



NATIONAL STANDARD EXAMINATION IN JUNIOR SCIENCE

NSEJS - 2024

DETAILED SOLUTIONS

Paper Code 51 | Questions 1-60 | Final answer key

TIME

120 min

QUESTIONS

60

MAX. MARKS

216

SOLUTION BOOKLET

Each question is explained through the central scientific idea and, where needed, a calculation or option-by-option check.

The final answer key supplied for Paper Code 51 is followed. **Question 20 is marked DROP and is not evaluated.**

FINAL ANSWER KEY

NSEJS 2024 - PAPER CODE 51

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

Section A-1: Questions 1-48 have one correct option. **Section A-2:** Questions 49-60 may have more than one correct option. **Question 20: DROP.**

BIOLOGY

SECTION A-1 | QUESTIONS 1-16

QUESTION 1

ANSWER: (d)

CONCEPT: Metamerism and animal classification

Metamerism means true serial repetition of body segments along the length of the body. Its first clear appearance in the animal kingdom is in **Annelida**, for example the earthworm.

Platyhelminthes are unsegmented. Arthropods and vertebrates show segmentation later in evolution. Therefore, the correct answer is **(d) Annelida**.

QUESTION 2

ANSWER: (c)

CONCEPT: Human-evolution terminology used in the paper

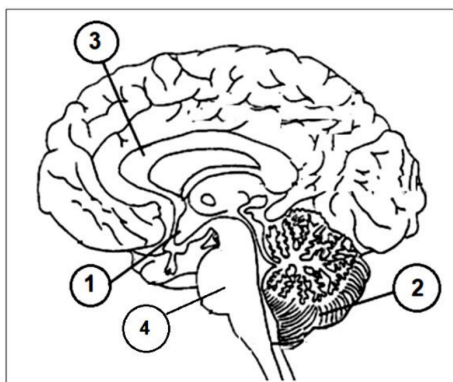
In the classification intended by this question, *Australopithecus* is placed among early hominid stocks, while *Homo habilis* is treated as a prehistoric human form.

Thus the required pair is *Australopithecus* and *Homo habilis*, so **(c)** is correct.

QUESTION 3

ANSWER: (b)

CONCEPT: Functions of major parts of the brain



Statement (i) describes the **pons**, labelled 4. Statement (ii) describes the **hypothalamus**, labelled 1. Statement (iii) describes the **cerebellum**, labelled 2. Statement (iv) describes the **corpus callosum**, labelled 3.

The matching is therefore (i)-4, (ii)-1, (iii)-2 and (iv)-3. Hence **option (b)** is correct.

QUESTION 4

ANSWER: (c)

CONCEPT: Systemic insecticides

A systemic insecticide is absorbed by a plant and carried in its tissues. Sap-sucking insects receive the chemical while feeding.

Metasystox (oxydemeton-methyl) is a classic systemic insecticide used against aphids and other sap-sucking pests. Therefore, **(c)** is correct.

QUESTION 5

ANSWER: (a)

CONCEPT: Pivot joint between atlas and axis

The odontoid process, or dens, of the axis acts as a pivot around which the atlas and head rotate. This is a **pivot (pivotal) joint**.

Hence the correct answer is **(a)**.

QUESTION 6

ANSWER: (c)

CONCEPT: Diagnostic zoological structures

Hexacanth is the six-hooked larva of *Taenia*; renette cells are excretory cells of *Ascaris*; the respiratory tree occurs in sea cucumbers; and piloerection produces goose flesh.

Thus 1-(iv), 2-(ii), 3-(iii), 4-(i), which is **option (c)**.

QUESTION 7

ANSWER: (d)

CONCEPT: Openings between middle and inner ear

The two membrane-covered openings are the **oval window (fenestra ovalis)** and the **round window (fenestra rotunda)**.

Therefore, the correct pair is **(d)**.

