1. C.

Details: whom is the object of a verb or preposition. That means whom is acted on. "Whom " when used, it is about asking question.

2. C.

Details: All options are possible but option C is surely true.

See example: option A: Some who were involved in strike were students

Possibility: As per statement in option, It is possible that other people can also be involved, so it can not be answer.

Option B: No student was involved in the strike.

It contradicts the statement given in question.

Option D: Some who were not involved in the strike were students.

Possibility: Those who were not involved in strike can be anyone like lawyers, doctors, farmers etc, so it can not be answer as it has another possibility.

3. C.

Details: Volume of cone, $V = 1/3\ \pi r^2 h$

$h'=h+0.1\ h = 1.1h$; $r'=r+0.1\ r = 1.1r$

$V' = 1/3\ \pi r'^2 h'$ $\Rightarrow V' = 1/3\ \pi\ (1.1r)^2(1.1h)$ $\Rightarrow V' = 1/3\ \pi\ *1.331\ r^2h$

%ge change in Volume, $\Delta V\% = \frac{(V'-V)}{V} * 100$ $\Rightarrow \Delta V\% = 33.1\%$

4. C.

Details: As per diretion 1. possible arrangements: i) 10, 7, 4, 5, 2 ii) 10, 5, 2, 7, 4 iii) 10, 7, 2, 5, 4 and there are many possible arrangements.

As per direction 2. possible arrangements: i) 10, 5, 4, 7, 2 ii) 10, 5, 2, 7, 4.

As per direction 3. possible arrangement is 10, 5, 4, 7, 2.

5. A.

Details: Past perfect tense and passive voice, sentence structure: Object + had + been + verb3.

And verb3 of defeat is defeated.

6. C.

Details: The other three options are not necessarily true.

7. A.

Details: Total population = 1400 million

#people whose having own mobile phones = 70% of 1400 = 0.7 * 1400 = 980 million

#people whose accesses the internet = 294 million

#people who buy goods from e-commercial portals = Half of internet users = 294/2 = 147 million

Percentage buyers = (147/1400) * 100 = 10.5 %

8. C.

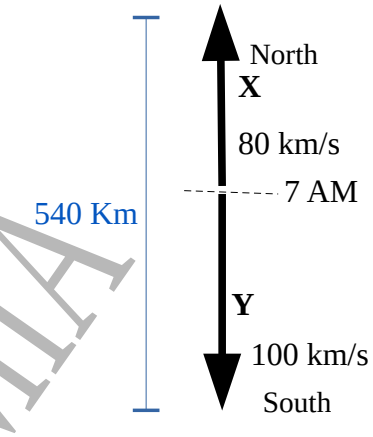
Details: Baaj corresponds to instrumental style not institution.

9. B

Details: $V_1 = 80$ Km/s, $V_2 = 100$ Km/s

Relative V, $V_{rel} = V_1 + V_2$; Time, t= Dist./(80+100)

t = 540/180 ; t= 3 hours, So train will reach at 10 A.M.



10. D

Details: Answer is direct, read the option, it is about head not kingdom.

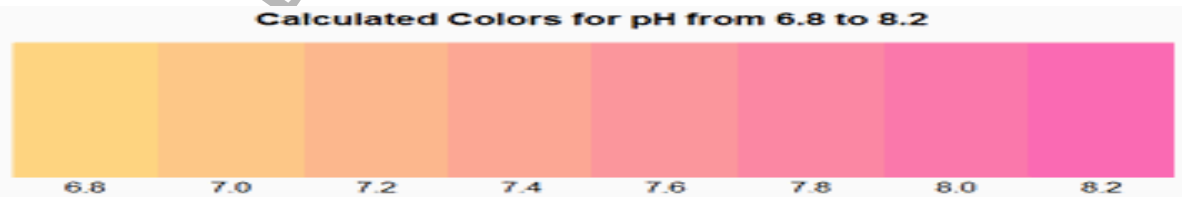
Part 2

1. A.

Details: B. thuringiensis forms protein crystals during a particular phase of their growth. These crystals contain a toxic insecticidal protein. Bt toxin protein exist as inactive protoxins but once an insect ingest the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals. The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect. The toxin is coded by a gene named cry. There are a number of them, for example, the proteins encoded by the genes cryIAc and cryIIAb control the cotton bollworms, that of cryIAb controls corn borer.

