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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

CLASS - 11 (PCB)

Question Paper Code : UN484

KEY

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11. C	12. B	13. C	14. D	15. D	16. C	17. C	18. D	19. C	20. C
21. D	22. C	23. D	24. D	25. C	26. D	27. C	28. C	29. D	30. C
31. D	32. C	33. C	34. C	35. D	36. C	37. A	38. B	39. C	40. A
41. B	42. A	43. C	44. B	45. B	46. A	47. B	48. C	49. C	50. B
51. B	52. D	53. D	54. D	55. B	56. C	57. D	58. D	59. C	60. B

SOLUTIONS

BIOLOGY

01. (D) Enlarging the vacuole rather than the cytoplasmic volume is an important strategy for plant cell growth. This allows plant cells to increase in size with minimal investment in cytoplasm synthesis which is costly since the cytoplasm contains many metabolically active components such as organelles. It also allows cells to increase in size without sacrificing surface area to volume ratio of the cytoplasm, since cytoplasmic contents continue to be pushed towards the periphery of the cell as the vacuole grows. This would maintain the rate of exchange of waste and useful substances between the cell and the environment.

02. (C) He can use the Benedict's test to test for the presence of reducing sugars, and the iodine test to test for the presence of starch. The Biuret test is used to indicate the presence of proteins, while the ethanol-emulsion test is used to indicate the presence of fats.

03. (C) Active transport is a process in which energy is used to move particles against a concentration gradient. A partially permeable membrane is not necessary in the definition of active transport, although it is usually present.

04. (C) Enzymes are made up of proteins (1). Haemoglobin is a molecule made up of four chains of polypeptides and iron. It is responsible for the transport of oxygen (2). Antibodies are made up of polypeptide chains (3). Fats are pimarily responsible for providing thermal insulations (4).

05. (C) The cell wall of plant cells exerts pressure on the cytoplasm when the cell is turgid, preventing more water from entering the cell. Because animal cells lack a cell wall, water continually enters the cell as long as the cell contents are more concentrated than the surroundings. Eventually the cell bursts when the cell membrane is no longer able to withstand the expanding volume of the cytoplasm.

06. (B) Saliva contains amylase and which breaks down the starch in bread to maltose, a disaccharide which tastes sweet.

07. (A) Since rabbits are herbivores, their diets would include large amounts of starch and cellulose, and low quantities of proteins and fats (usually obtained from meat). Hence their alimentary canals would contain cellulose-digesting bacteria to help break down the large amount of consumed cellulose. Bile is needed for the emulsification of fat and would be found at lower levels since rabbits have a lower intake of fat than humans.

08. (A) Splitting of water molecule takes place in the presence of sunlight.

09. (D) All proteins contain the elements oxygen, carbon, nitrogen and hydrogen. Some proteins may also contain sulfur.

10. (C) The red blood cells of the donor's blood must not agglutinate when they come into contact with the antibodies in the recipient's blood. Type A blood contains red blood cells with A antigen and anti-B antibodies while type O blood contains red blood cells with neither A nor B antigens, and both anti-A and anti-B antibodies. Hence, a person with blood type A can only receive blood froma donor of the same blood type or blood type O (universal donor).

11. (C) As seen from the diagram, the median septum is absent in the three-chambered heart but present in the four-chambered one. This allows mixing of blood between the right and left sides of the heart.

12. (B) The hepaic portal vein has the highest concentration of glucose because all the glucose that is absorbed into the small intestine is transported to the liver via this vein. In the liver, hormones regulate the amount of glucose leaving the liver to the other parts of the body, keeping the blood glucose level within narrow limits. Hence, the blood glucose level in other vessels should be less than that of the hepatic portal vein especially after a meal rich in glucose.

13. (C) The guard cells regulate the size of the stomata in the leaf, through which water loss (transpiration) and gaseous exchange occur. Light is able to penetrate the leaf to reach its inner mesophyll layers easily; the guard cells and stomata play no part in enhancing this (2).

14. (D) Respiration can refer to both aerobic and anaerobic respiration. The products of anaerobic respiration in yeast are carbon dioxide and ethanol. The products of anaerobic respiration in muscle cells are carbon dioxide and lactic acid. Glucose is not a product of respiration but a substrate.

