

## JEE MAIN 2021 · QUESTION PAPER

# 17 Mar 2021 Shift 1

81 questions in exam order, with answer key

| Subject              | Section A multiple choice                   | Section B numerical value |
|----------------------|---------------------------------------------|---------------------------|
| ● <b>Physics</b>     | <b>20</b> Q1 to Q20                         | <b>9</b> Q21 to Q29       |
| ● <b>Chemistry</b>   | <b>15</b> Q30 to Q44                        | <b>8</b> Q45 to Q52       |
| ● <b>Mathematics</b> | <b>19</b> Q53 to Q71                        | <b>10</b> Q72 to Q81      |
| <b>In this PDF</b>   | <b>81</b> 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.

[prepwis.in/pyqs/paper/2021-03-17-morning](https://prepwis.in/pyqs/paper/2021-03-17-morning) · 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? [prepwis.in/feedback](https://prepwis.in/feedback) · Terms: [prepwis.in/terms](https://prepwis.in/terms)

**Q1** Alternating Current

[Step-by-step solution](#) · [prepwiser.in/questions/fg6CUU2TB0](#)

An AC current is given by  $I = I_1 \sin \omega t + I_2 \cos \omega t$ . A hot wire ammeter will give a reading:

- (A)  $\frac{I_1 + I_2}{\sqrt{2}}$  (B)  $\sqrt{\frac{I_1^2 + I_2^2}{2}}$  (C)  $\sqrt{\frac{I_1^2 + I_2^2}{2}}$  (D)  $\frac{I_1 + I_2}{2\sqrt{2}}$

**Q2** Atomic Physics

[Step-by-step solution](#) · [prepwiser.in/questions/MA2XMo7nia](#)

If an electron is moving in the  $n^{\text{th}}$  orbit of the hydrogen atom, then its velocity ( $v_n$ ) for the  $n^{\text{th}}$  orbit is given as:

- (A)  $v_n \propto \frac{1}{n}$  (B)  $v_n \propto n^2$  (C)  $v_n \propto n$  (D)  $v_n \propto \frac{1}{n^2}$

**Q3** Atomic Physics

[Step-by-step solution](#) · [prepwiser.in/questions/ISnS6y38Su](#)

Which level of the single ionized carbon has the same energy as the ground state energy of hydrogen atom?

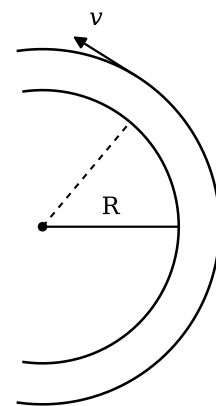
- (A) 8 (B) 6 (C) 1 (D) 4

**Q4** Circular Motion

[Step-by-step solution](#) · [prepwiser.in/questions/fkbw\\_TrL8u](#)

A modern grand - prix racing car of mass  $m$  is travelling on a flat track in a circular arc of radius  $R$  with a speed  $v$ . If the coefficient of static friction between the tyres and the track is  $\mu_s$ , then the magnitude of negative lift  $F_L$  acting downwards on the car is : (Assume forces on the four tyres are identical and  $g$  = acceleration due to gravity)

- (A)  $m \left( g - \frac{v^2}{\mu_s R} \right)$  (B)  $-m \left( g + \frac{v^2}{\mu_s R} \right)$   
(C)  $m \left( \frac{v^2}{\mu_s R} - g \right)$  (D)  $m \left( \frac{v^2}{\mu_s R} + g \right)$



**Q5** Current Electricity

[Step-by-step solution](#) · [prepwiser.in/questions/rWmQ5dwWdJ](#)

A current of 10A exists in a wire of cross-sectional area of  $5 \text{ mm}^2$  with a drift velocity of  $2 \times 10^{-3} \text{ ms}^{-1}$ . The number of free electrons in each cubic meter of the wire is \_\_\_\_\_.

- (A)  $625 \times 10^{25}$  (B)  $1 \times 10^{23}$  (C)  $2 \times 10^{25}$  (D)  $2 \times 10^6$

**Q6** Dual Nature of Radiation & Matter

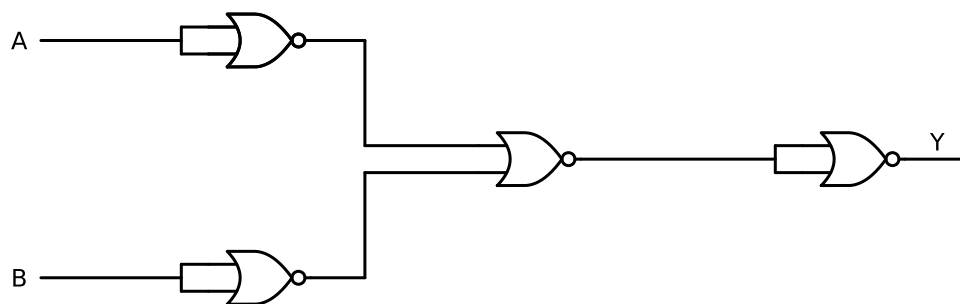
[Step-by-step solution](#) · [prepwiser.in/questions/U6fjdPx3ot](#)

An electron of mass  $m$  and a photon have same energy  $E$ . The ratio of wavelength of electron to that of photon is : ( $c$  being the velocity of light)

- (A)  $\frac{1}{c} \left( \frac{2m}{E} \right)^{1/2}$  (B)  $\frac{1}{c} \left( \frac{E}{2m} \right)^{1/2}$  (C)  $\left( \frac{E}{2m} \right)^{1/2}$  (D)  $c(2mE)^{1/2}$

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The output of the given combination gates represents:



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

The thickness at the centre of a plane convex lens is 3 mm and the diameter is 6 cm. If the speed of light in the material of the lens is  $2 \times 10^8 \text{ ms}^{-1}$ . The focal length of the lens is \_\_\_\_\_.

