Master JEE CLASSES

Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-9

Max.Marks:360

IMPORTANT INSTRUCTIONS:

1) Immediately fill in the particulars on this page of the Test Booklet with Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.
2) The test is of 3 hours duration.
3) The Test Booklet consists of 90 questions. The maximum marks are 360.
4) There are three parts in the question paper A, B, C consisting of **Chemistry, Mathematics** and **Physics** having 30 questions in each part of equal weightage. Each question is allotted 4 (four) marks for correct response.
5) Candidates will be awarded marks as stated above in instruction No. 4 for correct response of each question. (1/4) (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
6) There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 5 above.

SYLLABUS

MATHS:

Real numbers, Factor Theorem, Remainder Theorem, Finding roots of Polynomial Equation using Factor Theorem, Finding Polynomial with given roots, Wavy curve method, Rational Inequations, Irrational Equation & Inequation, Modulus: Its properties & graph, Logarithm: Its properties & graph, Equations/Inequation involving Logarithms, Exponentials, Modulus; Greatest Integer, Least Integer, Fractional Part Functions & their graph (100%)

PHYSICS:

Complete Reflection (100%)

CHEMISTRY:

Atomic Structure : Fundamental Particles - their characteristics; Thomson's, Rutherford's atomic model, Plank's Quantum theory, Bohr's atomic model, Applications of Bohr's atomic model - calculation of radius, velocity, frequency, time period and energy of electron in an orbit, Electro magnetic spectra, Hydrogen spectrum, Photoelectric effect (100%)

CHEMISTRY

1. Which of the following conclusions could **not** be derived from Rutherford's α – particle scattering experiment?

   1) most of the space in the atom in empty.

   2) The radius of the atom is about 10^{-10} m while that of nucleus is 10^{-15} m

   3) Electrons move in a circular path of fixed energy called orbits.

   4) electrons and the nucleus are held together by electrostatic forces of attraction.

2. The transition from the state $n=4$ to $n=3$ in H-like atom results in UV radiation. Infrared radiations will be emitted in the transition:

   1) $2\rightarrow 1$ 2) $3\rightarrow 2$

   3) $4\rightarrow 2$ 4) $5\rightarrow 4$

3. An energy of 24.6 eV is required to remove one of the electron from a neutral helium atom. The energy in eV required to remove both the electrons from a neutral helium atom:

   1) 38.2 2) 49.2

   3) 51.8 4) 79.0

4. If the shortest wavelength of Lyman series in H-atom is X, then the largest wave length of the Balmer series in He^{+} is:

   1) $\frac{X}{4}$ 2) $\frac{9X}{5}$

   3 $\frac{5X}{9}$ 4) $\frac{6X}{5}$

5. The ratio of the speed of electron in First Bohr orbit of H-atom to speed of light in vacuum is:

   1) 137 2) 7.30×10^{-3}

   3) 100 4) 10^{-2}

6. An excited hydrogen atom emits a photon of wavelength λ in returning to the ground state. If R is the Rydberg constant then the quantum number n of the excited state is:

   1) $\sqrt{\frac{\lambda R}{\lambda R+1}}$ 2) $\sqrt{\lambda R-1}$

   3) $\sqrt{\frac{\lambda R}{\lambda R-1}}$ 4) $\sqrt{\lambda R(\lambda R-1)}$.

7. The value of charge on the oil droplets experimentally observed were -1.6×10^{-19} and -4×10^{-19} coulomb. The value of the electronic charge, indicated by these results is:

1) 1.6×10^{-19} 2) -2.4×10^{-19}

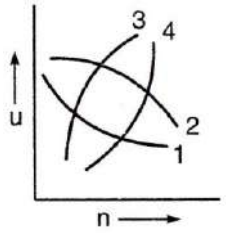
3) -4×10^{-19} 4) -0.8×10^{-19}

8. The specific charge of a proton is $9.6\times10^{7} C\ kg^{-1}$, then for an α – particle it will be:

1) $2.4\times10^{7} C kg^{-1}$ 2) $4.8\times10^{7} C kg^{-1}$

3) $19.2\times10^{7} C kg^{-1}$ 4) $38.4\times10^{7} C kg^{-1}$

9. Which of the following curves correctly represents the speed of electron in H-atom as a function of principal quantum number:



1) 4 2) 2

3) 3 4) 1

10. If the energy of H-atom in the ground state is –E, the velocity (u) of photo-electron emitted when a photon having energy E_p strikes a stationary Li^{2+} ion in ground state is given by:

1) $u=\sqrt{\frac{2(E_P-E)}{m}}$ 2) $u=\sqrt{\frac{2(E_P+9E)}{m}}$

3) $u=\sqrt{\frac{2(E_P-9E)}{m}}$ 4) $u=\sqrt{\frac{2(E_P-3E)}{m}}$

11. The electron in the hydrogen atom undergoes transition from higher orbit to orbit of radius 211.6 pm. This transition is associated with

1) Lyman series 2) Balmer series

3) Paschen series 4) Brackett series

12. The radius of second Bohr orbit of hydrogen atom is:

(Planck's constant $h=6.625\times10^{-34} Js$

$m_e=9.1091\times10^{-31} kg$

Charge $(q)=1.60210\times10^{-19} C$

$\varepsilon_0=8.854185\times10^{-12} Kg^{-1} m^{-3} A^2$)

1) 1.65 $A°$ 2) 4.76 $A°$

3) 0.529 $A°$ 4) 2.12 $A°$

13. The angular momentum of an electron in certain orbits is $2.5\frac{h}{\pi}$ and $\frac{h}{\pi}$ respectively. The maximum number of spectral lines emitted when electron is excited between these orbits.

1) 2 2) 3

3) 4 4) 6

14. The angular momentum of electron of H-atom is proportional to:

1) r^2 2) $\frac{1}{r}$

3) $\sqrt{r}$ 4) $\frac{1}{\sqrt{r}}$

15. The vividh Bharati station of all India Radio, Broadcasts on a frequency of 1368 kHz. Calculate the wavelength of the electromagnetic radiation emitted by transmitter.

1) 1.087 m 2) 108.7 m

3) 21.93 m 4) 219.3 m

16. Which of the following electromagnetic radiation has longest wavelength?

1) X-rays 2) UV-rays

3) visible 4) IR-rays

17. A 100 watt bulb emits monochromatic light of wavelength 400nm. Calculate the number of photons emitted per minute by the bulb:

1) 2.012×10^{20} 2) 1.2072×10^{22}

3) 3.353×10^{18} 4) 2.012×10^{22}

18. The photons of particular energy hit surface of certain metals in different experiment. The electron ejected from which of the following metals will have maximum kinetic energy?