15. (D) It is a common misconception that chloroplasts and mitochondria are interchangeable in their functions. Chloroplasts and mitochondria perform two distinct functions. Chloroplasts perform photosynthesis, the conversion of light energy into chemical energy stored in glucose. Mitochondria perform resiration, the oxidation of glucose to release stored chemical energy for cellular activities. A plant cell that contains only chloroplasts would be able to produce glucose but would not be able to utilise the chemical energy stored in glucose. Statement B is incorrect because energy cannot be produced, it can only be converted between different forms. Statement C is incorrect since mitochondria are necessary even during the day.

16. (C) Insulin stimulates the liver to convert glucose into glycogen. Without insulin, glycogen will be absent from the liver.

17. (C) When neurotransmitters are released from the synaptic bulb of an axon, they diffuse across the synaptic gap to the dendron of the next neurone.

18. (D) Endocrine glands are ductless glands that secrete hormones into the bloodstream.

19. (C) Adrenaline secretion results in an increase in heart rate to supply muscles with sufficient oxygen and glucose in the event that they need to be put into action. The pupils will also dilate with the secretion of adrenaline. There will also be an increased rate of coagulation of blood to protect the body in the event that it is injured.

20. (C) Adrenaline is secreted in "fight" or "flight" responses and enhancd vision would assist the individual in carrying out the appropriate responses. The dilation of the pupil would increase the darker areas of the eye but this does not help a person to escape detection.

21. (D) The pollen tube grows from the pollen grain, secreting enzymes that digest through the tissue of the stigma, followed by the tissue of the style, and finally the ovary wall to reach the ovule(s).

22. (C) 3 and 4 adaptations of insect pollinated flowers.

23. (D) Liver failure would result in the inability of the liver to break down alcohol, produce bile for the emulsification of fat, deaminate excess amino acids (from the digestion of proteins) and convert excess glucose (from the digestion of starch) into glycogen.

24. (D) Layer X is mostly blood plasma and so the most abundant component would be water which makes up about 90% of plasma.

25. (C) Vessel 1 represents a capillary because it is one-cell thick and only has a thin epithelial layer. Vessel 2 is an artery because it has a thicker muscular layer than vessel 3 which would then have to be a vein.

PHYSICS

26. (D) In instantaneous speed and instantaneous velocity $\Delta t \rightarrow O$, therefore,

|displacement| = distance

A particle may have variable velocity by changing direction even when magnitude is not changing.

27. (C) m = 400 g = 0.4 kg

h_1 = 5 m, F = 100 N, h_2 = 20 m

t = ?, g = 10 m/s^2

Now, $v_1 = \sqrt{2gh_1} = \sqrt{2\times10\times5} = 10$ m/s

$v_2 = \sqrt{2gh_2} = \sqrt{2\times10\times20} = 20$ m/s

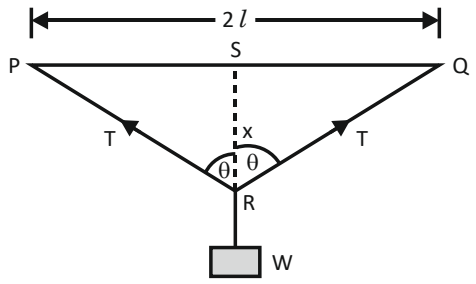
As, $F \times t = m[v_2 - (-v_1)]$

$\therefore$ $100 \times t = 0.4\ (20 + 10) = 12.0$

$t = \dfrac{12.0}{100} = 0.12$ s

28. (C) In the given figure, the increase in length

Δl = (PR + RQ) – PQ = 2 PR – PQ



$$= 2(l^2 + x^2)^{\frac{1}{2}} - 2l = 2l\left(1 + \frac{x^2}{l^2}\right) - 2l$$

$$= 2l\left[1 + \frac{1}{2}\frac{x^2}{l^2}\right] - 2l$$

$$= \frac{x^2}{l}$$ (By Binomial Theorem)

$$\therefore \text{ Strain} = \frac{\Delta l}{2l} = \frac{x^2}{2l^2}$$

29. (D) As no torque is being applied, angular momentum remains constant

$$I_1\omega_1 = I_2\omega_2$$

$$(mr_1^2)\omega_1 = (mr_2^2)\omega_2$$

$$\frac{\omega_1}{\omega_2} = \frac{r_2^2}{r_1^2}$$

30. (C) Here, c = $M^0 L^1 T^{-1}$ = × 10^8 m/s

g = $M^0 L^1 T^{-2}$ = 10 m/s^2

p = $M^1 L^{-1} T^{-2}$ = 10^5 N/m^2

$$\frac{c}{g} = \frac{LT^{-1}}{LT^{-2}} = T = \frac{3\times10^8}{10} = 3\times10^7 \text{ s}$$

