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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Paper Code: UN415

Solutions for Class : 10

Mathematics

1. (D) Given arithmetic progression is 10, 12, 14,

$$\Rightarrow a = 10, d = 2, n = 13$$

$$\Rightarrow S_n = \frac{n}{2}[2a + (n-1)d]$$

$$S_{13} = \frac{13}{2}[2(10) + 12(2)]$$

$$= \frac{13}{2}[20 + 24]$$

$$= 13 \times 22 = 286$$

2. (B) $\cos(\alpha + \beta) = 0$

$$\Rightarrow \alpha + \beta = 90^\circ$$

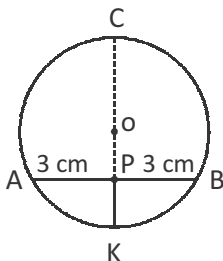
$$\Rightarrow \alpha = 90^\circ - \beta$$

$$\sin(\alpha - \beta) = \sin(90^\circ - \beta - \beta)$$

$$= \sin(90^\circ - 2\beta)$$

$$= \cos 2\beta$$

3. (A)



'O' is the centre of the circle.

$$CP \times PK = AP \times PB$$

$$CP = \frac{AP \times PB}{PK} = \frac{3 \times 3}{1} = 9 \text{ cm}$$

$$\therefore \text{Diameter CK} = CP + PK = (9 + 1) \text{ cm}$$

$$= 10 \text{ cm}$$

4. (D) $210 = 2 \times 3 \times 5 \times 7$

$$55 = 5 \times 11$$

$$\therefore \text{L.C.M.} = 2 \times 3 \times 5 \times 7 \times 11$$

$$= 2310$$

$$\text{H.C.F.} = 5$$

Difference of L.C.M. and H.C.F.

$$= 2310 - 5 = 2305$$

$$\text{Given } 2305 = 210 \times 6 + 55y$$

$$\Rightarrow y = \frac{2305 - 210 \times 6}{55} = 19$$

$$\therefore y^3 = 19^3 = 6859$$

5. (B) Let the cost of a chair be '₹ x'.

Let the cost of a table be '₹ y'.

$$\text{Given } 3x + 2y = 1850 \quad \dots (1)$$

$$5x + 3y = 2850 \quad \dots (2)$$

Solving eq. (1) and (2), we get

$$9x + 6y = 5550$$

$$10x + 6y = 5700$$

$$-x = -150$$

$$\Rightarrow x = 150$$

Substituting the value of 'x' in eq. (1)

$$\Rightarrow 450 + 2y = 1850$$

$$\Rightarrow 2y = 1400$$

$$\Rightarrow y = 700$$

Hence, the cost of one chair and one table = $x + y = ₹ 150 + ₹ 700 = ₹ 850$.

6. (D) Since the diagonals of a trapezium divide each other proportionally, $\frac{OA}{OC} = \frac{OB}{OD}$

$$\Rightarrow \frac{x-4}{4} = \frac{3x-19}{x-3}$$

$$\Rightarrow (x-4)(x-3) = 4(3x-19)$$

$$\Rightarrow x^2 - 7x + 12 - 12x + 76 = 0$$

$$\Rightarrow x^2 - 19x + 88 = 0$$

$$\Rightarrow x^2 - 11x - 8x + 88 = 0$$

$$\Rightarrow x(x-11) - 8(x-11) = 0$$

$$\Rightarrow x = 11 \text{ or } 8$$

∴ The required value of 'x' is 8 units.

7. (C) $AB = \sqrt{(2a-2a)^2 + (6a-4a)^2}$

$$= \sqrt{(2a)^2} = 2a$$

$$BC = \sqrt{(2a + \sqrt{3}a - 2a)^2 + (5a - 6a)^2}$$

$$= \sqrt{(\sqrt{3}a)^2 + (-a)^2}$$

$$= \sqrt{3a^2 + a^2}$$

$$= \sqrt{4a^2} = 2a$$

$$AC = \sqrt{(2a + \sqrt{3}a - 2a)^2 + (5a - 4a)^2}$$

$$= \sqrt{3a^2 + a^2}$$

$$= \sqrt{4a^2} = 2a$$

Hence, ΔABC is an equilateral triangle.

