



Detailed Solutions & Final Answer Key

PAPER CODE 51

TIME

75 minutes

QUESTIONS

33

MAX. MARKS

126

PAPER CODE 51

Question 17 accepts two alternatives. Question 18 is marked DROPPED and is not evaluated.

FINAL ANSWER KEY

DROPPED means that the question is not evaluated.

QUESTION	ANSWER
1	C
2	C
3	D
4	C
5	B
6	D
7	C
8	B
9	C
10	A
11	A
12	C
13	C
14	B
15	D
16	B
17	B OR D

QUESTION	ANSWER
18	DROP
19	C
20	D
21	A
22	C
23	C
24	D
25	A, C, D
26	A, B, C
27	A, B
28	A, D
29	B, D
30	B
31	A, B, C, D
32	A, B, C
33	A, B, D

Important: For Question 17, either option (b) or option (d) is accepted because the direction of inclination of the second coordinate system is not fixed. Question 18 is dropped; its solution entry explains the intended approximation only as a learning note, and no answer should be scored for it.

BIOLOGY

Detailed explanations, calculations and option-wise reasoning.

Question 1 Answer: C

Human Physiology - Blood

Mature RBCs carry oxygen and part of the carbon dioxide through haemoglobin. Haemoglobin also acts as a buffer and helps maintain acid-base balance. Blood-group antigens are present on the RBC membrane and are used in blood grouping. Immunoglobulins are antibodies made by plasma cells, not by mature RBCs. Hence (c) is not a function of mature RBCs.

Question 2 Answer: C

Animal Kingdom - Vertebrates

Snakes are limbless reptiles, and caecilians are limbless amphibians. Thus limbless groups occur in both Reptilia and Amphibia. The expected answer is (c).

Question 3 Answer: D

Animal Kingdom - Insects

Housefly, fruit fly and mosquito belong to the order Diptera. Dipterans have one functional pair of wings; the hind pair is modified into small balancing organs called halteres. Therefore the correct group is (d).

Question 4 Answer: C

Molecular Basis of Inheritance

Unequal purines and pyrimidines suggest a single strand, because strict base pairing is absent. The absence of thymine points to RNA, which normally contains uracil instead. RNA is also more easily hydrolysed in alkaline conditions because of its 2'-OH group and generally shows a higher mutation rate. The material is therefore single-stranded RNA: (c).

Question 5 Answer: B

Anatomy of Flowering Plants

Aerenchyma contains large air spaces that improve buoyancy and gas movement in aquatic plants. Water hyacinth has a swollen, spongy petiole rich in aerenchyma. Therefore the correct answer is (b).

Question 6 Answer: D

Plant Kingdom - Bryophytes

Bryophytes do not have true roots, stems and leaves; they possess simpler root-like and leaf-like structures. They are non-vascular, so xylem and phloem are absent. Water is required for the motile male gametes to reach the egg. Hence statements ii and iii are correct: (d).

Question 7 Answer: C

Photosynthesis - CAM Pathway

Many succulents conserve water by opening stomata at night. They initially fix carbon dioxide into organic acids at night and use it during the day. This adaptation is called Crassulacean acid metabolism (CAM). Correct answer: (c).

Question 8 Answer: B

Sexual Reproduction in Flowering Plants

Bat-pollinated flowers are often large, pale or white, open at night and produce a strong fruity or musky smell. These features help nocturnal bats locate the flowers. Therefore the answer is (b) Bats.

Question 25 Answer: A, C, D

Viruses

(a) is incorrect because viruses may contain either DNA or RNA. In the terminology intended by this paper, (b) refers to reverse-transcribing RNA viruses, in which a complementary DNA copy is produced, so it is not selected as incorrect. (c) is incorrect because viruses are acellular and cannot reproduce independently. (d) is incorrect because RNA viruses generally show higher mutation rates than DNA viruses. Therefore the incorrect statements are (a), (c) and (d).

Question 26 Answer: A, B, C

Neural Control and Coordination

The frontal region includes Broca's speech area, voluntary motor and motor-planning areas, and pathways related to smell. A frontal injury may therefore cause trouble in speaking, loss of smell and a frontal gait or motor-planning difficulty that can make walking on a narrow path difficult. Basic blood-pressure regulation is centred mainly in the medulla, not the frontal part of the brain. The accepted options are (a), (b) and (c).

Question 27 Answer: A, B

Cell Structure - Cytoskeleton

Actin forms microfilaments and alpha-tubulin is a building block of microtubules. These two cytoskeletal systems provide cell shape and take part in movement, intracellular transport, cilia, flagella and cell division. Lamins and desmin are intermediate-filament proteins used mainly for structural strength. Therefore (a) and (b) are selected.

