

JEE MAIN 2021 · QUESTION PAPER

16 Mar 2021 **Shift 2**

84 questions in exam order, with answer key

Subject	Section A multiple choice	Section B numerical value
● Physics	19 Q1 to Q19	10 Q20 to Q29
● Chemistry	16 Q30 to Q45	10 Q46 to Q55
● Mathematics	20 Q56 to Q75	9 Q76 to Q84
In this PDF	84 questions · answer key at the end	

- 1 Set a 3 hour timer and attempt the paper in one sitting, like the real exam.
- 2 In the 2021 to 2024 papers, Section B asked you to answer any 5 numerical questions per subject. Try each one here.
- 3 Check yourself against the answer key at the end. Every question names its chapter, so you can see where marks went.
- 4 Got one wrong? Tap "Step-by-step solution" at the top right of it for the full working, where available.

Attempt this paper online

The same questions in the same order, with instant answer checking and step-by-step solutions where available.

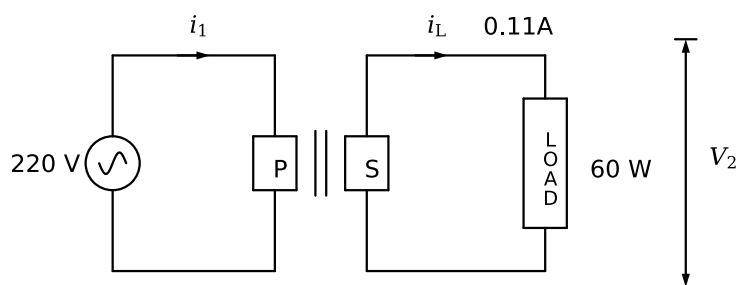
prepwise.in/pyqs/paper/2021-03-16-evening · Free, no signup needed to start

Answers follow NTA's final answer keys. Typing errors are possible, so check doubtful answers against the official key. Spotted a mistake? prepwise.in/feedback · Terms: prepwise.in/terms

Q1 Alternating Current

[Step-by-step solution](#) · [prepwisar.in/questions/_8mc1EO_7](https://www.prepwisar.in/questions/_8mc1EO_7)

For the given circuit, comment on the type of transformer used.



- (A) Auxiliary transformer (B) Step down transformer
(C) Step-up transformer (D) Auto transformer

Q2 Nuclear Physics

[Step-by-step solution](#) · [prepwisar.in/questions/cs7wAl3bCD](https://www.prepwisar.in/questions/cs7wAl3bCD)

Calculate the time interval between 33% decay and 67% decay if half-life of a substance is 20 minutes.

- (A) 40 minutes (B) 60 minutes (C) 13 minutes (D) 20 minutes

Q3 Nuclear Physics

[Step-by-step solution](#) · [prepwisar.in/questions/iLY9toRh8d](https://www.prepwisar.in/questions/iLY9toRh8d)

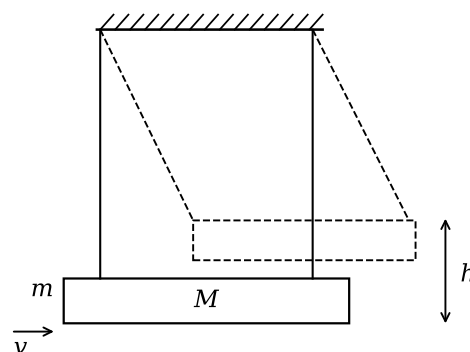
The half-life of Au^{198} is 2.7 days. The activity of 1.50 mg of Au^{198} if its atomic weight is 198 g mol^{-1} is, ($N_a = 6 \times 10^{23}/\text{mol}$).

- (A) 240 Ci (B) 357 Ci (C) 252 Ci (D) 535 Ci

Q4 Collision

[Step-by-step solution](#) · [prepwisar.in/questions/ihRjpECnoo](https://www.prepwisar.in/questions/ihRjpECnoo)

A large block of wood of mass $M = 5.99 \text{ kg}$ is hanging from two long massless cords. A bullet of mass $m = 10 \text{ g}$ is fired into the block and gets embedded in it. The (block + bullet) then swing upwards, their centre of mass rising a vertical distance $h = 9.8 \text{ cm}$ before the (block + bullet) pendulum comes momentarily to rest at the end of its arc. The speed of the bullet just before collision is:
(take $g = 9.8 \text{ ms}^{-2}$)



- (A) 831.4 m/s (B) 811.4 m/s (C) 841.4 m/s (D) 821.4 m/s

Q5 Circular Motion

[Step-by-step solution](#) · [prepwisar.in/questions/6hRFWEo-b3](https://www.prepwisar.in/questions/6hRFWEo-b3)

Statement I : A cyclist is moving on an unbanked road with a speed of 7 kmh^{-1} and takes a sharp circular turn along a path of radius of 2m without reducing the speed. The static friction coefficient is 0.2. The cyclist will not slip and pass the curve. ($g = 9.8 \text{ m/s}^2$)

Statement II : If the road is banked at an angle of 45° , cyclist can cross the curve of 2m radius with the speed of 18.5 kmh^{-1} without slipping.

In the light of the above statements, choose the correct answer from the options given below.

- (A) Statement I is incorrect and statement II is correct
(B) Both statement I and statement II are true
(C) Statement I is correct and statement II is incorrect
(D) Both statement I and statement II are false

Q6 Current Electricity[Step-by-step solution > prepwiser.in/questions/BuCrY6_vpD](https://www.prepwiser.in/questions/BuCrY6_vpD)

A resistor develops 500 J of thermal energy in 20 s when a current of 1.5 A is passed through it. If the current is increased from 1.5 A to 3 A, what will be the energy developed in 20 s.

