2006

*This booklet contains **16+4** printed pages.*

PAPER – 2 : MATHEMATICS & APTITUDE TEST

Test Booklet Code

Do not open this Test Booklet until you are asked to do so.

Read carefully the Instructions on the Back Cover of this Test Booklet.

IMPORTANT INSTRUCTIONS :

1. Immediately fill in the particulars on this page of the Test Booklet with Blue/Black Ball Point Pen.

2. This Test Booklet consists of three parts — **Part I, Part II** and **Part III.**
   Part I has **40** objective type questions of Mathematics consisting of **3** marks each for questions no. 1 to 10, **4·5** marks each for questions no. 11 to 30 and **6** marks each for questions no. 31 to 40, for each correct response.
   Part II has **50** objective type questions (4 options with single correct answer). Each question carries **3** marks. Mark your answers for these questions in the appropriate space against the number corresponding to the question in the Answer Sheet placed inside this Test Booklet. ***Use Blue/Black Ball Point Pen only for writing particulars/marking responses on Side-1 and Side-2 of the Answer Sheet.***
   Part III consists of **2** questions carrying **70** marks which are to be attempted on a separate Drawing Sheet which is also placed inside this Test Booklet. Marks allotted to each question are written against each question. ***Use colour pencils or crayons only on the Drawing Sheet. Do not use water colours.***

3. The test is of **3** hours duration. The maximum marks are **400**.

4. On completion of the test, the candidates must hand over the Answer Sheet of Mathematics and Aptitude Test – Part I & II and the Drawing Sheet of Aptitude Test – Part III to the Invigilator in the Room/Hall. Candidates are allowed to take away with them the Test Booklet of Aptitude Test – Part I & II.

5. The CODE for this Booklet is **C**. Make sure that the CODE printed on **Side-2** of the Answer Sheet and on Drawing Sheet (Part III) is the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of the Test Booklet, Answer Sheet and the Drawing Sheet.

Name of the Candidate (in Capitals) : _____

Roll Number : in figures | | | | | | | | |

: in words _____

Centre of Examination (in Capitals) : _____

Candidate's Signature : _____ Invigilator's Signature (1) : _____

Invigilator's Signature (2) : _____

SEAL

Part I

Mathematics

1. If the centroid of the triangle with vertices $(3c + 2, 2, 0)$, $(2c, -1, -1)$ and $(c + 2, 3c + 1, c + 3)$ coincides with the centre of the sphere $x^2 + y^2 + z^2 + 5ax - 4by - 2cz = 13$ then

(1) $c = 1$

(2) $c = 2$

(3) $c = 3$

(4) $c = 0$

2. A particle has two velocities $\vec{v_1}$ and $\vec{v_2}$. Its resultant velocity is equal to $\vec{v_1}$ in magnitude. The angle which the new resultant makes with $\vec{v_2}$ when $\vec{v_1}$ is doubled is

(1) $90°$

(2) $120°$

(3) $180°$

(4) $60°$

3. The domain of the function

$f(x) = \sqrt{2x - 3} + \sin x + \sqrt{x - 1}$

is

(1) $(-\infty, 1]$

(2) $[0, 1]$

(3) $\left[\frac{3}{2}, \infty\right)$

(4) $[1, \infty)$

4. The mean deviation of an ungrouped data is 10. If each observation is increased by 4%, the revised mean deviation is

(1) 10·0

(2) 10·4

(3) 10·04

(4) 9·6

5. If A and B are square matrices of the same order, then which of the following is always true ?

(1) $(A + B)^{-1} = A^{-1} + B^{-1}$

(2) adj (AB) = (adj B) (adj A)

(3) A and B are non-zero and $|AB| = 0 \Leftrightarrow |A| = 0$ and $|B| = 0$

(4) $(AB)^{-1} = A^{-1} B^{-1}$

6. The slope of the normal to the curve $y = x^3 - 4x^2$ at $(2, -1)$ is

(1) $\frac{1}{4}$

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

(3) 4

(4) -4

7. The line $x \sin\alpha - y \cos\alpha = a$ touches the circle $x^2 + y^2 = a^2$. Then

(1) $\alpha \in [0, \pi]$

(2) $\alpha \in [-\pi, \pi]$

(3) α can have any value

(4) $\alpha \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$

8. If f is a continuously differentiable function then $\int_0^{1\cdot5} [x^2] f'(x)\, dx$ is

(1) $f(1\cdot5) - f(\sqrt{2}) - f(1)$

(2) $f(1\cdot5) + f(\sqrt{2}) + f(1)$

(3) $2f(1\cdot5) + f(\sqrt{2}) + f(1)$

(4) $2f(1\cdot5) - f(\sqrt{2}) - f(1)$

9. If a circle of area 16π has two of its diameters along the lines $2x - 3y + 5 = 0$ and $x + 3y - 11 = 0$, then the equation of the circle is