- (A) 0.30 cm      (B) 30 cm      (C) 15 cm      (D) 1.5 cm

A polyatomic ideal gas has 24 vibrational modes. What is the value of  $\gamma$ ?

- (A) 1.37      (B) 1.30      (C) 1.03      (D) 10.3

Two ideal polyatomic gases at temperatures  $T_1$  and  $T_2$  are mixed so that there is no loss of energy. If  $F_1$  and  $F_2$ ,  $m_1$  and  $m_2$ ,  $n_1$  and  $n_2$  be the degrees of freedom, masses, number of molecules of the first and second gas respectively, the temperature of mixture of these two gases is:

- (A)  $\frac{n_1 F_1 T_1 + n_2 F_2 T_2}{F_1 + F_2}$       (B)  $\frac{n_1 F_1 T_1 + n_2 F_2 T_2}{n_1 F_1 + n_2 F_2}$       (C)  $\frac{n_1 T_1 + n_2 T_2}{n_1 + n_2}$       (D)  $\frac{n_1 F_1 T_1 + n_2 F_2 T_2}{n_1 + n_2}$

Two identical metal wires of thermal conductivities  $K_1$  and  $K_2$  respectively are connected in series. The effective thermal conductivity of the combination is:

- (A)  $\frac{2K_1 K_2}{K_1 + K_2}$       (B)  $\frac{K_1 + K_2}{K_1 K_2}$       (C)  $\frac{K_1 + K_2}{2K_1 K_2}$       (D)  $\frac{K_1 K_2}{K_1 + K_2}$

A Carnot's engine working between 400 K and 800 K has a work output of 1200 J per cycle. The amount of heat energy supplied to the engine from the source in each cycle is:

- (A) 2400 J      (B) 1600 J      (C) 1800 J      (D) 3200 J

A solenoid of 1000 turns per metre has a core with relative permeability 500. Insulated windings of the solenoid carry an electric current of 5A. The magnetic flux density produced by the solenoid is : (permeability of free space =  $4\pi \times 10^{-7} \text{ H/m}$ )

- (A)  $\pi \text{ T}$       (B)  $2 \times 10^{-3} \pi \text{ T}$       (C)  $10^{-4} \pi \text{ T}$       (D)  $\frac{\pi}{5} \text{ T}$

**Q14** Rectilinear Motion[Step-by-step solution > prepwisar.in/questions/HaVEpLrvWm](https://www.prepwisar.in/questions/HaVEpLrvWm)

A car accelerates from rest at a constant rate  $\alpha$  for some time after which it decelerates at a constant rate  $\beta$  to come to rest. If the total time elapsed is  $t$  seconds, the total distance travelled is:

- (A)  $\frac{4\alpha\beta}{(\alpha + \beta)}t^2$  (B)  $\frac{2\alpha\beta}{(\alpha + \beta)}t^2$  (C)  $\frac{\alpha\beta}{2(\alpha + \beta)}t^2$  (D)  $\frac{\alpha\beta}{4(\alpha + \beta)}t^2$

**Q15** Surface Tension[Step-by-step solution > prepwisar.in/questions/G-5j-QIHtp](https://www.prepwisar.in/questions/G-5j-QIHtp)

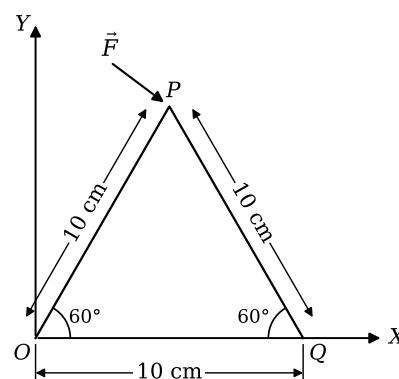
When two soap bubbles of radii  $a$  and  $b$  ( $b > a$ ) coalesce, the radius of curvature of common surface is:

- (A)  $\frac{b-a}{ab}$  (B)  $\frac{a+b}{ab}$  (C)  $\frac{ab}{a+b}$  (D)  $\frac{ab}{b-a}$

**Q16** Rotational Motion[Step-by-step solution > prepwisar.in/questions/BGQW\\_E2wvR](https://www.prepwisar.in/questions/BGQW_E2wvR)

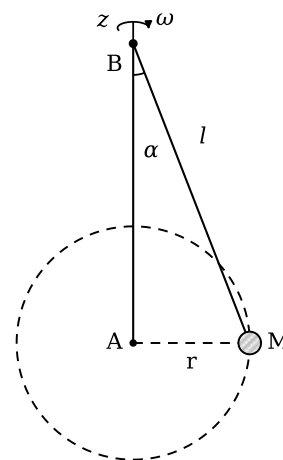
A triangular plate is shown. A force  $\vec{F} = 4\hat{i} - 3\hat{j}$  is applied at point P. The torque at point P with respect to point 'O' and 'Q' are:

- (A)  $-15 + 20\sqrt{3}, 15 + 20\sqrt{3}$  (B)  $15 - 20\sqrt{3}, 15 + 20\sqrt{3}$   
(C)  $15 + 20\sqrt{3}, 15 - 20\sqrt{3}$  (D)  $-15 - 20\sqrt{3}, 15 - 20\sqrt{3}$

**Q17** Rotational Motion[Step-by-step solution > prepwisar.in/questions/LrJWzkzdEN](https://www.prepwisar.in/questions/LrJWzkzdEN)

A mass  $M$  hangs on a massless rod of length  $l$  which rotates at a constant angular frequency. The mass  $M$  moves with steady speed in a circular path of constant radius. Assume that the system is in steady circular motion with constant angular velocity  $\omega$ . The angular momentum of  $M$  about point A is  $L_A$  which lies in the positive  $z$  direction and the angular momentum of  $M$  about point B is  $L_B$ . The correct statement for this system is:

- (A)  $L_A$  is constant, both in magnitude and direction  
(B)  $L_B$  is constant in direction with varying magnitude  
(C)  $L_B$  is constant, both in magnitude and direction  
(D)  $L_A$  and  $L_B$  are both constant in magnitude and direction

**Q18** Simple Harmonic Motion[Step-by-step solution > prepwisar.in/questions/nlSTsd-TzI](https://www.prepwisar.in/questions/nlSTsd-TzI)

For what value of displacement the kinetic energy and potential energy of a simple harmonic oscillation become equal?