- (A) 1000 J (B) 2000 J (C) 1500 J (D) 500 J

Q7 Dual Nature of Radiation & Matter[Step-by-step solution > prepwiser.in/questions/E5gMiRkX3](https://www.prepwiser.in/questions/E5gMiRkX3)

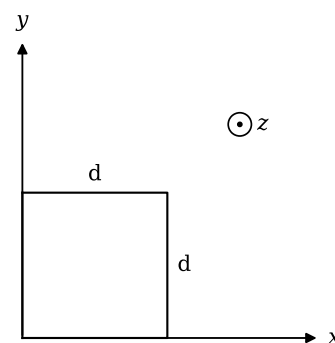
The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100 V. What should nearly be the ratio of their wavelengths? ($m_p = 1.00727u$, $m_e = 0.00055u$)

- (A) 41.4 : 1 (B) $(1860)^2$: 1 (C) 1860 : 1 (D) 43 : 1

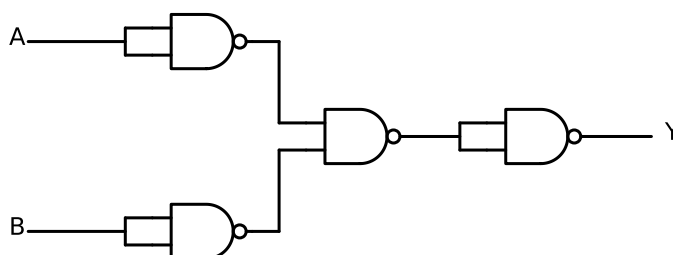
Q8 Electromagnetic Induction[Step-by-step solution > prepwiser.in/questions/TPxPk3hcsj](https://www.prepwiser.in/questions/TPxPk3hcsj)

The magnetic field in a region is given by $\vec{B} = B_o \left(\frac{x}{a}\right) \hat{k}$. A square loop of side d is placed with its edges along the x and y axes. The loop is moved with a constant velocity $\vec{v} = v_0 \hat{i}$. The emf induced in the loop is:

- (A) $\frac{B_o v_o d^2}{2a}$ (B) $\frac{B_o v_o^2 d}{2a}$ (C) $\frac{B_o v_o d}{2a}$ (D) $\frac{B_o v_o d^2}{a}$

**Q9** Semiconductors & Electronic Devices[Step-by-step solution > prepwiser.in/questions/VU4RTVDtj](https://www.prepwiser.in/questions/VU4RTVDtj)

The following logic gate is equivalent to:



- (A) NOR Gate (B) NAND Gate (C) OR Gate (D) AND Gate

Q10 Electrostatics I: Charges, Field & Gauss's Law[Step-by-step solution > prepwiser.in/questions/CciH-IVLUL](https://www.prepwiser.in/questions/CciH-IVLUL)

Find out the surface charge density at the intersection of point $x = 3$ m plane and x -axis, in the region of uniform line charge of 8 nC/m lying along the z -axis in free space.

- (A) 0.424 nC m⁻² (B) 4.0 nC m⁻² (C) 47.88 C/m (D) 0.07 nC m⁻²

Q11 Ray Optics[Step-by-step solution > prepwiser.in/questions/p19yBXtGyt](https://www.prepwiser.in/questions/p19yBXtGyt)

The refractive index of a converging lens is 1.4. What will be the focal length of this lens if it is placed in a medium of same refractive index? Assume the radii of curvature of the faces of lens are R_1 and R_2 respectively.

- (A) Zero (B) Infinite (C) 1 (D) $\frac{R_1 R_2}{R_1 - R_2}$

Attempt this paper online with instant answer checking > [prepwiser.in/pyqs/paper/2021-03-16-evening](https://www.prepwiser.in/pyqs/paper/2021-03-16-evening)

Q12 Electromagnetic Waves[Step-by-step solution](#) › prepwiser.in/questions/-7IF5_T_k2

Red light differs from blue light as they have:

- (A) Different frequencies and same wavelengths
- (B) Different frequencies and different wavelengths
- (C) Same frequencies and different wavelengths
- (D) Same frequencies and same wavelengths

Q13 Kinetic Theory of Gases[Step-by-step solution](#) › prepwiser.in/questions/uHnWlrlOet

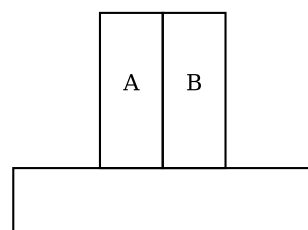
Calculate the value of mean free path (λ) for oxygen molecules at temperature 27°C and pressure 1.01×10^5 Pa. Assume the molecular diameter 0.3 nm and the gas is ideal. ($k = 1.38 \times 10^{-23} \text{ J K}^{-1}$)

- (A) 32 nm
- (B) 58 nm
- (C) 86 nm
- (D) 102 nm

Q14 Thermometry & Calorimetry[Step-by-step solution](#) › prepwiser.in/questions/pDtYrbRs0v

A bimetallic strip consists of metals A and B. It is mounted rigidly as shown. The metal A has higher coefficient of expansion compared to that of metal B. When the bimetallic strip is placed in a cold bath, it will:

- (A) Neither bend nor shrink
- (B) Bend towards the left
- (C) Not bend but shrink
- (D) Bend towards the right

**Q15** Moving Charges & Magnetism[Step-by-step solution](#) › prepwiser.in/questions/WS5SuURaMl

A charge Q is moving $\vec{dl}$ distance in the magnetic field $\vec{B}$. Find the value of work done by $\vec{B}$.

