

**Entrance Examinations, June 2012**  
**M.Sc. (5-Year Integrated) Sciences**

Maximum Marks : 100

Time : 2 Hours

Hall Ticket No.

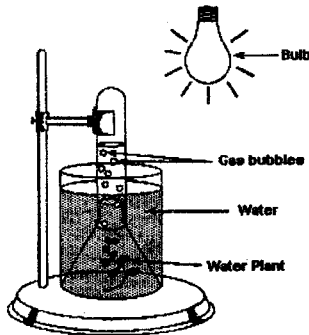
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**Instructions for students**

- I. Please enter your Hall Ticket Number on this page and on the OMR sheet without fail.
- II. Please read the following instructions carefully.
  1. There are 100 questions in this paper. Questions 1-25 are in Biology, 26-50 in Chemistry, 51-75 in Physics and 76-100 in Mathematics.
  2. Each question carries one mark. Each wrong answer will be awarded -0.33.
  3. Answers are to be marked on the OMR sheet following the instructions given there.
  4. Hand over both the question paper and the OMR sheet at the end of the examination.
  5. Non-programmable calculators are allowed. Log tables, programmable calculators and mobile phones are not allowed.
  6. Rough work can be done anywhere on the question paper but not on the OMR sheet.
  7. This book contains 18 pages including this page and pages for the rough work. Please check that your question paper has all the pages.

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1. ATP synthase is present in  
(A) chloroplast (B) mitochondria (C) *Escherichia coli* (D) all of the above
2. Which of the following can diffuse freely across the lipid bilayer of the plasma membrane?  
(A) Glucose (B) Sodium ion (C) DNA (D) Carbon dioxide
3. Lactose is composed of  
(A) fructose + galactose (B) glucose + glucose  
(C) glucose + fructose (D) glucose + galactose
4. Premature fall of leaves is due to the deficiency of  
(A) nitrogen (B) phosphorous (C) potassium (D) magnesium
5. In the setup shown below in the diagram, which color light will cause the plant to produce the *smallest* number of gas bubbles?

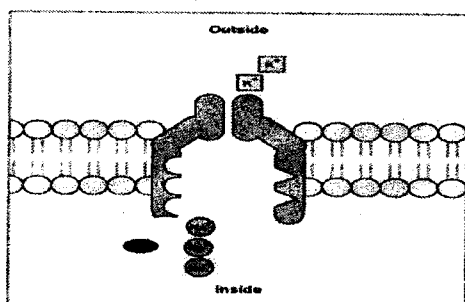


- (A) Red (B) Orange (C) Blue (D) Green
6. Which of the following events occurs soon after the beginning of diastole?  
(A) The aortic valve closes (B) The aortic valve opens  
(C) The atrial valve closes (D) The atrial valve opens
7. Gas exchange in the lungs takes place at the  
(A) trachea (B) bronchi (C) bronchioles (D) alveoli
8. A student accidentally places her hand on a hot pan and quickly pulls her hand away. The pan represents  
(A) a response (B) an impulse (C) a stimulus (D) an effector
9. Which one of the following statements is INCORRECT regarding the light-independent (dark) reactions of photosynthesis?  
(A) The energy source utilized is the ATP and NADPH obtained through the light reaction.  
(B) The reaction begins soon after sunset and ends before sunrise.  
(C) The five carbon sugar is constantly being regenerated.  
(D) The pathway used is usually a 3-carbon pathway, although a 4-carbon pathway does exist in some species.

10. Oxidative phosphorylation can be carried out in a test tube in the absence of intact cells, provided certain sub-cellular material is used. Assuming that the test tube contains all of the necessary substrates, what sub-cellular material would you expect to be the minimum requirement for the process to proceed?