1) Li 2) Na

3) K 4) Rb

19. The electron in certain orbit of He^+ has the energy $-8.72\times10^{-18}\,J$. What is the radius of this orbit?

1) $0.02645\,A°$ 2) $0.02645\,nm$

3) $0.0529\,A°$ 4) $0.0529\,nm$

20. The energy of electron in first Bohr orbit of H-atom is -13.6 eV. The possible energy value of electron in excited state of Li^{+2} is:

1) $-122.4\,eV$ 2) $+30.6\,eV$

3) $-30.6\,eV$ 4) $13.6\,eV$

21. A gas absorbs a photon of 300 nm and emits at two wavelengths. If one of the emission is at 700 nm the other is at:

1) 525 nm

2) 1050 nm

3) 275 nm

4) 400 nm

22. The kinetic and potential energy (in eV) of electron present in second excited state of hydrogen atom is:

1) $-1.51, -3.02$

2) $-3.02, 1.51$

3) $1.51, -3.02$

4) $1.51, -1.51$

23. What is the ratio of time periods $\left(\frac{T_1}{T_2}\right)$ in third orbit of He^+ and second orbit of hydrogen atom?

1) $\frac{27}{16}$ 2) $\frac{8}{27}$

3) $\frac{27}{32}$ 4) $\frac{32}{27}$

24. Assume that $2\times10^{-17}J$ of light energy is needed by the interior of human eye to see an object. How many photons of light with 595 nm are needed to generate this minimum energy?

1) 6 2) 30

3) 45 4) 60

25. Radiation corresponding to the transition n=4 to n=2 in hydrogen atom fall on a certain metal (work function 2.5 eV). The maximum kinetic energy of the photo electrons will be

1) 1 eV 2) 0.5 eV

3) 2.55 eV 4) 0.05eV

26. The excitation of electron from ground state to 4^{th} energy level is made. On de-excitation of electron, U.V., visible and IR wavelength are noticed. The simple ratio of the number of lines falling into U.V, visible and IR region are:

1) 3: 2: 1 2) 1: 2: 3

3) 1: 2: 4 4) 4: 2: 1

27. An electron from ground state of H atom during excitation travels a distance of nearly 0.8464nm. The angular momentum of the electron in this orbit is:

1) $4\frac{h}{\pi}$ 2) $2\frac{h}{\pi}$

3) $\frac{h}{\pi}$ 4) $\frac{h}{2}$

28. The kinetic energy of photoelectron emitted on irradiating a metal surface with frequency v is related by $KE = hv - IE$. The **incorrect** statement for plots of KE vs. Incident frequency v: (IE = incident energy)

1) a straight line with intercept on x-axis equal to threshold frequency

2) a straight line with slope equal to Planck's constant

3) a straight line with extra polated intercept on y-axis equal to work function

4) a straight line with intercept on x-axis equal to the product of threshold frequency and Plank's constant

29. Which statement about cathode rays is **incorrect?**

1) They travel in straight lines towards cathode.

2) They produce fluorescent discharge through the walls of the tube.

3) They produce heating effect.

4) They can affect photographic plate.

30. Which statements concerning light is **true?**

1) It is a form of energy and deflected by electric field.

2) It can be deflected by a magnet

3) It consists of photons of same energy.

4) It is part of electromagnetic spectrum

MATHS

31. $\log_5 10$ is

1) rational

2) irrational

3) a positive integer

4) a prime number

32. If $\log x = \frac{1}{2}(\bar{1}.38)$ then mantissa is

1) .19 2) .69

3) .38 4) none

33. $5^{\sqrt{\log_5 7}} - 7^{\sqrt{\log_7 5}} =$

1) log 2 2) 1

3) 0 4) -1

34. $\frac{\log_9 11}{\log_5 13} - \frac{\log_3 11}{\log_{\sqrt{5}} 13} =$

1) 1 2) -1

3) 0 4) 2

35. If $\log_{.1}(x-2) > \log_{0.01}(x-2)$, then x lies in the interval

1) [2, 3] 2) $(-\infty, 2) \cup (3, \infty)$

3) (2, 3) 4) $(3, \infty)$

36. If $(2.3)^x = (0.23)^y = 1000$, then $\frac{1}{x} - \frac{1}{y} =$

1) 1/5 2) 1/4

3) 1/3 4) 1/2

37. If x, y, z are three consecutive positive integers, then log (1 + xz) =

1) log y 2) log (y/2)

3) log (2y) 4) 2 log y

38. If $\log_{10} 343 = 2.5353$, then the least positive integer 'n' such that $7^n > 10^5$ is

1) 1 2) 6

3) 5 4) 4

39. If $\log_{10} 2 = 0.3010$, then the number of digits in 128^{20} is

1) 21 2) 40

3) 43 4) 42

40. If $\log_{10} 3 = 0.4771$, then the position of first significant figure in 81^{-25} is

1) 46 2) 47

3) 48 4) 49

41. When of the following is not a irrational number between $\sqrt{2}$ and $\sqrt{3}$

1) $6^{1/6}$ 2) $2^{1/4}6^{1/8}$

3) $6^{1/8}3^{1/4}$ 4) None of these

42. Which of the following is false

1) Product of two rational numbers is always a rotational number

2) product of two irrational numbers may be rational numbers

3) Product of a rational numbers and an irrational numbers can be rational number

4) Product of two irrational number is always irrational number

43. let $f(x) = ax^5 + bx^3 + cx + 1$ and the remainder obtained by diving f(x) with x-1 and x-2 are 1 and 2 then the remainder obtained when f(x) is divided with (x+1) (x+2) is

1) x 2) –x

3) x+2 4) x-2

44. If $\sqrt{x-1}\left(x^2-3x+2\right) > 0$ then the set of values of x is

1) $(-\infty,1)\cup(2,\infty)$ 2) $(2,\infty)$

3) $(-\infty,1)$ 4) None of these

45. Number of integral values of x satisfying $(x-1)(2-x)^{1/2}(x-3)^{1/3}(x-4)^{1/4} > 0$ is

1) 0 2) 1

3) 2 4) 3

46. Number of solutions $2^x + 3^x + 5^x = 10^x$ is

1) 0 2) 1

3) 2 4) 3

47. The solution set of $\left[\frac{x}{3}\right]+\left[\frac{x+1}{3}\right]+\left[\frac{x+2}{3}\right]=4$ is where [.] denotes G.I.F