8. (D) Given P and Q are the zeros of the polynomial $ax^2 + bx + c$,

$$\Rightarrow P^2 + Q^2 = (P+Q)^2 - 2PQ$$

$$= \left(\frac{-b}{a}\right)^2 - 2\left(\frac{c}{a}\right)$$

$$= \frac{b^2}{a^2} - \frac{2c}{a} = \frac{b^2 - 2ac}{a^2}$$

Hence, the value of $P^2 + Q^2 = \frac{b^2 - 2ac}{a^2}$.

9. (B) Given, $x^2 + 4mx + 4m^2 + m + 1 = 0$ have real roots.

$$\Rightarrow b^2 - 4ac \geq 0$$

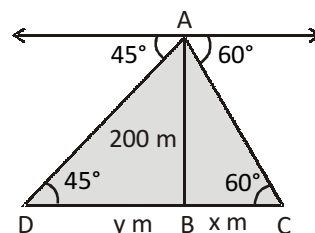
$$\Rightarrow (4m)^2 - 4(1)(4m^2 + m + 1) \geq 0$$

$$\Rightarrow 16m^2 - 16m^2 - 4m - 4 \geq 0$$

$$\Rightarrow 4m + 4 \leq 0$$

$$\Rightarrow m \leq -1$$

10. (B)



According to the problem, from the figure, AB is the tower of height 200 m.

The distance between the height is $(x + y)$ m.

$$\therefore \tan 45^\circ = \frac{200}{y} \Rightarrow y = 200 \text{ m} \quad \dots \quad (1)$$

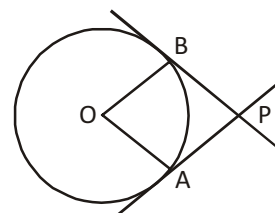
$$\tan 60^\circ = \frac{200}{x} \Rightarrow x = \frac{200}{\sqrt{3}} \quad \dots \quad (2)$$

∴ The required distance

$$= x + y = \frac{200}{\sqrt{3}} + 200$$

$$= 200 \left(\frac{1}{\sqrt{3}} + 1 \right) \text{ m}$$

11. (D)

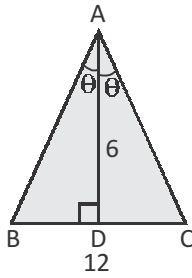


$OA = OB$, as radii of a circle are equal.

$PA = PB$, as tangents to a circle from an external point are equal.

∴ OAPB is a kite.

12. (C) In $\triangle ABC$, $AB = AC = 19$ cm
and $BD = DC = 6$ cm.



$$\text{In } \triangle ABD, AB^2 = AD^2 + BD^2 = 72$$

$$\Rightarrow AB = 6\sqrt{2}$$

$$\sin\theta = \frac{BD}{AB} = \frac{6}{6\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \theta = 45^\circ$$

$$\begin{aligned} \Rightarrow \angle BAC &= 2(\angle BAD) = 2 \times 45^\circ \\ &= 90^\circ \end{aligned}$$

13. (D) Area of $\triangle PQR$

$$\begin{aligned} &= \frac{1}{2} [p(r+p-p-q) + q(p+q-q-r) \\ &\quad + r(q+r-r-p)] \end{aligned}$$

$$= \frac{1}{2} [p(r-q) + q(p-r) + r(q-p)]$$

$$= \frac{1}{2} [pr - pq + pq - qr + rq - pr]$$

$$= \frac{1}{2} \times 0 = 0 \text{ sq. units.}$$

14. (B) $\triangle ABC \sim \triangle DEF$

$$\Rightarrow \frac{AB}{DF} = \frac{AC}{DE}$$

$$\Rightarrow \frac{5}{7.5} = \frac{8}{DE}$$

$$\Rightarrow DE = \frac{8 \times 7.5}{5}$$

$$\Rightarrow DE = 12$$

$$\text{and } \angle F = 100^\circ$$

15. (B) The numbers divisible by seven are 105, 112, 119,, 994.

$$t_n = a + (n-1)d$$

$$\Rightarrow 994 = 105 + (n-1)7$$

$$\Rightarrow \frac{889}{7} = n-1$$

$$\Rightarrow 127 + 1 = n$$

$$\Rightarrow 128 = n$$

16. (D) $\alpha + \beta = \frac{2}{k^2 - 14}$

$$\Rightarrow \frac{2}{k^2 - 14} = -1 \text{ (Given)}$$

$$\Rightarrow 2 = k^2 - 14$$

$$\Rightarrow k^2 = 16$$

$$\Rightarrow k = \pm 4$$

17. (B) All the three bulbs glow at once at 8 a.m.