- (A)  $x = \frac{A}{2}$  (B)  $x = \pm A$  (C)  $x = \pm \frac{A}{\sqrt{2}}$  (D)  $x = 0$

**Q19** Work, Energy & Power[Step-by-step solution > prepwisar.in/questions/OFScAd6cjA](https://www.prepwisar.in/questions/OFScAd6cjA)

A boy is rolling a 0.5 kg ball on the frictionless floor with the speed of  $20 \text{ ms}^{-1}$ . The ball gets deflected by an obstacle on the way. After deflection it moves with 5% of its initial kinetic energy. What is the speed of the ball now?

- (A)  $14.41 \text{ ms}^{-1}$  (B)  $19.0 \text{ ms}^{-1}$  (C)  $4.47 \text{ ms}^{-1}$  (D)  $1.00 \text{ ms}^{-1}$

The vernier scale used for measurement has a positive zero error of 0.2 mm. If while taking a measurement it was noted that '0' on the vernier scale lies between 8.5 cm and 8.6 cm, vernier coincidence is 6, then the correct value of measurement is \_\_\_\_\_ cm. (least count = 0.01 cm)

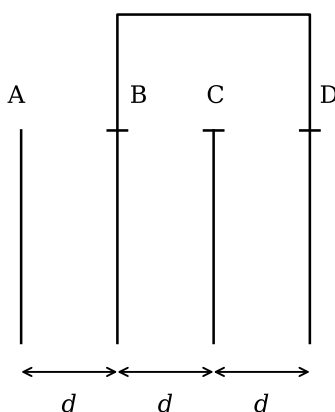
- (A) 8.58 cm                      (B) 8.54 cm                      (C) 8.56 cm                      (D) 8.36 cm

## Physics Section B · Numerical value

Q21 to Q29

A parallel plate capacitor whose capacitance  $C$  is 14 pF is charged by a battery to a potential difference  $V = 12$  V between its plates. The charging battery is now disconnected and a porcelain plate with  $k = 7$  is inserted between the plates, then the plate would oscillate back and forth between the plates with a constant mechanical energy of \_\_\_\_\_ pJ. (Assume no friction)

Four identical rectangular plates with length,  $l = 2$  cm and breadth,  $b = \frac{3}{2}$  cm are arranged as shown in figure. The equivalent capacitance between A and C is  $\frac{x\epsilon_0}{d}$ . The value of  $x$  is \_\_\_\_\_. (Round off to the Nearest Integer)



The equivalent resistance of series combination of two resistors is 's'. When they are connected in parallel, the equivalent resistance is 'p'. If  $s = np$ , then the minimum value for  $n$  is \_\_\_\_\_. (Round off to the Nearest Integer)

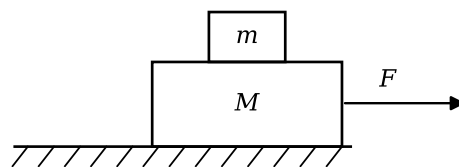
If  $2.5 \times 10^{-6}$  N average force is exerted by a light wave on a non-reflecting surface of  $30 \text{ cm}^2$  area during 40 minutes of time span, the energy flux of light just before it falls on the surface is \_\_\_\_\_  $\text{W/cm}^2$ . (Round off to the Nearest Integer)  
(Assume complete absorption and normal incidence conditions are there)

The radius in kilometer to which the present radius of earth ( $R = 6400$  km) to be compressed so that the escape velocity is increased 10 times is \_\_\_\_\_.

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**Q26** Friction **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/DIn81IyeKk) > prepwiser.in/questions/DIn81IyeKk

Two blocks ( $m = 0.5 \text{ kg}$  and  $M = 4.5 \text{ kg}$ ) are arranged on a horizontal frictionless table as shown in figure. The coefficient of static friction between the two blocks is  $\frac{3}{7}$ . Then the maximum horizontal force that can be applied on the larger block so that the blocks move together is \_\_\_\_\_ N. (Round off to the Nearest Integer) [Take  $g$  as  $9.8 \text{ ms}^{-2}$ ]

**Q27** Circular Motion **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/6Mnifz6iFf) > prepwiser.in/questions/6Mnifz6iFf

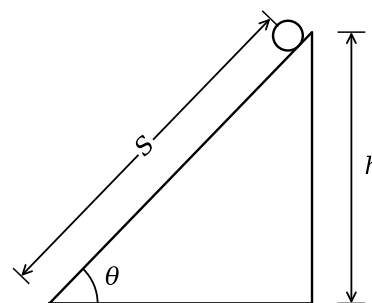
The angular speed of truck wheel is increased from 900 rpm to 2460 rpm in 26 seconds. The number of revolutions by the truck engine during this time is \_\_\_\_\_. (Assuming the acceleration to be uniform).