(1) $x^2 + y^2 - 4x + 6y - 13 = 0$

(2) $x^2 + y^2 - 4x - 6y - 3 = 0$

(3) $x^2 + y^2 - 4x - 6y - 13 = 0$

(4) $x^2 + y^2 - 4x + 6y - 3 = 0$

10. The system of equations

$x + y + z = 0$
$ax + by + z = 0$
$bx + y + z = 0$

has a non-trivial solution, when

(1) $b^2 = 2b + 1$

(2) $b^2 = 2b - 1$

(3) $b - a = 0$

(4) $b^2 = 2b$

SPACE FOR ROUGH WORK

11. The number of solutions of the equation

$$\tan x + \sec x = 2 \cos x$$

lying in the interval $[0, 2\pi]$ is

(1) 1

(2) 2

(3) 3

(4) 0

12. For the curve $x = t^2 - 1$, $y = t^2 - t$, the tangent line is perpendicular to the x-axis when

(1) $t = 0$

(2) $t = 1$

(3) $t = \frac{1}{\sqrt{3}}$

(4) $t = \frac{1}{2}$

13. For $\theta \neq 0$, if $\cos\theta + \sec\theta = 2$, then $\cos^n\theta + \sec^n\theta$ equals

(1) 2^n

(2) $(-2)^n$

(3) 2^{n+1}

(4) 2

14. The greatest resultant and the smallest resultant that two given forces can have are of magnitude R and S respectively. The given forces and a third force whose magnitude is $\sqrt{RS}$ keep a particle in equilibrium. Then

(1) angle between two of these forces is 60°

(2) angle between two of these forces is 45°

(3) two of these forces are perpendicular to each other

(4) two of these forces are parallel to each other

15. Two events A and B are such that

$P(B) = 0{\cdot}55$ and $P(AB') = 0{\cdot}15$.

The probability of the occurrence of at least one event is

(1) 0·70

(2) 0·20

(3) 0·35

(4) 0·30

16. Let $\bar{a} = (\hat{i} - 2\hat{j} + 3\hat{k})$ and $\bar{b} = (\hat{i} + 11\hat{j} + 7\hat{k})$ be given vectors. The vector $\bar{r} = \hat{i} + y\hat{j} + z\hat{k}$ that satisfies the equation $\bar{r} \times \bar{a} = \bar{b}$ is

(1) $(1, -9, 14)$

(2) $(1, 9, 14)$

(3) $(1, 9, -14)$

(4) $(1, -9, -14)$

17. A function f(x) is defined as

$$f(x) = \begin{cases} x\,g(x); & x \neq 0 \\ 0 \quad ; & x = 0 \end{cases}$$

where it is given that $\lim_{x \to 0} g(x) = 5$. Then $f'(0)$ is

(1) ∞

(2) 1

(3) 5

(4) 0

18. Two friends A and B start walking from the same point O. A heads straight towards north. But B first walks 4 km towards north-east, then heads towards 30° west of north. If A and B meet at a point X, then distance of X from O is

(1) $4\left(1+\frac{1}{2}\right)$ km

(2) $2\sqrt{2}\left(1+\frac{1}{2}\right)$ km

(3) $2\sqrt{2}\left(1+\frac{1}{\sqrt{3}}\right)$ km

(4) $2\sqrt{2}(1 + \sqrt{3})$ km

19. If $x = a\cos^3 t$, $y = a\sin^3 t$, then $\left(\frac{d^2y}{dx^2}\right)_{t=\frac{\pi}{3}}$ is

(1) $\frac{16}{3\sqrt{3}\,a}$

(2) $\frac{16}{27\,a}$

(3) $\frac{32}{27\,a}$

(4) $\frac{32}{3\sqrt{3}\,a}$

SPACE FOR ROUGH WORK

20. $\int_{-4}^{-5} e^{(x+5)^2}\,dx + 3\int_{1/3}^{2/3} e^{9\left(x-\frac{2}{3}\right)^2}\,dx$ is

(1) 0
(2) -2
(3) 1
(4) 2

21. An equilateral triangle is inscribed in the parabola $y^2 = 8x$ with one of its vertices at the vertex of the parabola. Then the length of its side is

(1) $8\sqrt{3}$
(2) $16\sqrt{3}$
(3) 16
(4) 8

22. A particular solution of the initial value differential equation

$$\log\left(\frac{dy}{dx}\right) = 3x + 4y, \quad y(0) = 0$$

is

(1) $16y = 3(4x - 3 + 3e^{4x})$
(2) $3e^{-4y} - 4e^{3x} = 1$
(3) $4e^{3x} + 3e^{-4y} = 7$
(4) $16y = -3(4x + 3 - 3e^{4x})$

23. A plane passes through a fixed point (p, q, r). The locus of the foot of the perpendicular to the plane from the origin is

(1) a plane inclined at an angle of $\frac{\pi}{4}$ with the given plane
(2) a straight line
(3) a sphere
(4) a plane perpendicular to the given plane