QUESTION 8

ANSWER: (a)

CONCEPT: Bharat Stage emission standard

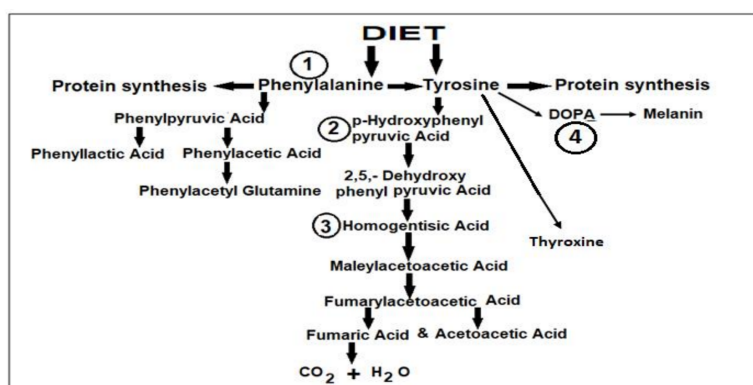
At the time of NSEJS 2024, new vehicles sold and registered in India were required to comply with **Bharat Stage VI (BS-VI)** emission norms.

Hence **option (a)** is correct.

QUESTION 9

ANSWER: (a)

CONCEPT: Inborn errors in phenylalanine-tyrosine metabolism



Accumulation at 1 is associated with **phenylketonuria**. Accumulation at 2 gives **tyrosinosis**.

Accumulation of homogentisic acid at 3 causes **alkaptonuria**. Failure of melanin formation at 4 causes **albinism**.

The sequence is Phenylketonuria, Tyrosinosis, Alkaptonuria, Albinism. Therefore, **(a)** is correct.

QUESTION 10

ANSWER: (c)

CONCEPT: Characteristic structures of selected plants

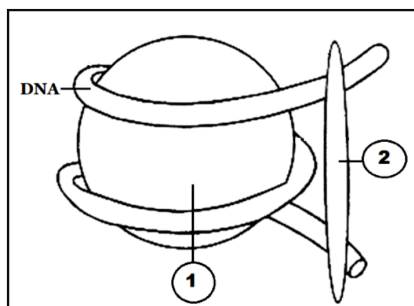
Wheat flowers have **glumes and lodicules**. Banyan develops **prop roots** and bears hypanthodia. Banana has a **pseudostem** and is monocarpic. Pine bears **seeds but no fruits**.

So the matching is 1-(ii), 2-(iv), 3-(i), 4-(iii), giving **option (c)**.

QUESTION 11

ANSWER: (c)

CONCEPT: Nucleosome histones



The nucleosome core is an octamer containing two molecules each of H2A, H2B, H3 and H4. Histone H1 is the linker histone associated with DNA between nucleosomes.

The five histone types are H2A, H2B, H3, H4 and H1. Therefore, **option (c)** is correct.

QUESTION 12

ANSWER: (a)

CONCEPT: Rods and vision in dim light

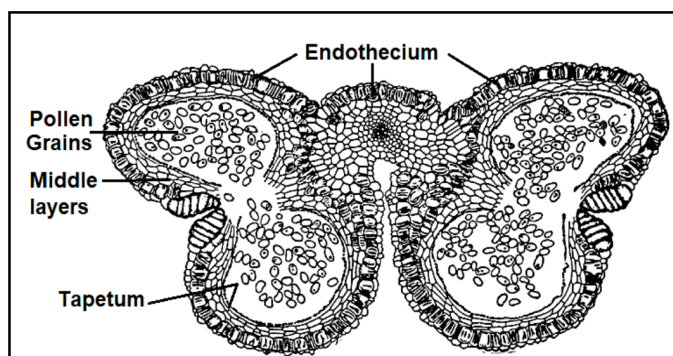
Rods are extremely sensitive to weak light, but they provide poor spatial detail and do not distinguish colours. These properties suit animals living in darkness.

Thus both Assertion and Reason are true, and the Reason explains the Assertion. The intended answer is **(a)**.

QUESTION 13

ANSWER: (d)

CONCEPT: Ploidy in anther tissues



Pollen grains are **haploid (n)**. The anther-wall tissues such as endothecium and middle layers are **diploid (2n)**. Tapetal cells may become binucleate or polyploid through endomitosis.

Therefore, the labelled regions can include haploid, diploid and polyploid cells. The correct answer is **(d)**.

QUESTION 14

ANSWER: (a)

CONCEPT: Cohesion-tension theory

Water molecules are held together by strong cohesive forces. The cohesive strength of a continuous water column is much greater than the approximately 50 atm of opposing forces in a tall tree.

The value intended in the question is about **350 atm**, so **option (a)** is correct.

QUESTION 15

ANSWER: (c)

CONCEPT: Y-linked inheritance

A gene located on the Y chromosome is called **holandric**. It passes directly from father to son and is expressed only in males.

