

Q1) Myopia occurs when the focal point falls _____ the retina. This can be corrected using a _____ lens.

- (A) in front of, convex
- (B) behind, convex
- (C) in front of, concave
- (D) behind, concave

Q2) Choose the correct sequence for the direction of blood flow in a healthy human being starting and ending with the left ventricle.

- (A) Left ventricle → Aorta → Systemic arteries → Systemic veins → Vena cavae → Pulmonary vein → Pulmonary artery → Right ventricle → Left ventricle
- (B) Left ventricle → Aorta → Systemic arteries → Systemic veins → Vena cavae → Right ventricle → Pulmonary artery → Pulmonary vein → Left ventricle
- (C) Left ventricle → Systemic arteries → Aorta → Systemic veins → Right ventricle → Pulmonary artery → Pulmonary vein → Left ventricle
- (D) Left ventricle → Aorta → Systemic arteries → Vena cavae → Systemic veins → Right ventricle → Pulmonary artery → Pulmonary vein → Left ventricle

Q3) In a healthy adult, which one of the following regions of the brain contains primarily white matter?

- (A) Cerebral cortex
- (B) Basal ganglia
- (C) Limbic system
- (D) Corpus callosum

Q4) Skeletal muscles are recruited to lift loads. If the force generated in the muscle due to contraction is not sufficient to lift the load, it is known as _____ contraction.

- (A) Isometric
- (B) Isotonic
- (C) Isokinetic
- (D) Isoinertial

Q5) Backscattered electron detector of a scanning electron microscope is used to

- (A) study surface topography of the sample
- (B) quantify surface roughness
- (C) measure atomic number
- (D) contrast areas with different chemical compositions

Q6) In the process of obtaining a Magnetic Resonance Image (MRI), the terms T1 and T2 time constants of the material are very crucial to decide on getting suitable weighted images. Choose the correct explanation relating to these two constants from the following options.

- (A) T1 is the spin-lattice or longitudinal relaxation time, and T2 is the spin-spin or transverse relaxation time
- (B) T1 and T2 indicate the durations that Free Induction Decay (FID) signal to be recorded in x and y axes directions, respectively
- (C) T1 and T2 refer to the durations of flipping pulses used to tilt the resultant magnetic vector into x-y plane and inverse z-direction, respectively
- (D) T1 is the spin-spin or transverse relaxation time, and T2 is the spin-lattice or longitudinal relaxation time

Q7) An ideal coronary stent should

- (A) be thromboresistant
- (B) promote accumulation of smooth muscle cells
- (C) be fatigue resistant
- (D) support deposition of extracellular matrix

Q8) Which of the following statements related to the safety of biomedical instruments are TRUE?

- (A) When a person is exposed to an electrical hazard, let-go current is defined as the maximum current at which the subject can withdraw voluntarily
- (B) Microshock is a physiological response resulting from an electrical current passing through heart
- (C) The patient in an intensive care unit is being exposed to the danger of microshock because of using internal conductive electrodes in the vicinity of the heart
- (D) The 50 Hz safe current limit for a microshock is greater than 50 mA

Q9) Which of the following statements related to the operating principle of pulse oximetry are CORRECT?

- (A) Pulse oximeter can non-invasively determine arterial oxygen saturation (SpO_2) by analyzing the light transmitted through the skin during the systolic phase of the blood flow through the tissue
- (B) In a pulse oximeter, isobestic wavelength is the wavelength at which Hb and HbO_2 have same optical absorbance
- (C) Pulse oximeter can accurately determine the SpO_2 of blood by computing the ratio of absorbances at 660 nm and 905 nm wavelengths
- (D) Pulse oximeter can accurately determine the SpO_2 of blood by computing the ratio of absorbances at 850 nm and 950 nm wavelengths

Q10) Which of the following statements related to biomedical measurements are TRUE?

- (A) Electrical activity of neurons in the peripheral nervous system can be measured by ENG
- (B) Electrical activity of the retina in response to light stimulus can be measured using EOG
- (C) In a human EEG, Gamma waves are high frequency waves compared to Beta, Delta, and Theta waves
- (D) P wave in ECG manifests ventricular repolarization

Q11) Which of the following mechanical prosthetic valves were invented as a replacement for diseased heart valves?