2. B.

Details: Acridine Orange a fluorescent cationic dye that intercalates DNA and RNA, is used in fluorescence and epifluorescence microscopy. It is suitable for detectionof nucleic acids, analysis of mitochondria and lysosomes by flow cytometry, DNA staining in apoptosis. **Phenol Red** changes colour from yellow below pH 6.8 to bright pink above pH 8.2.



Bromophenol blue is useful as a tracking dye in electrophoresis, an industrial dye, a laboratory acid-base indicator and a biological stain. It can be used to stain proteins and nucleic acids.Proteins are visualized by adding a dye **Coomassie blue.**

3. D.

Details: Tetracyclines (bacteriostatic) inhibit protein synthesis in bacteria by blocking the A site on the ribosome, preventing the binding of aminoacyl-tRNAs.

4. A.

Details: PROSITE is a database of protein families and domains. It is based on the observation that, while there is a huge number of different proteins, most of them can be grouped, on the basis of similarities in their sequences, into a limited number of families. **TrEMBL, (Translated EMBL)** is a very large protein database in SwissProt format generated by computer translation of the genetic information from the EMBL Nucleotide Sequence Database database. **SWISS-PROT** is a curated protein sequence database which strives to provide a high level of annotation (such as the description of the function of a protein, its domains structure, post-translational modifications, variants, etc.), a minimal level of redundancy and high level of integration with other databases. **PDB** contains the 3D shapes of proteins, nucleic acids, and complex assemblies that helps students and researchers understand all aspects of biomedicine and agriculture, from protein synthesis to health and disease.

5. A

Details: Virus are non-living outside the organism, because they do not have the nessary enzymes and other protein. They have their genetic material and revese transcriptase if it is RNA virus. (different types of virus have few other enzymes necessary for replication or transcription/reverse-transcription). HIV is a member of the genus Lentivirus, part of the family Retroviridae. Lentiviruses have many morphologies and biological properties in common. Many species are infected by lentiviruses, which are characteristically responsible for long-duration illnesses with a long incubation period. Lentiviruses are transmitted as single-stranded, positive-sense, enveloped RNA viruses. Upon entry into the target cell, the viral RNA genome is converted (reverse transcribed) into double-stranded DNA by a virally encoded enzyme, reverse transcriptase, that is transported along with the viral genome in the virus particle. The resulting viral DNA is then imported into the cell nucleus and integrated into the cellular DNA by a virally encoded enzyme, integrase, and host co-factors. Once integrated, the virus may become latent, allowing the virus and its host cell to avoid detection by the immune system, for an indiscriminate amount of time.

6. C.

Details: DNA synthesis occurs during S phase that's why its name given synthetic phase. In G1 phase of the cell cycle, many of the DNA replication regulatory processes are initiated. In eukaryotes, the vast majority of DNA synthesis occurs during S phase of the cell cycle, and the entire genome must be unwound and duplicated to form two daughter copies. During G2, any damaged DNA or replication errors are corrected. Finally, one copy of the genomes is segregated to

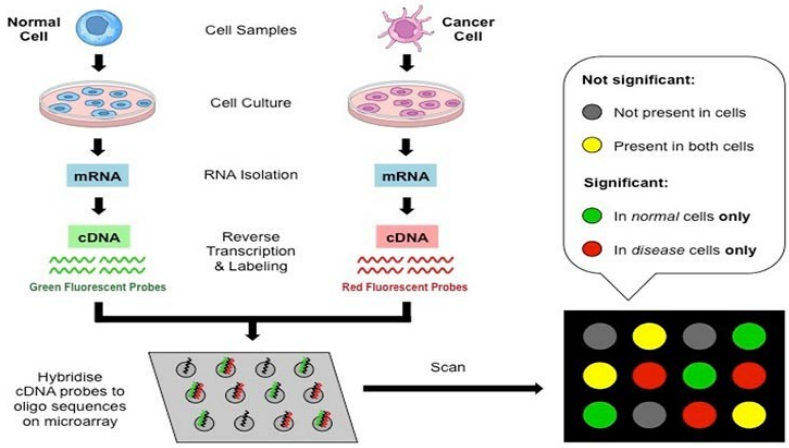
each daughter cell at mitosis or M phase. These daughter copies each contain one strand from the parental duplex DNA and one nascent antiparallel strand.

