Section A: Common

1. A student has performed an experiment in which he measured salt concentration of water using a conductivity meter. The meter reading for a sample is 40 milli-Siemens. The calibration plot of salt concentration versus conductivity is a straight line passing through 8% salt concentration for 100 milli-Siemens, and 0% salt concentration for 0 milli-Siemens. What is the % salt concentration of the sample?
   (a) 5.0 (b) 3.2 (c) 4.0 (d) 4.5 (e) Insufficient information

2. A certain family has an annual income of Rs. 2500000. Its monthly expenditures equals Rs. 75000. Out of this expenditure Rs. 2400 is reimbursed. The family is enrolled in an insurance scheme to which Rs. 8500 is paid monthly. Payments to insurance scheme end in June (6 months) and from July the family is paid Rs. 7250 per month by the insurance company until and including December (6 months). What are the savings of family until December 31? Assume no interest.
   (a) 1592500 (b) 1498000 (c) 1621300 (d) 1613800 (e) 1785000

3. Per capita income of a country is computed by dividing its Gross Domestic Product by its population. At the end of a financial year, economists predict that the GDP for the next year could increase by 11% over the current year. If the rise in percapita income is 2% over the current year, what is the % rise in population compared to the current year?
   (a) 109/1.02 (b) 102/1.11 (c) 111/1.02 (d) 102/1.09 (e) Insufficient information

4. One micrometer is 10^{-6} meters. One nanometer is 10^{-9} meters. One Angstrom is 0.1 nanometers. Which of the following is correct?

   (a) One Angstrom = 10^{-7} meters
   (b) One micrometer = 10^{-3} nanometers
   (c) One Angstrom = 10^{-4} micrometers
   (d) One Angstrom = 10^{-3} micrometers
   (e) None of the above

5. A man distributes his lifelong earnings to his sons in the ratio 3:2:1 with the eldest son receiving the most and the youngest son receiving the least. The youngest son in turn gives away his share to his two daughters in the ratio 2:5 with the younger daughter receiving more than the elder one. What percentage of the man's earnings did the elder daughter get? Round off your answer to one digit.
   (a) 14% (b) 12% (c) 36% (d) 5% (e) Cannot be calculated

6. A rectangle is inscribed in a circle. If the length of the rectangle is twice its breadth, the ratio of area of rectangle to that of circle is
   (a) $6/(5\pi)$ (b) $4/(5\pi)$ (c) $8/(5\pi)$ (d) $3/(5\pi)$ (e) Cannot be determined

7. You want to fill water in a cylindrical bucket which is empty to begin with. The radius of the bucket is 20 cm and the height of the bucket is 50 cm. If the water flows from the tap at a rate of 1000 cm^3/min, the time taken to completely fill the bucket will be (in mins):
   (a) 20π (b) 2π (c) 0.1 (d) $\pi/25$ (e) $2\pi/5$

8. Consider a coin with probability of obtaining a head on a single toss being 0.4 and probability of obtaining a tail being 0.6. If this coin is tossed two times, the probability of obtaining **exactly** one head in the two tosses is:
   (a) 0.24 (b) 0.52 (c) 0.64 (d) 0.36 (e) 0.48

9. Rajesh is a friendly neighbourhood kid. Ten times his age is 24 years less than the square of his age. What is Rajesh's age (in years)?
   (a) 5 (b) 15 (c) 10 (d) 12 (e) 8

10. You are standing 100 m away from the base of a mobile tower. You point a laser to the top of the tower. The laser light makes an angle of 30^0 from the horizontal line joining the location where you are standing and the base of the tower. The height of the tower is (in meters):
    (a) $100/\tan(30^o)$ (b) $100\cos(30^o)$ (c) $100\tan(30^o)$ (d) $100\sin(30^o)$ (e)cannot be determined

Section B: Non-Bio

1. A complex number, z, is such that $1/(z\bar{z}) = 4$. If the argument of the complex number is $2\pi/3$, then the complex number is:
   (a) $\frac{-1}{4} - i\frac{\sqrt{3}}{4}$ (b) $\frac{-1}{4} + i\frac{\sqrt{3}}{4}$ (c) $\frac{1}{4} - i\frac{\sqrt{3}}{4}$ (d) $\frac{1}{4} + i\frac{\sqrt{3}}{4}$ (e) $\frac{-1}{2} + i\frac{\sqrt{3}}{2}$

