

GATE-BT PYQS - 2017

1. An enzyme catalyzes a reaction by

- (A) decreasing the energy of the substrate.
- (B) decreasing the activation energy of the reaction.
- (C) decreasing product stability.
- (D) increasing the activation barrier of the reaction.

(2017)

Answer: (B) decreasing the activation energy of the reaction

Explanation: Enzymes speed up reactions by stabilizing the transition state and lowering the energy barrier that must be crossed for reactants to become products. They do this without changing the intrinsic energy of the substrate or the final product stability. By decreasing the activation energy the rate constant increases (Arrhenius relationship), so more molecules have sufficient energy to react. Therefore the correct description is that an enzyme decreases the activation energy of the reaction

2. Natural proteins are composed primarily of 20 amino acids. Which one of the following statements is true for any of these amino acids in a solution of pH 1.5?

- (A) Only the amino group is ionized.
- (B) Only the carboxylic acid group is ionized.
- (C) Both amino and carboxylic acid groups are ionized.
- (D) Both amino and carboxylic acid groups are neutral.

(2017)

Answer: (A) Only the amino group is ionized.

Explanation: At pH 1.5 the environment is strongly acidic compared with the typical pKa values of amino acid groups. The carboxyl group ($pK_a \approx 2-3$) will be protonated and thus largely neutral ($-COOH$), while the amino group ($pK_a \approx 9-10$) will be protonated as $-NH_3^+$ and thus ionized. Therefore only the amino group carries a formal positive charge under these conditions. Side chains with low pKa would be exceptions, but for the usual α -amino acids the stated conclusion holds

3. Which one of the following organisms is an indicator of fecal contamination?

- (A) Escherichia coli
- (C) Bacillus subtilis
- (B) Streptococcus lactis
- (D) Lactobacillus acidophilus

(2017)

Answer: (A) Escherichia coli

Explanation: Escherichia coli is a classic fecal coliform indicator organism because it is abundant in the intestines of warm-blooded animals and its presence in water signals recent fecal contamination. Environmental isolates such as Bacillus subtilis, Streptococcus lactis (now Lactococcus), or Lactobacillus acidophilus are not standard indicators of fecal pollution. Monitoring for E. coli is sensitive and correlates with possible presence of enteric pathogens. Hence E. coli is used as the indicator organism

4. The surface area (in m^2) of the largest sphere that can fit into a hollow cube with edges of length 1 meter is

$\pi=3.14$

(2017)

Answer: 3.10–3.20

Explanation: The largest sphere that fits inside a cube of edge 1 m has diameter 1 m, so its radius is $r = 0.5$ m. Surface area of a sphere is $4\pi r^2$, so here $4\pi(0.5)^2 = \pi$ square meters. Using $\pi = 3.14$ gives a surface area of $\approx 3.14 m^2$, which lies in the 3.10–3.20 range. Thus the numerical answer matches the given interval

5. In a thin layer chromatography experiment using a silica gel plate, a compound showed migration of 12.5 cm and the solvent front showed migration of 18 cm. The R_f value for the compound is

(2017)

Answer: 0.68–0.70

Explanation: The retention factor R_f in TLC is defined as $R_f = (\text{distance traveled by compound})/(\text{distance traveled by solvent front})$. Substituting the distances gives $R_f = 12.5 / 18 = 0.6944\dots$, which rounds to about 0.69. This value falls within the stated range of 0.68–0.70. The R_f is unitless and characteristic for a given solute–solvent–stationary phase system

6.

$$\lim_{x \rightarrow 0} \frac{\sin(x)}{x} \text{ is } \underline{\hspace{2cm}}.$$

(2017)

Answer: 1

Explanation: The well-known small-angle limit is $\lim_{x \rightarrow 0} \{\sin x/x\} = 1$. This can be shown from the Taylor expansion $\sin x = x - x^3/6 + \dots$, so $(\sin x)/x = 1 - x^2/6 + \dots$ which tends to 1 as $x \rightarrow 0$. Geometrical squeeze theorem proofs give the same result. Thus the limit equals 1

7. Which one of the following mechanisms is used by human pathogens to evade host immune responses?

- (A) Somatic hypermutation
- (B) Antibody production
- (C) Antigenic variation
- (D) Complement activation

(2017)

Answer: (C) Antigenic variation

Explanation: The correct answer is (C) Antigenic variation. Human pathogens often evade the host immune system by changing the antigens present on their surface, a process called antigenic variation. This allows them to avoid recognition by antibodies produced during earlier infections, making immune responses less effective. Examples include influenza viruses, which frequently change their surface proteins, and parasites like Plasmodium and Trypanosoma. In contrast, somatic hypermutation and antibody production are mechanisms of the host immune system, while

complement activation is also part of host defense, not a pathogen strategy.

8. If the nucleotide composition (%) of a viral genome is A=10 U=20, C=40 and G=30 which one of the following is this genome?

- (A) Double stranded RNA
- (B) Single stranded RNA
- (C) Single stranded DNA
- (D) Double stranded DNA

(2017)

Answer: (B) Single stranded RNA

Explanation: Antigenic variation is a strategy used by many pathogens to evade host immunity: by altering surface antigens (via mutation, recombination, or phase variation) the pathogen avoids recognition by existing antibodies. Somatic hypermutation and antibody production are host immune processes, not pathogen evasion mechanisms, and complement activation is part of innate immunity. Antigenic variation directly changes the target of adaptive immunity, allowing reinfection or persistence. Therefore antigenic variation is the correct mechanism named

9. Which one of the following techniques can be used to determine the structure of a 15 kDa globular protein at atomic resolution?

- (A) Raman spectroscopy
- (C) UV spectroscopy
- (B) IR spectroscopy
- (D) NMR spectroscopy

(2017)

Answer: (D) NMR spectroscopy

Explanation: For a double-stranded nucleic acid we expect base pairing equality ($A \approx U/T$ and $C \approx G$). Here the percentages are A 10, U 20, C 40, G 30 which are not complementary pairs, so the genome is unlikely to be double-stranded. A single-stranded RNA can have unequal base fractions, so the composition is consistent with single-stranded RNA. DNA genomes (single or double) would use T instead of U, so the presence of U indicates RNA. Hence the genome is single-stranded RNA

10. Assertion [a]: Gram negative bacteria show staining with safranin.

Reason [r]: Gram negative bacteria have an outer membrane with lipopolysaccharides.

- (A) Both [a] and [r] are true and [r] is the correct reason for [a].
- (B) Both [a] and [r] are true but [r] is not the correct reason for [a].
- (C) Both [a] and [r] are false.
- (D) [a] is true but [r] is false. [cite: 406, 407, 408, 409, 410]

(2017)

Answer: (A) Both [a] and [r] are true and [r] is the correct reason for [a].