- (A) Zero
- (B) -1
- (C) Infinite
- (D) 1

Q16 Vectors[Step-by-step solution](#) › prepwiser.in/questions/KsFKZL7U4k

A mosquito is moving with a velocity $\vec{v} = 0.5t^2\hat{i} + 3t\hat{j} + 9\hat{k}$ m/s and accelerating in uniform conditions. What will be the direction of mosquito after 2 s?

- (A) $\tan^{-1}\left(\frac{\sqrt{85}}{6}\right)$ from y-axis
- (B) $\tan^{-1}\left(\frac{5}{2}\right)$ from y-axis
- (C) $\tan^{-1}\left(\frac{2}{3}\right)$ from x-axis
- (D) $\tan^{-1}\left(\frac{5}{2}\right)$ from x-axis

Q17 Fluid Mechanics[Step-by-step solution](#) › prepwiser.in/questions/asIz9H7eYS

What will be the nature of flow of water from a circular tap, when its flow rate increased from 0.18 L/min to 0.48 L/min? The radius of the tap and viscosity of water are 0.5 cm and 10^{-3} Pa s, respectively. (Density of water : 10^3 kg/m^3)

- (A) Steady flow to unsteady flow
- (B) Unsteady to steady flow
- (C) Remains turbulent flow
- (D) Remains steady flow

Q18 Simple Harmonic Motion[Step-by-step solution](#) › prepwiser.in/questions/a3qF76MeY

Amplitude of a mass-spring system, which is executing simple harmonic motion decreases with time. If mass = 500g , Decay constant = 20 g/s then how much time is required for the amplitude of the system to drop to half of its initial value? ($\ln 2 = 0.693$)

- (A) 17.32 s
- (B) 34.65 s
- (C) 0.034 s
- (D) 15.01 s

In order to determine the Young's Modulus of a wire of radius 0.2 cm (measured using a scale of least count = 0.001 cm) and length 1m (measured using a scale of least count = 1 mm), a weight of mass 1 kg (measured using a scale of least count = 1 g) was hanged to get the elongation of 0.5 cm (measured using a scale of least count 0.001 cm). What will be the fractional error in the value of Young's Modulus determined by this experiment?

(A) 0.14%

(B) 9%

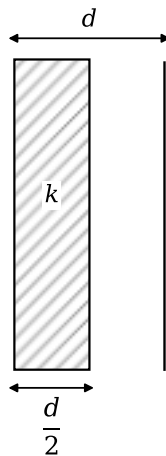
(C) 1.4%

(D) 0.9%

Physics Section B · Numerical value

Q20 to Q29

In a parallel plate capacitor set up, the plate area of capacitor is 2 m^2 and the plates are separated by 1 m. If the space between the plates are filled with a dielectric material of thickness 0.5 m and area 2 m^2 (see fig.) the capacitance of the set-up will be _____ ϵ_0 . (Dielectric constant of the material = 3.2) (Round off to the Nearest Integer)



The energy dissipated by a resistor is 10 mJ in 1 s when an electric current of 2 mA flows through it. The resistance is _____ Ω . (Round off to the Nearest Integer)

A deviation of 2° is produced in the yellow ray when prism of crown and flint glass are achromatically combined. Taking dispersive powers of crown and flint glass as 0.02 and 0.03 respectively and refractive index for yellow light for these glasses are 1.5 and 1.6 respectively. The refracting angles for crown glass prism will be _____ $^\circ$ (in degree). (Round off to the Nearest Integer)

If one wants to remove all the mass of the earth to infinity in order to break it up completely. The amount of energy that needs to be supplied will be $\frac{x}{5} \frac{GM^2}{R}$ where x is _____ (Round off to the Nearest Integer) (M is the mass of earth, R is the radius of earth, G is the gravitational constant)

For an ideal heat engine, the temperature of the source is 127°C . In order to have 60% efficiency the temperature of the sink should be _____ $^\circ\text{C}$. (Round off to the Nearest Integer)

Q25 Newton's Laws of Motion **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/Mvlt7B2lb5

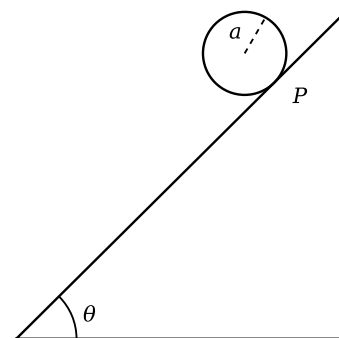
A body of mass 2 kg moves under a force of $(2\hat{i} + 3\hat{j} + 5\hat{k})$ N. It starts from rest and was at the origin initially. After 4s, its new coordinates are (8, b, 20). The value of b is _____. (Round off to the Nearest Integer)

Q26 Projectile Motion & Relative Motion **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/ROWkuNULI8

A swimmer can swim with velocity of 12 km/h in still water. Water flowing in a river has velocity 6 km/h. The direction with respect to the direction of flow of river water he should swim in order to reach the point on the other bank just opposite to his starting point is _____. (Round off to the Nearest Integer) (Find the angle in degrees)

Q27 Rotational Motion **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/no3DEzjZ2f