Hypertrichosis of the ear pinna is the classical example used for a holandric trait. Hence **(c)**.

QUESTION 16

ANSWER: (b)

CONCEPT: International protection of the ozone layer

The **Montreal Protocol** was framed to phase out substances such as chlorofluorocarbons that destroy stratospheric ozone.

Therefore, the correct answer is **(b)**.

CHEMISTRY

SECTION A-1 | QUESTIONS 17-32

QUESTION 17

ANSWER: (c)

CONCEPT: Density of a two-component mixture

Total volume = 1.00 L = $1.00 \times 10^{-3} \text{ m}^3$. Fat volume = 4% of 1 L = 0.04 L = $4.0 \times 10^{-5} \text{ m}^3$.

Mass of fat = $865 \times 4.0 \times 10^{-5} = 0.0346 \text{ kg}$. Therefore, mass of skimmed milk = $1.032 - 0.0346 = 0.9974 \text{ kg}$, and its volume = $0.96 \text{ L} = 9.6 \times 10^{-4} \text{ m}^3$.

Density = $0.9974 / (9.6 \times 10^{-4}) = 1038.96 \text{ kg m}^{-3}$, closest to **1038.95**. Hence **(c)**.

QUESTION 18

ANSWER: (d)

CONCEPT: Converting required sodium mass to sodium nitrate mass

Mass of Na^+ needed = $50 \text{ mL} \times 70.0 \text{ mg mL}^{-1} = 3500 \text{ mg} = 3.50 \text{ g}$.

Molar masses: Na = 23 and $\text{NaNO}_3 = 85$. Thus mass of $\text{NaNO}_3 = 3.50 \times 85/23 = 12.93 \text{ g}$.

The listed value is 12.94 g, so **option (d)** is correct.

QUESTION 19

ANSWER: (d)

CONCEPT: Distance between two atoms in tetrahedral geometry

The two C-I bonds of length $2.10 \text{ \AA}$ enclose the tetrahedral angle 109.5° . The I-I distance is the chord opposite this angle:

$$\text{I-I} = 2(2.10) \sin(109.5^\circ/2) = 4.20 \times \sin 54.75^\circ$$

$= 4.20 \times 0.815 = 3.42 \text{ \AA}$. Therefore, **option (d)** is correct.

QUESTION 20

DROP

CONCEPT: Dropped question

Question 20 was DROPPED in the supplied final answer key.

It is not to be evaluated, and no option is treated as the official answer.

QUESTION 21

ANSWER: (b)

CONCEPT: Mass of one mole of electrons

Mass of one electron = $9.11 \times 10^{-31} \text{ kg}$. Therefore, one mole of electrons has mass:

$$9.11 \times 10^{-31} \times 6.02 \times 10^{23} = 5.485 \times 10^{-7} \text{ kg}.$$

Moles in 1 kg = $1 / (5.485 \times 10^{-7}) = 1.82 \times 10^6$, which equals $[100 / (6.02 \times 9.11)] \times 10^6$. Hence **(b)**.

QUESTION 22

ANSWER: (a)

CONCEPT: Coulomb force and microscopic charge fraction

For equal charges q , $F = kq^2/r^2$. Therefore:

$$q = \sqrt{(Fr^2/k)} = \sqrt{[(10^{-5})(10^{-2})^2/(9 \times 10^9)]} = 3.33 \times 10^{-10} \text{ C.}$$

Excess electrons = $q/e \approx 2.08 \times 10^9$. Carbon atoms in 1 g = $N_A/12 \approx 5.02 \times 10^{22}$.

Ratio = $(2.08 \times 10^9)/(5.02 \times 10^{22}) = 4.15 \times 10^{-14}$. Hence **(a)**.

QUESTION 23

ANSWER: (a)

CONCEPT: Periodic properties and magnetic moment

Properties	A	B	C	D	E
Smallest ionic radius	Li ⁺	Na ⁺	K ⁺	Be ²⁺	Mg ²⁺
Highest electronegativity	Cl	S	O	He	N
Highest electron affinity	N	Cl	F	Be	O
Highest magnetic moment	Cr ⁺	Fe ²⁺	Cu ²⁺	Ni ⁴⁺	Sc ³⁺

Be²⁺ is the smallest ion in the first row, so the first letter is D. The intended electronegativity entry in the supplied key is He, letter D. Chlorine has the highest electron affinity in the third row, letter B.