24. The area enclosed by the parabola $y = 3(1 - x^2)$ and the x-axis is

(1) 4
(2) 3
(3) 9
(4) 2

25. If the roots of the quadratic equation $x^2 + 2px + q = 0$ are $\tan 30°$ and $\tan 15°$, respectively, then q is

(1) $1 + p$
(2) $1 - p$
(3) $1 - 2p$
(4) $1 + 2p$

26. If $|z| = 3$, then the point representing the complex number $-3 + 3z$ lies on a circle

(1) with centre -3 and radius 9
(2) with centre 3 and radius 3
(3) with centre 3 and radius 9
(4) with centre -3 and radius 3

27. If the first three terms of a sequence $\frac{1}{16}$, a, b, $\frac{1}{6}$ are in G.P. and the last three are in H.P., then the values of a and b respectively are

(1) $\frac{1}{12}, \frac{4}{9}$
(2) $\frac{4}{7}, \frac{3}{4}$
(3) $\frac{1}{9}, \frac{1}{12}$
(4) $-\frac{1}{4}, 1$

28. If the quadratic equations $ax^2 + cx - b = 0$ and $ax^2 - 2bx + \frac{c}{2} = 0$, $(b + \frac{c}{2} \neq 0)$ have a common root, then the value of $a - 4b + 2c$ is

(1) 0
(2) -1
(3) 2
(4) 1

29. $\frac{5 + i\sin\theta}{5 - 3i\sin\theta}$ is a real number when

(1) $\theta = \frac{\pi}{4}$
(2) $\theta = -\pi$
(3) $\theta = -\frac{\pi}{2}$
(4) $\theta = \frac{\pi}{2}$

30. The pair of straight lines joining the origin to the point of intersection of the straight lines $y = 2x + c$ and the curve $x^2 + y^2 = 7$ are at right angles if

(1) $c^2 = 11$
(2) $c^2 = 17{\cdot}5$
(3) $c^2 = 70$
(4) $c^2 = 35$

SPACE FOR ROUGH WORK

31. The circle passing through the distinct points (1, t), (t, 1) and (t, t) for all values of t passes through the point

(1) (1, — 1)

(2) (— 1, 1)

(3) (— 1, — 1)

(4) (1, 1)

32. Let $\vec{u}$, $\vec{v}$ and $\vec{w}$ be vectors such that

$$\vec{u} + \vec{v} + \vec{w} = 0.$$

If $|\vec{u}| = 3$, $|\vec{v}| = 4$ and $|\vec{w}| = 5$, then $\vec{u} \cdot \vec{v} + \vec{v} \cdot \vec{w} + \vec{w} \cdot \vec{u}$ is

(1) — 25

(2) 0

(3) 25

(4) 47

33. The line $y = x + 1$ divides the area between the curves $y = \cos x$, $[-\pi/2, \pi/2]$ and the x-axis into two regions which are in the ratio

(1) 2 : 1

(2) 1 : 3

(3) 2 : 3

(4) 1 : 1

34. If PQ is a double ordinate of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, such that OPQ is an equilateral triangle, O being the centre of the hyperbola, then the eccentricity e of the hyperbola satisfies

(1) $e = \frac{2}{\sqrt{3}}$

(2) $e = \frac{\sqrt{3}}{2}$

(3) $e > \frac{2}{\sqrt{3}}$

(4) $1 < e < \frac{2}{\sqrt{3}}$

35. A set B contains 2007 elements. Let C be the set consisting of subsets of B which contain atmost 1003 elements. The numbers of elements of C is

(1) 2^{2005}

(2) 2^{2006}

(3) 2^{1003}

(4) 2^{2007}

36. If $\sin(xy) + \cos(xy) = 1$ and $\tan(xy) \neq 1$, then $\frac{dy}{dx}$ is equal to

(1) xy

(2) — y/x

(3) — x/y

(4) — xy

37. If a, x, b are in H.P. and a, y, z, b are in G.P., then the value of $\frac{yz}{x(y^3 + z^3)}$ is

(1) ab

(2) $\frac{1}{2ab}$

(3) $\frac{1}{2}ab$

(4) 2ab

38. If $(1 + x)(1 + x + x^2)(1 + x + x^2 + x^3) + \ldots + (1 + x + x^2 + \ldots + x^n) = a_0 + a_1x + a_2x^2 + \ldots + a_mx^m$, then the value of a_1 is

(1) m + 1

(2) n + 1

(3) n

(4) m

39. If $f(x) = 4^{\sin x}$ satisfies the Rolle's theorem on $[0, \pi]$, then the value of $c \in (0, \pi)$ for which $f'(c) = 0$ is

(1) $c = \pi/6$

(2) $c = \pi/4$

(3) $c = \pi/2$

(4) $c = \pi/3$

40. If in the expansion of $\left(x^3 - \frac{1}{x^2}\right)^n$, the sum of coefficients of x^5 and x^{10} is 0, then the coefficient of the third term is

