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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION - 2015 (UPDATED)

Paper Code: UN412

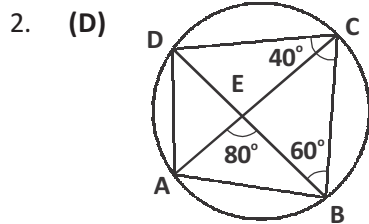
Solutions for Class : 9

Mathematics

1. (D) Probability of getting 1 or 6 in a single toss

$$= \frac{2}{6}$$

Probability not getting = $1 - \frac{2}{6} = \frac{4}{6}$



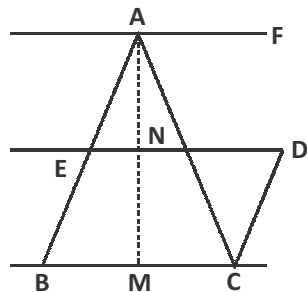
In $\angle BCD$, $\angle BDC = 180^\circ - 40^\circ - 60^\circ - 80^\circ$

$\angle DEC = \angle AEB = 80^\circ$

\therefore In $\triangle DEC$, $\angle ECD = 180^\circ - 80^\circ - 80^\circ = 20^\circ$

\therefore **AC bisects $\angle BCD$.**

3. (C) AF, ED and BC are parallel lines and AB, AM are transversals. As AE = EB, by Equal Intercepts Theorem, AN = NM. So, AM = 2NM.



Now, $ar(\triangle ABC) = \frac{1}{2} \times \text{base} \times \text{altitude}$

$$= \frac{1}{2} \times BC \times AM \quad \dots (i)$$

$ar(\text{parallelogram BCDE})$

$= \text{base} \times \text{altitude} = BC \times NM \quad \dots (ii)$

From (i) and (ii), $\frac{ar(\text{parallelogram BCDE})}{ar(\triangle ABC)}$

$$= \frac{BC \times NM}{\frac{1}{2} \times BC \times AM}$$

$$\therefore \frac{ar(\text{parallelogram BCDE})}{20 \text{ cm}^2} = \frac{NM}{\frac{1}{2} \times 2NM} = 1$$

$\therefore ar(\text{parallelogram BCDE}) = 20 \text{ cm}^2$

4. (D) For $x = 0$ and $x = \frac{1}{3}$ (verify by substitution)

5. (A) The diagonals of a rectangle are equal in length and the rectangle being a parallelogram, its diagonals bisect each other.

$\therefore AC = BD$

$\Rightarrow \frac{1}{2} AC = \frac{1}{2} BD$

$\Rightarrow OC = OD$

\therefore In $\triangle ODC$, $\angle ODC = \angle OCD = x^\circ$

But $\angle ODC = \angle OBA = 30^\circ$

(Since $AB \parallel DC$).

$\therefore x^\circ = 30^\circ$

Now, $y^\circ = \angle AOB = \angle COD$ (opposite angles)

$= 180^\circ - x^\circ - x^\circ$ (sum of three angles of $\triangle ODC$ is 180°)

$= 180^\circ - 30^\circ - 30^\circ = 120^\circ$

6. (D) $\angle NML = 180^\circ - 125^\circ = 55^\circ$

Since, $\overline{LN} = \overline{LM}$

$\angle LNM = \angle NML = 55^\circ$

$$\therefore \angle NLM = 180^\circ - 55^\circ - 55^\circ = 70^\circ$$

$$\angle KLN = 180^\circ - 90^\circ - 70^\circ = 20^\circ$$

$$\therefore \text{In } \triangle KLN, x^\circ = 180^\circ - 20^\circ - 90^\circ = 70^\circ$$

7. (D) $\frac{120}{x}$ of the planned distance.

8. (C) Area = $\sqrt{s(s-a)(s-b)(s-c)} = A$

where $s = \frac{a+b+c}{2}$ and a, b, c are sides of the triangle.

