

Name: _____

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Relevant physical constants:

gravitational acceleration = 9.8 m/s^2 .latent heat for ice/water transition = $80 \text{ cal/g} = 3.33 \cdot 10^5 \text{ J/kg}$ latent heat for water/steam transition = $540 \text{ cal/g} = 2.26 \cdot 10^6 \text{ J/kg}$ velocity of sound in air is taken to be 340 m/s unless otherwise specified.Heat conversion: $1 \text{ cal} = 4.186 \text{ J}$; $1 \text{ kcal} = 4186 \text{ J}$ Universal gas constant: $R = 8.31 \text{ J/(mol} \cdot \text{°K)}$

Specific heats:

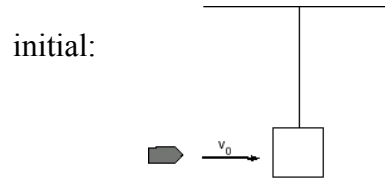
| c | water | ice | steam | aluminum | copper |
|-----------|-------|------|-------|----------|--------|
| kcal/kg°C | 1.0 | 0.50 | 0.48 | 0.22 | 0.093 |

Note on significant figures: If your answer is close to one of the choices offered, within the significant figure specified for the latter (with possible round-off), it should be considered as the right choice. For example: if you get 4.432156 and one of the choices given is 4.4, then the later is the answer. Similarly, if you get 5.6772 and one of the choices is 5.68, then it should be considered as the right choice.

- The frequency of a tuning fork is 468 Hz . Find the length of the shortest open pipe which will give 6 beats/s with the fork.
 - 0.18 m
 - 0.36 m
 - 0.72 m
 - 0.96 m
 - none of the above
- An elevator, with mass $m = 1000 \text{ kg}$, is going up with *acceleration* $a = 2.0 \text{ m/s}^2$. Find the tension T in the supporting cable.
 - 5000 kg m/s^2
 - 8000 N
 - 10000 kg m/s^2
 - 12000 N
 - 15000 kg m/s^2

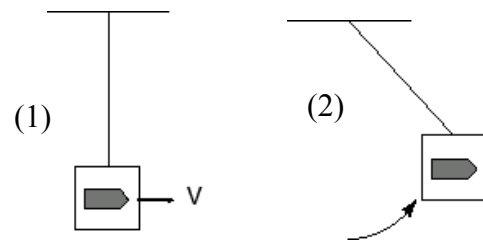
3. In a ballistic pendulum experiment, two processes occur in succession: (1) A bullet at high initial velocity v_0 is stopped in a wooden block (which is suspended from the ceiling by a string), and the combined system acquires a velocity of V ; and (2) the system executes a pendulum motion in which the velocity decreases as the pendulum rises until it reaches a maximum height and turns back. Linear momentum (along the direction of motion) is conserved in

- process (2) but not (1);
- proc. (1) but not (2);
- both (1) and (2);
- neither (1) nor (2);
- none of the above.



4. In the same ballistic pendulum problem as above, mechanical energy (kinetic plus potential energies) is conserved in

- process (2) but not (1);
- “(1) “ (2);
- both (1) and (2);
- neither (1) nor (2);
- none of the above.



5. If you increase the power level to your speakers by 27 dB, by what factor is the amplitude of the pressure wave increase?

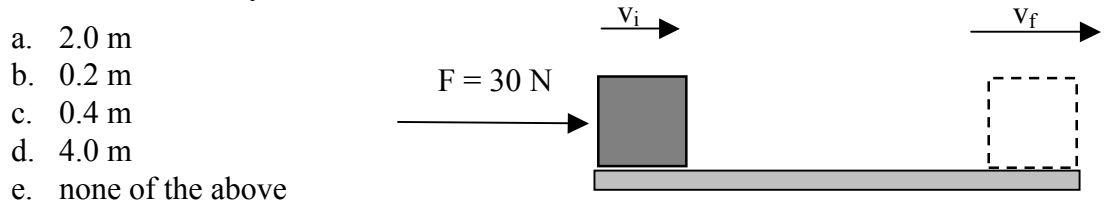
- 501
- 22.4
- 14.9
- 3.86
- none of the above

6. Waves propagate at 8 m/s along a stretched string. The end of the string is vibrated up and down once every 2.5 s. What is the wavelength of the waves that travel along the string?

