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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION (UPDATED)

CLASS - 11 (PCB)

Question Paper Code : UN487

KEY

1. D	2. B	3. D	4. D	5. A	6. D	7. C	8. C	9. D	10. B
11. A	12. A	13. B	14. A	15. B	16. D	17. B	18. A	19. C	20. A
21. D	22. C	23. C	24. B	25. A	26. D	27. D	28. D	29. B	30. B
31. B	32. D	33. C	34. A	35. A	36. B	37. B	38. D	39. B	40. A
41. A	42. C	43. C	44. A	45. D	46. D	47. C	48. D	49. A	50. B
51. C	52. B	53. C	54. C	55. B	56. C	57. A	58. B	59. B	60. C

SOLUTIONS

BIOLOGY

01. (D) Statement 1 is not conclusive enough as even many animal cells do not have visible vacuoles. It is the presence of a large, central vacuole in the micrograph, rather than the absence of small vacuoles, that indicates that this is a plant cell. Statement 2 is correct since the large central vacuoles in mature plant cells typically pushes the cytoplasm to the sides of the cell. Statement 3 and 4 are correct since plant cells contain chloroplasts and a cell wall – both of which are absent in animal cells.

02. (B) Two forms of digestion take place in the stomach - physical digestion through the churning of the stomach walls, and chemical digestion through the break down of proteins by pepsin. Ingestion takes place in the mouth (A). Absorption can take place in the stomach, small intestine and large intestine. The pancreas is not part of the alimentary canal and does not directly come into contact with ingested food (C). Egestion is the expulsion of undigested food (faeces) and this occurs through the anus (D).

03. (D) Boiling causes the cell membrane to become fully permeable so that large molecules, such as the red pigment, can diffuse out of the cell.

04. (D) The given structure is villus

05. (A) To release energy for active transport of mineral salts.

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

07. (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 ptoteins while the ethanol-emulsion test is used to indicate the presence of fats.

08. (C) The stones in the stomach help to grind food into smaller pieces, much like how human teeth grind food. This grinding action increases the surface area to volume ratio of the food so that enzymes can work on the food more efficiently.

09. (D) Not all organisms are able to utilise sunlight directly to synthesize sugars (1). Only photosynthetic organisms, e.g., plants, are able to do that.

10. (B) Animals are generally not able to utilise light energy as an energy source. Energy cannot be synthesised: it can only be converted from one form to another (A). Both plants and animals require essential minerals from the environment (C). D is incorrect as plants also digest food substances, e.g., during germination in a growing seed, or when utilising starch or fat reserves in storage organs.

11. (A) Phagocytes are white blood cells which carry out phagocytosis to engulf and digest foreign particles. The lymphocyte, a type of white blood cells, is responsible for producing antibodies. Antigens (found on the cell surface membranes) are not formed by white blood cells but are expressed by the cells themselves. The clotting of blood is a result of the release of thrombokinase by platelets and a cascade of reactions involving plasma proteins. Hence, clotting is not considered a major function of the white blood cell.

12. (A) The biconcave shape of red blood cells is important for enhancing their surface area to volume area ratio. This maximises the rate of exchange of gases with their environment, i.e., the uptake and release of oxygen and carbon dioxide.

13. (B) Due to the mixing of oxygenated and deoxygenated blood in the ventricle of a three-chambered heart, the blood reaching the brain may not be oxygenated enough for optimal function. There is no evidence to suggest that large hearts cannot have only ventricle (A). The blood pressure to the lungs will not be too low as it would be the same pressure as the blood going to all parts of the body. Also, a low blood pressure at the lungs would facilitate the diffusion of gases instead of impairing it (C). The transport of glucose would not be affected because the regulation in the levels of glucose in the body is the responsibility of the pancreas and its secretion of insulin and glucagon (D).

14. (A) Stomata are necessary for gaseous exchange; so that through stomata carbon dioxide can diffuse into the intercellular leaf spaces for photosynthesis. However, the presence of stomatal openings also causes the plant to lose water. To minimise water loss and yet allow sufficient gaseous exchange, it would be beneficial for plants to have more stomata located on th lower surface, which is less exposed to sunlight. This would minimise evaporation and thus transpiration rates.

15. (B) In aerobic respiration, glucose is broken down in the presence of oxygen to produce carbon dioxide and water. A large amount of energy is released in the process.