**Q28** Rotational Motion **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/J-tcnbNexj) > prepwiser.in/questions/J-tcnbNexj

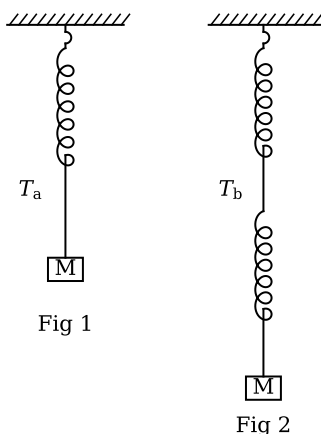
The following bodies,

- (1) a ring
- (2) a disc
- (3) a solid cylinder
- (4) a solid sphere,

of same mass ' $m$ ' and radius ' $R$ ' are allowed to roll down without slipping simultaneously from the top of the inclined plane. The body which will reach first at the bottom of the inclined plane is \_\_\_\_\_. [Mark the body as per their respective numbering given in the question]

**Q29** Simple Harmonic Motion **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/RwhaPg24Et) > prepwiser.in/questions/RwhaPg24Et

Consider two identical springs each of spring constant  $k$  and negligible mass compared to the mass  $M$  as shown. Fig. 1 shows one of them and Fig. 2 shows their series combination. The ratios of time period of oscillation of the two SHM is  $T_b/T_a = \sqrt{x}$ , where value of  $x$  is \_\_\_\_\_. (Round off to the Nearest Integer)

**Chemistry** Section A · Multiple choice

Q30 to Q44

**Q30** General Organic Chemistry (GOC)[Step-by-step solution](https://www.prepwiser.in/questions/GorANwIVfV) > prepwiser.in/questions/GorANwIVfV

Mesityl oxide is a common name of:

- |                                       |                              |
|---------------------------------------|------------------------------|
| (A) 3-Methyl cyclohexane carbaldehyde | (B) 4-Methyl pent-3-en-2-one |
| (C) 2,4-Dimethyl pentan-3-one         | (D) 2-Methyl cyclohexanone   |

**Q31** Carbohydrates & Biomolecules[Step-by-step solution](https://www.prepwisar.in/questions/ntaT3xwMnQ) > prepwisar.in/questions/ntaT3xwMnQ

Which of the following is correct structure of tyrosine?

**Q32** Chemical Bonding & Molecular Structure[Step-by-step solution](https://www.prepwisar.in/questions/XZ9fj59pk-) > prepwisar.in/questions/XZ9fj59pk-

A central atom in a molecule has two lone pairs of electrons and forms three single bonds. The shape of this molecule is:

- (A) trigonal pyramidal      (B) T-shaped      (C) see-saw      (D) planar triangular

**Q33** Chemistry in Everyday Life[Step-by-step solution](https://www.prepwisar.in/questions/Wma_BBMDYC) > prepwisar.in/questions/Wma\_BBMDYC

With respect to drug-enzyme interaction, identify the wrong statement.

- (A) Allosteric inhibitor changes the enzyme's active site  
(B) Allosteric inhibitor competes with the enzyme's active site  
(C) Competitive inhibitor binds to the enzyme's active site  
(D) Non-Competitive inhibitor binds to the allosteric site

**Q34** d & f Block Elements[Step-by-step solution](https://www.prepwisar.in/questions/bRtx2GhjJC) > prepwisar.in/questions/bRtx2GhjJC

What is the spin-only magnetic moment value (BM) of a divalent metal ion with atomic number 25, in its aqueous solution?

- (A) zero      (B) 5.26      (C) 5.0      (D) 5.92

**Q35** d & f Block Elements[Step-by-step solution](https://www.prepwisar.in/questions/BbBYmHgMDj) > prepwisar.in/questions/BbBYmHgMDj

Given below are two statements:

Statement I : Potassium permanganate on heating at 573K forms potassium manganate.

Statement II : Both potassium permanganate and potassium manganate are tetrahedral and paramagnetic in nature.

In the light of the above statements, choose the most appropriate answer from the options given below:

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

**Q36** Amines & Diazonium Salts[Step-by-step solution](https://www.prepwisar.in/questions/WG6WMvES0o) > prepwisar.in/questions/WG6WMvES0o

Which of the following reaction is an example of ammonolysis?

- (A)  $\text{C}_6\text{H}_5\text{COCl} + \text{C}_6\text{H}_5\text{NH}_2 \rightarrow \text{C}_6\text{H}_5\text{CONHC}_6\text{H}_5$       (B)  $\text{C}_6\text{H}_5\text{CH}_2\text{CN} \xrightarrow{[\text{H}]} \text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{NH}_2$   
(C)  $\text{C}_6\text{H}_5\text{CH}_2\text{CN} \xrightarrow{\text{HCl}} \text{C}_6\text{H}_5\text{CH}_2\text{NH}_3^+\text{Cl}^-$       (D)  $\text{C}_6\text{H}_5\text{CH}_2\text{Cl} + \text{NH}_3 \rightarrow \text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$

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The INCORRECT statement(s) about heavy water is (are)

- (A) used as a moderator in nuclear reactor
- (B) obtained as a by-product in fertilizer industry
- (C) used for the study of reaction mechanism
- (D) has a higher dielectric constant than water

Choose the correct answer from the options given below:

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

Which of the following compound CANNOT act as a Lewis base?