A solid disc of radius 'a' and mass 'm' rolls down without slipping on an inclined plane making an angle θ with the horizontal. The acceleration of the disc will be $\frac{2}{b}g \sin\theta$ where b is _____. (Round off to the Nearest Integer) (g = acceleration due to gravity, θ = angle as shown in figure)

**Q28** Rotational Motion **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/SBXoMFbLUH

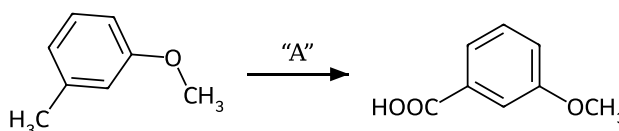
A force $\vec{F} = 4\hat{i} + 3\hat{j} + 4\hat{k}$ is applied on an intersection point of $x = 2$ plane and x -axis. The magnitude of torque of this force about a point (2, 3, 4) is _____. (Round off to the Nearest Integer)

Q29 Mechanical Waves **NUMERICAL**[Step-by-step solution](#) > prepwiser.in/questions/bReKlyQcY1

A closed organ pipe of length L and an open organ pipe contain gases of densities ρ_1 and ρ_2 respectively. The compressibility of gases are equal in both the pipes. Both the pipes are vibrating in their first overtone with same frequency. The length of the open pipe is $\frac{x}{3}L\sqrt{\frac{\rho_1}{\rho_2}}$ where x is _____. (Round off to the Nearest Integer)

Chemistry Section A · Multiple choice

Q30 to Q45

Q30 Metallurgy[Step-by-step solution](#) > prepwiser.in/questions/AO-5ioi11x

In the above reaction, the reagent "A" is:

- (A) LiAlH_4 (B) $\text{NaBH}_4, \text{H}_3\text{O}^+$ (C) $\text{HCl, Zn} - \text{Hg}$ (D) Alkaline $\text{KMnO}_4, \text{H}^+$

Q31 Carbohydrates & Biomolecules[Step-by-step solution](#) > prepwiser.in/questions/5Y6nsS8dhP

The secondary structure of protein is stabilised by:

- (A) Hydrogen bonding (B) glycosidic bond
(C) Peptide bond (D) van der Waals forces

Q32 Redox Reactions[Step-by-step solution](https://www.prepwiser.in/questions/M2-320t72Z) › prepwiser.in/questions/M2-320t72Z

Fe_x and Fe_y are known when x and y are:

- (A) $x = \text{F, Cl, Br, I}$ and $y = \text{F, Cl, Br, I}$
(C) $x = \text{F, Cl, Br, I}$ and $y = \text{F, Cl, Br}$

- (B) $x = \text{F, Cl, Br}$ and $y = \text{F, Cl, Br, I}$
(D) $x = \text{Cl, Br, I}$ and $y = \text{F, Cl, Br, I}$

Q33 d & f Block Elements[Step-by-step solution](https://www.prepwiser.in/questions/N5U03HLFYD) › prepwiser.in/questions/N5U03HLFYD

Arrange the following metal complex/compounds in the increasing order of spin only magnetic moment. Presume all the three, high spin system.

(Atomic numbers $\text{Ce} = 58$, $\text{Gd} = 64$ and $\text{Eu} = 63$)

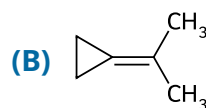
- (a) $(\text{NH}_4)_2[\text{Ce}(\text{NO}_3)_6]$
(b) $\text{Gd}(\text{NO}_3)_3$ and
(c) $\text{Eu}(\text{NO}_3)_3$

- (A) (a) < (b) < (c) (B) (b) < (a) < (c) (C) (a) < (c) < (b) (D) (c) < (a) < (b)

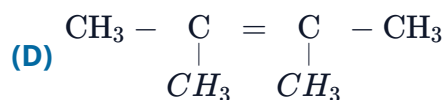
Q34 Hydrocarbons: Alkenes & Alkynes[Step-by-step solution](https://www.prepwiser.in/questions/G9q_mYln11) › prepwiser.in/questions/G9q_mYln11

An unsaturated hydrocarbon X on ozonolysis gives A. Compound A when warmed with ammonical silver nitrate forms a bright silver mirror along the sides of the test tube. The unsaturated hydrocarbon X is:

- (A) $\text{HC} \equiv \text{C} - \text{CH}_2 - \text{CH}_3$



- (C) $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$

**Q35** Hydrogen & s-Block Elements[Step-by-step solution](https://www.prepwiser.in/questions/O6VyjvHJWw) › prepwiser.in/questions/O6VyjvHJWw

The correct statements about H_2O_2 are:

- (A) used in the treatment of effluents.
(B) used as both oxidising and reducing agents.
(C) the two hydroxyl groups lie in the same plane.
(D) miscible with water.

Choose the correct answer from the options given below:

- (A) (A), (C) and (D) only (B) (A), (B), (C) and (D) (C) (A), (B) and (D) only (D) (B), (C) and (D) only

Q36 Metallurgy[Step-by-step solution](https://www.prepwiser.in/questions/RB0W_hrE2f) › prepwiser.in/questions/RB0W_hrE2f

Which of the following reduction reaction CANNOT be carried out with coke?

