



NATIONAL STANDARD EXAMINATION IN JUNIOR SCIENCE

NSEJS - 2023

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, the required calculation or reasoning, and the final option or options.

For Section A-2, every statement is checked separately.

FINAL ANSWER KEY

NSEJS 2023 - PAPER CODE 51

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

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

BIOLOGY

SECTION A-1 | QUESTIONS 1-16

QUESTION 1

ANSWER: (d)

CONCEPT: Valves of the mammalian heart

The valve between the **left atrium (left auricle)** and the **left ventricle** is the **mitral or bicuspid valve**. It opens when blood enters the ventricle and closes during ventricular contraction, preventing backflow.

Therefore, the correct answer is **(d) Mitral valve**.

QUESTION 2

ANSWER: (c)

CONCEPT: Parts of a reflex arc

A typical reflex pathway contains a receptor or sensory neuron, one or more connecting neurons (interneurons) in the spinal cord, and a motor or effector neuron carrying the response to an effector.

This is the arrangement described in **option (c)**.

QUESTION 3

ANSWER: (c)

CONCEPT: Cytoplasmic hybrids or cybrids

A cybrid is obtained by combining the nucleus of one cell with the cytoplasm and organelles of another. **Pomato** and **Bromato** are the intended plant examples produced through somatic-cell or cytoplasmic hybridisation.

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

QUESTION 4

ANSWER: (d)

CONCEPT: Pseudostratified epithelium

In pseudostratified epithelium, all cells touch the basement membrane, but not all reach the free surface. The nuclei therefore appear at different levels even though the tissue is not truly stratified.

Ciliated forms occur in the **trachea**; related pseudostratified epithelia occur in the **vas deferens and epididymis**. Thus, the intended answer is **(d)**.

QUESTION 5

ANSWER: (b)

CONCEPT: Recessive inheritance and conditional probability

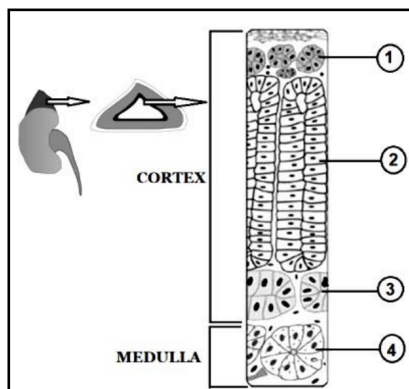
Let tasting be dominant **T** and non-tasting be recessive **t**. The woman is a non-taster, so she is **tt**. The man is a taster, but the birth of non-taster children proves that he carries the recessive allele: **Tt**.

For each child, $Tt \times tt$ gives $1/2$ **Tt** (taster) and $1/2$ **tt** (non-taster). Each birth is independent, so the probability for the third child is $1/2 = 0.50$. Hence **(b)**.

QUESTION 6

ANSWER: (d)

CONCEPT: Layers of the adrenal gland



The diagram shows the adrenal cortex above the medulla. Labels **2 and 3** represent the inner cortical zones, chiefly the zona fasciculata and zona reticularis. These cortical regions are associated with secretion of C_{21} corticosteroids, including cortisol and corticosterone.

Therefore, the answer is **(d) 2 and 3**.

QUESTION 7

ANSWER: (b)

CONCEPT: Presbyopia

With age, the ciliary muscles weaken and the lens loses flexibility. The eye then cannot increase lens curvature sufficiently for clear near vision. This age-related defect is **presbyopia**.

Hence, **option (b)**.

QUESTION 8

ANSWER: (b)

CONCEPT: Stored-grain insect pests

The Angoumois grain moth belongs to the genus *Sitotroga*. Its larvae enter and damage stored cereal grains such as wheat and paddy.

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

QUESTION 9

ANSWER: (b)

CONCEPT: Meiosis needed for seeds and pollen

To make 300 seeds, the plant needs 300 functional embryo sacs. One megaspore mother cell undergoes meiosis for each ovule, so this requires **300 meiotic divisions**.

