

2nd Semester Physics Review

Problem

1. A cube of wood with a density of 0.780 g/cm^3 is 10.0 cm on each side. When the cube is placed in water, what buoyant force acts on the wood? ($\rho_w = 1.00 \text{ g/cm}^3$)
2. According to legend, to determine whether the king's crown was made of pure gold, Archimedes measured the crown's volume by determining how much water it displaced. The density of gold is $19,300 \text{ kg/m}^3$. If the crown's mass was 0.60 kg , what volume of water would have been displaced if the crown was indeed made of pure gold?
3. How much pressure is exerted on a swimmer at the bottom of a 5.0 m deep swimming pool? ($\rho_w = 1.00 \times 10^3 \text{ kg/m}^3$, $P_0 = 1.01 \times 10^5 \text{ Pa}$, and $g = 9.81 \text{ m/s}^2$.)
4. What is the pressure at a depth of 580 m in a lake? ($\rho_w = 1.00 \times 10^3 \text{ kg/m}^3$, $P_0 = 1.01 \times 10^5 \text{ Pa}$, and $g = 9.81 \text{ m/s}^2$.)
5. At a constant pressure, 6.00 m^3 of an ideal gas at 348 K is cooled until its volume is halved. What is the new temperature of the gas?
6. The initial volume, pressure, and temperature of an ideal gas in a tank are 15 L , 2.0 atm , and 310 K , respectively. If the pressure increases to 3.5 atm and the temperature increases to 430 K , what is the final volume of the gas?
7. A cylinder with a movable piston contains an ideal gas at an initial temperature of $3.0 \times 10^1 \text{ K}$, a volume of 1.5 m^3 , and a pressure of $0.20 \times 10^5 \text{ Pa}$. What is the final volume of the gas if the temperature is increased to 287°C and the pressure remains constant?
8. A 0.2 kg mass of metal with a specific heat capacity of $1.26 \times 10^3 \text{ J/kg}\cdot^\circ\text{C}$ and an initial temperature of 90°C is placed in a 500 g calorimeter at an initial temperature of 20°C with a specific heat capacity of $4.19 \times 10^2 \text{ J/kg}\cdot^\circ\text{C}$. The calorimeter is filled with 0.1 kg of water with an initial temperature of 20°C . When the combination of the metal, the calorimeter, and the water reaches equilibrium, what is the final temperature?
9. A $1.00 \times 10^2 \text{ g}$ piece of copper at an initial temperature of 95°C is dropped into $2.00 \times 10^2 \text{ g}$ of water contained in a 0.28 kg aluminum calorimeter. The water and calorimeter are initially at 15°C . What is the final temperature of the system when it reaches equilibrium? ($c_c = 3.9 \times 10^2 \text{ J/kg}\cdot^\circ\text{C}$ and $c_a = 9.00 \times 10^2 \text{ J/kg}\cdot^\circ\text{C}$.)
10. A pitcher of iced tea is made by adding ice to 1.8 kg of hot tea with an initial temperature of 80.0°C . How many kilograms of ice, which has an initial temperature of 0.0°C , are required to bring the mixture to 10.0°C ? ($L_f = 3.3 \times 10^5 \text{ J/kg}$)
11. A $5.0 \times 10^2 \text{ g}$ ice cube with an initial temperature of 0.0°C is placed in a plastic-foam box whose walls are 1.0 cm thick and whose total surface area is $6.0 \times 10^2 \text{ cm}^2$. If the temperature of the air surrounding the box is exactly 20.0°C and it takes 4.0 h for the ice to completely melt, what is the conductivity of the plastic-foam material? ($L_f = 3.3 \times 10^2 \text{ J/g}$)
12. A 1.0 kg cube of ice is dropped into 1.0 kg of water, and, when equilibrium is reached, there are 2.0 kg of ice at 0.0°C . The initial temperature of the water was 0°C . What was the original temperature of the ice? ($c_w = 4186 \text{ J/kg}\cdot^\circ\text{C}$, $c_i = 2093 \text{ J/kg}\cdot^\circ\text{C}$, and $L_f = 3.3 \times 10^5 \text{ J/kg}\cdot^\circ\text{C}$)
13. A heat engine performs 2000.0 J of net work while adding 5000.0 J of heat to the cold-temperature reservoir. What is the efficiency of the engine?