When the sides are increased by 200%, the sides become 3a, 3b and 3c.

$$s_1 = \frac{3a+3b+3c}{2} = 3 = \frac{(a+b+c)}{2} = 3s$$

$$A_1 = \sqrt{s_1(s_1-3a)(s_1-3b)(s_1-3c)}$$

$$= \sqrt{3s \cdot 3(s-a) \cdot 3(s-b) \cdot 3(s-c)}$$

$$= 9\sqrt{s(s-a)(s-b)(s-c)} = 9A$$

\therefore Increase in area = $9A - A = 8A$ or **800%**

9. (C) Edge of the cube = $a\sqrt{\frac{2}{3}} = 4\sqrt{2} \times \sqrt{\frac{2}{3}}$

$$= \frac{8}{\sqrt{3}} \text{ cm}$$

\therefore Diagonal of the cube = $\sqrt{3}$ (edge)

$$= \sqrt{3} \times \frac{8}{\sqrt{3}} = 8 \text{ cm}$$

10. (D) (5, 6), (6, 5) i.e.,

$$\text{The probability} = \frac{2}{36} = \frac{1}{18}$$

11. (C) $pq = 36$, since p and q are positive integers, hence 36 can be factorised as (36×1) and (18×2) , (12×3) , (9×4) , and (6×6) . Hence $p - q$ can be $6 - 6 = 0$, $3 - 12 = -9$, $(9 - 4) = 5$, $36 - 1 = 35$, but it can NOT be **8**.

12. (A) Since, $AB = BC \Rightarrow w^\circ = z^\circ$

BD bisects $AC \Rightarrow AD = DC \Rightarrow x^\circ = y^\circ$

$\therefore w^\circ = x^\circ$ is not possible.

13. (C) $\sqrt{(2-0)^2 + (-1-0)^2} = \sqrt{5}$

$\Rightarrow (2, -1)$ is the nearest point.

14. (A) Since, in the list 5 appears 4 times and 6 appears 3 times.

So, the value of n can be any value other than **6** as mode of the given list is 5.

15. (D) $\frac{a_1}{a_2} = \frac{3}{12} = \frac{1}{4}$

$$\frac{b_1}{b_2} = \frac{-4}{-16} = \frac{1}{4}$$

$$\frac{c_1}{c_2} = \frac{5}{20} = \frac{1}{4}$$

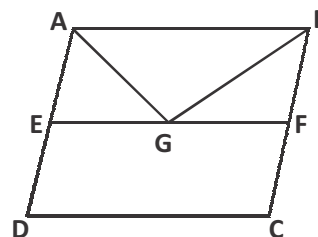
Since, $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$,

The given equations are coincident lines.

\therefore There are **more than two solutions**.

16. (C) $AB \square CD \square EF$

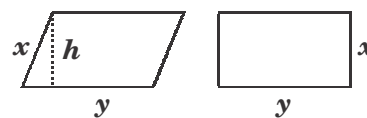
$$\Rightarrow \text{ar. } \triangle AGB = \frac{1}{2} \square \text{gm AEFB}$$



(Since $\triangle AGB$ and $\square \text{gm AEFB}$ are on the same base and between the same \square lines AB and EF).

$$\text{area } \triangle AGB = \frac{1}{4} \square \text{gm ABCD} = \frac{S}{4}$$

17. (A) Area of rectangle = $xy = \beta$



Area of parallelogram = $y \times h = \alpha$

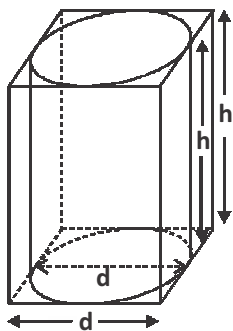
Since, $h < x \Rightarrow y \times h < x \times y$

$$\therefore \alpha < \beta$$

18. (C) $AP + PB = AB$



19. (B)



Hence, the dimensions of rectangular box is $d \times d \times h$.

\therefore Volume of rectangular box = d^2h

20. (Del)

21. (C) Since, $x + y + z = 0$

$$\Rightarrow x^2 + y^2 + z^2 + 2(xy + yz + zx) = 0$$

$$\therefore x^2 + y^2 + z^2 = -2(xy + yz + zx)$$

$$= -2[x(y + z) + yz]$$

$$= -2(x \times -x + yz)$$

$$\text{(Since, } x + y + z = 0\text{)}$$

$$= 2(x^2 - yz)$$

$$\therefore \frac{x^2 + y^2 + z^2}{x^2 - yz} = 2$$

22. (D) Of the given statements only (ii) and (iii) are true.