- (A)  $\text{SF}_4$                       (B)  $\text{NF}_3$                       (C)  $\text{ClF}_3$                       (D)  $\text{PCl}_5$

The absolute value of the electron gain enthalpy of halogens satisfies:

- (A)  $\text{Cl} > \text{Br} > \text{F} > \text{I}$                       (B)  $\text{Cl} > \text{F} > \text{Br} > \text{I}$                       (C)  $\text{I} > \text{Br} > \text{Cl} > \text{F}$                       (D)  $\text{F} > \text{Cl} > \text{Br} > \text{I}$

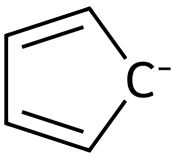
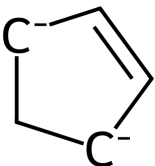
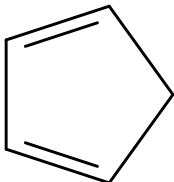
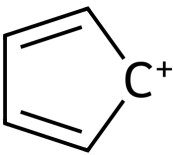
The correct order of conductivity of ions in water is:

- (A)  $\text{K}^+ > \text{Na}^+ > \text{Cs}^+ > \text{Rb}^+$                       (B)  $\text{Cs}^+ > \text{Rb}^+ > \text{K}^+ > \text{Na}^+$   
(C)  $\text{Na}^+ > \text{K}^+ > \text{Rb}^+ > \text{Cs}^+$                       (D)  $\text{Rb}^+ > \text{Na}^+ > \text{K}^+ > \text{Li}^+$

A colloidal system consisting of a gas dispersed in a solid is called a/an:

- (A) foam                      (B) aerosol                      (C) solid sol                      (D) gel

Which of the following is an aromatic compound?

- (A)  (B)  (C)  (D) 

Given below are two statements:

Statement I : Retardation factor ( $R_f$ ) can be measured in meter/centimeter.

Statement II :  $R_f$  value of a compound remains constant in all solvents.

Choose the most appropriate answer from the options given below:

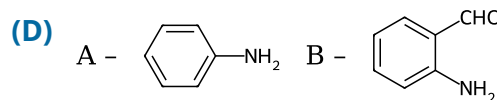
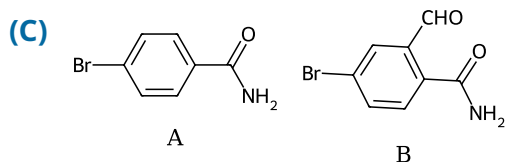
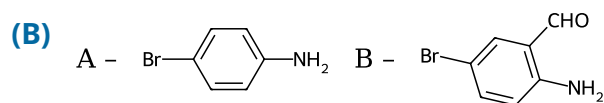
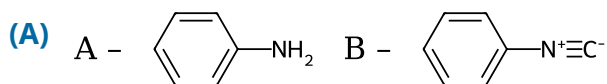
- (A) Statement I is true but statement II is false                      (B) Statement I is false but statement II is true  
(C) Both statement I and statement II are true                      (D) Both statement I and statement II are false

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**Q44** Amines & Diazonium Salts[Step-by-step solution](https://www.prepwiser.in/questions/wj5C4UskVH) > prepwiser.in/questions/wj5C4UskVH

Hoffmann bromomide degradation of benzamide gives product A, which upon heating with  $\text{CHCl}_3$  and  $\text{NaOH}$  gives product B.

The structures of A and B are:

**Chemistry Section B · Numerical value**

Q45 to Q52

**Q45** Chemical Kinetics **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/pRzO74r1Ek) > prepwiser.in/questions/pRzO74r1Ek

For a certain first order reaction 32% of the reactant is left after 570s. The rate constant of this reaction is  $\text{_____} \times 10^{-3} \text{ s}^{-1}$ . (Round off to the Nearest Integer). [Given :  $\log_{10} 2 = 0.301$ ,  $\ln 10 = 2.303$ ]

**Q46** Solutions & Colligative Properties **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/2VpbtCZVF8) > prepwiser.in/questions/2VpbtCZVF8

The oxygen dissolved in water exerts a partial pressure of 20 kPa in the vapour above water. The molar solubility of oxygen in water is  $\text{_____} \times 10^{-5} \text{ mol dm}^{-3}$ . (Round off to the Nearest Integer).

[Given : Henry's law constant =  $K_H = 8.0 \times 10^4 \text{ kPa}$  for  $\text{O}_2$ . Density of water with dissolved oxygen =  $1.0 \text{ kg dm}^{-3}$ ]

**Q47** Redox Reactions **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/oASeQ8g4ET) > prepwiser.in/questions/oASeQ8g4ET

15 mL of aqueous solution of  $\text{Fe}^{2+}$  in acidic medium completely reacted with 20 mL of 0.03 M aqueous  $\text{Cr}_2\text{O}_7^{2-}$ . The molarity of the  $\text{Fe}^{2+}$  solution is  $\text{_____} \times 10^{-2} \text{ M}$ . (Round off to the Nearest Integer).

**Q48** Mole Concept & Stoichiometry **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/Ah6660gjtK) > prepwiser.in/questions/Ah6660gjtK

The mole fraction of a solute in a 100 molal aqueous solution is  $\text{_____} \times 10^{-2}$ . (Round off to the Nearest Integer).

[Given : Atomic masses : H : 1.0 u, O : 16.0 u]

**Q49** Atomic Structure **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/GbVapIMkdb) > prepwiser.in/questions/GbVapIMkdb

A certain orbital has  $n = 4$  and  $m_l = -3$ . The number of radial nodes in this orbital is  $\text{_____}$ . (Round off to the Nearest Integer).

**Q50** Chemical Thermodynamics **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/-qg1WYTzf) > prepwiser.in/questions/-qg1WYTzf

The standard enthalpies of formation of  $\text{Al}_2\text{O}_3$  and  $\text{CaO}$  are  $-1675 \text{ kJ mol}^{-1}$  and  $-635 \text{ kJ mol}^{-1}$  respectively.

For the reaction

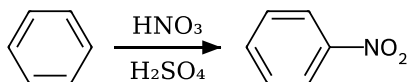
$3\text{CaO} + 2\text{Al} \rightarrow 3\text{Ca} + \text{Al}_2\text{O}_3$  the standard reaction enthalpy  $\Delta_r H^\circ = \text{_____ kJ}$ .