CHEMISTRY

Detailed explanations, calculations and option-wise reasoning.

Question 9 Answer: C

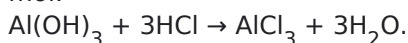
Mole Concept and Environmental Chemistry

Sulphur in coal mainly forms sulphur dioxide, SO_2 . One molecule of SO_2 has three atoms. Therefore one mole contains $3N_A$ atoms $= 3 \times 6.02 \times 10^{23} = 1.806 \times 10^{24}$, approximately 1.81×10^{24} . Correct answer: (c).

Question 10 Answer: A

Acids, Bases and Stoichiometry

Only HCl supplies the acidity; KCl and NaCl are neutral salts. Moles of HCl $= 0.01 \times 2 = 0.020$ mol.

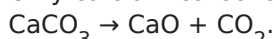


Moles of $\text{Al}(\text{OH})_3$ needed $= 0.020/3$ mol. Mass $= (0.020/3) \times 78 = 0.52$ g. Correct answer: (a).

Question 11 Answer: A

Mole Concept - Thermal Decomposition

Only calcium carbonate loses mass on heating:



Mass lost $= 0.500 - 0.434 = 0.066$ g $=$ mass of CO_2 .

Moles $\text{CO}_2 = 0.066/44 = 0.0015$ mol, so initial CaCO_3 mass $= 0.0015 \times 100 = 0.150$ g. Initial CaO mass $= 0.500 - 0.150 = 0.350$ g. Percentage $= 0.350/0.500 \times 100 = 70\%$. Correct answer: (a).

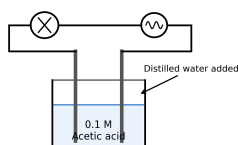
Question 12 Answer: C

Periodic Classification

Across a period, metallic character decreases from left to right, so in Period 2: $\text{O} < \text{C} < \text{Be} < \text{Li}$. Down Group 1, metallic character increases, so Na is more metallic than Li. Therefore the increasing order is $\text{O} < \text{C} < \text{Be} < \text{Li} < \text{Na}$, option (c).

Question 13 Answer: C

Electrolytic Conductance



Acetic acid is a weak electrolyte. On dilution, its degree of ionisation increases, so a larger fraction of acid molecules forms mobile H^+ and CH_3COO^- ions. In the open-wire arrangement shown, the added liquid also wets a greater length of the electrodes. The intended observation is therefore a gradual increase in current and bulb intensity, giving (c).

Teacher note: The specific conductivity of a weak-electrolyte solution decreases on dilution even though its molar conductivity increases. The accepted answer follows the intended geometry and school-level interpretation of the apparatus shown in the paper.

Question 14 Answer: B

Salts, Hydrolysis and Qualitative Analysis

Heating an ammonium salt with NaOH gives pungent ammonia. A white precipitate with AgNO_3 that darkens in sunlight identifies chloride as AgCl . Thus X is NH_4Cl . The NH_4^+ ion hydrolyses in water and makes the solution slightly acidic. Correct answer: (b).

Question 15 Answer: D

Mole Concept and Gases

At the same temperature and pressure, equal volumes contain equal numbers of moles. If equal masses also occupy equal volumes, the two gases must have equal molar masses. N_2 and CO both have molar mass 28 g mol^{-1} . Therefore the answer is (d).

Question 16 Answer: B

Solutions - Osmotic Pressure

For equal temperature, volume and formula moles, osmotic pressure is proportional to the number of dissolved particles. Na_2SO_4 gives 3 ions, MgSO_4 gives 2 ions, and $\text{Al}_2(\text{SO}_4)_3$ gives 5 ions. Thus $Q < P < R$. Correct answer: (b).

Question 28 Answer: A, D

Chemical Bonding and States of Matter

Dry ice is solid CO_2 . Each CO_2 molecule contains covalent $\text{C}=\text{O}$ bonds. Separate molecules are held together in the solid by weak intermolecular van der Waals forces. Hence (a) and (d) are correct.

Question 29 Answer: B, D

Thermochemistry

Dissolving KOH in water releases heat, and diluting concentrated HCl is also strongly exothermic. Dissolving ammonium chloride is endothermic and cools the water; glucose does not produce the stated strong warming effect. Therefore (b) and (d) are correct.

Question 30 Answer: B

Soaps and Detergents

Soap contains sodium or potassium salts of long-chain fatty acids. Ca^{2+} ions form insoluble calcium soaps, producing the characteristic slimy scum in X_2 . Synthetic detergents do not form the same insoluble calcium salts. Concentrated salt can salt out soap under some conditions, but the specific observation asked here is a slimy calcium-soap precipitate; the final response is therefore only (b).