The time when they glow simultaneously again

$$= \text{L.C.M. (24, 48, 54) seconds}$$

$$= 216 \text{ seconds}$$

$$= 3 \text{ minutes } 36 \text{ seconds}$$

\therefore The time when the three bulbs glow together again is at 8 : 03 : 36 a.m.

18. (A) Let the digits in the tens place and the ones place be x and y respectively.

Then, according to the problem,

$$10x + y = 4(x + y) \Rightarrow y = 2x$$

$$\text{and } 10x + y = xy + 16$$

$$\Rightarrow 10x + 2x = x(2x) + 16$$

$$\Rightarrow 12x = 2x^2 + 16$$

$$\Rightarrow 2x^2 - 12x + 16 = 0$$

$$\Rightarrow x^2 - 6x + 8 = 0$$

$$\Rightarrow x^2 - 4x - 2x + 8 = 0$$

$$\Rightarrow x(x-4) - 2(x-4) = 0$$

$$\Rightarrow (x-4)(x-2) = 0$$

$$\Rightarrow x = 4 \text{ or } 2$$

$$\text{If } x = 2, \text{ then } y = 2x = 4.$$

\therefore The number is 24.

$$\text{If } x = 4 \text{ then } y = 8.$$

\therefore The number is 48.

Hence, the required number is 48.

19. (D) If we take AE as the base of triangle AEC , then the height is CD .

The height of the triangle is therefore, 9 (given).

To find the base we need to see that

triangles AEB and CDE are similar. The ratio AB : CD, is therefore equal to the ratio AE : ED. The given information shows that the ratio is 3 : 9, or 1 : 3. Now dividing AD (4) in this ratio gives us AE as 1.

The area of AEC = $\frac{1}{2}$ base \times height

$$= \frac{1}{2} \times 9 = 4.5$$

20. (B) $(1 + 1 + \dots \dots \dots \text{'n' terms}) -$

$$\left(\frac{1}{n} + \frac{2}{n} + \dots \dots \dots \text{'n' terms} \right)$$

$$= n - \left(\frac{1+2+3+\dots+\text{'n' terms}}{n} \right)$$

$$= n - \frac{n(n+1)}{2n} = n - \frac{n+1}{2}$$

$$= \frac{n-1}{2}$$

21. (D) If the ratio is $\lambda : 1$,

$$x = \frac{7-4\lambda}{\lambda+1} \text{ or } \frac{7-4\lambda}{\lambda+1} = 0$$

Since, the line segment is divided by Y-axis

$$\therefore \lambda = \frac{7}{4}$$

\Rightarrow The required ratio = 7 : 4

22. (C) The minute hand moves 6° in one minute.

\therefore It will move 30° in 5 minutes (from 2 to 3).

Also the hour hand moves 30° in one hour.

\therefore It will move $\left(\frac{30 \times 15}{60} \right)^\circ$ in 15 minutes,

$$\text{i.e., } \left(7\frac{1}{2} \right)^\circ$$

So, the angle between the two hands is

$$= 30^\circ - \left(7\frac{1}{2} \right)^\circ = 22\frac{1}{2}^\circ$$

23. (C) $\angle QOS = 120^\circ$ (Given)

$$\Rightarrow \angle OQS = \angle OSQ$$

$$= \frac{180^\circ - 120^\circ}{2} = 30^\circ$$

$\angle OPT = 90^\circ$ [Since, $QP \perp PT$.]

$$\Rightarrow \angle PTS = 180^\circ - [90^\circ + 30^\circ]$$

$$\Rightarrow \angle PTS = 60^\circ$$

24. (B) Since the nature of z is not known.

If $z = + \text{ive} = +k$ then, $x > y \Rightarrow xk > yk$

If $z = - \text{ive} = -k$ then, $x > y \Rightarrow -xk < -yk$.