Cr⁺ has a half-filled 3d⁵ arrangement with five unpaired electrons, giving the largest magnetic moment, letter A.

The official sequence is D, D, B, A, so **option (a)**.

QUESTION 24

ANSWER: (c)

CONCEPT: Fahrenheit-Celsius conversion

Use $C = (F - 32) \times 5/9$.

$$C = (102.6 - 32) \times 5/9 = 70.6 \times 5/9 = 39.2^\circ\text{C.}$$

Therefore, **option (c)** is correct.

QUESTION 25

ANSWER: (d)

CONCEPT: Neutral pH changes with temperature

Heating increases the ionic product of water, K_w . Both $[H^+]$ and $[OH^-]$ increase equally, so neutral water has a pH below 7 at 70°C.

The water remains neutral because $[H^+] = [OH^-]$. Hence **(d)**.

QUESTION 26

ANSWER: (c)

CONCEPT: Using the definition of pH

$$\text{pH} = -\log[\text{H}_3\text{O}^+], \text{ so } [\text{H}_3\text{O}^+] = 10^{-8.26}.$$

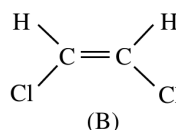
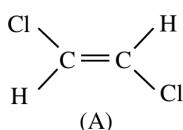
$$10^{-8.26} = 5.5 \times 10^{-9} \text{ mol L}^{-1}.$$

Therefore, **option (c)** is correct.

QUESTION 27

ANSWER: (a)

CONCEPT: Dipole moment and boiling point of geometrical isomers



A is trans-1,2-dichloroethene, whose bond dipoles largely cancel. B is the cis isomer and has a net dipole moment, producing stronger intermolecular attraction.

Therefore, B has the higher boiling point: $T_A < T_B$. Hence **(a)**.

QUESTION 28

ANSWER: (c)

CONCEPT: Tensile strength of advanced materials

Graphene is a one-atom-thick sheet of sp^2 -bonded carbon with exceptionally strong in-plane C-C bonds. Its tensile strength exceeds that of the other listed materials.

Thus **option (c) Graphene** is correct.

QUESTION 29

ANSWER: (c)

CONCEPT: Inert-pair effect in Group 13

Boron most stably shows the +3 oxidation state. Down the group, the inert-pair effect makes +1 increasingly stable; therefore thallium is most stable as Tl^+ .

The pair is B^{3+} , Tl^+ , giving **option (c)**.

QUESTION 30

ANSWER: (a)

CONCEPT: Gas generation in automobile air bags

Traditional air bags used sodium azide, NaN_3 . On rapid decomposition it produces nitrogen gas, which inflates the bag.

Therefore, **option (a)** is correct.

QUESTION 31

ANSWER: (b)

CONCEPT: MRI contrast agents

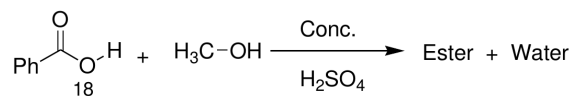
Gadolinium ions are strongly paramagnetic. In clinical contrast agents, Gd is safely bound in a chelate and alters the relaxation of nearby hydrogen nuclei.

Hence **option (b) Gd** is correct.

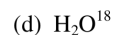
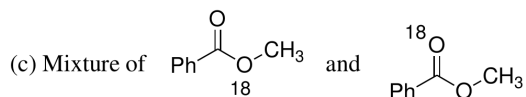
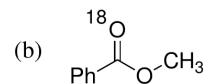
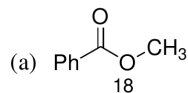
QUESTION 32

ANSWER: (b)

CONCEPT: Oxygen-18 labelling in esterification



The fate of the labelled oxygen (O^{18}) atom in the product is:



The supplied final key places the labelled oxygen at the carbonyl oxygen of the ester shown in **option (b)**. Under the strongly acidic conditions, proton-transfer and oxygen-exchange steps within the carboxyl group account for the intended labelled product.

Therefore, according to the final key, the answer is **(b)**.