(Round off to the Nearest Integer)

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**Q51** Ionic Equilibrium **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/RhWhEV_2lJ) › prepwiser.in/questions/RhWhEV\_2lJ

0.01 moles of a weak acid HA ( $K_a = 2.0 \times 10^{-6}$ ) is dissolved in 1.0 L of 0.1 M HCl solution. The degree of dissociation of HA is \_\_\_\_\_  $\times 10^{-5}$  (Round off to the Nearest Integer).  
[Neglect volume change on adding HA. Assume degree of dissociation  $\ll 1$ ]

**Q52** Mole Concept & Stoichiometry **NUMERICAL**[Step-by-step solution](https://www.prepwiser.in/questions/To8Pjk8wNS) › prepwiser.in/questions/To8Pjk8wNS

In the above reaction, 3.9 g of benzene on nitration gives 4.92 g of nitrobenzene. The percentage yield of nitrobenzene in the above reaction is \_\_\_\_\_. (Round off to the Nearest Integer).  
(Given atomic mass : C : 12.0 u, H : 1.0 u, O : 16.0 u, N : 14.0 u)

**Mathematics** Section A · Multiple choice

Q53 to Q71

**Q53** Three Dimensional Geometry[Step-by-step solution](https://www.prepwiser.in/questions/rvBVQc0RW2) › prepwiser.in/questions/rvBVQc0RW2

The equation of the plane which contains the y-axis and passes through the point (1, 2, 3) is:

- (A)  $x + 3z = 0$  (B)  $3x - z = 0$  (C)  $x + 3z = 10$  (D)  $3x + z = 6$

**Q54** Binomial Theorem[Step-by-step solution](https://www.prepwiser.in/questions/xamMOa4KHR) › prepwiser.in/questions/xamMOa4KHR

If the fourth term in the expansion of  $(x + x^{\log_2 x})^7$  is 4480, then the value of x where  $x \in \mathbb{N}$  is equal to:

- (A) 3 (B) 1 (C) 4 (D) 2

**Q55** Circles[Step-by-step solution](https://www.prepwiser.in/questions/37M9gJJ0Fa) › prepwiser.in/questions/37M9gJJ0Fa

The line  $2x - y + 1 = 0$  is a tangent to the circle at the point (2, 5) and the centre of the circle lies on  $x - 2y = 4$ . Then, the radius of the circle is:

- (A)  $5\sqrt{3}$  (B)  $4\sqrt{5}$  (C)  $3\sqrt{5}$  (D)  $5\sqrt{4}$

**Q56** Circles[Step-by-step solution](https://www.prepwiser.in/questions/YIPtNYrPbg) › prepwiser.in/questions/YIPtNYrPbg

Choose the incorrect statement about the two circles whose equations are given below:

$$x^2 + y^2 - 10x - 10y + 41 = 0 \text{ and}$$

$$x^2 + y^2 - 16x - 10y + 80 = 0$$

- (A) Distance between two centres is the average of radii of both the circles.  
(B) Both circles pass through the centre of each other.  
(C) Circles have two intersection points.  
(D) Both circle's centers lie inside region of one another.

**Q57** Complex Numbers[Step-by-step solution](https://www.prepwiser.in/questions/fgMAbBIyoY) › prepwiser.in/questions/fgMAbBIyoY

The area of the triangle with vertices A(z), B(iz) and C(z + iz) is:

- (A) 1 (B)  $\frac{1}{2} |z|^2$  (C)  $\frac{1}{2} |z + iz|^2$  (D)  $\frac{1}{2}$

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Which of the following statements is correct for the function  $g(\alpha)$  for  $\alpha \in \mathbb{R}$  such that

$$g(\alpha) = \int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \frac{\sin^{\alpha} x}{\cos^{\alpha} x + \sin^{\alpha} x} dx$$

- (A)  $g(\alpha)$  is a strictly increasing function  
 (B)  $g(\alpha)$  is an even function  
 (C)  $g(\alpha)$  has an inflection point at  $\alpha = -\frac{1}{2}$   
 (D)  $g(\alpha)$  is a strictly decreasing function

Which of the following is true for  $y(x)$  that satisfies the differential equation

$$\frac{dy}{dx} = xy - 1 + x - y; y(0) = 0:$$

- (A)  $y(1) = 1$   
 (B)  $y(1) = e^{-\frac{1}{2}} - 1$   
 (C)  $y(1) = e^{\frac{1}{2}} - e^{-\frac{1}{2}}$   
 (D)  $y(1) = e^{\frac{1}{2}} - 1$

The inverse of  $y = 5^{\log x}$  is:

- (A)  $x = 5^{\log y}$   
 (B)  $x = y^{\frac{1}{\log 5}}$   
 (C)  $x = 5^{\frac{1}{\log y}}$   
 (D)  $x = y^{\log 5}$

The sum of possible values of  $x$  for

$$\tan^{-1}(x+1) + \cot^{-1}\left(\frac{1}{x-1}\right) = \tan^{-1}\left(\frac{8}{31}\right) \text{ is:}$$

- (A)  $-\frac{32}{4}$   
 (B)  $-\frac{33}{4}$   
 (C)  $-\frac{31}{4}$   
 (D)  $-\frac{30}{4}$

If  $\cot^{-1}(\alpha) = \cot^{-1} 2 + \cot^{-1} 8 + \cot^{-1} 18 + \cot^{-1} 32 + \dots$  upto 100 terms, then  $\alpha$  is:

- (A) 1.02  
 (B) 1.03  
 (C) 1.01  
 (D) 1.00

The value of

$$\lim_{x \rightarrow 0^+} \frac{\cos^{-1}(x - [x]^2) \cdot \sin^{-1}(x - [x]^2)}{x - x^3}$$

