

IIT JAM (GEO-PHYSICS)-2013

IMPORTANT NOTE FOR CANDIDATES

Select any TWO Sections (Objective, Fill in the Blanks & Descriptive) among the three listed below:

GEOLOGY SECTION: Q.Nos. 01-05 (Objective Questions)
Q. Nos. 06-10 (Fill in the Blank Questions)
Q. Nos. 11-15 (Descriptive Questions)

PHYSICS SECTION: Q. Nos. 16-20 (Objective Questions)
Q. Nos. 21-25 (Fill in the Blank Questions)
Q. Nos. 26-30 (Descriptive Questions)

MATHEMATICS SECTION: Q. Nos. 31-35 (Objective Questions)
Q. Nos. 36-40 (Fill in the Blank Questions)
Q. Nos. 41-45 (Descriptive Questions)

Distribution of Marks in each section:

| 05 x 02 =10 marks | 05 x 03 =15 marks | 05 x 05 =25 marks | Total: 50 marks

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

GEOLOGY SECTION: (Objective Questions)

Q1. Match the natural features listed in **Group-I** with the corresponding geological environments listed in **Group-II**

Group I

P. Atoll

Q. Esker

R. Caldera

S. Braid bar

(a) P-1, Q-3, R-4, S-2

(c) P-3, Q-4, R-1, S-2

Group II

1. River

2. Volcano

3. Sea

4. Glacier

(b) P-3, Q-4, R-2, S-1

(d) P-3, Q-2, R-4, S-1

Q2. Orogenic belts are associated with

(a) divergent plate boundaries

(b) transform faults

(c) convergent plate boundaries (collision zones)

(d) convergent plate boundaries (subduction zones)

Q3. Which one of the following sequences, show arrangement of the stratigraphic units in the increasing order of their ages?

(a) Subathu Formation, Po Formation, Umia Formation, Bijaigarh Shale

(b) Subathu Formation, Umia Formation, Po Formation, Bijaigarh Shale

(c) Subathu Formation, Umia Formation, Bijaigarh Shale, Po Formation,

(d) Bijaigarh Shale, Po Formation, Umia Formation, Subathu Formation

Head office

fiziks, H.No. 23, G.F, Jia Sarai,

Near IIT, Hauz Khas, New Delhi-16

Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,

28-B/6, Jia Sarai, Near IIT

Hauz Khas, New Delhi-16

Q4. Match the fossils listed in **Group I** with the corresponding morphological features listed in **Group II**

Group I

P. Arca

Q. Trochus

R. Mya

S. Ostrea

(a) P-3, Q-4, R-1, S-2

(c) P-3, Q-2, R-4, S-1

Group II

1. Broad pallial sinus

2. Dysodont dentition

3. Taxodont dentition

4. Conical-spiral

(b) P-1, Q-4, R-3, S-2

(d) P-2, Q-4, R-1, S-3

Q5. Match the items listed in **Group I** with the those listed in **Group II**

Group I

P. Perthite

Q. Graphic texture

R. Ophitic texture

S. Myrmekitic texture

(a) P-1, Q-4, R-1, S-3

(c) P-2, Q-4, R-3, S-1

Group II

1. Intergrowth of quartz and alkali Feldspar

2. Intergrowth of albite and potassic Feldspar

3. Plagioclase laths enclosed by augite

4. Intergrowth of quartz and sodic plagioclase

(b) P-1, Q-2, R-3, S-4

(d) P-2, Q-1, R-3, S-4

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

GEOLOGY SECTION : (Fill in the blank Questions)

- Q6. The concept of hanging wall/foot wall does not hold good in the case of faults which are/have_____
- Q7. A light blue mineral occurring in bladed form is of composition Al_2SiO_5 . A specimen of this mineral has hardness (Mohs scale) 4-5 as well as 6-7. The name of the mineral is _____
- Q8. Volcanic equivalents of granite, syenite and diorite are _____, _____ and _____ respectively.
- Q9. Individual suture lines characterized by 'cerrated lobes' alternating with 'rounded saddles' in ammonoids are called_____.
- Q10. In an area of normal stratigraphic sequence of conformable beds, an older bed gets exposed by erosional process only. Such an exposure of an older bed surrounded by younger beds is termed as_____.

