

1. Calculate Young's modulus (E) for bone with initial length $l_0 = 31.5$ cm and cross-sectional area of 2.5 cm^2 if under the applied force of 12 N its absolute deformation stands at 0.28 mm.
2. Sample has length of 2.5 m before deformation and 2,45 m after. Determine absolute and relative deformation (extension) of the given sample.
3. Calculate mechanical tension in the bone with cross-sectional area of 2.5 cm^2 under applied force F of 12 N.
4. What is the wavelength (λ) of ultraviolet radiation of frequency $1.2 \cdot 10^{15} \text{ Hz}$, given the speed of light is $3 \cdot 10^8 \text{ m/s}$.
5. What level of loudness corresponds to the sound intensity of 10^{-7} W/m^2 at frequency of sound 1 kHz?
6. Calculate the volume of blood in human body with masses 10 kg, 70 kg and 100 kg respectively.
7. After passing through the barrier sound intensity decreased 1000 folds. How much the loudness decreased if the sound frequency is 1 kHz?
8. The maximum frequency of sound at which human ear can hear is 20 kHz. Find the wavelength (λ), which corresponds to that frequency, if the speed of sound in air is $V = 340 \text{ m/s}$.
9. What is the overall magnification of microscope given the lens magnification is $20\times$ and magnification of ocular is $15\times$?
10. 10% sugar solution turns the plane of polarization by $\varphi_1 = 30^\circ$. At which concentration of sugar in solution the plane of polarization rotates by $\varphi_2 = 20^\circ$?
11. Determine the concentration of sugar in urine of diabetic patients by means of polarimetry given the angle of polarization stands at $\varphi = 7^\circ$, polarimeter tube length is $l = 20 \text{ cm}$ and specific polarization angle $[\varphi_0]$ is $6,67 \text{ degree} \cdot \text{cm}^2/\text{g}$.

12. Calculate the distance resolution Z of the optical microscope with wavelength $\lambda = 555 \text{ nm}$ (to which the human eye is the most sensitive) if there is an air between the object and lens. Aperture angle is $\theta = 90^\circ$.
13. Calculate the distance resolution Z of the optical microscope for wavelength $\lambda = 555 \text{ nm}$ (to which the human eye is most sensitive) if there is Vaseline oil between the object and the lens. Refractive index of Vaseline oil $n = 1.503$. Aperture angle of microscope is $\theta = 90^\circ$.
14. What is the grid scale of ECG strip in seconds or milliseconds if the recording speed of the cardiograph is 50 mm/s , 25 mm/s ?
15. Cardiograph calibration impulse is 1 mV (10^{-3} V), which corresponds to 20 mm on ECG strip. Determine the amplitude of the R wave in the ECG in mV if its height of the peak is 24 mm .
16. Calculate the cardiac output (CO) in liters (l) if the stroke volume (SV) is 70 ml and heart rate is 80 beats/min .
17. Calculate the average flow rate of blood in aorta if $SV = 70 \text{ ml}$ and ejection lasts 0.9 s .
18. Calculate the electric field (E) across membrane of 6 nm in thickness given the membrane potential difference stands at 80 mV .
19. Calculate the Nernst equilibrium potentials for K^+ , Na^+ и Cl^- ions at $t = 20^\circ\text{C}$ given $[\text{K}^+]_i = 300 \text{ mmol/l}$, $[\text{Na}^+]_i = 50 \text{ mmol/l}$ and $[\text{Cl}^-]_i = 100 \text{ mol/l}$ and $[\text{K}^+]_o = 10 \text{ mmol/l}$, $[\text{Na}^+]_o = 450 \text{ mmol/l}$, $[\text{Cl}^-]_o = 600 \text{ mol/l}$.
20. Light travels from flint glass into ethanol. The angle of refraction in the ethanol is 25.0° . What is the angle of incidence in the glass?
21. A prism bends violet light more than it bends red light. Explain.
22. A beam of light strikes the flat, glass side of a water-filled aquarium at an angle of 40.0° to the normal. For glass, $n = 1.50$. At what angle does the beam enter the glass?