From $c = \frac{L}{T} = 3\times10^8$

L = 3 × 10^8 T

= 3 × 10^8 × 3 × 10^7

= 9 × 10^{15} m

From $M^1 L^{-1} T^{-2}$ = 10^5

M = $10^5 \times L^1 T^2$

= $10^5 \times 9 \times 10^{15} (3 \times 10^7)^2$

= 81 × 10^{34} kg

31. (D) As the acceleration of the projectile is always downward (because of its gravitational acceleration), the vertical speed decreases as the projectile rises and increases as the projectile falls.

Option (A) is false because the acceleration vector is straight down, but the velocity is never straight up or straight down. It would be true of the vertical component of the velocity, but not of the total velocity.

Option (B) is false because the projectile still has its horizontal velocity at the top of the trajectory.

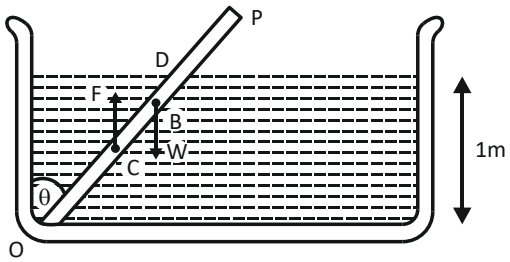
Option (C) is false because the vertical component of the velocity changes, even if the horizontal component does not, so the total speed changes.

32. (C)

$$\Delta U = U_f - U_i = \frac{-GMm}{R + \frac{R}{5}} - \left[\frac{-GMm}{R}\right] = \frac{GMm}{R}\left[1 - \frac{5}{6}\right]$$

$$\text{or } \Delta U = \frac{GMm}{6R} = \frac{mR}{6}\left(\frac{GM}{R^2}\right) = \frac{1}{6}mgR = \frac{5}{6}mgh$$

33. (C) Let B be the centre of gravity of rod and C be the middle point of the length of rod in water, OD = 1.0 secθ



Then $OC = \frac{OD}{2} = \frac{1}{2}\sec\theta$. If A is the area of cross-section of rod, then mass of rod

$$= 2.0 = 2 \times A \times 500 \text{ or } A = \frac{1}{500}m^2$$

Upthrust on rod F

$$=(1.0\sec\theta)\left(\frac{1}{500}\right)\times 1000\times 10=20\sec\theta$$

Weight of rod, W = 2 × 10 = 20 N.

For rotational equilbrium of rod, net torque about O should be zero.

$\therefore$ F × (OC sin θ) = W × (OB sin θ)

or $20\sec\theta\times\left(\frac{1}{2}\sec\theta\right)\sin\theta=20\times(1.0\sin\theta)$

or $\sec^2\theta = 2$ or $\sec\theta = \sqrt{2} = \sec 45°$

or $\theta = 45°$

$\therefore$ F = 20 sec 45° = 20 $\sqrt{2}$ N

For vertical equilibrium of the rod, force exerted by the hinge on the rod will be

= (20 $\sqrt{2}$ – 20) N downwards

= 8.28 N or 8.3 N downwards

34. (C) The work done by external force F is equal to the increase in potential energy of the bob.

Therefore, $W_F = \Delta U = mgL(1 - \cos\theta)$

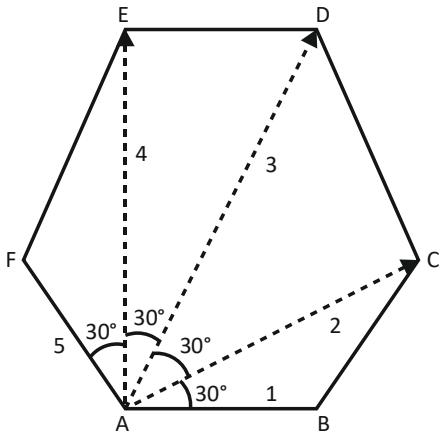
35. (D) Growth of ice in a pond is conduction process governed by the relation,

$$t=\frac{\rho L}{K\theta}\frac{y^2}{2}$$

The ratio of times for thickness of ice from 0 to y; y to 2 y = 1 : 3

$\therefore$ Time taken to increase the thickness from 1 cm to 2 cm is equal to 3 × 7 = 21 hours.