It also needs at least 300 pollen grains. One pollen mother cell produces four pollen grains, so $300/4 = 75$ **meiotic divisions**.

Total meiotic divisions = $300 + 75 = 375$. Hence, **option (b)**.

QUESTION 10

ANSWER: (c)

CONCEPT: Internal anatomy of Equisetum

Equisetum stems possess two characteristic canal systems: **carinal canals** associated with the vascular bundles and **vallecular canals** in the cortex beneath the grooves.

Thus, the correct answer is **(c) Equisetum**.

QUESTION 11

ANSWER: (b)

CONCEPT: Human satellite chromosomes

In humans, nucleolar organiser regions and satellites occur on the short arms of the acrocentric chromosomes **13, 14, 15, 21 and 22**.

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

QUESTION 12

ANSWER: (b)

CONCEPT: Bordered pits in plant cell walls

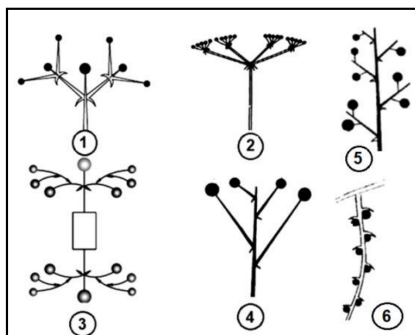
In a bordered pit pair, the pit membrane has a thick central region called the **torus**, surrounded by a more porous region called the margo. The torus can move and close the pit opening.

Hence, the correct answer is **(b) Torus**.

QUESTION 13

ANSWER: (c)

CONCEPT: Cymose inflorescences



yogenesis include members of all of the

In a cymose inflorescence, the main axis ends in a flower, so growth is determinate. In the supplied diagram, structures **1 and 3** show this cymose pattern.

Therefore, the correct answer is **(c) 1 and 3**.

QUESTION 14

ANSWER: (c)

CONCEPT: Genes involved in embryonic development

Proto-oncogenes, growth-factor genes and Hox genes have direct, recognised roles in controlling growth, signalling and body pattern during embryogenesis. In the classification intended by this question, **tumour-suppressor genes** are the exception.

Hence, **option (c)**.

QUESTION 15

ANSWER: (c)

CONCEPT: CAM photosynthesis

In CAM plants, stomata open at night. CO_2 combines with phosphoenolpyruvate (PEP) to form oxaloacetate and is stored as organic acid. **Aloe** is a succulent CAM plant.

Therefore, the answer is **(c) Aloe**.

QUESTION 16

ANSWER: (b)

CONCEPT: Hemiparasitic mistletoe

Dendrophthoe falcata is a common Indian mistletoe. It is a green, photosynthetic plant but obtains water and minerals from its host through haustoria, so it is a hemiparasite.

Hence, **option (b)**.

CHEMISTRY

SECTION A-1 | QUESTIONS 17-32

QUESTION 17

ANSWER: (b)

CONCEPT: Electron affinity and successive electron addition

Adding one electron to a neutral chlorine atom releases energy, so formation of Cl^- is **exothermic**. Adding a second electron to O^- to form O^{2-} must overcome repulsion from an already negative ion, so it is **endothermic**.

The required pair is therefore Cl^- and O^{2-} , **option (b)**.

QUESTION 18

ANSWER: (c)

CONCEPT: Kinetic isotope effect

H-H and D-D bonds do not have exactly the same vibrational zero-point energy. The D-D bond has a slightly greater effective dissociation energy, so the reaction involving D_2 has a higher activation barrier.

Thus H_2 reacts faster because its effective activation energy is lower. This is **option (c)**.

QUESTION 19

ANSWER: (a)

CONCEPT: Properties of water and heavy water

At 293 K, the intended comparisons are: dielectric constant $\text{H}_2\text{O} > \text{D}_2\text{O}$; refractive index $\text{H}_2\text{O} > \text{D}_2\text{O}$; and intermolecular association $\text{D}_2\text{O} > \text{H}_2\text{O}$.