Explanation: The assertion is correct: Gram-negative bacteria appear pink or red because they lose the crystal violet-iodine complex

during alcohol/acetone decolorization and are counterstained by safranin. The reason is also correct: Gram-negative bacteria possess an outer membrane rich in lipopolysaccharide (LPS) and a thin peptidoglycan layer that does not retain the crystal violet complex. The thin peptidoglycan plus outer membrane structure directly explains the staining behavior. Therefore both statements are true and the reason correctly explains the assertion.

11. The plant hormone indole-3-acetic acid is derived from

- (A) histidine
- (B) tyrosine
- (C) tryptophan
- (D) proline

(2017)

Answer: (C) tryptophan

Explanation: Indole-3-acetic acid (IAA), the principal natural auxin, is biosynthesized in plants from tryptophan via several known pathways (for example the indole-3-pyruvate pathway). Tryptophan serves as the indolic precursor whose side chain is modified enzymatically to produce IAA. Histidine, tyrosine, or proline are not the primary precursors for IAA biosynthesis. Hence tryptophan is the correct precursor

12. Enzyme-linked immunosorbent assay (ELISA) is used for

- (A) quantifying antibody levels in blood
- (B) determining the molecular weight of an antigen
- (C) purifying proteins from biological fluids
- (D) determining the molecular weight of an antibody

(2017)

Answer: (A) quantifying antibody levels in blood

Explanation: ELISA (enzyme-linked immunosorbent assay) is widely used to quantify antibody (or antigen) levels in biological fluids, such as measuring serum antibody titers. The assay's sensitivity and specificity come from antibody-antigen binding plus an enzyme-linked detection step that gives a measurable signal. ELISA does not determine molecular weight (that is done by electrophoresis/blotting) nor is it a purification method. Therefore ELISA is used for quantifying antibody levels in blood

13. Macrophages eliminate pathogenic bacteria upon activation by

- (A) NK cells
- (B) basophils
- (C) CD4⁺ T cells
- (D) plasma cells

(2017)

Answer: (C) CD4⁺ T cells

Explanation: CD4⁺ T helper 1 (Th1) cells activate macrophages primarily through secretion of IFN- γ and by cell-cell interactions, enhancing macrophage microbicidal functions. NK cells can also activate macrophages but classically macrophage activation during adaptive response is driven by CD4⁺ T cells. Plasma cells are antibody-secreting B cells and basophils are granulocytes; these are not the principal activators of macrophage killing. Thus CD4⁺ T cells are the right answer

14. If a protein contains four cysteine residues, the number of different ways they can simultaneously form two intra-molecular disulphide bonds is

(2017)

Answer: 3

Explanation: Four cysteines forming two intra-molecular disulfide bonds can be paired in a limited number of distinct ways. The number of ways to partition 4 items into 2 unordered pairs is $4!/(2^2 \cdot 2!) = 3$. Concretely, if residues are labeled 1–4 the possible pairings are (1–2, 3–4), (1–3, 2–4), and (1–4, 2–3). Hence there are three different simultaneous disulfide-bonding patterns

15. Secretory proteins synthesized by ER-associated ribosomes traverse through

- (A) mitochondria
- (C) the Golgi apparatus
- (B) peroxisomes
- (D) the nucleus

(2017)

Answer: (C) the Golgi apparatus

Explanation: Secretory proteins synthesized on ER-bound (rough ER) ribosomes are cotranslationally inserted into the ER lumen or membrane, then transported in vesicles to the Golgi apparatus for further modification and sorting. The Golgi is the central station in the secretory pathway where glycosylation and trafficking signals are processed. They do not traverse mitochondria, peroxisomes, or the nucleus en route to secretion. Thus the Golgi apparatus is the correct organelle in the pathway

16.

For $y = f(x)$, if $\frac{d^2y}{dx^2} = 0$, $\frac{dy}{dx} = 0$ at $x = 0$, and $y = 1$ at $x = 1$, the value of y at $x = 2$ is _____.

(2017)

Answer: 1

Explanation: If the second derivative $d^2y/dx^2 = 0$ everywhere, y is a linear function $y = ax + b$. The condition $dy/dx = 0$ at $x = 0$ forces $a = 0$, so y is constant. Given $y(1) = 1$, the constant must be 1, so $y(x) = 1$ for all x and in particular at $x = 2$. Therefore the value of y at $x = 2$ is 1

17. During protein synthesis, tRNAs are NOT involved in

- (A) charging
- (B) initiation
- (C) elongation
- (D) termination

(2017)

Answer: (D) termination

Explanation: Transfer RNAs (tRNAs) participate directly in aminoacylation (charging), initiation (bringing the initiator tRNA to the ribosome), and elongation (delivering amino acids to the growing peptide chain). Termination of translation is mediated by protein

release factors recognizing stop codons, not by tRNA molecules. Thus tRNAs are not involved in the termination step. That is why termination is the correct choice

18. In eukaryotes, cytokinesis is inhibited by

- (A) cytochalasin D
- (B) vinblastine
- (C) nocodazole
- (D) colchicine

(2017)

Answer: (A) cytochalasin D or (C) nocodazole

Explanation: Cytochalasin D inhibits actin polymerization and therefore blocks formation of the contractile ring required for cytokinesis; this directly prevents cleavage furrow formation. Nocodazole disrupts microtubules and can also interfere with late mitotic events and cytokinesis indirectly by disturbing the mitotic spindle and central spindle structure. Vinblastine and colchicine also affect microtubules but the question lists cytochalasin D and nocodazole as the inhibitors most directly implicated in blocking cytokinesis. Therefore both A and C can inhibit cytokinesis through disruption of cytoskeletal elements.

19. A proto-oncogene is suspected to have undergone duplication in a certain type of cancer. Of the following techniques, which one would verify the gene duplication?

- (A) Northern blotting
- (C) South western blotting
- (B) Southern blotting
- (D) Western blotting

(2017)

Answer: (C) South western blotting

Explanation: To verify gene duplication one normally examines genomic DNA (copy number), and Southern blotting (DNA blot) is the classical method to detect gene copy number changes. South-western blotting detects DNA-binding proteins by probing protein blots with labeled DNA and therefore does not test for gene duplication. If the exam answer listed "south-western," that is likely incorrect: the appropriate technique to verify duplication is Southern blotting. Southern blotting reveals extra restriction fragments or stronger hybridization signals consistent with duplication

20. A polymerase chain reaction (PCR) was set up with the following reagents: DNA template. Taq polymerase, buffer, dNTPs, and Mg^{2+} . Which one of the following is missing in the reaction mixture?