PHYSICS

SECTION A-1 | QUESTIONS 33-48

QUESTION 33

ANSWER: (d)

CONCEPT: Comparing accelerations

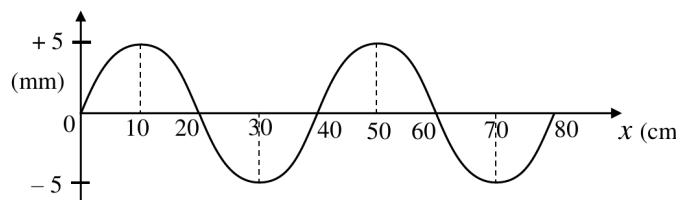
- (a) $72 \text{ km h}^{-1} = 20 \text{ m s}^{-1}$, so $|a| = 20/2.5 = 8 \text{ m s}^{-2}$.
 (b) Free fall gives about 9.8 m s^{-2} .
 (c) $108 \text{ km h}^{-1} = 30 \text{ m s}^{-1}$, so $a = 30/4 = 7.5 \text{ m s}^{-2}$.
 (d) From $s = \frac{1}{2}at^2$, $a = 2(216)/6^2 = 12 \text{ m s}^{-2}$.

The largest is 12 m s^{-2} . Hence **(d)**.

QUESTION 34

ANSWER: (c)

CONCEPT: Reading a travelling-wave graph



Amplitude = 5 mm. The distance between successive crests is $50 - 10 = 40 \text{ cm} = 0.40 \text{ m}$, so $f = v/\lambda = 360/0.40 = 900 \text{ Hz}$.

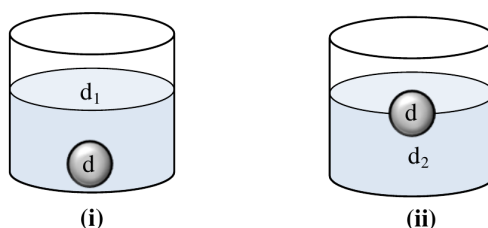
In 0.01 s the wave moves $360 \times 0.01 = 3.6 \text{ m} = 360 \text{ cm} = 9$ wavelengths, so the graph repeats at the same positions; troughs remain at 30 cm and 70 cm, not 20 cm and 40 cm. Also, $360 \times 4.5 = 1620 \text{ m} = 1.62 \text{ km}$.

Thus the incorrect statement is **(c)**.

QUESTION 35

ANSWER: (c)

CONCEPT: Buoyant force



In liquid d_1 , the sinking sphere is fully immersed, so $F_1 = d_1 Vg$.

In liquid d_2 , the floating sphere is in equilibrium, so $F_2 = \text{weight} = dVg$. Therefore:

$$F_1/F_2 = d_1/d.$$

Hence **option (c)**.

QUESTION 36

ANSWER: (b)

CONCEPT: Uniform velocity and balanced forces

Uniform velocity means zero acceleration, so S_1 is true. It means the *net* force is zero, not that no forces act; S_2 is false.

Constant speed and direction give constant kinetic energy and momentum, so S_3 is true. The engine can still do work against friction and air resistance, so S_4 is false.

Only S_1 and S_3 are true: **(b)**.

QUESTION 37

ANSWER: (c)

CONCEPT: Uniform circular motion

A 45° arc is one-eighth of a revolution. Therefore, the time period $T = 8 \times 0.02 = 0.16$ s and $f = 1/T = 6.25$ Hz.

The circumference is $\pi D = \pi(0.14) \approx 0.44$ m. Thus $v = 0.44/0.16 = 2.75$ m s⁻¹.

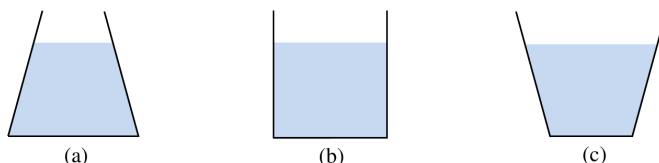
The correct pair is **(c)**.

QUESTION 38

ANSWER: (d)

CONCEPT: Hydrostatic paradox

(c). Each vessel has equal base area.



Pressure at a depth h is ρgh . Since the liquid, height and base level are the same, $P_a = P_b = P_c$.

The vessels contain different volumes: vessel (a) narrows upward, vessel (b) has constant cross-section, and vessel (c) widens upward. Therefore $W_a < W_b < W_c$.

Hence **option (d)**.

QUESTION 39

ANSWER: (c)

CONCEPT: Velocity of an image in a concave mirror

For object distance $u > f$, the image distance is $v = fu/(u-f)$. As the ant approaches the focus, $u-f$ becomes smaller and the image moves away increasingly rapidly.