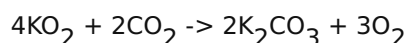
These are statements (i), (iii) and (vi), giving **option (a)**.

QUESTION 20

ANSWER: (b)

CONCEPT: Potassium superoxide in breathing systems

Potassium superoxide, KO_2 , is used in closed breathing systems because it removes carbon dioxide and can regenerate oxygen. A simplified reaction is:



Therefore, the correct answer is **(b) KO_2** .

QUESTION 21

ANSWER: (d)

CONCEPT: Lewis structure of I_3^-

I_3^- is linear. Each terminal iodine has three lone pairs, and the central iodine also has three lone pairs in the expanded-valence description.

Total lone pairs = $3 + 3 + 3 = 9$. Hence, **option (d)**.

QUESTION 22

ANSWER: (d)

CONCEPT: Naturally absent elements below uranium

The elements normally identified as having no stable natural occurrence in the range H to U are **technetium (Z = 43)** and **promethium (Z = 61)**. None of the listed number-pairs is 43 and 61.

Therefore, **option (d) None of these**.

QUESTION 23

ANSWER: (b)

CONCEPT: Extreme states of matter

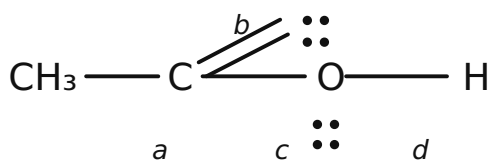
At very high temperature, atoms become ionised and matter exists as **plasma**. At temperatures extremely close to absolute zero, suitable bosons can occupy one quantum state and form a **Bose-Einstein condensate**.

Thus, the answer is **(b) Plasma, BEC**.

QUESTION 24

ANSWER: (b)

CONCEPT: Acid activation of a carboxyl group



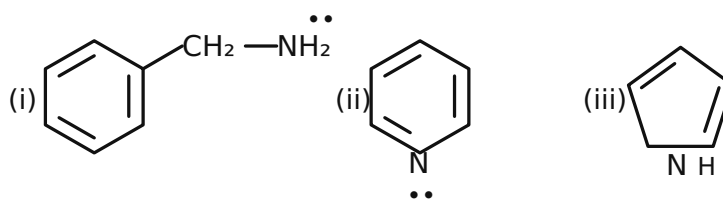
Hydronium first protonates the carbonyl oxygen. In the electron-pair description, the C=O pi component labelled **b** is the bond whose bond order is first disrupted during this acid-activation step.

Therefore, the keyed answer is **(b) bond b**.

QUESTION 25

ANSWER: (a)

CONCEPT: Lewis basicity and availability of a lone pair



In pyrrole (iii), the nitrogen lone pair is part of the aromatic sextet, so it is least available for protonation. In pyridine (ii), the lone pair is not part of the aromatic sextet and is more available. Benzylamine (i) is an aliphatic amine and is the strongest base of the three.

Increasing basic strength: **iii < ii < i**. Hence, **option (a)**.

QUESTION 26

ANSWER: (c)

CONCEPT: Maximum branching in an alkane

A methyl group is a terminal carbon of the carbon skeleton. To maximise terminal carbons in $C_{11}H_{24}$, use three quaternary carbons connected in a chain. The two end quaternary carbons carry three methyl groups each, and the middle one carries two.

Maximum CH_3 groups = $3 + 2 + 3 = 8$. Therefore, **option (c)**.

QUESTION 27

ANSWER: (b)

CONCEPT: Ideal gas equation

Moles of methane = $4/16 = 0.25$ mol. At the bursting point, $P = 10$ atm and $V = 1$ L.

$$T = PV/(nR) = (10 \times 1)/(0.25 \times 0.0821) = 487.2 \text{ K}$$

The closest listed value is **487.6 K**. Hence, **option (b)**.