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

GEOLOGY SECTION: (Descriptive Questions)

- Q11. Name the crystal system in which the mineral galena crystallizes. Give its element of symmetry in terms of number of (i) axial and diagonal planes of symmetry and (ii) axes of various folds of symmetry. Write its chemical composition, streak and hardness. With which ore mineral is it commonly found associated in the Zawar mines of Rajasthan?
- Q12. With the help of neat sketches, describe characteristic features of the following drainage patterns (i) Dendritic (ii) Trellised (iii) Centripetal (iv) Radial and (v) Annular.
- Q13. What is an anticline? How does it differ from an antiform? In an east-west trending, doubly plunging antiform, the northern limb dips steeper than the southern limb. Sketch this fold by stratum contours.
- Q14. Define the term sand. What is ϕ – scale for measuring the grain size of sediments? Giving reasons, explain which one of the following two samples of sandstone has better sorting
- | | Standard Deviation (grain size ϕ) |
|----------|---|
| Sample P | 0.38 |
| Sample Q | 0.74 |
- A sequence of sandstone, shale and limestone has undergone metamorphism. Name possible resultant metamorphic rocks.
- Q15. What is the difference between petroleum pool and petroleum field. What is a reservoir trap? Define the absolute porosity and effective porosity.

Head office

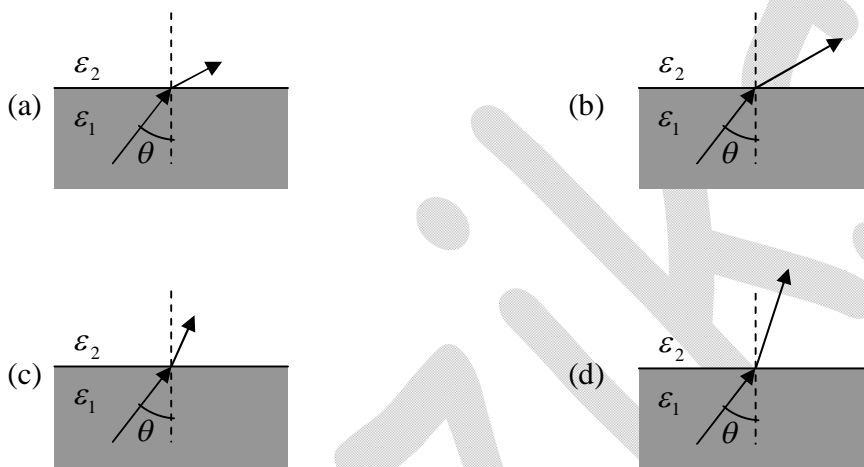
fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

PHYSICS SECTION: (Objective Questions)

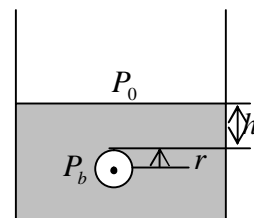
Q16. A uniform electric field is directed at an angle θ from vertical in a dielectric medium of permittivity ϵ_1 . This field extends to another dielectric medium of permittivity ϵ_2 ($\epsilon_2 > \epsilon_1$). There is no charge at the interface between the two dielectric regions. Which of the following figure depicts correct electric field lines?



Q17. Consider an X – ray diffraction experiment using a cubic crystal. The smallest angle of Bragg scattering from (001) planes is 14.5° . The smallest angle of Bragg scattering from (002) planes would be

- (a) 14.5° (b) 21° (c) 30° (d) 42°

Q18. A container is filled with a liquid of density ρ and surface tension S . There is a bubble of radius r at a depth h below the surface of the liquid (see figure). P_b is the pressure inside the bubble whereas P_0 is atmospheric $P_b - P_0$ will be equal to



- (a) $h\rho g$ (b) $(h+r)\rho g$ (c) $h\rho g + \frac{25}{r}$ (d) $h\rho g + \frac{45}{r}$

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

Q19. In an experiment, two masses of liquid, each being m , are taken. One mass is at temperature T_1 whereas the other is at temperature T_2 ($T_2 > T_1$). These masses are mixed. The change in the entropy of the system is

(a) $mC_p \ln \left[\frac{T_1 + T_2}{2\sqrt{T_1 T_2}} \right]$

(b) $2mC_p \ln \left[\frac{T_1 + T_2}{2\sqrt{T_1 T_2}} \right]$

(c) $2mC_p \ln \left[\frac{T_1 - T_2}{2\sqrt{T_1 T_2}} \right]$

(d) $2mC_p \ln \left[\frac{T_1 + T_2}{2T_1 T_2} \right]$

Q20. Consider two reference frames $S(xy)$ and $S'(x'y')$. S' is moving with a velocity v with respect to S along the common axes, x & x' . A rod 1 meter length in S' makes an angle 20° with the x' -axis. The angle of the rod is observed to be 30° with respect to the x -axis. The angle of the rod is observed to be 30° with respect to the x -axis in S . if c is the speed of light in free space, v is