25. (D) $S_n = \frac{n}{2} [2\pi + (n-1)d] = 0$

$$S_m = S_{m+n} - S_n = \frac{(m+n)}{2} [2\pi + (m+n-1)d] - 0$$

$$= (m+n)\pi + \frac{(m+n)(m+n-1)d}{2}$$

$$= m\pi + n\pi + \frac{(m^2 + n^2 + 2mn - m - n)d}{2}$$

$$= n\pi + \frac{(n^2 - n)d}{2} + m\pi + \frac{(m^2 + 2mn - m)d}{2}$$

$$= \frac{n}{2} [\pi + (n-1)d] + m\pi + \frac{m(m+2n-1)d}{2}$$

$$= 0 + m\pi + \frac{m(m+2n-1)d}{2}$$

Physics



When resistors are connected in series, their values add up. This arrangement will always give the maximum resistance.

27. (D) A solar panel is a packaged inter-connected assembly of solar cells (photovoltaic cells). Solar cell converts light energy into electrical energy. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity for commercial and residential use.

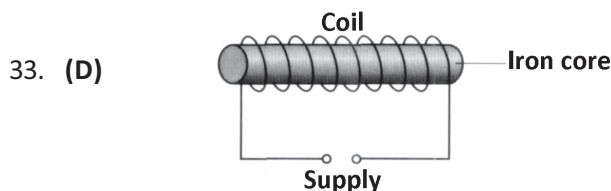
The power generated by a solar panel would most likely be affected by the surface area of the solar panel itself and the cloud cover percentage.

- The greater the surface area, the greater the power generated.
- The lesser the cloud cover percentage, the greater the power generated.

Wind and humidity do not affect the power generated by a solar panel.

Solar panel (D) has the greatest surface area and it is put at a place with the least cloud cover percentage. Therefore, solar panel (D) would likely provide the most power.

28. (A) The refracted angle in a denser medium is less than the incident angle because the speed of light slows down in a denser medium. In slowing down, the light bends towards the normal and the refracted angle is therefore less than the angle of incidence. 35° is less than 45° . The other options are incorrect.
29. (D) Ammeter is used to measure the amount of current flowing in an electrical circuit, and it must be connected in series to the circuit. Electrical current (unit: Ampere) consists of moving negative charges (also known as electrons).
30. (D) Electromagnetic effect is temporary.
31. (C) Biomass is an alternative source of energy that contains organic wastes which includes continuous crop residues, wood, cow dung etc., These organic wastes are used immediately for the production of biogas.
32. (D) An object placed at F of a concave mirror produces a highly enlarged, real and inverted image at infinity.



An electromagnet is a solenoid with an iron core inserted into it. If a current flows in the coil, a magnetic field is generated. The core greatly enhances the strength of the electromagnet.

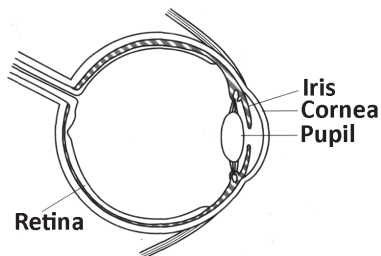
There are three ways to make the electromagnet stronger:

- Increasing the number of turns of wire in the coil
- Increasing the current in the coil
- Using a soft iron core

Resistance will decrease the amount of current flowing in the coil, and hence it cannot improve the strength of the electromagnet.

34. (D) To calculate the number of units of electrical energy used by the appliance, multiply the power (in kW) of the appliance by the amount of time (in h) that the appliance was used. $600\text{ W microwave for } 10\text{ minutes} = 0.6\text{ kW} \times 10/60\text{ hour} = 0.1\text{ kWh}$.
35. (A) In waterfalls, gravitational potential energy is first converted to kinetic energy of water which then will be converted into electric energy by a generator. This type of electricity production using kinetic energy of water is called hydroelectricity. It is a renewable source of energy.
36. (C) Electricity can easily be converted into other useful forms of energy like heat, light and sound.
37. (D) Water has higher refractive index than air. When light travels from air into water, it bends towards the normal line as it moves with lower speed inside the water. This phenomenon is called refraction.
38. (C) A combination of mirrors arranged in a magic mirror can be easily identified without touching it based on the characteristics of the image formed in each mirror of an object/girl.
- The girl's head appeared bigger as a concave mirror will produce a magnified image.
 - The middle portion of the girl's body appeared to be of same size indicates that it is a plane mirror as the object and image size are same for any position.
 - As a convex mirror produces a diminished image, the girl's legs appeared smaller.