7. C.

Details: Disease and their causing agents are given, which are very direct.

8. B.

Details: DNA microarray explained in the figure. **PCR** is used for the amplification of DNA. **Northern and Southern hybridisation** are techniques where isolated RNA and DNA, respectively are separated by gel electrophoresis, transferred to a membrane.



9. B and C.

Details: Conjugation, transformation and transduction are three methods

10. D.

Details: Antibody is very specific, it recognises specific pattern of the antigen so it is an example of specific defence system.

11. B.

Details: Non-sense mutation is a specific kind of **mis-sense** mutation where edition of one base pair cause termination of translation. **Synonymous mutation** is observed due to degeneracy of codon which is because of third base pair in the code. A **silent mutation** causes no change in the protein that is produced, which is why it's considered **silent**.

12. B.

Details: asac

13. B.

Details: R: 1, 3, 9, 27, 81, ... where 3/1=9/3=27/3=81/27 = 3 which is common factor hence an example of geometric series.

S: 4, -8, 16, -32, 64, ... where -8/4 = 16/(-8) = -32/16 = 64/(-32) = -2, which is common factor hence an example of geometric series.

14. D.

Details: $E + S \leftrightarrows ES \leftrightarrows EP \leftrightarrows E + P$

In figure 6-3, one can see that ΔG between S and P does not change but the path of conversion (E_A) is changed. Keq =[P]/[S], so we can see Keq does not depend on enzyme's presence. So, option D is correct.

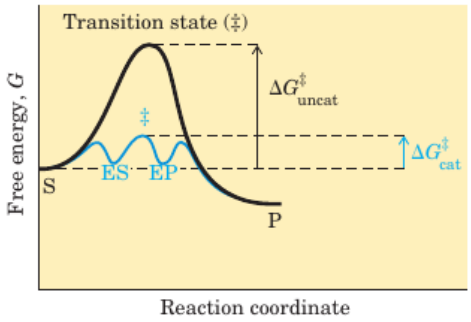


FIGURE 6-3 Reaction coordinate diagram comparing enzyme-catalyzed and uncatalyzed reactions. In the reaction S⟶P, the ES and EP intermediates occupy minima in the energy progress curve of the enzyme-catalyzed reaction. The terms $\Delta G^{\ddagger}_{uncat}$ and $\Delta G^{\ddagger}_{cat}$ correspond to the activation energy for the uncatalyzed reaction and the overall activation energy for the catalyzed reaction, respectively. The activation energy is lower when the enzyme catalyzes the reaction.

15. D.

Details: Intracellular carbon source if diminishes, microbes start metabolising external carbon sources like glucose etc, actually this is one of the reason of continuous life.

16. C.

Details: Heat transfer coefficient, h = q/ΔT, where q is heat flow per unit area [q=Q/A] and T is the temperature. So the unit is watt-meter^{-2}Kelvin^{-1}.

17. A.

Details: As reaction is endogenous it must use something that is inside, e.i., internal reserves.

18. C.

Details: C6H12O6 + 0.48 NH 3 + 3 O 2 0.48 C6H10O3N + 3.12 CO2 + 4.32 H2O

this is the equation given in question no. 51 of the same questio paper. Here one can see the moles in LHS and RHS are not equal. Also, mentioned in material balance chapter 4 of Pauline Doran. Others like mass, elements and energy are constant in chemical reaction except nuclear reaction.

19. 3.

Details: Using formula, No. of roots = (2n-3)!/(2^{n-2})(n-2)! Where n is the no of species.

No. of roots=(2*3-3)!/(2^{3-2})(3-2)! = 3

20. -6.

Details: Method 1:

If $A_{ij} = -A_{ji}$ then A is skew-symmetric. Since, $A_{12} = 6$, and $A_{21} = P = -A_{12} = -6$

Method 2:

$A^T = -A$ A is skew symmetric matrix.

Given, $A = \begin{pmatrix} 0 & 6 \\ P & 0 \end{pmatrix}$ => $-A = \begin{pmatrix} 0 & -6 \\ -P & 0 \end{pmatrix}$

$A^T = \begin{pmatrix} 0 & 6 \\ P & 0 \end{pmatrix}$ Since, $A^T = -A$ => $\begin{pmatrix} 0 & 6 \\ P & 0 \end{pmatrix} = \begin{pmatrix} 0 & -6 \\ -P & 0 \end{pmatrix}$ => P = -6

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21. 16.