(a) $0.30c$

(b) $0.50c$

(c) $0.77c$

(d) $0.90c$

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

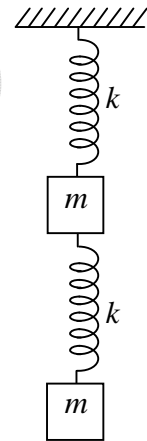
Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

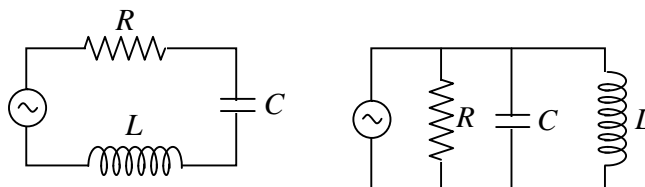
PHYSICS SECTION: (Fill in the blank Questions)

Q21. A particle is thrown vertically upward with an initial velocity of 49 m/s from the ground. After rising vertically for 3 seconds, particle breaks into two pieces of mass ratio 1:3. The lighter mass acquires a horizontal velocity of 10 m/s at the instant of breaking. With respect to the point from where the particle was thrown initially, heavier piece will land at _____. ($g = 9.8\text{ m/s}^2$)

Q22. Two equal masses, each being $m (= 1\text{ kg})$, are connected with two identical springs of spring constant $k (200\text{ N/m})$ as shown in the figure. The angular frequencies of the two normal modes of vertical oscillations are _____.



Q23. A resistor $R (2\Omega)$, a capacitor $C (2\text{ mF})$ and an inductor $L (4\text{ mH})$ are connected in series with a generator operating at a frequency of 40 Hz in one experiment. The impedance of this circuit is Z_s . In another experiment, the same R, C and L are connected in parallel to the same generator as shown in the figure. The impedance of this circuit is Z_p . The ratio Z_s / Z_p is _____.



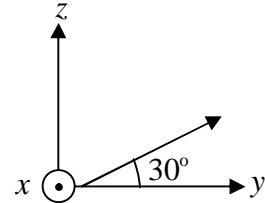
Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

Q24. A plane electromagnetic (EM) wave is traveling in yz -plane at an angle 30° from y -axis. Motion is confined in vacuum and the wavelength of the EM wave is 500 nm ($1 \text{ nm} = 10^{-9}$). Electric field, associated with the EM wave, is confined along x -axis and has a magnitude of 10 V/m . The expression of the associated magnetic field \vec{H} would be _____.



Q25. The activity of $3 \times 10^{-9} \text{ kg}$ of a radioactive sample, ^{222}Rn , is 46 Ci . The activity of the same sample exactly after one hour, correct to one decimal digit, would be _____ Ci . (Avogadro's no. = $6.025 \times 10^{26} \text{ kmol}^{-1}$, $\text{Ci} = 3.7 \times 10^{10} \text{ decays/sec}$)

Head office

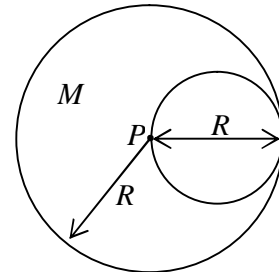
fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

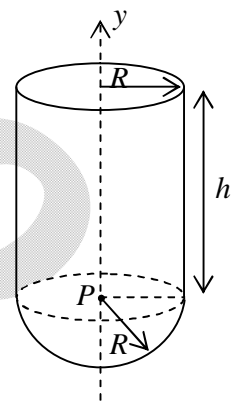
Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

PHYSICS SECTION: (Descriptive Questions)

