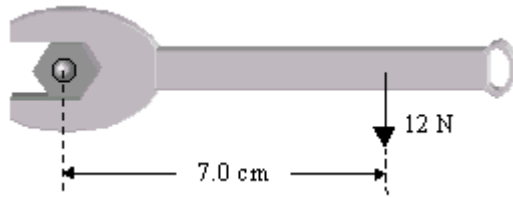


1. A wrench is used to tighten a nut as shown in the figure. A 12-N force is applied 7.0 cm from the axis of rotation. What is the torque due to the applied force?



- A) 0.58 N m B) 0.84 N m C) 1.71 N m D) 14 N m E) 58 N m
2. A submarine is operating at 100.0 m below the surface of the ocean. If the air inside the submarine is maintained at a pressure of 1.0 atmosphere, what is the magnitude of the force that acts on the rectangular hatch 2.0 m \times 1.0 m on the deck of the submarine?

- A) 980 N B) 2.0×10^3 N C) 5.0×10^4 N D) 9.8×10^5 N E) 2.0×10^6 N

3. A horizontal, 10-m plank weighs 100 N. It rests on two supports that are placed 1.0 m from each end as shown in the figure. How close to one end can an 800-N person stand without causing the plank to tip?



- A) 0 m B) 0.2 m C) 0.5 m D) 0.6 m E) 0.8 m

4. Which one of the following statements concerning the moment of inertia I is false?
- A) I may be expressed in units of $\text{kg} \cdot \text{m}^2$.
 - B) I depends on the angular acceleration of the object as it rotates.
 - C) I depends on the location of the rotation axis relative to the particles that make up the object.
 - D) I depends on the orientation of the rotation axis relative to the particles that make up the object.
 - E) Of the particles that make up an object, the particle with the smallest mass may contribute the greatest amount to I .
5. A hollow cylinder of mass M and radius R rolls down an inclined plane. A block of mass M slides down an identical inclined plane. If both objects are released at the same time,
- A) the cylinder will reach the bottom first.
 - B) the block will reach the bottom first.
 - C) the block will reach the bottom with the greater kinetic energy.
 - D) the cylinder will reach the bottom with the greater kinetic energy.
 - E) both the block and the cylinder will reach the bottom at the same time.
6. The position of a simple harmonic oscillator is given by
- $$x(t) = (0.5 \text{ m}) \cos\left(\frac{\pi}{3}t\right)$$

where t is in seconds. What is the period of the oscillator?

- A) 0.17 s B) 0.67 s C) 1.5 s D) 3.0 s E) 6.0 s

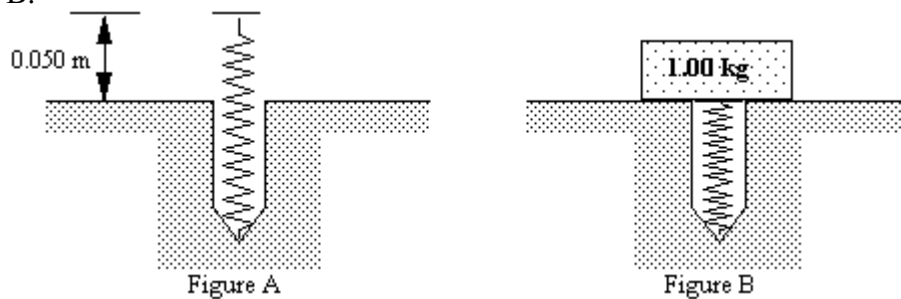
7. When a force of 20.0 N is applied to a spring, it elongates 0.20 m. Determine the period of oscillation of a 4.0-kg object suspended from this spring.

- A) 0.6 s B) 1.3 s C) 3.1 s D) 4.1 s E) 6.3 s

Use the following to answer question 8:

A relaxed spring protrudes from an opening 0.050 meters as shown in Figure A.

A 1.00-kg block is found to just force the spring completely into the opening as shown in Figure B.



12. A 2-kg block displaces 10 kg of water when it is held fully immersed. The object is then tied down as shown in the figure; and it displaces 5 kg of water. What is the tension in the string?