- (A) Intact outer mitochondrial membranes (B) Intact thylakoid membranes  
(C) Vesicles composed of inner mitochondrial membrane (D) Golgi complex fractions

11. The following picture refers to a section of



- (A) cell membrane (B) organ system (C) synapse (D) cell wall

12. The order of development of male gametophyte in plants

- i) The developing pollen grains consume the products of middle layers and tapetum
- ii) Formation of two gametophytes from generative cell
- iii) Pollen grain is the first cell of a male gametophyte
- iv) Generation of bigger vegetative cell and a smaller generative cell
- v) Pollen grain is uninucleate with two layered cells

- (A) iii,v,i,iv,ii (B) iii,i,v,ii,iv (C) iii,i,ii,v,iv (D) iii,v,iv,i,ii

13. A biotic or an abiotic resource in the environment that causes population size to decrease is a

- (A) carrying capacity (B) limiting nutrient  
(C) limiting factor (D) growth factor

14. The compound leaves of *Mimosa pudica*, popularly known as “touch me not” fold inwards and droop and also close up when touched. Similar behavior is also observed with various other stimuli, such as warming, blowing, or shaking and re-opening within minutes. These types of movements have been termed as

- (A) Cell to cell and systemic movement (B) Nyctinastic movement  
(C) Seismonastic movements (D) Vander wall movement

15. Closure of stomata under severe drought stress is signaled by the:

- (A) exodus of  $K^+$  ions (B) production of abscisic acid  
(C) production of ethylene (D) loss of  $H^+$

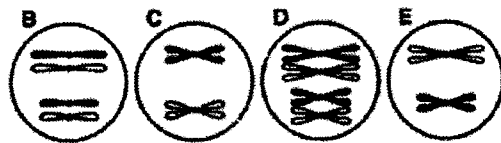
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16. A lack of or decrease in insulin hormone receptors on cells can result in:  
(A) Diabetes insipidus (B) Type I diabetes mellitus  
(C) Insulin-dependent diabetes mellitus (IDDM) (D) Type II diabetes mellitus

17. The blood type of the person who has both anti-A and anti-B antibodies in his blood is:  
(A) Type AB (B) Type A (C) Type B (D) Type O

18. Only 10 percent of the energy stored in an organism can be passed on to the next trophic level. Of the remaining energy, some is used for the organisms's life processes, and the rest is  
(A) used in reproduction (B) stored as body tissue  
(C) stored as fat (D) eliminated as heat

19. Which of the diagrams below depicts a cell at the beginning of mitosis?



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

20. Which one of the following is an essential amino acid?  
(A) Tyrosine (B) Isoleucine (C) Proline (D) Serine

21. The peptide bond has a "backbone" of atoms in which of the following sequence?  
(A) C-N-N-C (B) C-C-C-N (C) C-C-N-C (D) C-O-C-N

22. Choose the correct matches of fruits to their edible parts

- |               |                                |
|---------------|--------------------------------|
| 1. Apple      | A. Fleshy and juicy aril       |
| 2. Fig        | B. Fleshy thalamus             |
| 3. Pine-apple | C. Fleshy receptacle           |
| 4. Litchi     | D. Outer portion of receptacle |

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

23. Which of the following is not required for normal blood clot formation?  
(A) Vitamin K (B) Thrombin (C) Proteolysis (D) Plasmin

24. Choose the correct matches of useful recombinant proteins to their applications

- |                  |   |
|------------------|---|
| 1. Human insulin | A. Enhancement of action of immune system   |
| 2. Calcitonin    | B. Treatment of rickets                     |
| 3. Interferon    | C. Treatment of diabetes                    |
| 4. Interleukins  | D. Treatment of pathogenic viral infections |