At $u = 2f$, the image-speed magnitude equals the object-speed magnitude, but the two velocities are in opposite directions, so they are not the same velocity. Thus S_2 is false while S_3 is true.

Only S_3 is correct, giving **(c)**.

QUESTION 40

ANSWER: (d)

CONCEPT: Dimensional forms of electric current

C/s = A. Also J/C = V, so J/(C·Ω) = V/Ω = A. Further, W/V = A.

V/(C·m) does not reduce to ampere. Therefore, the expression that cannot be a unit of current is **(d)**.

QUESTION 41

ANSWER: (c)

CONCEPT: Mass-energy equivalence

$$E = mc^2 = (1.6605 \times 10^{-27})(2.9979 \times 10^8)^2 \approx 1.492 \times 10^{-10} \text{ J.}$$

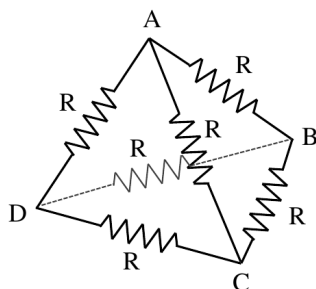
Dividing by $1.602 \times 10^{-19} \text{ J/eV}$ gives $9.31 \times 10^8 \text{ eV} = 931 \text{ MeV}$.

Hence **option (c)**.

QUESTION 42

ANSWER: (d)

CONCEPT: Symmetry in a tetrahedral resistor network



Choose any two vertices as terminals. By symmetry, the remaining two vertices are at the same potential, so no current flows through the resistor joining them.

The two side resistors from the first terminal are in parallel, giving $R/2$; similarly on the other side. These add to R , in parallel with the direct resistor R . Thus $R_{eq} = R/2 = 6 \Omega$.

Therefore, **(d)**.

QUESTION 43

ANSWER: (b)

CONCEPT: Momentum at equal kinetic energy

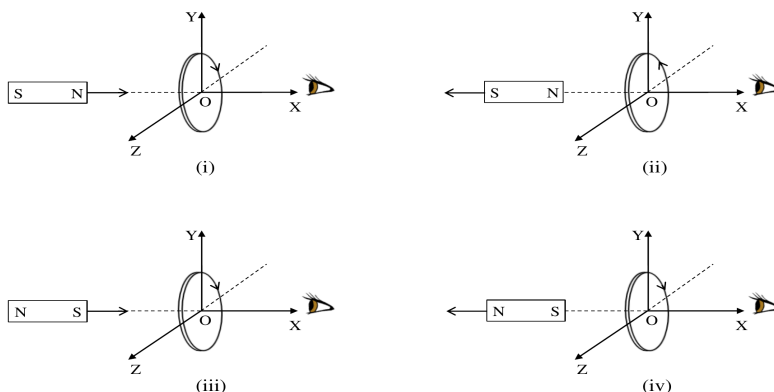
$$K = p^2/(2m), \text{ so for equal } K, p \propto \sqrt{m}.$$

Therefore $p_1:p_2 = \sqrt{1}:\sqrt{4} = 1:2$. Hence **(b)**.

QUESTION 44

ANSWER: (d)

CONCEPT: Lenz's law and induced-current direction



For each diagram, first decide whether the magnetic flux through the loop is increasing or decreasing. Lenz's law says the induced field opposes that change. The right-hand rule then gives the current direction as seen from +X.

Applying this test shows that diagrams (i), (ii) and (iv) are correct, while (iii) has the wrong current direction. Hence **option (d)**.

QUESTION 45

ANSWER: (c)

CONCEPT: Heating power and resistance of a wire

$R = \rho L/A$ and $A \propto D^2$. For the new wire:

$$R' / R = (2L/L) \times (D^2/(2D)^2) = 2/4 = 1/2.$$

At fixed voltage, $P = V^2/R$, so the power doubles. The same heat therefore takes half the time: $6/2 = 3$ min. Hence **(c)**.

QUESTION 46

ANSWER: (b)

CONCEPT: Distance under uniform retardation

The wagon slows uniformly from v to 0 in time t , so its average speed is $v/2$. Hence $d_1 = vt/2$.

The train continues at v , so $d_2 = vt$. Thus $d_1/d_2 = 1/2$, giving **(b)**.

QUESTION 47

ANSWER: (d)

CONCEPT: Correction of myopia

For a distant object, the correcting lens must form a virtual image at the person's far point, 2.5 m in front of the eye. Thus $f = -2.5$ m.

