1. The bulk modulus is a proportionality constant that relates the pressure acting on an object to:

   A. the shear
   B. the fractional change in volume
   C. the fractional change in length
   D. Young's modulus
   E. the spring constant

2. Which *one* of the following is true of *any* fluid (not necessarily ideal)?

   A. It has a large shear modulus.
   B. It supports both transverse and longitudinal sound waves.
   C. It is incompressible.
   D. It is nonviscous.
   E. It conforms to the boundary of any container in which it is placed.

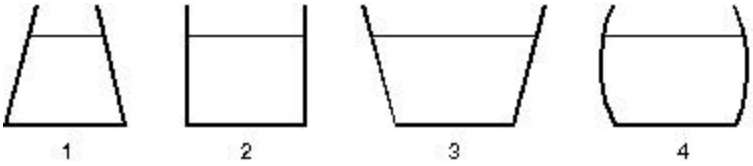
3. A sinusoidal wave of frequency 400 Hz has a velocity of 350 m/s. The distance between two points that differ in phase by $\pi/3$ rad is:

   A. 0.117 m
   B. 0.139 m
   C. 0.146 m
   D. 0.876 m
   E. 0.917 m

4. A traveling sound wave moves through an air filled cylindrical pipe. At a certain instant in time t and at a certain position x along the pipe, the longitudinal displacement $s(x,t)$ of air is observed to be a maximum. At that same point and same instant, the pressure variation $\Delta p(x,t)$ of the air is:

   A. a maximum
   B. zero
   C. a minimum
   D. somewhere between zero and a maximum, depending on the frequency of the wave.
   E. somewhere between zero and a minimum, depending on the frequency of the wave.

5. The vessels shown below all contain water to the same height. Rank them according to the pressure exerted by the water on the vessel bottoms, least to greatest.



A. 1, 2, 3, 4
B. 3, 4, 2, 1
C. 4, 3, 2, 1
D. 2, 3, 4, 1
E. All pressures are the same

6. A scientist pours mercury very slowly into the top of a vertical, cone-shaped tube (radius r_{top} = 0.5 m). It flows out a small hole in the bottom (radius r_{bottom} = 1 mm) of the tube. If the height of the tube is 2 m, what is the flow rate (mass per unit time) exiting through the small hole? (Assume that mercury is an ideal fluid of density 13.6 x 10^3 kg/m^3.)

A. 0.13 kg/s
B. 0.27 kg/s
C. 1.3 kg/s
D. 21 kg/s
E. 43 kg/s

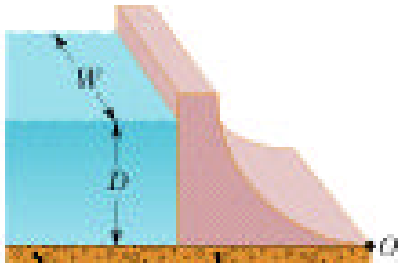
7. A light and very thin metal wire (of circular cross-section and radius 1 mm) hangs down 13.9 cm from the ceiling. It is observed to stretch by 0.1% when a weight 100 N is attached to it. What is the Young's modulus of this wire?

A. 1.6 x 10^{10} N/m^2
B. 3.2 x 10^{10} N/m^2
C. 4.8 x 10^{10} N/m^2
D. 6.4 x 10^{10} N/m^2
E. 9.6 x 10^{10} N/m^2

8. A sinusoidal wave is traveling on a string under tension. If the tension in the string is quadrupled and the frequency of the wave is kept the same, what happens to the wavelength?

   A. It is doubled.
   B. It is quadrupled.
   C. It remains the same.
   D. It is halved.
   E. It is reduced by a factor of 4.

9. Water stands at a depth D =35.0 m behind the vertical upstream face of a dam of width W=314 m. The net horizontal force on the dam from the gauge pressure of the water is



   A. 3.4×10^5 N
   B. 1.1×10^8 N
   C. 1.1×10^9 N
   D. 1.9×10^9 N
   E. 3.8×10^9 N

10. The following two waves are traveling on a string:
   · $y_1(x,t) = (10\text{ cm})\sin(3x - 6t)$
   · $y_2(x,t) = (10\text{ cm})\sin(3x + 6t)$

   Which of the following equations correctly describes the standing wave produced by these two waves?

