General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	"He often _____ the numbers. False claims are not going to help. Honesty _____ trust", said the manager. Choose the option with the correct order of words to fill the blanks.
(A)	exaggerates; engenders
(B)	excels; encourages
(C)	aggravates; alleviates
(D)	diminishes; eliminates

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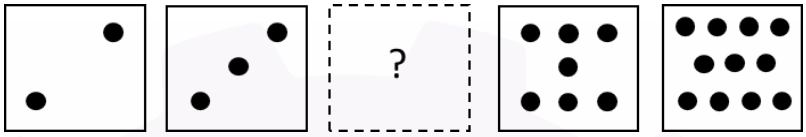
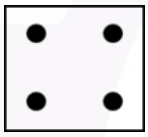
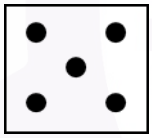
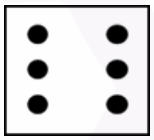
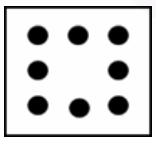
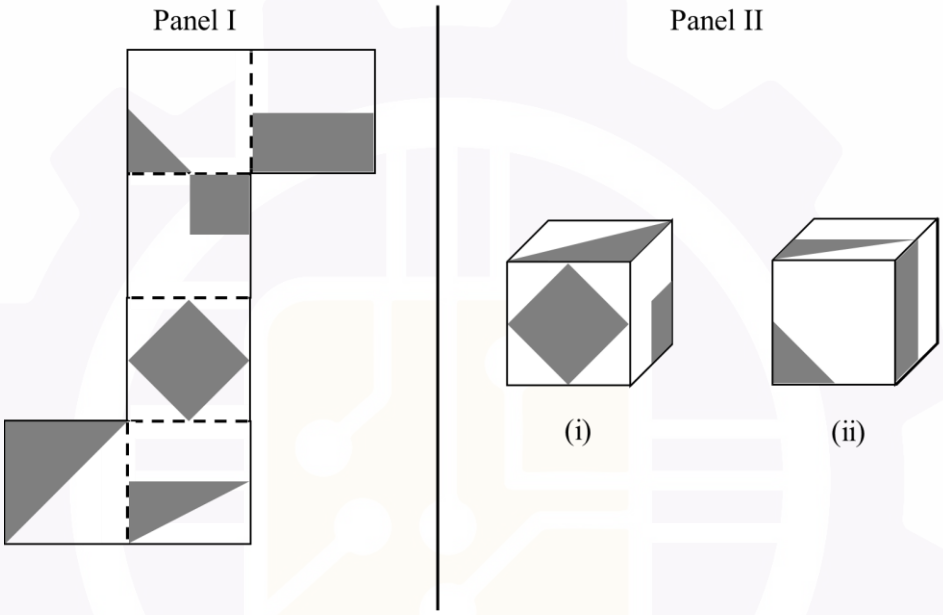
Q.2	In the sequence of tiles shown below, the missing tile indicated by the question mark should be 
(A)	
(B)	
(C)	
(D)	

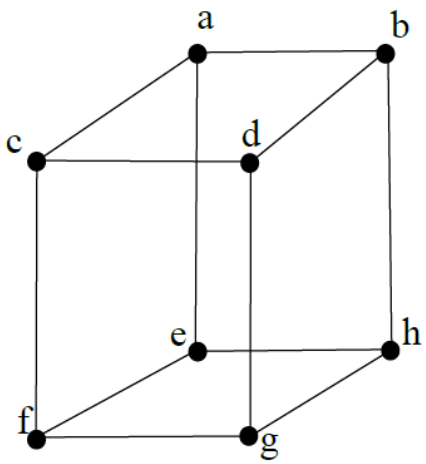
Q.3	A school has 100 students distributed among 1st to 10th standards. Based on this, which one of the following statements is always correct?
(A)	There are at least 10 students who belong to the same standard.
(B)	There is at least one student in each standard.
(C)	There are at most 10 students in 10th standard.
(D)	The total number of students from 1st to 5th standards is at least 50.
Q.4	How many 3-digit numbers can be formed using three distinct single digit prime numbers?
(A)	64
(B)	24
(C)	12
(D)	4

Q.5	In a group of students, 10 students like Mathematics, 12 students like English, 4 students like both Mathematics and English, and 6 students like neither Mathematics nor English. The number of students in the group is ____
(A)	18
(B)	20
(C)	24
(D)	32

