SAMPLE PAPERS

JEE Advanced

Paper-02

Time: 3 Hours ***Maximum Marks: 183***

Topics Covered:

Physics	:	*Properties of Solids, Properties of Liquids, Heat & Thermodynamics, Ray Optics, Wave Optics, Electromagnetic Waves*
Chemistry	:	*p-Block (13 & 14 Group), Thermodynamics, Thermochemistry, Solid State, Alkyl Halides & Haloalkane, Surface Chemistry, Metallurgy, Chemistry in Everyday Life*
Mathematics	:	*Sequence and Series, Permutation and Combination, Straight Lines, Definite Integrals, Indefinite Integrals*

Read the Important Instructions Carefully:

1. *You are allowed to take away the Question Paper at the end of the examination.*
2. *Do not tamper with or mutilate the OMR. Do not use the OMR for rough work.*
3. *Use a **BLACK BALL POINT PEN** to darken the bubbles on the OMR.*
4. *The OMR is machine-gradable. Ensure that the bubbles are darken in the correct way.*
5. *Darken the bubbles **ONLY IF** you are sure of the answer. There is **NO WAY** to erase or "un-darken" a darkened bubble.*

PART-I : PHYSICS

SECTION-1 (MAXIMUM MARKS : 21)

- *This section contains **SEVEN** questions*
- *Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct*
- *For each question, darken the bubble corresponding to all the correct option in the OMR*
- *For each question, marks will be awarded in one of the following categories:*

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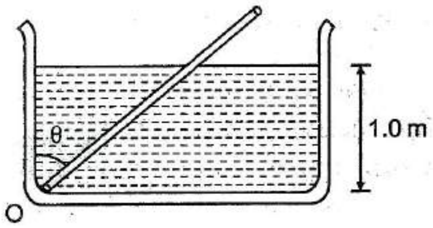
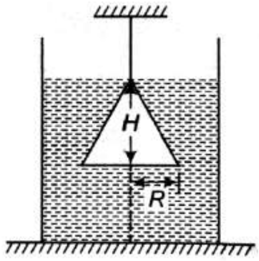
Zero Marks	:	***0***	***If none of the bubbles is darkened***
Negative Marks	:	***–1***	***In all other cases***

1. A uniform rod of length 2.0 m specific gravity 0.5 and mass 2 kg is hinged at one end to the bottom of a tank of water (specific gravity = 0.5) filled upto a height of 1.0 m as shown in figure. Taking the case $\theta \neq 0°$ the force exerted by the hinge on the rod is ($g = 10\ m/s^2$)



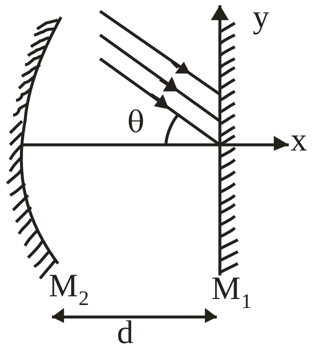
(A) 10.2 N upwards (B) 4.2 N downwards (C) 8.3 N downwards (D) 6.2 N upwards

2. A cone of radius R and height H, is hanging inside a liquid of density ρ by means of a string as shown in the figure . The force, due to the liquid acting on the slant surface of the cone is (Neglect atmosphere pressure)



(A) $\rho\pi gHR^2$ (B) $\pi\rho HR^2$ (C) $\frac{4}{3}\pi\rho gHR^2$ (D) $\frac{2}{3}\pi\rho gHR^2$

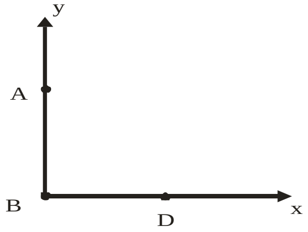
3. In the figure shown a thin parallel beam of light is incident on a plane mirror M_1 at small angle 'θ'. M_2 is a concave mirror of focal length 'f'. After three successive reflections of this beam the x and y coordinates of the image is:



(A) $x = f - d,\ y = f\theta$ (B) $x = d + f,\ y = f\theta$ (C) $x = f - d,\ y = -f\theta$ (D) $x = d - f,\ y = -f\theta$