QUESTION 28

ANSWER: (b)

CONCEPT: Very dilute strong acid and water autoionisation

For 10^{-8} M HCl, the H^+ supplied by water itself cannot be ignored. Adding the acid makes $[H^+]$ slightly greater than 10^{-7} M, so the pH is slightly less than 7 (about 6.98).

Thus, **option (b) pH < 7**.

QUESTION 29

ANSWER: (d)

CONCEPT: Average atomic mass from isotope abundance

Use the weighted average:

$$\text{Average mass} = 10.013(0.198) + 11.009(0.802) = 10.811792 \text{ u}$$

This is closest to **10.812 u**. Therefore, **option (d)**.

QUESTION 30

ANSWER: (b)

CONCEPT: Equivalent mass in acid-base titration

50 mL of 0.25 N HCl supplies $0.050 \times 0.25 = 0.0125$ equivalents. Let x g be Na_2CO_3 . Its equivalent mass is $106/2 = 53$, while that of K_2CO_3 is $138/2 = 69$.

$$x/53 + (0.75 - x)/69 = 0.0125$$

Solving gives x about 0.373 g, so Na_2CO_3 is about 49.7% of the mixture. The nearest option is **49.4%**, so **(b)**.

QUESTION 31

ANSWER: (c)

CONCEPT: Moles and Avogadro number

Three carats = 3×200 mg = 600 mg = 0.600 g. Diamond is carbon.

$$\text{Moles of C} = 0.600/12 = 0.050 \text{ mol}$$

$$\text{Atoms} = 0.050 \times 6.02 \times 10^{23} = 3.01 \times 10^{22}$$

Hence, **option (c)**.

QUESTION 32

ANSWER: (c)

CONCEPT: Soap and detergents in hard water

Soaps such as sodium palmitate form insoluble calcium and magnesium salts (scum), so they do not lather well in hard water. A sulphonate detergent does not form the same insoluble precipitate.

Potassium n-dodecylbenzene sulphonate therefore forms foam. The correct answer is **(c)**.

PHYSICS

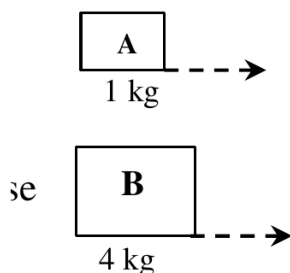
SECTION A-1 | QUESTIONS 33-48

QUESTION 33

ANSWER: (d)

CONCEPT: Equal kinetic energies: speed and momentum

Equal kinetic energies



For equal kinetic energy $K = (1/2)mv^2$, speed varies as $1/\sqrt{m}$. Therefore $v_A:v_B = \sqrt{4/1} = 2:1$, not $1:2$, so S1 is false.

Also $K = p^2/(2m)$, so p is proportional to $\sqrt{m}$. Thus $p_A:p_B = 1:2$, and S2 is true.

Therefore, **option (d)**.

QUESTION 34

ANSWER: (a)

CONCEPT: Resistance, resistivity, density and wire length

For a wire, $R = \rho L/A$ and mass $m = dAL$. Multiplying eliminates A :

$$Rm = \rho d L^2, \text{ so } L = \sqrt{Rm/(\rho d)}$$

$$L = \sqrt{(0.065)(0.02095)/(1.7 \times 10^{-8} \times 8900)} = 3.00 \text{ m}$$

Hence, **option (a)**.