- (A) $\text{ZnO} \rightarrow \text{Zn}$ (B) $\text{Fe}_2\text{O}_3 \rightarrow \text{Fe}$ (C) $\text{Cu}_2\text{O} \rightarrow \text{Cu}$ (D) $\text{Al}_2\text{O}_3 \rightarrow \text{Al}$

Q37 p-Block Elements: Part I (Group 13 & 14)[Step-by-step solution](https://www.prepwiser.in/questions/I1WmWp-Sfp) › prepwiser.in/questions/I1WmWp-Sfp

The INCORRECT statement regarding the structure of C_{60} is:

- (A) The five-membered rings are fused only to six-membered rings.
(B) It contains 12 six-membered rings and 24 five-membered rings.
(C) Each carbon atom forms three sigma bonds.
(D) The six-membered rings are fused to both six and five-membered rings.

The characteristics of elements X, Y and Z with atomic numbers, respectively, 33, 53 and 83 are:

- (A) X and Y are metalloids and Z is a metal.
 (B) X and Z are non-metals and Y is a metalloid.
 (C) X is a metalloid, Y is a non-metal and Z is a metal.
 (D) X, Y and Z are metals.

Identify the elements X and Y using the ionisation energy values given below:

	Ionization energy (kJ/mol)	
	1st	2nd
X	495	4563
Y	731	1450

- (A) X = F; Y = Mg (B) X = Mg; Y = F (C) X = Na; Y = Mg (D) X = Mg; Y = Na

Which of the following polymer is used in the manufacture of wood laminates?

- (A) Melamine formaldehyde resin (B) Urea formaldehyde resin
 (C) cis-poly isoprene (D) Phenol and formaldehyde resin

Statement I : Sodium hydride can be used as an oxidising agent.

Statement II : The lone pair of electrons on nitrogen in pyridine makes it basic.

Choose the CORRECT answer from the options given below:

- (A) Statement I is false but statement II is true (B) Both statement I and statement II are true
 (C) Statement I is true but statement II is false (D) Both statement I and statement II are false

The exact volumes of 1 M NaOH solution required to neutralise 50 mL of 1 M H_3PO_3 solution and 100 mL of 2 M H_3PO_2 solution, respectively, are:

- (A) 100 mL and 50 mL (B) 100 mL and 200 mL (C) 100 mL and 100 mL (D) 50 mL and 50 mL

The INCORRECT statements below regarding colloidal solutions is:

- (A) The flocculating power of Al^{3+} is more than that of Na^+ .
 (B) A colloidal solutions shows Brownian motion of colloidal particles.
 (C) An ordinary filter paper can stop the flow of colloidal particles.
 (D) A colloidal solutions shows colligative properties.

Which of the following is least basic?

- (A) $(\text{CH}_3\text{CO})_2\ddot{\text{N}}\text{H}$ (B) $(\text{CH}_3\text{CO})\ddot{\text{N}}\text{HC}_2\text{H}_5$
 (C) $(\text{C}_2\text{H}_5)_3\ddot{\text{N}}$ (D) $(\text{C}_2\text{H}_5)_2\ddot{\text{N}}\text{H}$

Match List - I with List - II:

	List - I Test/Reagents/Observation(s)		List - II Species detected
(a)	Lassaigne's Test	(i)	Carbon
(b)	Cu(II) oxide	(ii)	Sulphur
(c)	Silver nitrate	(iii)	N, S, P, and halogen
(d)	The sodium fusion extract gives black precipitate with acetic acid and lead acetate	(iv)	Halogen Specifically

The correct match is:

(A) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

(B) (a)-(i), (b)-(iv), (c)-(iii), (d)-(ii)

(C) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

(D) (a)-(i), (b)-(ii), (c)-(iv), (d)-(iii)

Chemistry Section B · Numerical value

Q46 to Q55

Q46 Chemical Kinetics **NUMERICAL**

Step-by-step solution > prepwiser.in/questions/ct5JoXYwcN

A and B decompose via first order kinetics with half-lives 54.0 min and 18.0 min respectively. Starting from an equimolar non reactive mixture of A and B, the time taken for the concentration of A to become 16 times that of B is _____ min. (Round off to the Nearest Integer).

Q47 Coordination Compounds **NUMERICAL**

Step-by-step solution > prepwiser.in/questions/-EP55Kkj61

$[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ absorbs light of wavelength 498 nm during a d – d transition. The octahedral splitting energy for the above complex is _____ $\times 10^{-19}$ J. (Round off to the Nearest Integer). $h = 6.626 \times 10^{-34}$ Js; $c = 3 \times 10^8$ ms $^{-1}$

Q48 Electrochemistry **NUMERICAL**

Step-by-step solution > prepwiser.in/questions/fZzdX8zQf_

A 5.0 m mol dm $^{-3}$ aqueous solution of KCl has a conductance of 0.55 mS when measured in a cell of cell constant 1.3 cm $^{-1}$. The molar conductivity of this solution is _____ mSm ^{2} mol $^{-1}$. (Round off to the Nearest Integer).

Q49 Ionic Equilibrium **NUMERICAL**

Step-by-step solution > prepwiser.in/questions/IBlpHAGK8e

Sulphurous acid (H_2SO_3) has $K_{a1} = 1.7 \times 10^{-2}$ and $K_{a2} = 6.4 \times 10^{-8}$. The pH of 0.588 M H_2SO_3 is _____. (Round off to the Nearest Integer).

Q50 Solid State **NUMERICAL**

Step-by-step solution > prepwiser.in/questions/tEqIqfRVyw

Ga (atomic mass 70 u) crystallizes in a hexagonal close packed structure. The total number of voids in 0.581 g of Ga is _____ $\times 10^{21}$. (Round off to the Nearest Integer). [Given : $N_A = 6.023 \times 10^{23}$]

Q51 Solutions & Colligative Properties **NUMERICAL**

Step-by-step solution > prepwiser.in/questions/yUcKr_FY4H

At 363 K, the vapour pressure of A is 21 kPa and that of B is 18 kPa. One mole of A and 2 moles of B are mixed. Assuming that this solution is ideal, the vapour pressure of the mixture is _____ kPa. (Round off to the Nearest Integer).