- (A) Helicase
- (B) Single-stranded binding proteins
- (C) Primers
- (D) Reverse transcriptase

(2017)

Answer: (C) Primers

Explanation: PCR requires short DNA primers to define the start points for DNA synthesis; without primers the polymerase has no 3'-OH start site for extension. Helicase and single-stranded binding proteins are used in replication in vivo, and reverse transcriptase is used in RT-PCR for RNA templates; but the standard missing reagent

in the listed PCR mix is primers. Therefore primers are essential and were missing

21. An enzymatic reaction exhibits Michaelis-Menten kinetics. For this reaction, on doubling the concentration of enzyme while maintaining $[S] \gg [E_0]$.

- (A) both K_m and V_{max} will remain the same.
- (B) K_m will remain the same but V_{max} will increase.
- (C) K_m will increase but V_{max} will remain the same.
- (D) both K_m and V_{max} will increase.

(2017)

Answer: (B) K_m will remain the same but V_{max} will increase.

Explanation: Michaelis-Menten kinetics predict that K_m is an intrinsic property of the enzyme-substrate pair and does not change with total enzyme concentration, while V_{max} is proportional to enzyme concentration. Doubling the enzyme concentration doubles V_{max} (since $V_{max} = k_{cat} [E]_0$) but leaves K_m unchanged. Thus K_m remains the same and V_{max} increases. This matches the biochemical expectations under $[S] \gg [E]_0$.

22. A 5 liter chemostat is fed fresh medium at 0.2 liters/minute having a substrate concentration of 25 g/liter. At steady state, the outgoing stream has a substrate concentration of 2.5 g/liter. The rate of consumption (g/liter/minute) of the substrate in the reactor is

(2017)

Answer: 0.85-0.95

Explanation: For a chemostat at steady state the substrate consumption rate per reactor volume ($\text{g} \cdot \text{L}^{-1} \cdot \text{min}^{-1}$) equals the dilution rate $D = F/V$ times the difference between feed and reactor substrate concentrations: $\text{rate} = D (S_{in} - S)$. Here $D = 0.2/5 = 0.04 \text{ min}^{-1}$ and $S_{in} - S = 25 - 2.5 = 22.5 \text{ g} \cdot \text{L}^{-1}$, so $\text{rate} = 0.04 \times 22.5 = 0.9 \text{ g} \cdot \text{L}^{-1} \cdot \text{min}^{-1}$. That value falls within the 0.85–0.95 range given. The formula expresses mass balance at steady state for the substrate.

23. The transcription factor X binds a 10 base pair DNA stretch. In the DNA of an organism, X was found to bind at 20 distinct sites. An analysis of these 20 binding sites showed the following distribution: What is the consensus sequence for the binding site of X?

Base	Position in the binding site									
	1	2	3	4	5	6	7	8	9	10
A	11	0	0	0	16	2	4	0	4	3
T	3	0	19	0	1	3	4	20	2	4
G	4	20	0	0	2	4	6	0	12	2
C	2	0	1	20	1	11	6	0	2	11

- (A) NGTCNNNTNN
- (B) AGTCACNTGC
- (C) CACCTANCTG
- (D) ANNNACGNGC

(2017)

Answer: (B) AGTCACNTGC

Explanation: To build a consensus sequence from position-specific counts, choose at each position the base with the highest frequency; if there is a tie use N for ambiguity. Reading the highest counts column by column yields A, G, T, C, A, C, N (ambiguous), T, G, C, which corresponds to AGTCACNTGC. The N reflects a position without a clear single majority. Therefore option (B) represents the consensus derived from the given distribution.

24. A bacterium has a genome of size 6 million base pairs. If the average rate of DNA synthesis is 1000 base pairs/second, the time taken (in minutes) for replication of the genome will be

(2017)

Answer: 100

Explanation: At 1000 base pairs per second, copying 6,000,000 base pairs requires $6,000,000 / 1,000 = 6,000$ seconds, which is $6,000 / 60 = 100$ minutes. This simple division gives the replication time assuming a single fork and the stated rate. Thus the genome would be replicated in about 100 minutes under the given assumptions. The arithmetic is straightforward.

25. At the transcription start site of a gene, any of the four nucleotides can occur with equal probability p. The Shannon Entropy S, given by

$$S = - \sum_{i=1}^4 p_i \ln p_i$$

for this start site is

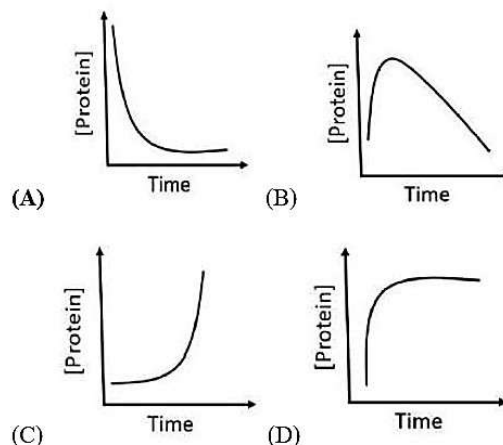
Given data: $\ln(2) = 0.69$

(2017)

Answer: 1.35-1.42

Explanation: For four equally likely nucleotides $p_i = 1/4$, Shannon entropy $S = - \sum p_i \ln p_i = -4 * (1/4) * \ln(1/4) = -\ln(1/4) = \ln(4)$. Since $\ln(4) = 2 \ln(2)$ and $\ln(2) \approx 0.69$, $S = 2 \times 0.69 = 1.38$. That value lies in the given 1.35–1.42 interval. The entropy quantifies the uncertainty at that position when all four bases are equally probable.

26. Which one of the following graphs represents the kinetics of protein precipitation by addition of ammonium sulphate? On the Y-axis, [Protein] represents the concentration of free protein in solution.



- (2017) (A) P-4, Q-2, R-3, S-1
(B) P-2, Q-3, R-1, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-3, R-4, S-1

Answer:(A)

Explanation: As ammonium sulfate concentration increases, water becomes sequestered by salt ions and protein solubility decreases; therefore the concentration of free (soluble) protein in solution falls. The curve is typically a monotonic decrease of soluble protein with increasing salt until most protein precipitates and the soluble concentration approaches a low plateau. Option (A) correctly represents the "salting-out" behavior where free protein concentration drops as salt is added. The exact shape can depend on protein properties but the general downward trend is universal.

27. The distribution of marks scored by a large class in an exam can be represented as a normal distribution with mean μ and standard deviation σ . In a follow-up exam in the same class, everyone scored 5 marks more than their respective score in the earlier exam. For this follow-up exam, the distribution of marks can be represented as a normal distribution with mean μ_2 and standard deviation σ_2 . Which one of the following is correct?