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

25. Which of the following is not a stem modification?  
 (A) Tuber (B) Bulb (C) Rhizome (D) Pitcher
26. The number of unpaired electrons in ferrous iron is  
 (A) 5 (B) 2 (C) 3 (D) 4
27. The triad of the nuclei that is isotonic  
 (A)  ${}_6\text{C}^{14}$ ,  ${}_7\text{N}^{14}$ ,  ${}_9\text{F}^{19}$  (B)  ${}_6\text{C}^{14}$ ,  ${}_7\text{N}^{15}$ ,  ${}_9\text{F}^{17}$  (C)  ${}_6\text{C}^{14}$ ,  ${}_7\text{N}^{14}$ ,  ${}_9\text{F}^{17}$  (D)  ${}_6\text{C}^{12}$ ,  ${}_7\text{N}^{14}$ ,  ${}_9\text{F}^{19}$
28. The energy of light with a wavelength of  $65000\text{\AA}$   
 (A)  $9.04 \times 10^{-24}\text{J}$  (B)  $3.02 \times 10^{-20}\text{J}$  (C)  $3.06 \times 10^{-19}\text{J}$  (D)  $6.02 \times 10^{-20}\text{J}$
29. 1 mole of  $\text{CH}_4$  contains  
 (A)  $6.02 \times 10^{23}$  atoms of hydrogen (B) 4 gram atoms of hydrogen  
 (C) 3 g of carbon (D)  $1.81 \times 10^{23}$  molecules of  $\text{CH}_4$
30. The number of atoms contained in 44 g of  $\text{CO}_2$  is  
 (A)  $6.02 \times 10^{23}$  (B)  $6.02 \times 10^{24}$  (C)  $1.806 \times 10^{24}$  (D)  $18.06 \times 10^{22}$
31. The number of types of Bravais lattices are  
 (A) 7 (B) 10 (C) 17 (D) 14
32. How many  $\text{Na}^+$  ions are there around  $\text{Cl}^-$  in  $\text{NaCl}$  crystals?  
 (A) 3 (B) 4 (C) 6 (D) 8
33. In the ideal gas equation, the unit of R is  
 (A) mole atm/K (B) litre/mole (C) litre atm/K mole (D) erg/K
34. The equilibrium constant for a reaction  $\text{X} + 2\text{Y} \rightleftharpoons 2\text{Z}$  is '40'. The equilibrium constant for the reaction  $\text{Z} \rightleftharpoons \text{Y} + \frac{1}{2}\text{X}$  is  
 (A)  $1/(40)^{1/2}$  (B)  $1/40$  (C)  $(1/40)^{1/2}$  (D) 40
35. The dissociation constants of four acids are given below. Find the strongest acid  
 (A)  $2 \times 10^{-2}$  (B)  $0.003 \times 10^{-3}$  (C)  $3 \times 10^{-3}$  (D)  $2.0 \times 10^{-4}$
36. The half-life period of a first order reaction is 1.6 minutes. Time taken for 90% reaction is  
 (A) 0.8 min (B) 3.2 min (C) 5.3 min (D) 1.6 min
37. 6 grams of urea is dissolved in 9.9 moles of water. Find the vapour pressure of the resulting solution considering the vapour pressure of pure water to be  $P_0$   
 (A)  $0.99P_0$  (B)  $0.10P_0$  (C)  $1.10P_0$  (D)  $0.90P_0$
38. The standard reduction potential of Zn and Cu electrode are  $-0.76\text{V}$  and  $+0.34\text{V}$  respectively. The standard EMF of Daniel cell is  
 (A)  $1.10\text{V}$  (B)  $-0.42\text{V}$  (C)  $-1.10\text{V}$  (D)  $-0.76\text{V}$

