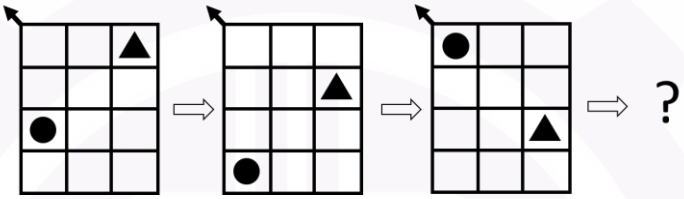
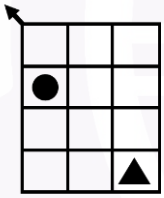
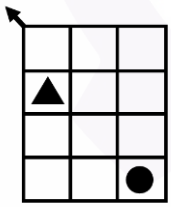
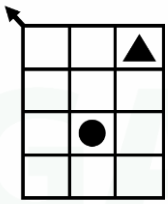
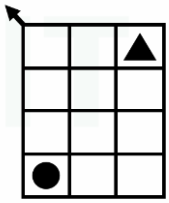
General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	‘The team _____ more than 300 runs in 20 overs _____ rains. However, some players needed to improve their batting skills.’ Choose the option with the correct sequence of words to fill the blanks.
(A)	score; despite
(B)	scoring; instead of
(C)	scored; despite
(D)	scoring; in spite of

Q.2	If a positive real x satisfies the following equation $$\log_2 x + \log_{\sqrt{2}} x = 48,$$ then the value of x is _____
(A)	2^{16}
(B)	4^{16}
(C)	2^{14}
(D)	4^{14}

Q.3	The next figure (indicated by '?') in the sequence is 
(A)	
(B)	
(C)	
(D)	

Q.4	‘All the mangoes in the basket are good.’ If the above statement is **false**, then which one of the following statements is necessarily true?
(A)	All the mangoes in the basket are not good.
(B)	No mango in the basket is good.
(C)	In the basket, some of the mangoes are good and some are not good.
(D)	There exists at least one mango in the basket that is not good.

Q.5	Consider the following statements about four numbers: (S1) The average of the four numbers is 25 (S2) Each number is at most 40 (S3) Each number is at least 20 Choose the option that is necessarily correct.
(A)	(S1) and (S2) together imply (S3)
(B)	(S2) and (S3) together imply (S1)
(C)	(S1) and (S3) together imply (S2)
(D)	(S1) implies (S3)

Q.6 – Q.10 Carry TWO marks Each

Q.6	‘People are crowding around ___ pit into which ___ elephant has fallen. I have never seen an elephant looking more bewildered ___ miserable. Here it is in a most undignified position, thrust into a pit and made to look up ___ a vast, curiosity-stricken crowd.’ Choose the option with the correct sequence of words to fill the blanks.
(A)	an; a; at; and
(B)	a; an; and; at
(C)	and; a; an; at
(D)	at; a; an; and

Q.7

The table lists the unit selling price of five products P, Q, R, S, and T. On a particular day, 250 items were sold with the average selling price of Rs. 60. The following observations were made:

(i) The quantity of S sold was twice that of T.
(ii) The quantity of R sold was thrice that of T.
(iii) The quantity of Q sold was four times that of T.

Product	P	Q	R	S	T
Unit selling price (Rs.)	100	50	40	60	60

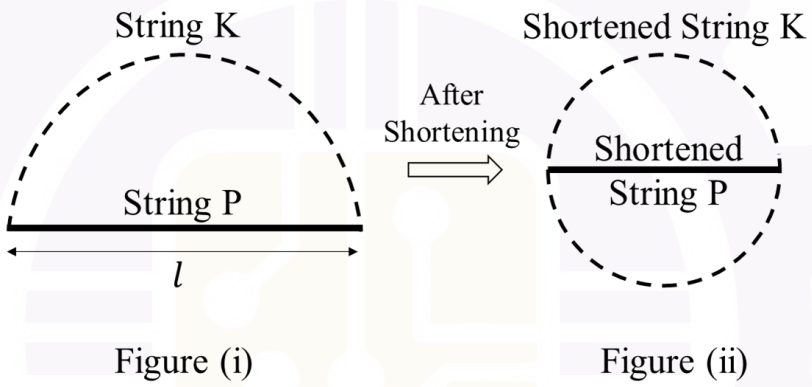
What is the quantity of product P sold on that day?