(1) 455

(2) 105

(3) 605

(4) 120

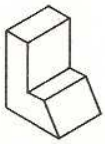
SPACE FOR ROUGH WORK

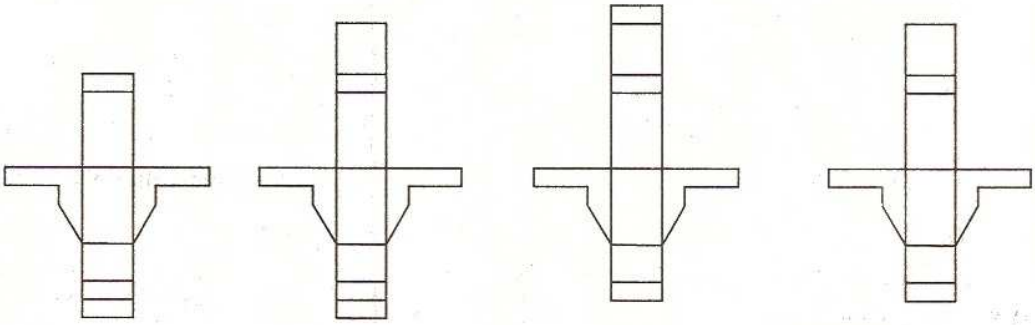
Part II
Aptitude Test

Directions : (For Q. 41, 42 and 43). *Which one of the answer figures, shows the correct view of the 3-D problem figure, after it is opened up ?*

Problem Figure *Answer Figures*

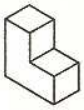
41.

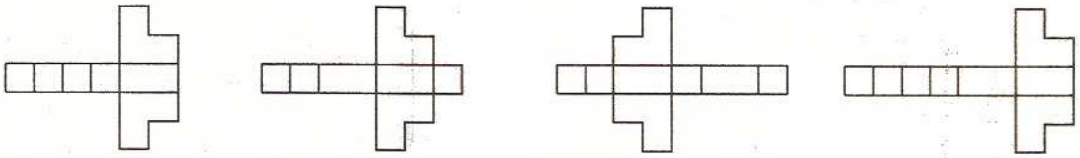




(1) (2) (3) (4)

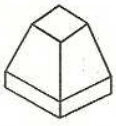
42.

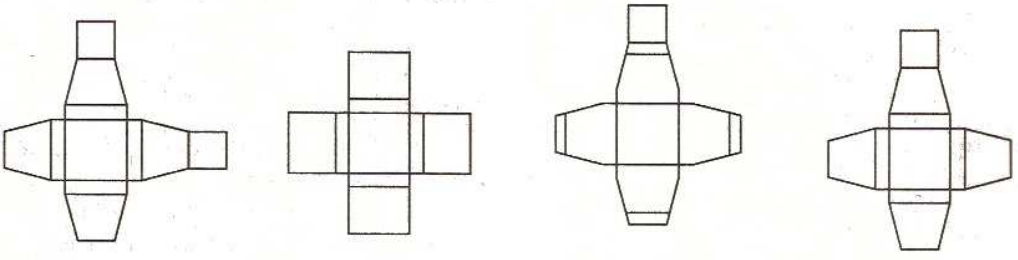




(1) (2) (3) (4)

43.



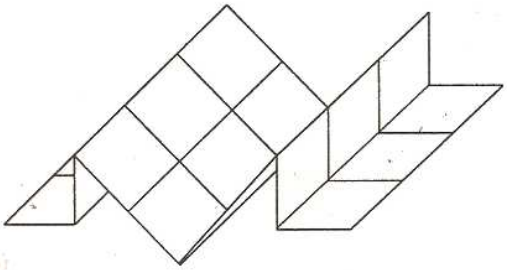


(1) (2) (3) (4)

SPACE FOR ROUGH WORK

Directions : (For Q. 44). *Squares were drawn on one side of the entire sheet of paper. The paper was then folded as shown in the figure. How many total number of squares are there on the flat surfaces ?*

44.



(1) 28

(2) 32

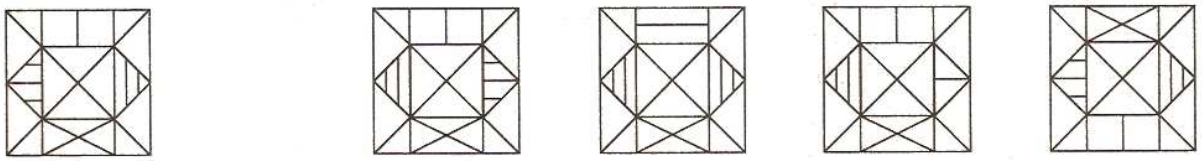
(3) 34

(4) 24

Directions : (For Q. 45 and 46). *Which one of the answer figures is the correct mirror image of the given problem figure ?*

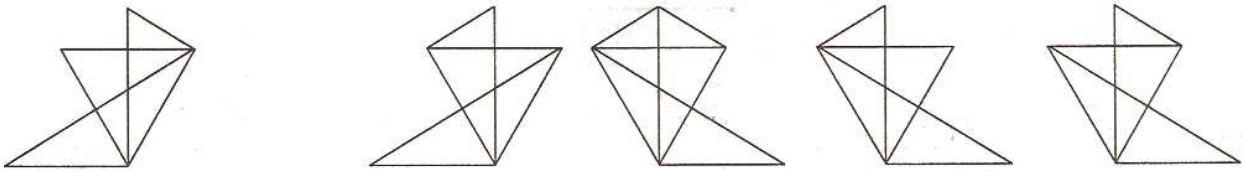
Problem Figure *Answer Figures*

45.