23. (C) A : Getting prime number

$$A = (2, 3, 5, 7, 11, 13, 17, 19, 23)$$

$$n(A) = 9, n(S) = 25$$

\therefore Required probability

$$= P(A) = \frac{n(A)}{n(S)} = \frac{9}{25}$$

24. (C) $\angle FDG = \angle KCD$ (corresponding angles)

$$= \angle ECA \text{ (vertically opp. angles)}$$

$$\Rightarrow \angle ECA = 55^\circ$$

$$\angle EAC = 40^\circ \text{ (given)}$$

$$\therefore \angle E = 180^\circ - (55^\circ + 40^\circ) = 85^\circ$$

$$x^\circ = 85^\circ \text{ (corresponding angles)}$$

25. (D) $\angle B = \angle C$

$$\Rightarrow AB = AC$$

$$\angle CAD = 30^\circ$$

$$\therefore \angle CAD > \angle CDA$$

$$\Rightarrow CD > AC$$

(In a triangle, greater angle has longer side opposite to it)

$$\angle BAC = 180^\circ - 110^\circ = 70^\circ > \angle ABC$$

$$\Rightarrow BC > AB \text{ and } BC > AC$$

$$\therefore BC > CA \text{ and } CA < CD$$

Physics

26. (C) Initial kinetic energy = $\frac{1}{2}mv^2$

$$= \frac{1}{2}(2)(3)^2 = 9 \text{ J}$$

$$\text{Final kinetic energy} = \frac{1}{2}mv^2$$

$$= \frac{1}{2}(2)(7)^2 = 49 \text{ J}$$

$$\text{Increase in kinetic energy} = 49 \text{ J} - 9 \text{ J}$$

$$= 40 \text{ J}$$

27. (A) A cat that has become wet shakes its body from head to tail to shed the water from its coat by moving its head and tail on right and left sides respectively to make the water droplets to fall down. It is based on the concept of inertia of motion.

28. (B) Statements (A), (C) and (D) are not true of mass. Mass of an object is always constant whether it is on the earth, the moon or even in outer space.

29. (C) The momentum of a body is the product of its mass and velocity ($P = m \times v$). The momentum of four objects P, Q, R and S are calculated below.

$$\text{Object P} = \text{Mass} \times \text{velocity} =$$

$$0.3 \text{ kg} \times 5 \text{ m s}^{-1} = 1.5 \text{ kg m s}^{-1}$$

$$\text{Object Q} = \text{Mass} \times \text{velocity} =$$

$$0.6 \text{ kg} \times 2 \text{ m s}^{-1} = 1.2 \text{ kg m s}^{-1}$$

$$\text{Object R} = \text{Mass} \times \text{velocity} =$$

$$1.2 \text{ kg} \times 0.3 \text{ m s}^{-1} = 0.36 \text{ kg m s}^{-1}$$

$$\text{Object S} = \text{Mass} \times \text{velocity} =$$

$$1.5 \text{ kg} \times 1.8 \text{ m s}^{-1} = 2.7 \text{ kg m s}^{-1}$$

So, object 'R' has the lowest momentum.

30. (D) Car I is not moving, so it has no kinetic energy. Bus I has a bigger mass than car II, so bus I has more kinetic energy even though they are moving at the same speed. Bus II has the same mass as bus I, but it is moving at the fastest speed, so it has the

most kinetic energy. Bus I and car II are moving at the same speed, but car II has less kinetic energy because it has a smaller mass.

31. (Del)

32. (B) Time taken for sound to travel from the lightning to the observer = 2.5 s

Speed of sound in air is approximately 330 m/s.

Therefore, distance travelled by the sound = speed \times time

$$= 330 \times 2.5 = 825 \text{ m}$$

33. (B) Pressure = Force / Area, the smaller the area, the greater the pressure.