23. A beam of light strikes the flat, glass side of a water-filled aquarium at an angle of 40.0° to the normal. For glass, $n = 1.50$. At what angle does the beam enter the water?
24. A diamond's index of refraction for red light, 656 nm, is 2.410, while that for blue light, 434 nm, is 2.450. Suppose that white light is incident on the diamond at 30.0° . Find the angles of refraction for red and blue light.
25. The index of refraction of crown glass is 1.53 for violet light, and it is 1.51 for red light. What is the speed of violet light in crown glass?
26. The index of refraction of crown glass is 1.53 for violet light, and it is 1.51 for red light. What is the speed of red light in crown glass?
27. A ray of light travels from air into a liquid. The ray is incident upon the liquid at an angle of 30.0° . The angle of refraction is 22.0° . Using Snell's law, calculate the index of refraction of the liquid.
28. The critical angle for a special glass in air is 41.0° . What is the critical angle if the glass is immersed in water?
29. A ray of light in a tank of water has an angle of incidence of 55.0° . What is the angle of refraction in air?
30. What angle is needed between the direction of polarized light and the axis of a polarizing filter to reduce its intensity by 90.0%?
31. $\theta = 71.6^\circ$
32. At what angle will light traveling in air be completely polarized horizontally when reflected from water? (b) From glass?
33. Two point charges exert a 5.00 N force on each other. What will the force become if the distance between them is increased by a factor of three?
34. What magnitude point charge creates a 10,000 N/C electric field at a distance of 0.250 m? How large is the field at 10.0 m?
35. During open-heart surgery, a defibrillator can be used to bring a patient out of cardiac arrest. The resistance of the path is $500\ \Omega$ and a 10.0-mA current is needed. What voltage should be applied?

36. A defibrillator passes 12.0 A of current through the torso of a person for 0.0100 s. How much charge moves? (b) How many electrons pass through the wires connected to the patient?
37. Blood is flowing through an artery of radius 2 mm at a rate of 40 cm/s. Determine the flow rate and the volume that passes through the artery in a period of 30 s.
38. A major artery with a cross-sectional area of 1.00 cm² branches into 18 smaller arteries, each with an average cross-sectional area of 0.400 cm². By what factor is the average velocity of the blood reduced when it passes into these branches?
39. As blood passes through the capillary bed in an organ, the capillaries join to form venules (small veins). If the blood speed increases by a factor of 4.00 and the total cross-sectional area of the venules is 10.0 cm², what is the total cross-sectional area of the capillaries feeding these venules?
40. As blood passes through the capillary bed in an organ, the capillaries join to form venules (small veins). If the blood speed increases by a factor of 4.00 and the total cross-sectional area of the venules is 10.0 cm², how many capillaries are involved if their average diameter is 10.0 μm ?
- 41.5. The human circulation system has approximately 1×10^9 capillary vessels. Each vessel has a diameter of about 8 μm . Assuming cardiac output is 5 L/min, determine the average velocity of blood flow through each capillary vessel.
- 42.6. The flow rate of blood through a 2.00×10^{-6} -m - radius capillary is 3.80×10^9 cm³ /s. What is the speed of the blood flow?