Details: $\lim_{x\to 8}\left[\frac{(x^2-64)}{(x-8)}\right] = \lim_{x\to 8}\left[\frac{((x-8)(x+8))}{(x-8)}\right] = \lim_{x\to 8}(x+8) = 8 + 8 = 16$

22. 20.

Details: Arrange the given data in particular order (ascending or descending), ascending order arrangement is: 8, 10, 12, **16, 24**, 30, 50, 90.

Median value = Average of the middle data = (16 + 24)/2 = 20

23. 4.

Details: First, calculate the **number of electrons** each atom of the molecule can **donat**e to reach a full valence shell. For example, *Hydrogen* = 1, *Carbon* = 4, *Oxygen* = -2 (since it receives electrons instead of donating). After finding these values, calculate the **sum** of these values for all atoms of the molecule. For C2H4O2, (4*2) + (1*4) + (-2*2) = 8.

Secondly, divide this value by the **number of *Carbon* atoms** in the molecule. For the given molecule 2 *Carbon* atoms), Degree of reduction = 8 / 2 = 4.

24. 32000.

Details: Since, Mass of 1 mol Oxygen molecule (O2) = 16*2 = 32 g

So, Mass of 1 kmol (1000 mol) Oxygen molecule (O2) = 32*1000 = 32000 g

25. 50.

Details: Specific activity of enzyme, $S = \frac{No.\,Of\,enzyme\,units\,per\,ml\,(unit = \mu mol\,min^{-1})}{concentration\,of\ protein * volume\,of\,sample}$

$\Rightarrow S = \frac{5}{10*10*10^3} = 50$ unit/mg (Here 10 is the protein conc. In mg/ml and $10 * 10^3$ is voume of sample in ml).

26. C.

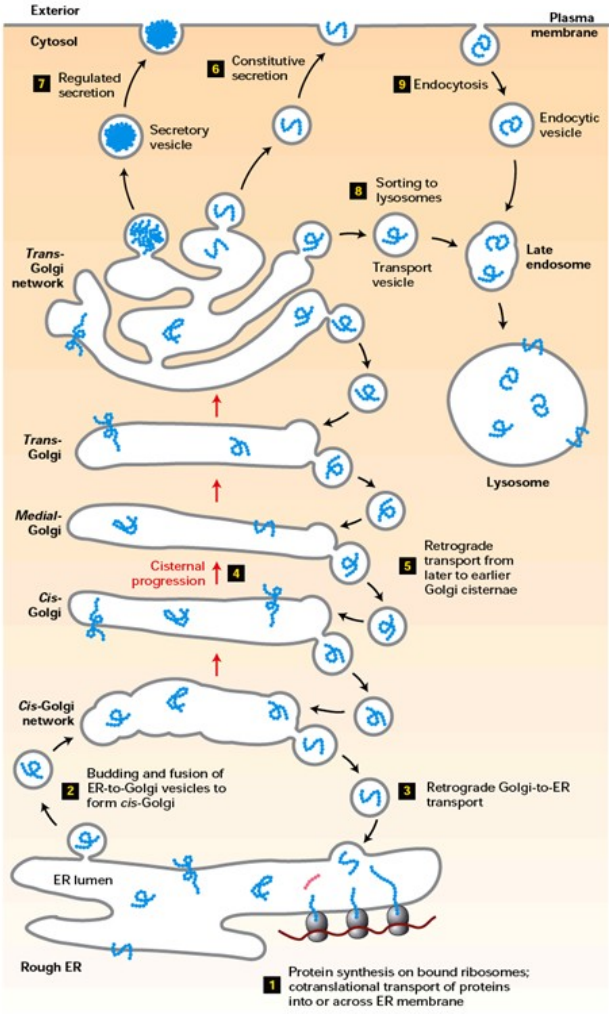
Details: A **hydrogen bond** (**H-bond**) is a primarily electrostatic force of attraction between a **hydrogen** (**H**) atom which is covalently bound to a more electronegative (en) atom or group and the en atoms. Bond formed by electrostatic attraction is an asymmetric situation, and thus it has an intrinsic directionality. Conventionally, a hydrogen bond is depicted as pointing from the hydrogen atom to the atom it is electrostatically attracted to. The direction of this convention was arbitrarily decided, in that it would be just as valid to always depict the bond as pointing toward the hydrogen from the atom it is electrostatically attracted to. As it is electrostatic in nature and vander waal bond is formed due to correlations in the fluctuating polarizations of nearby particles, so **H-bond is stronger comparative to van der waal bond.** Proteins have H-bond which play major role in determining its 2^0 and 3^0 structure.