- (A) Globe valve
- (B) Ball and cage valve
- (C) Bi-leaflet valve
- (D) Swing check valve

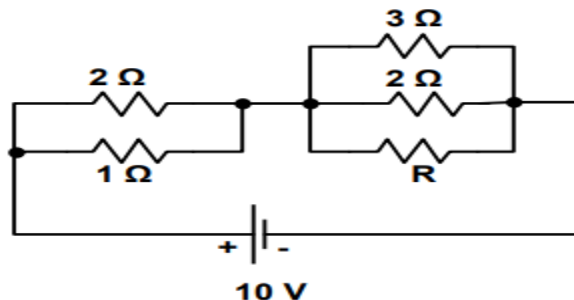
Q12) Due to the current COVID pandemic conditions, assume that positive or negative status of any individual are equally likely. There are 3 members in a family. If one of the members has tested COVID positive, the conditional probability that at least 2 members are COVID positive is _____ (rounded off to three decimal places).

Q13) A series RLC circuit with $R = 10 \Omega$, $L = 50 \text{ mH}$ and $C = 100 \mu\text{F}$ connected to 200 V, 50 Hz supply consumes power P . The value of L is changed such that this circuit consumes same power P but operates with lagging power factor. The new value of L is _____ mH (rounded off to two decimal places).

Q14) The thickness of piezoelectric crystal (PZT5A) used in ultrasound applications will determine the resonant frequency of the transducer. To work at a resonance frequency of 5 MHz, the thickness of a PZT5A transducer must be _____ mm (rounded off to three decimal places).

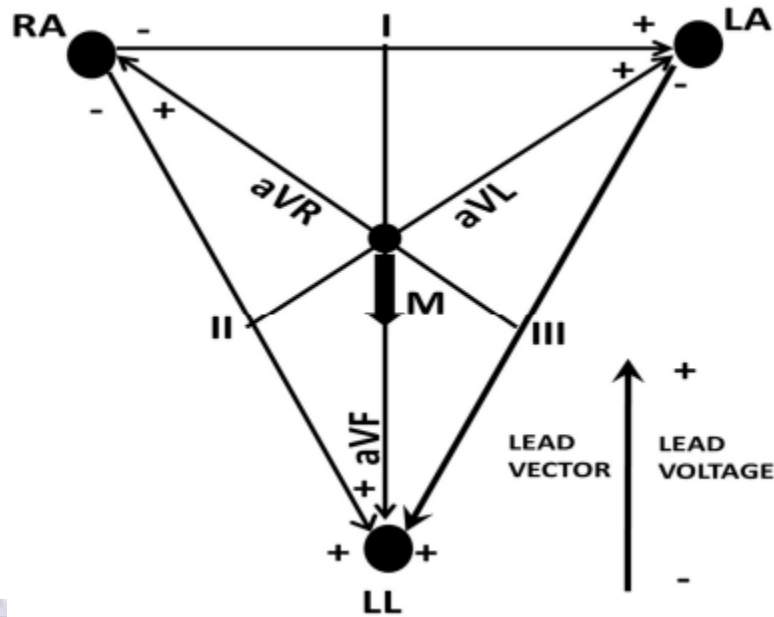
Given: The velocity of sound in PZT5A is $4350 \text{ m}\cdot\text{s}^{-1}$.

Q15) Power consumed by the 3Ω resistor is 12 W in the given circuit. The value of the resistor R in the circuit is _____ Ω



Q16) Consider the Einthoven's triangle of frontal ECG for the 3 electrodes RA, LA and LL shown in the figure. The augmented lead vectors bisect the bipolar lead vectors. At the peak of R wave, the cardiac vector M points vertically downwards with $|M| = 5\text{mV}$.

The voltages on leads I and II are _____ mV and _____ mV, respectively.



- (A) 0, 4.33
- (B) 2.17, 0
- (C) 0, 2.17
- (D) 4.33, 0

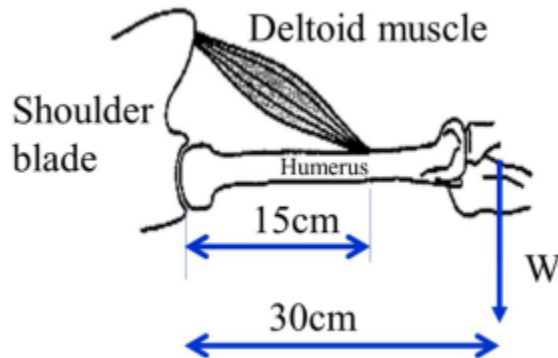
Q17) Which one of the following statements is TRUE?