Space for Rough Work

4. An interference is observed due to two coherent sources 'A' and 'B' having phase constant zero separated by a distance 4λ along the y-axis where λ is the wavelength of the source. A detector D is moved on the positive x-axis. The number of points on the x-axis excluding the points x = 0 and x = ∞ at which maxima will be observed is

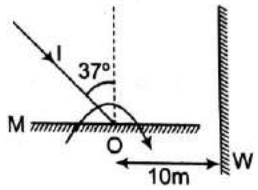


(A) 3 (B) 4 (C) 5 (D) infinite

5. One mole of an ideal gas undergoes a process in which $T = T_0 + aV^3$, where T_0 and 'a' are positive constants and V is the volume. The volume for which pressure will be minimum is

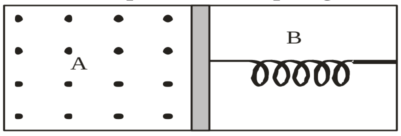
(A) $\left(\frac{T_0}{2a}\right)^{1/3}$ (B) $\left(\frac{T_0}{3a}\right)^{1/3}$ (C) $\left(\frac{a}{2T_0}\right)^{2/3}$ (D) $\left(\frac{a}{3T_0}\right)^{2/3}$

6. A light ray I is incident on a plane mirror M. The mirror is rotated in the direction as shown in the figure by an arrow at frequency $9/\pi$ rps. The light reflected by the mirror is received on the wall W at a distance 10 m from the axis of rotation. When the angle of incidence becomes 37°, the speed of the spot (a point) on the wall is



(A) 10 m/s (B) 1000 m/s (C) 500 m/s (D) 20 m/s

7. A thermally insulated chamber of volume $2v_0$ is divided by a frictionless piston of area 'S' into two equal parts A and B. Part 'A' has an ideal gas at pressure P_0 and temperature T_0 and in part B there is vacuum. A massless spring of force constant k is connected with piston and the wall of the container as shown. Initially spring is unstretched. Gas in chamber A is allowed to expand. Consider the compression in spring to be x_0 in equilibrium.



(A) Final pressure of the gas is $\frac{kx_0}{2S}$ (B) Work done by the gas is kx_0^2

(C) Change in internal energy of the gas is $\frac{1}{2}kx_0^2$ (D) Temperature of the gas is increased

Space for Rough Work

SECTION-2 (MAXIMUM MARKS : 28)

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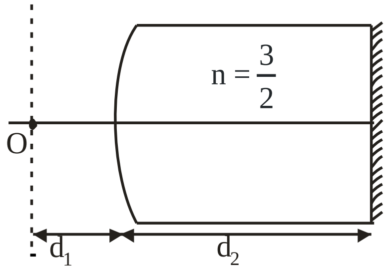
- *For each question, marks will be awarded in one of the following categories:*

Full Marks	:	***+4***	***If only the bubble(s) corresponding to all the correct option(s) is(are) darkened***
Partial Marks	:	***+1***	***For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened***
Zero Marks	:	***0***	***If none of the bubbles is darkened***
Negative Marks	:	***–2***	***In all other cases***

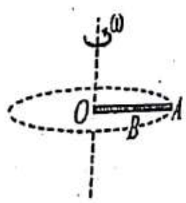
- *For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will results in +4 marks; darkening only (A) and (D) will result in +2 marks; and darkening (A) and (B) results in –2 marks, as a wrong option is also darkened*

8. In the figure shown a point object O is placed in air on the principal axis. The radius of curvature of the spherical surface is 60cm. I_f is the final image formed after all the refractions and reflections.



(A) If d_1 = 120cm, then the 'I_f' is formed on 'O' for any value of d_2.
(B) If d_1 = 240cm, then the 'I_f' is formed on 'O' only if d_2 = 360cm.
(C) If d_1 = 240cm, then the 'I_f' is formed on 'O' for all values of d_2.
(D) If d_1 = 240cm, then the 'I_f' can't be formed on 'O'.

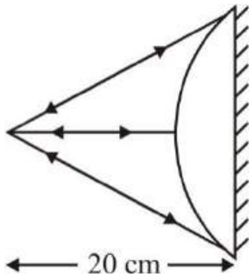
9. A rod OA of mass m and length L is rotating in a horizontal circle about point O as shown in figure. B is the mid-point of rod. If T represents tension in the rod at any point and U represents elastic potential energy per unit volume at any point of rod, then choose correct alternative (s).