16. (D) When the leaves fold up, the surface area exposed to sunlight is reduced. Guard cells become flaccid since they are not able to photosynthesise, closing the stomata (1). Less carbon dioxide enters the leaves and thus photosynthetic rate drops (2). As stomata close, less water is able to leave the plant via transpiration (3).

17. (B) At higher altitudes, the air is "thinner" due to the lower atmospheric pressure and this lack of oxygen would cause him to have trouble breathing as he is unable to obtain sufficient oxygen. Air will rush into the lungs slower only when atmospheric pressure is lower. Also, the atmospheric pressure at higher altitudes is lower (A). The concentration of carbon dioxide is lower at higher altitudes (C). Due to the lower concentration of oxygen at higher altitudes, people who live there tend to have more red blood cells with a hgher amount of haemoglobin than people at lower altitudes (D).

18. (A) The pancreas secretes digestive enzymes into the gut, as well as hormones to regulate blood glucose levels (insulin and glucagon) into the blood. If the cells are deficient in Golgi bodies, they would be unable to modify the relevant polypeptides to produce functional digestive enzymes and hormones. They would also be unable to package these enzymes and hormones for secretion by the cell. Statements 2 and 4 are irrelevant since it is ADH secreted by the pituitary gland that is involved in regulating blood water potential and urine production by the kidneys.

19. (C) The central nervous system consists of the brain and spinal cord. Nerves and sensory organs are considered parts of the peripheral nervous system.

20. (A) Insulin and glucogon are produced by pancreas.

21. (D) Voluntary actions are deliberate and are always initiated by the brain. A voluntary action may not always involve the contraction of muscles. It could also involve relaxation of muscles (A). It does not always involve the spinal cord, e.g. in the voluntary blinking of the eyes (B). It may or may not involve a stimulus from a sense organ (C).

22. (C) Pepsin is secreted in the stomach and digests proteins into polypeptides. Amino acids are already small and soluble molecules that do not used to be digested further.

23. (C) The higher levels of glucose are required to prepare the body in the event of "flight" or "fight" responses. Glucose is necessary for respiration to release energy.

24. (B) Both xylem and phloem are found in stems and leaves. Long extensions correspond to root hair cells (D).

25. (A) The diagram shows an air sac (alveolus) and a blood capillary associated with it.

PHYSICS

26. (D) The negative value of area of the a – t graph shows that the change in velocity in the time interval is negative. The final velocity depends on the initial velocity of the particle.

i.e., $= v_f = v_t$ [area of a – t graph]$_i^f$

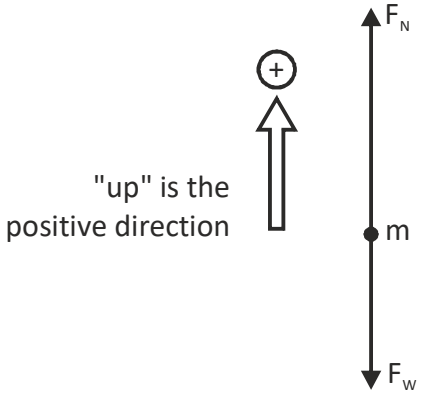
Thus, it may happen that the final velocity of the particle becomes zero.

The negative value of area of the v – t graph shows that the change in displacement in the time interval is negative. The final displacement is given by

$x_f = x_i$ + [area of v – t graph]

The particle may return to its original position if area of v – t graph is 0. If this area is negative the particle will always cross its original position.

27. (D) First draw a free-body diagram.



The person exerts a downward force on the scale, and the scale pushes up on the person with an equal (but opposite) force, F_N. Thus, the scale reading is F_N, the magnitude of the normal force. As $F_N - F_w = ma$, we have

$F_N = F_w + ma$ = (800 N) + [800 N/(10 $\frac{m}{s^2}$)](5 m/s^2) = 1200 N.

28. (D) Let m_1 be the mass of the bullet and m_2 that of the block.

Total mass,

$M = m_1 + m_2 = 0.01 + 4.0 = 4.01$ kg

$\mu = 0.25$ and $g = 9.8$ m s^{-2}

Frictional force,

$F = \mu R = 0.25 \times 4.01 \times 9.8$

Acceleration, $a = \frac{F}{M} = \frac{0.25 \times 4.01 \times 9.8}{4.01}$

$= 2.45$ m s^{-2}

Let u_1 be the initial velocity of the bullet.