27. B

Details: Important part of site-directed mutagenesis is eliminating the template with a methylation-recognizing-nuclease, as DpnI. Although digestion of DpnI can eliminate fully methylated parental DNA, around 20–30% of hemimethylated molecules (parental strand combined with PCR-generated strand) could not be removed due to hemimethylated DNA, and the PCR product would be more resistant to DpnI.

28. B

Details: Lysosomes act in digesting intracellular components such as worn out organelles (autophagy) or by fusing with phagosomes to break down phagocytosed material. Their abundance is greatest in phagocytes, such as macrophages, but almost all cells contain some lysosomes.



29. B

Details: The Expect value (E) is a parameter that describes the number of hits one can "expect" to see by chance when searching a database of a particular size. It decreases exponentially as the Score (S) of the match increases. Essentially, the E value describes the random background noise.

E < 0.05: probably related (homologous); E < 1 : may be related; E >= 1 : no statistical significance, but may be biologically significant anyway.

$E = Kmn\,e^{-\lambda S}$ sequence lengths *m* and *n*, the statistics of high-scoring segment pairs (HSP) scores are characterized by two parameters, *K* and *lambda. S is score*, and equation shows the relationship between score and e-value. From the above interpretations: Statement p and s are false and q is correct.

30. B.

Details: There are three antigens in the ABO blood group system, A, B and H. The *ABO* gene is located on chromosome 9 and has three alleles *A*, *B* and *O*. The *A* allele encodes a **glycosyltransferase** that adds N-acetylgalactosamine to the glycoprotein H antigen that is expressed on all normal red cells. The *B* allele encodes a different **glycosyltransferase** that adds d-galactose. The *O* allele is a deletion that results in loss of enzyme translation and therefore presence of unmodified H antigen. *A* and B are co-dominant alleles; AB individuals express both antigens.

31. D.

Details: The fidelity of DNA synthesis is known to be affected by a variety of factors including polymerase structure, $3' \rightarrow 5'$ exonuclease activity, dNTP and divalent cation concentrations, and pH. So mg^{2+} and pH only correct. The annealing temperature of a standard PCR protocol is either 55°C or 60°C. The chosen temperature depends on the strand-melting temperature of the primers and the desired specificity. For greater stringency higher temperatures are recommended.

32. C.

Details: IR (infrared) spectroscopy is useful in organic chemistry because it enables you to identify different functional groups. This is because each functional group contains certain bonds, and these bonds always show up in the same places in the IR spectrum. **Circular dichroism (CD)** spectroscopy is widely used for protein secondary structure analysis. However, quantitative estimation for β-sheet–containing proteins is problematic due to the huge morphological and spectral diversity of β-structures. **Nuclear magnetic resonance spectroscopy** of proteins (usually abbreviated protein NMR) is a field of structural biology in which NMR spectroscopy is used to obtain information about the structure and dynamics of proteins, and also nucleic acids, and their complexes.

33. A.

Details: Glutamate has acidic side chains so it is more negative so it has tendency to move towards cathode, where as valine has aliphatic neutral side chain so it has tendecy to move towards anode. This satisfies first statement. (at pH > pI or pKa surface of the protein is predominantly negatively charged)

34. B.

Details: A type of white blood cell, the B cell, produces antibodies that bind to the injected antigen. These newly produced antibodies are then harvested from the mouse. These isolated B cells are in turn fused with immortal myeloma, Plasma B Cells, to produce a hybrid cell line called a hybridoma, which has both the antibody-producing ability of the B-cell and the exaggerated longevity and reproductivity of the myeloma.