34. (D) Statement (i), (ii) and (iii) are the safety measures, few are inbuilt in the vehicles and some are to be followed by passengers moving in various vehicles to reduce the negative effects of inertia.

The speed and weight limits for heavy vehicles are strictly enforced. For example buses, lorries etc., are allowed to travel at a maximum speed of 90 kmh^{-1} . This is because the above vehicles have greater mass and if they travel at high speeds, it will be difficult for them to stop the vehicle.

35. (C) Potential energy is stored in the bow. To release an arrow from the bow, there is a change in the shape of stretched string of the bow. Hence, potential energy of the bow is converted to kinetic energy to stretch the string and release an arrow from it.

36. (A) Mass is a measure of the inertia of a body. Mass = Density \times volume.

Density in g cm^3

Copper – 8.9 Aluminium – 2.7

Glass – 2.4 to 2.8 Wood – 0.48

The heaviest material copper has the greatest inertia.

37. (D) Power = work done \div time = force \times distance \div time. When the applied force on the weight is higher, the power used to do the work will increase.

Force = mass \times acceleration. When a higher force is applied, the weight will move at a higher acceleration. In other words, the object will move faster and thus the work can be completed in a shorter time.

The energy used to lift the weight comes from the boy. From the conservation of

energy point of view, the faster the energy has gone to work, the faster will the energy of the boy be used up.

38. (D) The correct order of density of three substances P, Q, R from least to most dense is Q, P and R.

Density of a substance =

$$\frac{\text{Mass of substance}}{\text{Volume of substance}}$$

$$\text{Density of substance P} = \frac{65}{15} = 4.33 \dots\dots (2)$$

$$\text{Density of substance Q} = \frac{80}{20} = 4 \dots\dots (1)$$

$$\text{Density of substance R} = \frac{60}{12} = 5 \dots\dots (3)$$

39. (B) Point Q has the deepest water because ultrasound took the longest time to return back to the receiver on the ship.

40. (B) Work done is the product of the applied force and the distance moved by the object in the direction of the force. When the spaceship is cruising in space, although there is distance travelled but there is no force acting on it. As a result, no work is done.

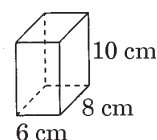
41. (A) If an object moves with a constant speed along a circular path, then its velocity will not be constant because velocity changes in a specified direction. So, the object moving in a circular path has a variable velocity.

42. (C) The frequency will not change as the source is not being disturbed. Sound travels faster in water than in air as vibrations travel faster when the particles are closer together. According to the relationship $v = f\lambda$, when the frequency is constant, the speed increases and the wavelength will also increase.

43. (B) The smallest base area = $6 \times 8 = 48 \text{ cm}^2$

Pressure = Force / Area

$$= 24 / 48 = 0.5 \text{ N cm}^{-2}$$



44. (D) Net force = Mass \times acceleration

45. (A) Work is force times displacement. Since, the girl does not displace at all from her initial point, the work done remains at zero.

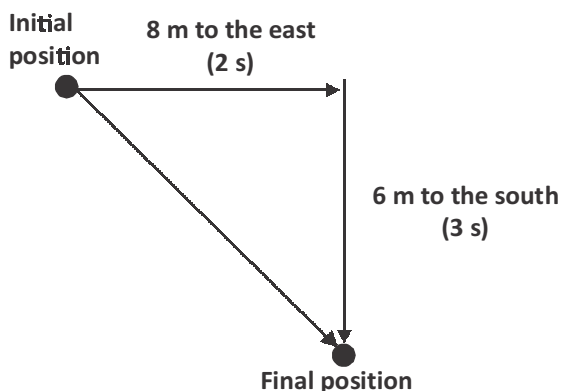
Common mistake occurs when we think that the work done by the girl depends on the distance travelled by her as she jumps.

Displacement is a different term with distance, and they are often used ambiguously. In this case, the initial and final position of the girl remains unchanged, which means she does not displace at all, i.e., her displacement is zero.