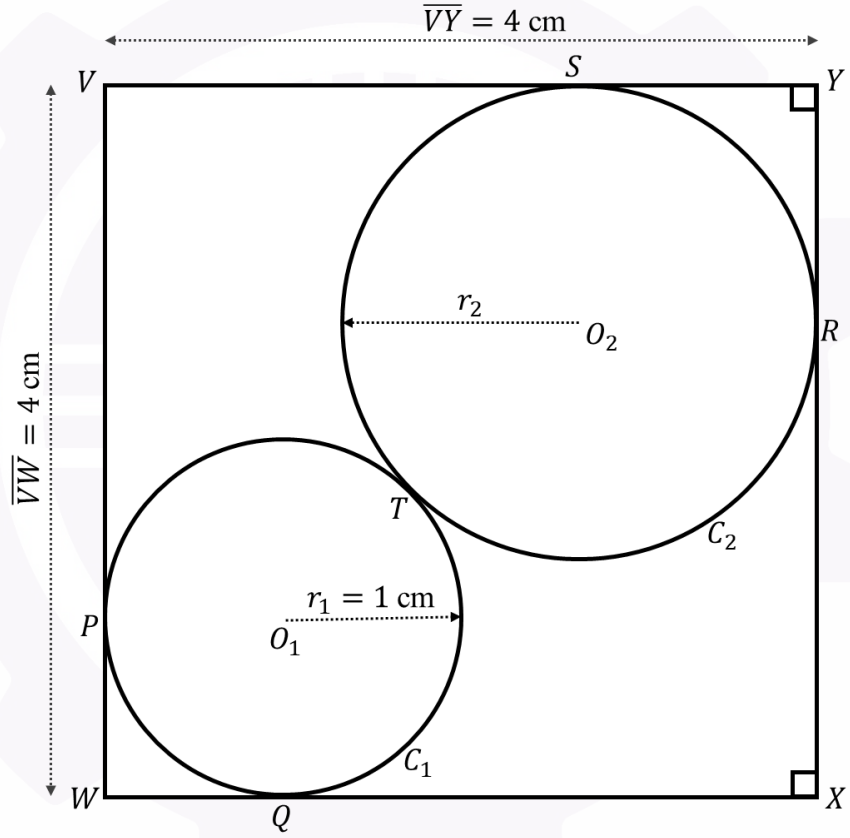
Q.6 – Q.10 Carry TWO marks Each

Q.6	Charity : P :: Retaliation : Q Choose the appropriate pair of words P and Q that fit the analogy.
(A)	P = Parsimonious; Q = Vengeful
(B)	P = Altruistic; Q = Amicable
(C)	P = Resentful; Q = Spiteful
(D)	P = Magnanimous; Q = Vindictive

Q.7	A paper shown in Panel I is folded along the dashed lines (- - -) to construct a cube. The shaded regions shown in Panel I appear on the outer surface of the cube. Referring to cubes shown in Panel II, which one of the options is correct? 
(A)	Only (i) can correspond to the unfolded cube in Panel I.
(B)	Only (ii) can correspond to the unfolded cube in Panel I.
(C)	Both (i) and (ii) can correspond to the unfolded cube in Panel I.
(D)	Neither (i) nor (ii) can correspond to the unfolded cube in Panel I.

Q.8	Consider the cube shown below with its 8 corners labelled a, b, c, d, e, f, g, and h. The figure is representative. All corners are to be colored such that any two corners that are connected by an edge must be of different colors. The minimum number of colors required to achieve this is _____ 
(A)	8
(B)	4
(C)	3
(D)	2

Q.9	Four hills H1, H2, H3, and H4 are present in an area. The following observations are made about them: i. Neither H2 nor H3 is the easternmost hill. ii. Neither H2 nor H3 is the westernmost hill. iii. Neither the easternmost hill nor the westernmost hill is the southernmost hill. iv. Two hills are located to the west of H2. v. The southernmost hill has at least two hills to its east. The southernmost hill is _____.
(A)	H1
(B)	H2
(C)	H3
(D)	H4