Q52 Mole Concept & Stoichiometry **NUMERICAL**

Step-by-step solution > prepwiser.in/questions/uKZfv5dCma

When 35 mL of 0.15 M lead nitrate solution is mixed with 20 mL of 0.12 M chromic sulphate solution, _____ $\times 10^{-5}$ moles of lead sulphate precipitate out. (Round off to the Nearest Integer).

The number of orbitals with $n = 5$, $m_l = +2$ is _____. (Round off to the Nearest Integer).

At 25°C , 50 g of iron reacts with HCl to form FeCl_2 . The evolved hydrogen gas expands against a constant pressure of 1 bar. The work done by the gas during this expansion is _____. J. (Round off to the Nearest Integer).

[Given : $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$. Assume, hydrogen is an ideal gas] [Atomic mass of Fe is 55.85 u]

In Duma's method of estimation of nitrogen, 0.1840 g of an organic compound gave 30 mL of nitrogen collected at 287 K and 758 mm of Hg pressure. The percentage composition of nitrogen in the compound is _____. (Round off to the Nearest Integer). [Given : Aqueous tension at 287 K = 14 mm of Hg]

Mathematics Section A · Multiple choice

Q56 to Q75

If the foot of the perpendicular from point $(4, 3, 8)$ on the line $L_1 : \frac{x-a}{l} = \frac{y-2}{3} = \frac{z-b}{4}$, $l \neq 0$ is $(3, 5, 7)$, then the shortest distance between the line L_1 and line $L_2 : \frac{x-2}{3} = \frac{y-4}{4} = \frac{z-5}{5}$ is equal to:

- (A) $\frac{1}{\sqrt{6}}$ (B) $\frac{1}{2}$ (C) $\frac{1}{\sqrt{3}}$ (D) $\sqrt{\frac{2}{3}}$

If (x, y, z) be an arbitrary point lying on a plane P which passes through the points $(42, 0, 0)$, $(0, 42, 0)$ and $(0, 0, 42)$, then the value of the expression

$3 + \frac{x-11}{(y-19)^2(z-12)^2} + \frac{y-19}{(x-11)^2(z-12)^2} + \frac{z-12}{(x-11)^2(y-19)^2} - \frac{x+y+z}{14(x-11)(y-19)(z-12)}$ is equal to:

- (A) 3 (B) 39 (C) -45 (D) 0

Let f be a real valued function, defined on $\mathbb{R} - \{-1, 1\}$ and given by

$$f(x) = 3 \log_e \left| \frac{x-1}{x+1} \right| - \frac{2}{x-1}.$$

Then in which of the following intervals, function $f(x)$ is increasing?

- (A) $(-\infty, -1) \cup \left(\frac{1}{2}, \infty\right) - \{1\}$ (B) $(-\infty, \infty) - \{-1, 1\}$
(C) $(-\infty, \frac{1}{2}] - \{-1\}$ (D) $(-1, \frac{1}{2}]$

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The maximum value of

$$f(x) = \begin{vmatrix} \sin^2 x & 1 + \cos^2 x & \cos 2x \\ 1 + \sin^2 x & \cos^2 x & \cos 2x \\ \sin^2 x & \cos^2 x & \sin 2x \end{vmatrix}, x \in R$$

is:

(A) $\sqrt{5}$

(B) $\frac{3}{4}$

(C) 5

(D) $\sqrt{7}$

Let the lengths of intercepts on x-axis and y-axis made by the circle

$x^2 + y^2 + ax + 2ay + c = 0$, ($a < 0$) be $2\sqrt{2}$ and $2\sqrt{5}$, respectively. Then the shortest distance from origin to a tangent to this circle which is perpendicular to the line $x + 2y = 0$, is equal to:

(A) $\sqrt{10}$

(B) $\sqrt{6}$

(C) $\sqrt{11}$

(D) $\sqrt{7}$

The least value of $|z|$ where z is complex number which satisfies the inequality

$$\exp\left(\frac{(|z| + 3)(|z| - 1)}{||z| + 1|} \log_e 2\right) \geq \log_{\sqrt{2}} |5\sqrt{7} + 9i|, i = \sqrt{-1}$$

, is equal to:

(A) 8

(B) 3

(C) 2

(D) $\sqrt{5}$

Consider the integral

$$I = \int_0^{10} \frac{[x]e^{[x]}}{e^{x-1}} dx,$$

where $[x]$ denotes the greatest integer less than or equal to x . Then the value of I is equal to:

(A) $45(e - 1)$

(B) $45(e + 1)$

(C) $9(e + 1)$

(D) $9(e - 1)$

Let $P(x) = x^2 + bx + c$ be a quadratic polynomial with real coefficients such that $\int_0^1 P(x) dx = 1$ and $P(x)$ leaves remainder 5 when it is divided by $(x - 2)$. Then the value of $9(b + c)$ is equal to:

(A) 9

(B) 11

(C) 7

(D) 15

If $y = y(x)$ is the solution of the differential equation

$$\frac{dy}{dx} + (\tan x)y = \sin x, 0 \leq x \leq \frac{\pi}{3}, \text{ with } y(0) = 0, \text{ then } y\left(\frac{\pi}{4}\right) \text{ equal to:}$$

