Practice Questions for a PS 160 Final Exam

1. A 1200-kg car has a suspension system with an effective spring constant of 1.5×10^5 N/m, but with no shock absorbers. What is the car's natural frequency ω?

   (a) 0.01 rad/s

   (b) 0.1 rad/s

   (c) 10 rad/s

   (d) 100 rad/s

   (e) 1000 rad/s

2. An object executing simple harmonic motion is described by

$$x(t) = (2.00 \text{ cm}) \cos(\omega t + 3.00),$$

where the phase angle is, of course, in radians. The maximum speed of this object is 8.00 cm/s. What is the frequency f of this object?

(a) 0.637 Hz

(b) 0.950 Hz

(c) 4.00 Hz

(d) 6.00 Hz

(e) 16.0 Hz

3. A correctly calibrated pendulum clock is transported to the top of a tall mountain. Does the clock now run

   (a) slow

   (b) fast

   (c) correctly

   (d) no way to tell

4. Which function correctly describes a wave traveling in the positive x direction with an amplitude of 0.02 m, a frequency of 440 Hz, and a speed of 330 m/s?

(a) $y = (0.02\text{ m})\sin\left[880\pi\left(\frac{x}{330\text{ m}} - (1\text{ Hz})t\right)\right]$

(b) $y = (0.02\text{ m})\sin\left[880\pi\left(\frac{x}{330\text{ m}} - (440\text{ Hz})t\right)\right]$

(c) $y = (0.02\text{ m})\sin\left[880\pi\left(\frac{x}{330\text{ m}} + (1\text{ Hz})t\right)\right]$

(d) $y = (0.02\text{ m})\sin\left[2\pi\left(\frac{x}{330\text{ m}} - (440\text{ Hz})t\right)\right]$

(e) $y = (0.01\text{ m})\sin\left[2\pi\left(\frac{x}{330\text{ m}} - (440\text{ Hz})t\right)\right]$

5. Process C depicted on the PV-diagram is best described as an

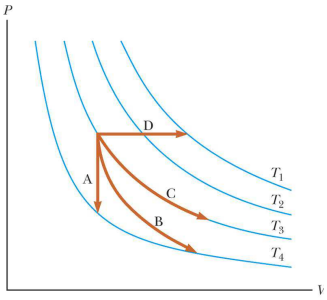
(a) Adiabatic process

(b) Isothermal process

(c) Isovolumetric process

(d) Isobaric process

(e) Isotropic process



6. A refrigerator does 1500 J of work while transferring a total of 9800 J of thermal energy into the kitchen. What is the refrigerator's coefficient of performance?

   (a) 0.45

   (b) 1.34

   (c) 3.27

   (d) 4.18

   (e) 5.53

7. Two moles of an ideal, diatomic gas at atmospheric pressure is enclosed in a 2-m^3 container, but confined to a 1 m^3 corner by a valve. The valve is opened and the gas undergoes a "free expansion" into the entire container. Calculate the change in entropy ΔS of the system during this expansion process.

   (a) 1230 J/K

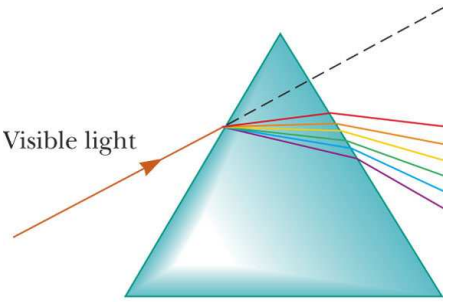
   (b) 11.5 J/K

   (c) 0 J/K

   (d) -11.5 J/K

   (e) -1230 J/K

8. The index of refraction of a particular transparent material is 1.4503 for the red end ($\lambda_r = 700$ nm) of the visible spectrum and 1.4698 for the blue end ($\lambda_b = 400$ nm). If white light is incident on a prism of this material at an angle of incidence of 45°, what is the angular separation between the red and blue end of the visible spectrum *inside* the prism? Assume that the index of refraction of air is 1.0.



(a) 0.42°

(b) 0.33°

(c) 0.78°

(d) 1.02°

(e) 17.4°

9. A string is 0.400 m long and has a mass-per-unit-length of 9.00×10^{-3} kg/m. What must be the tension in the string if its second harmonic has the same frequency as the second resonance mode of a 1.75-m-long pipe open at one end?

   (a) 31.1 N

   (b) 45.6 N

   (c) 66.6 N

   (d) 101 N

   (e) 300 N

10. What is the pressure on a diver at a depth of 500 m in sea water?

(a) 40.0 atm

(b) 13.0 atm

(c) 50.0 atm

(d) 21.5 atm

(e) 5.0 atm

11. A wide enclosed tank containing is pierced at a distance 2.5 m below the surface of the water. The pressure above the surface of the water is maintained at 3 atm. At what speed does the liquid exits the tank?

    (a) 10.0 m/s

    (b) 21.3 m/s

    (c) 19.4 m/s

    (d) 2.43 m/s

    (e) 38.0 m/s

12. The density of air is 1/800 that of water and the density of helium gas is 1/7 that of air. How many kilograms can a light balloon filled with 100 m^3 of helium lift?

    (a) 27

    (b) 44

    (c) 107

    (d) 114

    (e) 314

13. A light ray whose frequency is 6×10^{14} Hz in vacuum is incident on water ($n = 1.33$). The wavelength of the light after it enters the water is

    (a) 798 nm

    (b) 500 nm

    (c) 376 nm

    (d) 665 nm

    (e) 266 nm

14. According to Huygens' principle, in a uniform homogeneous medium we can construct a new wave front from an old wave front by

    (a) drawing rays perpendicular to all points on the old wave front.

