm tall object placed 10 cm in front of it. What is the size and orientation of the image?  
a) 4.0 cm, inverted  
b) 4.0 cm, upright  
c) 8.9 cm, inverted  
d) 8.9 cm, upright  
e) 25 cm, upright  
Ans

29) A thin lens of focal length –12.5 cm has a 5.0-cm tall object placed 10 cm in front of it. What are the size and orientation of the image?  
a) 4.0 cm, inverted  
b) 4.0 cm, upright  
c) 2.8 cm, inverted  
d) 2.8 cm, upright  
e) 100 cm, inverted  
Ans: d

30) If 50 kJ of heat flows into a system and 35 kJ of work is done by the system, then what is the change in internal energy?  
a) 85 kJ  
b) 70 kJ  
c) 65 kJ  
d) 15 kJ  
e) 10 kJ  
Ans: d

31) If 30 kJ of heat flows into a system and the internal energy increases by 15 kJ, then what is the work done by or on the system?  
a) +85 kJ  
b) +65 kJ  
c) -65 kJ
d) +15 kJ

e) -15 kJ

Ans: d

32) On a PV diagram where pressure is in atmospheres and V is in liters the area is measured in liter-atmospheres. What is the number of Joules in 1.0 liter-atmosphere?

   a) 101.3
   b) 83.1
   c) 65.2
   d) 22.4
   e) 15.7

Ans: a

33) The PV diagram for one mole of an ideal gas is shown in the figure above. 
P_1 = 3 atm, P_2 = 1 atm, V_1 = 7 liters, and V_2 = 21 liters. What is the temperature T_1 at point a?

   a) 256 K
   b) 200 K
   c) 175 K
   d) 115 K
   e) 100 K

Ans: a

34) One mole of an ideal gas undergoes an isobaric process from point a to point b in the figure above. P_1 = 3 atm, P_2 = 1 atm, V_1 = 7 liters, and V_2 = 21 liters. What is the work done by or on the system?

   a) 1,850 J
   b) 3,030 J
   c) 4,260 J
   d) 5,720 J
   e) 6,230 J

Ans: c

35) One mole of an ideal gas undergoes an isobaric process from point a to point b in the figure above. P_1 = 3 atm, P_2 = 1 atm, V_1 = 7 liters, and V_2 = 21 liters. What is the heat lost or gained by the system?

   a) 3,750 J
   b) 4,260 J
c) 6,380 J  
d) 10,640 J  
e) 12,540 J  
Ans: b

36) One mole of an ideal gas undergoes an isometric process from point b to point c in the figure above. P₁ = 3 atm, P₂ = 1 atm, V₁ = 7 liters, and V₂ = 21 liters. What is the change in the internal energy of the system?
a) −4,500 J  
b) +4,500 J  
c) −6,380 J  
d) +6,380 J  
e) +2,450 J  
Ans: c

37) One mole of an ideal gas undergoes an isothermal process from point c to point a in the figure above. P₁ = 3 atm, P₂ = 1 atm, V₁ = 7 liters, and V₂ = 21 liters. What is the work done by or on the system?
a) +4,330 J  
b) −4,330 J  
c) +2,340 J  
d) −2,340 J  
e) +6,650 J  
Ans: d

38) One mole of an ideal gas undergoes an isothermal process from point c to point a in the figure above. P₁ = 3 atm, P₂ = 1 atm, V₁ = 7 liters, and V₂ = 21 liters. What is the heat lost or gained by the system?
a) +5,780 J  
b) −5,780 J  
c) +2,340 J  
d) −2,340 J  
e) +8,120 J  
Ans: d

39) The PV diagram for an ideal gas is shown in the figure above. P₁ = 4 atm, V₁ = 1 liter, T₁ = 200 K, P₂ = 1 atm, V₂ = 4 liters, and T₂ = 800 K. What is the work done on or by the gas in the isobaric process from point a to point b?
a) +1,220 J  
b) −1,220 J  
c) +3,450 J  
d) −3,450 J  
e) +4,670 J  
Ans: a
40) The PV diagram for an ideal gas is shown in the figure above. \( P_1 = 4 \text{ atms} \), \( V_1 = 1 \text{ liter} \), \( T_1 = 200 \text{ K} \), \( P_2 = 1 \text{ atm} \), \( V_2 = 4 \text{ liters} \), and \( T_2 = 800 \text{ K} \). What is the heat gained or lost by the gas in the isometric process from point \( b \) to point \( c \)?

a) \(+1,820 \text{ J}\)

b) \(–1,820 \text{ J}\)

c) \(+3,040 \text{ J}\)

d) \(–3,040 \text{ J}\)

e) \(+4,860 \text{ J}\)

Ans: b

41) The PV diagram for an ideal gas is shown in the figure above. \( P_1 = 4 \text{ atms} \), \( V_1 = 1 \text{ liter} \), \( T_1 = 200 \text{ K} \), \( P_2 = 1 \text{ atm} \), \( V_2 = 4 \text{ liters} \), and \( T_2 = 800 \text{ K} \). What is the net work done by the gas in the cyclic process from point \( a \) to point \( b \) to point \( c \) to point \( a \)?

a) \(+654 \text{ J}\)

b) \(–654 \text{ J}\)

c) \(+562 \text{ J}\)

d) \(–562 \text{ J}\)

e) \(+361 \text{ J}\)

Ans: a

42) The PV diagram for an ideal gas is shown in the figure above. \( P_1 = 4 \text{ atms} \), \( V_1 = 1 \text{ liter} \), \( T_1 = 200 \text{ K} \), \( P_2 = 1 \text{ atm} \), \( V_2 = 4 \text{ liters} \), and \( T_2 = 800 \text{ K} \). What is the total heat output in the cyclic process from point \( a \) to point \( b \) to point \( c \) to point \( a \)?

a) \(1,823 \text{ J}\)

b) \(2,385 \text{ J}\)

c) \(3,034 \text{ J}\)

d) \(4,500 \text{ J}\)

e) \(5,020 \text{ J}\)

Ans: b

43) A engine goes through a cyclic process. During the cyclic process the engine does 600 \text{ J} of work and has a heat output of 2400 \text{ J}. What is the efficiency of the engine?

a) \(10\%\)

b) \(20\%\)

c) \(35\%\)

d) \(55\%\)

e) \(62\%\)

Ans: b

44) A sample of a monatomic ideal gas undergoes an adiabatic compression from 2 liters to 1 liter. When the gas has a volume of 2 liters, the pressure is 1 atm and the temperature is 300 \text{ K}. When the volume is 1 liter, what is the temperature?

a) \(325 \text{ K}\)

b) \(476 \text{ K}\)

c) \(533 \text{ K}\)
45) A sample of a monatomic ideal gas undergoes an adiabatic compression from 2 liters to 1 liter. When the gas has a volume of 2 liters, the pressure is 1 atm and the temperature is 300 K. What is the work done on the system?
   a) 429 J
   b) 378 J
   c) 235 J
   d) 178 J
   e) 135 J
   Ans: d

46) A heat pump uses 100 J of work to output 150 J of heat at some temperature. What is the coefficient of performance for the heat pump?
   a) 1.0
   b) 1.5
   c) 2.0
   d) 2.5
   e) 3.0
   Ans: b