1) [1,4) 2) [1,4]

3) [4,5] 4) [4,5)

48. The least value of $\left|x^2-3x+2\right|+\left|x^2-4x+3\right|+\left|x^2-5x+4\right|$ is

1) 9 2) 8

3) 7 4) 0

49. If $f(x) = x^3 - 5x^2 + 5x + 1$ then $f\left(2-\sqrt{3}\right) =$ _____

1) 0 2) 1
3) 2 4) 3

50. The leading coefficients (coefficient of highest degree term) of the remainders when a fourth degree polynomial divided with $(x-1)^5, (x-1)^4, (x-1)^3, (x-1)^2, (x-1)$ are 5, 4, 3, 2, 1 respectively then the constant term of the polynomial is

1) 0 2) 1
3) 2 4) 3

51. If $\left[|x|\right] + \left[\left[x\right]\right] = 1$ and $x \in [-5, 5]$ then number of possible values of x of the type $a - \sqrt{b}\,(a, b \in N)$, where [.] denotes G.I.F

1) 0 2) 1
3) 10 4) Infinite

52. If [x] + [y] = [x + y] then the maximum value of {x}{y} is, where [.] denotes G.I.F, {x} denotes fractional part of x

1) 0 2) 1
3) $\frac{1}{4}$ 4) Undefined

53. If [x]{x} = x then number of possible values of x is

1) 0 2) 1
3) 2 4) Infinite

54. If $60^a = 3$ and $60^b = 5$ then the value of $12^{\frac{1-a-b}{2(1-b)}}$ equals

1) 2 2) 3
3) $\sqrt{3}$ 4) $\sqrt{12}$

55. The minimum value of the expression $|x - p| + |x - 15| + |x - p - 15|$ for 'x' in the range $p \le x \le 15$ where $0 < p < 15$, is

1) 10 2) 15
3) 30 4) 0

56. The set of values of x satisfying simultaneously the inequalities $\frac{\sqrt{(x-8)\,(2-x)}}{\log_{0.3}\left(\frac{10}{7}\left(\log_2 5 - 1\right)\right)} \ge 0$ and $2^{x-3} - 31 > 0$ is :

1) a unit set
2) an empty set
3) an infinite set
4) a set consisting of exactly two elements

57. Number of solutions of the equation $\sqrt{x^2}-\sqrt{(x-1)^2}+\sqrt{(x-2)^2}=\sqrt{5}$, is

1) 0 2) 1

3) 2 4) More than 2

58. If $\sqrt{x+5}+\sqrt{x+21}=\sqrt{6x+40}$, then number of possible real values of x is

1) 0 2) 1

3) 2 4) More than 2

59. Number of integral values of x for which $\sqrt{x+3-4\sqrt{x-1}}+\sqrt{x+8-6\sqrt{x-1}}=1$

1) 5 2) 6

3) 7 4) More than 8

60. Number of solutions of the equation $3(16)^x+2(81)^x=5(36)^x$ is

1) 0 2) 1

3) 2 4) More than 2

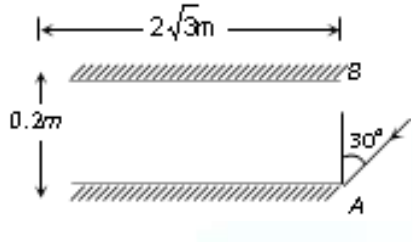
PHYSICS

61. A plane mirror 50 cm long, is hung on a vertical wall of a room, with its lower edge 50 cm above the ground. A man stands in front of the mirror at a distance 2 m away from the mirror. If his eyes are at a height 1.8 m above the ground, find the length (distance between the extreme points of the visible region perpendicular to the mirror) of the floor visible to him due to reflection from the mirror approximately.

1) 1.73 m 2) 2.73 m

3) 3.73 m 4) 4.73 m

62. Two plane mirrors. A and B are aligned parallel to each other, as shown in the figure. A light ray is incident at an angle of $30°$ at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one) before it emerges out is



1) 31 2) 30

3) 32 4) 34

63. A concave mirror forms the real image of a point source lying on the optical axis at a distance of 50 cm from the mirror. The focal length of the mirror is 25 cm. The mirror is cut into two halves and its halves are drawn a distance of 1 cm apart (from each other) in a direction perpendicular to the optical axis. How will the images formed by the two halves of the mirror be arranged?

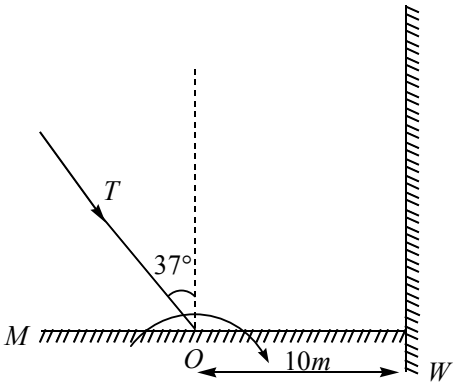
1) At a distance of 40 cm from the mirror & 1 cm from each other

2) At a distance of 50 cm from the mirror & 2 cm from each other

3) At a distance of 50 cm from the mirror & 1 cm from each other

4) At a distance of 40 cm from the mirror & 2 cm from each other

64. 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 mirror is perpendicular to wall and the angle of incidence becomes 37º then the speed of the spot (a point) on the wall is:

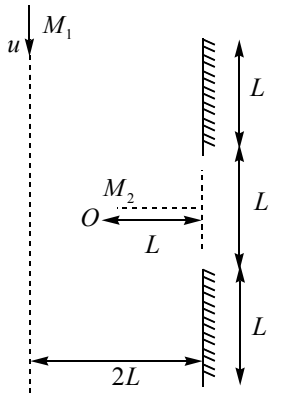


1) 10 m/s 2) 1000 m/s

3) 500 m/s 4) None of these

65. Two plane mirrors of length L are separated by distance L and a man M_2 is standing at distance L from the

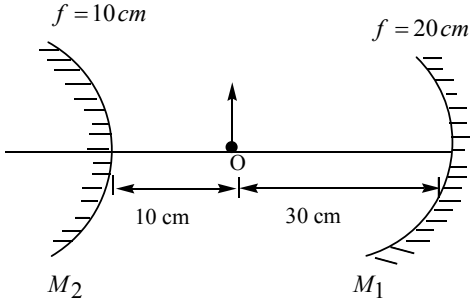
connecting line of mirrors as shown in figure. A man M_1 is walking in a straight line at distance 2 L parallel to mirrors at speed u, then man M_2 at O will be able to see image of M_1 for time:



1) $\frac{4L}{u}$ 2) $\frac{3L}{u}$

3) $\frac{6L}{u}$ 4) $\frac{9L}{u}$

66. In the figure shown find the total magnification after two successive reflections first on M_1 and then on M_2:



1) +1 2) –1

3)+4 4) +2

67. The distance between an object and its doubly magnified image by a concave mirror of focal length f is:

1) 3f/2

2) 2f/3

3) 3 f

4) depends on whether the image is real or virtual.