35. C.

Details: fetal bovine serum is rich in natural growth-factors required to stimulate cell growth, cell proliferation, differentiation & also for regulation of cellular activity. Because of its high quantity of hormones, carrier proteins and macromolecular proteins, fetal bovine serum is frequently present in culture medium used in in vitro fertilization. In this process, embryonic stem cells are transferred into the culture medium; this results in growth of the cells. Bovine serum is a constituent of most media used for the culture of animal cells. The adhesion-promoting properties of serum are generally attributed to fibronectin, and other adhesion-promoting molecules.

36. C.

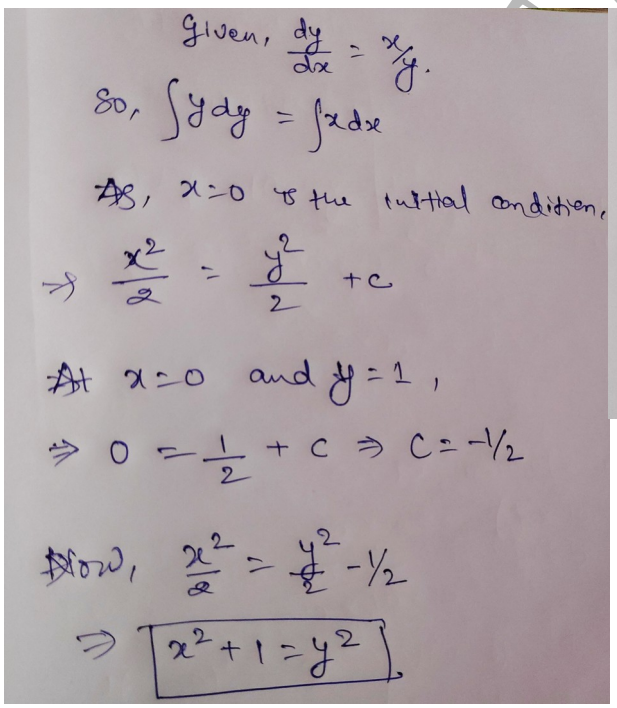
Details: The 7-methylguanosine cap is joined to the first transcribed nucleotide via the 5′ hydroxyl group, through a triphosphate linkage, to produce m7G(5′)ppp(5′)X, where m7G is 7-methylguanosine, p is a phosphate group and X is the first transcribed nucleotide. This 5′–5′ linkage is in contrast with the 3′–5′ phosphodiester bond, which links nucleotides in transcribed RNA.

37. A.

Details: Prolines in alpha helices after the first turn (4th residue) cause a kink in the helix.This kink is caused by prolinebeing unable to complete the H-bonding chain of the helixand steric or rotamer effects that keep proline from adapting the prefered helical geometry.

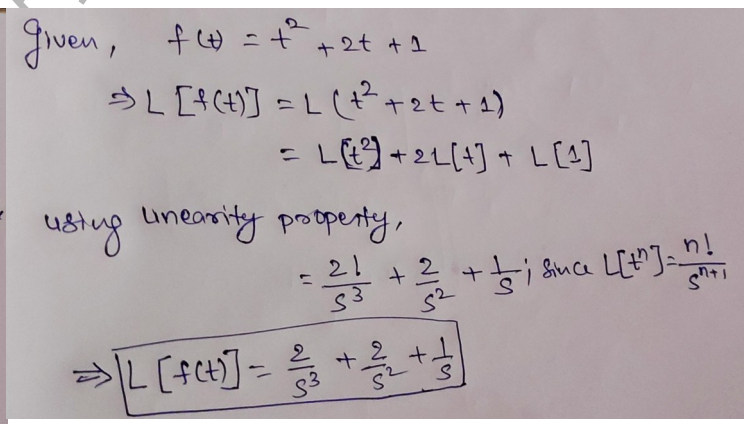
38. B.

Details:



39. D.

Details:



40. D.

Details: factors that can influence the lag phase of a microbial culture in a batch fermentor are

inoculums age, inoculums size and media composition. It's intutive.

41. B.

Details: One can answer it using omission rule.

Proportional controller is a type of continuos controller. In a proportional controller the output (also called the actuating signal) is directly proportional to the error signal. Mathematically, $P_{out}(t) \propto e(t)$

Advantages of Proportional Controller

1.The proportional controller helps in reducing the steady-state error, thus makes the system more stable.
2.The slow response of the overdamped system can be made faster with the help of these controllers.