43. The flow rate of blood through a 2.00×10^{-6} -m - radius capillary is 3.80×10^9 cm³ /s . Assuming all the blood in the body passes through capillaries, how many of them must there be to carry a total flow of 90.0 cm³ /s ? (The large number obtained is an overestimate, but it is still reasonable.)
44. The pressure drop along a length of artery is 100 Pa, the radius is 10 mm, and the flow is laminar. The average speed of the blood is 15mm/s. What is the net force on the blood in this section of artery?
45. The pressure drop along a length of artery is 100 Pa, the radius is 10 mm, and the flow is laminar. The average speed of the blood is 15mm/s. What is the power expended maintaining the flow?
46. A small artery has a length of 1.1×10^{-3} m and a radius of 2.5×10^{-5} m . If the pressure drop across the artery is 1.3 kPa, what is the flow rate through the artery? (Assume that the temperature is 37° C .)
47. The arterioles (small arteries) leading to an organ, constrict in order to decrease flow to the organ. To shut down an organ, blood flow is reduced naturally to 1.00% of its original value. By what factor did the radii of the arterioles constrict? Penguins do this when they stand on ice to reduce the blood flow to their feet.
48. Angioplasty is a technique in which arteries partially blocked with plaque are dilated to increase blood flow. By what factor must the radius of an artery be increased in order to increase blood flow by a factor of 10?
49. Suppose a blood vessel's radius is decreased to 90.0% of its original value by plaque deposits and the body compensates by increasing the pressure difference along the vessel to keep the flow rate constant. By what factor must the pressure difference increase? If turbulence is created by the obstruction, what additional effect would it have on the flow rate?

50. The aorta is the principal blood vessel through which blood leaves the heart in order to circulate around the body. Calculate the average speed of the blood in the aorta if the flow rate is 5.0 L/min. The aorta has a radius of 10 mm.
51. Blood flows through smaller blood vessels known as capillaries. When the rate of blood flow in the aorta is 5.0 L/min, the speed of blood in the capillaries is about 0.33 mm/s. Given that the average diameter of a capillary is $8.0 \mu\text{m}$, calculate the number of capillaries in the blood circulatory system.
52. How many cubic meters of blood does the heart pump in a 75-year lifetime, assuming the average flow rate is 5.00 L/min?
- ($V = 2.0 \times 10^5 \text{ m}^3$ This amount is about 200,000 tons of blood. For comparison, this value is equivalent to about 200 times the volume of water contained in a 6-lane 50-m lap pool).
53. When physicians diagnose arterial blockages, they quote the reduction in flow rate. If the flow rate in an artery has been reduced to 10.0% of its normal value by a blood clot and the average pressure difference has increased by 20.0%, by what factor has the clot reduced the radius of the artery?
54. During a marathon race, a runner's blood flow increases to 10.0 times her resting rate. Her blood's viscosity has dropped to 95.0% of its normal value, and the blood pressure difference across the circulatory system has increased by 50.0%. By what factor has the average radii of her blood vessels increased?
55. What is the intensity in watts per meter squared of 85.0-dB sound?
56. What sound intensity level in dB is produced by earphones that create an intensity of $4.00 \times 10^{-2} \text{ W/m}^2$?
57. Show that if one sound is twice as intense as another, it has a sound level about 3 dB higher.
58. You are given that the ratio of two intensities is 2 to 1, and are then asked to find the difference in their sound levels in decibels. You can solve this problem using of the properties of logarithms.
59. What is the decibel level of a sound that is twice as intense as a 90.0-dB sound? (b) What is the decibel level of a sound that is one-fifth as intense as a 90.0-dB sound?
60. What is the intensity of a sound that has a level 7.00 dB lower than a $4.00 \times 10^{-9} \text{ W/m}^2$ sound?

61. What is the intensity of a sound that is 3.00 dB higher than a $4.00 \times 10^{-9} \text{ W/m}^2$ sound?
62. How much more intense is a sound that has a level 17.0 dB higher than another? (b) If one sound has a level 23.0 dB less than another, what is the ratio of their intensities?
63. People with good hearing can perceive sounds as low in level as -8.00 dB at a frequency of 3000 Hz. What is the intensity of this sound in watts per meter squared?
64. An 8-hour exposure to a sound intensity level of 90.0 dB may cause hearing damage. What energy in joules falls on a 0.800-cm-diameter eardrum so exposed?
65. Find the range of an eardrum displacement with respect to the range of audible sound intensity and frequency. The acoustic impedance of the eardrum muscle is $Z(\rho \cdot v) = 1.64 \times 10^6 \frac{\text{kg}}{\text{m}^2 \text{s}}$