68. A square of side 3cm is placed at a distance of 25cm from a concave mirror of focal length 10cm. The centre of the square is on the axis of the mirror and the plane is normal to the axis. The area enclosed by the image of the square is

1) $4cm^2$ 2) $6cm^2$

3) $16cm^2$ 4) $36cm^2$

69. A film projector using spherical mirror magnifies a film on the screen. Area of film is $100cm^2$. If linear magnification is 4, then area of magnified film on screen will be

1)1600cm^2 2) 800cm^2

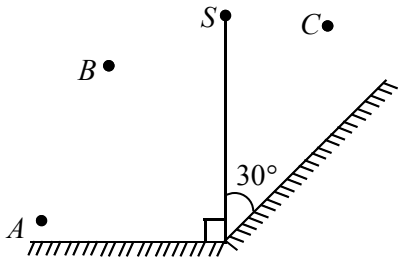
3) 400cm^2 4) 200cm^2

70. The suns diameter is $1.4\times10^{9}\,m$ and its distance from the earth is $10^{11}\,m$. The diameter of its image, formed by a convex mirror of focal length 2m will be

1)0.7 cm 2)1.4 cm

3)2.8 cm 4)10 cm

71. A point source of light S is placed in front of two large mirrors as shown. Which of the following observers will see only one image of S?



1) Only A 2) Only C

3) Both A and C 4) Both B and C

72. A straight line joining the object (real) point and the image (virtual) point is always perpendicular to the mirror

1) if mirror is plane

2) if mirror is concave

3) if mirror is convex

4) irrespective of the type of mirror.

73. An infinitely long rod lies along the axis of a concave mirror of focal length f. The near end of the rod is at a distance u > f from the mirror. Its image will have a length

1) $\frac{f^2}{u-f}$ 2) $\frac{uf}{u-f}$

3) $\frac{f^2}{u+f}$ 4) $\frac{uf}{u+f}$

74. A boy of height 1.5m with his eye level at 1.4 m stands before a plane mirror of length 0.75 m fixed on the wall. The height of the lower edge of the mirror above the floor is 0.8 m. Then:

1) the boy will see his full image

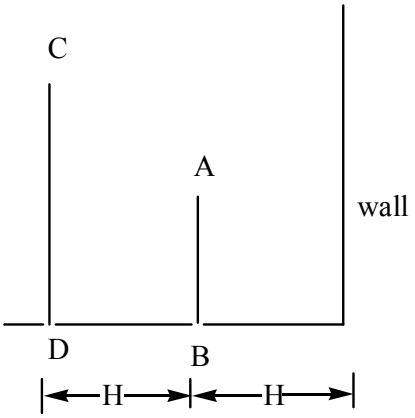
2) the boy can see his hair

3) the boy can see his feet

4) the boy can see neither his hair nor his feet.

75. A child (AB) is standing in front of a straight plane mirror fixed to a vertical wall . His father (CD) is standing behind him, as shown in the fig. The height of

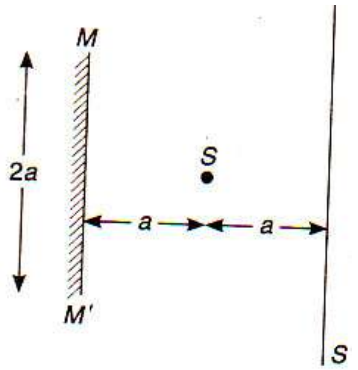
the father is double the height of the child. What is the minimum length of the mirror required so that the child can completely see his own image and his father's image in the mirror? Given that the height of father is 2H. (Assume eye level at the top most point)



1) $\frac{H}{2}$ 2) $\frac{5H}{6}$

3) $\frac{3H}{2}$ 4) $\frac{5H}{2}$

76. Figure shows a plane mirror of length $2a$ kept parallel to a screen S', at a distance of $2a$ from it with a small light source S in between. The length on the screen receiving the reflected light is:



1) zero 2) $2a$

3) $4a$ 4) $6a$

77. A person has a 15 cm wide face and his two eyes are separated by 9 cm. The minimum width of a mirror required for the person to view his complete face laterally is:

1) 15 cm 2) 9 cm

3) 6 cm 4) 3 cm

78. A point object forms a real, enlarged image, in front of a concave mirror of curvature radius 40 cm. If the distance between the object and the image be 30 cm, then the object distance will be:

1) 10 cm 2) 30 cm

3) 40 cm 4) 60 cm

79. A plane mirror and a concave mirror of curvature radius 60 cm are placed facing each other, with a point object at the centre of them. If the image formed by first reflection at the spherical and then at the plane mirror coincides with the object, then the separation between the two mirror will be:

1) 40 cm 2) 80 cm

3) 30 cm 4) 60 cm

80. The light on reflection from a plane mirror can give a real point sized image when

1) a convergent beam is incident on the mirror.

2) a divergent beam is incident on the mirror.

3) a point sized object is placed very close to the mirror.

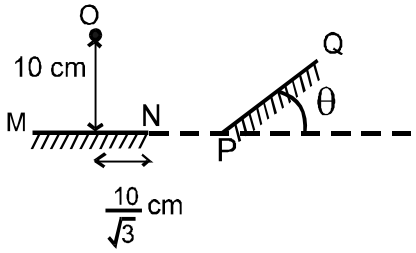
4) a point sized object is placed very far away from the mirror.

81. A concave mirror of curvature radius 40 cm forms the image of an object kept at a distance of 100 cm from the mirror on the horizontal principal axis. The mirror is cut symmetrically along the principal axis and is separated vertically with the gap between the two parts as 2 cm. The distance between the two images will be :

1) 0.5 cm 2) 2 cm

3) 2.5 cm 4) 3 cm

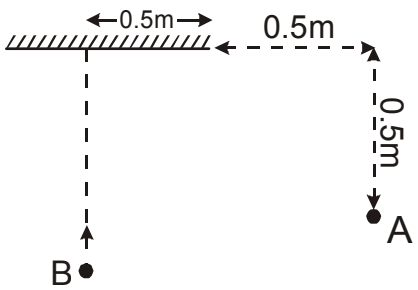
82. The figure shows two plane mirrors MN and PQ inclined at an angle θ as shown in figure. O is a point source 10 cm above the horizontal mirror MN . The normal drawn from O to mirror MN is at a distance $\frac{10}{\sqrt{3}}$ cm from the end N as shown in figure. For light rays striking on the mirror MN directly from O to not strike the mirror PQ, the maximum value of θ is : (assume mirror PQ to be very large and is above the dashed segment as shown).