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39. The hybridization of phosphorous in  $\text{PF}_3$  is  
(A)  $sp^3$  (B)  $sp^2$  (C)  $dsp^3$  (D)  $d^2sp^3$
40. The IUPAC name for the compound  $[\text{CuCl}_2(\text{CH}_3\text{NH}_2)_2]$  is  
(A) dichlorobis (dimethylamine) copper II (B) dichlorobis (methylamine) copper II  
(C) dimethylamine copper (II) chloride (D) bis (dimethylamine) copper (II) chloride
41. In transition elements, the incoming electron occupies (n-1)d subshell in preference to the  
(A) (n+1)s subshell (B) ns subshell (C) np subshell (D) (n-1)p subshell
42. Dry ice consists of  
(A)  $\text{H}_2\text{O}$  (B)  $\text{CO}_2$  (C)  $\text{SO}_2$  (D)  $\text{NH}_3$
43. In the borax bead test, the brown colour is due to  
(A)  $\text{Cr}^{3+}$  (B)  $\text{Co}^{2+}$  (C)  $\text{Mn}^{2+}$  (D)  $\text{Fe}^{2+}$
44. Which one of the following is a secondary alcohol?  
(A) 3-methyl-1-butanol (B) 2-methyl-1-butanol  
(C) 2,2-dimethyl-1-propanol (D) 3-methyl-2-butanol
45. A compound contains three elements carbon, hydrogen and nitrogen in the ratio 9:1:3.5. The empirical formula of the compound is  
(A)  $\text{C}_2\text{H}_4\text{N}$  (B)  $\text{C}_3\text{H}_4\text{N}$  (C)  $\text{C}_3\text{H}_6\text{N}$  (D)  $\text{C}_2\text{H}_6\text{N}$
46. Which of the following alkyl halides will undergo  $\text{S}_{\text{N}}1$  reaction most readily?  
(A)  $(\text{CH}_3)_3\text{C-Br}$  (B)  $(\text{CH}_3)_3\text{C-I}$  (C)  $(\text{CH}_3)_3\text{C-F}$  (D)  $(\text{CH}_3)_3\text{C-Cl}$
47. The compound (X) with molecular formula  $\text{C}_3\text{H}_8\text{O}$  on oxidation gives a compound (Y) of formula  $\text{C}_3\text{H}_6\text{O}_2$ . The compound X is  
(A) primary alcohol (B) secondary alcohol (C) aldehyde (D) tertiary alcohol
48. The element present in teflon is  
(A) fluorine (B) chlorine (C) nitrogen (D) oxygen
49. The order of ease of formation of Grignard reagent using alkyl halides  $\text{CH}_3\text{I}$ ,  $\text{C}_2\text{H}_5\text{I}$  and  $\text{C}_3\text{H}_7\text{I}$  is  
(A)  $\text{C}_2\text{H}_5\text{I} > \text{C}_3\text{H}_7\text{I} > \text{CH}_3\text{I}$  (B)  $\text{CH}_3\text{I} > \text{C}_2\text{H}_5\text{I} > \text{C}_3\text{H}_7\text{I}$   
(C)  $\text{C}_3\text{H}_7\text{I} > \text{C}_2\text{H}_5\text{I} > \text{CH}_3\text{I}$  (D)  $\text{C}_2\text{H}_5\text{I} > \text{CH}_3\text{I} > \text{C}_3\text{H}_7\text{I}$
50. The reduction of alkyl cyanides with sodium and alcohol is called  
(A) Rosenmund reduction (B) Clemmensen reduction  
(C) Mendius reduction (D) Sandmeyer reaction