(A) $T_O = \frac{4}{3} T_B$ (B) $T_0 = 2T_B$ (C) $U_O = \frac{16}{9} U_B$ (D) $U_0 = 4U_B$

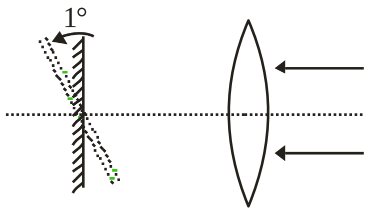
Space for Rough Work

10. Figure shows the behaviour of light rays with respect to a thin plano-convex lens whose plane surface is silvered as shown in the figure. If the refractive index of the material of the lens is 1.5. Choose the correct option(s).



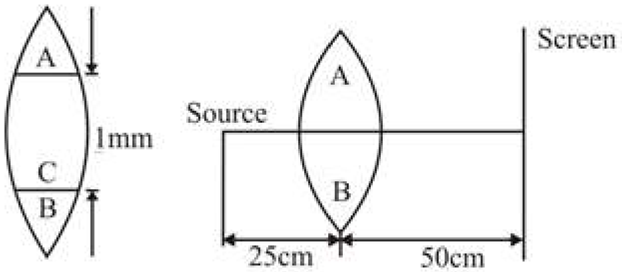
(A) The focal length of the silvered lens (which acts as a mirror) is 10 cm.
(B) Radius of curvature of the curved part of the lens is 10 cm.
(C) In the silvered lens, rays fall normally on the silvered surface.
(D) The focal length of the lens (without silvering) is 20 cm.

11. A thin equiconvex lens of glass $\left(\mu = \frac{3}{2}\right)$ having a focal length of 30 cm is placed in air at a distance of 10 cm from a plane mirror, which is placed with its plane perpendicular to the optical axis of the lens. Water $\left(\mu = \frac{4}{3}\right)$ fills the space between lens and mirror. A parallel beam of light is incident on the lens parallel to the principal axis. Choose the correct option(s):



(A) Final image is 18 cm left to the lens.
(B) Final image is 18 cm right to the lens.
(C) If mirror is rotated by 1°, as shown in figure, final image is displaced by $\frac{\pi}{3}$ cm.
(D) If mirror is rotated by 1°, as shown in figure, final image is displaced by $\frac{5\pi}{9}$ cm.

12. A convex lens of focal length 50 cm is cut along the diameter into two identity halves A and B and in the process a layer C of the lens thickness 1 mm is lost. Then the two halves A and B are put together to form a composite lens. Now in front of this composite lens a source of light emitting wavelength λ = 6000 Å is placed at a distance of 25 cm as shown in the figure. Behind the lens there is a screen at a distance 50 cm from it. Choose the correct option(s):



(A) Two image will be formed by lens which will result in interference pattern on the screen.
(B) One image will be formed by lens which will produce diffraction pattern on the screen.
(C) Fringe width of the interference pattern obtained on the screen is 0.6 mm.
(D) Fringe width of the central maxima on the screen will be 1.2 mm.

Space for Rough Work

13. White light is used to illuminate the two slits in YDSE. The separation between the slits is b and the screen is at a distance d (>>b) from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are

(A) $\lambda = \frac{b^2}{d}$ (B) $\lambda = \frac{2b^2}{d}$ (C) $\lambda = \frac{b^2}{3d}$ (D) $\lambda = \frac{2b^2}{3d}$

14. A block of density 2000 kg/m^3 and mass 10 kg is suspended by a spring stiffness 100 N/m. The other end of the spring is attached to a fixed support. The block is completely submerged in a liquid of density 1000 kg/m^3. If the block is in equilibrium position then,
(A) the elongation of the spring is 1 cm.
(B) the magnitude of buoyant force acting on the block is 50N.
(C) the spring potential energy is 12.5 J.
(D) magnitude of spring force on the block is greater than the weight of the block.

SECTION-3 (MAXIMUM MARKS : 12)

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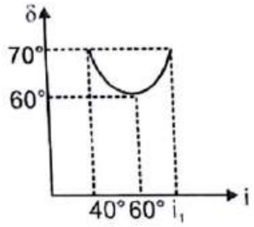
Zero Marks : 0 If none of the bubbles is darkened

PARAGRAPH-01

The curve of angle of incidence versus angle of deviation shown below has been plotted for prism.