   A. $y(x,t) = (20\text{ cm})\cos(3x)\sin(6t)$
   B. $y(x,t) = (20\text{ cm})\sin(3x)\cos(6t)$
   C. $y(x,t) = (10\text{ cm})\sin(3x)\cos(6t)$
   D. $y(x,t) = (20\text{ cm})\sin(1.5x)\cos(3t)$
   E. $y(x,t) = (20\text{ cm})\sin(6x)\cos(12t)$

11. A string of length 100 cm is held fixed at both ends and vibrates in a standing wave pattern. The wavelengths of the constituent traveling waves *cannot* be:

A. 400 cm
B. 200 cm
C. 100 cm
D. 66.7 cm
E. 50 cm

12. A noisy office has a sound level of 60 dB. What fraction of the sound intensity would have to be kept out or absorbed to bring the level down to 50 dB?

A. 90 %
B. 83 %
C. 17 %
D. 10 %
E. 9 %

13. An irregularly shaped piece of plastic of volume 0.0214 m^3 but unknown density floats on a liquid of unknown density. 35% of the volume of the plastic is submerged. A 0.500 kg mass is placed on top of the plastic, which still floats, but now with 37% of its volume submerged. What is the density of the *unknown liquid*? The added mass is entirely above the liquid level.

A. 63.1 kg/m^3
B. 584 kg/m^3
C. 1000 kg/m^3
D. 1170 kg/m^3
E. 3340 kg/m^3

14. At a point P, the path lengths from two point sound wave sources have a difference of 1/4 λ. The sound waves from the two sources are in phase when emitted. What is the phase difference between the sound waves at point P?

A. 0
B. $\pi/4$
C. $\pi/2$
D. π
E. 2π

15. A train at rest has a whistle that blows a note at 500 Hz. If the train is moving away from a stationary observer at a speed of 50 m/s, what is the frequency heard by the observer? Assume that the speed of sound in air is 340 m/s.

A. 444 Hz
B. 589 Hz
C. 436 Hz
D. 576 Hz
E. 400 Hz

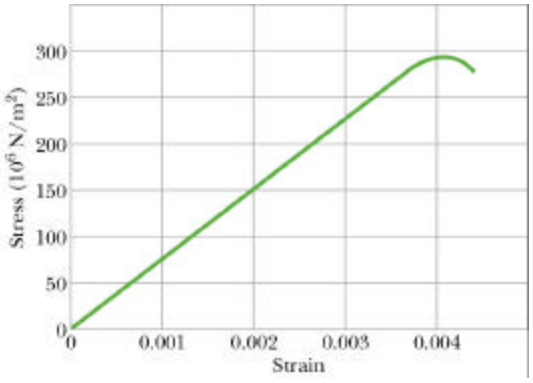
16. A hollow sphere of inner radius 8.0 cm and outer radius 9.0 cm floats half-submerged in liquid of density 800 kg/m^3. What is the density of the material of which the sphere is made?

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

17. What is the wavelength of the first overtone (or second harmonic) of an open-closed pipe if the length of the pipe is 3m?

A. 4m
B. 12m
C. 2.4m
D. 6m
E. 3m

18. The figure shows the stress-strain curve for quartzite. Approximately what is the Young's modulus of quartzite?



A. 2.5×10^8 Pa
B. 0.25×10^{10} Pa
C. 0.5×10^{10} Pa
D. 1×10^9 Pa
E. 7.5×10^{10} Pa

19. A sinusoidal transverse wave is traveling on a string. Any point on the string:

A. moves in simple harmonic motion with the same angular frequency as the wave.
B. moves in the same direction as the wave.
C. moves in simple harmonic motion with a different frequency than that of the wave.
D. moves with constant velocity equal to the wave velocity.
E. moves with the same acceleration as the wave.

20. A one-dimensional longitudinal wave traveling along a string is described by the following equation: $s(z,t) = (0.2\text{ m}) \sin(\pi z + 10\pi t)$, where all distances are measured in meters and time in seconds. Which of the following statements is **incorrect**?

A. The amplitude of the wave is 0.2 m.
B. The wave has a speed of 10 m/s.
C. The wave travels in the -z direction.
D. The wavelength of the wave is 2m.
E. The frequency of the wave is 10 Hz.

Answer Key for Test "213MtFa04.tst", 9/24/2004

No. in Q-Bank		No. on Test	Correct Answer
67	16	1	B
68	19	2	E
69	29	3	C
70	12	4	B
68	35	5	E
68	13	6	B
67	1	7	B
69	21	8	A
10	7	9	D
69	20	10	B
69	15	11	A
70	27	12	A
68	18	13	D
70	19	14	C
70	18	15	C
68	45	16	D
69	35	17	A
67	7	18	E
69	16	19	A
69	23	20	E