- 10 m
- 20 m
- 5.0 m
- 15 m
- none of the above

7. Which one of the following quantities is at a maximum when an object in simple harmonic motion is at zero displacement?
- potential energy
 - frequency
 - acceleration
 - kinetic energy
 - force
8. One person hits the rail with a hammer, while another one is some distance away with one ear on the rail. Suppose that the time difference between the arrivals of the two sounds traveling through air and through steel is 3.98 s. If the speed of sound in air was 340 m/s, how far (in km) are the two persons apart? (For steel: Young's modulus is $2.0 \cdot 10^{11} \text{ N/m}^2$ and the density is 7800 kg/m^3)
- 1.45 km
 - 2.34 km
 - 5.68 km
 - 3.55 km
 - none of the above

9. A force of magnitude 30 N acts on a 1.2 kg block. If the initial velocity of the block is 4 m/s and the force acts in the direction of this velocity, over what distance must this force act to change the block's velocity from 4 to 6 m/s?



10. A gas is at an initial pressure of $1.5 \cdot 10^4 \text{ Pa}$, and occupies a volume of 0.25 m^3 . The (slow) addition of 25000 cal of heat to the system causes it to expand isobarically to a volume of 0.40 m^3 . What is the increase in the internal energy of the system?
- 2250 J
 - 25000 cal
 - 5972 J
 - $107 \times 10^3 \text{ J}$
 - $102 \times 10^3 \text{ J}$

11. A 0.5 kg mass oscillates in simple harmonic motion on a spring which has a spring constant of 2500 N/m. The spring was initially compressed 12 cm (a negative displacement). What is the velocity in m/s when the mass is at a positive displacement of 5 cm?

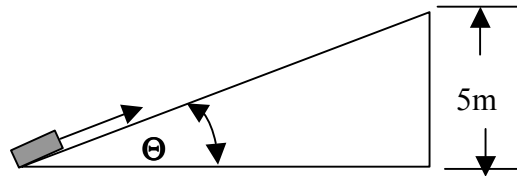
- a. 3.5 m/s
- b. 5.8 m/s
- c. 7.7 m/s
- d. 15.1 m/s
- e. 22.5 m/s

12. An ideal Carnot engine takes in 20 kcal of heat at 80 °C and exhausts some of this at 10 °C. How much work in J must have been done by the engine?

- a. 4.22×10^5
- b. 100.9
- c. 100 900
- d. 2.12×10^4
- e. 2120

13. A 100 kg mass is pushed up a frictionless inclined plane. How much work has to be done against gravity to move the block from the bottom to the top of a plane whose height is 5 m and which makes an angle $\Theta = 37^\circ$ with the horizontal?

- a. 3913 J
- b. 500 J
- c. 4900 J
- d. 1960 J
- e. none of the above



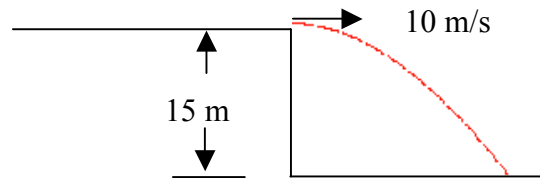
14. A heat engine exhausts heat of amount $Q_c = 3000$ J while performing useful work of the amount $W=1500$ J. What is the efficiency of the engine?

- a. 15 %
- b. 50 %
- c. 60 %
- d. 33 %
- e. 100 %

15. Heat is added to 2 kg of ice at $-18\text{ }^{\circ}\text{C}$. How many kilocalories are required to change the ice to steam at $110\text{ }^{\circ}\text{C}$.
- a. 1458.0
 - b. 1449.6
 - c. 360.0
 - d. 1467.6
 - e. none of the above

16. A ball is thrown horizontally from the top of a 15 m high cliff. If the initial speed of the ball is 10 m/s, what is the speed of the ball when it hits the ground?