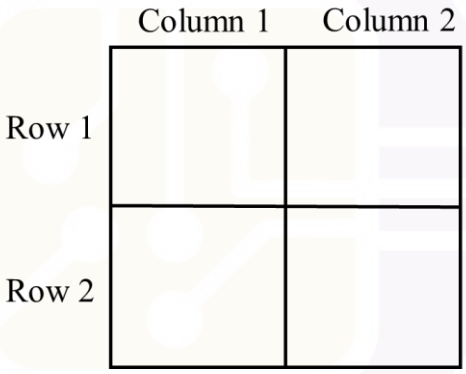
(A) 40

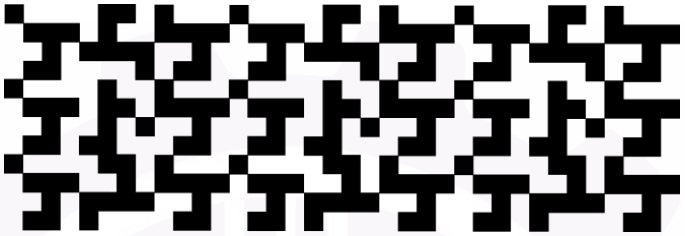
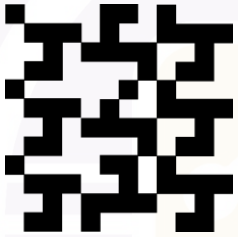
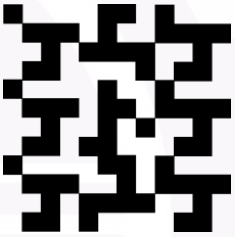
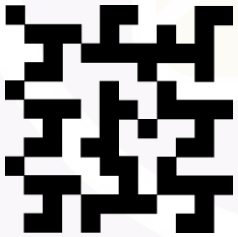
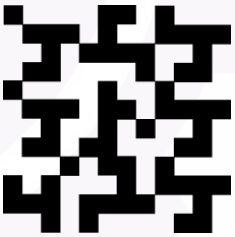
(B) 50

(C) 60

(D) 70

Q.8	Consider a string P of length l that is laid out as a straight-line segment. Another string K is laid out as a semicircular arc with string P as its diameter, as represented in Figure (i). When both the strings are shortened by a length x they can be re-arranged such that the shortened string K forms a full circle with the shortened string P as its diameter, as represented in Figure (ii). The value of x/l is _____ 
(A)	π
(B)	$\frac{\pi-1}{2\pi}$
(C)	$\frac{\pi}{2(\pi-1)}$
(D)	$\frac{\pi}{\pi-1}$

Q.9	The Roman senator Meritorius, his brother, his son, and his daughter have varying oratory skill levels. They are seated in rows and columns as shown in the figure with exactly one person sitting in each box. It is known that (i) Meritorius' daughter and his brother are seated in the same column. (ii) His son is seated diagonally across the sibling of the worst orator. (iii) The best and worst orators are seated in the same row. Who is the best orator? Seating Arrangement 
(A)	Meritorius
(B)	Meritorius' brother
(C)	Meritorius' son
(D)	Meritorius' daughter

Q.10	Which one of the patterns labelled P, Q, R, and S is used to generate the following figure?   P  Q  R  S
(A)	P
(B)	Q
(C)	R
(D)	S

Q.11 – Q.35 Carry ONE mark Each

Q.11	Which one of the following will **not** coagulate when placed on a glass slide that does not have any surface coatings?
(A)	Blood serum
(B)	Fresh blood obtained from an artery
(C)	Fresh blood obtained from a vein
(D)	Blood depleted of neutrophils alone
Q.12	Which one of the following options represents the tissues/organs of a healthy adult human, arranged in the correct decreasing order of their Young's modulus?
(A)	Bone > Cartilage > Liver > Lung
(B)	Bone > Cartilage > Lung > Liver
(C)	Bone > Lung > Cartilage > Liver
(D)	Bone > Lung > Liver > Cartilage

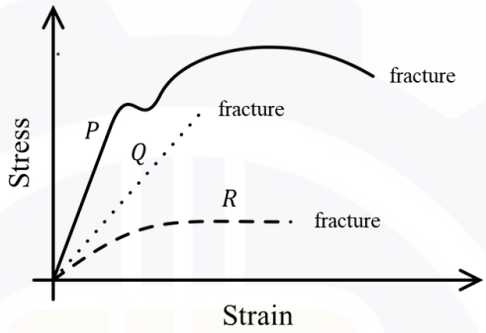
Q.13	Which one of the following is **not** a polymer?
(A)	DNA
(B)	Albumin
(C)	Cholesterol
(D)	Dextran
Q.14	Electrostatic interaction between a positively charged polymer and a negatively charged polymer in an aqueous medium most likely results in the formation of a _____.
(A)	chemical-crosslinked hydrogel
(B)	complex coacervate
(C)	photo-crosslinked hydrogel
(D)	liposome