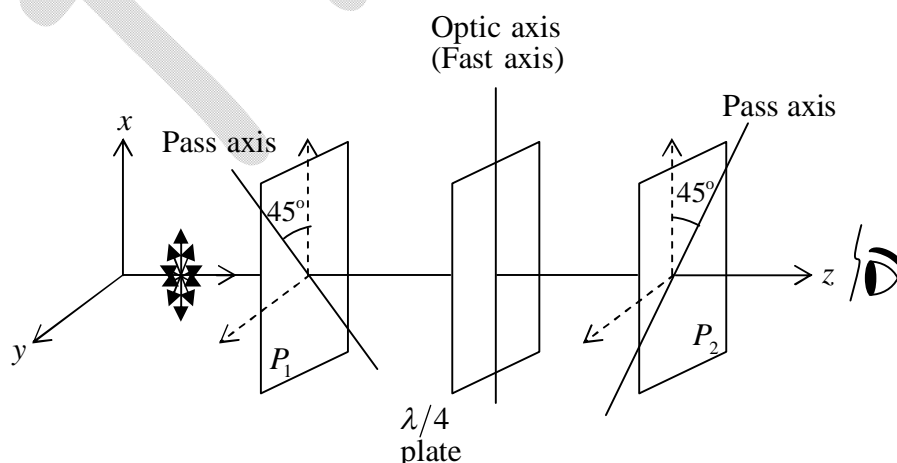
Q26. A disc of radius $R/2$ is removed from a disc of radius R as shown in the figure. Mass of the new structure is M . Find the moment of inertia of the new structure about an axis, which is normal to the plane of the disc and passing through the center (P) of the big disc.



Q27. A metallic hemispherical bowl is attached to a hollow metallic circular cylinder at the bottom as shown in the figure. Radius of hemisphere as well as of the cylinder is R . Height of the cylinder is h . Entire system carries a uniform surface charge density σ . Find electric field (E) at point P .



Q28. A Calcite $\lambda/4$ plate is introduced between the two crossed polarizers (P_1 & P_2) as shown in the figure. An unpolarized beam is incident normal to P_1 from left hand side. Write down the expressions for the electric fields associated with the beam after P_1 , after $\lambda/4$ plate and after P_2 . Also find the state-of-polarization after P_1 , after $\lambda/4$ plate and after P_2 as observed by an observer shown in the figure.



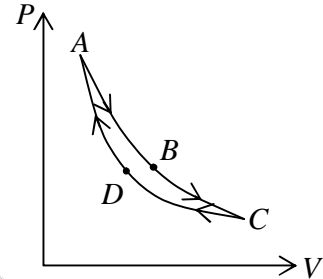
Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

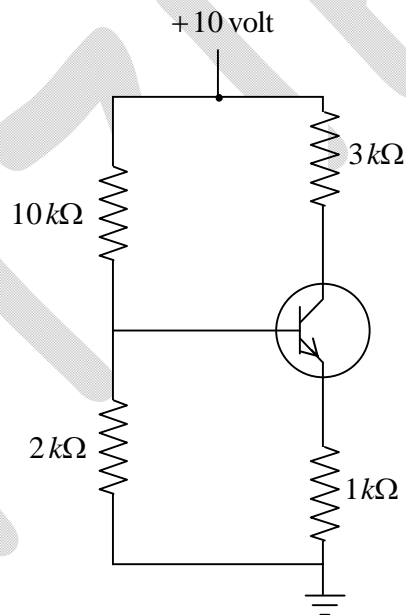
Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

- Q29. An ideal monatomic gas ($\gamma = 5/3$) is taken through a cyclic process ABCDA as shown in the figure. $A \rightarrow B$ is an isothermal expansion at temperature 900 K, $B \rightarrow C$ is an adiabatic expansion, $C \rightarrow D$ is an isothermal compression at temperature 300 K and $D \rightarrow A$ is an adiabatic compression. The volume at the point B is 60 liters. The volume and pressure at the point D are 30 liters and P_0 , respectively. Calculate pressure at points A, B and C. Also calculate volume at A and C.



- Q30. Assume that the transistor shown in the figure is biased in the active region. Calculate the value of V_{CE} , I_C and I_B (take $\beta = 100$ and $V_B = 0.7$ volt).



Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

MATHEMATICS SECTION: (Objective Questions)

- Q31. The sum of the series $\sum_{n=0}^{\infty} \frac{4n+6}{(n+1)^2(n+2)^2}$ is
 (a) 2 (b) 1 (c) 1/4 (d) 1/2
- Q32. The orthogonal trajectories of the family of curves represented by $\frac{dy}{dx} = (x-3y)$ are
 (a) $x-3y+3+ce^y=0$ (b) $-x+3y-3+ce^{-y}=0$
 (c) $3x+y+ce^y=0$ (d) $-3x+y+ce^y=0$
- Q33. A unit normal vector to the surface $z^2 = 4x^2 - 2y$ at the point $(2, 0, 4)$ is
 (a) $\frac{1}{9}(\hat{i} + 4\hat{j} + 8\hat{k})$ (b) $\frac{1}{9}(8\hat{i} + 4\hat{j} - \hat{k})$
 (c) $\frac{1}{9}(8\hat{i} - \hat{j} + 4\hat{k})$ (d) $\frac{1}{9}(-8\hat{i} + \hat{j} + 4\hat{k})$
- Q34. Let $T: R^2 \rightarrow R^3$ be a linear transformation such that $T(1, 2) = (1, 3, 2)$ and $T(2, 3) = (0, 4, 2)$. Then $T(10, 17)$ is
 (a) $(2, 22, 12)$ (b) $(6, 26, 16)$ (c) $(4, 24, 14)$ (d) $(0, 20, 10)$
- Q35. Consider the polynomial $f(x) = \frac{1}{120}(x^6 + 7x^5 + 4x^3 + 2x + 5)$. If the interval of differencing is 2, then the value of $\Delta^6 f(x)$ is
 (a) 720 (b) 1920
 (c) 384 (d) 320

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
 Near IIT, Hauz Khas, New Delhi-16
 Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
 28-B/6, Jia Sarai, Near IIT
 Hauz Khas, New Delhi-16

MATHEMATIC SECTION: (Fill in the blank Question)

- Q36. The area bounded by the curves $2y - 2x + 1 = 0$ and $y = x(x - 1)$ is _____
- Q37. The solution of the differential equation $\frac{d^2y}{dx^2} + \frac{dy}{dx} - 6y = e^{2x}$ subject to the initial conditions $y(0) = 5, \frac{dy}{dx}(0) = \frac{1}{5}$ is _____
- Q38. An eigenvector of the matrix $A = \begin{bmatrix} 5 & 0 & 1 \\ 1 & 1 & 0 \\ -7 & 1 & 0 \end{bmatrix}$ is _____
- Q39. A random sample of size 100 is taken from an infinite population. The population mean, $\mu = 75$ and the variance, $\sigma^2 = 256$. Using the central limit theorem, the probability that the mean of the sample will fall between 73 and 77 is _____ (correct to four decimal places).
Given: If Z is the standard normal variate, then $P(0 < Z < 1.2) = 0.3849$, $P(0 < Z < 1.25) = 0.3944$ and $P(0 < Z < 1.3) = 0.4032$.
- Q40. The cubic polynomial $p(x)$, which takes on values $p(0) = -2, p(1) = 0, p(2) = 8, p(3) = 34$ and $p(4) = 90$, is _____

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16

MATHEMATICS SECTION: (Descriptive Questions)

- Q41. Find the maximum and minimum values of the function $f(x) = xe^{-|x-2|}$, $-\infty < x < \infty$.
- Q42. Consider the region that lies inside the sphere $x^2 + y^2 + z^2 = 2$ and outside the cylinder $x^2 + y^2 = 1$. Find the volume of this region using triple integral.
- Q43. Use Stokes' theorem to evaluate $\int_C \vec{F} \cdot d\vec{r}$, where $\vec{F} = (x+z)\hat{i} + (2y-z)\hat{j} + (x-z)\hat{k}$ and C is the boundary of the triangle with vertices $P(6,0,0)$, $Q(0,4,0)$ and $R(0,0,3)$.
- Q44. In a university, 15% of the students are female and the remaining students are male. Furthermore, 10% of the male students and 2% of the female students are over 6 feet tall. A student is randomly selected and is observed to be over 6 feet tall. Find the probability (correct to three decimal places) that this student is a female.
- Q45. It was proposed to compare the average earnings per day of men and women in an industry. From a sample data of 60 men, it was observed that the average earning of men per day is Rs. 285 and a standard deviation is Rs. 15. On the other hand, a sample data of 60 women showed their average earning as Rs. 251 per day and the standard deviation as Rs. 18. Test the hypothesis that the average earning of men per day exceeds that of the women by more than Rs. 30. Use 0.05 level of significance.
- Given: If Z is the standard normal variate, then $P(0 < 1.645) = 0.45$ and $P(0 < Z < 1.96) = 0.475$.

Head office

fiziks, H.No. 23, G.F, Jia Sarai,
Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498

Branch office

Anand Institute of Mathematics,
28-B/6, Jia Sarai, Near IIT
Hauz Khas, New Delhi-16