Physics 103 CQZ2 SOLUTIONS and EXPLANATIONS

1. The specific heat of lead is c = 0.030 cal/g · °C. 300 g of lead shots at 100°C are mixed with 100 g of water (c =1.0 cal/g · °C) at 70°C. The final temperature of the mixture is:

A 100°C

B. 85.5°C

C. 79.5°C

D. 72.5°C

E. 70°C

$Q = mc\Delta T$

Heat lost = Heat gained

Put in the numbers for lead in the equation and set it equal to the numbers for water.

Solve for temperature T.

$300g(.030\ cal/g\cdot{}^{o}C)\ (100\ {}^{o}C - T_f) = 900 - 9\ T_f$

$100g(1\ cal/g\cdot{}^{o}C)\ (T_f - 70) = 100\ T_f - 7000$

$900 - 9\ T_f = 100\ T_f - 700$

$\frac{7900}{109} = \frac{109\ T_f}{109}$

$T_f = 72.5\ {}^{o}C$

2. An ideal gas occupies 1 m^3 when its temperature is 100 K and its pressure is 3 atm. Its temperature is now raised to 400 K and its volume increased to 2 m^3. The new pressure is:

A 1.5 atm

B. 3 atm

C. 6 atm

D. 0.547 atm

E. 0.333 atm

$P_1V_1/T_1=P_2V_2/T_2$

Solve for Pressure P_2 by setting the two equations equal to each other.

Multiply P_1 by V_1 and divide by temperature T_1. Then do the same thing to P_2, V_2, and T_2.:

$\frac{3\ atm(1m^3)}{100\ K} = \frac{P_2(2m^3)}{400K}$

$P_2 = 6$ atm

3. What is the temperature of 2 moles of ideal gas at a pressure of 400 kPa held in a volume of 15×10^{-3} m^3?

A. 102°C

B. 88°C

C. 33°C

D. -22°C

E. -66°C

Use ideal gass law equation and solve for temperature T

PV = nRT

$T = \frac{PV}{nR}$

Convert 400 kPa to Pascals (400,000)

P = 400,000

V = $15 \text{x} 10^{-3}$ m^3

n = 2

R = 8.31 J/K

$T = \frac{400{,}000\ (15 \text{x} 10^{-3})}{2(8.31)}$

= 361.01 ^{o}K

Convert temperature Kelvin to Celsius

(361-273 = 88)

= 88^{o}C

4. An isothermal process (*T* = Constant) for an ideal gas is represented on a *p*-*V* diagram by:

A. a horizontal line

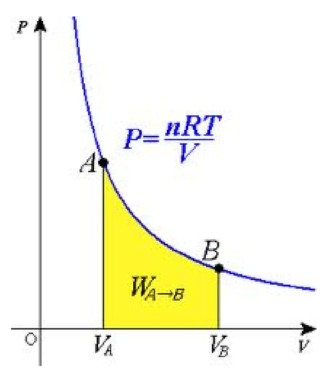
B. a vertical line

C. a portion of an ellipse

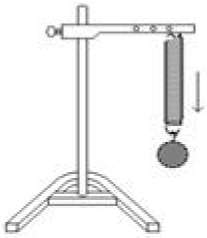
D. a portion of a parabola

E. a hyperbola

In an isothermal process, the temperature of a system does not change. It is shown on a p-V diagram by a hyperbola. (See page 396 in textbook)



5. An object attached to one end of a spring makes 20 vibrations in 10 s. Its period is:



2 Hz

A.

B. 10 s

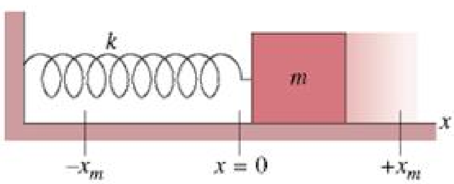
C. 0.5 Hz

D. 2 s

E. 0.50 s

Period is equal to time per one vibration. In this case T = 10/20
T = .50 s

6. A 0.20-kg object mass attached to a spring whose spring constant is 500 N/m executes simple harmonic motion. If its maximum speed is 5.0 m/s, the amplitude of its oscillation is:



A. 0.0020 m

B. 0.10 m

C. 0.20 m

D. 25 m

E. 250 m

The amplitude, angular frequency, and maximum velocity are related as follows: v=ω×A.
Angular frequency is $\omega = (k/m)^{1/2}$
The amplitude of oscillations is:
$A = v/\omega = v*(m/k)^{1/2} = 5*(0.2/500)^{1/2}$
= 0.1 m

7. A particle moves in simple harmonic motion according to $x = 2\cos(50t)$, where x is in meters

and t is in seconds.
Its **maximum velocity** in m/s is:

A. 100 sin(50t)

B. 100 cos(50t)

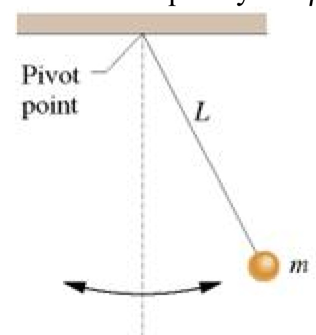
C. 100

D. 200

E. none of these

According to the laws of simple harmonic motion,
$v_{max} = A*\omega = 2*50 = 100$ m/s

8. A simple pendulum of length L and mass m has frequency f. To increase its frequency to 2f:



A. increase its length to 4L

B. increase its length to 2L

C. decrease its length to L/2

D. decrease its length to L/ 4

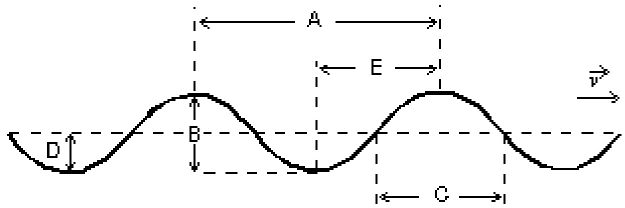
E. decrease its mass to m/4

The period of a simple pendulum does not depend on the mass, but on the length of the string.
By looking at the equation for angular frequency:

$f_1 = \sqrt{g / L_1}$

we can understand that the length divided by 4 would result in a frequency that is twice its original value. $f_2 = \sqrt{g / (L_1 / 4)} = 2\sqrt{g / L_1} = 2 f_1$

9. A sinusoidal mechanical wave is traveling toward the right as shown. Which letter correctly labels the amplitude of the wave?



A. A

B. B

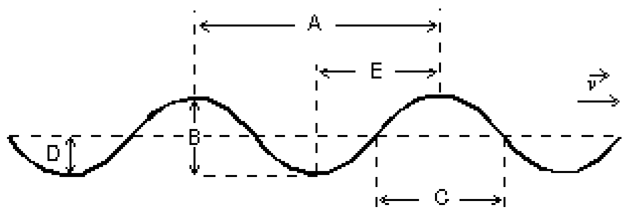
C. C

D. D

E. E

In a sinusoidal mechanical wave, the amplitude is described as the outermost positive or negative displacement from the undisturbed position of the medium to the top or bottom of a crest.

10. A sinusoidal wave is traveling toward the right as shown. Which letter correctly labels the wavelength of the wave?



A. A

B. B

C. C

D. D

E. E

In a sinusoidal mechanical wave, the wavelength is described as the distance between any two adjacent equivalent locations on the wave. In this case, A shows the distance from one maximum to another. A is the wavelength. C and E is ½ of the wavelength. B is a double amplitude.

11. A wave is described by $y(x,t) = 0.1 \sin(3x - 10t)$, where x is in meters, y is in centimeters and t is in seconds. The angular frequency is:

A. 0.10 rad/s

B. 3.0 rad/s

C. 10π rad/s

D. 20π rad/s

E. 10/ rad/s

Angular frequency is the parameter that is multiplied by time (t). So, it is the number 10, which should be measured in rad/s.

12. The speed of a sinusoidal wave on a string depends on:

A. the frequency of the wave

B. the wavelength of the wave

C. the length of the string

D. the tension in the string

E. the amplitude of the wave

The speed of a wave depends only on properties of the medium, such as $v = \sqrt{\tau / \mu}$, where the ratio under the square root is tension/linear mass. The speed of a wave does not depend on frequency, wavelength, or amplitude. When tension increases, the speed of the string is affected as well.