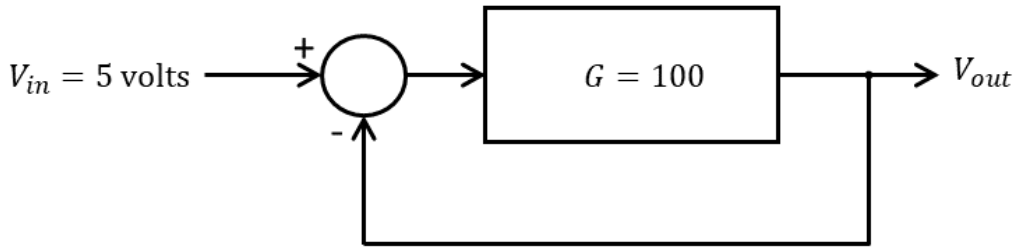
Q.15	The eigenvalues of the matrix $P = \begin{pmatrix} 1 & -2 \\ 3 & -4 \end{pmatrix}$ are
(A)	-1 and -2
(B)	1 and 2
(C)	0 and -1
(D)	0 and 1
Q.16	X is a random variable whose mean is 3 and standard deviation is 2. A new random variable Y is defined as: $$Y = \frac{X-3}{4}$$ The standard deviation of Y is ____
(A)	0.5
(B)	1
(C)	2
(D)	8

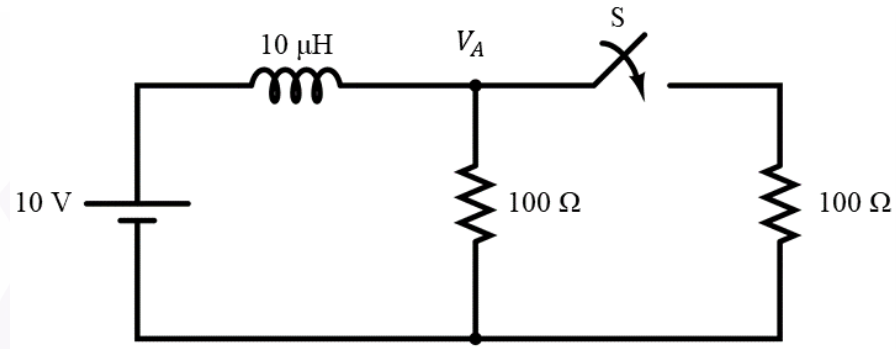
Q.17	Let f be a function of real variables x and y, defined as: $$f(x,y) = x^2y + 3y^2x$$ The value of $\frac{\partial^2 f}{\partial x^2}$ at $x = 1, y = 1$ is _____
(A)	0
(B)	1
(C)	2
(D)	3
Q.18	An invertible $n \times n$ matrix P satisfies $P^3 = I$, where I is the identity matrix of size n. Which one of the following options is true?
(A)	$P^5 = P$
(B)	$P^5 = P^{-1}$
(C)	$P^4 = P^{-1}$
(D)	$P^4 = P^2$

Q.19	Which one of the following cell types is the most abundant in healthy adult human blood?
(A)	Erythrocytes
(B)	Lymphocytes
(C)	Basophils
(D)	Neutrophils
Q.20	Consider an incompressible cylindrical tissue with a diameter of 2 cm and a height of 3 cm. If this tissue is stretched by 10% in the axial direction, its diameter in the stretched configuration is _____ cm. Assume homogeneous deformation of the tissue.
(A)	2.4
(B)	2.2
(C)	1.6
(D)	1.9

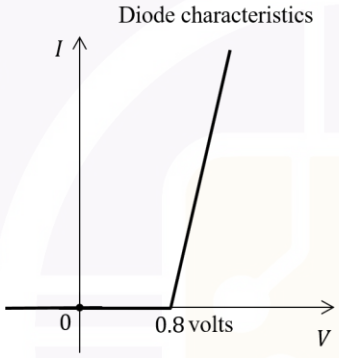
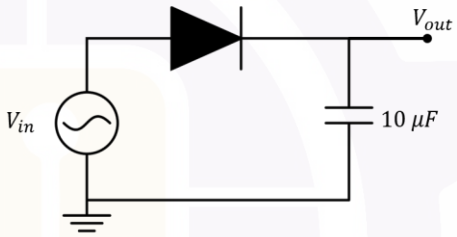
Q.21	A biased coin has a probability of heads equal to $1/3$ and a probability of tails equal to $2/3$. A binary random variable X assumes a value 1 for heads and -1 for tails. The variance of X is _____
(A)	$1/3$
(B)	$5/9$
(C)	$8/9$
(D)	1
Q.22	Which one of the following options represents the correct order of the speed of ultrasound wave propagation in bone, air, and soft tissue?
(A)	bone > air > soft tissue
(B)	bone > soft tissue > air
(C)	air > bone > soft tissue
(D)	soft tissue > bone > air

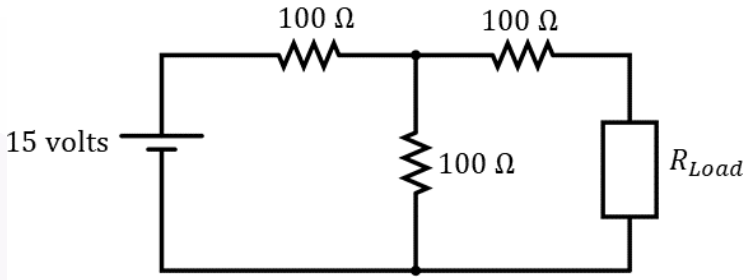
Q.23	The three curves shown in the figure represent the trends in Stress-Strain relationship in Bone, Glass and Steel. Which one of the following options correctly matches the curve labels (P, Q, and R) with these three materials? 
(A)	P-Bone; Q-Glass; R-Steel
(B)	P-Steel; Q-Bone; R-Glass
(C)	P-Steel; Q-Glass; R-Bone
(D)	P-Glass; Q-Bone; R-Steel