51. Consider two charges with same magnitude  $q$  but with opposite signs separated by a distance  $d$ . The electric potential for  $d \rightarrow 0$  with  $qd$  finite, at a far off point P at a distance  $r$  from the midpoint of the charges
- (A) is zero. (B) scales as  $1/r$ .  
 (C) scales as  $1/r^2$ . (D) scales as  $1/r^3$ .
52. The superposition of two periodic oscillations with frequencies  $f_1$  and  $f_2$  is
- (A) always periodic.  
 (B) always aperiodic.  
 (C) periodic if  $(f_1/f_2)$  is a rational number.  
 (D) periodic if  $(f_1/f_2)$  is an irrational number.
53. If a heater coil rated 1kW, 220 V is connected in series with an electric bulb of 100 W, 220 V and are supplied 200V, power consumed by the bulb in this circuit is
- (A) 68.4 W (B) 45.8 W  
 (C) 10.6 W (D) 29.5 W
54. A particle of mass 10 mg and having a charge of  $50 \mu\text{C}$  is projected with a speed of 15 m/s into a uniform magnetic field of 125 mT. Assuming that the particle is projected with its velocity perpendicular to the magnetic field, the time after which the particle reaches its original position for the first time is
- (A) 14 s (B) 12 s  
 (C) 10 s (D) 8 s
55. A soap bubble of 2 cm diameter is formed on one end of a glass tube having closed stopcock at its centre. If a soap bubble of 4 cm diameter is formed at the other end and the stopcock opened then
- (A) each bubble becomes larger in diameter  
 (B) each bubble becomes smaller  
 (C) the 2 cm bubble will become larger while the 4 cm bubble becomes smaller  
 (D) the 2 cm bubble will become smaller while the 4 cm bubble becomes larger
56. If the frequency of sound waves produced by a siren increases from 400 Hz to 1200 Hz while the amplitude remains constant, then the ratio of intensity of 1200 Hz to the 400 Hz wave will be
- (A) 1:3 (B) 3:1  
 (C) 9:1 (D) 1:9

57. The production of a rainbow by the action of sunlight on raindrops is due to  
 (A) reflection only (B) refraction only  
 (C) reflection and diffraction (D) reflection and refraction
58. A convex lens with radii of curvature  $R_1=R_2$  is immersed in water. Assuming that the refractive indices of glass and water are  $3/2$  and  $4/3$  respectively, its focal length  $f_1$  in comparison to that in air,  $f$ , is  
 (A)  $f_1 = 4f$  (B)  $f_1 = 2f$   
 (C)  $f_1 = f/4$  (D)  $f_1 = f$
59. The length of a simple pendulum which takes 36 sec to complete 20 oscillations is (assume  $g=9.75 \text{ m/sec}^2$ )  
 (A) 60 cm (B) 70 cm  
 (C) 80 cm (D) 90 cm
60. Electric field intensity has dimensions  
 (A)  $MLT^{-1}$  (B)  $ML^{-1}T^{-1}$   
 (C)  $MLTI$  (D)  $MLT^{-3}I^{-1}$
61. Three point charges  $+2$ ,  $+2$ , and  $+5 \mu\text{C}$  are placed respectively at the vertices A, B, C of an equilateral triangle of side 0.2 m. The magnitude of the force experienced by the charge at C is (assume  $1/4\pi\epsilon_0=9 \times 10^9 \text{ Nm}^2/\text{C}^2$ )  
 (A) 2.25 N (B)  $2.25\sqrt{3}$  N  
 (C) 4.5 N (D)  $4.5\sqrt{3}$  N
62. In a Vernier callipers 1 cm of the main scale is divided into 20 equal parts. If 19 divisions of the main scale coincide with 20 divisions on the Vernier scale the least count of the instrument is  
 (A) 0.1 mm (B) 0.25 mm  
 (C) 0.025 mm (D) 1 mm
63. A stone is projected upwards with a velocity 60 m/sec. The maximum height the stone reaches is (assuming  $g= 10\text{m/sec}^2$ )  
 (A) 600 m (B) 360 m  
 (C) 180 m (D) 90 m
64. A gas occupies a volume of  $800 \text{ cm}^3$  at a pressure of 76 cm of mercury. If the pressure is increased to 80 cm of mercury at the same temperature, the volume of the gas would now be