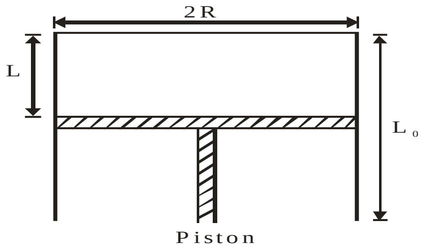
15. The value of refractive index of the prism used is
(A) $\sqrt{3}$ (B) $\sqrt{2}$ (C) $\sqrt{3}/\sqrt{2}$ (D) $2/\sqrt{3}$

16. The value of angle i_1 in degrees is
(A) 40° (B) 60° (C) 70° (D) 90°

Space for Rough Work

PARAGRAPH-02

A fixed thermally conducting cylinder has a radius R and height L_0. The cylinder is open at its bottom and has a small hole at its top. A piston of mass M is held at a distance L from the top surface, as shown. The atmospheric pressure is P_0.



17. The piston is now pulled out slowly and held at a distance 2L from the top. The pressure in the cylinder between its top and the piston will be

(A) P_0 (B) $\frac{P_0}{2}$ (C) $\frac{P_0}{2}+\frac{Mg}{\pi R^2}$ (D) $\frac{P_0}{2}-\frac{Mg}{\pi R^2}$

18. While the piston is at a distance 2L from the top, the hole at the top is sealed. The piston is then released, to a position where it can stay in equilibrium. In this condition, the distance of the piston from the top is

(A) $\left(\frac{2P_0\pi R^2}{\pi R^2 P_0 + Mg}\right)(2L)$ (B) $\left(\frac{P_0\pi R^2 - Mg}{\pi R^2 P_0}\right)(2L)$ (C) $\left(\frac{P_0\pi R^2 + Mg}{\pi R^2 P_0}\right)(2L)$ (D) $\left(\frac{P_0\pi R^2}{\pi R^2 P_0 - Mg}\right)(2L)$

Space for Rough Work

PART-II : CHEMISTRY

SECTION-1 (MAXIMUM MARKS : 21)

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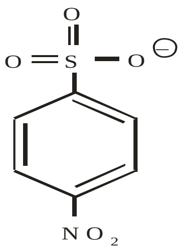
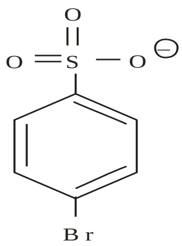
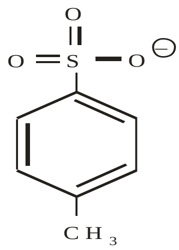
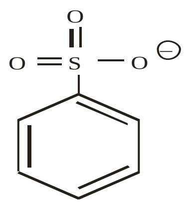
Negative Marks	:	***–1***	***In all other cases***

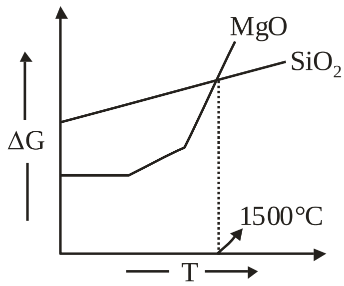
19. $H_2O(s) \rightarrow H_2O(l)$
This phase transition is carried out at constant temperature and pressure, then work done during the process:
(A) $W < 0$ (B) $W > 0$ (C) $W = 0$ (D) can't determined

20. Which of the following oxides will dissolve in H_2SO_4?
(A) B_2O_3 (B) Al_2O_3 (C) CO_2 (D) SiO_2

21. Lithium crystallizes in a body centred cubic lattice. How many next nearest neighbours does each Li have?
(A) 6 (B) 8 (C) 12 (D) 4

22. The best leaving group is:
(A) 
(B) 
(C) 
(D) 

23. Smoke has generally blue tinge. It is due to:
(A) Scattering (B) Coagulation (C) Brownian motion (D) Electro-osmosis

24. For this graph, which option is correct?


(A) At less than 1500°C, Mg acts as reducing agent for SiO_2.
(B) At more than 1500°C, Si acts as reducing agent for MgO.
(C) Both (A) and (B)
(D) None of these

Space for Rough Work

25. Octane number is zero for:
(A) Isoheptane (B) n-heptane (C) Isooctane (D) n-octane

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26. Borax bead test is given by:
(A) An aluminium salt (B) A cobalt salt (C) A copper (II) salt (D) A nickel salt

27. Which of the following statement(s) is/are correct?
(A) Aspirin is an antibiotic.
(B) Methyl orange is an azo dye.
(C) Phenyl butazone is considered as an unsafe drug.
(D) The chemical name of aspirin is acetyl salicylic acid.