36. (C) The lines AE and AB are perpendicular to each other and are taken as the Y-axis and X-axis respectively. The vectors are resolved along the X and the Y axis. The algebraic sum of the x component is



x = 1 + 2 cos 30° + 3 cos 60° – 5 cos 60°

$$=1+2\times\frac{\sqrt{3}}{2}+3\times\frac{1}{2}-\frac{5}{2}=\sqrt{3}\text{ unit}$$

The algebraic sum of the y component is

= 2 sin 30 + 3 sin 60 + 4 + 5 sin 60

$$= 2\times\frac{1}{2}+3\times\frac{\sqrt{3}}{2}+4+5\times\frac{\sqrt{3}}{2}$$

= (5 + $4\sqrt{3}$) unit

The resultant

R = $\sqrt{x^2+y^2}=\sqrt{3+(5+4\sqrt{3})^2}$ = 12.05 unit

Let θ be the angle between the resultant and the side AB

$$\tan\theta=\frac{y}{x}=\frac{5+4\sqrt{3}}{\sqrt{3}}=6.887,\ \theta=81°\,45'$$

37. (A) Process 1 is isobaric (P = Constant) expansion. Hence, temperature of gas will increase.

$\therefore$ ΔU_1 = Positive

Process 2 is an isothermal process

$\therefore$ $\Delta U_2 = 0$

Process 3 is an adiabatic expansion.

Hence, temperature of gas will fall.

$\therefore$ ΔU_3 = Negative

$\therefore$ $\Delta U_1 > \Delta U_2 > \Delta U_3$

38. (B) As, $T = 2\pi\sqrt{\frac{(R+x)^3}{MG}}$

or $\frac{T^2}{4\pi^2} = \frac{(R+x)^3}{MG}$

Centripetal acceleration,

$a = \frac{GM}{(R+x)^2}$

or $\frac{(R+x)^2}{GM} = \frac{1}{a}$

or $(R+x) = \frac{T^2}{4\pi^2} \times a$

$= \left(\frac{5.26\times10^3}{2\pi}\right)^2 \times 9.32$

$= 160 \times 10^3$ m = 160 km

39. (C) l = 4.234 m, b = 1.005 m, thickness h = 2.01 cm = 0.0201 m

Total area = 2[lb + lh + bh]

= 2[4.234 × 1.005 + 4.234 × 0.0201 + 1.005 × 0.0201]

= 8.7209 m^2 = 8.72 m^2

Correcting to three significant figures as there are only three significant figures in thickness,

Volume = l × b × h

= 4.234 × 1.005 × 0.0201 = 0.085528 m^3

= 0.0855 m^3

Volume is corrected upto three significant figures.

40. (A) K.E. $= \frac{1}{2}mv^2 = \frac{1}{2}\times9\times10^{-31}(10^3)^2$

= 4.5 × 10^{-25} J

From $v^2 - u^2 = 2as$, $v^2 = 2as$,

$a = \frac{v^2}{2s} = \frac{(10^3)^2}{2\times10^{-1}}$

F = ma = 9 × 10^{-31} (0.5 × 10^7) N

$= \frac{4.5\times10^{-24}}{9.8}$ kg wt $= 0.46\times10^{-24}$ kg wt

CHEMISTRY

41. (B) Energy absorbed in the ionization of 1 mole of Mg (g) to Mg^+ (g) = 750 kJ.

Energy left unconsumed = 1200 – 750 = 450 kJ

This energy is required to convert Mg^+ (g) to Mg^{2+} (g)

Thus, % of Mg^{2+} (g) = $\frac{450}{1450}\times\frac{100}{1} = 31\%$

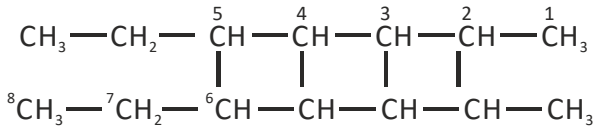
and % of Mg^+ (g) = 100 – 31 = 69%

42. (A) Reaction (b) is double of (a) and reverse of (a).