(1) (2) (3) (4)

46.

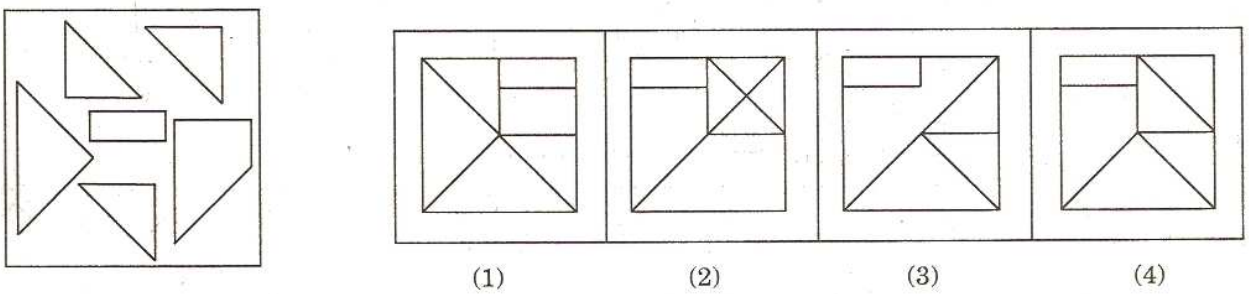


(1) (2) (3) (4)

Directions : (For Q. 47). *Some geometrical figures are given in the problem figure. After assembling them, which figure will be formed, from amongst the answer figures ?*

Problem Figure *Answer Figures*

47.



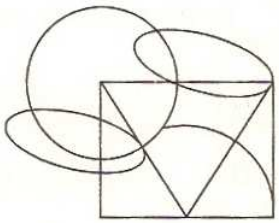
(1) (2) (3) (4)

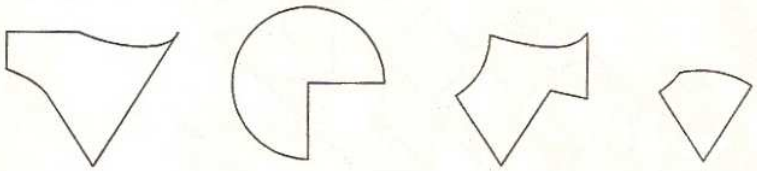
SPACE FOR ROUGH WORK

Directions : (For Q. 48). *One of the following answer figures is* ***not*** *hidden in the problem figure, in the same size and direction. Select that one as the correct answer.*

Problem Figure *Answer Figures*

48.



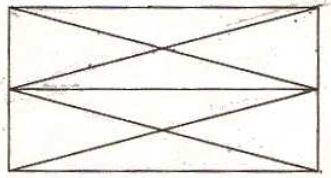


(1) (2) (3) (4)

Directions : (For Q. 49 and 50). *How many total number of triangles are there in the problem figure given below ?*

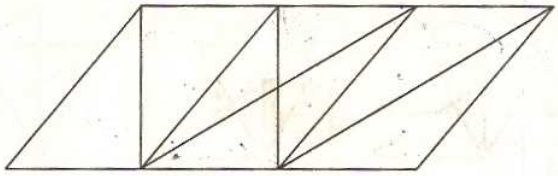
Problem Figure

49.



(1) 18
(2) 20
(3) 22
(4) 16

50.

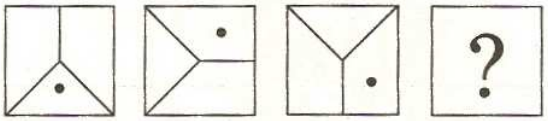


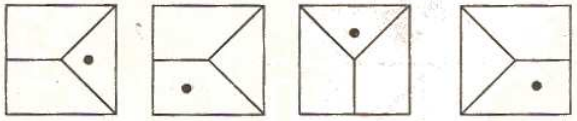
(1) 12
(2) 14
(3) 16
(4) 10

Directions : (For Q. 51 and 52). *Which one of the answer figures will complete the sequence of the three problem figures ?*

Problem Figures *Answer Figures*

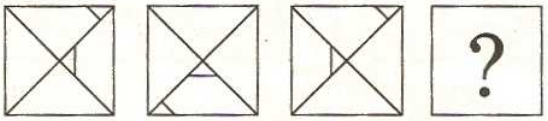
51.

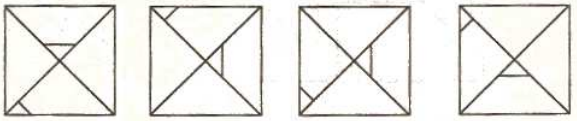




(1) (2) (3) (4)

52.





