Physics 20  Exam 3 Practice Problems Fall 14

Short Conceptual Questions (2 points each). Circle the best answer.

1. When bringing water to a boil in the mountains, the time needed to reach the boiling point is
   a. less than at sea level  b. more than at sea level  c. the same as at sea level

2. The second law of thermodynamics says that
   A. the entropy of an isolated system never decreases.   B. heat never flows spontaneously from cold to hot.
   C. the total thermal energy of an isolated system is constant.   D. both a and b.   E. both a and c.

3) Consider a flat steel plate with a hole through its center as shown in the figure.  When the temperature of the plate is increased, the hole will

   A) expand only if it takes up more than half the plate's surface area.
   B) contract if it takes up less than half the plate's surface area.
   C) always contract as the plate expands into it.
   D) always expand with the plate.
   E) remain the same size as the plate expands around it.

4. On a cold day, a piece of metal feels much colder to the touch than a piece of wood. This is due to the difference in which one of the following physical properties of these materials?
   A) density
   B) specific heat
   C) emissivity
   D) thermal conductivity
   E) mass

5) The process in which heat flows by the mass movement of molecules from one place to another is known as
   A) conduction.  
   B) convection.  
   C) radiation.

6. Express a body temperature 98.6°F in Celsius degrees.
   A) 37.0°C
   B) 45.5°C
   C) 66.6°C
   D) 72.6°C

7. Oxygen molecules are 16 times more massive than hydrogen molecules. At a given temperature, how do their average molecular speeds compare? The oxygen molecules are moving
   A) four times faster than the hydrogen molecules.
   B) at 1/4 the speed of the hydrogen molecules.
   C) sixteen times faster than the hydrogen molecules.
   D) at 1/16 the speed of the hydrogen molecules.
   E) at \(1/\sqrt{2}\) the speed of the hydrogen molecules.

8. If the frequency of a system undergoing simple harmonic motion doubles, by what factor does the maximum value of acceleration change?
   A) 4
   B) 2
   C) \(\sqrt{2}\)
   D) \(2/\pi\)
9) A pendulum of length $L$ is suspended from the ceiling of an elevator. When the elevator is at rest the period of the pendulum is $T$. How does the period of the pendulum change when the elevator moves upward with constant acceleration?
A) The period does not change.
B) The period increases.
C) The period decreases.
D) The period becomes zero.
E) The period increases if the upward acceleration is more than $g/2$ but decreases if the upward acceleration is less than $g/2$.

10. What is the wavelength of the wave shown in the figure?
A) 8 m.
B) 4 m.
C) 2 m.
D) 1 m.
E) It cannot be determined from the given information.

11) What is the frequency of the wave shown in the figure?
A) 0.5 Hz.
B) 1 Hz.
C) 2 Hz.
D) 4 Hz.
E) It cannot be determined from the given information.

12) The intensity of the waves from a point source at a distance $d$ from the source is $I$. At what distance from the sources is the intensity equal to $2I$?
A) $d/2$
B) $d/\sqrt{2}$
C) $d/4$
D) $d/8$

13) Suppose that a sound source is emitting waves uniformly in all directions. If you move to a point twice as far away from the source, the frequency of the sound will be
A) unchanged.
B) half as great.
C) one-fourth as great.
D) twice as great.

14. Frequencies that are too low for humans to hear are called:
   a) supersonic  b) infrasonic  c) hypersonic  d) ultrasonic  e) subsonic  f) funkasonic

15. When a damping force is applied to a simple harmonic oscillator which has angular frequency $\omega_0$ in the absence of damping, the new angular frequency $\omega$ is such that
   a. $\omega < \omega_0$.
   b. $\omega = \omega_0$.
   c. $\omega > \omega_0$. 
1. A person consumes a snack containing 14 food calories (14 kcal). What is the power this food produces if it is to be "burned off" due to exercise in 6 hours? (1 cal = 4.186 J)
   A) 2.7 W
   B) 9763 W
   C) 0.6 W
   D) 0.0027 W

2. A cylinder contains 1.50 moles of an ideal monatomic gas that is initially at a temperature of 317 K. If the gas gains 2730 J of heat and performs 780 J of work, what is its final temperature? (R = 8.31 J/mol ∙ K)
   A) 359 K
   B) 421 K
   C) 526 K
   D) 687 K
   E) 756 K

3. During an isothermal process, 5.0 J of heat is removed from an ideal gas. What is the work done by the gas in the process?
   A) 0 J
   B) 5.0 J
   C) -5.0 J
   D) -10 J

4. A certain heat engine extracts 1.30 kJ of heat from a hot temperature reservoir and discharges 0.70 kJ of heat to a cold temperature reservoir. What is the efficiency of this engine?
   A) 46%
   B) 54%
   C) 86%
   D) 27%
   E) 13%

5. An aluminum rod 17.400 cm long at 20°C is heated to 100°C. What is its new length? Aluminum has a linear expansion coefficient of 25 × 10⁻⁶ K⁻¹.
   A) 17.435 cm
   B) 17.365 cm
   C) 0.348 cm
   D) 0.0348 cm
6. How much heat is required to raise the temperature of a 225-g lead ball from 15.0°C to 25.0°C? The specific heat of lead is 128 J/kg \cdot K.
A) 725 J
B) 576 J
C) 145 J
D) 217 J
E) 288 J

7. An aluminum electric tea kettle with a mass of 500 g is heated with a 500-W heating coil. How long will it take to heat up 1.0 kg of water from 18°C to 98°C in the tea kettle? The specific heat of aluminum is 900 J/kg \cdot K and that of water is 4186 J/kg \cdot K.
A) 5.0 minutes
B) 7.0 minutes
C) 12 minutes
D) 15 minutes
E) 18 minutes