Q.24	A control system shown in the figure below has a forward gain $G = 100$. An input $V_{in} = 5$ volts is supplied to the system. What is the absolute error between the output V_{out} and input V_{in} in volts? 
(A)	0.00
(B)	0.05
(C)	0.50
(D)	1.00

Q.25	The circuit given below is initially in steady-state with the switch S open. Immediately after the switch S is closed, the voltage V_A is _____ volts. 
(A)	0
(B)	10
(C)	5
(D)	-10

Q.26	A standard n-type MOSFET, biased in the saturation region, has the following parasitic capacitances: 1. C_{GS}: gate to source capacitance 2. C_{GD}: gate to drain capacitance 3. C_{DS}: drain to source capacitance Which one of the following options is correct?
(A)	$C_{GS} > C_{GD} > C_{DS}$
(B)	$C_{GD} > C_{DS} > C_{GS}$
(C)	$C_{DS} > C_{GD} > C_{GS}$
(D)	$C_{GD} > C_{GS} > C_{DS}$
Q.27	$x[n]$ is a real and odd signal. Which one of the following statements is true about its Discrete Time Fourier Transform (DTFT) $X(e^{j\omega})$?
(A)	$X(e^{j\omega})$ is real and even
(B)	$X(e^{j\omega})$ is imaginary and even
(C)	$X(e^{j\omega})$ is real and odd
(D)	$X(e^{j\omega})$ is imaginary and odd

Q.28	The $I-V$ characteristics of a diode with a knee voltage $V_{knee} = 0.8$ volts is shown in Figure 1. This diode is used in the circuit shown in Figure 2, in which an input signal of $V_{in} = 100\sin(1000t)$ volts is applied. What is the voltage V_{out} (in volts) across the capacitor at steady state? Assume that the capacitor is initially discharged and the reverse breakdown voltage of the diode is much greater than 100 volts.  Figure 1  Figure 2
(A)	99.2
(B)	$99.2\cos(1000t)$
(C)	$99.2\sin(1000t)$
(D)	-99.2

Q.29	Which one of the following options is the Thevenin voltage (in volts) across the resistor R_{Load} in the circuit given below? 
(A)	7.5
(B)	5.0
(C)	15.0
(D)	10.0

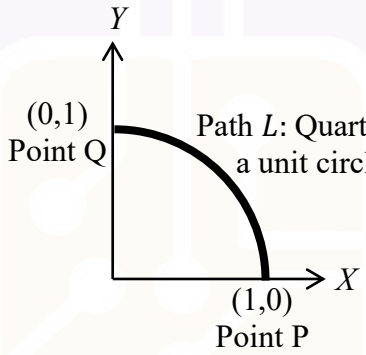
Q.30	In humans, the pyloric sphincter is located between _____.
(A)	esophagus and stomach
(B)	stomach and duodenum
(C)	mouth and esophagus
(D)	ileum and large intestine
Q.31	Which one of the following epithelial cell types is primarily located in the tracheal mucosa of a healthy adult human?
(A)	Transitional
(B)	Keratinized stratified squamous
(C)	Simple squamous
(D)	Ciliated pseudostratified columnar
Q.32	The shell of a hollow spherical nanoparticle has a uniform thickness of 3 nanometers (nm). The outer radius of the nanoparticle is 5 nm. The ratio of the volume of the shell to the volume of the hollow core is _____ *(Round off to one decimal place)*

Q.33	An MRI signal acquired from a tissue has a transverse relaxation time (T_2) of 100 milliseconds (ms). If the signal intensity at time $t = 0$ ms is 500 a.u., the signal intensity at $t = 50$ ms is _____ a.u. *(Round off to one decimal place)*
Q.34	The gyromagnetic ratio of ^{31}P nucleus is 17.23 MHz/Tesla. The Larmor frequency of ^{31}P nucleus in an MRI scanner with a field strength of 3 Tesla is _____ MHz. *(Round off to one decimal place)*
Q.35	The vital capacity, tidal volume, and inspiratory reserve volume of the lungs of a healthy individual are 4600 milliliters (mL), 500 mL, and 2500 mL, respectively. The expiratory reserve volume of the lungs of this individual is _____ mL. *(Round off to the nearest integer)*