QUESTION 35

ANSWER: (d)

CONCEPT: Speed of sound and absolute temperature

Since v is proportional to $\sqrt{T}$,

$$360/332 = \sqrt{T/273}$$

$$T = 273(360/332)^2 \text{ about } 321 \text{ K}$$

321 K is about 48 degrees C. Therefore, **option (d)**.

QUESTION 36

ANSWER: (c)

CONCEPT: Lenz law and magnetic braking

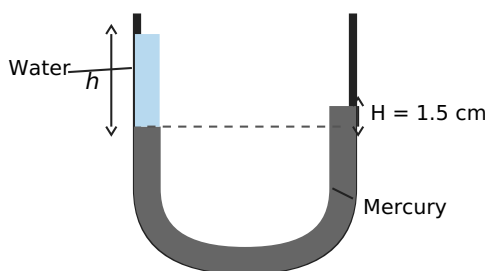
As the magnet approaches and passes the conducting ring, the magnetic flux through the ring changes. The induced current produces a magnetic effect that opposes the change, so the magnetic force opposes the fall.

The force depends on position and speed, so the acceleration is **less than g and non-uniform**. Hence, **option (c)**.

QUESTION 37

ANSWER: (b)

CONCEPT: Hydrostatic balance in a U-tube



At the same horizontal level in the mercury, pressures must be equal. The water column of height h balances a mercury-level difference H :

$$\rho_w g h = \rho_{Hg} g H$$

$$h = 13.6 \times 1.5 \text{ cm} = 20.4 \text{ cm}$$

Therefore, **option (b)**.

QUESTION 38

ANSWER: (b)

CONCEPT: Newton form of the lens formula

The object is 10 cm beyond the first focus and the image is 40 cm beyond the second focus. Newton's lens relation is $xx' = f^2$.

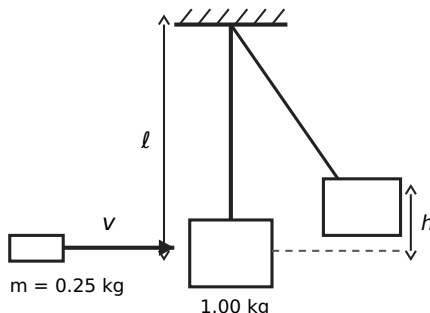
$$f^2 = 10 \times 40 = 400, \text{ so } f = 20 \text{ cm}$$

Hence, **option (b)**.

QUESTION 39

ANSWER: (c)

CONCEPT: Ballistic pendulum: momentum and energy



After the bullet embeds, the combined mass is 1.25 kg. During the rise, kinetic energy changes to gravitational potential energy:

$$V = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 0.196} = 1.96 \text{ m s}^{-1}$$

During impact, momentum is conserved:

$$0.25v = 1.25(1.96), \text{ so } v = 9.8 \text{ m s}^{-1}$$

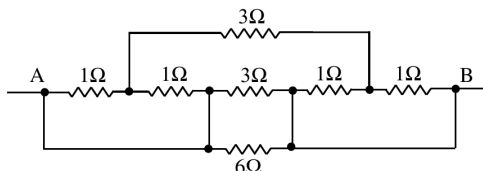
Therefore, **option (c)**.

QUESTION 40

ANSWER: (b)

CONCEPT: Reduction of a resistor network using equipotential wires

Equivalent resistance between points A and B in the following electrical network is



$$\frac{3}{4} \Omega$$

$$(b) \frac{4}{3} \Omega$$

$$(c) \frac{2}{5} \Omega$$

$$(d) \frac{9}{14} \Omega$$

The lower wires make the junction after the second 1-ohm resistor the same node as A, and the next junction the same node as B. Thus each pair of 1-ohm resistors at the left and right becomes $1 \parallel 1 = 0.5$ ohm.

One A-B branch is then $0.5 + 3 + 0.5 = 4$ ohm. The other direct branches are 3 ohm and 6 ohm.

$$1/R = 1/4 + 1/3 + 1/6 = 3/4, \text{ so } R = 4/3 \text{ ohm}$$

Hence, **option (b)**.

QUESTION 41

ANSWER: (b)

CONCEPT: Order of magnitude of pressure

An adult weight is roughly 600-800 N. The combined contact area of two feet is of order $0.04\text{-}0.06 \text{ m}^2$.