Q.10	As shown in the figure, circle C_1 with center O_1 and radius r_1 touches the square $VWXY$ at points P and Q while circle C_2 with center O_2 and radius r_2 touches the square $VWXY$ at points R and S. The two circles touch each other at T. Given $r_1 = 1$ cm and $\overline{VY} = \overline{VW} = 4$ cm, r_2 = _____ cm. 
(A)	$4 - 3\sqrt{2}$
(B)	$1 + 2\sqrt{2}$
(C)	$7 - 4\sqrt{2}$
(D)	$5 + 3\sqrt{2}$

Q.11 – Q.35 Carry ONE mark Each (MCQ)

Q.11	Consider the two functions $f_1(x) = \frac{x^2-4}{x-2}$ and $f_2(x) = x^2 - 2x + 2$. Which of the following is the value of $(f_1(x) + f_2(x))$ as $x \to 2$?
(A)	0
(B)	6
(C)	8
(D)	∞
Q.12	Which of the following is one of the eigenvalues for the matrix given below? $\begin{bmatrix} 3 & 4 \\ 4 & -3 \end{bmatrix}$
(A)	1
(B)	3
(C)	5
(D)	7

Q.13	Which of the following functions has the highest area under the curve between $x = 0$ and $x = 10$?
(A)	$y = x + 8$
(B)	$y = 3x$
(C)	$y = 2x + 1$
(D)	$y = x + 2$
Q.14	Cancer cells display a high level of heterogeneity in the expression of TP53 protein. Which of the following techniques can be directly used to determine the intra-tumoral heterogeneity of TP53 expression in a given tumor sample, without resorting to additional cell separation techniques?
(A)	Immunoblotting
(B)	Flow cytometry
(C)	ELISA
(D)	Quantitative RT-PCR

Q.15	The transfer function of a Proportional-Integral (PI) controller $G_C(s)$ is given by $$G_C(s) = K_C\left(1 + \frac{1}{\tau_I s}\right)$$ where K_C is the controller gain, τ_I is the controller integral time constant and s is the Laplace variable. The role of the integral component of the controller is to _____.
(A)	integrate the difference between the process and manipulated variable
(B)	integrate the difference between the set point and disturbance variable
(C)	integrate the difference between the set point and the measured variable
(D)	integrate the difference between the input and output variable
Q.16	Which of the following enzyme is involved in the protection of cells from reactive oxygen species?
(A)	Hexokinase
(B)	Glucose 6-phosphate dehydrogenase
(C)	Enolase
(D)	Pyruvate kinase

Q.17	In nitrogen fixation, to reduce nitrogen to ammonia, which one of the following shows the correct order of electron flow?
(A)	Ferredoxin → reductase → nitrogenase
(B)	NADH → reductase → nitrogenase
(C)	Ferredoxin → nitrogenase → reductase
(D)	Reductase → NADH → nitrogenase
Q.18	For monoclonal antibody production, hypoxanthine _____.
(A)	allows DNA synthesis in the absence of *de novo* dTMP synthesis
(B)	allows purine synthesis in cells containing HGPRT
(C)	induces cell fusion
(D)	prevents *de novo* nucleotide synthesis

Q.19	Which one of the following proteins would elute third in gel filtration chromatography from a mixture of four proteins given below?
(A)	Insulin (6 kDa)
(B)	Myoglobin (17 kDa)
(C)	Thrombin (37 kDa)
(D)	Albumin (66 kDa)
Q.20	Which one of the following antibiotics blocks protein chain elongation by preventing the action of peptidyl transferase ?
(A)	Bleomycin
(B)	Rifampicin
(C)	Chloramphenicol
(D)	Tetracycline

Q.21	The catalytic efficiency of an enzyme following Michaelis-Menten kinetics is defined by
(A)	k_{Cat}
(B)	$V_{\text{max}} / k_{\text{Cat}}$
(C)	$k_{\text{Cat}} / K_{\text{M}}$
(D)	$k_{\text{Cat}} / V_{\text{max}}$
Q.22	The RNA primer synthesized during bacterial DNA replication is removed by _____.
(A)	DNA gyrase
(B)	DNA Polymerase I
(C)	Primase
(D)	DNA Polymerase III

Q.23 Match the carbohydrates in **Column I** with the correct glycosidic linkages involved in **Column II.**

Column I	**Column II**
P. Amylose	1. β (1→ 4)
Q. Sucrose	2. α (1→ 4)
R. Amylopectin	3. α1→ β2
S. Cellulose	4. α (1→ 4), α (1→ 6)