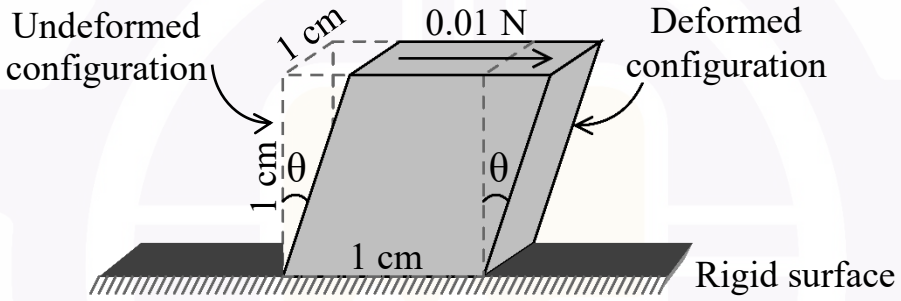
Q.36 – Q.65 Carry TWO marks Each

Q.36	A drug is loaded in a polymeric device through a process. Which one of the following ratios defines the drug encapsulation efficiency of this process?
(A)	$\frac{\text{Amount of drug successfully loaded}}{\text{Amount of polymer in the device}}$
(B)	$\frac{\text{Amount of drug successfully loaded}}{\text{Amount of drug used in the process}}$
(C)	$\frac{\text{Amount of drug used in the process}}{\text{Amount of drug successfully loaded}}$
(D)	$\frac{\text{Amount of polymer in the device}}{\text{Amount of drug used in the process}}$
Q.37	Which one of the following complement system pathways is most likely to be activated on biomaterials implanted in a healthy human?
(A)	classical pathway
(B)	lectin pathway
(C)	alternative pathway
(D)	extrinsic pathway

Q.38	Choose one of the following options that correctly fills the blanks labelled as I and II in the paragraph below. Lower critical solution temperature (LCST) polymers exhibit a decrease in their water solubility with an increase in temperature. This happens because, at low temperatures, the hydrogen bonding between the ___I___ segments of polymer chain and the water molecules dominates. At high temperatures, the interactions between the ____II___ segments dominate.
(A)	I-hydrophilic; II-hydrophobic
(B)	I-hydrophobic; II-hydrophilic
(C)	I-hydrophilic; II-polar
(D)	I-hydrophobic; II-polar
Q.39	The Newton-Raphson method is used to find the roots of the equation $x = e^{-2x}$. If the initial guess $x_0 = 0$, the estimate of the root after the first iteration, x_1 = _____
(A)	1
(B)	1/2
(C)	1/3
(D)	1/4

Q.40	Let f be a function of two real variables x and y, defined as: $$f(x,y) = x^2 + y^2$$ The value of the line integral $\int \vec{\nabla} f \cdot d\vec{l}$ from point P to point Q along the path L shown in the figure below is _____ Here $\vec{\nabla} = \hat{x}\frac{\partial}{\partial x} + \hat{y}\frac{\partial}{\partial y}$, with $\hat{x}$ and $\hat{y}$ as the unit vectors along X and Y axes, respectively. 
(A)	0
(B)	1
(C)	-1
(D)	π

Q.41	The output $y[n]$ of a digital moving average filter for an input $x[n]$ is given by $$y[n] = \frac{1}{4}(x[n] + 2x[n-1] + x[n-2])$$ Which one of the following options is a correct statement about the transfer function of this filter?
(A)	It has two poles and two zeros
(B)	It has two poles and no zeros
(C)	It has no poles and two zeros
(D)	It has one pole and one zero

Q.42	A uniform shear force of magnitude 0.01 Newton (N) is applied to the top surface of a cubical tissue sample with side of length 1 cm (marked with dashed lines in the figure below). In the deformed configuration (marked with solid lines), the angle θ = 5 degrees. The shear modulus of the tissue is _____ kilopascals (kPa). Assume the tissue to be a linear, isotropic and homogenous elastic solid. 
(A)	1.14
(B)	10.40
(C)	5.14
(D)	3.14

Q.43

The table below shows the average values of the power spectral density (PSD) of an EEG signal in different frequency bands.

Frequency bands (Hertz)	**Average PSD (microvolts^2/Hertz)**
0.4 – 4.0	3
4.0 – 8.0	4
8.0 – 13.0	8
13.0 – 30.0	5
30.0 – 100.0	3

The PSD of the EEG signal has a noise floor of 2 microvolts^2/Hertz. The signal to noise ratio for the alpha-band, expressed in decibels, is _____