2. Given that $f(x)$ and $f'(x)$ equal 10 and 2, respectively, at $x = 2$. What is the approximate value of $f(x)$ at $x = 2.1$?
   (a) 10.1   (b) 2.2   (c) 1.0   (d) 10.05   (e) 10.2

3. An object starts from rest and moves such that its rate of change of its speed equals time. Speed is measured in metres per second and time in seconds. What distance does it cover in 6 seconds?
   (a) 72   (b) 18   (c) 6   (d) 36   (e) Insufficient information

4. The longest diagonal of a room is given as 21 meters. If two dimensions are 10 meters and 14 meters, what is the length of third dimension (in meters)? Round-off to nearest integer.
   (a) 10   (b) 11   (c) 12   (d) 13   (e) 14

5. How many kilograms of 34% (w/w) sulphuric acid should to be mixed with 100 kg of 10% (w/w) to produce a mixture having 18% (w/w) sulphuric acid?
   (a) 25.0   (b) 40.0   (c) 53.8   (d) 50.0   (e) 44.4

6. The two functions, $f(x) = 1/x$ and $g(x) = x + 1$

   (a) Intersect at one point

   (b) Do not intersect

   (c) Intersect at two points, both in the first quadrant

   (d) Intersect at two points, one in first quadrant and another in second quadrant

   (e) Intersect at two points, one in first quadrant and another in third quadrant

7. A cube of side 12-cm is to be cut into 64 equal small cubes. What is the side (in cm) of a small cube ?
   (a) 4   (b) 2   (c) 6   (d) 3   (e) 8

8. To attract customers, a shop has come up with a novel discount scheme. Every time you shop at it, it gives you a discount which is one-third of the discount it gave you the last time. If it gives you a discount of 100 Rs. the first time you shop at it, what is the total discount you will get from the shop over your life time. You can assume that since you like this scheme very much, you will buy things from the shop for your entire life (essentially infinite number of times):
   (a) 100   (b) 200   (c) 150   (d) 300   (e) ∞

9. You have a really old phone whose battery discharges according to the following equation:

$$\frac{dx}{dt} = -4x \tag{1}$$

   where x is the battery charge in % and t is time in hours. Starting from a fully charged phone $x = 100\%$, the time required for the battery to reach 50% charge will be (in hours):
   (a) $0.25\ln(1/0.5)$ (b) $0.25\ln(0.5)$ (c) $\ln(1/0.5)$ (d) $\ln(0.5)$ (e) $\ln(0.5)/0.25$

10. The current drawn by a household electrical appliance which has a rating 20 Watts, and is connected to a 220 Volts power supply, is (in Amperes):
    (a) $1/\sqrt{11}$ (b) $1/11$ (c) 11   (d) $\sqrt{11}$

11. The minimum of the polynomial: $\frac{1}{3}x^3 - 5x^2 + 24x + 100$ occurs at $x =$:
    (a) 4   (b) 0   (c) 6   (d) ∞ (e) $-\infty$

12. You have to post 10 envelopes in 5 letter-boxes. Any number of envelopes can be put in a letter box. In how many different ways can you post the envelopes?

    $(a)\,^{10}C_5$ $(b)\,^{5}C_{10}$ $(c)\,5^{10}$ $(d)\,10^5$ $(e)\,50$

13. Consider the following system of equations in unknowns x_1, x_2, x_3:

$$x_1 + 2x_2 + 3x_3 = 6$$
$$2x_1 + 4x_2 + 6x_3 = 12$$
$$x_1 + 2x_2 - 3x_3 = 0$$

   The system has:

   (a) No solution (b) Unique (exactly one) solution (c) Infinite number of solutions
   (d) Two solutions (e) Can't say about number of solutions

14. The density of two liquids (A and B) is given as 1000 kg/m^3 and 600 kg/m^3, respectively. The two liquids are mixed in a certain proportion and the density of the resulting liquid is 900 kg/m^3. How much of liquid B (in kg) does 1 kg of the mixture contain? Assume the volume of the two liquids is additive when mixed.

   (a) 1/6 (b) 2/3 (c) 3/5 (d) 3/8 (e) 1/3

15. The inverse of a matrix $\begin{bmatrix} 2 & 3 \\ 3 & 5 \end{bmatrix}$ is:

   $(a)\,\begin{bmatrix} 2 & 3 \\ 3 & 5 \end{bmatrix}$ $(b)\,\begin{bmatrix} 5 & -3 \\ -3 & 2 \end{bmatrix}$ $(c)\,\begin{bmatrix} 5 & 3 \\ 3 & 2 \end{bmatrix}$ $(d)\,\begin{bmatrix} 2 & -3 \\ -3 & 5 \end{bmatrix}$ $(e)\,\begin{bmatrix} 3 & 2 \\ 5 & 3 \end{bmatrix}$

Section C: Bio

1. In a plot of 1/V against 1/S for an enzymatic reaction, the presence of a competitive inhibitor will alter the

   (a) V_{max}.