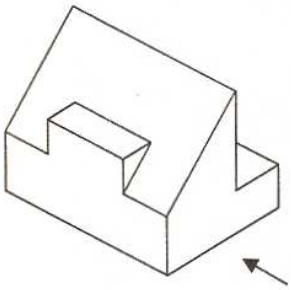
(1) (2) (3) (4)

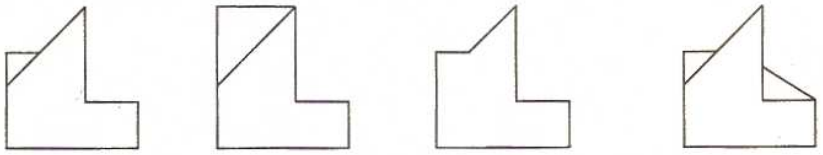
SPACE FOR ROUGH WORK

Directions : (For Q. 53 to 57). *3-D problem figure shows the view of an object. Identify the correct front view, from amongst the answer figures, looking in the direction of arrow.*

Problem Figure *Answer Figures*

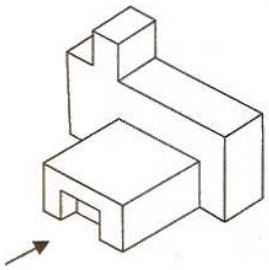
53.

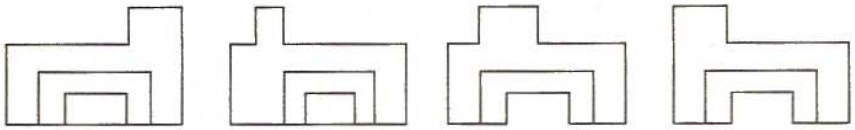




(1) (2) (3) (4)

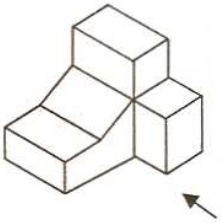
54.





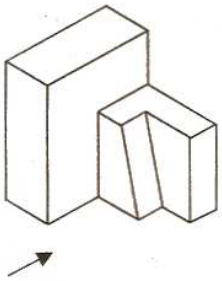
(1) (2) (3) (4)

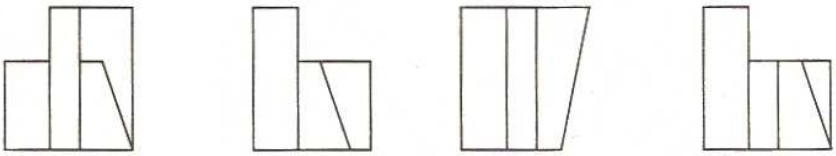
55.



(1) (2) (3) (4)

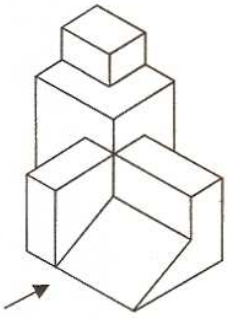
56.

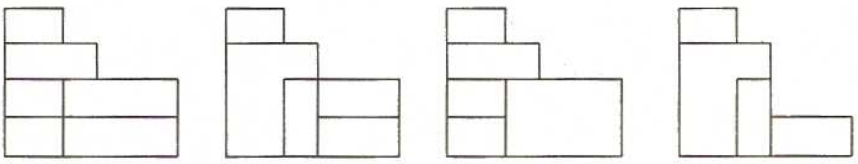




(1) (2) (3) (4)

57.





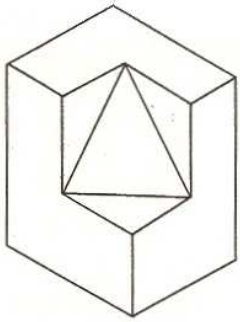
(1) (2) (3) (4)

SPACE FOR ROUGH WORK

Directions : (For Q. 58 to 61). *Find out the total number of surfaces of the object given below in the problem figures.*

Problem Figure

58.



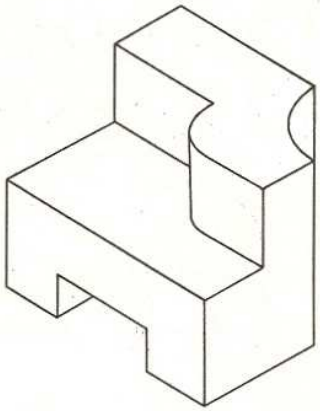
(1) 10

(2) 12

(3) 14

(4) 8

59.



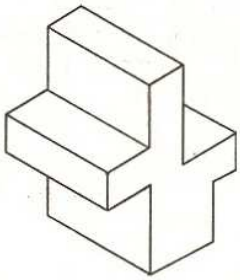
(1) 13

(2) 14

(3) 15

(4) 12

60.



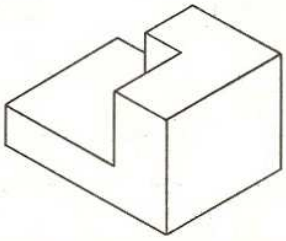
(1) 12

(2) 13

(3) 14

(4) 11

61.