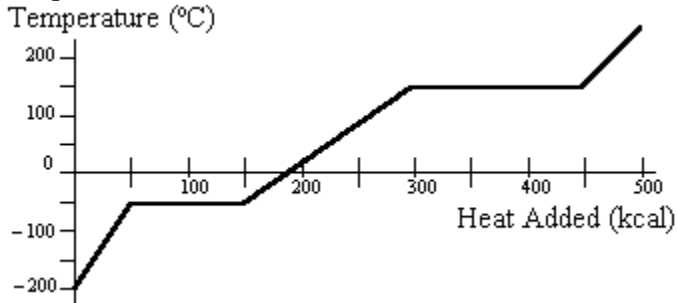


- A) 10 N B) 20 N C) 30 N D) 70 N E) 100 N
13. The container, fluid, and block are dropped from a window 10 m from the surface. Which of the following statements regarding the tension of the string is true?
- A) The tension remains unchanged from the value it had before being dropped
 - B) The block falls to the bottom of the container resulting in a value of 0 for the tension
 - C) The tension increases because gravity accelerates the water more than it does the block
14. Complete the following statement: The term *heat* most accurately describes
- A) the internal energy of an object.
 - B) a measure of how hot an object is.

- C) the absolute temperature of an object.
- D) the molecular motion inside of an object.
- E) the flow of energy due to a temperature difference.

Use the following to answer question 15:

Heat is added to a 1.0-kg solid sample of a material at $-200\text{ }^{\circ}\text{C}$. The figure shows the temperature of the material as a function of the heat added.



15. Which one of the following statements concerning this substance is true?
- A) It boils at $300\text{ }^{\circ}\text{C}$.
 - B) It melts at $-200\text{ }^{\circ}\text{C}$.
 - C) It is a liquid at $200\text{ }^{\circ}\text{C}$.
 - D) It can coexist as a solid and a liquid at $-50\text{ }^{\circ}\text{C}$.
 - E) It can exist as a solid, liquid, and gas at $150\text{ }^{\circ}\text{C}$.

16. A pebble is dropped in a lake; and it produces ripples with a frequency of 0.25 Hz. When should a second pebble be dropped at the same place to produce destructive interference?
- A) 0.50 s after the first
B) 0.75 s after the first
C) 1.0 s after the first
D) 1.5 s after the first
E) 2.0 s after the first
17. Assuming a filament in a 100 W light bulb acts like a perfect blackbody, what is the temperature of the hottest portion of the filament if it has a surface area of $6.3 \times 10^{-5} \text{ m}^2$? The Stefan-Boltzmann constant is $5.67 \times 10^{-8} \text{ W}/(\text{m}^2 \text{ K}^4)$.
- A) 130 K B) 1100 K C) 2300 K D) 5800 K E) 30 000 K
18. A 5.0-g sample of ice at $0.0 \text{ }^\circ\text{C}$ falls through a distance of 20.0 m and undergoes a completely inelastic collision with the earth. If all of the lost mechanical energy is absorbed by the ice, how much of it melts?
- A) $2.9 \times 10^{-3} \text{ g}$
B) $4.3 \times 10^{-3} \text{ g}$
C) $7.6 \times 10^{-3} \text{ g}$
D) $1.8 \times 10^{-2} \text{ g}$
E) $2.1 \times 10^{-2} \text{ g}$

19. A transverse wave is traveling in the $-x$ direction on a string that has a linear density of 0.011 kg/m . The tension in the string is 7.4 N . The amplitude of the wave is 0.017 m ; and its wavelength is 1.5 m . Which one of the following is the correct equation for the displacement of a particle from its equilibrium position?

- A) $y = (0.017 \text{ m}) \sin[(84 \text{ Hz})t + (4.2 \text{ m}^{-1})x]$
- B) $y = (0.017 \text{ m}) \sin[(110 \text{ Hz})t + (4.2 \text{ m}^{-1})x]$
- C) $y = (4.2 \text{ m}) \sin[(84 \text{ Hz})t + (59 \text{ m}^{-1})x]$
- D) $y = (4.2 \text{ m}) \sin[(110 \text{ Hz})t - (59 \text{ m}^{-1})x]$
- E) $y = (0.017 \text{ m}) \sin[(110 \text{ Hz})t - (8.4 \text{ m}^{-1})x]$

20. A bell is ringing inside of a sealed glass jar that is connected to a vacuum pump. Initially, the jar is filled with air. What does one hear as the air is slowly removed from the jar by the pump?

- A) The sound intensity gradually decreases.
- B) The frequency of the sound gradually increases.
- C) The frequency of the sound gradually decreases.
- D) The speed of the sound gradually increases.
- E) The sound intensity of the bell does not change.

Answer Key -- Spr02-final

1. B
2. E
3. C
4. B
5. B
6. E
7. B
8. A
9. A
10. B
11. D
12. C
13. B
14. E
15. D
16. E
17. C
18. A
19. B
20. A