Hence, $K_2 = \frac{1}{K_1^2}$ or $K_1^2 = \frac{1}{K_2}$

43. (C) SF_4 (sp^3d, trigonal bipyramidal with one equatorial position occupied by 1 lone pair) CF_4 (sp^3, tetrahedral, no lone pair), XeF_4 (sp^3d^2, square planar, two lone pairs).

44. (B) Supplying requisite number of H-atoms, the given hydrocarbon becomes :



5-Ethyl-2,3,4-trimethyloctane

45. (B) $n(H_2O) = \frac{\text{Mass of water}}{\text{Molar mass of water}}$

$= \frac{12\text{ g}}{18\text{ g mol}^{-1}} = 0.67$ mol

$n(C_2H_5OH) = \frac{\text{Mass of ethanol}}{\text{Molar mass of ethanol}}$

$= \frac{92\text{ g}}{46\text{ g mol}^{-1}} = 2.00$ mol

$n(CH_3COOH) = \frac{\text{Mass of acetic acid}}{\text{Molar mass of acetic acid}}$

$= \frac{108\text{ g}}{60\text{ g mol}^{-1}} = 1.80$ mol

So, Total number of moles in the solutions, n_{total} = (0.67 + 2.00 + 1.80) mol = 4.47 mol

Therefore,

$$X_{water} = \frac{n(H_2O)}{n_{total}} = \frac{0.67\,mol}{4.47\,mol} = 0.15$$

$$X_{ethanol} = \frac{n(C_2H_5OH)}{n_{total}} = \frac{2.00\,mol}{4.47\,mol} = 0.45$$

$$X_{acetic\ acid} = \frac{n(CH_3COOH)}{n_{total}} = \frac{1.80\,mol}{4.47\,mol} = 0.40$$

Thus, the mole fraction of water in the given mixture is 0.15.

46. (A) The balanced chemical equation is

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

47. (B) As the hydrogen atom has only one orbit containing only one electron, the ionisation potential of the ground state of the hydrogen atom is the energy of the electron of the first orbit, i.e.,

$E_1 = -2.17 \times 10^{-11}$ erg.

Thus, $E_2 = \frac{E}{n^2}$ ..... (Eqn. 5)

$$= -\frac{2.17\times10^{-11}}{2^2} \quad \text{..... (n = 2)}$$

$\therefore$ Energy of the radiation emitted,

$$\Delta E = E_2 - E_1$$

$$= \frac{-2.17\times10^{-11}}{2^2} - (-2.17\times10^{-11})$$

$= 1.627 \times 10^{-11}$ erg.

We know that $\Delta E = hv = \frac{hc}{\lambda}$

Thus, $\frac{hc}{\lambda} = 1.627\times10^{-11}$

$$\lambda = \frac{6.62\times10^{-27}\times3\times10^{10}}{1.627\times10^{-11}} = 1.22\times10^{-5}\ cm$$

= 1220 Å.

48. (C) $RCOOH + NaHCO_3 \rightarrow RCOONa + H_2O + CO_2$

or

$$RCOOH + HCO_3^- \rightleftharpoons RCOO^- + H_2O + CO_2$$

As equilibrium goes in the forward direction, the conjugate base, $RCOO^-$ is more stable than RCOOH.

49. (C) $$\%\ of\ N\ in\ C_3H_9N_3 = \frac{42}{87}\times100 = 48.27$$

$$\%\ of\ N\ in\ C_2H_8N_2 = \frac{28}{60}\times100 = 46.66$$

$$\%\ of\ N\ in\ C_6H_{12}N_4 = \frac{56}{140}\times100 = 40.00$$

Thus, the decreasing percentage of N is :