- (A)  $760 \text{ cm}^3$  (B)  $76 \text{ cm}^3$   
 (C)  $800 \text{ cm}^3$  (D)  $80 \text{ cm}^3$
65. A uniform metre rod of weight 100 N carries weights of 40 N and 60 N suspended from 20 cm and 90 cm marks respectively. To balance the metre scale one would have to provide a knife edge at the  
 (A) 50 cm mark (B) 52 cm mark  
 (C) 54 cm mark (D) 56 cm mark
66. A boy standing between two cliffs claps and hears two echoes after 1 sec and 1.5 sec respectively. If the velocity of sound is 360 m/sec, the distance between the two cliffs is  
 (A) 180 m (B) 270 m  
 (C) 90 m (D) 450 m
67. If a bus of 3000 kg travelling with a velocity of 72 km/hr is brought to rest by applying brakes over a distance of 30 m, the breaking force is  
 (A) 500 N (B) 1000 N  
 (C) 15000 N (D) 20000 N
68. A vessel contains oil (density  $0.8 \text{ g/cm}^3$ ) over mercury (density  $13.6 \text{ g/cm}^3$ ). A sphere of homogeneous composition floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in  $\text{g/cm}^3$  is  
 (A) 3.3 (B) 6.4  
 (C) 7.2 (D) 12.8
69. Young's modulus for aluminium is  $7 \times 10^{10} \text{ Pa}$ . The force needed to stretch an aluminium wire of diameter 2 mm and length 800 mm by 1 mm is  
 (A) 2.75 N (B) 275 N  
 (C) 1.10 N (D) 275 kN
70. A man standing on the road has to hold his umbrella at  $30^\circ$  with the vertical to keep the rain away. He throws away the umbrella and starts running at 10 km/h and finds raindrops hitting his head vertically. The speed of the raindrops with respect to the road is  
 (A) 20 km/h (B) 10 km/h  
 (C)  $10\sqrt{3} \text{ km/h}$  (D)  $10/\sqrt{3} \text{ km/h}$

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71. Two boys, one 52 inches tall and the other 55 inches tall, are standing at distances 4 m and 5 m respectively from an observer at ground level. To the observer
- (A) the first boy appears taller
  - (B) the second boy appears taller
  - (C) both appear to be of the same height
  - (D) both will appear to be of the same height if the second boy were to move forward by 1m.
72. 70 cal of heat is required to raise the temperature of 2 mole of an ideal gas at constant pressure from 30°C to 35°C. The amount of heat required to raise the temperature of the gas through the same range at constant volume will be (assume  $R = 2 \text{ cal/mol-K}$ ).
- (A) 30 cal
  - (B) 50 cal
  - (C) 70 cal
  - (D) 90 cal
73. For normal operation of a common-emitter amplifier
- (A) the base-emitter junction is reverse biased and the base-collector junction is forward biased
  - (B) the base-emitter junction is forward biased and the base-collector junction is reverse biased
  - (C) both the junctions are forward biased
  - (D) both the junctions are reverse biased
74. As compared to  $^{12}\text{C}$  atom,  $^{14}\text{C}$  atom has
- (A) two extra protons and two extra electrons
  - (B) two extra protons and no extra electron
  - (C) two extra neutrons and no extra electron
  - (D) two extra neutrons and two extra electrons
75. The half life of a radioactive nuclide is 20 hrs. The fraction of the original activity that will remain after 40 hrs is
- (A) 1/8
  - (B) 1/2
  - (C) 1/4
  - (D) 1/6

76. Let  $f : X \rightarrow Y$  be a function,  $A, B \subseteq X$  and  $C, D \subseteq Y$ . Pick-up the FALSE statement from the following:

- (A)  $f(A) \cup f(B) \subseteq f(A \cup B)$
- (B)  $f(A) \cap f(B) \subseteq f(A \cap B)$
- (C)  $f^{-1}(C) \cup f^{-1}(D) \subseteq f^{-1}(C \cup D)$
- (D)  $f^{-1}(C) \cap f^{-1}(D) \subseteq f^{-1}(C \cap D)$

77. Let  $f : (1, \infty) \rightarrow \mathbb{R}$  and  $f(x) = \log \left[ \sin \left( \frac{\pi x}{1+x} \right) \right]$ . The range of  $f$  is  
 (A)  $(1, \infty)$       (B)  $(-1, \infty)$       (C)  $(-\infty, 1)$       (D)  $(-\infty, 0)$