(A) 1.76

(B) 3.01

(C) 6.02

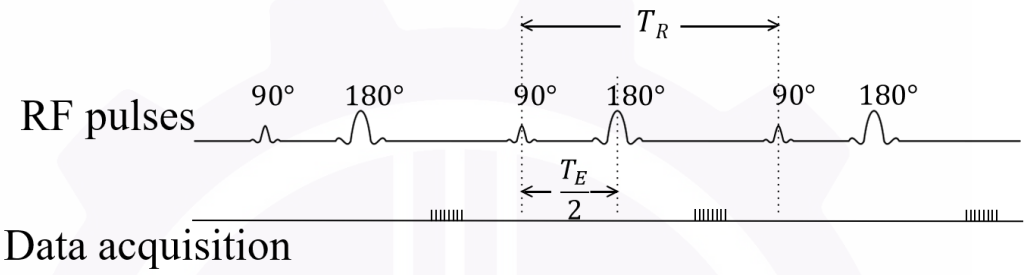
(D) 3.98

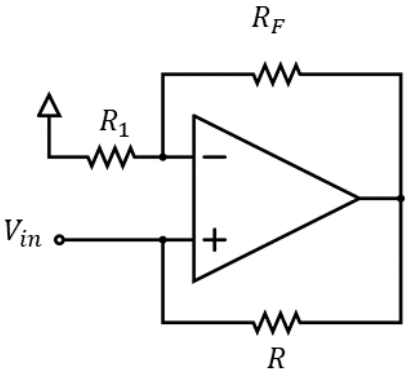
Q.44 Which one of the following options correctly matches the ECG signals in Panel-1 with the cardiac conditions in Panel-2?

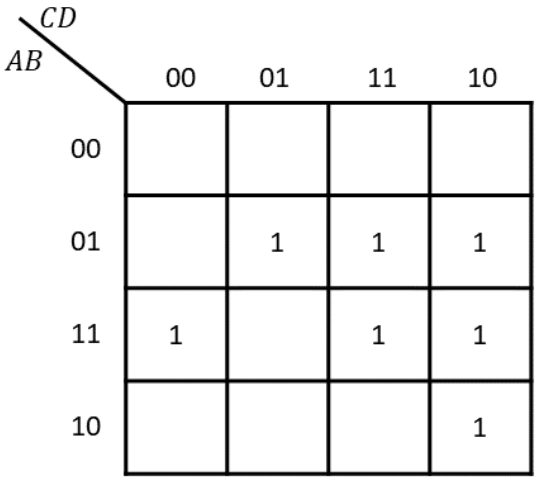
Panel-1 **ECG signals**	Panel-2 **Cardiac Conditions**
X  Y  Z 	(i) Normal condition (ii) Atrial flutter (iii) Atrioventricular block

(A)	X-(i); Y-(iii); Z-(ii)
(B)	X-(i); Y-(ii); Z-(iii)
(C)	X-(ii); Y-(i); Z-(iii)
(D)	X-(ii); Y-(iii); Z-(i)

Q.45	An ultrasound wave is incident normal to the interface of muscle and bone. The acoustic impedances of muscle and bone are 1.7×10^{-4} kg m^{-2} sec^{-1} and 6.1×10^{-4} kg m^{-2} sec^{-1}, respectively. The fraction of the incident energy that is reflected is _____
(A)	0.98
(B)	0.32
(C)	0.50
(D)	0.65
Q.46	An ultrasound beam traversing through 5 cm of a material is attenuated at a rate of 2 dB/cm. The intensity of the beam at the exit of the material is I_{exit} and the intensity at the entry into the material is I_{entry}. The ratio $\frac{I_{exit}}{I_{entry}}$ = _____
(A)	0.5
(B)	0.9
(C)	0.1
(D)	0.7

Q.47	A Magnetic Resonance Imaging (MRI) sequence is shown in the figure below, wherein T_R is the repetition time and T_E is the echo time. Which one of the following options is the correct name of this MRI sequence? 
(A)	Spin echo sequence
(B)	Echo planar imaging sequence
(C)	Inversion recovery sequence
(D)	Saturation recovery sequence

Q.48	If the operational amplifier in the circuit below is ideal, the input impedance looking into terminal V_{in} is _____ 
(A)	∞
(B)	$-\frac{R \times R_1}{R_F}$
(C)	$\frac{R \times R_F}{R_1}$
(D)	R

Q.49	The figure below shows the Karnaugh map (K-map) for a truth table with 4 variables A, B, C and D. Which one of the following expressions represents the **minimum** sum of products? Note: The empty cells in the K-map are 0's. 
(A)	$BC + \bar{A}BD + AC\bar{D} + AB\bar{D}$
(B)	$AB\bar{C}\bar{D} + \bar{A}B\bar{C}D + A\bar{B}C\bar{D} + BC$
(C)	$BC + AC\bar{D} + \bar{A}BD + AB\bar{C}\bar{D}$
(D)	$AB\bar{D} + \bar{A}BD + AC\bar{D} + BCD + BC\bar{D}$

Q.50 Which one of the following options correctly matches the cell types (Panel-1) with the organs in which they are primarily located (Panel-2)?

Panel-1	Panel-2
(p) Microglia	(i) Brain
(q) Mesangial cells	(ii) Kidney
(r) Microfold cells	(iii) Small intestine

(A) (p)-(i); (q)-(ii); (r)-(iii)

(B) (p)-(i); (q)-(iii); (r)-(ii)

(C) (p)-(ii); (q)-(i); (r)-(iii)

(D) (p)-(iii); (q)-(ii); (r)-(i)

Q.51 Which one of the following options correctly matches the lobes of the cerebral cortex of a healthy human being (Panel-1) with their canonical sensory function (Panel-2)?