1) 30º 2) 45º

3) 60º 4) 75º

83. A man 'A' stands at the position shown in the figure and a second man 'B' approaches the mirror along the line perpendicular to it which passes through its centre. At the moment when 'A' and 'B' first see each other in the mirror, the distance of B from the mirror is:



1) 0.25 m 2) 0.5m

3) 0.75m 4) 1m

84. Two plane mirrors are placed parallel to and facing each other at separation of 50 cm. Infinite images are formed with different intensities corresponding to an object placed 20 cm from one of the mirror. The distance, from the mirror farther from the object, to the image formed after two reflections at each mirror starting from the mirror closer to the object is :

1) 160 cm 2) 170 cm

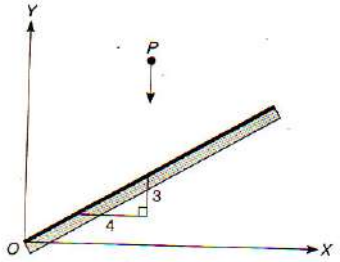
3) 180 cm 4) 220 cm

85. In a concave mirror if x_1 and x_2 are the distance of object and its image respectively from the focus, then the focal length of the mirror is

1) $x_1 \ x_2$ 2) $\sqrt{x_1 x_2}$

3) $(x_1 + x_2)/2$ 4) $x_1 x_2 / (x_1 + x_2)$

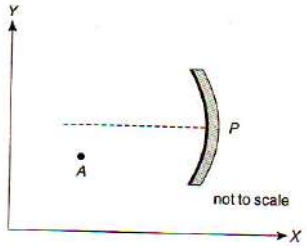
86. Figure shows a plane mirror kept inclined to X-axis. A small object P moves parallel to the Y-axis. The unit vector along which the image moves is:



1) $-\hat{i}$ 2) $\frac{1}{5}-\left(4\hat{i}+3\hat{j}\right)$

3) $-\frac{1}{25}\left(7\hat{i}-24\hat{j}\right)$ 4) $-\frac{1}{25}\left(24\hat{i}-7\hat{j}\right)$

87. Figure shows a concave mirror with its principal axis parallel to X-axis and focus on the Y-axis. The centre of curvature is at (-108cm, 54 cm). The coordinates of the image of point A(81 cm, 48 cm) will be:



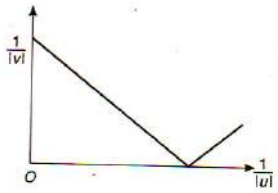
1) (90 cm, 50 cm)

2) (36 cm, 62 cm)

3) (144 cm, 62 cm)

4) (144 cm, 46 cm)

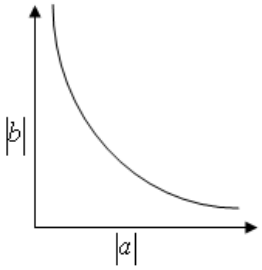
88. Figure shows the variation of $\frac{1}{|v|}$ versus $\frac{1}{|u|}$ for a concave mirror. The line $y=3x$ cuts the graphs at an ordinate $1.5\ \text{m}^{-1}$. The curvature radius of the mirror is:



1) 25 cm 2) 50 cm

3) 100 cm 4) 200 cm

89. If a and b denote the distances of the object and image from the focus of a concave mirror, then Fig. shows the graph of $|b|$ versus $|a|$.

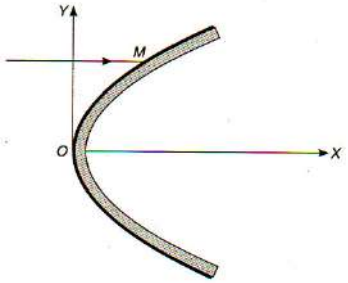


The line $y=4x$ cuts the graph at a point whose abscissa is 20 cm. The curvature radius of the mirror is:

1) 100 cm 2) 80 cm

3) 40 cm 4) 20 cm

90. Figure shows a parabolic mirror with the equation of a section on the XY plane as $y^2 = 4ax$. A light ray parallel to the X – axis is incident on the mirror at a point with abscissa $4a$. The unit vector along the reflected ray will be:



1) $\frac{1}{5}\left(4\hat{i}+3\hat{j}\right)$ 2) $\frac{1}{5}\left(4\hat{i}-3\hat{j}\right)$

3) $\frac{1}{5}\left(3\hat{i}+4\hat{j}\right)$ 4) $\frac{1}{5}\left(3\hat{i}-4\hat{j}\right)$

Master JEE CLASSES

Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-9

Max. Marks: 360

KEY SHEET

CHEMISTRY			MATHS			PHYSICS	
Q.NO	ANSWER		Q.NO	ANSWER		Q.NO	ANSWER
1	**3**		31	**2**		61	**1**
2	**4**		32	**2**		62	**2**
3	**4**		33	**3**		63	**2**
4	**3**		34	**3**		64	**2**
5	**2**		35	**3**		65	**3**
6	**3**		36	**3**		66	**4**
7	**4**		37	**4**		67	**1**
8	**2**		38	**2**		68	**1**
9	**4**		39	**3**		69	**1**
10	**3**		40	**3**		70	**3**
11	**2**		41	**4**		71	**2**
12	**4**		42	**4**		72	**4**
13	**4**		43	**3**		73	**1**
14	**3**		44	**2**		74	**2**
15	**4**		45	**1**		75	**2**
16	**4**		46	**2**			**4**
	4			**4**			**4**
	4			**4**			**2**
	2			**3**			**2**
	3			**4**			**1**
	1			**4**			**3**
	3			**4**			**3**
	3			**2**			**2**
	4			**1**			**2**
	4			**2**			**2**
	1			**1**			**4**
	2			**3**			**4**
	4			**2**			**3**
	1			**2**			**3**
	4			**3**			**3**