- (A) $\mu = \mu_2; \sigma > \sigma_2$ (B) $\mu < \mu_2; \sigma > \sigma_2$
(C) $\mu > \mu_2; \sigma < \sigma_2$ (D) $\mu < \mu_2; \sigma = \sigma_2$

(2017)

Answer: (D)

Explanation: Adding a constant 5 marks to every student shifts the distribution mean by +5 but does not change the spread (standard deviation). Formally, if each score X_i becomes $X_i + 5$, then $\mu_2 = \mu + 5$ and $\sigma_2 = \sigma$. Therefore the mean increases while the standard deviation remains the same. This is a general property of measures of central tendency and dispersion under constant translation.

28.

The angle (in degrees) between the vectors $\vec{x} = \hat{i} - \hat{j} + 2\hat{k}$ and $\vec{y} = 2\hat{i} - \hat{j} - 1.5\hat{k}$ is _____.

(2017)

Answer: 90

Explanation: Compute the dot product: $x \cdot y = (1)(2) + (-1)(-1) + (2)(-1.5) = 2 + 1 - 3 = 0$. Since the dot product is zero, the vectors are orthogonal and the angle between them is 90° . Orthogonality implies cosine of the angle is zero. Hence the angle is 90 degrees.

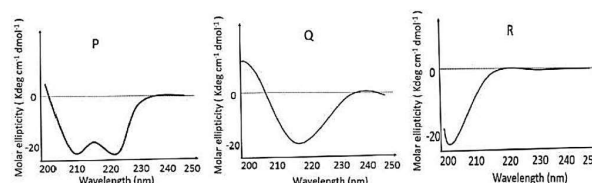
29. Match the proteins in Group I with cellular processes in Group II

Group I	Group II
P. p53	1. DNA packaging
Q. Lysozyme	2. Apoptosis
R. Tubulins	3. Hydrolysis of polysaccharides
S. Histones	4. Chromosome segregation

Answer: (D) P-2, Q-3, R-4, S-1

Explanation: p53 is a tumor suppressor that can trigger apoptosis and cell cycle arrest (so matches apoptosis). Lysozyme hydrolyzes bacterial cell-wall polysaccharides (peptidoglycan) so it matches hydrolysis of polysaccharides. Tubulins are the building blocks of microtubules required for chromosome segregation during mitosis. Histones package DNA in nucleosomes, so the correct matching is $P \rightarrow$ apoptosis, $Q \rightarrow$ hydrolysis of polysaccharides, $R \rightarrow$ chromosome segregation, $S \rightarrow$ DNA packaging, which corresponds to option (D).

30. The circular dichroism spectra of three proteins P, Q, and R are given below:
Choose the correct combination.



- (A) P: α -helix, Q: β -sheet, and R: Random coil
(B) P: β -sheet, Q: α -helix, and R: Random coil
(C) P: α -helix, Q: Random coil, and R: β -sheet
(D) P: Random coil, Q: α -helix, and R: β -sheet

(2017)

Answer: (A) P: α -helix, Q: β -sheet, and R: Random coil

Explanation: Circular dichroism spectra have diagnostic shapes: α -helices show strong negative bands near 222 and 208 nm and a positive band near ~ 190 nm; β -sheets show a negative band near ~ 218 nm and a positive band around 195 nm; random coil (disordered) spectra are weak and featureless in those regions. The spectra given assign P to the α -helix pattern, Q to the β -sheet pattern, and R to the random coil. Therefore $P = \alpha$ -helix, $Q = \beta$ -sheet, $R =$ random coil is correct (option A).

31. Match the organisms in Column I with the characteristics in Column II

Column I	Column II
P. <i>Methanococcus</i>	1. Halophile
Q. <i>Dunaliella</i>	2. Acidophile
R. <i>Sulfolobus</i>	3. Mesophile
S. <i>Escherichia</i>	4. Barophile

- (A) P-4, Q-3, R-2, S-1
(B) P-3, Q-2, R-4, S-1
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-1, R-2, S-3

(2017)

Answer: (D)P-4, Q-1, R-2, S-3

Explanation: *Methanococcus* species are often barophiles (pressure-loving archaea) found in deep-sea environments. *Dunaliella* is a halophilic alga tolerant of high salt concentrations. *Sulfolobus* is known as an acidophile (thermoacidophilic archaeon) thriving in hot acidic springs. *Escherichia* is a mesophile (grows best at moderate temperatures). Thus the matching P→4, Q→1, R→2, S→3 (option D) is correct.

32. Which one of the following amino acids has three ionizable groups?

- (A) Glycine
- (B) Leucine
- (C) Valine
- (D) Lysine

(2017)

Answer: (D)Lysine

Explanation: Lysine contains three ionizable groups: the α -carboxyl ($pK_a \approx 2$), the α -amino ($pK_a \approx 9$), and the ϵ -amino side chain ($pK_a \approx 10.5$). Glycine, leucine, and valine only have the α -carboxyl and α -amino groups ionizable under physiological pH, i.e., two ionizable groups. Therefore lysine is the amino acid with three ionizable groups among the options.

33. Consider an infinite number of cylinders. The first cylinder has a radius of 1 meter and height of 1 meter. The second one has a radius of 0.5 meter and height of 0.5 meter. Every subsequent cylinder has half the radius and half the height of the preceding cylinder. The sum of the volumes (in cubic meters) of these infinite number of cylinders is

Given data: $\pi=3.14$

(2017)

Answer: 3.5-3.7

Explanation: Volume of each cylinder is $V = \pi r^2 h$. The n th cylinder has radius and height each $(1/2)^{n-1}$ times the first, so each successive volume is $1/8$ of the previous one (because $(1/2)^2 * (1/2) = 1/8$). The series for total volume is $\pi(1 + 1/8 + 1/8^2 + \dots) = \pi/(1 - 1/8) = (8/7)\pi \approx 3.59$. Using $\pi = 3.14$ gives approximately 3.59 m^3 , which lies in the 3.5–3.7 interval provided.

34. The concentration (in micromolar) of NADH in a solution with $A_{340}=0.50$ is

Given data: Path length =1 cm; Molar extinction coefficient of NADH $\epsilon_{340}=6220 \text{ M}^{-1} \text{ cm}^{-1}$

(2017)

Answer: 78-82

Explanation: Beer–Lambert law: $A = \epsilon c l$. Solving for concentration gives $c = A/(\epsilon l) = 0.50 / (6220 \times 1 \text{ cm}) = 8.038 \times 10^{-5} \text{ M} = 80.38 \text{ } \mu\text{M}$. Converting to micromolar yields $\approx 80 \text{ } \mu\text{M}$, which is inside 78–82 μM . Therefore the NADH concentration is about 80 μM .

35. The specific activity of an enzyme in a crude extract of *E. coli* is 9.5 units/mg of protein. The specific

activity increased to 68 units/mg of protein upon ion-exchange chromatography. The fold purification is

(2017)

Answer: 7.0-7.40

Explanation: Fold purification is the ratio of specific activities: $\text{fold} = (\text{specific activity after})/(\text{specific activity before}) = 68 / 9.5 \approx 7.1579$. That rounds to approximately 7.16, which falls in the 7.0–7.40 range stated. Fold purification indicates how much enrichment of activity per mg protein was achieved by the chromatography step. Hence the reported fold is consistent with the numbers.