78. If  $a, b, c \in \mathbb{R}$ ,  $a + b + c = 0$  then the roots of  $\begin{vmatrix} a-x & c & b \\ c & b-x & a \\ b & a & c-x \end{vmatrix} = 0$  are  
 (A)  $0, \pm\sqrt{a^2 + b^2 + c^2}$       (B)  $0, \pm\sqrt{\frac{3}{2}(a^2 + b^2 + c^2)}$   
 (C)  $0, \pm 3\sqrt{a^2 + b^2 + c^2}$       (D)  $0, \pm\frac{3}{2}\sqrt{a^2 + b^2 + c^2}$

79. The maximum area of right angled triangle whose hypotenuse is 60cm is  
 (A) 450 sq.cm      (B) 900 sq.cm      (C) 1800 sq.cm      (D) 3600 sq.cm

80. If  $\omega \neq 1$  is a cube root of unity then  $\begin{vmatrix} \omega + \omega^2 & \omega^2 + \omega^9 & \omega^9 + \omega \\ \omega^{27} + \omega^{31} & \omega^{31} + \omega^{17} & \omega^{17} + \omega^{27} \\ \omega^{30} + \omega^{41} & \omega^{41} + \omega^{19} & \omega^{19} + \omega^{30} \end{vmatrix}$  is equal to  
 (A) 0      (B) 1      (C) 2      (D) 3

81.  $\lim_{x \rightarrow 0} x^2 \sin \left( \frac{1}{x^2} \right) =$   
 (A)  $\infty$       (B) 1      (C) 0      (D)  $-\infty$

82. Consider two statements:  $S_1 : 99^{100} > 100^{99}$ ,  $S_2 : (1.01)^{10000} > 5000$   
 (A)  $S_1$  is true but  $S_2$  is false      (B)  $S_1$  is false but  $S_2$  is true  
 (C)  $S_1$  is true and  $S_2$  is true      (D)  $S_1$  is false and  $S_2$  is false

83. Let  $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ , where  $a, b, c, d \in \mathbb{R}$ . If  $A^2 = 0$  then  
 (A)  $a^2 + b^2 = c^2$       (B)  $b^2 + c^2 = 0$   
 (C)  $a^2 = d^2$       (D)  $(A - I)^2 = 0$

84.  $\sin(\sin x) \leq \sin x$  when  $x$  belongs to

- (A)  $[0, \pi]$       (B)  $[\pi, 2\pi]$       (C)  $[-\pi, 0]$       (D)  $\left[\frac{-\pi}{2}, \frac{\pi}{2}\right]$

85. Let  $f$  be a differentiable function. If  $g(x, y) = xf\left(\frac{x}{y}\right)$  then  $x\frac{\partial g}{\partial x} + y\frac{\partial g}{\partial y}$  is

- (A) 0      (B)  $f\left(\frac{x}{y}\right)$       (C)  $g(x, y)$       (D)  $2g(x, y)$

86. Which of the following regions is bounded in the complex plane

- (A)  $\{z : |z - 1| < |z|\}$       (B)  $\{z : 1 + |z - 2| < |z + 2|\}$   
 (C)  $\{z : |z - 3| < 2|z + 3|\}$       (D)  $\{z : |z + 3| + |z - 3| < 20\}$

87. If  $n \in \mathbb{N}$ , then  $\cos \frac{2\pi}{n} + \cos \frac{4\pi}{n} + \dots + \cos \left(\frac{2(n-1)\pi}{n}\right) =$

- (A)  $2^{n/2}$       (B) 0      (C) 1      (D) -1

88.  $\int_{-2}^2 |x \sin(\pi x)| dx =$

- (A)  $\frac{8}{\pi}$       (B)  $\frac{4}{\pi}$       (C)  $\frac{2}{\pi}$       (D)  $\frac{1}{\pi}$