PHYSICS

Detailed explanations, calculations and option-wise reasoning.

Question 17 Answer: B OR D

**Kinematics and
Coordinate Geometry**

P_1 moves $\frac{1}{2} \times 1.25 \times 4^2 = 10$ m, so its final coordinate on X_1 is $-2 + 10 = 8$ m. P_2 moves $\frac{1}{2} \times 5 \times 2^2 = 10$ m. If θ is the smaller angle between $+X_1$ and $+X_2$, then $6^2 = 8^2 + 10^2 - 2(8)(10)\cos \theta$, so $\cos \theta = 0.8$ and $\theta = 36.8^\circ$. Depending on whether X_2 is inclined clockwise or anticlockwise from X_1 , its angle with $+Y_1$ is $90^\circ - 36.8^\circ = 53.2^\circ$ or $90^\circ + 36.8^\circ = 126.8^\circ$. The final key accepts (b) or (d).

Question 18 Answer: DROPPED

**Mathematical Tools in
Physics**

This question was dropped in the final answer key and is not to be evaluated.

The intended small- u expansion is $Z = A(1 + u/R)^{-3} \approx A[1 - 3u/R] = A - (3A/R)u$. This would give a straight line with intercept A and slope $-3A/R$, corresponding to option (c). However, because the final key marks the item as dropped, no option is treated as the official answer.

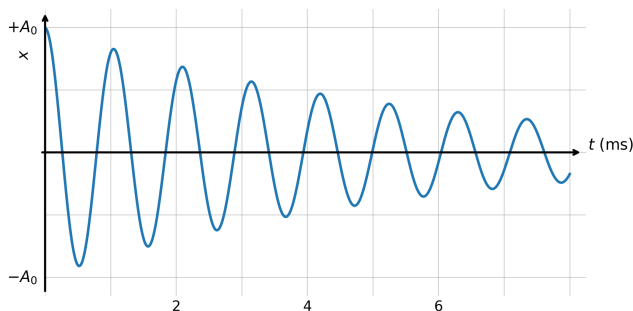
Question 19 Answer: C

**Mechanical Properties of
Fluids**

For the same liquid, equal hydrostatic pressure requires $\rho g_E h_E = \rho g_M h_M$. Thus $h_M = 200 \times 9.81/3.7 \approx 530$ m. Correct answer: (c).

Question 20 Answer: D

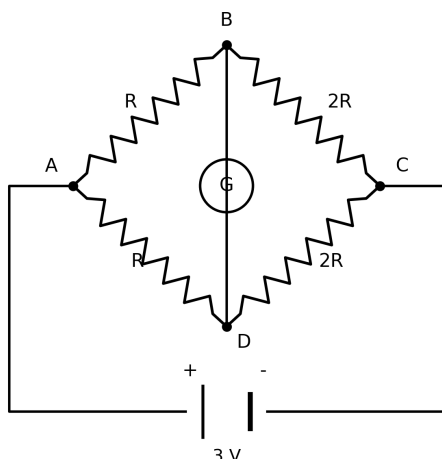
Oscillations



The amplitude decreases with time, so the oscillation is damped. The spacing of successive peaks is nearly unchanged, so the time period is not shown decreasing. At $t = 0$ the displacement is at its positive maximum, where the speed is zero and the elastic potential energy is maximum. Hence (d).

Question 21 Answer: A

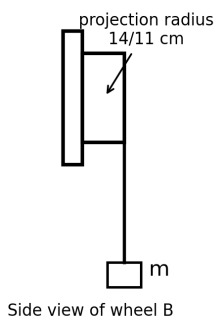
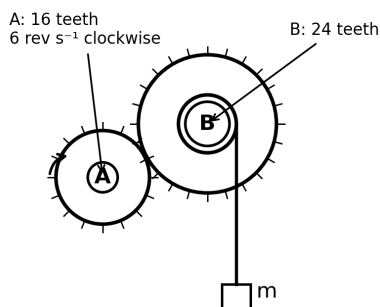
**Current Electricity -
Wheatstone Bridge**



The bridge is balanced because $R/R = 2R/2R$, so no current flows through G. The upper path has resistance $R + 2R = 3R$ and the lower path also has $3R$. These equal paths are in parallel, giving $R_{eq} = 3R/2$. For $R = 2 \Omega$, $R_{eq} = 3 \Omega$. Current = $3 \text{ V}/3 \Omega = 1 \text{ A}$. Correct answer: (a).