(A) P-4; Q-3; R-2; S-1

(B) P-2; Q-1; R-4; S-3

(C) P-2; Q-3; R-4; S-1

(D) P-1; Q-3; R-4; S-2

Q.24	The correct sequence of the four steps involved in anaerobic production of biogas from complex organics is:
(A)	Hydrolysis → Acidogenesis → Acetogenesis → Methanogenesis
(B)	Methanogenesis → Acetogenesis → Acidogenesis → Hydrolysis
(C)	Acidogenesis → Hydrolysis → Methanogenesis → Acetogenesis
(D)	Hydrolysis → Methanogenesis → Acidogenesis → Acetogenesis
Q.25	Which one of the following options represents the products of light reactions of photosynthesis in plants?
(A)	O_2/NADH/H_2
(B)	O_2/$NADP^+$/CO_2
(C)	O_2/NADPH/ATP
(D)	O_2/$NADP^+$/ATP

Q.26	Which component of the CRISPR/Cas9 gene editing system is NOT of natural origin?
(A)	CAS9 protein
(B)	CRISPR repeats
(C)	PAM sequence
(D)	sgRNA

Q.27 – Q.30 Carry ONE mark Each (MSQ)

Q.27	The equation $\frac{d^2y}{dx^2} - y = 0$ has a solution of the form $y = e^{Ax}$. The value(s) of *A* satisfying this is/are:
(A)	0
(B)	1
(C)	-1
(D)	-∞
Q.28	Which of the following drugs inhibit(s) ATP-ADP translocase?
(A)	Oligomycin
(B)	Atractyloside
(C)	Amytal
(D)	Bongkrekic acid

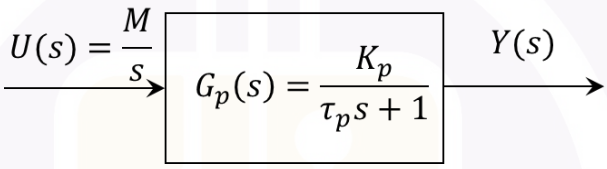
Q.29	Which of the following is/are extra-cellular matrix protein(s)?
(A)	Myosin
(B)	Fibronectin
(C)	Lamin
(D)	Collagen
Q.30	BLAST and its extensions can be used to determine similarity of a query protein sequence with which of the following database(s)?
(A)	A database of translated nucleotide sequences
(B)	A database of binding ligands and small translated peptides
(C)	A database of protein structures
(D)	A database of binding, linking and self-assembling proteins

Q.31 – Q.35 Carry ONE mark Each (NAT)

Q.31	The mean of the following series is _____. (*rounded off to three decimal places*) $0.01, 0.02, 0.03, \cdots \cdots, 1$
Q.32	You are characterizing a new enzyme isolated and purified in the laboratory. If the maximum velocity of the enzyme is 1800 µmoles L^{-1} min^{-1} and the total concentration of the enzyme in the reaction mixture is 1.5 µM, then the turnover number of the enzyme is _____ s^{-1}. (*answer in integer*)
Q.33	To determine the viable cell count of a bacterial culture, you have plated 50 µL of a 100-fold diluted sample of the culture on a nutrient agar plate and obtained 20 colonies after overnight incubation. The viable cell count of the culture is _____ CFU mL^{-1}. (*answer in integer*)
Q.34	Given below is the Gibbs free energy change (ΔG) in kilo Joules per electron equivalent (kJ $e^{-}eq^{-1}$) at pH 7.0, of organic and inorganic half reactions. Acetate synthesis: $\frac{1}{8}CO_2 + \frac{1}{8}HCO_3^- + H^+ + e^- \rightarrow \frac{1}{8}CH_3COO^- + \frac{3}{8}H_2O$ ΔG=27.4 kJ $e^{-}eq^{-1}$ Reduction reaction: $\frac{1}{4}O_2 + H^+ + e^- \rightarrow \frac{1}{2}H_2O$ ΔG= -78.72 kJ $e^{-}eq^{-1}$ The free energy change of acetate oxidation to CO_2, H_2O and HCO_3^- is _____ kJ $e^{-}eq^{-1}$. (*rounded off to two decimal places*)
Q.35	You have purified an enzyme using a series of chromatographic methods. It was observed that a 10 µg mL^{-1} of this purified enzyme converted 10 mM substrate per hour at 25°C and pH 7. Its specific activity is _____ IU $µg^{-1}$. (*rounded off to three decimal places*)