SOLUTIONS:
CHEMISTRY

2. $5 \to 4$ brackett series appear in IR region

3. $I.E_{He^+} = 13.6 \times z^2 = 13.6 \times 4eV = 54.4eV$

$\therefore I.E_{He \to He^{+2}} = 54.4 + 24.6 = 79.0eV$

4. $\frac{x}{\lambda} = \frac{R \times 1^2\left[\frac{1}{1^2} - \frac{1}{\infty}\right]}{r \times 2^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right]} \Rightarrow \quad \lambda = 4 \times \left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5\times}{9}$

5. $\frac{V_{1,\ H}}{C} = \frac{2.16 \times 10^6 \times 1/1\ m/s}{3 \times 10^8\ m/s} = 7.30 \times 10^{-3}$

6. $\frac{1}{\lambda} = R\ 1^2\left[\frac{1}{1^2} - \frac{1}{n^2}\right] \Rightarrow n = \sqrt{\frac{\lambda R}{\lambda R - 1}}$

7. Change on oil drop is integral multiple of electronic charge.

8. $\frac{(1/m)_P}{(e/m)_\alpha} = \frac{(1/m)_P}{(e/m)_P}$

$(e/m)_\alpha = \frac{(e/m)_P}{2} = 4.8 \times 10^7\ C\,kg^{-1}$

9. $V\alpha\frac{1}{n}$

10. $E_{Li^{+2}} = Exn^2 = -9E \Rightarrow$ work function $= 9E$

$\therefore$ K.E. $E_P - 9E$

$V = \sqrt{\frac{2(E_P - 9E)}{m}}$

11. $0.529 \times 10^{-10} \times n^2 = 211.6 \times 10^{-12}$

$n^4 = 4 \Rightarrow n = 2$

Transition to second stationary state is Blamer series

12. $r_2 = 0.529 \times 2^2 = 2.12A^0$

13. $\frac{n_2\lambda}{2\alpha} = \frac{2.5\lambda}{\alpha} \Rightarrow n_2 = 5$; $\frac{n_1\lambda}{2\alpha} = \frac{\lambda}{\alpha}\ \ n_1 = 2$

$\therefore$ number of spectral lines $= \sum(5-2) = 3+2+1 = 6$

14. $L = \frac{nh}{2\pi} = \sqrt{\frac{r}{0.529}} \times \frac{h}{2\pi} = \text{cons tan t} \times \sqrt{r}$

$L \alpha \sqrt{r}$

15. $\gamma = \frac{c}{\lambda} \Rightarrow \lambda = \frac{c}{\gamma} = \frac{3 \times 10^{10}}{136^8 \times 10^3} = 219.3\text{m}$

16. Conceptual

17. $E = 100\,J/s \Rightarrow \frac{nhc}{\lambda} =$

$n = \frac{100 \times 400 \times 10^{-9}}{6.6 \times 10^{-34} \times 3 \times 10^8}$

$= 2.012 \times 10^{20}\ /s$

$= 2.012 \times 10^{22}\ \text{min}^{-1}$

18. Lower the ionization energy, greater is the kinetic energy.

19. $E = -8.72 \times 10^{-18} J = \frac{-8.72 \times 10^{-18}}{1.6 \times 10^{-19}} eV$

$= 54.5eV$

$13.6 \times n^2 54.5$

$n = 2 \qquad r_2 = 0.0\frac{529 \times 1^2}{2} = 0.02645\,nm$

20. $E_{Li^{+2}} = \frac{-13.6 \times 3^2}{n^2}$

For first excited state $= \frac{-13.6 \times 3^2}{2^2} = -30.6eV$

21. $\frac{1}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2} \Rightarrow \frac{1}{300} = \frac{1}{700} + \frac{1}{\lambda_2} = \frac{400}{300 \times 700}$

$\frac{1}{\lambda_2} = \frac{2100}{40} nm = 525nm$

22. $T.E = -\frac{1}{2}\frac{kze^2}{r}, P.E. = \frac{kze^2}{r}, K.E = -\frac{1}{2}\frac{kze^2}{r}$

$T.E_3 = \frac{-13.6 \times 1}{9} = 1.51eV$

$\therefore K.E = 1.51eV;\ P.E = -3.02eV$

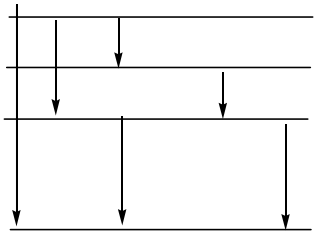
23. $T\alpha\frac{n^3}{2^2}\ \frac{T_1}{T_2}=\frac{3^3}{2^2}\times\frac{1^2}{2^3}=\frac{27}{32}$

24. $E=\frac{Nhc}{\lambda}\qquad N=\frac{2\times10^{-17}\times595\times10^{-9}}{6.63\times10^{-34}\times3\times10^{10}}=60$

25. Energy of incident radiation $=13.6\times1^2\left[\frac{1}{16}-\frac{1}{4}\right]=\frac{13.6\times12}{4\times16}=2.55eV$

$\therefore$ K.E of ejected electron = 2.55 – 2.5 = 0.05eV

26.



UV = 3

Visible = 2 3: 2 : 1

I R = 1

27. $0.0529\times n^2=0.8464\rightarrow n=4$

$L=\frac{nh}{2\pi}=\frac{2h}{\pi}$

28. conceptual

29. conceptual

30. conceptual

MATHS

41. $\sqrt{\sqrt{2}\sqrt{3}}=6^{1/4}$

$\sqrt{\sqrt{2}6^{1/4}}=2^{1/4}6^{1/8}$

$\sqrt{6^{1/4}\sqrt{3}}=6^{1/8}3^{1/4}$

49. $f(x)=(x-1)\left(x^2-4x+1\right)+2$

50. Use remainder theorem

52. $\{x\}\{y\}<\frac{1}{4}$

53. $x = 0$

54. $60^a = 3 \quad \Rightarrow \quad a = \log_{60}3$

$60^b = 5 \quad \Rightarrow \quad b = \log_{60}5$

$12^{\frac{1-a-b}{2(1-b)}} = 2$

56. Note that $D^r < 0$, hence given inequality (1) is true only if $N^r \geq 0$

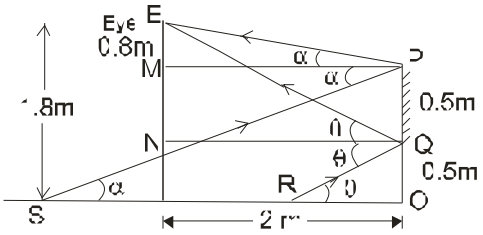
i.e. $(x - 8)(x - 2) < 0$ and $2^{x-3} > 31$

i.e. $2 \leq x \leq 8$ and $2^{x-3} \geq 31$

only $x = 8$ satisfies both the inequality

57. Plot the graph

MATHS

61. 