46. (D) Based on the fact that iron must have a higher density than feathers and the formula of “density = mass ÷ volume” and “weight = mass × gravitational acceleration”, a table of the situation is given below.

| | Material | Density | Mass | Volume | Weight |
|--------|----------|---------|------|--------|--------|
| Sack X | iron | high | 2 kg | low | 20 N |
| Sack Y | feathers | low | 2kg | high | 20 N |

47. (B) Applied force – opposing force
= Resultant force = ma
 $90 - 60 = 15a$; $a = 2 \text{ m s}^{-2}$
48. (D) When the speed of a truck changes in an irregular manner, then the velocity-time graph is a curved line.
49. (A) Distance is the total length travelled by the man whereas displacement is the position of the man as compared to his original position.



$$\text{Total Distance} = 8 \text{ m} + 6 \text{ m} = 14 \text{ m}$$

$$\text{Total time} = 2 \text{ s} + 3 \text{ s} = 5 \text{ s}$$

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}} = 14 \text{ m} \div 5 \text{ s} = 2.8 \text{ m s}^{-1}$$

$$\text{Displacement} = \sqrt{8^2 + 6^2} = 10 \text{ m}$$

$$\text{Velocity} = \frac{\text{displacement}}{\text{time}} = 10 \text{ m} \div 5 \text{ s} = 2.0 \text{ m s}^{-1}$$

50. (C) As radius is maximum at the equator, the value of ‘g’ will be minimum at the equator. Due to flattening of the earth at the poles, radius is minimum and ‘g’ is maximum at the poles. An object when weighed at the north pole will be the heaviest.

Chemistry

51. (C) Uranium-235 isotope is used as a fuel in the reactors of nuclear power plants for generating electricity.
52. (C) Mercury-ethanol is an immiscible liquid mixture. Hence, it can be separated by a separating funnel.
- (i) Distillation is the process of heating a liquid to form vapour, and then cooling the vapour to get back the liquid e.g., salt water. Both salt and water can be recovered by this process.
- (ii) Fractional distillation is the process of separating two or more miscible liquids based on the difference in their boiling points. Mercury-ethanol is an immiscible liquid mixture which cannot be separated either by distillation or fractional distillation.
53. (C) Among the three states of matter, the rate of diffusion is very fast in gases. The particles in gases move very quickly in all directions. The rate of diffusion of a gas depends on its density. Lighter gases diffuse faster than heavier gases.

Nitrogen and carbon monoxide are a pair of gases which diffuse into the vacuum at the same speed due to their equal molecular weights.

$$\text{Nitrogen (N}_2\text{)} = 2 \times 14 = 28$$

$$\text{Carbon monoxide (CO)} = \text{Carbon } 12, \text{ Oxygen } 16 = 28$$

54. (C) Relative atomic mass of neon =

$$\frac{20 \times 90 + 21 \times 1 + 22 \times 9}{90 + 1 + 9} = 20.19$$

55. (C) The perfume molecules travel only short distances in straight lines before they collide with another molecule, change direction to collide again and so on. Infact at room temperature and atmospheric pressure, a perfume (gas) molecule in the air experiences several billion collisions per second. As the room is very large, slow diffusion occurs and perfume molecules travel in haphazard paths. So, it takes

several minutes before its smell can be detected at the other end.

56. (B) Number of glucose molecules =
 (no. of moles) \times (6.0×10^{23})
 = $0.8 \times 6.0 \times 10^{23}$
 = 4.8×10^{23}
 One glucose molecule contains 12 H atoms.
 Hence, total number of H atoms
 = $4.8 \times 10^{23} \times 12 = 57.6 \times 10^{23}$ atoms
 = 5.76×10^{24} atoms

57. (C) Soap solution is a colloid.
 Brass is a solution of zinc in copper, a solid in a solid metallic alloy.
 Milk of magnesia is a sol, i.e., a colloidal suspension of magnesium hydroxide in water.

Copper sulphate dissolves in water, it is a true solution.