Q.36 – Q.65 Carry TWO marks Each

Q.36 – Q.40 MCQ

Q.36	In the open-loop process shown in the figure, the input $U(s)$, the transfer function $G_p(s)$ and the output $Y(s)$ are given in the Laplace domain in terms of the Laplace variable s. For this process, which of the following is true? (where M, τ_p, K_P, are the magnitude of the input, the characteristic time and the gain for the process, respectively) 
(A)	$y(t) = K_p\left(1 - e^{-t/\tau_p}\right)$
(B)	$y(t) = MK_p\left(1 - e^{-t/\tau_p}\right)$
(C)	$y(t) = K_p\left(M - e^{-t/\tau_p}\right)$
(D)	$y(t) = K_p\left(1 - Me^{-t/\tau_p}\right)$

Q.37 Match the immunological terms in **Column I** with their function/description in the **Column II**

Column I	**Column II**
P. *J* gene	1. Suppresses immune system by blocking calcineurin
Q. Cyclosporin	2. Antibody binding site on a large molecule
R. Epitope	3. Small foreign molecule which elicits an immune response only when combined with a carrier molecule
S. Hapten	4. Contributes to antibody diversity

(A) P-3; Q-4; R-2; S-1

(B) P-2; Q-4; R-1; S-3

(C) P-4; Q-1; R-2; S-3

(D) P-1; Q-3; R-4; S-2

Q.38 Match the genetic disorders in **Column I** to the corresponding underlying cause in **Column II**

Column I	**Column II**
P. Klinefelter Syndrome	1. X-chromosome insufficiency
Q. Turner syndrome	2. DNA helicase mutations
R. Bloom syndrome	3. Nucleotide excision repair defects
S. Xeroderma pigmentosum	4. Extra X chromosome(s) in a male

(A) P-1; Q-3; R-4; S-2

(B) P-4; Q-1; R-2; S-3

(C) P-4; Q-2; R-3; S-1

(D) P-3; Q-2; R-4; S-1

Q.39 Match the biomolecules in **Column I** with their function given in **Column II**

Column I	**Column II**
P. Lectins	1. Acts as ATP dependent pump to efflux out small molecules
Q. P-glycoprotein	2. Targets lysosomal enzymes to their destination
R. Digitoxigenin	3. Specific carbohydrate binding proteins
S. Mannose 6-phosphate	4. Inhibits Na^+-K^+ pump

(A) P-3; Q-2; R-1; S-4

(B) P-1; Q-3; R-4; S-2

(C) P-2; Q-1; R-3; S-4

(D) P-3; Q-1; R-4; S-2

Q.40	By elemental analysis of a biomass sample, it was found that the cells in the given sample are composed of (by weight) C=50%, H=8%, O=20%, N=10% and ash content=12%. Which of the following is the correct empirical formula of the ash-free cells, normalized with respect to Nitrogen?
(A)	$C_{5.8}H_{11.2}O_{1.7}N$
(B)	$C_{5.0}H_{10.2}O_{1.1}N$
(C)	$C_{6.8}H_{12.2}O_{2.1}N$
(D)	$C_{4.8}H_{9.2}O_{3.1}N$

Q.41 – Q.65 MSQ / NAT

Q.41 – Q.45 MSQ

Q.41	For the given matrix, which of the statements given below is/are true? $\begin{bmatrix} 3 & 1 & 5 \\ 2 & -1 & 0 \\ 5 & 2 & 9 \end{bmatrix}$
(A)	The matrix is full rank
(B)	The matrix is invertible
(C)	The matrix has a determinant
(D)	The matrix has a transpose

Q.42	Messenger RNAs (mRNAs) translate to generate polypeptides and the translation terminates at the UGA, UAG or UAA stop codons. The AGA codon acts as additional stop codon in the mitochondria. The longest possible polypeptide(s) that can be hypothetically translated in the cytosol and/or mitochondria, from the given *full length* mRNA sequence (36 nucleotides) is/are 5'-AACACCAUGACCCAUGUGGCGAGACGGUAGUUAAAA- 3'
(A)	7 amino acids long in the cytosol
(B)	5 amino acids long in the mitochondria
(C)	6 amino acids long in the mitochondria
(D)	8 amino acids long in the cytosol