39. (A)



Retina which is located at the back part of the eye is the film of the eye. The retina has a large number of light-sensitive cells. When the image falls on the retina of an object, then these light-sensitive cells get activated and generate electrical signals. The retina sends these electrical signals to the brain through the optic nerve and gives rise to the sensation of vision.

40. (C) Deviation angle (or the angle of deviation) is the angle between the original incident ray and the emergent ray.

41. (D) When the diameter of the coil increases, the magnetic field cutting the conducting coil will be weaker because the magnet is further away from the coil. The induced e.m.f. will be smaller and thus the induced current is also smaller. The induced e.m.f. depends on the rate of change of magnetic flux cutting the coil. Therefore the stronger the magnet, the higher will be the induced e.m.f and thus the higher will be the induced current. The thickness of the wire will affect the resistance of the wire. Although the induced e.m.f is not affected, the induced current will increase if the diameter of the wire is increased.

42. (C) Uranium atoms are split in a nuclear reactor to produce nuclear energy, which is used to boil water to obtain steam.

Steam under high pressure is used to turn a turbine which then drives a dynamo to produce electrical energy.

The steam which has been used for turning the turbine is later condensed to water in a condenser to be used in the boiler again.

43. (B) The retina of our eye has two kinds of light sensitive cells called rods and cones. Cone cells are sensitive to bright light and also cause sensation of colour of objects in our eyes. Cone cells help us to see, identify and distinguish between various colours.

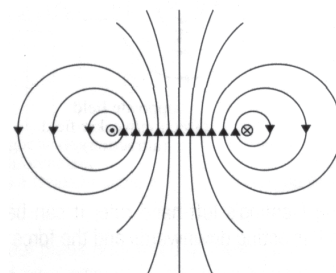
44. (B) $R = 40 \Omega$, $d = 1\text{mm}$, $l = 2\text{m}$

$$\rho = \frac{RA}{l}, \rho = \frac{R\pi d^2}{4l}, \frac{40 \times 22 \times 1}{4 \times 7 \times 2 \times 10^8} = \frac{880}{56 \times 10^8}$$

$$= \frac{880 \times 10^{-8}}{560} \therefore \rho = 1.57 \times 10^{-8} \Omega \text{ m}$$

45. (A) A convex mirror forms virtual, erect and diminished images of objects when placed at infinity and anywhere between the pole and infinity. A convex mirror does not form an inverted image of the object.

46. (A) The correct field pattern and directions are shown below.



47. (A) Light sensitive cells get activated on illumination enabling formation of image.

48. (D) The power is 700 W, the voltage is 230 V and the current is 13 A.

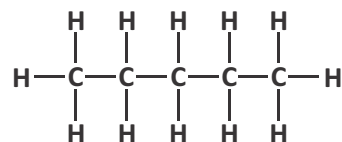
49. (B) A bulb is placed at the focus of a concave mirror that acts as reflector in torch, search and headlights respectively to produce a powerful beam of parallel light rays to see objects upto a considerable distance in the darkness of night.

50. (C) Steel is a hard magnetic material. It retains some magnetism after the magnet is being removed. Steel will continue to attract the iron based on induced magnetism.