Power $P = 1/f = -1/2.5 = -0.4$ D. Therefore, **(d)**.

QUESTION 48

ANSWER: (b)

CONCEPT: Surface gravity of planets

$g = GM/R^2$. For planet 2:

$$g_2 = G(2M)/(2R)^2 = (1/2)GM/R^2 = g_1/2.$$

Therefore $g_1:g_2 = 2:1$, so **(b)**.

BIOLOGY

SECTION A-2 | QUESTIONS 49-52

QUESTION 49

ANSWER: (a, b, d)

CONCEPT: Aril and edible seed coverings

- (a) **Litchi**: true - the fleshy edible part is an aril.
(b) **Rambutan**: true - the edible fleshy covering is an aril.
(c) **Cashew**: false - the edible cashew apple is a swollen accessory structure, not an aril.
(d) **Nutmeg**: true - the red mace is an aril.

Correct options: **(a), (b), (d)**.

QUESTION 50

ANSWER: (c, d)

CONCEPT: Structure and reproduction of viruses

- (a) Accepted as correct: complete viral particles may be infectious.
(b) Accepted as correct in the intended statement: viral multiplication is directed by their genetic material using a host cell.
(c) Incorrect: the envelope is a lipid bilayer containing viral glycoproteins; calling it simply a glycolipid envelope is not correct.
(d) Incorrect: viruses do not possess ribosomes.

Incorrect statements: **(c), (d)**.

QUESTION 51

ANSWER: (b, c)

CONCEPT: Flagella in major algal divisions

Rhodophyta have no flagellated stages. Phaeophyta have motile cells with two unequal flagella. Chlorophyta commonly have motile cells with two flagella. Cyanophyta lack true flagella.

Correct options: **(b), (c)**.

QUESTION 52

ANSWER: (a, c, d)

CONCEPT: Immunity and protective barriers

- (a) True: immunoglobulins are glycoproteins.
(b) False in the intended classification: eosinophils are polymorphonuclear granulocytes and can show limited phagocytosis.
(c) True: cilia help sweep trapped material from the respiratory tract and form a mechanical defence.
(d) True: mature naive B cells display surface IgM and IgD.

Correct options: **(a), (c), (d)**.

CHEMISTRY

SECTION A-2 | QUESTIONS 53-56

QUESTION 53

ANSWER: (a, b, c)

CONCEPT: Medicinal colloids

Argyrol is a colloidal silver preparation used as an antiseptic. Sulfur sols have medicinal applications, especially in skin preparations. Milk of magnesia is a colloidal suspension of $\text{Mg}(\text{OH})_2$ used as an antacid and laxative.

Purple of Cassius is mainly used in colouring glass and ceramics, not as a medicine. Correct options: **(a), (b), (c)**.

QUESTION 54

ANSWER: (c, d)

CONCEPT: Reduction of nitrogen

Reduction means a decrease in oxidation number.

- (a)** N changes from -3 in NH_4^+ to 0: oxidation.
- (b)** N changes from -3 in NH_2^- to +2 in NO: oxidation.
- (c)** N changes from +4 in NO_2 to +3 in NO_2^- : reduction.
- (d)** N changes from +5 in NO_3^- to -3 in NH_4^+ : reduction.

Correct options: **(c), (d)**.

QUESTION 55

ANSWER: (a, d)

CONCEPT: Basicity of oxyacids of phosphorus

40 g NaOH is 1 mol. Since 1 mol of acid is completely neutralised by 1 mol NaOH, the acid is monobasic.

H_3PO_2 ($x = 2$) has only one ionisable O-H hydrogen; the two P-H hydrogens are not acidic. Therefore it is monobasic and cannot form an acid salt.

Correct options: **(a), (d)**.

QUESTION 56

ANSWER: (a, b, c)

CONCEPT: Electronic configuration from shell population

Total electrons = $2 + 8 + 9 + 2 = 21$, so the element is scandium: $[\text{Ar}] 3d^1 4s^2$.

It has one unpaired electron and one d-electron. Its p-electrons are $2p^6 + 3p^6 = 12$. Scandium is a metal.

Correct options: **(a), (b), (c)**.