Q.43	The RNA sequence below depicts the part of a 330 nucleotides long mRNA and it encodes the C-terminal portion of a protein. 5'-… … … AAC ACC ACG ACC CAU GUG GCG AGA CGG UAG- 3' A mutation was identified in this RNA denoted as 322A→U. This nucleotide change is represented by which of the following class(es) of mutation?
(A)	Missense mutation
(B)	Non-sense mutation
(C)	Transversion mutation
(D)	Silent mutation
Q.44	A microbial culture is being grown in a bioreactor with continuous aeration. The dissolved oxygen probe provided with the system shows a reading of zero. In this context, which of the following inferences is/are correct?
(A)	The culture has died due to absence of oxygen
(B)	The culture has run out of carbon source
(C)	The culture growth becomes oxygen limited
(D)	The culture growth is independent of dissolved oxygen

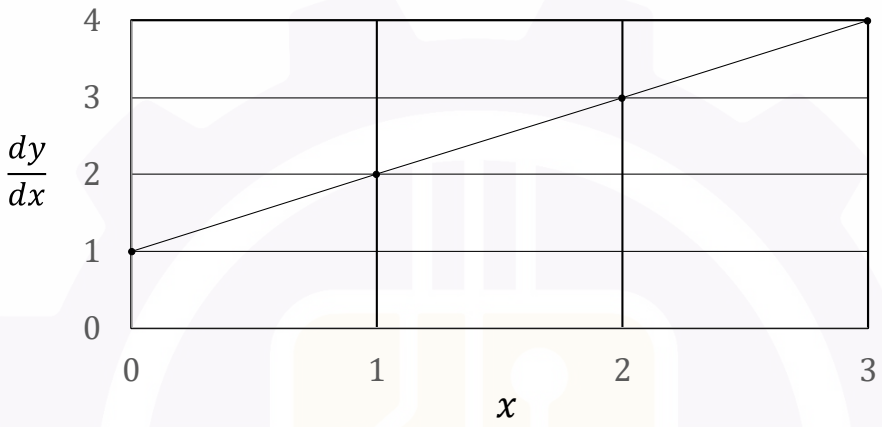
Q.45	For a Newtonian fluid, a plot of shear stress (on Y axis) against shear rate (on X axis) will result in a straight line _____.
(A)	parallel to the X axis
(B)	parallel to the Y axis
(C)	with a negative slope
(D)	with a positive slope
Q.46	In an aerobic fermentation with air sparging, which of the following options can be used to increase the volumetric mass transfer coefficient for oxygen transfer?
(A)	Using pure oxygen in place of air
(B)	Increasing the volumetric flow rate of air
(C)	Reducing the bubble diameter
(D)	Decreasing the agitation rate

Q.47	For a liquid flowing in a circular cross section pipe, the transition from laminar to turbulent flow will NOT depend on which of the following factor(s)?
(A)	The diameter of the pipe
(B)	The length of the pipe
(C)	The linear velocity of the liquid
(D)	The viscosity of the liquid
Q.48	Which of the following is/are posttranslational modification(s) involved in epigenetic control of gene expression?
(A)	Arginine methylation
(B)	Lysine acetylation
(C)	Cytosine methylation
(D)	Cytosine deamination

Q.49	For an ideal plug flow reactor, which of the following statements is/are true?
(A)	It can be approximated by a large number of ideal continuous stirred tank reactors connected in series
(B)	It has significant back mixing
(C)	It has significant axial mixing
(D)	It has a uniform velocity profile across any cross section
Q.50	An enzyme-catalyzed reaction is found to have $\Delta G = -100$ kJ mol^{-1}. Which of the following statements about this reaction is/are true?
(A)	The rate of the reaction cannot be predicted
(B)	The rate of the reaction is high
(C)	The rate of the reaction is low
(D)	The reaction is irreversible

Q.51 – 65 (NAT)