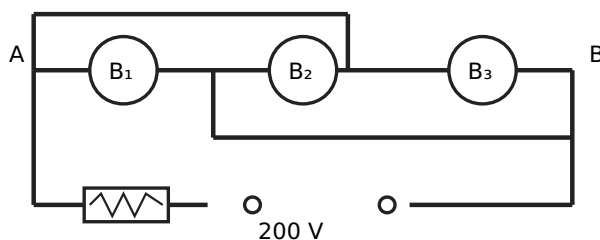
$$\text{Pressure} = \text{force/area, of order } 700/0.05 \text{ about } 1.4 \times 10^4 \text{ Pa}$$

Thus the order of magnitude is **10^4 Pa** , option **(b)**.

QUESTION 42

ANSWER: (d)

CONCEPT: Bulbs connected in parallel and fuse rating



The cross-connections in the diagram place all three bulbs directly across A and B, so they operate in parallel at 200 V.

$$\text{Total current} = 100/200 + 60/200 + 40/200 = 0.5 + 0.3 + 0.2 = 1.0 \text{ A}$$

A 1.0 A fuse rating is therefore required. Hence, **option (d)**.

QUESTION 43

ANSWER: (b)

CONCEPT: Object-image separation in a convex mirror

A convex mirror always forms a virtual image behind the mirror. As the ant moves toward the pole, both the object distance and the image distance from the pole decrease.

The sum of these two distances, which is the ant-image separation, therefore **decreases throughout**. Hence, **option (b)**.

QUESTION 44

ANSWER: (d)

CONCEPT: Possible series-parallel combinations

Values below 2 ohm are possible by using parallel combinations. Also:

$$2 + (4 \parallel 6) = 2 + 2.4 = 4.4 \text{ ohm}$$

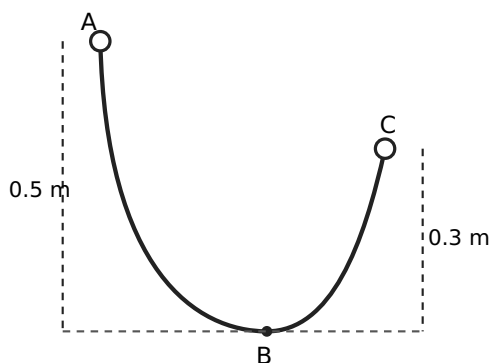
$$4 + (2 \parallel 6) = 4 + 1.5 = 5.5 \text{ ohm}$$

Checking all series-parallel arrangements of 2, 4 and 6 ohm does not produce 7.6 ohm. Therefore, **option (d)**.

QUESTION 45

ANSWER: (d)

CONCEPT: Work-energy theorem with friction



The bead starts and ends at rest. Its decrease in gravitational potential energy is the work done against friction:

$$W_f = mg(0.5 - 0.3) = (0.003)(9.8)(0.2)$$

For track length 0.8 m, average friction f satisfies $f(0.8) = W_f$.

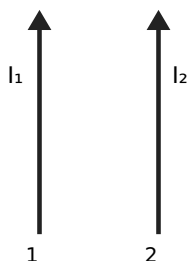
$$f = 7.35 \times 10^{-3} \text{ N, close to } 7.36 \times 10^{-3} \text{ N}$$

Hence, **option (d)**.

QUESTION 46

ANSWER: (d)

CONCEPT: Forces between parallel current-carrying wires



Ordinary current-carrying wires are electrically neutral overall, so the net electrostatic force F_e between them is zero. Parallel currents in the same direction attract magnetically.

Thus F_e is zero and F_m is attractive. The answer is **(d)**.

QUESTION 47

ANSWER: (b)

CONCEPT: Celsius to kelvin conversion

Kelvin temperature is obtained by adding 273.15:

$$T = 37.3 + 273.15 = 310.45 \text{ K}$$

Therefore, the correct answer is **(b) 310.45 K**.