(1) 10

(2) 11

(3) 12

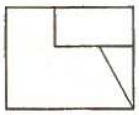
(4) 9

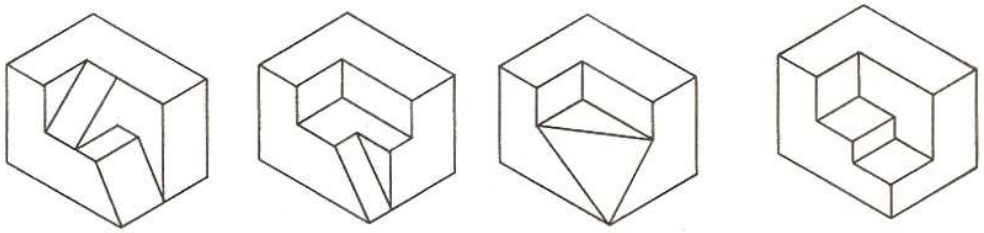
SPACE FOR ROUGH WORK

Directions : (For Q. 62 and 63). *Identify the correct 3-D figure from the answer figures, which has the elevation, as given in the problem figure on the left.*

Problem Figure *Answer Figures*

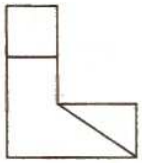
62.

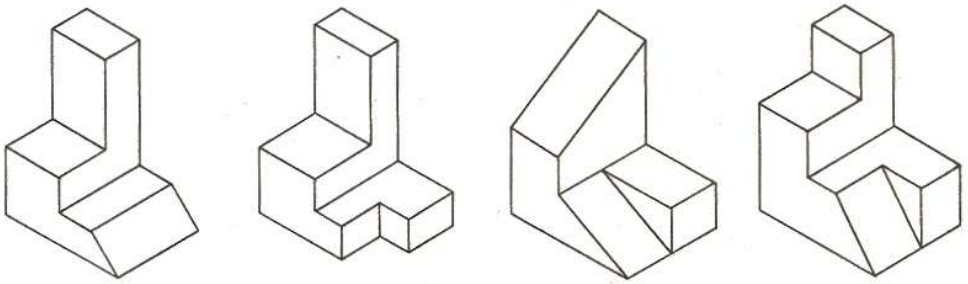




(1) (2) (3) (4)

63.

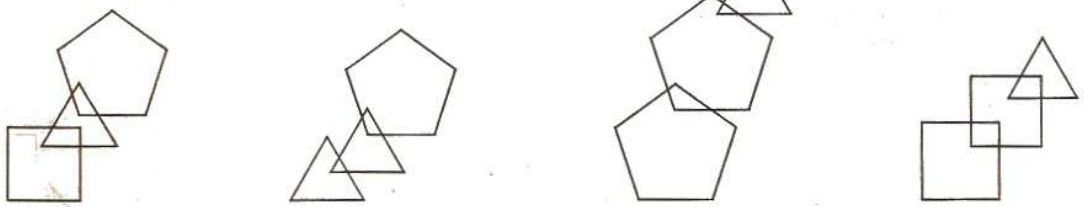




(1) (2) (3) (4)

Directions : (For Q. 64). *Find the odd figure out.*

64.

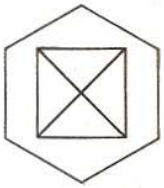


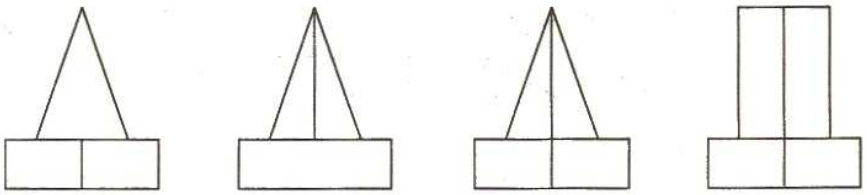
(1) (2) (3) (4)

Directions : (For Q. 65). *Problem figure shows top view of an object. Identify the correct elevation, from amongst the answer figures.*

Problem Figure *Answer Figures*

65.





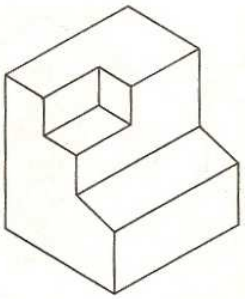
(1) (2) (3) (4)

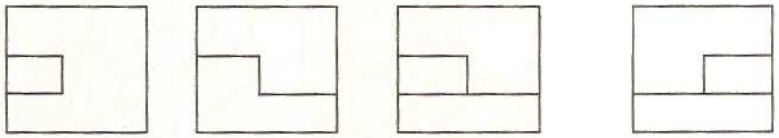
SPACE FOR ROUGH WORK

Directions : (For Q. 66 to 70). *3-D problem figure shows the view of an object. Identify the correct top view from amongst the answer figures.*

Problem Figure *Answer Figures*

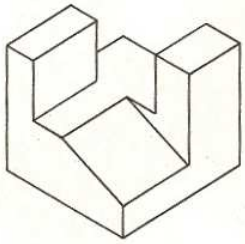
66.