28. Heat of formation of CH_4 is:
If given:

$C(s) + O_2(g) \longrightarrow CO_2(g) \qquad \Delta H = -394\ kJ$

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell) \qquad \Delta H = -284\ kJ$

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell) \qquad \Delta H = -892\ kJ$

(A) –70 kJ (B) –16.7 kcal (C) –244 kJ (D) –50 kcal

29. Which of the following statement(s) is/are correct?
(A) Schottky defect lowers the density.
(B) Frenkel defect increases the dielectric constant of the crystals.
(C) Stoichiometric defects make the crystals electrical conductors.
(D) In the schottky defect, equal number of extra cations and electrons are present in the interstitial sites.

Space for Rough Work

30. $H_3C-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-O-K^{+} + CH_3-Br \longrightarrow Y + KBr$

Which of the following is not possible for Y?

(A) $H_3C-\overset{CH_2}{\overset{\|}{C}}-CH_3$

(B) $CH_3-\overset{CH_3}{\overset{|}{CH}}-CH_2-CH_3$

(C) $CH_3-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-O-CH_3$

(D) CH_3-CH_3

31. The smelting of ore in a blast furnace involves, which of the following process / (es)?

(A) Combustion (B) Reduction (C) Slag formation (D) Sublimation

32. Identify the reactions that includes inhibitors in the reaction mixtures.

(A) $N_2 + 3H_2 \xrightarrow[Mo]{Fe} 2NH_3$

(B) Vegetable oil + $H_2 \xrightarrow[Cu]{Ni}$ Vegetable ghee

(C) $N_2 + 3H_2 \xrightarrow[Co/H_2S]{Fe} 2NH_3$

(D) $RCOCl + H_2 \xrightarrow[BaSO_4]{Pd} RCHO + HCl$

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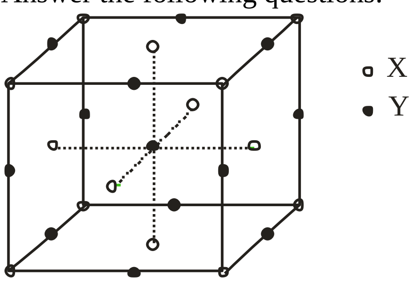
PARAGRAPH-01

Consider the figure given for solid XY. Answer the following questions:



33. The number of XY units per unit cell is:

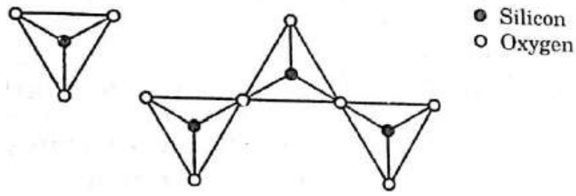
(A) 4 (B) 3 (C) 6 (D) 8

34. Coordination number of Y is:
(A) 4 (B) 3 (C) 6 (D) 8

PARAGRAPH-02

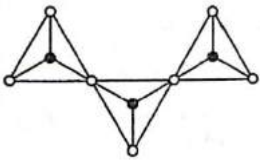
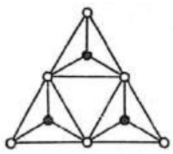
Read the following short write-up and answer the questions at the end of it.
The name 'Silica' covers an entire group of minerals, which have the general formula SiO_2, the most common of which is quartz. Quartz is a framework silicate with SiO_4 tetrahedra arranged in spirals. The spirals can turn in a clockwise or anticlockwise direction – a feature that results in there being two mirror images, optically active, varieties of quartz.