Chemistry

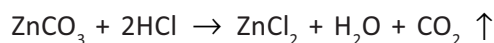
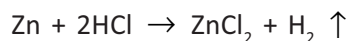
51. (D) There are 2 double bonds (4 electrons each) and 2 single bonds (2 electrons each) surrounding the sulphur atom. Hence, the total number of electrons around S = 2(4) + 2(2) = 12.
52. (D) H₂ and Br₂ are the two elements that combine chemically to form a compound 2HBr. It is an element-element combination reaction to form a single compound.
53. (C) The acidic portion of ethanoic acid is the -COOH portion, with the H from the -OH being lost during reaction with the base.
54. (B) Since the solution turns universal indicator orange, it is acidic in nature. Only an acidic oxide will produce an acidic solution in water.
55. (A) Semi-metals, also known as metalloids, have properties in between of metals and non-metals. In terms of conductivity, it lies in between metals as a good conductor and non-metals as an insulator.
56. (B) Heat is required to decompose calcium carbonate. Thus, this reaction proceeds with absorption of heat therefore, it is an endothermic reaction.
57. (A) Copper is below hydrogen in the reactivity series and therefore does not react with H₂SO₄.
58. (D) Tin is in group IV A of 5th period.
59. (D) The residue formed is Na₂CO₃ which can react with more dilute acid to form carbon dioxide gas.
$$\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 \uparrow$$
60. (C) Polyethene has a high C:H ratio of 1:2. It is also a long chain molecule and will require a large supply of oxygen to burn completely. Hence, in normal circumstances, polyethene will burn with the sootiest flame.
61. (D) The atoms of Group I elements (being metals) have 1 outermost shell electron each which is easily given away. Atoms of Group VII elements (being non-metals) have 7 outermost shell electrons and easily accept 1 more electron to form a stable octet structure. Hence, these two types of elements are most likely to form ionic compounds with transfer of electrons.

62. (C)



Pentane

63. (A) Zinc will give hydrogen gas and zinc carbonate will give carbon dioxide with an acid.



64. (C) On moving down any group in a periodic table, the number of valence electrons in the outermost shell of respective elements remains the same.

65. (C) 24 carat gold is soft and not suitable for making ornaments as it is not malleable. 22 parts of pure gold is alloyed with 2 parts of copper or silver to make ornaments.

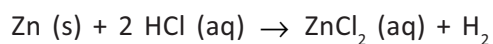
66. (A) Iron reacts with moist air and forms Fe₂O₃ that is the formation of rust.

67. (C) The general formula of : alkanes is C_nH_{2n+2}. The formula of Hexane- C₆H₁₄, Ethane-C₂H₆, Butane C₄H₁₀. Alkenes have general formula C_nH_{2n}. The formula of Pentene is C₅H₁₀ and Hexene is C₆H₁₂.
a-5, b-4, c-3, d-2, e-1

68. (B) On adding a few drops of universal indicator to a solution in a test tube that turned purple indicates that it is alkaline and its pH is >11.

69. (D) Thermite is a mixture of iron (III) oxide and aluminium powder.

70. (D) Statements (A), (B) and (C) describe the given observations.



Biology

71. (A) The given equation represents aerobic respiration. Glucose + oxygen → carbon dioxide + water + energy

72. (A) During photosynthesis plants take in carbon dioxide and give out oxygen.

73. (C) Spinal nerves and cranial nerves together constitute the peripheral nervous system.

74. (C) The sex of a baby is determined by the father's chromosomes. If a sperm carries an X chromosome and an egg carries a Y chromosome, the zygote formed as XY is a male baby.
75. (C) Archaeopteryx is a connecting link between reptiles and birds.
76. (B) The given sequence shows the movement of energy: sun → grass → insects → frog.
77. (A) Amrita Devi Bishnoi is associated with the conservation of the khejri tree.
78. (B) Frogs and earthworms have moist skins. Moist skin helps in breathing in these organisms.
79. (C) Plastic is a non-biodegradable substance. Hence it is not used in compost pits.
80. (C) Reduction of carbon dioxide takes place during photosynthesis.
81. (D) In the given experiment, the part below the ring is shrivelled as the food has been used up and above is swollen due to the accumulation of food.
82. (C) Hemodialysis is used to remove nitrogenous waste products from the blood.
83. (D) Movements induced in plants due to temperature are called thermonastic movements.
84. (D) Budding, binary fission and spore formation are types of asexual reproduction.
85. (C) Hargobind Khorana was an Indian-born scientist who settled in the United States. He did a lot of work in the field of molecular biology. He solved the genetic code for several amino acids along with other scientists. He was the first person to synthesize "gene". He did extensive work in the discovery of the genetic code and for this he was awarded the Nobel Prize.
86. (B) Primary consumers in an ecosystem are herbivores. They feed directly on producers.
87. (D) Spirogyra reproduces by fragmentation.
88. (C) Sunlight is used to produce electricity in solar cells.
89. (D) The cerebellum coordinates the body movements.
90. (D) Before air is breathed into the lungs, it is filtered in the nostrils, moistened by mucus and gets warmer equal to the body temperature.