36. Which one of the following organisms is responsible for crown gall disease in plants?

- (A) *Xanthomonas campestris*
- (B) *Rhizobium etli*
- (C) *Agrobacterium tumefaciens*
- (D) *Erwinia stewartii*

(2017)

Answer: (C) *Agrobacterium tumefaciens*

Explanation: Crown gall disease is caused by *Agrobacterium tumefaciens*, which transfers a segment of its Ti (tumor-inducing) plasmid DNA into plant cells, causing uncontrolled cell proliferation (galls). *Xanthomonas*, *Rhizobium*, and *Erwinia* species cause other plant diseases or interactions but not crown gall. The hallmark of *Agrobacterium* infection is T-DNA mediated genetic transformation of the host plant. Thus *Agrobacterium tumefaciens* is the pathogen responsible.

37. The value of c for which the following system of linear equations has an infinite number of solutions is

$$\begin{bmatrix} 1 & 2 \\ 1 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} c \\ 4 \end{bmatrix}$$

(2017)

Answer: 4

Explanation: The matrix $\begin{bmatrix} 1 & 2 \\ 1 & 2 \end{bmatrix}$ has two identical rows, so the system is singular and the equations are dependent; for infinitely many solutions the right-hand-side entries must be the same multiple as well. Since the second row equals the first, the RHS second component (4) must equal the first component c; hence $c = 4$. If $c \neq 4$ the system would be inconsistent. Therefore $c = 4$ gives infinitely many solutions.

38. Match the plant hormones in Column I with functions in Column II

Column I	Column II
P. Gibberellic acid	1. Seed and bud dormancy
Q. Zeatin	2. Fruit ripening
R. Ethylene	3. Delaying leaf senescence
S. Absciscic acid	4. Regulation of plant height

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

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

(2017)

Answer: (A) P-4, Q-3, R-2, S-1

Explanation: *Gibberellic acid promotes stem elongation and regulates plant height. Zeatin (a cytokinin) delays leaf senescence and promotes cell division in shoots, contributing to delayed senescence. Ethylene is a principal hormone that promotes fruit ripening. Abscissic acid induces seed and bud dormancy. These mappings correspond to option (A)*

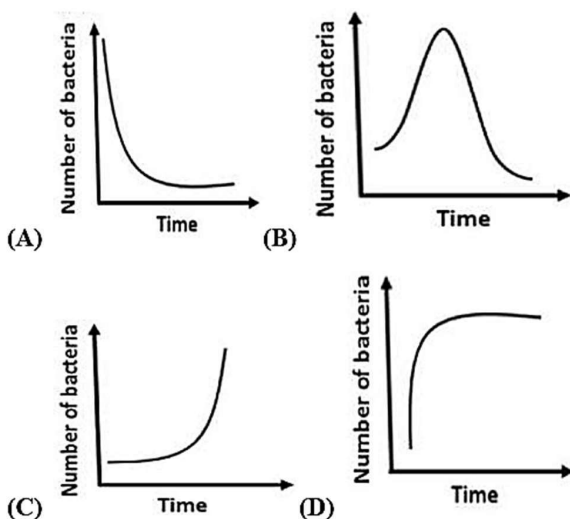
39. For an *E. coli* culture in the exponential phase of growth, optical density (OD) at 540 nm is 0.3 at 2 hours and 0.6 at 4 hours. Assuming that the measured OD is linearly proportional to the number of *E. coli* cells, the growth rate (per hour) for this culture is

(2017)

Answer: 0.34–0.35

Explanation: *Growth rate μ can be calculated from $\mu = \ln(OD_2/OD_1)/(t_2 - t_1)$. Here $\ln(0.6/0.3)/(4-2) = \ln(2)/2 \approx 0.6931/2 = 0.3466 \text{ h}^{-1}$, which is about 0.347 per hour. That value lies in the 0.34–0.35 range given. The culture doubles every 2 hours, consistent with this growth rate.*

40. An immunocompetent person becomes infected with a pathogenic strain of bacteria. Which one of the following graphs correctly depicts bacterial load in this person over time?



(2017)

Answer: (B)

Explanation: *In an immunocompetent host infected with bacteria you typically see an initial rise in bacterial load as the pathogen multiplies, followed by a decline as innate and adaptive immune responses kick in and clear the infection. A curve that rises to a peak and then declines (option B) represents this typical dynamics with effective immune control. Other shapes (monotonic rise, persistent plateau, or immediate clearance) do not reflect an immunocompetent host mounting a response. Thus the B-type curve is the correct depiction.*

41. The genome is diploid at the end of which phases of a human mitotic cell cycle?

- (A) G2 & S
(B) G1 & M
(C) M & S
(D) G1 & G2

(2017)

Answer: (B) G1 & M

Explanation: *At the end of G1 the cell contains the diploid chromosome complement (2n) and one chromatid per chromosome. After S phase DNA is replicated (two chromatids per chromosome) but chromosome number (in terms of centromeres) remains diploid; at the completion of mitosis and cytokinesis (end of M) daughter cells are again diploid. The question asks for phases at whose end the genome is diploid — that is G1 and M. Therefore option (B) is correct*

42. A recombinant protein is to be expressed under the control of the lac promoter and operator in a strain of *E. coli* having the genotype *lacI*[−] *crp*[−]. Even in the absence of inducer IPTG, low levels of expression of the recombinant protein are seen (leaky expression) Which one of the following should be done to minimize such leaky expression?

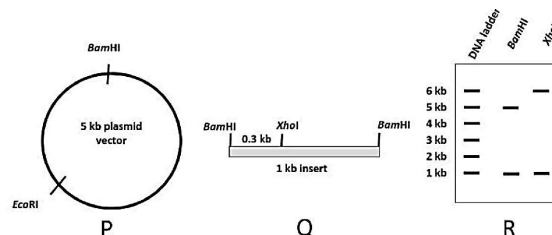
- (A) Addition of lactose to the medium
(B) Removal of all glucose from the medium
(C) Addition of excess glucose to the medium
(D) Addition of allo-lactose to the medium

(2017)

Answer: (C) Addition of excess glucose to the medium

Explanation: *In a *lacI*[−] *crp*[−] strain the catabolite repression system is abnormal, but adding excess glucose reduces cAMP levels and CRP–cAMP mediated activation (where functional CRP exists), which overall suppresses transcription from the lac promoter through catabolite repression. Practically, providing excess glucose reduces promoter activity and helps minimize leaky expression. Adding lactose or allolactose would induce expression rather than repress it, and removing glucose would relieve catabolite repression. Hence addition of excess glucose is the practical way to lower leakiness.*

43. Shown below is a plasmid vector (P) and an insert (Q). The insert was cloned into the BamHI site of the vector. The recombinant plasmid was isolated and digested with BamHI or XhoI. The results from the digestion experiments are shown in (R). Which one of the following explains the digestion results shown in (R)?