35. The following pictures represent various silicate anions. Their formulae are respectively:



(A) SiO_3^{2-} $Si_3O_7^{2-}$ (B) SiO_4^{4-} $Si_3O_{10}^{8-}$ (C) SiO_4^{2-} $Si_3O_9^{2-}$ (D) SiO_3^{4-} $Si_3O_7^{8-}$

36. $Si_3O_9^{6-}$ (having three tetrahedral units) is represented as:

(A)  (B)  (C) both (A) and (B) (D) none of these

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Space for Rough Work

PART-III : MATHEMATICS

SECTION-1 (MAXIMUM MARKS : 21)

- *This section contains **SEVEN** questions*
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Zero Marks : 0 If none of the bubbles is darkened

Negative Marks : –1 In all other cases

37. The value of $\int_1^{16} \tan^{-1}\sqrt{\sqrt{x}-1}\,dx$ is

(A) $\frac{16\pi}{3} + 2\sqrt{3}$ (B) $\frac{4}{3}\pi - 2\sqrt{3}$ (C) $\frac{4}{3}\pi + 2\sqrt{3}$ (D) $\frac{16}{3}\pi - 2\sqrt{3}$

38. Let P(x) be a polynomial of least degree whose graph has three points of inflection as (–1, – 1), (1, 1) and a point with abscissa 0 at which the curve is inclined to the axis of abscissa at an angle of 60º. Then $\int_0^1 P(x)\,dx$ equals to

(A) $\frac{3\sqrt{3}+4}{14}$ (B) $\frac{3\sqrt{3}}{7}$ (C) $\frac{\sqrt{3}+\sqrt{7}}{14}$ (D) $\frac{\sqrt{3}+2}{7}$

39. The number of points on the line 3x + 4y = 5, which are at a distance of $\sec^2\theta + 2\,\mathrm{cosec}^2\theta$, $\theta \in R$, from the point (1, 3), is

(A) 1 (B) 2 (C) 3 (D) infinite

40. If the line ax + by = 1 passes through point of intersection of $y = x\tan\alpha + p\sec\alpha$, $y\sin(30^\circ - \alpha) - x\cos(30^\circ - \alpha) = p$ and is inclined at 30º with $y = \tan\alpha x$, then the value of $a^2 + b^2$ can be

(A) $\frac{1}{p^2}$ (B) $\frac{2}{p^2}$ (C) $\frac{3}{2p^2}$ (D) $\frac{3}{4p^2}$

41. If the sum $\sum_{k=1}^{\infty} \frac{1}{(k+2)\sqrt{k} + k\sqrt{k+2}} = \frac{\sqrt{a}+\sqrt{b}}{\sqrt{c}}$ where a, b, c $\in$ N and lie in [1, 15], then a + b + c equals to

(A) 6 (B) 8 (C) 10 (D)11

42. In a polygon no three diagonals are concurrent. If the total number of points of intersection of diagonals interior to the polygon be 70, then the number of diagonals of the polygon is

(A) 8 (B) 20 (C) 28 (D) None of these

43. If the sixth term of an increasing A.P. is equal to 2, then the value of the common difference of the A.P. such that the product $a_1 a_4 a_5$ is greatest, is (the i^{th} term is denoted by a_i)

(A) $\frac{8}{5}$ (B) 3 (C) 2 (D) $\frac{4}{5}$

Space for Rough Work

SECTION-2 (MAXIMUM MARKS : 28)

- *This section contains **SEVEN** questions*
- *Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is correct*
- *For each question, darken the bubble(s) corresponding to the correct option(s) in the OMR.*
- *For each question, marks will be awarded in one of the following categories:*

Full Marks	:	***+4***	***If only the bubble(s) corresponding to all the correct option(s) is(are) darkened***
Partial Marks	:	***+1***	***For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened***
Zero Marks	:	***0***	***If none of the bubbles is darkened***
Negative Marks	:	***–2***	***In all other cases***

- *For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will results in +4 marks; darkening only (A) and (D) will result in +2 marks; and darkening (A) and (B) results in –2 marks, as a wrong option is also darkened*

44. If $\int_0^{\alpha} \frac{dx}{1 - \cos\alpha \cos x} = \frac{A}{\sin\alpha} + B$ $(\alpha \neq 0)$. Then possible values of A and B are