14. An electrical power plant manages to transfer 88 percent of the heat produced in the burning of fossil fuel to convert water to steam. Of the heat carried by the steam, 40 percent is converted to the mechanical energy of the spinning turbine. Which best describes the overall efficiency of the heat-to-work conversion in the plant?
15. A steam engine takes in 2.06×10^5 J of energy added as heat and exhausts 1.53×10^5 J of energy removed as heat per cycle. What is its efficiency?
16. How much displacement will a coil spring with a spring constant of 120 N/m achieve if it is stretched by a 60 N force?
17. A mass on a spring that has been compressed 0.1 m has a restoring force of 20 N. What is the spring constant?
18. An amusement park ride has a frequency of 0.05 Hz. What is the ride's period?
19. An amusement park ride swings back and forth once every 40.0 s. What is the ride's frequency?
20. What is the period of a 4.12 m long pendulum?
21. A periodic wave has a wavelength of 0.50 m and a speed of 20 m/s. What is the wave frequency?
22. A musical tone sounded on a piano has a frequency of 410 Hz and a wavelength of 0.80 m. What is the speed of the sound wave?
23. A radio wave has a speed of 3.00×10^8 m/s and a frequency of 107 MHz. What is the wavelength?
24. What is the lowest frequency that will resonate in a 2.0 m length organ pipe closed at one end? The speed of sound in air at this temperature is 340 m/s.
25. If a guitar string has a fundamental frequency of 500 Hz, what is the frequency of its second harmonic?
26. What is the energy associated with a light quantum that has a wavelength of 5.0×10^{-7} m? ($h = 6.63 \times 10^{-34}$ J•s)
27. What is the frequency of a photon with an energy of 1.7×10^{-19} J? ($h = 6.63 \times 10^{-34}$ J•s)
28. What is the energy of a photon whose frequency is 6.0×10^{20} Hz? ($h = 6.63 \times 10^{-34}$ J•s; $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$)
29. A quantum of radiation has an energy of 2 keV. What is its frequency? ($h = 6.63 \times 10^{-34}$ J•s; $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$)
30. How much energy does a photon of red light that has a wavelength of 640 nm contain? ($h = 6.63 \times 10^{-34}$ J•s; $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$)
31. What is the de Broglie wavelength for a proton that has a mass of 1.67×10^{-27} kg and is moving at a speed of 5.0×10^{-5} m/s? ($h = 6.63 \times 10^{-34}$ J•s)
32. What is the de Broglie wavelength for a proton that has a mass of 1.67×10^{-27} kg and is moving at a speed of 6.0×10^7 m/s? ($h = 6.63 \times 10^{-34}$ J•s)
33. What speed does a 0.06 kg golf ball have if its de Broglie wavelength is 4.25×10^{-34} m?
34. What is the speed of a 50 g rock if its de Broglie wavelength is 3.32×10^{-34} m? ($h = 6.63 \times 10^{-34}$ J•s)
35. A radioactive material initially is observed to have an activity of 800 counts/s. If 4 h later it is observed to have an activity of 200 counts/s, what is its half-life?
36. If a fossil bone is found to contain one-eighth as much carbon-14 as the bone of a living animal, what is the approximate age of the fossil? (half-life of carbon-14 = 5800 years)

37. Tritium has a half-life of 12.3 years. How many years will have elapsed when the radioactivity of a tritium sample has decreased to 10 percent of its original value?
38. Calculate the binding energy of the sodium-23 nucleus. ($c^2 = 931.50$ MeV/u; atomic masses:
 ${}_{11}^{23}\text{Na} = 22.989\,767$ u; ${}^1_1\text{H} = 1.007\,825$ u; $m_n = 1.008\,665$ u)
39. Calculate the binding energy of the copper-63 nucleus. ($c^2 = 931.50$ MeV/u; atomic masses:
 ${}_{29}^{63}\text{Cu} = 62.929\,599$ u; ${}^1_1\text{H} = 1.007\,825$ u; $m_n = 1.008\,665$ u)
40. Calculate the binding energy of the zinc-64 nucleus. ($c^2 = 931.50$ MeV/u; atomic masses:
 ${}_{30}^{64}\text{Zn} = 63.929\,144$ u; ${}^1_1\text{H} = 1.007\,825$ u; $m_n = 1.008\,665$ u)