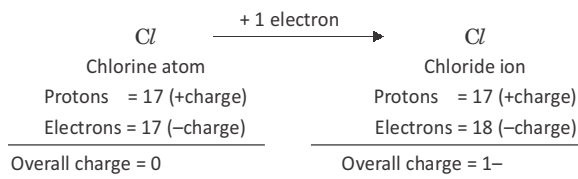
58. (A) The atomic number of the element = 7, which is nitrogen, N. The number of electrons in the particle = 10. Hence, the atom has gained $3 e^-$ to form a nitride ion = N^{3-} .

59. (B) 60 g of KNO_3 dissolves in 100 g of water at $40^\circ C$
 ? g of KNO_3 dissolves in 25 g of water at $40^\circ C$

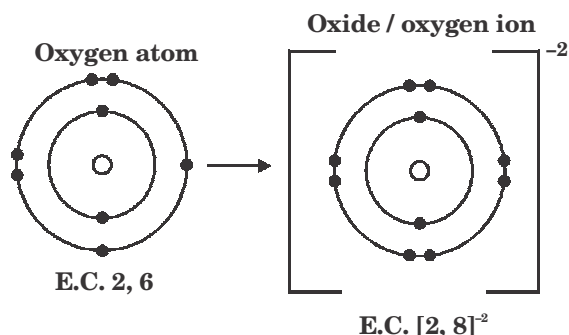
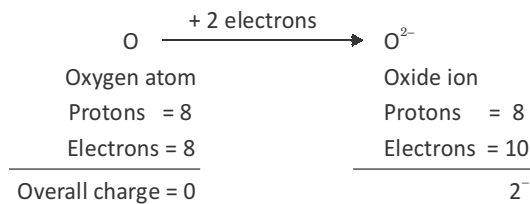
$$= \frac{60 \times 25}{100} = 15 \text{ g}$$

So, 15 g of KNO_3 dissolves in 25 g of water to produce a saturated solution at $40^\circ C$.

60. (C) Chlorine atom has 7 electrons in its outermost shell. It needs 1 more electron to achieve the 8-electron configuration or octet. So, the chlorine atom gains (accepts) 1 electron to form a chloride ion, Cl^- having an inert gas electronic configuration of 2, 8, 8.



61. (D) An atom gains or loses electrons when it becomes an ion. The number of protons before the gain/lose of electrons in an atom is same. Its atomic number or proton number remains the same as shown below.



An atom gains or loses the right number of electron to produce an ion with a complete outer shell of electron or a stable octet.

62. (D) Condensation and freezing both involve the loss of heat energy by particles of a substance. However, the change of state from a gas to a liquid/solid involves the larger change in volume as particles in gaseous state are far apart, and when they condense, they come very close together to form a liquid/solid.
63. (B) Element 'T' has 12 protons. It is magnesium, a metal
- (i) Magnesium reacts with oxygen to form an oxide MgO not MgO_2 .
 $2 Mg + O_2 \rightarrow 2MgO$
 - (ii) Magnesium reacts with chlorine to form Magnesium chloride ($Mg Cl_2$)
 - (iii) Magnesium forms a dipositive ion with charge $+2$ (Mg^{+2}) by losing 2 electrons.
 - (iv) Magnesium is a metal.
64. (D) It has the highest nucleon number, indicating the largest number of neutrons, since the isotopes share the same number of protons.

| | Carbon 12 | Carbon 13 | Carbon 14 |
|----------|-----------|-----------|-----------|
| Protons | 6 | 6 | 6 |
| Neutrons | 6 | 7 | 8 |

Carbon 14 has 8 neutrons, highest but not the least among the three isotopes of carbon.

65. (B) The melting point of pure substance 'X' is $1535^\circ C$. It belongs to iron.
 Melting point of ice is $0^\circ C$

Melting point of copper is 1083 °C

Melting point of wax is 63 °C

66. (A) Ethanol is a compound made up of carbon, hydrogen and oxygen elements chemically bonded together - C₂H₅OH . Petrol is a mixture of C₅ – C₁₀ hydrocarbons (alkanes). Steel is an alloy made up of iron and 1–2% of carbon. Tap water has dissolved minerals, chloride and fluoride ions.

