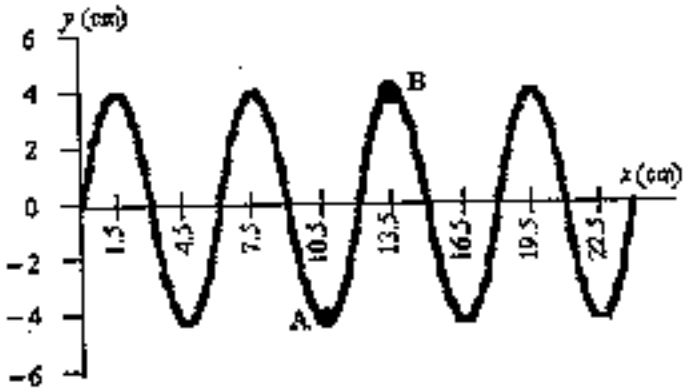
Use the following to answer question 1:

The displacement of a vibrating string versus position along the string is shown in the figure. The periodic waves have a speed of 10 cm/s. A and B are two points on the string.



1. What is the frequency of the wave?
   A) 0.60 Hz B) 0.90 Hz C) 1.11 Hz D) 1.25 Hz E) 1.67 Hz

2. A railroad whistle is sounded. An echo is heard 5.0 seconds later. If the speed of sound is 343 m/s, how far away is the reflecting surface?
   A) 68 m B) 140 m C) 860 m D) 1700 m E) 2000 m

3. A guitar string produces 4 beats/s when sounded with a 250 Hz tuning fork and 9 beats per second when sounded with a 255 Hz tuning fork. What is the vibrational frequency of the string?
   A) 240 Hz B) 246 Hz C) 254 Hz D) 259 Hz E) 263 Hz

Use the following to answer question 4:

A 3-m long string sustains a three-loop standing wave pattern as shown. The wave speed is 100 m/s.

4. What is the *lowest* possible frequency for standing waves on this string?
   A) 50.0 Hz B) 33.3 Hz C) 25.0 Hz D) 16.7 Hz E) 8.33 Hz

5. At a distance of 5.0 m from a point sound source, the sound intensity level is 110 dB. At what distance is the intensity level 95 dB?
   A) 5.0 m B) 7.1 m C) 14 m D) 28 m E) 42 m

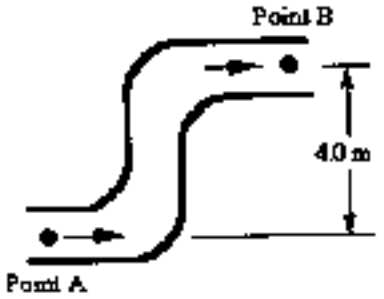
6. Determine the shortest length of pipe, open at both ends, which will resonate at 256 Hz. The speed of sound is 343 m/s.
   A) 0.33 m B) 0.67 m C) 0.99 m D) 1.32 m E) 1.67 m

7. The ends of a cylindrical steel rod are maintained at two different temperatures. The rod conducts heat from one end to the other at a rate of 10 cal/s. At what rate would a steel rod twice as long and twice the diameter conduct heat between the same two temperatures?
A) 5 cal/s B) 10 cal/s C) 20 cal/s D) 40 cal/s E) 80 cal/s

8. The coefficient of linear expansion of steel is $12 \times 10^{-6}/C°$. A railroad track is made of individual rails of steel 1.0 km in length. By what length would these rails change between a cold day when the temperature is −10 °C and a hot day at 30 °C?
A) 0.62 cm B) 24 cm C) 48 cm D) 480 cm E) 620 cm

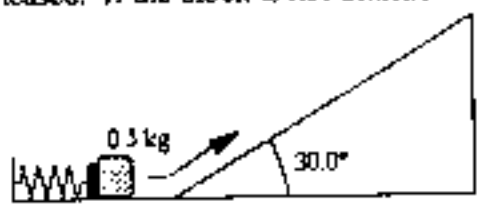
9. A thermos bottle contains 3.0 kg of water and 2.0 kg of ice in thermal equilibrium at 0 °C. How much heat is required to bring the system to thermal equilibrium at 50 °C?
A) 250 kcal B) 310 kcal C) 410 kcal D) 540 kcal E) 2700 kcal

12. Oil (ρ = 925 kg/m^3) is flowing through a pipeline at a constant speed when it encounters a vertical bend in the pipe raising it 4.0 m. The cross sectional area of the pipe does not change. What is the difference in pressure ($P_B - P_A$) in the portions of the pipe before and after the rise?



A) +2.4 × 10^4 Pa B) −3.6 × 10^4 Pa C) +5.1 × 10^5 Pa D) −7.2 × 10^5 Pa E) −1.8 × 10^3 Pa

13. A spring with constant k = 40.0 N/m is at the base of a frictionless, 30.0°-inclined plane. A 0.50-kg block is pressed against the spring, compressing it 0.20 m from its equilibrium position. The block is then released. If the block is not attached to the spring, how far along the incline will it travel before it stops?

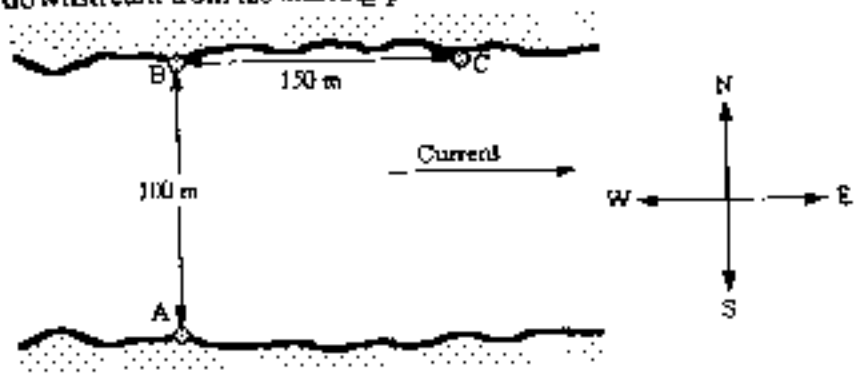


A) 0.080 m B) 0.16 m C) 0.32 m D) 1.6 m E) 3.2 m

14. A 2.0-kg solid cylinder of radius 0.5 m rotates at a rate of 40 rad/s about its cylindrical axis. What *power* is required to bring the cylinder to rest in 10 s?
A) 20 W B) 40 W C) 160 W D) 200 W E) 400 W

Use the following to answer question 24:

A man points his rowboat north from A to B, straight across a river of width 100 m. The river flows due east. The man starts across, rowing steadily at 0.75 m/s and reaches the other side of the river at point C, 150 m downstream from his starting point.



24. What is the speed of the river?
A) 0.38 m/s B) 0.67 m/s C) 1.1 m/s D) 6.7 m/s E) 7.5 m/s

25. Two sleds are hooked together in tandem as shown in the figure. The front sled is twice as massive as the rear sled.

The sleds are pulled along a frictionless surface by an applied force F. The tension in the rope between the sleds is T. Determine the ratio of the magnitudes of the two forces,

$$\frac{T}{F}$$

A) 0.25 B) 0.33 C) 0.50 D) 0.67 E) 2.0

1. E
2. C
3. B
4. D
5. D
6. B
7. C
8. C
9. C
10. E
11. B
12. B
13. C
14. A
24. C
25. B