13. The tension in a string with a linear density of 0.0010 kg/m is 0.40 N. A 100 Hz sinusoidal wave on this string has a wavelength of:

A. 0.05 cm

B. 2.0 cm

C. 5.0 cm

D. 20 cm

E. 100 cm

First use this equation to find the wave speed: $v = \sqrt{\tau / \mu} = \sqrt{0.4 / 0.001} = 20\ m/s$

Then use the equation for solving frequency of a wavelength, and solve for wavelength $\lambda = v/f = 20/100 = .2$ m = 20 cm.

14. A stretched string, clamped at its ends, vibrates in its fundamental frequency.

To double the fundamental frequency, one can change the string tension by a factor of:

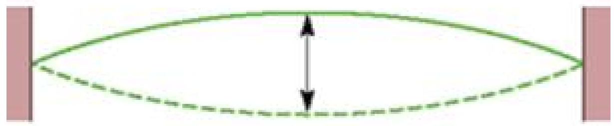
A. 2

B. 4

C. $\sqrt{2}$

D. 1/2

E. $1/\sqrt{2}$



$f = v/\lambda = \sqrt{\tau/\mu}/\lambda$, To double the fundamental frequency, one can change the string tension by a factor of 4. Wavelength is defined by the clamps.

15. The speed of a sound wave inside a medium (for example in the air, water, or stone) is determined by:

A. its amplitude

B. its intensity

C. its pitch

D. number of overtones present

E. the transmitting medium

The speed of a wave depends only on properties of the medium - not the frequency, wavelength, or amplitude.

16. A fire whistle emits a tone of 170 Hz. Take the speed of sound in air to be 340 m/s. The wavelength of this sound is about:

A. 0.5 m

B. 1.0 m

C. 2.0 m

D. 3.0 m

E. 340 m

Use this equation and solve for wavelength

$v = \lambda f$

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

= 340/170

= 2.0 m

17. The intensity of sound wave **A** is 100 times that of sound wave **B**. Relative to wave B the sound level of wave A is:

A. –2 db

B. +2 db

C. +10 db

D. +20 db

E. +100 db

B: $10\log(1/10^{-12}) = 120$
A: $10\log(100/10^{-12}) = 140$
A-B = 140-120 = 20
= +20db

18. The intensity of a certain sound wave is 6 $\mu W/cm^2$. If its intensity is raised by 10 decibels, the new intensity (in $\mu W/cm^2$) is:

A. 60

B. 6.6

C. 6.06

D. 600

E. 12

Decibels are relative numbers. For sound intensity, the dB difference depends on the ratio of the two intensities as
$dB = 10 \log (I_2/I_1)$,
I_1 and I_2 are the two intensities
$10 = 10 \log (I/6)$
$1 = \log(I/6)$
$10 = I/6$
$I=60$

19. A source emits sound with a frequency of 1000 Hz. Both, a source and an observer are moving **in the same direction**
with the same speed of 100 m/s. If the speed of sound is 340 m/s, the observer hears sound with a frequency of:

A. 294 Hz

B. 545 Hz

C. 1000 Hz

D. 1830 Hz

E. 3400 Hz

Solve for the frequency using the Doppler Effect Equation.
fs = 1000 Hz
vs = 100 m/s
v = 340 m/s
v0 = 0
f0 = fs (v + v0/v - vs)
= 1000*(340 – 100)/(340 - 100)
= 1000(1)
= 1000 Hz

20. A source emits sound with a frequency of 1000 Hz. A source and an observer are moving **toward each other**,
each with a speed of 100 m/s. If the speed of sound is 340 m/s, the observer hears sound with a frequency of:

A. 294 Hz

B. 545 Hz

C. 1000 Hz

D. 1830 Hz

E. 3400 Hz

Solve for the frequency using the Doppler Effect Equation.
fs = 1000 Hz
vs = 100 m/s
v = 340 m/s (speed of sound)
v0 = 100 Hz
f0 = fs (v + v0/v - vs)= 1000*(340 + 100)/(340 - 100)= 1000(440/240)= 1830 Hz