K.E. of the bullet = $\frac{1}{2} m_1 u_1^2$

The kinetic energy of the bullet is transferred to the wooden block.

Let the block and bullet move with the velocity V.

$$\frac{1}{2} m_1 u_1^2 = \frac{1}{2} MV^2$$

$$V^2 = \frac{m_1 u_1^2}{M} = \frac{0.01 \times u_1^2}{4.01} \quad \text{.....(i)}$$

The block comes to rest after covering 20 m.

$0 = V^2 - 2 \times 2.45 \times 20$

$V^2 = 2 \times 2.45 \times 20$ .....(ii)

From equation (i) and (ii)

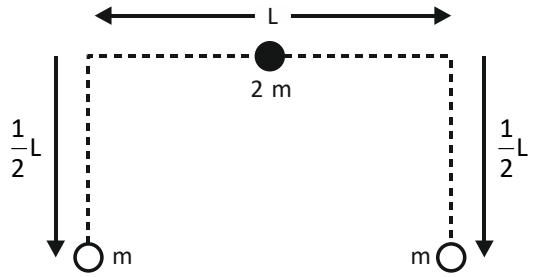
$$\frac{0.01 u_1^2}{4.01} = 2 \times 2.45 \times 20$$

$$u_1^2 = \frac{2 \times 2.45 \times 20 \times 4.01}{0.01} = 39298$$

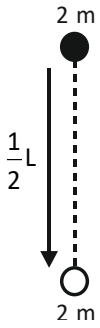
$u = \sqrt{39298} = 198.24$ m/s

29. (B) In case of a viscous liquid, the strain produced increases with decrease in stress, hence portion QR of the graph agrees with viscous liquid.

30. (B) First replace each rod by concentrating its mass at its center of mass position.



The center of mass of the two m's is at their midpoint, at a distance of $\frac{1}{2}L$ below the center of mass of the rod of mass 2 m.



Now, applying the equation for locating the center of mass (letting y = 0 denote the position of the center of mass of the top horizontal rod), we find

$$y_{cm} = \frac{(2m)(0)+(2m)\left(\frac{1}{2}L\right)}{2m+2m} = \frac{1}{4}L$$

31. (B) Radius of hydrogen atom,

$r = 0.5\ \text{Å} = 0.5 \times 10^{-10}$ m

Volume of hydrogen atom $= \left(\frac{4}{3}\right)\pi r^3$

$$= \left(\frac{4}{3}\right)\times\left(\frac{22}{7}\right)\times\left(0.5\times10^{-10}\right)^3$$

$= 0.524 \times 10^{30}$ m^3

1 mole of hydrogen contains 6.023×10^{23} hydrogen atoms

$\therefore$ Volume of 1 mole of hydrogen atoms = $6.023 \times 10^{23} \times 0.524 \times 10^{-30}$

$= 3.16 \times 10^{-7}$ m^3

32. (D) The range of both the balls will be equal because the angles of projection 60° and 30° are complementary. Therefore, the ball Y also travels 40 m in the horizontal direction.

For complementary angles, the time of flight T_1 and T_2 are related as

$$T_1T_2 = \frac{2R}{g}$$

$$\therefore\ T_2 = \frac{2(40\,\text{m})}{(10\,\text{m s}^{-2})(4\,\text{s})} = 2\,\text{s}$$

33. (C) In addition to acceleration due to gravity, gravitational intensity also provides the necessary centripetal force.

$$\therefore\ g = g_0 - \omega^2 R\cos^2\theta$$

34. (A) As the hemispherical bowl just floats without sinking in a liquid, therefore, it is completely immersed in the liquid.