- (A) A myelinated axon has a greater ATP requirement than an unmyelinated axon of the same diameter and length
- (B) An unmyelinated axon has a greater ATP requirement than a myelinated axon of the same diameter and length
- (C) An unmyelinated axon has the same ATP requirement as a myelinated axon of the same diameter and length
- (D) An unmyelinated axon always has a greater ATP requirement than a myelinated axon irrespective of their diameter and length

Q18) The deltoid muscle connects the humerus to the shoulder blade and facilitates out stretching of the arm as shown in the figure. The humerus is connected to the shoulder blade with a ball and socket joint.

Assume the equivalent weight (W) of the arm to be 30 N and acts vertically down at a horizontal distance of 30 cm.

Assume that the deltoid muscle is connected to the humerus at a distance of 15 cm and makes an average angle of 20° with the horizontal. The magnitude of tension in the deltoid muscle is _____ N.

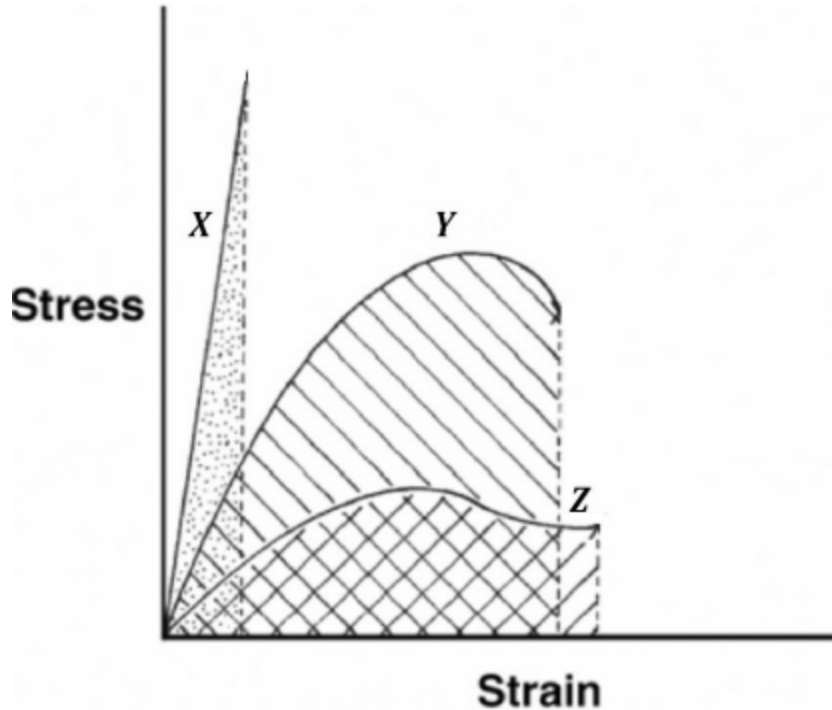


- (A) 31.9
- (B) 63.8
- (C) 87.7
- (D) 175.4

Q19) A person has a total blood volume of 5 L. Out of this total, assume that 4 L is contained in the systemic circulation and 1 L in pulmonary circulation. The cardiac output of the person is $5 \text{ L} \cdot \text{min}^{-1}$. Time taken for a drop of blood to go from right ventricle to left ventricle is _____ s.

- (A) 60
- (B) 20
- (C) 15
- (D) 12

Q20) Based on the stress-strain curves of three different materials (X, Y, and Z) shown in the figure, which one of the following choices is CORRECT?



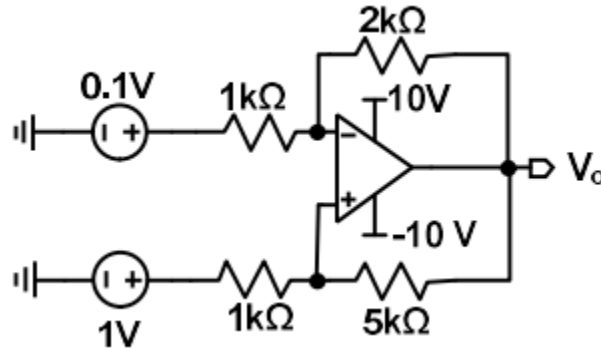
- (A) X – Titanium, Y – Hydroxyapatite, Z – Polyethylene
 (B) X – Hydroxyapatite, Y – Titanium, Z – Polyethylene
 (C) X – Hydroxyapatite, Y – Polyethylene, Z – Titanium
 (D) X – Polyethylene, Y – Titanium, Z – Hydroxyapatite

Q21) In a biological study, the experimental values measured from 6 subjects are given in the table below. Using this data, the linear regression coefficient for estimating the weight of the heart based on the systolic pressure is _____ (rounded off to two decimal places).