- a. 10 m/s
- b. 29.8 m/s
- c. 15 m/s
- d. 19.8 m/s
- e. none of the above



17. A block of aluminum with a mass of 3.8 kg is at $8\text{ }^{\circ}\text{C}$ and comes in contact with a hot block of copper with a mass of 8 kg at $56\text{ }^{\circ}\text{C}$. What is the final temperature?

- a. $21.5\text{ }^{\circ}\text{C}$
- b. $30.6\text{ }^{\circ}\text{C}$
- c. $35.3\text{ }^{\circ}\text{C}$
- d. $42.7\text{ }^{\circ}\text{C}$
- e. none of the above

18. Find the amount of heat Q transferred per square meter in 1 hr by conduction through a composite wall of thickness 0.36 m if the inside temperature is T_i and the outside temperature is T_o . Assume the thermal conductivity of this wall to be $1.0\text{ J/s} \cdot \text{m} \cdot ^{\circ}\text{C}$. Let $T_i = 30\text{ }^{\circ}\text{C}$ and $T_o = 10\text{ }^{\circ}\text{C}$, then the amount of heat is:

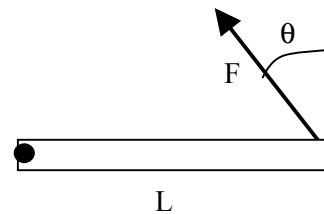
- a. 2000 J
- b. 10000 J
- c. 36000 J
- d. 200000 J
- e. none of the above.

19. A gas cylinder of volume 30 liters contains an ideal gas at temperature 27 degrees C and pressure 1870 kPa. Some of the gas leaks, until the pressure falls to 1330 kPa. How many moles of gas leaked, assuming that the temperature remains constant during this process?

- a. 2.5
- b. 4.7
- c. 6.5
- d. 9.6
- e. none of the above.

20. A wooden beam of length L is hinged at one end. A force F acts on the other end at an angle as shown in the figure. The resulting torque which determines the rotational motion of the beam around the pivot point is:

- a. $L F \cos\theta$
- b. $-L F \cos\theta$
- c. $L F$
- d. $L F \sin\theta$
- e. $-L F \sin\theta$



21. A piece of moon rock reads 28.2 grams on a scale when in air, but 14 grams in alcohol (specific gravity = 0.79). What is its density in kg/m^3 ?

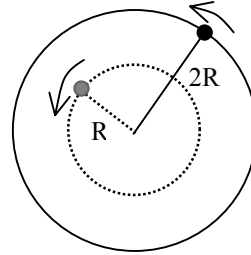
- a. 567
- b. 1268
- c. 1453
- d. 1569
- e. none of the above

22. A steel wire, 100 m long at 10°C , has a coefficient of linear expansion of $1 \times 10^{-5}/\text{C}^\circ$. Give its change in length as the temperature changes from 10°C to 40°C .

- a. 1.0 cm
- b. 3.0 cm
- c. 4.0 cm
- d. 1.0 m
- e. 0.3 m

23. A puck of mass m is attached to a string and is whirled around in a circular motion. Initially, the radius of the circle is R and the angular speed is ω . The string is gradually extended outward until the radius becomes $2R$. What is the angular speed at the new radius?

- a. $\omega / 4$
- b. $\omega / 2$
- c. ω
- d. 2ω
- e. 4ω



24. Consider a child playing on a swing. As she reaches the lowest point in her swing, which of the following statements is true?

- a. her acceleration is downward and equal to g (9.8 m/s^2).
- b. the tension in the rope is equal to her weight, mg .
- c. the tension in the rope is equal to her mass times her acceleration, ma .
- d. the tension is equal to $mg + mv^2/L$ where L is the length of the swing.
- e. none of the above.

25. A cylinder ($I = MR^2/2$) is rolling along the ground at 8 m/s . It comes to a hill and starts going up. Assuming no losses to friction, how high does it get before it stops?

- a. 3.75 m
- b. 0.30 m
- c. 2.50 m
- d. 4.90 m
- e. none of the above