QUESTION 48

ANSWER: (d)

CONCEPT: Orbital speed in a circular orbit

For a circular orbit around the same star, $v = \sqrt{GM/r}$, so v is proportional to $1/\sqrt{r}$.

$$v_1/v_2 = \sqrt{10^{12}/10^{13}} = 1/\sqrt{10}$$

Hence, **option (d)**.

BIOLOGY

SECTION A-2 | QUESTIONS 49-52 | EVALUATE EVERY OPTION

QUESTION 49

ANSWER: (a), (b)

CONCEPT: Diagnostic features of mammalian orders

(a) Correct. Lagomorph incisors are open-rooted and grow continuously.

(b) Correct. In microchiropteran bats, the first digit is clawed and the tail is commonly enclosed in an interfemoral membrane.

(c) Incorrect. Armadillos show polyembryony, but they are not truly toothless.

(d) Incorrect. Baleen is a whale feature, not a proboscidean feature.

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

QUESTION 50

ANSWER: (b), (d)

CONCEPT: Historical pedigree examples

The language in this question comes from historical eugenics literature and is now considered stigmatising. In that historical classification, the **Zero family of Switzerland** and the **Jukes of New York** were the examples associated with the description used in the question.

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

QUESTION 51

ANSWER: (a), (b), (c)

CONCEPT: Mechanism of root gravitropism

(a) Correct. Starch-containing statoliths sediment in columella cells and help sense gravity.

(b) Correct. Auxin influx and efflux carriers create unequal auxin distribution, producing unequal growth on the two sides of the root.

(c) Correct in the classical explanation cited by the paper. A laterally redistributed inhibitor from the root cap was proposed to explain curvature.

(d) Incorrect. Gravity-sensing plastids are starch-containing amyloplasts, not proplastids characterised by carotenoids and protochlorophyll.

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

QUESTION 52

ANSWER: (a), (b)

CONCEPT: Cyclic photophosphorylation

(a) Correct. Cyclic photophosphorylation uses photosystem I; photosystem II is not involved.

(b) Correct. Electrons return to photosystem I, producing ATP but not reducing NADP^+ ; therefore no NADPH (and no NADH) is formed.

(c) Incorrect. Water splitting is not required.

(d) Incorrect. The active centre is P700, not P680.

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

CHEMISTRY

SECTION A-2 | QUESTIONS 53-56 | EVALUATE EVERY OPTION

QUESTION 53

ANSWER: (a), (c), (d)

CONCEPT: Bohr model of the atom

- (a) **Correct.** An electron closer to the positive nucleus has lower electrostatic potential energy.
 (b) **Incorrect.** In Bohr's stationary orbit, an electron does not continuously radiate energy.
 (c) **Correct.** The model does not correctly explain spectra of multi-electron atoms.
 (d) **Correct.** It was the first atomic model to build quantised energy levels into the atom.

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

QUESTION 54

ANSWER: (a), (b), (c), (d)

CONCEPT: First ionisation-energy trends and exceptions

The measured comparisons are $\text{Ag} < \text{Au}$, $\text{Pd} < \text{Pt}$, $\text{Pb} > \text{Sn}$ and $\text{Sb} > \text{Bi}$. Relativistic effects and detailed electronic structure produce the first two and the Pb-Sn anomaly, while the general decrease down Group 15 gives $\text{Sb} > \text{Bi}$.

All four statements are correct: (a), (b), (c), (d).

QUESTION 55

ANSWER: (a), (b), (c)

CONCEPT: Solvent-system concept of acids and bases

- (a) **Correct.** CH_3COOH transfers a proton strongly in liquid NH_3 and increases NH_4^+ .
 (b) **Correct.** H_2SO_4 behaves as a strong acid in water and in liquid ammonia.
 (c) **Correct.** In liquid HCl , CH_3COOH can accept a proton and therefore acts as a base in the solvent-system sense.
 (d) **Incorrect.** Water donates a proton to NH_3 more readily than NH_3 does, so water behaves as an acid rather than a base in liquid ammonia.