, where  $[x]$  denotes the greatest integer  $\leq x$  is:

- (A)  $\pi$   
 (B)  $\frac{\pi}{4}$   
 (C)  $\frac{\pi}{2}$   
 (D) 0

The system of equations  $kx + y + z = 1$ ,  $x + ky + z = k$  and  $x + y + zk = k^2$  has no solution if  $k$  is equal to:

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

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If

$$A = \begin{pmatrix} 0 & \sin \alpha \\ \sin \alpha & 0 \end{pmatrix}$$

and  $\det(A^2 - \frac{1}{2}I) = 0$ , then a possible value of  $\alpha$  is:

- (A)  $\frac{\pi}{4}$  (B)  $\frac{\pi}{6}$  (C)  $\frac{\pi}{2}$  (D)  $\frac{\pi}{3}$

Team 'A' consists of 7 boys and  $n$  girls and Team 'B' has 4 boys and 6 girls. If a total of 52 single matches can be arranged between these two teams when a boy plays against a boy and a girl plays against a girl, then  $n$  is equal to:

- (A) 5 (B) 2 (C) 4 (D) 6

Two dice are rolled. If both dice have six faces numbered 1, 2, 3, 5, 7 and 11, then the probability that the sum of the numbers on the top faces is less than or equal to 8 is:

- (A)  $\frac{4}{9}$  (B)  $\frac{1}{2}$  (C)  $\frac{5}{12}$  (D)  $\frac{17}{36}$

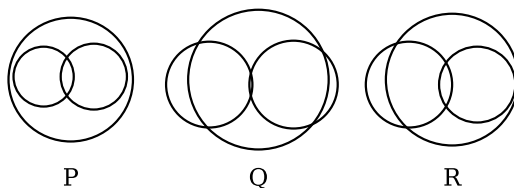
The value of

$$4 + \frac{1}{5 + \frac{1}{4 + \frac{1}{5 + \frac{1}{4 + \dots \infty}}}}$$

is:

- (A)  $2 + \frac{2}{5}\sqrt{30}$  (B)  $2 + \frac{4}{\sqrt{5}}\sqrt{30}$  (C)  $5 + \frac{2}{5}\sqrt{30}$  (D)  $4 + \frac{4}{\sqrt{5}}\sqrt{30}$

In a school, there are three types of games to be played. Some of the students play two types of games, but none play all the three games. Which Venn diagrams can justify the above statement?



- (A) Q and R (B) None of these (C) P and R (D) P and Q

Let  $\vec{a} = 2\hat{i} - 3\hat{j} + 4\hat{k}$  and  $\vec{b} = 7\hat{i} + \hat{j} - 6\hat{k}$ .

If  $\vec{r} \times \vec{a} = \vec{r} \times \vec{b}$ ,  $\vec{r} \cdot (\hat{i} + 2\hat{j} + \hat{k}) = -3$ , then  $\vec{r} \cdot (2\hat{i} - 3\hat{j} + \hat{k})$  is equal to:

- (A) 10 (B) 8 (C) 13 (D) 12

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**Q71** Straight Lines[Step-by-step solution](#) › [prepwisar.in/questions/tBStH81732](https://www.prepwisar.in/questions/tBStH81732)

In a triangle PQR, the co-ordinates of the points P and Q are  $(-2, 4)$  and  $(4, -2)$  respectively. If the equation of the perpendicular bisector of PR is  $2x - y + 2 = 0$ , then the centre of the circumcircle of the  $\Delta PQR$  is:

- (A)  $(-1, 0)$  (B)  $(1, 4)$  (C)  $(0, 2)$  (D)  $(-2, -2)$

**Mathematics** Section B · Numerical value

Q72 to Q81

**Q72** Three Dimensional Geometry **NUMERICAL**[Step-by-step solution](#) › [prepwisar.in/questions/JT\\_bqdqvcq](https://www.prepwisar.in/questions/JT_bqdqvcq)

If the equation of the plane passing through the line of intersection of the planes  $2x - 7y + 4z - 3 = 0$ ,  $3x - 5y + 4z + 11 = 0$  and the point  $(-2, 1, 3)$  is  $ax + by + cz - 7 = 0$ , then the value of  $2a + b + c - 7$  is \_\_\_\_\_.

**Q73** Binomial Theorem **NUMERICAL**[Step-by-step solution](#) › [prepwisar.in/questions/H37U3iIRaX](https://www.prepwisar.in/questions/H37U3iIRaX)

If  $(2021)^{3762}$  is divided by 17, then the remainder is \_\_\_\_\_.

**Q74** Circles **NUMERICAL**[Step-by-step solution](#) › [prepwisar.in/questions/UPTqxhGZ2L](https://www.prepwisar.in/questions/UPTqxhGZ2L)

The minimum distance between any two points  $P_1$  and  $P_2$  while considering point  $P_1$  on one circle and point  $P_2$  on the other circle for the given circles' equations

$$x^2 + y^2 - 10x - 10y + 41 = 0$$

$$x^2 + y^2 - 24x - 10y + 160 = 0 \text{ is } \underline{\hspace{2cm}}.$$

**Q75** Definite Integration **NUMERICAL**[Step-by-step solution](#) › [prepwisar.in/questions/t5axcgeLD7](https://www.prepwisar.in/questions/t5axcgeLD7)

If  $[.]$  represents the greatest integer function, then the value of

$$\left| \int_0^{\sqrt{\frac{\pi}{2}}} [x^2] - \cos x \, dx \right|$$

is \_\_\_\_\_.