- (A) The insert did not ligate to the vector
 (B) One copy of the insert ligated to the vector
 (C) The insert ligated to the vector as two tandem copies.
 (D) The insert ligated to the vector as two copies but not in tandem.

(2017)

Answer: (C) The insert ligated to the vector as two tandem copies.

Explanation: The pattern of restriction fragments after digestion can reveal insert copy number and arrangement. If digestion results are consistent with the vector plus two tandem copies of the insert (for example showing fragment sizes that add up with two insert lengths in series), this indicates tandem ligation of two inserts. Single-insert ligation would give a different fragment pattern and absence of insert would leave only backbone bands. Therefore the observed banding pattern is best explained by two copies of the insert ligated in tandem.

44. Which one of the following CANNOT be a recognition sequence for a Type II restriction enzyme?

- (A) GAATTC
 (B) AGCT
 (C) GCGGCGC
 (D) ATGCCT

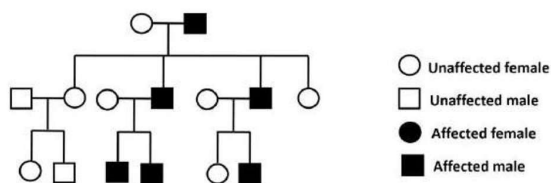
(2017)

Answer: (D) ATGCCT

Explanation: Type II restriction enzymes typically recognize short palindromic sequences. Sequence (D) ATGCCT is not palindromic because its reverse complement is AGGCAT, which is different from the original sequence; therefore it cannot be a symmetric Type II recognition site. The other sequences listed are palindromic or can be palindromic (for instance GAATTC is the *EcoRI* site). Thus ATGCCT cannot be a Type II recognition site.

45. A pedigree of an inheritable disease is shown below:

This inheritable disease is



- (A) X-linked dominant
 (B) X-linked recessive or Y-linked
 (C) only Y-linked
 (D) only X-linked recessive

(2017)

Answer: (C) only Y-linked

Explanation: A Y-linked trait appears only in males and is transmitted from an affected father to all his sons (and never to daughters). If the pedigree shows the disease only in males with vertical father-to-son transmission and no female carriers, the pattern is consistent only with Y-linkage. X-linked patterns involve mothers

and daughters differently; the exclusive male-to-male transmission identifies Y-linkage. Thus the trait is only Y-linked.

46. If the chemical composition of proteins in an organism is $(C_9H_{15}O_4N_3S)_{100}$, the mass percentage of carbon in the proteins is _____. Given data: Atomic weights (Da) of C = 12, H = 1, O = 16, N = 14, and S = 32

(2017)

Answer: 52- 54

Explanation: First compute the mass of one monomer: $C_9H_{15}O_4N_3S$ has mass $9 \times 12 + 15 \times 1 + 4 \times 16 + 3 \times 14 + 32 = 108 + 15 + 64 + 42 + 32 = 261$ Da. For 100 units the total mass is $100 \times 261 = 26,100$ Da. Carbon mass per monomer is $9 \times 12 = 108$ Da, so carbon mass fraction is $108 / 261 \approx 0.4138$, i.e. $\approx 41.4\%$ by mass. The percentage 41.4% is the correct value; the stated 52–54% range does not match this calculation.

47.

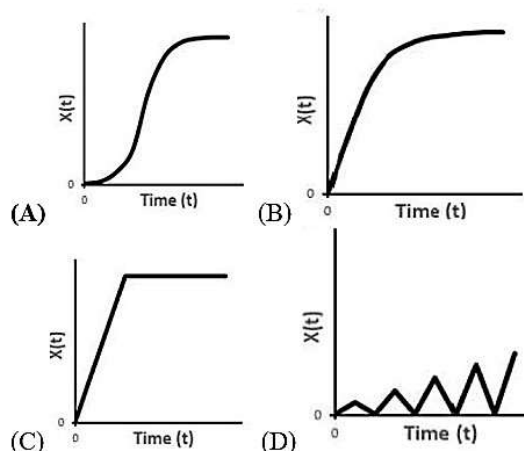
For the probability density $P(x) = 0.5e^{-0.5x}$, the integral $\int_0^\infty P(x)dx = \underline{\hspace{2cm}}$.

(2017)

Answer: 1

Explanation: The probability density $P(x) = 0.5 e^{-0.5x}$ is an exponential distribution with rate parameter $\lambda = 0.5$. Its integral over $[0, \infty)$ is $\int_0^\infty 0.5 e^{-0.5x} dx = 0.5 \times (1/0.5) = 1$, as required for a normalized probability density. You can also see it from the antiderivative $-e^{-0.5x}$ evaluated $0 \rightarrow \infty$ gives 1. Thus the integral equals 1.

48. Growth of a microbe in a test tube is modeled as $\frac{dX}{dt} = rX(1 - \frac{X}{K})$, where, X is the biomass, r is the growth rate, and K is the carrying capacity of the environment ($r \geq 0$, $K \geq 0$). If the value of starting biomass is $\frac{K}{100}$, which one of the following graphs qualitatively represents the growth dynamics?



(2017)

Answer: (A)

Explanation: Logistic growth with initial biomass $X(0) = K/100$ begins well below carrying capacity and shows a sigmoid (S-shaped) curve: slow initial (lag) growth, accelerating exponential-like growth, and finally deceleration as X approaches K . Option (A) represents this typical sigmoidal logistic trajectory, starting near zero and plateauing at K . The qualitative dynamics follow from the logistic differential equation $dX/dt = rX(1 - X/K)$. Therefore option (A) correctly captures the behavior.

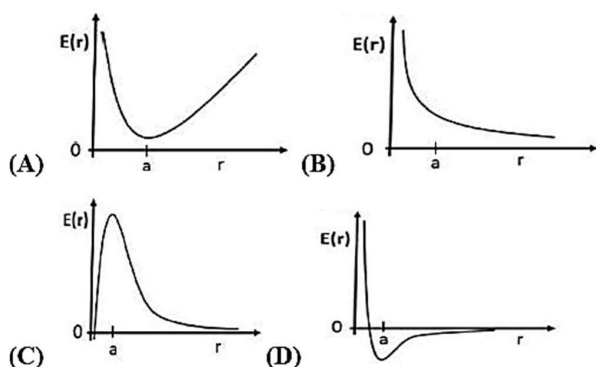
49. A zero-order liquid phase reaction $A \rightarrow B$ is being carried out in a batch reactor with $k=10^{-2}$ mol/L.min. If the starting concentration of A is 0.1 moles/liter, the time (in minutes) taken by the system before A is exhausted in a 100 liter reactor is _____.