Question 22 Answer: C

**Rotational Motion and
Gears**



The rotational speeds are inversely proportional to tooth numbers. Gear B turns at $6 \times 16/24 = 4$ revolutions per second in the opposite direction. In $1/2 \text{ s}$ it makes 2 revolutions. The string movement is $2 \times 2\pi \times (14/11) \text{ cm} = 16 \text{ cm}$, using $\pi = 22/7$. The direction of B raises the hanging mass, so its potential energy increases by $mgh = 16mg$ in CGS units. Correct answer: (c).

Question 23 Answer: C

**Energy, Radiation and
Mass-Energy
Equivalence**

The star's power output is spread over a sphere: $L = 4\pi r^2 F$. With $r = 300 \text{ light years} \approx 300 \times 3.0 \times 10^8 \times 3.156 \times 10^7 \text{ m}$, $L \approx 5.1 \times 10^{30} \text{ W}$. From $E = mc^2$, mass loss per second is $L/c^2 \approx 5.1 \times 10^{30}/9 \times 10^{16} \approx 5.62 \times 10^{13} \text{ kg s}^{-1}$. Correct answer: (c).

Question 24 Answer: D

Work, Power and Energy

Heat load from the people = $50 \times 100 \text{ W} = 5000 \text{ W} = 5 \text{ kW}$. At 50% efficiency, the electrical input required is $5/0.5 = 10 \text{ kW}$. In 4 h, energy used = $10 \times 4 = 40 \text{ kWh}$, or 40 units. Correct answer: (d).

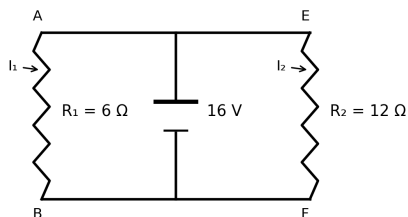
Question 31 Answer: A, B, C, D

Modern Physics - Photons

Frequency $\nu = c/\lambda = 3.0 \times 10^8 / (650 \times 10^{-9}) \approx 4.6 \times 10^{14}$ Hz, so (a) is true. Pulse energy = $Pt = 0.6 \times 0.030 = 0.018$ J = $0.018 / (1.6 \times 10^{-19}) \approx 1.1 \times 10^{17}$ eV, so (b) is true. One photon has $E = hc/\lambda \approx 3.1 \times 10^{-19}$ J, so (c) is true. Number of photons = $0.018 / (3.1 \times 10^{-19}) \approx 5.9 \times 10^{16}$, so (d) is true. Thus all four options are correct.

Question 32 Answer: A, B, C

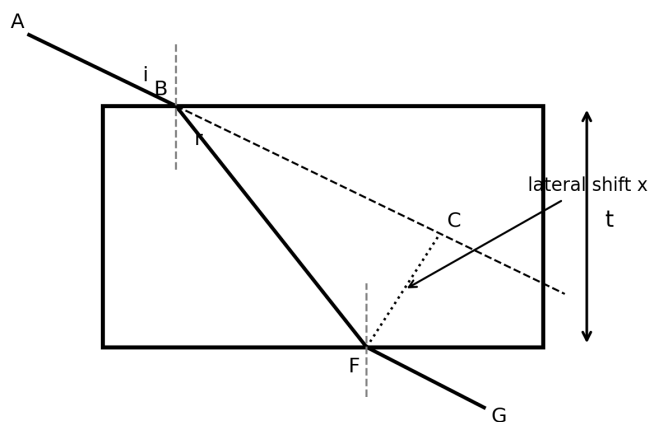
Current Electricity - Parallel Circuits



Both resistors are connected directly across 16 V. Thus $I_1 = 16/6 = 8/3$ A and $I_2 = 16/12 = 4/3$ A, giving $I_1/I_2 = 2$. Total current is $8/3 + 4/3 = 4$ A. Power in R_1 is $V^2/R_1 = 256/6 \approx 42.7$ W. Parallel branches have equal voltage, so (d) is false. Correct options: (a), (b) and (c).

Question 33 Answer: A, B, D

Ray Optics - Refraction through a Slab



The standard lateral-shift relation is $x = t \sin(i - r) / \cos r$. Expanding $\sin(i - r)$ gives $t[\sin i \cos r - \cos i \sin r / \cos r]$, so (a) is correct. Since r follows Snell's law, x depends on μ , so (b) is correct. Refractive index normally depends on wavelength, so (c) is not generally true. As i approaches 90° , $\sin(i - r)$ approaches $\cos r$ and x approaches t , so (d) is correct. Hence (a), (b) and (d).