1. For a simple harmonic motion governed by Hooke's Law, $F = -kx$, if T is the period then the quantity $T/2\pi$ is equal to

   (a) $\sqrt{\frac{m}{k}}$

   (b) $\sqrt{\frac{k}{m}}$

   (c) $\frac{m}{k}$

   (d) $\frac{k}{m}$

   (e) the angular frequency ω

2. If the mass of a simple pendulum is quadrupled, then its period of small oscillations

   (a) doubles

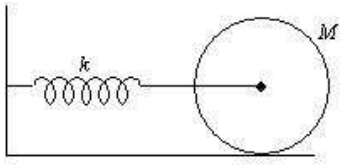
   (b) quadruples

   (c) is reduced to half

   (d) is reduced to one quarter

   (e) remains the same

3. A solid cylinder, of radius $R = 0.3$ m, mass $M = 2$ kg, has a horizontal spring with spring constant $k = 1000$ N/m attached to its axis as shown in the figure. The angular frequency for small oscillations if the cylinder rolls without slipping is closest to



   (a) 17 rad/s

   (b) 16 rad/s

   (c) 20 rad/s

   (d) 19 rad/s

   (e) 18 rad/s

4. If $y(x,t) = (0.02\text{ m})\sin\left[(30\text{ m}^{-1})x - (400\text{ s}^{-1})t\right]$, then the wavelength of the wave is

   (a) $\frac{\pi}{15}$ m

   (b) $\frac{15}{\pi}$ m

   (c) 60π m

   (d) 4.2 m

   (e) 30 m

5. The Principle of Superposition describes the observational fact that the total displacement at a given position (due to the superposition of two separate wave functions) can be obtained by

   (a) adding the phases of the two separate wave functions at that position

   (b) subtracting the magnitudes of the two separate wave functions at that position

   (c) multiplying the magnitudes of the two separate wave functions at that position

   (d) adding the two separate wave functions at that position

   (e) multiplying the two separate wave functions at that position

6. A sinusoidal sound wave is described by the molecular displacement wave function

$$s(x,t) = (2\ \mu\text{m}) \cos\left[(20\ \text{m}^{-1})x - (1000\ \text{s}^{-1})t\right]$$

   The maximum speed of the molecules' oscillatory motion is

   (a) 2.00 mm/s

   (b) 50 m/s

   (c) 100 m/s

   (d) 20 mm/s

   (e) 343 m/s

7. Two instruments produce a beat frequency of 5 Hz. If one has a frequency of 264 Hz, what could be the frequency of the other instrument?

   (a) 269 Hz

   (b) 254 Hz

   (c) 264 Hz

   (d) 266 Hz

   (e) 274 Hz

8. A violin string 35.0 cm long has a mass density of 2.7 g/m. What is the string tension if the second harmonic has a frequency of 880 Hz?

   (a) 77 N

   (b) 325 N

   (c) 1024 N

   (d) 256 N

   (e) 312 N

9. A pipe has a length of 1.23 m. If the pipe is open at both ends, what is the frequency of the third harmonic?

   (a) 139 Hz

   (b) 278 Hz

   (c) 417 Hz

   (d) 349 Hz

   (e) 209 Hz

10. The reason why a coconut floats in water is because:

    (a) the surface area of the coconut contacting the water is the same as the surface area of the water contacting the coconut

    (b) the gravitational force acting on the coconut is less than the buoyant force

    (c) the density of the coconut is less than the density of the water it displaces

    (d) the density of the coconut is equal to the density of the water it displaces

    (e) no one knows, it is still a mystery

11. An open milk carton is pierced by an ice pick 12 cm below the surface of the liquid. Milk exits the carton at a speed of

    (a) 1.0 m/s

    (b) 1.5 m/s

    (c) 1.9 m/s

    (d) 2.4 m/s

    (e) 3.8 m/s

12. An alloy of copper and gold has a mass of 300 g, but it weighs 2.74 N when completely submerged in water. What is its volume?

    (a) 109 m^3

    (b) 10.9 cm^3

    (c) 2.79 cm^3

    (d) 2.79×10^{-3} m^3

    (e) 20.7 cm^3

13. According to the kinetic theory of gases, the temperature of a gas is directly proportional to its

    (a) potential energy

    (b) kinetic energy

    (c) volume

    (d) universal gas constant

    (e) specific heat

14. A steel beam is 5.0 m long at a temperature of 20°C. On a hot day, the temperature rises to 40°C. What is the change in the beam's length due to thermal expansion?

    (a) 1.2 mm

    (b) 3.0 μm

    (c) 2.4 mm

    (d) 0.24 mm

    (e) 5.0 mm

15. What is the volume of two moles of gas at standard temperature and pressure?

    (a) 0.045 L

    (b) 22.4 L

    (c) 45 L

    (d) 4.49×10^{-5} L

    (e) 11.2 L

16. A half-liter of water, initially at 30°C, is cooled by removing 63 kJ of heat energy. What is the final temperature of the water?