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

QUESTION 56

ANSWER: (a), (b), (c)

CONCEPT: Polyiodide formation and formal electron transfer

I^- combines with I_2 to form the polyiodide ion I_3^- . It is unquestionably a **complex-formation** reaction. In the formal oxidation-number bookkeeping intended by the question, iodine from I^- is partly oxidised while iodine from I_2 is partly reduced. It is not an acid-base neutralisation.

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

PHYSICS

SECTION A-2 | QUESTIONS 57-60 | EVALUATE EVERY OPTION

QUESTION 57

ANSWER: (b), (c)

CONCEPT: Work, power and efficiency of cranes

Both cranes lift the same car through the same height, so each does the same useful work mgh . Since their efficiencies are equal, the required input energy, and therefore fuel consumption under the question's assumption, is also equal: **(b) is correct**.

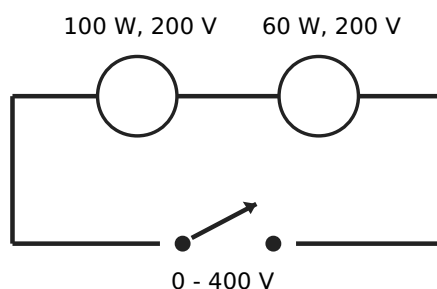
Crane A performs the same work in half the time, so its power is greater: **(c) is correct**. The stated 1000 kW for crane B is far too large, and A does not consume more fuel.

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

QUESTION 58

ANSWER: (a), (b), (d)

CONCEPT: Rated bulbs in series and filament temperature



(a) Correct. The 60 W bulb has the larger hot resistance, so the same series current gives it greater power and it glows brighter.

(b) Correct in the physical situation. Using hot rated resistances gives 37.5 W at 200 V; at this reduced operating temperature tungsten resistance is lower, so actual total power is greater than 37.5 W.

(c) Incorrect. The 60 W bulb, not the 100 W bulb, is the one more strongly over-volted as the supply rises.

(d) Correct. Once that bulb fuses, the series circuit is open and neither bulb glows.

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

QUESTION 59

ANSWER: (a), (b), (c)

CONCEPT: Floating fraction and density

(a) Correct. In water, $\rho_s/\rho_w = \text{submerged fraction} = 0.60$, so $\rho_s = 600 \text{ kg m}^{-3}$.

(b) Correct. In oil, $600/\rho_{\text{oil}} = 0.80$, giving $\rho_{\text{oil}} = 750 \text{ kg m}^{-3}$.

(c) Correct. $V = (4/3)\pi(0.1)^3 = 4.189 \times 10^{-3} \text{ m}^3$; mass is about 2.513 kg and weight about 24.64 N.

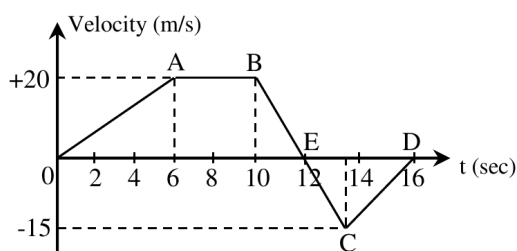
(d) Incorrect. While floating, buoyant force equals the weight, about 24.64 N, not 30.82 N.

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

QUESTION 60

ANSWER: (b), (c),
(d)

CONCEPT: Area and slope of a velocity-time graph



(a) Incorrect. Initial acceleration = $20/6 = 3.33 \text{ m s}^{-2}$, not 4.

(b) Correct. Positive area = $60 + 80 + 20 = 160 \text{ m}$. Negative triangular area = 30 m . Net displacement = $160 - 30 = 130 \text{ m}$.

(c) Correct. Total distance = $160 + 30 = 190 \text{ m}$, so average speed = $190/16 = 11.875 \text{ m s}^{-1}$, about 11.88 m s^{-1} .

(d) Correct. From B to E, velocity falls from 20 m s^{-1} to 0 m s^{-1} in 2 s, so retardation is 10 m s^{-2} .

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