Panel-1	Panel-2
(p) Parietal lobe	(i) Sight
(q) Occipital lobe	(ii) Touch
(r) Temporal lobe	(iii) Hearing

(A) (p)-(i); (q)-(ii); (r)-(iii)

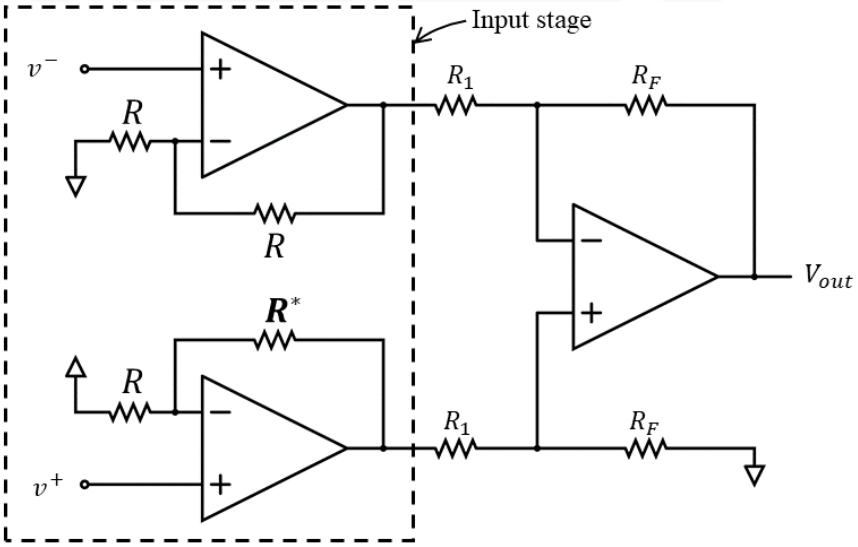
(B) (p)-(ii); (q)-(i); (r)-(iii)

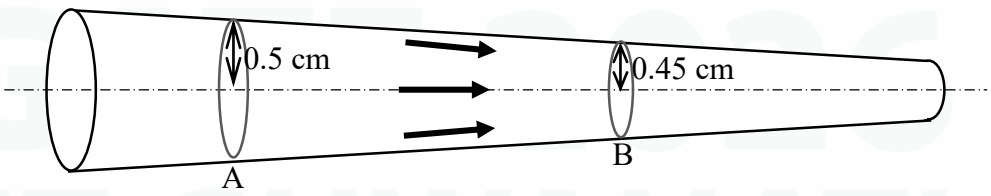
(C) (p)-(iii); (q)-(i); (r)-(ii)

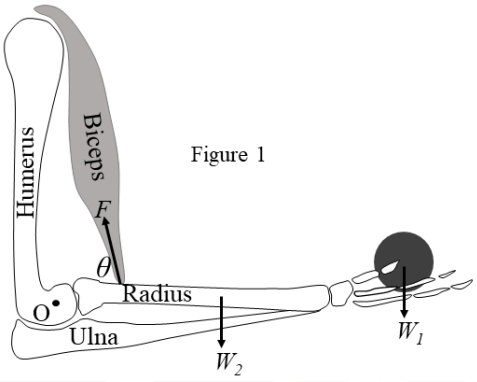
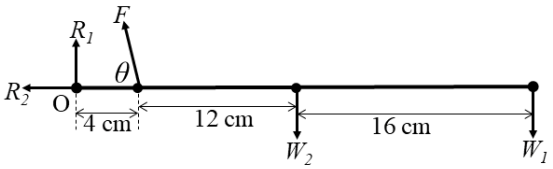
(D) (p)-(i); (q)-(iii); (r)-(ii)

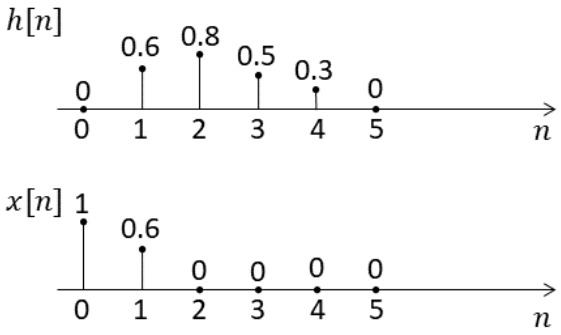
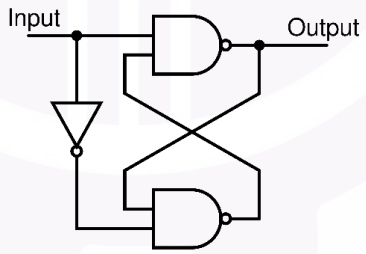
Q.52	Which of the following cells is/are primarily located in the epidermis of healthy human skin?
(A)	Keratinocytes
(B)	Melanocytes
(C)	Oxyntic cells
(D)	Goblet cells
Q.53	Which of the following conditions result(s) in a higher statistical power for comparing means of two samples using t-test?
(A)	An increase in the sizes of both the samples from 100 to 1000
(B)	An increase in the significance level from $\alpha = 0.01$ to $\alpha = 0.2$
(C)	A decrease in the significance level from $\alpha = 0.2$ to $\alpha = 0.01$
(D)	A decrease in the sizes of both the samples from 1000 to 100