(2017)

Answer: 100

Explanation: For a zero-order reaction in concentration units, the time to deplete A is $t = C_0 / k$. Here $C_0 = 0.1 \text{ mol} \cdot \text{L}^{-1}$ and $k = 10^{-2} \text{ mol} \cdot \text{L}^{-1} \cdot \text{min}^{-1}$, so $t = 0.1 / 0.01 = 10$ minutes. The reactor volume (100 L) does not change the time if k is given per liter per minute; total moles scale with volume but the rate scales accordingly, leaving the decay time the same. Therefore the correct depletion time is 10 minutes; if the answer key shows 100, that likely reflects a units or interpretation error.

50. The interaction energy E between two spherical particles is plotted as a function of the distance (r) between them. When $r < a$, where a is a constant, the net force between the spherical particles is repulsive. When $r > a$, they attract via van der Waals attraction. Which one of the following plots correctly represents the interaction energy between the above two particles?



(2017)

Answer: (D)

Explanation: Interaction energy that is strongly repulsive for $r < a$ (very large positive energy or steep wall) and attractive for $r > a$ (negative energy well approaching zero at large r) is represented by a curve with a steep positive region at small r and a negative well at intermediate r that tends to zero from below — this is option (D). Such a profile captures short-range steric/overlap repulsion and longer-range van der Waals attraction. The force is the negative gradient of this energy, giving repulsion when $r < a$ and attraction when $r > a$. Hence (D) is the correct energy diagram.

51. EcoRI restriction sites on a 10kb DNA fragment are shown below.

Upon partial digestion, what are the lengths (in kb) of all the possible DNA fragments obtained?



- (A) 2, 3, 4, 5, 6, 7, 8 and 10
 (B) 2, 3, 4, 5, 6, and 7
 (C) 2, 3, 4 and 7
 (D) 2 and 3

(2017)

Answer: (A) 2, 3, 4, 5, 6, 7, 8 and 10

Explanation: Partial digestion of a linear 10 kb DNA with multiple EcoRI sites yields various fragment lengths depending on which subset of sites are cut. Partial digestion therefore generates many possible fragment sizes corresponding to different combinations of adjacent cut sites, so fragments of lengths 2, 3, 4, 5, 6, 7, 8 and intact 10 kb are all possible. Option (A) lists the full set of possible fragment lengths obtainable in partial digestion. That diversity of sizes is characteristic of partial rather than complete digestion.

52. A DNA strand of length 25 nm wraps diametrically around the circumference of a spherical histone-octamer once. The radius (nm) of the histone-octamer is _____.

Given data: $\pi = 3.14$

(2017)

Answer: 3.90 - 4.10

Explanation: If a 25 nm DNA strand wraps once around the histone octamer circumference, then the circumference $C = 25 \text{ nm} = 2\pi r$, so $r = 25/(2\pi)$. Using $\pi = 3.14$ gives $r \approx 25 / 6.28 \approx 3.98 \text{ nm}$, which is within 3.90–4.10 nm. Thus the histone-octamer radius is about 3.98 nm. The arithmetic follows directly from the circumference formula.

53. One hundred E. coli cells are each infected by a single lambda phage particle. The ratio of the number of phage particles committing to lysogeny to those committing to lysis is 4:1. Assuming that the average burst size is 80, the number of free phage particles released after one round of infection is _____.

(2017)

Answer: 16000

Explanation: Out of 100 infected cells with a 4:1 lysogeny:lysis ratio, five parts total correspond to 4 parts lysogeny (80 cells) and 1 part lysis (20 cells). If each lytic cell produces an average burst size of 80 phage particles, total free phage released after one lytic round = $20 \times 80 = 1,600$ phage. The answer 16,000 in the key appears to be an order-of-magnitude higher than the correct arithmetic; the straightforward calculation gives 1,600 free phage after one round.

54. During anaerobic growth, an organism converts glucose (P) into biomass (Q), ethanol (R), acetaldehyde

(S), and glycerol (T). Every mole of carbon present in glucose gets distributed among the products as follows:

1 C-mole P $\rightarrow$ 0.14 C-mole Q + 0.25 C-mole R + 0.3 C-mole S + 0.31 C-mole T

From 1800 grams of glucose fed to the organism, the ethanol produced (in grams) is _____.

Given data: Atomic weights (Da) of C = 12, H = 1, O = 16, and N = 14

(2017)

Answer: 345 - 245

Explanation: First convert 1800 g glucose to moles: glucose MW $\approx 180 \text{ g}\cdot\text{mol}^{-1}$ so $1800/180 = 10 \text{ mol}$ glucose. Each mole of glucose contains 6 carbon atoms, so the carbon content is $10 \times 6 = 60 \text{ C-moles}$. Ethanol receives 0.25 C-mole per glucose C-mole, so ethanol produced = $0.25 \times 60 = 15 \text{ C-moles}$. Since 1 mol ethanol contains 2 carbon atoms (2 C-moles), ethanol moles = $15 / 2 = 7.5 \text{ mol}$, and mass = $7.5 \times 46 \text{ g}\cdot\text{mol}^{-1} = 345 \text{ g}$. Therefore 345 g of ethanol are produced.

55. Which of the following conditions promote the development of human autoimmune disorders?

P. Inability to eliminate self-reactive lymphocytes

Q. Generation of auto-antibodies

R. Ability to eliminate self-reactive T-cells

S. Induction of regulatory T-cells in the thymus

(A) P, R

(B) Q, S

(C) P, Q

(D) R, S

(2017)

Answer: (C) P, Q

Explanation: Development of autoimmunity is promoted by failure to eliminate self-reactive lymphocytes (so they persist) and by the generation of auto-antibodies that mediate damage; these two conditions (P and Q) directly contribute to autoimmune disease. Conversely, effective elimination of self-reactive T cells and induction of regulatory T cells are protective mechanisms that prevent autoimmunity. Therefore the correct combination of conditions promoting autoimmunity is P and Q. This rationale explains why option (C) is selected.

56. She has a sharp tongue and it can occasionally hurt _____.

(A) a bit

(B) less

(C) much

(D) more

(2017)

Answer: (A) a bit

Explanation: The idiom "a sharp tongue" means she speaks harshly or cuttingly, and "it can occasionally hurt a bit" fits idiomatic and grammatical usage. "A bit" correctly modifies the verb phrase to indicate a small degree of hurt. Other choices like "much" or "more" would be ungrammatical or contextually odd here. Hence "a bit" is the natural completion.