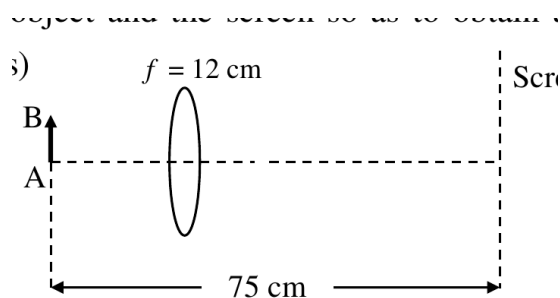
PHYSICS

SECTION A-2 | QUESTIONS 57-60

QUESTION 57

ANSWER: (a, b, c, d)

CONCEPT: Two positions of a convex lens



Let object and image distances be u and v . Since the screen is 75 cm from the object, $u + v = 75$. The lens formula gives $uv = f(u+v) = 12 \times 75 = 900$.

Thus $t^2 - 75t + 900 = 0$, whose roots are 15 cm and 60 cm. The lens can therefore be 15 cm or 60 cm from the object.

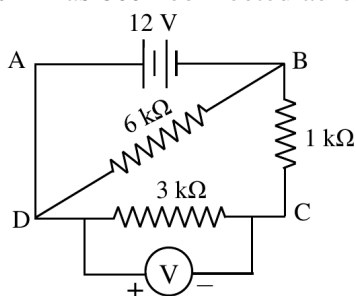
The magnification is v/u : it is 4 in one position and $1/4$ in the other, so the image can be larger or smaller. Correct options: **(a), (b), (c), (d)**.

QUESTION 58

ANSWER: (a, c, d)

CONCEPT: Loaded voltmeter circuit

6000 Ω has been connected across 3



The 3 k Ω resistor is in parallel with the 6 k Ω voltmeter, giving 2 k Ω . In series with 1 k Ω , that branch is 3 k Ω . It is in parallel with the diagonal 6 k Ω resistor across 12 V.

Current in the 3 k Ω branch = $12/3000 = 4$ mA. Voltage across the parallel pair = $(4 \text{ mA})(2 \text{ k}\Omega) = 8$ V, so the voltmeter reads 8 V. Current in the 1 k Ω resistor is 4 mA, not 2 mA.

The diagonal 6 k Ω branch carries 2 mA. Total current = $4 + 2 = 6$ mA, and its power is $(2 \text{ mA})^2(6 \text{ k}\Omega) = 24$ mW.

Correct options: **(a), (c), (d)**.

QUESTION 59

ANSWER: (a, b, c, d)

CONCEPT: Echo from a hill while the source moves

Train speed = $108 \text{ km h}^{-1} = 30 \text{ m s}^{-1}$. Let total echo time be t . The sound travels 1200 m to the hill and then meets the approaching train. Equivalently, the total closing relation gives:

$$330t = 1200 + (1200 - 30t), \text{ so } 360t = 2400 \text{ and } t = 20/3 \text{ s.}$$

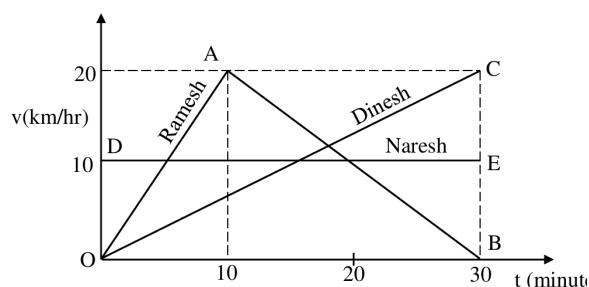
$20/3 \text{ s} = 1/9 \text{ minute}$. In this time the train moves $30 \times 20/3 = 200 \text{ m}$, so it is 1000 m from the hill. The wavelength used in the question is $\lambda = 330/550 = 0.60 \text{ m} = 60 \text{ cm}$.

Correct options: **(a), (b), (c), (d)**.

QUESTION 60

ANSWER: (b, c)

CONCEPT: Area and slope of velocity-time graphs



Distance is the area under a v-t graph. Ramesh's triangular area is $\frac{1}{2} \times 0.5 \text{ h} \times 20 \text{ km h}^{-1} = 5 \text{ km}$.

Dinesh's triangle gives the same 5 km. Naresh's rectangle gives $0.5 \text{ h} \times 10 \text{ km h}^{-1} = 5 \text{ km}$.

Dinesh's acceleration is $\Delta v / \Delta t = 20 / (0.5) = 40 \text{ km h}^{-2}$. Naresh is in uniform motion, so statement (d) is false.

Correct options: **(b), (c)**.