8. A glass window pane is 2.7 m high, 2.4 m wide, and 9.0 mm thick. The temperature at the inner surface of the glass is 19°C and at the outer surface 4°C. How much heat is lost each hour through the window?
A) 3.1 \times 10^7 J
B) 3.1 \times 10^4 J
C) 8.6 \times 10^3 J
D) 8.6 J
E) 3.1 \times 10^5 J

9. What is the net power radiated by a little animal with a surface area of 0.075 m² if his emissivity is 0.75, his skin temperature is 315 K, and he is in a room with a temperature of 290 K? \( \sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4 \)
A) 8.8 W
B) 6.0 W
C) 8.0 W
D) 15 W
E) 18 W

10. Your lungs hold 4.2 L of air at a temperature of 27°C and a pressure of 101.3 kPa. How many moles of air do your lungs hold? \( R = 8.31 \text{ J/mol} \cdot \text{K} \)
A) 0.15 moles
B) 0.17 moles
C) 0.19 moles
D) 0.21 moles
E) 0.23 moles
11. A balloon originally has a volume of 1.0 m³ when the gas in it is at 20°C and under a pressure of 1.0 atm. As it rises in the earth's atmosphere, its volume expands. What will be its new volume if its final temperature and pressure are -40°C and 0.10 atm?
A) 2.0 m³  
B) 4.0 m³  
C) 6.0 m³  
D) 8.0 m³

12. An object undergoing simple harmonic motion has a maximum displacement of 6.2 m at $t = 0.00$ s. If the angular frequency of oscillation is 1.6 rad/s, what is the object's displacement when $t = 3.5$ s?
A) 4.8 m  
B) 5.6 m  
C) 3.7 m  
D) 3.1 m

13. A 0.250-kg stone is attached to an ideal spring and undergoes simple harmonic oscillations with a period of 0.640 s. What is the force constant (spring constant) of the spring?
A) 2.45 N/m  
B) 12.1 N/m  
C) 24.1 N/m  
D) 0.102 N/m  
E) 0.610 N/m

14. A 0.150-kg air track cart is attached to an ideal spring with a force constant (spring constant) of 3.58 N/m and undergoes simple harmonic oscillations. What is the period of the oscillations?
A) 2.57 s  
B) 0.527 s  
C) 0.263 s  
D) 1.14 s  
E) 1.29 s

15. A 1.53-kg piece of iron is hung by a vertical ideal spring. When perturbed slightly, the system is moves up and down in simple harmonic oscillations with a frequency of 1.95 Hz and an amplitude of 7.50 cm. If we choose the total potential energy (elastic and gravitational) to be zero at the equilibrium position of the hanging iron, what is the total mechanical energy of the system?
A) 0.844 J  
B) 0.646 J  
C) 0.633 J  
D) 0.955 J  
E) 0.000 J
16. The period of a simple pendulum that is 1.00 m long on another planet is 1.66 s. What is the acceleration due to gravity on this planet if the mass of the pendulum bob is 1.5 kg?
A) 14.3 m/s²
B) 13.3 m/s²
C) 15.7 m/s²
D) 17.2 m/s²

17. A fisherman fishing from a pier observes that the float on his line bobs up and down, taking 2.4 s to move from its highest point to its lowest point. He also estimates that the distance between adjacent wave crests is 48 m. What is the speed of the waves going past the pier?
A) 1.0 m/s
B) 20 m/s
C) 10 m/s
D) 5.0 m/s
E) 120 m/s

18. A piano wire of linear mass density 0.0050 kg/m is under a tension of 1350 N. What is the wave speed in this wire?
A) 130 m/s
B) 260 m/s
C) 520 m/s
D) 1040 m/s

19. Light from a laser forms a 1.31-mm diameter spot on a wall. If the light intensity in the spot is $1.58 \times 10^4 \text{ W/m}^2$, what is the power output of the laser? Assume that all the light emitted by the laser hits the spot.
A) 21.3 mW
B) 13.2 mW
C) 17.9 mW
D) 24.7 mW

20. A barking dog delivers about 1.0 mW of power, which is assumed to be uniformly distributed in all directions. What is the intensity level in decibels at a distance 5.00 m from the dog? The threshold of human hearing is $1.0 \times 10^{-12} \text{ W/m}^2$.
A) 61 dB
B) 63 dB
C) 65 dB
D) 68 dB
21. A whistle produces sound of frequency of 1.00 kHz. If a listener moves with a speed of 30 m/s away from the whistle, what frequency does this person hear if the sound speed is 340 m/s?
A) 912 Hz  
B) 919 Hz  
C) 1000 Hz  
D) 1090 Hz

22. The lowest tone to resonate in pipe of length $L$ that is open at both ends is 200 Hz. Which one of the following frequencies will \textit{not} resonate in the same pipe?
A) 200 Hz  
B) 400 Hz  
C) 600 Hz  
D) 800 Hz  
E) 900 Hz

23. The lowest tone to resonate in a pipe of length $L$ that is closed at one end but open at the other end is 200 Hz. Which one of the following frequencies will \textit{not} resonate in that pipe?
A) 200 Hz  
B) 400 Hz  
C) 600 Hz  
D) 1000 Hz  
E) 1400 Hz

24. Two tuning forks have frequencies of 440 and 522 Hz. What is the beat frequency if both are sounding simultaneously?
A) 962 Hz  
B) 481 Hz  
C) 82 Hz  
D) 55 Hz  
E) 41 Hz

25. A 4.0-g string is 0.39 m long and is under tension. The string vibrates at 600 Hz in its third harmonic. What is the tension in this string?
A) 250 N  
B) 200 N  
C) 160 N  
D) 290 N  
E) 340 N