    (b) drawing tangent lines to all points of the old wave front.

    (c) drawing circles with each point of the old wave front the center of a circle.

    (d) drawing ellipses with each point of the old wave front the center of an ellipse.

    (e) using the geometrical center of the old wave front as a point source for spherical waves.

15. A concave mirror has a radius of curvature of 30 cm. If an object is placed 20 cm from the mirror, what is the value of the lateral magnification M?

(a) -0.5

(b) +4

(c) +0.75

(d) -3

(e) -1.3

16. A thin converging lens of 20 cm focal length has an object located on its principal axis 10 cm from the lens. Which of the following describes the image formed by the lens?

    (a) Upright, larger, virtual

    (b) Upright, smaller, virtual

    (c) Upright, larger, real

    (d) Inverted, larger, real

    (e) Inverted, smaller, real

17. A square hole 8.00 cm along each side is cut in a sheet of aluminum. Calculate the change in area of this hole that results when the temperature of the sheet is increased by 50.0 K.

(a) 9.63×10^{-1} cm^2

(b) 1.20×10^{-3} cm^2

(c) 2.40×10^{-5} cm^2

(d) 9.63×10^{-3} cm^2

(e) 1.54×10^{-1} cm^2

18. How much internal energy E_{int} is in the air in a 10 m $\times$ 10 m $\times$ 10 m room at standard temperature and pressure?

    (a) 2.5 $\times 10^5$ J

    (b) 2.5 $\times 10^6$ J

    (c) 2.5 $\times 10^7$ J

    (d) 2.5 $\times 10^8$ J

    (e) 2.5 $\times 10^9$ J

19. In their physics lab, Amanda and Megan take a 28.9 g block of an unknown metal and submerge it in 100 mL of water. If the metal was initially at 100°C, the water was initially at 23.5°C, and the final equilibrium temperature of the water and metal is 25.5°C, what is the specific heat capacity of the unknown metal?

    (a) 389 J/(kg K)

    (b) 4186 J/(kg K)

    (c) 1830 J/(kg K)

    (d) 2010 J/(kg K)

    (e) 628 J/(kg K)

20. How much thermal energy does it take to increase the temperature of 2.5 mol of a diatomic ideal gas by 30 K if the gas is held at constant volume?

(a) 2.4×10^4 J

(b) 1.6×10^3 J

(c) 3.3×10^4 J

(d) 7.7×10^3 J

(e) 4.1×10^4 J

21. The wavelength of light visible to the human eye is on the order of 5×10^{-7} m. What is the frequency of the light wave?

(a) 2×10^{7} Hz

(b) 4×10^{9} Hz

(c) 5×10^{11} Hz

(d) 6×10^{14} Hz

(e) 4×10^{15} Hz

22. A piano string of density 0.005 kg/m is under a tension of 1350 N. Find the velocity with which a wave travels on the string.

(a) 260 m/s

(b) 520 m/s

(c) 1040 m/s

(d) 2080 m/s

(e) 4160 m/s

23. Which one of the following is true when a standing wave is set up on a string fixed at both ends?

    (a) The number of nodes is equal to the number of antinodes.

    (b) The wavelength is equal to the length of the string divided by an integer.

    (c) The frequency is equal to the number of nodes times the fundamental frequency.

    (d) The center of the string is either a node or an antinode.

    (e) All of the above are true.

24. A student holds a tuning fork oscillating at 256 Hz. How fast must she walk away from a wall to hear a beat frequency of 5.00 Hz?

(a) 3.38 m/s

(b) 2.56 m/s

(c) 5.00 m/s

(d) 3.43 m/s

(e) 7.12 m/s

25. A customer stands 5 m in front of a convex mirror with a radius of curvature of 100 cm. How tall will she appear in the mirror if she is 2 m tall?

(a) 68 cm

(b) 48 cm

(c) 18 cm

(d) 88 cm

(e) 22 cm

26. What is the limiting angle of resolution using 550-nm light for the Embry-Riddle telescope, which has a 20-inch (51 cm) diameter mirror?

(a) 0.27 arc seconds

(b) 1.3×10^{-6} arc seconds

(c) 1.0 arc seconds

(d) 0.51 arc seconds

(e) 2.8×10^{-7} arc seconds

27. Which one of the following will cause the fringes in a two-slit interference pattern to move farther apart?

(a) decreasing the wavelength of the light

(b) decreasing the screen distance

(c) decreasing the slit separation

(d) immersing the entire apparatus in water

(e) illuminating the slits with incoherent light

ANSWERS

1. c) 10 rad/s *
2. a) 0.637 Hz *
3. a) slow *
4. a) $y = (0.02\text{ m})\sin\left[880\pi\left(\frac{x}{330\text{ m}} - (1\text{ Hz})t\right)\right]$ *
5. b) Isothermal process *
6. e) 5.53 *
7. b) 11.5 J/K *
8. a) 0.42° *
9. a) 31.1 N*
10. c) 50.0 atm *
11. b) 21.3 m/s *
12. c) 107 *
13. c) 376 nm *
14. c) drawing circles with each point of the old wave front the center of a circle. *
15. d) -3 *
16. a) Upright, larger, virtual *
17. e) 1.54×10^{-1} cm^2 *
18. d) 2.5 $\times 10^8$ J *
19. a) 389 J/(kg K) *
20. b) 1.6 $\times 10^3$ J *
21. d) 6×10^{14} Hz *
22. b) 520 m/s *
23. d) The center of the string is either a node or an antinode.*
24. a) 3.38 m/s*
25. e) 22 cm *
26. a) 0.27 arc seconds *
27. c) decreasing the slit separation*