Q.51	Consider the equation $\frac{dy}{dx} = \frac{1}{x}$ The value of the integral $\int_1^2 dy$ using trapezoidal method and interval $h = 0.25$ is _____. (*rounded off to two decimal places*)
Q.52	If the straight lines given by the following two equations are parallel to each other, the value of $\boldsymbol{a}$ is _____. (*answer in integer*) $4x + 7y = 6; \quad 3\boldsymbol{a}x + 42y = 24$
Q.53	A straight line $y = x - 1$ intersects a circle with center at $x = 1, y = 1$ and radius of magnitude 1 at two points. The length of the chord formed by this intersection is _____. (*rounded off to three decimal places*)
Q.54	A heat exchanger during operation in a bioprocess has a steady temperature of 90 ^{o}C. After completion of its operation, it was shut down and it was observed that the rate of decrease of temperature at any time was directly proportional to the difference $T(t) - 30$ ^{o}C, where $T(t)$ denotes temperature at time t. It was observed that it took 30 min for the temperature to drop to 70 ^{o}C. The temperature after 51.5 min will be_____ ^{o}C. (*rounded off to the nearest integer*)
Q.55	A microbial culture (following Monod model for growth) has a maximum specific growth rate of 0.1 h^{-1}, Monod constant of 1 mg L^{-1} and endogenous decay rate of 0.1 day^{-1}. At limiting substrate concentration of 23 g L^{-1}, the net specific growth rate will be _____day^{-1}. (*rounded off to one decimal place*)
Q.56	A CSTR with a volume of 100 m^3 is operated in cell recycle mode. At a volumetric flow rate of 10 m^3 day^{-1} and effluent biomass of 20 mg L^{-1}, the steady state biomass concentration is 200 mg L^{-1}. The mean cell retention time in the reactor is ____ days. (*answer in integer*)
Q.57	The electron equivalent per liter (e^{-}eq L^{-1}) of acetate ion solution of concentration 10 g L^{-1} is _____ e^{-}eq L^{-1}. (*rounded off to one decimal place*)

Q.58	From the following plot of $\frac{dy}{dx}$ versus x and if y(2) = 5, the value of y(3) is _____. (*rounded off to one decimal place*) 
Q.59	A batch sterilizer is being operated at 121 ^{o}C for sterilizing a medium containing microbial cells. Assume that the thermal deactivation of cells is a first order process with a death rate constant of 0.69 min^{-1} at 121 ^{o}C. If the initial concentration of microbes in the medium is 10^{10} cells m^{-3}, the time taken to reduce the microbial load to a final concentration of 10 cells m^{-3} is _____ min. (*rounded off to the nearest integer*)
Q.60	A substrate is consumed in a zero order reaction such that its concentration falls from 42 g L^{-1} to 14 g L^{-1} in 4 hours. The total time taken for complete utilization of substrate will be _____ hours. (*answer in integer*)
Q.61	A microbe that follows Monod growth kinetics on a limiting substrate (maximum specific growth rate of 0.5 h^{-1} and Monod constant of 0.1 mg L^{-1}) is cultivated in a continuous reactor for microbial growth (chemostat) with sterile feed. Given that the chemostat volume is 5 L and inlet concentration of limiting substrate is 10 g L^{-1}, the minimum inlet feed flow rate for chemostat washout is _____ L h^{-1}. (*rounded off to one decimal place*)
Q.62	It is desired to cultivate 150 mg (dry weight) microbial cells with an empirical formula of $C_5H_7O_2N$. If the phosphorus requirement for the cells is 20% of the nitrogen requirement (on a weight/weight basis), the minimum amount of phosphorous required to be added to the cultivation medium is _____ mg. (*rounded off to one decimal place*)

Q.63	In the process of generating a clonal mammalian cell line, a single cell was seeded in a well of a cell culture plate. After the first 48 hours, one of the progeny cells underwent apoptosis due to a new mutation. If the doubling time of the cells is 24 hours and no more cell death occurs, the total number of cells after a total of 7 days from seeding will be _____. (*answer in integer*)
Q.64	A disease-associated allele shows X-linked recessive inheritance. If the mother is a carrier of the disease, the father is genetically normal and the child born is a son, then the probability that he is born with the disease is _____. (*rounded off to one decimal place*)
Q.65	A packed bed bioreactor with length 1 m and inside diameter 10 cm has liquid flowing at an interstitial velocity of 1 cm s^{-1}. Given a volumetric flow rate of 0.025 L s^{-1}, the void fraction of the packed bed is _____. (*rounded off to two decimal places*)

END OF QUESTION PAPER