Systolic pressure (in mm Hg)	120	90	100	110	140	130
Weight of the heart (in g)	500	300	420	390	490	450

Q22) A series RLC circuit is connected to 220 V, 50 Hz supply. For a fixed value of R and C, the inductor L is varied to deliver the maximum current. This value is 0.4 A and the corresponding potential drop across the capacitor is 330 V. The value of the inductor L is _____ H (rounded off to two decimal places).

Q23) An ideal opamp with an infinite gain and infinite bandwidth is connected in feedback as shown below. The output voltage V_o for the given input voltages in the circuit is _____ V (accurate to one decimal place).



Q24) A moving coil voltmeter has an internal resistance of $50\ \Omega$. The scale of the meter is divided into 100 equal divisions. When a potential of 1 V is applied to terminals of voltmeter, a deflection of 100 divisions is obtained. However, it is desired that when a potential of 500 V is applied to the terminals, a deflection of 100 divisions should be obtained.

The value of resistance that needs to be connected in series to achieve this is _____ Ω .

Q25) A patient has a breathing rate of 18 breaths per minute, with a tidal volume of 500 mL, having an anatomical dead space of 150 mL. If the person has a heart rate of 120 beats per minute and a stroke volume of 50 mL, the alveolar ventilation to perfusion ratio is _____ (accurate to two decimal places).

Q26) Assume that the ratio of total blood volume in liters to total body weight in kg is 0.07 and the blood consists of plasma and RBCs only. The plasma volume of a 70-kg man with 52% hematocrit is _____ L (rounded off to two decimal places).

Q27) The 1st generation (1G) CT scanner uses a point X-ray source and a detector. The source detector assembly can move linearly at a speed of $0.5\ \text{m}\cdot\text{s}^{-1}$ and that it takes 0.5 s for source detector assembly to rotate one angular increment, regardless of the angle. This scanner is expected to collect 360 projections over 180° of span. The field of view used for data collection has a diameter of 0.5 m. The scan time required is _____ s.

Q28) The inverse square law has a very practical use in radiography. While taking an acceptable chest radiograph of a subject at a distance of 0.75 m from the X-ray generator, X-ray source settings were kept at 50 kVp, 50 mA.s.

If the subject is moved to a distance of 1 m, and the kVp is kept the same, the new value of mA.s to obtain the same exposure will be _____ mA.s (rounded off to two decimal places).

Q29) A Hall effect flow meter is used to measure the volumetric flow through a blood vessel. The flow meter induces a magnetic field across the vessel and uses a voltmeter to measure the voltage across the vessel which is normal to both magnetic field and blood flow. A caliper is used to measure the vessel diameter. The system calculated the flow rate to be $100 \text{ cm}^3 \cdot \text{s}^{-1}$ using the known magnetic field, and measured values of voltage and vessel diameter.

After the measurement, a calibration is performed, and it is discovered that the voltmeter was measuring 40% larger than the actual value and the caliper was measuring the diameter 10% smaller than the actual value.

Assuming a uniform flow profile along the vessel and ignoring viscosity, the actual blood flow is _____ $\text{cm}^3 \cdot \text{s}^{-1}$ (rounded off to two decimal places).

Q30) A catheter based arterial blood pressure measurement device uses a flexible diaphragm mounted with four identical strain gauges in a Wheatstone bridge configuration as shown in the figure. Assume that the strain gauges have a nominal resistance value of $R_G = 10 \text{ k}\Omega$, Gauge Factor $G = 40$ and Young's Modulus $E = 10 \text{ MPa}$. Blood pressure variations results in small finite change in strain ϵ ($\epsilon > 0$).

If V_o is the output voltage of the Wheatstone bridge and σ is the stress in MPa, the sensitivity V_o/σ is _____ $\text{V} \cdot \text{MPa}^{-1}$.