(A) $\frac{1}{2} \log_e 2$

(B) $\left(\frac{1}{2\sqrt{2}}\right) \log_e 2$

(C) $\log_e 2$

(D) $\frac{1}{4} \log_e 2$

Let C_1 be the curve obtained by the solution of differential equation

$$2xy \frac{dy}{dx} = y^2 - x^2, x > 0. \text{ Let the curve } C_2 \text{ be the}$$

solution of $\frac{2xy}{x^2 - y^2} = \frac{dy}{dx}$. If both the curves pass through $(1, 1)$, then the area enclosed by the curves C_1 and C_2 is equal to:

(A) $\frac{\pi}{4} + 1$

(B) $\pi + 1$

(C) $\pi - 1$

(D) $\frac{\pi}{2} - 1$

Q66 Ellipse[Step-by-step solution](#) › [prepwiser.in/questions/jdyQT9V3IF](https://www.prepwiser.in/questions/jdyQT9V3IF)

If the points of intersections of the ellipse $\frac{x^2}{16} + \frac{y^2}{b^2} = 1$ and the circle $x^2 + y^2 = 4b$, $b > 4$ lie on the curve $y^2 = 3x^2$, then b is equal to:

- (A) 12 (B) 10 (C) 6 (D) 5

Q67 Inverse Trigonometric Functions[Step-by-step solution](#) › [prepwiser.in/questions/BPM9Bud2Ib](https://www.prepwiser.in/questions/BPM9Bud2Ib)

Given that the inverse trigonometric functions take principal values only. Then, the number of real values of x which satisfy

$$\sin^{-1}\left(\frac{3x}{5}\right) + \sin^{-1}\left(\frac{4x}{5}\right) = \sin^{-1}x$$

is equal to:

- (A) 2 (B) 0 (C) 3 (D) 1

Q68 Differentiation[Step-by-step solution](#) › [prepwiser.in/questions/_y70i_z10u](https://www.prepwiser.in/questions/_y70i_z10u)

Let $f: S \rightarrow S$ where $S = (0, \infty)$ be a twice differentiable function such that $f(x+1) = xf(x)$. If $g: S \rightarrow \mathbb{R}$ be defined as $g(x) = \log_e f(x)$, then the value of $|g''(5) - g''(1)|$ is equal to:

- (A) 1 (B) $\frac{187}{144}$ (C) $\frac{197}{144}$ (D) $\frac{205}{144}$

Q69 Continuity & Differentiability[Step-by-step solution](#) › [prepwiser.in/questions/4Nphrvd0vv](https://www.prepwiser.in/questions/4Nphrvd0vv)

Let $\alpha \in \mathbb{R}$ be such that the function

$$f(x) = \begin{cases} \frac{\cos^{-1}(1-\{x\}^2)\sin^{-1}(1-\{x\})}{\{x\}-\{x\}^3}, & x \neq 0 \\ \alpha, & x = 0 \end{cases}$$

is continuous at $x = 0$, where $\{x\} = x - [x]$ is the greatest integer less than or equal to x . Then:

- (A) no such α exists (B) $\alpha = 0$ (C) $\alpha = \frac{\pi}{4}$ (D) $\alpha = \frac{\pi}{\sqrt{2}}$

Q70 Parabola[Step-by-step solution](#) › [prepwiser.in/questions/7L8p3doO30](https://www.prepwiser.in/questions/7L8p3doO30)

Let C be the locus of the mirror image of a point on the parabola $y^2 = 4x$ with respect to the line $y = x$. Then the equation of tangent to C at $P(2, 1)$ is:

- (A) $x - y = 1$ (B) $2x + y = 5$ (C) $x + 3y = 5$ (D) $x + 2y = 4$

Q71 Permutations & Combinations[Step-by-step solution](#) › [prepwiser.in/questions/XB-n-6xjQQ](https://www.prepwiser.in/questions/XB-n-6xjQQ)

Consider a rectangle $ABCD$ having 5, 7, 6, 9 points in the interior of the line segments AB , CD , BC , DA respectively. Let α be the number of triangles having these points from different sides as vertices and β be the number of quadrilaterals having these points from different sides as vertices. Then $(\beta - \alpha)$ is equal to:

- (A) 717 (B) 795 (C) 1890 (D) 1173

Q72 Probability: Basic[Step-by-step solution](#) › [prepwiser.in/questions/kY1xibOvMR](https://www.prepwiser.in/questions/kY1xibOvMR)

Let A denote the event that a 6-digit integer formed by 0, 1, 2, 3, 4, 5, 6 without repetitions, be divisible by 3. Then probability of event A is equal to:

- (A) $\frac{4}{9}$ (B) $\frac{9}{56}$ (C) $\frac{11}{27}$ (D) $\frac{3}{7}$

Let $A = \{2, 3, 4, 5, \dots, 30\}$ and ' $\simeq$ ' be an equivalence relation on $A \times A$, defined by $(a, b) \simeq (c, d)$, if and only if $ad = bc$. Then the number of ordered pairs which satisfy this equivalence relation with ordered pair $(4, 3)$ is equal to:

- (A) 5 (B) 6 (C) 8 (D) 7

Let $\vec{a} = \hat{i} + 2\hat{j} - 3\hat{k}$ and $\vec{b} = 2\hat{i} - 3\hat{j} + 5\hat{k}$. If $\vec{r} \times \vec{a} = \vec{b} \times \vec{r}$,
 $\vec{r} \cdot (\alpha\hat{i} + 2\hat{j} + \hat{k}) = 3$ and

$$\vec{r} \cdot (2\hat{i} + 5\hat{j} - \alpha\hat{k})$$

$= -1$, $\alpha \in \mathbb{R}$, then the
 value of $\alpha + \left| \vec{r} \right|^2$ is equal to:

- (A) 13 (B) 11 (C) 9 (D) 15

Let $A(-1, 1)$, $B(3, 4)$ and $C(2, 0)$ be given three points.