(A) $A = \frac{\pi}{2}, B = 0$ (B) $A = \frac{\pi}{4}, B = \frac{\pi}{4\sin\alpha}$ (C) $A = \frac{\pi}{6}, B = \frac{\pi}{\sin\alpha}$ (D) $A = \pi, B = \frac{\pi}{\sin\alpha}$

45. The expression $\frac{\int_0^n [x]\,dx}{\int_0^n \{x\}\,dx}$ where [x] and {x} are integral and fractional part of x and $n \in N$ is equal to

(A) $\frac{1}{n-1}$ (B) $n - 1$ (C) $\sum_{r=1}^{n-1} r - \sum_{r=1}^{n-2} r$ (D) $\frac{\prod_{r=1}^{n} r - \prod_{r=2}^{n} r-1}{\prod_{r=2}^{n} r-1}$

46. A straight line passing through the point A(–2, –3) cuts the line $x + 3y = 9$ and $x + y + 1 = 0$ at B and C respectively. If AB.AC = 20, then equation of line can be
(A) $x - y = 1$ (B) $x - y + 1 = 0$ (C) $3x - y + 3 = 0$ (D) $3x - y = 3$

47. Let A(1, 2) and B(7, 10) are two points. If P(x, y) is a point such that the $\angle APB$ is 60° and the area of the ΔAPB is maximum, then which of the following is/are true.
(A) P lies on any line perpendicular to AB
(B) P lies on the perpendicular bisector of AB
(C) P lies on the straight line $3x + 4y = 36$
(D) P lies on the circle passing through the points (1, 2) and (7, 10) and having a radius of 10 units

Space for Rough Work

48. The sum to 'n' terms of the series

$\tan^{-1}\left(\frac{1}{2}\right) + \tan^{-1}\left(\frac{2}{9}\right) + \tan^{-1}\left(\frac{1}{8}\right) + \tan^{-1}\left(\frac{2}{25}\right) + \tan^{-1}\left(\frac{1}{18}\right) + \ldots\ldots \infty$ terms

(A) $\tan^{-1}3$ (B) $\cot^{-1}\left(\frac{1}{3}\right)$ (C) $\tan^{-1}\left(\frac{1}{3}\right)$ (D) None of these

49. If m and n are positive integers greater than or equal to 2, m > n, then (mn)! is divisible by
(A) $(m!)^n$ (B) $(n!)^m$ (C) $(m + n)!$ (D) $(m - n)!$

50. The number of ways in which we can choose 2 distinct integers from 1 to 100 such that the difference between them is less than 10 is
(A) ${}^{100}C_2 - {}^{90}C_2$ (B) ${}^{100}C_{98} - {}^{90}C_{88}$ (C) ${}^{100}C_2 - {}^{90}C_{88}$ (D) None of these

SECTION-3 (MAXIMUM MARKS : 12)

- *This section contains **TWO** paragraphs*
- *Based on each paragraph, there are **TWO** questions*
- *Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct*
- *For each question, darken the bubble corresponding to the correct option in the OMR*
- *For each question, marks will be awarded in one of the following categories:*

Full Marks : +3 If only the bubble corresponding to the correct option is darkened.

Zero Marks : 0 If none of the bubbles is darkened

PARAGRAPH-01

Suppose f(x) and g(x) are two continuous functions defined for $0 \le x \le 1$.

Given $f(x) = \int_0^1 e^{x+t}.f(t)\,dt$ and $g(x) = \int_0^1 e^{x+t}.g(t)\,dt + x$.

51. The value of f(1) equals
(A) 0 (B) 1 (C) e^{-1} (D) e

52. The value of g(0) – f(0) equals
(A) $\frac{2}{3 - e^2}$ (B) $\frac{3}{e^2 - 2}$ (C) $\frac{1}{e^2 - 1}$ (D) 0

PARAGRAPH-02

The line 6x + 8y = 48 intersects the coordinate axes at A and B respectively. A line L bisects the area and the perimeter of the triangle OAB where O is the origin.

53. The slope of the line L can be
(A) $\frac{10 + 5\sqrt{3}}{10}$ (B) $\frac{10 - 5\sqrt{6}}{10}$ (C) $\frac{8 + 3\sqrt{6}}{10}$ (D) None of these

54. The line L does not intersect the side ....of the ΔOAB.
(A) AB (B) OB (C) OA (D) None of these

Space for Rough Work