67. (D) Isotopes are the atoms of the same element having the same atomic number but different mass numbers. The number of protons and electrons are equal in an atom but the number of protons and neutrons inside the nucleus differ due to increase in the number of neutrons. The stability of an isotopic nucleus depends on its neutron-to-proton ratio.

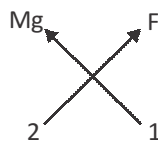
68. (C) In the purification of water, some alum is added to the sedimentation tank. The heavy particles of dissolved alum deposit on the suspended clay particles in water. The suspended clay particles in water get clumped with alum particles, become heavy and settle down at the bottom of the sedimentation tank.

69. (C) (i) The electron structure of atom 'X' is magnesium. Its atomic number is 12 and mass number is 24.

(ii) The electron structure of atom 'Y' is fluorine. Its atomic number is 9 and mass number is 19

(iii) Valency of magnesium is +2 and fluorine is –1

(iv) Atoms 'X' and 'Y' combine to form one molecule of compound called Magnesium fluoride (MgF₂).



(v) Atomic mass of magnesium = 24 g

Atomic mass of fluorine (2 × 19) = 38 g

= 62 g

The mass of one molecule of compound MgF₂ is 62 g.

70. (B) Helium and nitrogen have different molecular masses. Helium (M_r=4) is much lighter than nitrogen (M_r=28) and thus will diffuse faster out of the balloon. Over the same period of time, more of the lighter

helium will have escaped from the balloon, compared to the heavier nitrogen, thus leaving behind a higher proportion of nitrogen. Helium diffuses faster as it has a smaller molar mass.

$$N_2 = 2 \times 14 = 28 \text{ g/mole}$$

$$H_e = 1 \times 4 = 4 \text{ g/mole}$$

$$\text{Rate} = \frac{He}{N_2} = \sqrt{\frac{28 \text{ g/mole}}{4 \text{ g/mole}}} = 2.6$$

Biology

71. (B) In the given figure the part labelled as P is the cytoplasm. Most of the cell processes take place here.

72. (D) Euglena is a single celled organism that has both plant and animal characteristics.

73. (A) Monocotyledons are the flowering plants that are reproduced through flowers.

74. (B) Marchantia is a bryophyte.

75. (B) Mitochondria produce energy by cellular respiration. They are also called power houses of the cell.

76. (D) All insects body is divided into three parts head, thorax and abdomen. They have six legs. Birds, fishes, amphibians and reptiles reproduce by laying eggs. A pair of wings are present in birds and mammal like bat.

77. (B) The increase in food grains production after the introduction of improved varieties of crop production is called green revolution.

78. (B) Frog is a cold blooded animal.

79. (A) Cell → Tissue → organ → system → organism.

Cell → Muscles → Heart → System → organism.

80. (B) Centipedes “from latin prefix centi-hundred” and Pedere, foot are arthropods with jointed legs.

81. (B) As per the given information, Cell P is a plant cell and cell Q is an animal cell. Respiration takes place in plant cell all the time.

82. (A) The given figures P is a nerve cell, Q a RBC and R is a sperm cell. Red blood cell does not have a well defined nucleus.

83. (B) The science of classification is called taxonomy.

84. **(D)** In the given diagram 4 represents the host 3 pathogen and 1 vector.
85. **(A)** Bat and dolphin are mammals.
86. **(C)** Tapeworm is a parasite. The relationship between the tape worm and the man is called parasitism.
87. **(B)** The characteristic feature of dicotyledonous plants is the reticulate type of venation and tap root system. By observing the leaves we can identify the plant as dicotyledonous plant.
88. **(B)** Tendon is the inelastic band which connects muscle and bone together and is able to withstand tension. Tendon and muscle works together to exert a pulling force.
89. **(A)** Organism W is most probably yeast because yeast is a single celled organism that does not produce its own food.
90. **(A)** Energy leaving the decomposer is lost as heat.
99. **(Del)** The chairman of ISRO was K. Radhakrishnan at the time of questionpaper setting, but he had retired on December 31st, 2014. So, now the present chairman of ISRO is A.S. Kiran Kumar.

Hence, the question is deleted.