   (b) intercept on the 1/V axis.

   (c) intercept on the 1/S axis.

   (d) curvature of the plot

2. Which of the following statements is not a function of tRNA?

   (a) It contains an anticodon.

   (b) It can be covalently attached to an amino acid.

   (c) It interacts with mRNA during the process of transcription.

   (d) It serves as an adapter between an individual amino acid and mRNA

3. A crude extract contains 1000 mg of total protein and 100 units of activity. This extract is then processed through a sequence of three steps as follows; the total protein content and units of activity are reported next to them.

   - Ammonium sulphate precipitation: 900 mg, 45 units.
   - Ion-exchange fractionation: 160 mg, 40 units.
   - Size-exclusion fractionation: 4 mg, 32 units.

   The final fold purification is
   (a) 4   (b) 8   (c) 32   (d) 80

4. Which of these is not a role for nucleic acids or nucleotides in the cell?

   (a) energy

   (b) information transfer

   (c) enzyme cofactor

   (d) cell structure

5. Three buffers are made by combining a 1 M solution of acetic acid with a 1 M solution of sodium acetate in the ratios shown below.

	1 M acetic acid	1 M sodium acetate
Buffer 1	10 ml	90 ml
Buffer 2	50 ml	50 ml
Buffer 3	90 ml	10 ml

   Which of these statements is true of the resulting buffers?

   (a) pH of buffer 1 > pH of buffer 2 > pH of buffer 3

   (b) pH of buffer 1 < pH of buffer 2 < pH of buffer 3

   (c) pH of buffer 1 = pH of buffer 2 = pH of buffer 3

   (d) The problem cannot be solved without knowing the value of pKa

6. As water turns to ice, the decreased density of water is due to

   (a) The loss of hydrogen bonds.

   (b) The gain of ionic bonds.

   (c) The gain of more van der Waals contacts.

   (d) Rearrangement of molecules as the maximum number of hydrogen bonds form.

7. 0.1 mL of a protein solution was diluted with 2.9 mL of water. The A280 of the diluted solution was 0.25. How many mL of the original solution should be mixed with water to make 1.0 mL of solution of A280 = 0.75?

   (a) 0.01 mL

   (b) 0.75 mL

   (c) 0.25 mL

   (d) 0.1 mL

8. Which of the following amino acids is most soluble in water at pH 7.0?

   (a) glutamate

   (b) tryptophan

   (c) leucine

   (d) tyrosine

9. When E. coli is shifted from a high temperature to a cooler growth temperature, it compensates by

   (a) Putting longer-chain fatty acids into its membrane.

   (b) Putting more unsaturated fatty acids into its membrane.

   (c) Increasing its metabolic rate to generate more heat.

   (d) Synthesizing thicker membranes to insulate the cell.

10. With respect to the plasma membrane, most enzymic receptors are

    (a) entirely internal

    (b) entirely on the surface

    (c) multipass

    (d) single pass

11. Which of the following statements about collagen is correct?

    (a) Collagen contains a high proportion of hydroxylated proline residues.

    (b) Collagen is a globular, intracellular protein.

    (c) Post-translational modification of collagen involves vitamin A.

    (d) The structure of collagen consists of a superhelix of three α helices twisted together.

12. In desmosomes, cadherins link to — of an adjacent cell.

    (a) integrins

    (b) connexons

    (c) ras proteins

    (d) intermediate filaments

    (e) plasmodesmata

13. Fibroblasts from prematurely aging patients with progeria have

    (a) DNA mismatch repair
    (b) Mitochondrial defect
    (c) Chromosomal translocation
    (d) Short telomeres

14. Hayflick's Limit of the Cells from fetal tissue are capable of about — population doublings then lose ability to replicate further in vitro .
    (a) 200   (b) 100   (c) 50   (d) 25

15. Which of the following statement is **not** correct?

    (a) Eukaryotic genes often have introns
    (b) Bacterial genes are organized in operons.
    (c) Splicing of RNA is common in bacteria
    (d) There is no polyadenlyation signal in bacteria