A line $y = mx$, $m > 0$, intersects lines AC and BC at point P and Q respectively. Let A_1 and A_2 be the areas of $\triangle ABC$ and $\triangle PQC$ respectively, such that $A_1 = 3A_2$, then the value of m is equal to:

- (A) 1 (B) 3 (C) 2 (D) $\frac{4}{15}$

Mathematics Section B · Numerical value

Q76 to Q84

If the distance of the point $(1, -2, 3)$ from the plane $x + 2y - 3z + 10 = 0$ measured parallel to the line, $\frac{x-1}{3} = \frac{2-y}{m} = \frac{z+3}{1}$ is $\sqrt{\frac{7}{2}}$, then the value of $|m|$ is equal to _____.

Let n be a positive integer. Let

$$A = \sum_{k=0}^n (-1)^k C_k \left[\left(\frac{1}{2} \right)^k + \left(\frac{3}{4} \right)^k + \left(\frac{7}{8} \right)^k + \left(\frac{15}{16} \right)^k + \left(\frac{31}{32} \right)^k \right]$$

. If

$63A = 1 - \frac{1}{2^{30}}$, then n is equal to _____.

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Let $f: \mathbb{R} \rightarrow \mathbb{R}$ and $g: \mathbb{R} \rightarrow \mathbb{R}$ be defined as

$$f(x) = \begin{cases} x + a, & x < 0 \\ |x - 1|, & x \geq 0 \end{cases}$$

and

$$g(x) = \begin{cases} x + 1, & x < 0 \\ (x - 1)^2 + b, & x \geq 0 \end{cases}$$

where a, b are non-negative real numbers. If $(g \circ f)(x)$ is continuous for all $x \in \mathbb{R}$, then $a + b$ is equal to _____.

Let $A = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix}$ and $B = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$ be two 2×1 matrices with real entries such that $A = XB$, where

$$X = \frac{1}{\sqrt{3}} \begin{bmatrix} 1 & -1 \\ 1 & k \end{bmatrix}$$

, and $k \in \mathbb{R}$.

If $a_1^2 + a_2^2 = \frac{2}{3}(b_1^2 + b_2^2)$ and $(k^2 + 1)b_2^2 \neq -2b_1b_2$, then the value of k is _____.

$S_n(x) = \log_a^{1/2}x + \log_a^{1/3}x + \log_a^{1/6}x + \log_a^{1/11}x + \log_a^{1/18}x + \log_a^{1/27}x + \dots$ up to n -terms, where $a > 1$. If $S_{24}(x) = 1093$ and $S_{12}(2x) = 265$, then value of a is equal to _____.

Let $\frac{1}{16}, a$ and b be in G.P. and $\frac{1}{a}, \frac{1}{b}, 6$ be in A.P., where $a, b > 0$. Then $72(a + b)$ is equal to _____.

Consider the statistics of two sets of observations as follows: If the variance of the combined set of these two observations is $\frac{17}{9}$, then the value of n is equal to _____.

	Size	Mean	Variance
Observation I	10	2	2
Observation II	n	3	1

Let $\vec{c}$ be a vector perpendicular to the vectors, $\vec{a} = \hat{i} + \hat{j} - \hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$. If $\vec{c} \cdot (\hat{i} + \hat{j} + 3\hat{k}) = 8$ then the value of $\vec{c} \cdot (\vec{a} \times \vec{b})$ is equal to _____.

For real numbers α, β, γ and δ , if

$$\int \frac{(x^2 - 1) + \tan^{-1}\left(\frac{x^2 + 1}{x}\right)}{(x^4 + 3x^2 + 1)\tan^{-1}\left(\frac{x^2 + 1}{x}\right)} dx = \alpha \log_e \left(\tan^{-1}\left(\frac{x^2 + 1}{x}\right) \right) + \beta \tan^{-1}\left(\frac{\gamma(x^2 - 1)}{x}\right) + \delta \tan^{-1}\left(\frac{x^2 + 1}{x}\right) + C$$

where C is an arbitrary constant, then the value of $10(\alpha + \beta\gamma + \delta)$ is equal to _____.

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Physics

1. C	2. D	3. B	4. A	5. B	6. B	7. D	8. D
9. A	10. A	11. B	12. B	13. D	14. B	15. A	16. A
17. A	18. B	19. C	20. 3	21. 2500	22. 12	23. 3	24. -113
25. 12	26. 120	27. 3	28. 20	29. 4			

Chemistry

30. D	31. A	32. C	33. C	34. A	35. C	36. D	37. B
38. C	39. C	40. B	41. A	42. B	43. C	44. A	45. C
46. 108	47. 4	48. 14	49. 1	50. 15	51. 19	52. 525	53. 3
54. 2218	55. 19						

Mathematics

56. A	57. A	58. A	59. A	60. B	61. B	62. A	63. C
64. B	65. D	66. A	67. C	68. D	69. A	70. A	71. A
72. A	73. D	74. D	75. A	76. 2	77. 6	78. 1	79. 1
80. 16	81. 14	82. 5	83. 28	84. 6			

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