    (a) 79.1°C

    (b) 45.1°C

    (c) 0°C

    (d) 15°C

    (e) 12°C

17. There is no heat flow into or out of the system in an

    (a) adiabatic process

    (b) isothermal process

    (c) isovolumetric process

    (d) isobaric process

    (e) isotropic process

18. A diatomic ideal gas with initial pressure 2.50×10^5 Pa expands isobarically from 0.700 m^3 to 1.60 m^3. What is the change in the internal energy of the gas?

    (a) 5.63 $\times 10^5$ J

    (b) 3.38 $\times 10^5$ J

    (c) 2.74 $\times 10^5$ J

    (d) 4.22 $\times 10^5$ J

    (e) 0

19. A monatomic ideal gas with initial pressure 1.2×10^5 Pa and initial volume of 0.50 m^3 expands isothermally to a volume of 1.8 m^3. What amount of thermal energy is transferred to the gas during this process?

    (a) 2.4 $\times 10^4$ J

    (b) 1.2 $\times 10^5$ J

    (c) 3.3 $\times 10^4$ J

    (d) 7.7 $\times 10^4$ J

    (e) 4.1 $\times 10^4$ J

20. What is the change in entropy of 1 kg of ice initially at 0°C that melts to water and then warms to the ambient temperature of 25.0°C?

    (a) 1230 J/K

    (b) 1590 J/K

    (c) 846 J/K

    (d) 1010 J/K

    (e) 628 J/K

21. Which of the following statements is false?

(a) The entropy of an isolated system cannot decrease.

(b) During a given process, the entropy change of the universe as a whole is always greater than or equal to zero.

(c) The entropy change during an adiabatic process is zero.

(d) The entropy change of a system in contact with its environment can never be negative.

(e) The entropy change for a reversible cycle is zero.

22. A heat engine does 1700 J of work while rejecting 4500 J to the cold reservoir. What is its efficiency?

(a) 0.45

(b) 0.34

(c) 0.27

(d) 0.18

(e) 0.22

23. A light ray traveling through air incident on a transparent material at an angle of 30.0° from the normal is refracted to 17.5°. What is the speed of light in the material?

(a) 2.4×10^8 m/s

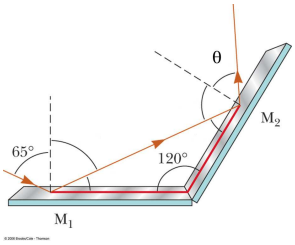
(b) 3.6×10^8 m/s

(c) 1.8×10^8 m/s

(d) 3.0×10^8 m/s

(e) 2.7×10^8 m/s

24. A square mirror is lying on the ground with an identical mirror at a 60.0° angle with respect to the horizontal butting up to it. If a ray hits the first mirror at an angle of 65.0° with respect to the normal, at what angle with respect to the normal does it reflect off the second mirror?



(a) 65°

(b) 55°

(c) 25°

(d) 45°

(e) 35°

25. Rainbows are created due to what two physical effects?

    (a) Reflection and transmittance

    (b) Refraction and inversion

    (c) Dispersion and refraction

    (d) Diffraction and dispersion

    (e) Reflection and refraction

26. An object is placed 6 cm in front of a converging lens that has a focal length of 4 cm. What is the character of the image?

    (a) Real and inverted

    (b) Real and upright

    (c) Real and horizontal

    (d) Virtual and upright

    (e) Virtual and inverted

27. The diameter of Mars is 6794 km, and when it is closest to Earth, its distance from Earth is 5.58×10^7 km. When Mars is at this distance, find the diameter of the image of Mars formed by a spherical, concave, telescope mirror with a focal length of 1.75 m.

    (a) 0.213 mm

    (b) 0.213 m

    (c) 1.75 m

    (d) 3.14×10^{-11} m

    (e) 3.14 mm

28. Young's double-slit experiment is performed with 589-nm light and a distance of 2.00 m between the slits and the screen. The tenth interference minimum is observed 7.26 mm from the central maximum. Determine the spacing between the slits.

    (a) 7.26 mm

    (b) 589 nm

    (c) 3.67 μm

    (d) 54.9 mm

    (e) 1.54 mm

ANSWERS

1. $\sqrt{\frac{m}{k}}$ (a)
2. remains the same (e)
3. 18 rad/s (e)
4. $\frac{\pi}{15}$ m (a)
5. adding the two separate wave functions at that position (d)
6. 2.00 mm/s (a)
7. 269 Hz (a)
8. 256 N (d)
9. 417 Hz (c)
10. the density of the coconut is less than the density of the water it displaces (c)
11. 1.5 m/s (b)
12. 20.7 cm^3 (e)
13. kinetic energy (b)
14. 1.2 mm (a)
15. 45 L (c)
16. 0°C (c)
17. adiabatic process (a)
18. 5.63 $\times 10^5$ J (a)
19. 7.7 $\times 10^4$ J (d)
20. 1590 J/K (b)
21. The entropy change of a system in contact with its environment can never be negative. (d)
22. 0.27 (c)
23. 1.8×10^8 m/s (c)
24. 55° (b)
25. Dispersion and refraction (c) [or (e) is also correct]

26. Real and inverted (a)

27. 0.213 mm (a)

28. 1.54 mm (e)