Disadvantages of Proportional Controller

1.Due to the presence of these controllers, we get some offsets in the system.
2.Proportional controllers also increase the maximum overshoot of the system.

42. C.

Details: Manometer = manos (greek) meaning thin and mètre meaning instrument to measure so manometer is an instrument for determining and indicating elastic pressure of gases or vapors. Tachometer = tachos (latinised takho) meaning speed, swiftness, it is a device to measure speed of rotation. Rotameter = rota (latin) meaning wheel, an instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine. The hemocytometer (haem = blood, cyto = cell) is a counting-chamber device originally designed and usually used for counting blood cells.

43. D.

Details: Option R is wrong, biomass concentration do not always increase with increase in dilution rate.

44. B.

Details: Plant stem cells are innately undifferentiated cells located in the meristems of plant. They serve as the origin of plant vitality, as they maintain themselves while providing a steady supply of precursor cells to form differentiated tissues and organs in the plant. It can develop into whole plant. Animal cells are more delicate to handle and further more difficult to introduce transgene into it as compared to plant cells. But this is not the reason of regeneration of plant body from its single cell but the stem cell is.

45. 2.

Details: For spectrometer, A = εCl (where A is absorbance, ε is molar extinction coefficient, C is concentration and l is the path length).

So, $0.02 = 10{,}000*C*1 \Rightarrow C = 2*10^{-6}$ mol = 2 μmol

46. 289.5.

Details: Active transport so uphil transport, low conc --------> high conc.

x 1.6x

$\Delta G = (RT/nF) \ln([product]/[reactant])$ (q= nF=1 (monovalent) assumed as it's not mentioned)

=> $\Delta G = 1.987*310*\ln(1.6)$ (T=273+37 K, R = 1.987, ln1.6 = 0.47)

So, ΔG = 289.5 cal/mol

47. 0.75.

Details: Purple flowers genotypes: PP, Pp ; White flowers genotype: pp

As one of the offspring is white flower the cross should be between heterozygous purple flower and homozygous white flower. To have at least 1 white offspring (homozygous recessive) both parents need to have recessive allele.

So, Pp*Pp----- two purple flowers crossing

We get four off springs----- PP, Pp, Pp, pp.

Third offspring to be purple flower possibility 1 in 4 off springs 1/4 = 0.25; probability of purple flower = 3/4=0.75

48. 0.6.

Details: Average molecular weight of an amino acid = 110 Da. (known, 1 kDa = 1000 Da)

So, No. of amino acids (n) = Total weight (w)/Molecular weight (M) => n = W/M

=> 22 * 1000/110 = 200 amino acids

Since 1 amino acid = 3 base pairs so toatal length = 200 * 3 = 600 base pairs = 0.6 kb

49. 129.

Details: Given table is clearly discrete probability distributions;

since $\Sigma P(x) = 1$; where x is discrete Random Variable.

Mean of x, $\bar{x} = \Sigma x.p(x)$

=> $\bar{x} = (-100)[0.25] + (0)[0.5] + (100)[0.2] + (500)[0.05]$

=> $\bar{x} = -25 + 20 + 25$

=> $\bar{x} = 20$

$\bar{x^2} = \Sigma x^2.P(x)$

=> $\bar{x^2} = (-100)^2 * 0.25 + (0)^2 *0.5 + (100)^2 *0.2 + (500)^2 * 0.05 = 17,000$

As Variance of x, $S^2 = \bar{x^2} - \bar{x}^2$

So, $S^2 = 17,000 - 400 = 16,600$ Now, As Standard deviation, $\sigma = \sqrt{S^2}$

So, $\sigma = \sqrt{16,600} \sim 129$

50. 2.37.

Details: Trapezoidal rule: Under this rule, the area under a curve is evaluated by dividing the total area into little trapezoids.

Let f(x) be continuous on [a,b]. We partition the interval [a,b] into n equal subintervals, each of width $\Delta x = (b-a)/n$ where "b" is the upper limit and "a" is the lower limit of definite integration and "n" is the no. of interval between a and b.