From figure, ΔEMP and ΔPOS are similar.

So, $\frac{EM}{PO} = \frac{MP}{OS} \Rightarrow OS = 1 \times \frac{2}{0.8}$ m $= 2.5$ m.

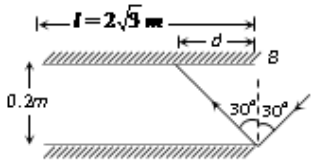
Similarly, ΔENQ and ΔQOR are similar.

So, $\frac{EN}{QO} = \frac{QN}{RO}$ $\because \Rightarrow RO = \frac{0.5 \times 2}{(1.8 - 0.5)}$ m. $= 0.77$ m.

Hence, length of wall visible in mirror.

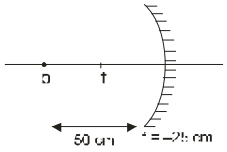
$= OS - OR = (2.5 \times 0.77)$ m $= 1.73$ m.

62. From the following ray diagram

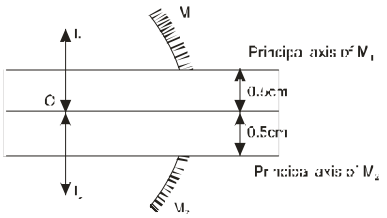


$d = 0.2 \tan 30° = \frac{0.2}{\sqrt{3}} \Rightarrow \frac{l}{d} = \frac{2\sqrt{3}}{0.2/\sqrt{3}} = 30$

Therefore maximum number of reflections are 30.

63. 

$\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ $\frac{1}{-25}=\frac{1}{v}+\frac{1}{-50}$ v = – 50 cm



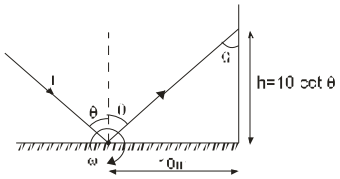
For M_1, $m=\frac{I}{o}=-\frac{v}{u}$ $\Rightarrow$ $\frac{I_1}{-0.5}=-\left(\frac{-50}{-50}\right)$ $\Rightarrow I_1=0.5cm$

For M_2, $m=\frac{I}{o}=\frac{-v}{u}$ $\Rightarrow$ $\frac{I_2}{0.5}=-\left(\frac{-50}{-50}\right)$ $\Rightarrow I_2=-0.5cm$

$\therefore$ Distance between I_1 *and* I_2 I_1 I_2

= 0.5 + 0.5 + 1 = 2 cm.

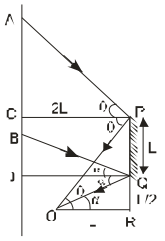
64.



When mirror is rotated with angular speed ω, the reflected ray rotates with angular speed 2ω (= 36 rad/s)

speed of the spot = $\left|\frac{dh}{dt}\right| = \left|\frac{d}{dt}(10\cot\theta)\right| = \left|-10\,\mathrm{cosec}^2\theta \quad \frac{d\theta}{dt}\right| = \left|-\frac{10}{(0.6)^2}\times 36\right| = 1000$ m/s.

65.



$\tan\theta=\frac{PR}{OR}=\frac{AC}{PC}$

$\Rightarrow$ $\frac{3L/2}{L}=\frac{AC}{2L}$

$\Rightarrow$ AC = 3L

$\tan\alpha=\frac{QR}{OR}=\frac{BD}{DQ}$

$\Rightarrow$ $BD=\frac{L/2}{L}\times 2L=L$

$\therefore$ AB = AD – BD = (3L + L) – L = 3L.

From A to B observer can observe M_1

Making similar diagram for lower mirror

Total visible distance = 3L + 3L = 6L

Total time = $\frac{6L}{u}$.

67. For m = 2

$$m = -\frac{v}{u} = 2$$

$$V = -2u \quad \ldots\ldots\ldots\ldots\ldots\ldots(i)$$

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \quad \Rightarrow \quad \frac{1}{f} = \frac{1}{-2u} + \frac{1}{u}$$

$$\Rightarrow \quad \frac{1}{f} = \frac{1}{2u} \quad \Rightarrow \quad u = \frac{f}{2}$$

& $v = -f$

Distance between object & image = $f + f/2 = 3f/2$

For $m = -2$

$$m = -\frac{v}{u} = -2$$

$$v = 2u$$

$$\Rightarrow \quad \frac{1}{f} = \frac{1}{2u} + \frac{1}{u} \quad \Rightarrow \quad u = \frac{3f}{2}$$

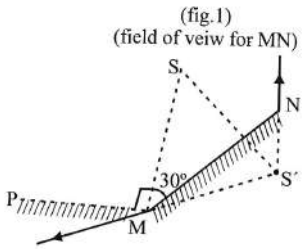
& $v = 3f$

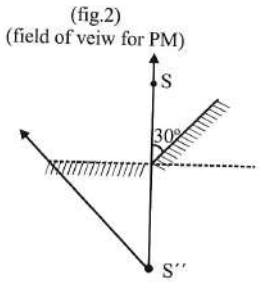
Distance between object & image = $3f - \frac{3f}{2}$.

68. $$m = \frac{I}{O} = \frac{f}{u-f} = \frac{10}{25-10} = \frac{10}{15} = \frac{2}{3}$$

$$m^2 = \frac{A_i}{A_o} \Rightarrow A_i = m^2 \times A_o = \left(\frac{2}{3}\right)^2 \times (3)^2 = 4 \ cm^2$$

71. S' and S" are the images of S w.r.t. Mirrors MN & PM respectively. After drawing the field of S for both the mirrors, we find that B and A lie on the field of view of both the mirrors whereas C lies on the field of view of only mirror MN. So, C will see only one image.



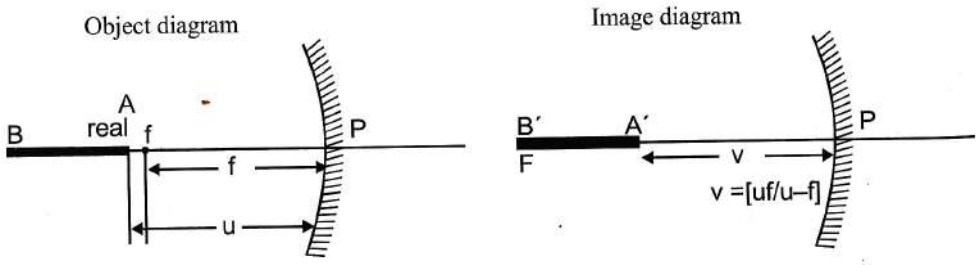


72. Straight line joining the object and the image is $\perp$ to the mirror because it passes through center of curvature in spherical mirror and in case of a plane mirror, it is a property that plane mirror bisects line joining the object and the image.