Let d and D be the inner and outer diameter of the bowl, then

$$\frac{2}{3}\pi\frac{(D^3-d^3)}{8}\rho = \frac{2}{3}\pi\left(\frac{D^3}{8}\right)\rho_l$$

or $$\frac{D^3-d^3}{D^3} = \frac{\rho_l}{\rho}$$

or $$\frac{d^3}{D^3} = 1-\frac{\rho_l}{\rho}$$

or $$d = D\left[1-\frac{\rho_l}{\rho}\right]^{1/3}$$

Here D = 1 m; $\frac{\rho_l}{\rho} = \frac{1.2\times10^3}{6\times10^3} = 0.2$

$\therefore$ $d = (1)\,(1-0.2)^{1/3} = 0.93$ m

35. (A) From $v = u + at = 100 - 10 \times 5 = 50$ m/s

This is the velocity at the time of explosion. According to the principle of conservation of linear momentum,

$$1\times50 = \frac{400}{1000}\times(-25)+\frac{600}{1000}\times v_2$$

$50 + 10 = 0.6\ v_2$

$$v_2 = \frac{60}{0.6} = 100 \text{ m/s}$$

$\therefore$ The second fragment will go upwards with a speed of 100 m/s.

36. (B) As the gas is confined, n remains constant, and the volume is fixed, V remains constant as well. As R is a universal constant, the ideal gas law, PV = nRT, represents that P and T are proportional. Therefore, if T increases by a factor of 2, then so does P.

37. (B) $A + B = 16$,

$8\sqrt{3} = (A^2 + B^2 + 2AB\cos\theta)^{1/2}$

$$\text{And } \tan 90° = \frac{B\sin\theta}{A + B\cos\theta}$$

or $$\infty = \frac{B\sin\theta}{A + B\cos\theta}$$

or $A + B\cos\theta = 0$

or $B\cos\theta = -A$

$\therefore$ $8\sqrt{3} = [A^2 + B^2 + 2A(-A)]^{1/2}$

or $192 = B^2 - A^2 = (B - A)(B + A) = (B - A) \times 16$

or $B - A = 192/16 = 12$

On solving, A = 2 and B = 14.

38. (D) Option (A) Process BC : $V \alpha T$, therefore,

$$T_C = \left(\frac{V_C}{V_B}\right) T_B = 6T_0$$

Option (B) Process DA : $V \alpha T$, therefore,

$$T_D = \left(\frac{V_D}{V_A}\right) T_A = 3T_0$$

Option (C) Process AB : $P \alpha T$, therefore,

$$T_B = \left(\frac{P_B}{P_A}\right) T_A = 2T_0$$

39. (B) Here, $m_1 = m_2 = 100$ kg; r = 100 m

Acceleration of first astronaut,

$$a_1 = \frac{Gm_1m_2}{r^2} = \frac{1}{m_1} = \frac{Gm_2}{r^2}$$

Acceleration of second astronaut,

$$a_2 = \frac{Gm_1m_2}{r^2} = \frac{1}{m_2} = \frac{Gm_1}{r^2}$$

Net acceleration of approach

$$a = a_1 + a_2 = \frac{Gm_2}{r^2} + \frac{Gm_1}{r^2} = \frac{2Gm_1}{r^2}$$

$$= \frac{2 \times (6.67 \times 10^{-11}) \times 100}{(100)^2}$$

$= 2 \times 6.67 \times 10^{-13}$ m/s^2 As $s = \frac{1}{2}$ at^2

$$\therefore \quad t = \left(\frac{2s}{a}\right)^{1/2} = \left[\frac{2 \times (1/100)}{2 \times 6.67 \times 10^{-13}}\right]^{1/2} \text{ second}$$

On solving we get t = 1.41 days

40. (A) 1. Stefan's constant $\sigma = \frac{E}{T^4}$

$$= \frac{ML^2T^{-2}}{T.L^2K^2} = [ML^0T^{-3}K^{-4}]$$

2. Coefficient of volume expansion

$$\gamma = \frac{\Delta v}{V \times T}$$

$$= \frac{L^3}{L^3K} = [M^0L^0T^0K^{-1}]$$

3. Work done = $[M^1L^2T^{-2}]$

4. Velocity gradient =

$$\frac{\text{Velocity}}{\text{Distance}} = \frac{LT^{-1}}{L} = T^{-1}$$

The correct order is 2, 4, 3, 1.

CHEMISTRY

41. (A) $\Delta = E_{C-H} - \sqrt{E_{H-H} \times E_{C-C}}$

$= 98.8 - ((104.2) \times 83.1)^{1/2} = 5.75$ k cal

$x_C - x_H = 0.18\sqrt{\Delta} = 0.18\ (5.75)^{1/2} = 0.43$

$\therefore \quad x_C = 0.43 + x_H = 0.43 + 2.1 = 2.53$

42. (C) Decrease of K with rise of temperature means that the forward reaction is exothermic or the backward reaction (formation of HI) is endothermic. As the given reaction is exothermic, energy of HI is greater or stability is less than H_2 and I_2.