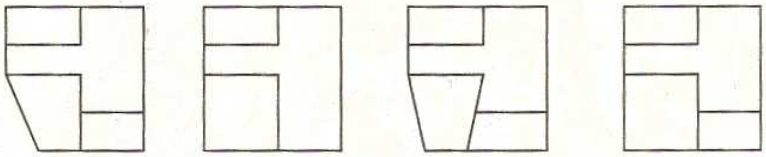




(1) (2) (3) (4)

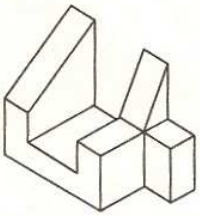
67.

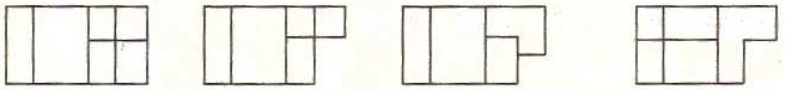




(1) (2) (3) (4)

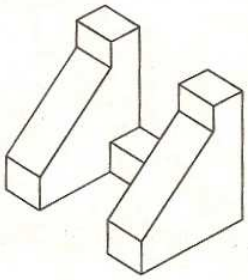
68.

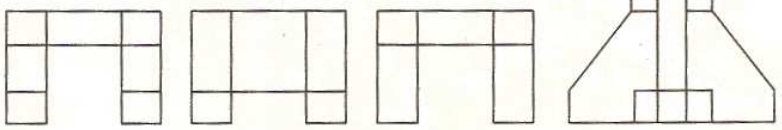




(1) (2) (3) (4)

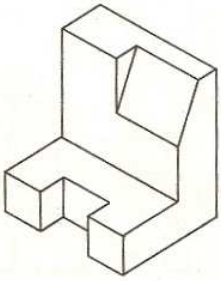
69.

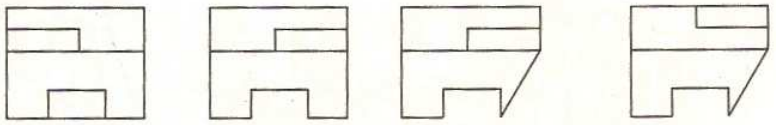




(1) (2) (3) (4)

70.





(1) (2) (3) (4)

SPACE FOR ROUGH WORK

71. Which of the following does ***not*** possess a smooth texture ?
(1) Sandpaper
(2) Photo print
(3) Polished Kotah stone
(4) Mica

72. Which one of the following is a complementary colour scheme ?
(1) Orange and blue
(2) Violet and yellow
(3) Orange and yellow
(4) Red and green

73. HUDCO is an organisation for
(1) Hills Area Development
(2) Housing Development
(3) Hotel Development
(4) Horticulture Development

74. Which of these is ***not*** a residential building ?
(1) Rashtrapati Bhavan
(2) House of Commons
(3) Buckingham Palace
(4) 10, Downing Street

75. The Parliament House, New Delhi is designed by
(1) Le-Corbusier
(2) Herbert Baker
(3) A.P. Kanvinde
(4) Louis Kahn

76. Arc de Triomphe is a famous monument found in the city of
(1) London (2) Rome
(3) Athens (4) Paris

77. Which of the following colours does ***not*** occur in a rainbow ?
(1) Red (2) Black
(3) Yellow (4) Green

78. The stair handrail should be
(1) Rough (2) Corrugated
(3) Abrasive (4) Smooth

79. Maximum insulation is offered by
(1) Metal
(2) Wool
(3) Timber
(4) Glass

80. Gold colour matches with
(1) Brass (2) Copper
(3) Aluminium (4) Titanium

81. On the top of Rashtrapati Bhawan, New Delhi, one will find a
(1) Shikhara form
(2) Stupa form
(3) Gopuram form
(4) Pagoda form

82. Eiffel Tower is built in
(1) Steel
(2) Concrete
(3) Bronze
(4) Brick and Mortar

83. Which learned text did ancient Indian architects use for their profession ?
(1) Upanishads (2) Vastushastra
(3) Kamsutra (4) Kalpsutra

84. Statue of Liberty is situated at
(1) America (2) Germany
(3) France (4) England

85. Madhya Pradesh Vidhan Sabha is designed by
(1) Le-Corbusier
(2) Uttam C. Jain
(3) Charles Correa
(4) Raj Rewal

86. Which of the following city has canals as transportation channels ?
(1) Paris (2) London
(3) Athens (4) Venice

87. Which secondary colour will you get when red and yellow colours are mixed together ?
(1) Green (2) Pink
(3) Orange (4) Purple

88. The marble used for the construction of Taj Mahal is
(1) French marble
(2) Makrana marble
(3) Venetian marble
(4) Italian marble

89. A red rose viewed through a green coloured glass, will appear
(1) Black (2) Blue
(3) Orange (4) Purple

90. Plaster of Paris is used for
(1) False ceiling
(2) Flooring
(3) Walls
(4) Structural frame

SPACE FOR ROUGH WORK