**Q76** Differentiation **NUMERICAL**[Step-by-step solution](#) › [prepwisar.in/questions/ep5xfODW8f](https://www.prepwisar.in/questions/ep5xfODW8f)

If

$$f(x) = \sin \left( \cos^{-1} \left( \frac{1 - 2^{2x}}{1 + 2^{2x}} \right) \right)$$

and its first derivative with respect to  $x$  is  $-\frac{b}{a} \log_e 2$  when  $x = 1$ , where  $a$  and  $b$  are integers, then the minimum value of  $|a^2 - b^2|$  is \_\_\_\_\_.

**Q77** Continuity & Differentiability **NUMERICAL**[Step-by-step solution](#) › [prepwisar.in/questions/KD7k1ZZPSI](https://www.prepwisar.in/questions/KD7k1ZZPSI)

If the function  $f(x) = \frac{\cos(\sin x) - \cos x}{x^4}$  is continuous at each point in its domain and  $f(0) = \frac{1}{k}$ , then  $k$  is \_\_\_\_\_.

**Q78** Determinants **NUMERICAL**[Step-by-step solution](#) › [prepwisar.in/questions/YB8pMEpN0B](https://www.prepwisar.in/questions/YB8pMEpN0B)

If  $A = \begin{bmatrix} 2 & 3 \\ 0 & -1 \end{bmatrix}$ , then the value of  $\det(A^4) + \det(A^{10} - (\text{Adj}(2A))^{10})$  is equal to \_\_\_\_\_.

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Let there be three independent events  $E_1$ ,  $E_2$  and  $E_3$ . The probability that only  $E_1$  occurs is  $\alpha$ , only  $E_2$  occurs is  $\beta$  and only  $E_3$  occurs is  $\gamma$ . Let 'p' denote the probability of none of events occurs that satisfies the equations

$(\alpha - 2\beta)p = \alpha\beta$  and  $(\beta - 3\gamma)p = 2\beta\gamma$ . All the given probabilities are assumed to lie in the interval  $(0, 1)$ .

Then,

$$\frac{\text{Probability of occurrence of } E_1}{\text{Probability of occurrence of } E_3}$$

is equal to \_\_\_\_\_.

If  $\vec{a} = \alpha\hat{i} + \beta\hat{j} + 3\hat{k}$ ,

$\vec{b} = -\beta\hat{i} - \alpha\hat{j} - \hat{k}$  and

$\vec{c} = \hat{i} - 2\hat{j} - \hat{k}$

such that  $\vec{a} \cdot \vec{b} = 1$  and  $\vec{b} \cdot \vec{c} = -3$ , then

$$\frac{1}{3} \left( (\vec{a} \times \vec{b}) \cdot \vec{c} \right)$$

is equal to \_\_\_\_\_.

The maximum value of  $z$  in the following equation  $z = 6xy + y^2$ , where  $3x + 4y \leq 100$  and  $4x + 3y \leq 75$  for  $x \geq 0$  and  $y \geq 0$  is \_\_\_\_\_.

# Answer key: JEE Main 2021 · 17 Mar · Shift 1

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## Physics

|               |               |                |              |                |              |              |               |
|---------------|---------------|----------------|--------------|----------------|--------------|--------------|---------------|
| 1. <b>C</b>   | 2. <b>A</b>   | 3. <b>B</b>    | 4. <b>C</b>  | 5. <b>A</b>    | 6. <b>B</b>  | 7. <b>C</b>  | 8. <b>B</b>   |
| 9. <b>C</b>   | 10. <b>B</b>  | 11. <b>A</b>   | 12. <b>A</b> | 13. <b>A</b>   | 14. <b>C</b> | 15. <b>D</b> | 16. <b>D</b>  |
| 17. <b>A</b>  | 18. <b>C</b>  | 19. <b>C</b>   | 20. <b>B</b> | 21. <b>864</b> | 22. <b>2</b> | 23. <b>4</b> | 24. <b>25</b> |
| 25. <b>64</b> | 26. <b>21</b> | 27. <b>728</b> | 28. <b>4</b> | 29. <b>2</b>   |              |              |               |

## Chemistry

|                 |               |               |              |                |              |               |              |
|-----------------|---------------|---------------|--------------|----------------|--------------|---------------|--------------|
| 30. <b>B</b>    | 31. <b>D</b>  | 32. <b>B</b>  | 33. <b>B</b> | 34. <b>D</b>   | 35. <b>A</b> | 36. <b>D</b>  | 37. <b>A</b> |
| 38. <b>D</b>    | 39. <b>B</b>  | 40. <b>B</b>  | 41. <b>C</b> | 42. <b>A</b>   | 43. <b>D</b> | 44. <b>A</b>  | 45. <b>2</b> |
| 46. <b>1389</b> | 47. <b>24</b> | 48. <b>64</b> | 49. <b>0</b> | 50. <b>230</b> | 51. <b>2</b> | 52. <b>80</b> |              |

## Mathematics

|              |               |              |              |                |              |              |                |
|--------------|---------------|--------------|--------------|----------------|--------------|--------------|----------------|
| 53. <b>B</b> | 54. <b>D</b>  | 55. <b>C</b> | 56. <b>D</b> | 57. <b>B</b>   | 58. <b>B</b> | 59. <b>B</b> | 60. <b>B</b>   |
| 61. <b>A</b> | 62. <b>C</b>  | 63. <b>C</b> | 64. <b>C</b> | 65. <b>A</b>   | 66. <b>C</b> | 67. <b>D</b> | 68. <b>A</b>   |
| 69. <b>B</b> | 70. <b>D</b>  | 71. <b>D</b> | 72. <b>4</b> | 73. <b>4</b>   | 74. <b>1</b> | 75. <b>1</b> | 76. <b>481</b> |
| 77. <b>6</b> | 78. <b>16</b> | 79. <b>6</b> | 80. <b>2</b> | 81. <b>904</b> |              |              |                |

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