43. (C) H_3O^+ = Pyramidal, $H_2C = NH$ = Planar, ClO_2^- = Angular, NH_4^+ = Tetrahedral, PCl_5 = Trigonal bipyramidal

44. (A) $HO—CH_2—CH = CH_2$ is Vinylcarbinol

45. (D) Mass of the given sample (impure) of sodium chloride = 6.5 g

Mass of silver chloride formed = 14.35 g

Percentage purity of sodium chloride = ?

The chemical equation for the reaction is,

	$NaCl$	+ $AgNO3$ →	$AgCl(s)$	+ $NaNO_3$
Stoichiometric mass	(23 + 35.5) g 58.5 g		(108 + 35.5) g 143.5 g	

Thus, 143.5 g of silver chloride is obtained from = 58.5 g of pure $NaCl$

1 g of silver chloride is obtained from

$= \frac{58.5}{143.5}$

14.35 g of silver chloride is obtained

from $= \frac{14.35 \times 58.5}{143.5}\text{g} = 5.85\text{ g}$

Mass of pure $NaCl$ in 6.5 g of impure sample = 5.85 g

Percentage purity of sodium chloride

$= \frac{5.85}{6.5} \times 100 = 90$

46. (D) $CuSO_4(aq) + 2KI(aq) \longrightarrow CuI_2 + K_2SO_4$

$2CuI_2 \longrightarrow Cu_2I_2 + I_2$

evolved iodine

$2Na_2S_2O_3 + I_2 \longrightarrow 2Na_2S_4O_6 + 2NaI$

The evolved iodine is reduced

47. (C) The spectral series in hydrogen spectra which appears in the visible region is the Balmer series. For Balmer series, in the equation.

$$\bar{v} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \quad \text{where } n_2 > n_1$$

$n_1 = 2$ and $n_2 = 3, 4, 5$ ..... 1.

So, the lowest energy transition in Balmer series will be that from 3rd shell ($n_2 = 3$) to the second shell ($n_1 = 2$). Then,

$$\bar{v} = 1.1 \times 10^7\ m^{-1}\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

So, $\bar{v} = 15.28 \times 10^5\ m^{-1}$

Now, the energy for 1.0 g atom (1 mol of H atoms) is given by,

$E = N_A\ h\ v = N_A\ h\ c\ \bar{v} = 6.02 \times 10^{23} \times 6.62 \times 10^{-34} \times 3 \times 10^8 \times 15.28 = 10^5$ J

$E = 18.26 \times 10^4$ J/g atom = 182.6 kJ/g atom

48. (D) In the stomach, the medium is acidic while in the small intestine, the medium is basic. Hence, acetyl salicylic acid is almost unionised in the stomach but ionized in the small intestine.

49. (A) Given C = $\frac{12}{13} \times 100\% = 92.3\%$

H = $\frac{1}{13} \times 100\% = 7.69\%$

C = $\frac{92.3}{12} = 7.69 = 1$

H = $\frac{7.69}{1} = 7.69 = 1$

So, empirical formula is CH

As P decolourises $Br_2 - H_2O$, but Q does not. Therefore, P = C_2H_2 (acetylene) and Q = C_6H_6 (benzene).

50. (B) Ethyl alcohol undergoes combustion according to the reaction,

$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$

$\Delta H = -1367$ kJ mol^{-1}

Then $\Delta_c H = \Sigma aH_{products} - \Sigma bH_{reactants}$

As the enthalpy of a compound is taken as equal to its heat of formation, and the enthalpy of an element is taken as zero, we can write,

$-1367 = [2\,\Delta_f H\,(CO_2)\;3\,\Delta_f H\,(H_2O)] - [\Delta_f H\,(C_2H_5OH) + 0]$

Therefore, $\Delta_f H\,(C_2H_5OH) = 2(-393.4) + 3(-285.9) + 1367 = -277.5$ kJ mol^{-1}

51. (C)

Element	%	% / At. wt.	Ratio
N	30.5	30.5 / 14 = 2.18	1
O	69.5	69.5 / 16 = 4.34	2

Empirical formula = NO_2. E.F. wt. = 46

$\therefore \quad n = \frac{92}{46} = 2$. Hence, mol. formula = N_2O_4

52. (B) By Hannay and Smith equation, % ionic character

$= 16\,(4-1.2) + 3.5\,(4-1.2)^2$

$= 44.8 + 27.44 = 72.24.$

53. (C) Isotones are the atoms of different elements which have equal number of neutrons but different number of protons inside their nuclei.