$C_3H_9N_3 > C_2H_8N_2 > C_6H_{12}N_4$

50. (B) The entropy of vaporisation ($\Delta_{vap}S$) of a liquid is given by,

$$\Delta_{vap}S = \frac{\Delta_{vap}H}{T_{vap}} = \frac{42.4\,kJ\,mol^{-1}}{(78.4+273)\,K} = \frac{42.4}{351.4}\,kJ\,K^{-1}\,mol^{-1}$$

$$\Delta_{vap}S = \frac{42.4}{351.4}\times1000\,J\,K^{-1}mol^{-1} = 120.7\,J\,K^{-1}\,mol^{-1}$$

51. (B) $2\,Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3\,H_2$

$2 \times 27\ g = 54\ g \qquad 3 \times 2 = 6\ g$

$2\ g\ H_2 = 18\ g\ Al$

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

$65\ g \qquad 2\ g$

$2\ g\ H_2 = 65\ g\ Zn$

$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

$56\ g \qquad 2\ g$

$2\ g\ H_2 = 56\ g\ Fe$

52. (D) μ (100% ionic) = q × d

$= 4.8 \times 10^{-10}\ cm \times 1.3 \times 10^{-8}\ cm = 6.24\ D$

$\therefore$ $$\%\ ionic\ character = \frac{\mu_{obs}}{\mu_{100\%\ ionic}}\times100$$

$$= \frac{1.03}{6.24}\times100 = 16.5\ \%\ or\ 17\%$$

53. (D) When intensity x is doubled, number of electrons emitted per second y is also doubled but average energy z of photoelectrons emitted remains the same.

54. (D) KOH is a strong alkali and is completely dissociated into the constituent ions,

$KOH + H_2O$ (excess) $\rightarrow K^+(aq) + OH^-(aq)$

In a solution having pH = 12, the hydrogen ion concentration is given by the equation,

pH = – log [H+]

12 = – log [H+]

or $[H^+] = 10^{-12}$ mol L^{-1}

As the ionic product of water should have a fixed value, hence at 25° C.

$K_w = 1.0 \times 10^{-14}$

So, $1.0 \times 10^{-14} = [H^+]\,[OH^-]$

This gives, $[OH^-] = \frac{1.0 \times 10^{-14}}{10^{-12}}$

$= 1.0 \times 10^{-2}$ mol L^{-2}

As KOH is completely dissociated, hence

$[KOH] = [OH^-] = 1.0 \times 10^{-2}$ mol L^{-2}

Molar mass of KOH = (39 + 16 + 1) g mol^{-1} = 56 g mol^{-1}

Then, Conc. of KOH = 1.0×10^{-2} mol L^{-1} × 56 g mol^{-1} = 0.56 g L^{-1}

Thus, 0.56 g of KOH should be dissolved per litre of the solution to obtain a solution of pH 12.

55. (B) Statements (i), (iii) and (iv) are correct

In the isoelectronic series, all isoelectronic anions belong to the same period and cations to the next period.

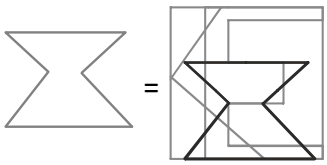
CRITICAL THINKING

56. (C) Option A is incorrect: The passage nowhere refers to or makes an implied reference to Ramsar Convention.

Option B is incorrect: The passage is suggesting for the opposite as to what is mentioned in option B. Instead of focusing on modernizing and augmenting the water system(i.e. augmenting the water supply), policies must focus on the source of such water i.e. it must try to strengthen the capacity of ecological systems. However, as per the given passage, public policies are doing just the opposite.

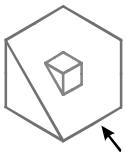
Option C is correct: The first statement clearly states that "One of the biggest ironies, around water is that it comes from rivers and other wetlands. Yet it is seen as divorced from them. While water is used as a resource, public policy does not always grasp that is a part of the natural ecosystem."

Option D is incorrect: While the statement given in option D is correct in its own merit, it is out of context with respect to the given passage, as the author does not state or indicate towards any such measure. Also, the statement is rather narrow in approach, as compared to the overall broader tone of the author.

57. (D) 

58. (D) So that one dot appears in the triangle and one circle; and the other dot appears in the triangle and three circles;

59. (C) The central and state governments share the cost of the Midday Meal Scheme, with the center providing 60 percent and the states 40 percent. The central government provides grains and financing for other food. Costs for facilities, transportation, and labor is shared by the federal and state governments.

60. (B) 

The End