The Trapezoidal Rule for approximating $\int_a^b f(x)\,dx$ is given by:

$$\int_a^b f(x)\,dx \approx T_n = (\Delta x/2)\,[f(x_0) + 2f(x_1) + 2f(x_2) + \ldots + 2f(x_{n-1}) + f(x_n)]$$

where $\Delta x = -2/3-(-1) = 1/3$

$T_n = [\ \frac{1}{3}\ /2]\,[0.37 + 2*0.51 + 2*0.71 + 2*1.0 + 2*1.40 + 2*1.95 + 2.71] = 1/6 * (3.08 + 11.14)$

$\Rightarrow T_n = 2.37$

51. 13021.

Details: Weight of biomass to produce is 50g/L * 10^5 L = 50 * 10^5 g.

Given equation,

$$C_6H_{12}O_6 + 0.48\ NH_3 + 3\ O_2 \text{ ------> } 0.48\ C_6H_{10}O_3N + 3.12\ CO_2 + 4.32\ H_2O$$

Mol. wt. 180 g 144 g

from mole-mole balance, 1 mole of glucose produces 0.48 mole of biomass.

So, 1*180 g of glucose gives 0.48*144 g of biomass or reverse can be said 0.48*144 g of biomass is generated by 180g of glucose.

= 1 g of biomass is generated by 180/(0.48*144) g glucose.

= 50*10^5 g of biomass is generated by $\frac{180*50*10^5}{0.48*144}$ g of glucose. = 13020833.3 g = 13021 kg

52. 988.

Details: Given, initial concentration (C_0) = 10 ppm = 10 mg/L

K_s = 100 mg/L; kd = 0.01 h^{-1} ; μ_m = 1 h^{-1}

Dilution rate = Flow rate/Volume => D=F/V

In steady state, specific growth rate = dilution rate; => μ =D

So, D = $\frac{\mu m * S}{(Ks+S)}$ (Monod equation)

$\Rightarrow S = \frac{Ks*D}{(\mu m - D)}$

Monod equation with cell death constant (k_d) modifies to:

$S = \frac{Ks*(D+kd)}{(\mu m-(D+kd))}$ substituting the value of S,K_s,μ_m,and k_d

we get D = 0.081

So, V = F/D = 988 L

53. 1.

Details: Average transmembrane pressure, $\Delta p_m = \frac{(Pi+Po)}{2} + Pf$

where inlet feed pressure, P_i = 3 atm (given)

Also given that pressure drop, $\Delta P = P_i - P_o$ = 2atm; => $3 - P_o = 2$; => $P_o = 1$

Po = outlet feed pressure.

Given value of P_f = 1 atm

So, $\Delta p_m = (3+1)/2 + 1 = 1$ atm

54. 9.21.

Details: Given, Volume = 10^4 L; Initial conc. of spores (C_0) = $10^6 * 10^3$ spores/L

Hence, Initial no. of spores (N_0) = $10^9 * 10^4$ spores; Final no. of microbes (N_t) = 1 in 1000 = 10^{-3}

Death constant (k_d) = 4/min

Holding time (t_{ho}) + Heating time (t_{he}) + Cooling time (t_c) = $\frac{1}{k_d} * \ln(N_0/N_t)$

=> $t_{ho} + 0 + 0 = \frac{1}{4} * \ln\left(\frac{10^{13}}{10^{-3}}\right) = \frac{1}{4} * 2.303 * \log\left(10^{16}\right) = \frac{2.303}{4} * 16$ (as, $\log 10^{16} = 16$)

=> t_{ho} = 9.21 min

55. 30.

Details: impeller tip speed = $\pi N_i D_i$

Data given, Volume of small fermentor, V_s = 1 L; Diameter of small fermentor, D_{sf} = 20 cm;

Volume of large fermentor, V_L = 8000L; Agitator speed, N_{si} = 600 rpm;

scale-up factor is the cube root of $V_L = \sqrt[3]{8000}$ = 20 hence $D_{LI} = 20 * D_{si}$ = 120 cm

and $D_{Lf} = 20 * D_{sf}$ = 400 cm

Ratio of impeller diameter to fermentor diameter, D_{si}/D_{sf} = 0.3

So, $D_{si} = D_{sf}$ (=20) * 0.3 => D_{si} = 6 cm

Now as impeller tip speed = $\pi N_i D_i$ (constant)

So, $\pi N_{si} D_{si} = \pi N_{Li} D_{Li}$

=> $600*6 = N_{Li}*120$

=> N_{Li} = 30 rpm

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