$^{39}_{19}K$ and $^{40}_{20}Ca$ contain 20 neutrons in their nuclei and 19 and 20 protons respectively.

54. (C) The reaction is,

Initial amount :

$H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2(g)$

1 mol 1mol 0 0

Amounts reacted up to equilibrium :

$\frac{40}{100} \times 1 \text{ mol} = \frac{40}{100} \times 1 \text{ mol}$

= 0.4 mol = 0.4 mol

Amounts at equilibrium:

(1 – 0.4) mol (1 – 0.4) mol 0.4 mol 0.4 mol

= 0.6 mol = 0.6 mol 0.4 mol 0.4 mol

Volume of the reaction vessel = 10 L.

Equilibrium concentration :

$\frac{0.6 \text{ mol}}{10 \text{ L}}$ $\frac{0.6 \text{ mol}}{10 \text{ L}}$ $\frac{0.4 \text{ mol}}{10 \text{ L}}$ $\frac{0.4 \text{ mol}}{10 \text{ L}}$

0.06 mol L^{-1} 0.06 mol L^{-1} 0.04 mol L^{-1} 0.04 mol L^{-1}

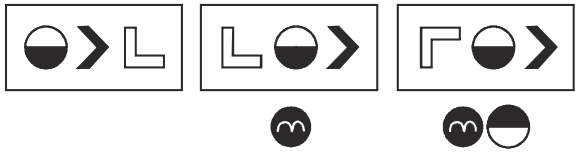
The equilibrium constant of this reaction is then given by, $K = \frac{[H_2(g)][CO_2(g)]}{[H_2O(g)][CO(g)]}$ =

$\frac{(0.04 \text{ mol L}^{-1})(0.04 \text{ mol L}^{-1})}{(0.06 \text{ mol L}^{-1})(0.06 \text{ mol L}^{-1})} = \frac{16}{36} = 0.44$

55. (B) In alkali metals, the reactivity increases down the group due to decrease in IE_1. But in case of halogens, the reactivity decreases down the group due to decrease in their electrode potentials.

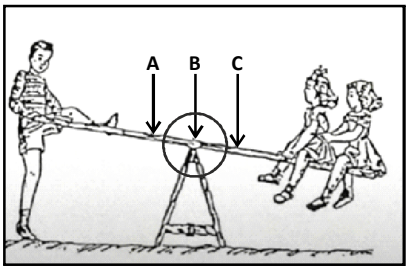
CRITICAL THINKING

56. (C)



57. (A) In case your visualized figure didn't match any of the available options, identify a unique characteristic (e.g., shape) of one of the provided pieces and try to locate that same characteristic in one of the options. In this example, it is the Trapezoid.

58. (B) Most of the tension is creating at point B and secondly due to the edge at point B it is more likely to break so the answer is B



59. (B) The delivery boy needs to walk from the grocery store to the firehouse. First, locate the grocery store and the firehouse. The grocery store is on Second Avenue between B1 Street and C1 Street. The firehouse is on D1 Street between Second and Third Avenues. Since the delivery boy is walking, you can ignore the one-way streets. Tracea route. Beginning at the grocery store, the delivery boy should walk east on Second Avenue to D1 Street, turn right, and go half a block to the firehouse.

Now read the answer choices. Choice B is the route you would have directed the delivery boy to use to get from the grocery store to the firehouse. Choices A and C have him walking west on Second Avenue, which is not the correct direction from the grocery store to the firehouse. Choice D has the delivery boy walking on First Avenue, which is not where the entrance to the grocery store is located, and left on D1 Street, which will not take him to the firehouse.

60. (C) From I, we conclude that weight of each pole = (4 × 5) kg = 20 kg.

So, total weight of 10 poles

= (20 × 10) kg = 200 kg.

From II, we conclude that:

Weight of each pole = (weight of 3 poles) – (weight of 2 poles) = 20 kg.

So, total weight of 10 poles = (20 × 10) kg = 200 kg.

The End