73. At infinity

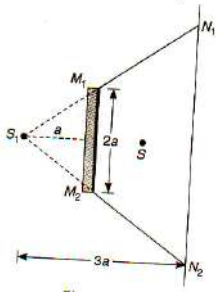
Image of B will form at focus since it is at infinity image of A will be at A which can be calculated by mirror formula.

$$\frac{1}{v} + \frac{1}{-u} = \frac{1}{-f} \Rightarrow v = \frac{fu}{f-u} = -\left[\frac{fu}{u-f}\right] \text{ image length } = f - v = f - \left(\frac{fu}{f-u}\right) = \frac{f^2}{u-f}$$



75. From laws of reflection $5H/6$.

76. S_1 is the image of source S, at a distance a behind the mirror. Evidently, the required length is N_1N_2. From similar triangles $M_1S_1M_2$ and $N_1S_1N_2$



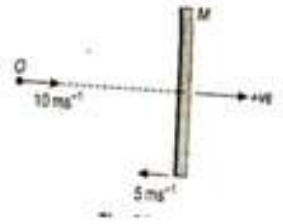
$$\frac{2a}{a}=\frac{N_1N_2}{3a}$$

or, $N_1N_2=6a$.

77. Conceptual

78. Since the image is enlarged, so the object is more closer to the mirror as compared to the image. Furher, since the image is real, so both object and image are located beyond focus. If x be the distance of object from the focus, then the distance of image from the focus will be $y=30+x\,cm$.

From Newton's formula. $xy=f^2$



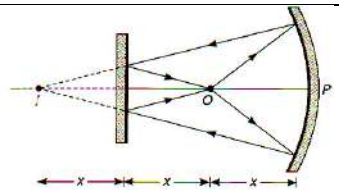
$$=\left(\frac{40}{2}cm^2\right)^2=400\,cm^2.$$

$\therefore\ x(30+x)=400$

or, $x=10cm$.

$\therefore\ u=x+f=10+20=30$ cm.

79. For the reflection at the concave mirror I is the image $u=-x, v=-3x$ and $f=-30\,cm$.



From mirror formula

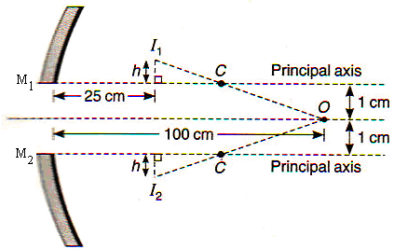
$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f},\ \frac{1}{x}+\frac{1}{3x}=\frac{1}{30\ cm}.$$

$\therefore \quad x=40\ cm.$

$\therefore$ The required separation $=2x=80cm.$

81. Here, $u=-10cm;\ f=-20cm;\ v=?$

Using, mirror formula $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$



We have, $\frac{1}{v}-\frac{1}{100cm}=-\frac{1}{20cm}.$

$\therefore\ v=-25cm$

$\therefore \quad m=\frac{h}{1\ cm}=\frac{25\ cm}{100\ cm}$

$\therefore \quad h=0.25\ \text{cm}.$

$\therefore$ Required distance $= 2(h+1cm)$

$= 2.50\ \text{cm}$

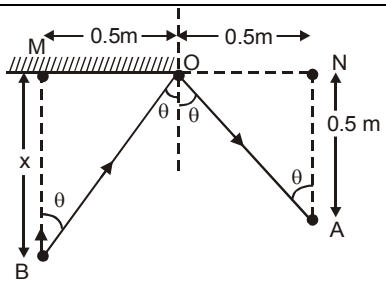
82. Sol. See figure

$\tan\theta = \frac{10}{10/\sqrt{3}}$

$\therefore \phi = 60°$

if $\theta < 60°$, the ray will not strike the mirror PQ.

83. Sol. When A and B first see each other;



As in triangles BMO and ANO

$\tan\theta = \frac{0.5}{x} = 1$

$\therefore x = 0.5$ m.

84. Conceptual

86. Slope of mirror is $\tan\theta = 3/4$.

$\therefore$ Slope of normal to the mirror = -4/3.

$\therefore$ Unit vector along the outward normal = $\left(3\hat{i} - 4\hat{j}\right)\frac{1}{5}$ and unit vector along the incident ray (motion of object) = - $\hat{j}$

$\therefore$ The image moves along the direction of the corresponding reflected rays.

$\therefore$ The required direction

$$= -\hat{j} + \frac{2}{5}\left(3\hat{i} - 4\hat{j}\right)\left[\frac{\hat{j}.\left(3\hat{i} - 4\hat{j}\right)}{5}\right]$$

87. Conceptual

88. Since point of intersection lies on line $y = 3x$,

at $y = 1.5m, x = 0.5\ m$

or, $\frac{1}{|u|} = \frac{1}{2m}$ *and* $\frac{1}{|v|} = \frac{3}{2m}$

From mirror formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, $\left(\therefore \frac{1}{f} = 2m^{-1}\right)$

$f = 50cm$

$R = 2f = 100cm$

89. The point of intersection lies on the line $y = 4x$

$\therefore$ For abscissa $x = 20$ cm; ordinate $y = 80cm$

Now, from Newton's formula $(u - f)(v - f) = f^2$

or, $|u-f||v-f| = f^2 \quad or,\ |a||b| = f^2$

$\therefore 20\ cm \times 80\ cm = f^2$ or, $f = 40cm$

$\therefore \qquad R = 2f = 80cm$.

90. The point of incidence M lies on the mirror

$\therefore\ y^2 = 4a(4a)$

or, $y = 4a$ (being positive)

The incident ray PM parallel to the principal (X) axis, after reflection appear to come from focus $S(a,0)$.

$\therefore$ Equation of reflected ray = $(4a-a)\hat{i} + (4a-0)\hat{j} = a(3\hat{i} + 4\hat{j})$

$\therefore$ Unit vector along the reflected ray will be $\dfrac{a(3\hat{i}+4\hat{j})}{\sqrt{(3a)^2+(4a)^2}} = \dfrac{1}{5}(3\hat{i}+4\hat{j})$