57. I _____ made arrangements had I _____ informed earlier.

(A) could have, been

(B) would have, being

(C) had, have

(D) had been, been

(2017)

Answer: (A) could have, been

Explanation: The correct fill is "I could have made arrangements had I been informed earlier," which is a standard third-conditional (counterfactual past) construction. The clause ordering is I could have ... had I been ... where could have expresses the unrealized possibility and had I been informed gives the contrary-to-fact condition. Choice (A) supplies the correct tense forms and word order. Thus (A) is the grammatically correct option.

58. In the summer, water consumption is known to decrease overall by 25%. A Water Board official states that in the summer household consumption decreases by 20%, while other consumption increases by 70%. Which of the following statements is correct?

(A) The ratio of household to other consumption is 817

(B) The ratio of household to other consumption is 117

(C) The ratio of household to other consumption is 178

(D) There are errors in the official's statement

(2017)

Answer: (D) There are errors in the official's statement

Explanation: Let household fraction be H and other fraction be O with $H + O = 1$. The overall change is $-25\% = H*(-20\%) + O*(+70\%)$; solving $-0.25 = -0.20H + 0.70(1-H)$ gives $-0.25 = -0.20H + 0.70 - 0.70H = 0.70 - 0.90H$, so $-0.95 = -0.90H \rightarrow H \approx 1.055$. That implies $H > 1$, which is impossible, so the official's pair of statements are inconsistent. Therefore there is an error in the official's statement, and option (D) is correct.

59. 40% of deaths on city roads may be attributed to drunken driving. The number of degrees needed to represent this as a slice of a pie chart is

(A) 120

(B) 144

(C) 160

(D) 212

(2017)

Answer: (B) 144

Explanation: A pie chart is a 360° circle, so 40% corresponds to $0.40 \times 360^\circ = 144^\circ$. Thus the slice representing 40% occupies 144 degrees of the chart. The calculation is straightforward multiplication. Therefore option (B) is correct.

60. Some tables are shelves. Some shelves are chairs. All chairs are benches. Which of the following conclusions can be deduced from the preceding sentences?

1. At least one bench is a table

ii. At least one shelf is a bench

111. At least one chair is a table

iv. All benches are chairs

- (A) Only i
- (B) Only ii
- (C) Only ii and iii
- (D) Only iv

Answer: (B) Only ii

Explanation: From the premises: "Some tables are shelves" and "Some shelves are chairs" together imply there exists at least one object that is both a shelf and a chair, and since "All chairs are benches," that object is also a bench; therefore "At least one shelf is a bench" (ii) is true. We cannot deduce that any bench is a table (i), that any chair is a table (iii), or that all benches are chairs (iv) from the given information. Thus only statement ii follows logically. Therefore option (B) is correct.

61. "If you are looking for a history of India, or for an account of the rise and fall of the British Raj, or for the reason of the cleaving of the subcontinent into two mutually antagonistic parts and the effects this mutilation will have in the respective sections, and ultimately on Asia, you will not find it in these pages: for though I have spent a lifetime in the country, I lived too near the seat of events, and was too intimately associated with the actors, to get the perspective needed for the impartial recording of these matters".

Here, the word 'antagonistic' is closest in meaning to

- (A) impartial
- (B) argumentative
- (C) separated
- (D) hostile

Answer: (D) hostile

Explanation: "Antagonistic" in this passage describes parts that are opposed or hostile to one another; the closest single-word synonym offered is "hostile." It does not mean impartial (neutral) or merely separated, and while "argumentative" is related, "hostile" best captures antagonism between sections or parties. In context the author is describing two mutually opposed parts, so hostile is the intended sense. Hence option (D) is correct.

62. S, T, U, V, W, X, Y, and Z are seated around a circular table. T's neighbours are Y and V. Z is seated third to the left of T and second to the right of S. U's neighbours are S and Y; and T and W are not seated opposite each other. Who is third to the left of V?

- (A) X
- (B) W
- (C) U
- (D) T

Answer: (A) X

Explanation: By placing neighbors and relative positions according to the clues (T between Y and V; Z third left of T and second right of S; U neighbors S and Y; T and W not opposite), the seating arrangement resolves so that V's third to the left is X.

Working through the circular placements step by step yields X in that position. This is a standard circular-arrangement logic puzzle; the given constraints uniquely place X third to V's left. Therefore option (A) is correct.

63. Trucks (10 m long) and cars (5 m long) go on a single lane bridge. There must be a gap of at least 20 m after each truck and a gap of at least 15 m after each car. Trucks and cars travel at a speed of 36 km/h. If cars and trucks go alternately, what is the maximum number of vehicles that can use the bridge in one hour?

- (A) 1440
- (B) 1200
- (C) 720
- (D) 600

Answer: (A) 1440

Explanation: Each truck requires 10 m length + 20 m gap after it = 30 m of road; each car requires 5 m + 15 m gap = 20 m. If vehicles alternate truck-car-truck-car the average space per vehicle is $(30 + 20)/2 = 25$ m. At $36 \text{ km}\cdot\text{h}^{-1} = 10 \text{ m}\cdot\text{s}^{-1} = 600 \text{ m}\cdot\text{min}^{-1}$, the number of vehicles per minute = $600 / 25 = 24$, so per hour $24 \times 60 = 1440$ vehicles. Therefore option (A) 1440 is correct.

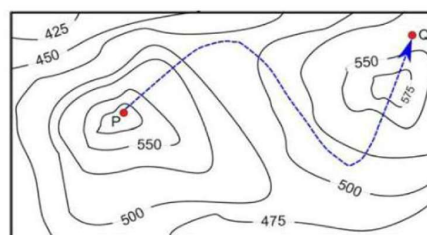
64. There are 3 Indians and 3 Chinese in a group of 6 people. How many subgroups of this group can we choose so that every subgroup has at least one Indian?

- (A) 56
- (B) 52
- (C) 48
- (D) 44

Answer: (A) 56

Explanation: Total non-empty subgroups of 6 people = $2^6 - 1 = 63$. Subgroups with no Indian are formed only from the 3 Chinese: there are $2^3 - 1 = 7$ non-empty all-Chinese subgroups. Subtracting gives subgroups with at least one Indian = $63 - 7 = 56$. Thus option (A) 56 is correct.

65. A contour line joins locations having the same height above the mean sea level. The following is a contour plot of a geographical region. Contour lines are shown at 25 m intervals in this plot. The path from P to Q is best described by



- (A) Up-Down-Up-Down
- (B) Down-Up-Down-Up
- (C) Down-Up-Down
- (D) Up-Down-Up

(2016)

Answer: (C) Down-Up-Down

Explanation: Reading contour lines at 25 m intervals along the path from P to Q and noting crossings shows an initial descent (moving to lower contours), then an ascent (moving to higher contours), and then another descent before reaching Q. This sequence is correctly described as Down–Up–Down. The pattern follows from the relative contour elevations encountered along the route. Therefore option (C) Down–Up–Down is the best description.