89. The largest subset of  $\mathbb{R}$  in which  $\csc^{-1}(x) + \cot^{-1}(x) = \frac{\pi}{2}$  is

- (A) the empty set      (B) a finite set.  
 (C)  $(-\infty, -1) \cup (1, \infty)$       (D)  $\mathbb{R}$

90. The number of solutions of the equation  $\frac{1 + \sin x}{\cos x} + \frac{\cos x}{1 + \sin x} = 2$  in the open interval

$\left(0, \frac{\pi}{2}\right)$  is

- (A) 0      (B) 1      (C) 2      (D) 3

91. The locus of the midpoints of straight lines which pass through a fixed point  $(x_0, y_0)$ ,  $x_0^2 + y_0^2 \neq 0$  intercepted between the axes is

- (A)  $\frac{x_0}{2x} + \frac{y_0}{2y} = 1$       (B)  $\frac{x}{2x_0} + \frac{y}{2y_0} = 1$   
 (C)  $\frac{2x_0}{x} + \frac{2y_0}{y} = 1$       (D)  $\frac{2x}{x_0} + \frac{2y}{y_0} = 1$

92. If  $12x^2 + 7xy + ky^2 + 13x - y + 3 = 0$  represents a pair of straight lines for some  $k$ . Then the angle between them is

- (A)  $\tan^{-1}\left(\frac{23}{2}\right)$  (B)  $\tan^{-1}\left(\sqrt{\frac{23}{2}}\right)$   
 (C)  $\tan^{-1}\left(\frac{23}{22}\right)$  (D)  $\tan^{-1}\left(\frac{\sqrt{43}}{2}\right)$

93. The eccentricity of the conic given by  $9x^2 + 25y^2 - 18x - 100y = 116$  is

- (A)  $\frac{2}{5}$  (B)  $\frac{4}{5}$  (C)  $\frac{\sqrt{34}}{25}$  (D)  $\frac{\sqrt{34}}{5}$

94. If  $y = mx + 1$  is a tangent to the parabola  $y^2 = 4x$  then the point of contact is

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

95. Consider two circles  $C_1 : x^2 + y^2 - 2x = 0$ ,  $C_2 : x^2 + y^2 - 6x + 8 = 0$ . The equation of circle whose diameter is a line segment joining centers of  $C_1, C_2$  is

- (A)  $x^2 + y^2 - 4x - 3 = 0$  (B)  $x^2 + y^2 - 4x + 3 = 0$   
 (C)  $x^2 + y^2 + 4x - 3 = 0$  (D)  $x^2 + y^2 + 4x + 3 = 0$

96. Let  $a$  be the position vector of a point on the ellipse  $\frac{x^2}{9} + \frac{y^2}{25} = 1$ . Let  $b$  be a unit vector. The maximum value that  $a \cdot b$  can take is

- (A) 3 (B) 4 (C) 5 (D) 8

97. Let  $a = i + j + k$ . Let  $b$  be the position vector of a point which lies on the unit sphere. The number of such  $b$ 's that satisfy  $|a \cdot b| = |a \times b|$  is

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

98. A committee of three people is selected from a group of six people  $p_1, p_2, \dots, p_6$ . The probability that  $p_1, p_2$  are selected given that  $p_5, p_6$  are not selected is

- (A)  $\frac{1}{10}$  (B)  $\frac{1}{5}$  (C)  $\frac{1}{3}$  (D)  $\frac{1}{2}$

99. In a box there are 4 black, 6 gray, 2 white balls. Two balls are drawn at random from the box. The probability that both the balls drawn will be of the same colour is

- (A)  $\frac{1}{3}$  (B)  $\frac{2}{3}$  (C)  $\frac{7}{11}$  (D)  $\frac{2}{11}$

100. In a bag there are 2 identical blue balls, 1 red ball and 4 white balls of different sizes. The total number of possible arrangements of these 7 balls in a row such that 2 white balls are at the two extreme positions is

- (A) 180 (B) 360 (C) 720 (D) 1440