Q.54	Select the peptide hormone(s) from the following options.
(A)	Cortisol
(B)	Testosterone
(C)	Oxytocin
(D)	Insulin

Q.55	The circuit shown below is used as an instrumentation amplifier. Among the resistors used in the input stage, the value of resistance of one of the resistors ($\boldsymbol{R}^*$) is slightly mismatched from that of the rest of the resistors (R). Assume all operational amplifiers are ideal. Which of the following statements is/are true? 
(A)	The resistance mismatch introduces a gain error
(B)	The resistance mismatch degrades the common mode rejection ratio (CMRR)
(C)	The resistance mismatch introduces an offset error
(D)	V_{out} is not sensitive to any resistance mismatch

Q.56	A resistor with $60 \pm 2\ \Omega$ resistance is part of a circuit. The voltage measured across this resistor is 120 ± 10 mV (millivolts). The uncertainty in the estimation of the power dissipated by the resistor is _____ mW (milliwatts). (*Round off to one decimal place).*
Q.57	A photodiode is in series with a 10 kΩ resistor. A laser beam with wavelength 532 nanometer shines on this photodiode such that the entire beam is incident on its active area. The photodiode responsivity is 0.5 ampere per watt (A/W) at this wavelength. If a voltage of 10 millivolts (mV) is developed across the 10 kΩ resistor, the laser power incident on the photodiode is _____ microwatts (μW). (*Round off to one decimal place).* Assume that the dark current of the photodiode is zero.
Q.58	If $\begin{pmatrix} 2 \\ a \end{pmatrix}$ is an eigenvector corresponding to the smallest eigenvalue of the matrix $\begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}$, the value of *a* is _____ (*Answer in integer)*
Q.59	There is a steady laminar blood flow in a tapered cylindrical vessel of circular cross-section, as shown in the figure below. Two cross-sections, labeled A and B in the figure, have radii 0.5 centimeter (cm) and 0.45 cm, respectively. If the average flow speed of the blood at cross-section A is 1 cm/second, the average flow speed at cross-section B is _____cm/second. (*Round off to one decimal place).* Assume blood to be an incompressible fluid. 

Q.60	Figure 1 depicts an arm holding a ball in static equilibrium. Figure 2 shows the free-body diagram of the lower arm where F is the force applied by the biceps muscle at an angle of θ = 60 degrees with respect to the lower arm, and R_1 and R_2 are the reaction forces acting at point O. The weights of the ball and the lower arm are W_1 = 50 Newtons (N) and W_2 = 20 N, respectively. The force exerted by the biceps muscle is F = _____ N. (*Round off to the nearest integer)* Assume the lower arm to be a rigid body.  Figure 1  Figure 2
Q.61	The concentration p (in µg/dL i.e., micrograms/deciliter) of a hormone, as a function of time t (in hours) is governed by the following differential equation for $t \geq 0$ $$\frac{dp}{dt} = e^{-0.1t} - 0.1\,p$$ If $p(0) = 20$ µg/dL, then $p(10)$ = _____ µg/dL. (*Round off to one decimal place)*
Q.62	The half-life of ^{113m}In nuclei is 1.7 hours, and the ^{99m}Tc nuclei is 6.0 hours. If the initial activity levels of ^{113m}In and ^{99m}Tc in their respective samples are 100 Gigabecquerels (GBq) and 20 GBq, the time at which their activity levels become equal is _____ hours. (*Round off to one decimal place)*

Q.63	The figure below shows the impulse response of a linear time-invariant (LTI) system, $h[n] = [0, 0.6, 0.8, 0.5, 0.3, 0]$. For an input $x[n] = [1, 0.6, 0, 0, 0, 0]$, the maximum value of its output $y[n]$ is _____ (*Round off to one decimal place)* 
Q.64	In the following digital circuit, the delay of both the NAND gates is 4 nanoseconds (ns) and the delay of the NOT gate is 1 ns. If a 10 MHz clock signal with 50% duty cycle is provided as the input, the duty cycle of the output is _____% *(Answer in integer)* 
Q.65	Solid polymeric particles of diameter 20 micrometers (μm) are suspended in water such that the concentration of polymeric particles in the solution is 1% weight/volume (w/v). If the mass density of the polymeric particle is 1 g/cm^3, the number of polymeric particles present in 1 mL of this solution is _____ $\times 10^6$. *(Round off to one decimal place)*