

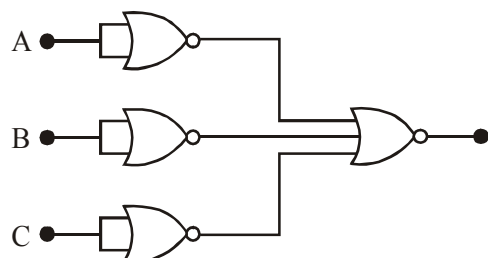
# FINAL JEE–MAIN EXAMINATION – SEPTEMBER, 2020

(Held On Friday 04<sup>th</sup> SEPTEMBER, 2020) TIME : 3 PM to 6 PM

## PHYSICS

## TEST PAPER WITH ANSWER & SOLUTION

1. Identify the operation performed by the circuit given below :



- (1) AND (2) NAND  
(3) OR (4) NOT

2. Consider two uniform discs of the same thickness and different radii  $R_1 = R$  and  $R_2 = \alpha R$  made of the same material. If the ratio of their moments of inertia  $I_1$  and  $I_2$ , respectively, about their axes is  $I_1 : I_2 = 1 : 16$  then the value of  $\alpha$  is :

- (1)  $\sqrt{2}$  (2) 2 (3) 4 (4)  $2\sqrt{2}$

3. A capacitor C is fully charged with voltage  $V_0$ . After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance  $\frac{C}{2}$ . The energy loss in the process after the charge is distributed between the two capacitors is :

- (1)  $\frac{1}{6}CV_0^2$  (2)  $\frac{1}{2}CV_0^2$   
(3)  $\frac{1}{3}CV_0^2$  (4)  $\frac{1}{4}CV_0^2$

4. A person pushes a box on a rough horizontal platform surface. He applies a force of 200 N over a distance of 15 m. Thereafter, he gets progressively tired and his applied force reduces linearly with distance of 100 N. The total distance through which the box has been moved is 30 m. What is the work done by the person during the total movement of the box ?

- (1) 5690 J (2) 5250 J  
(3) 3280 J (4) 2780 J

5. The electric field of a plane electromagnetic wave is given by

$$\vec{E} = E_0(\hat{x} + \hat{y})\sin(kz - \omega t)$$

Its magnetic field will be given by :

- (1)  $\frac{E_0}{c}(\hat{x} - \hat{y})\cos(kz - \omega t)$   
(2)  $\frac{E_0}{c}(-\hat{x} + \hat{y})\sin(kz - \omega t)$   
(3)  $\frac{E_0}{c}(\hat{x} - \hat{y})\sin(kz - \omega t)$   
(4)  $\frac{E_0}{c}(\hat{x} + \hat{y})\sin(kz - \omega t)$

6. Find the binding energy per nucleon for  $^{120}_{50}\text{Sn}$ .

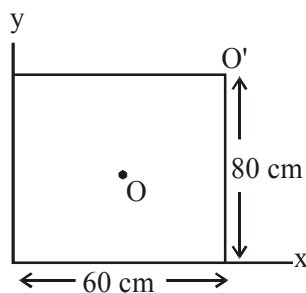
Mass of proton  $m_p = 1.00783$  U, mass of neutron  $m_n = 1.00867$  U and mass of tin nucleus  $m_{\text{Sn}} = 119.902199$  U. (take  $1\text{U} = 931$  MeV)

- (1) 8.5 MeV (2) 7.5 MeV  
(3) 8.0 MeV (4) 9.0 MeV

7. A small ball of mass is thrown upward with velocity  $u$  from the ground. The ball experiences a resistive force  $mkv^2$  where  $v$  is its speed. The maximum height attained by the ball is :

- (1)  $\frac{1}{2k}\tan^{-1}\frac{ku^2}{g}$  (2)  $\frac{1}{2k}\ln\left(1 + \frac{ku^2}{g}\right)$   
(3)  $\frac{1}{k}\tan^{-1}\frac{ku^2}{2g}$  (4)  $\frac{1}{k}\ln\left(1 + \frac{ku^2}{2g}\right)$

8.



For a uniform rectangular sheet shown in the figure, the ratio of moments of inertia about the axes perpendicular to the sheet and passing through O (the centre of mass) and O' (corner point) is :

- (1)  $1/2$       (2)  $2/3$       (3)  $1/8$       (4)  $1/4$

9. Match the thermodynamic processes taking place in a system with the correct conditions. In the table :  $\Delta Q$  is the heat supplied,  $\Delta W$  is the work done and  $\Delta U$  is change in internal energy of the system :

Process	Condition
(I) Adiabatic	(A) $\Delta W = 0$
(II) Isothermal	(B) $\Delta Q = 0$
(III) Isochoric	(C) $\Delta U \neq 0, \Delta W \neq 0, \Delta Q \neq 0$
(IV) Isobaric	(D) $\Delta U = 0$
(1) I-B, II-D, III-A, IV-C	
(2) I-B, II-A, III-D, IV-C	
(3) I-A, II-A, III-B, IV-C	
(4) I-A, II-B, III-D, IV-D	

10. A paramagnetic sample shows a net magnetisation of 6 A/m when it is placed in an external magnetic field of 0.4 T at a temperature of 4 K. When the sample is placed in an external magnetic field of 0.3 T at a temperature of 24 K, then the magnetisation will be :
- (1) 4 A/m      (2) 0.75 A/m  
(3) 2.25 A/m      (4) 1 A/m

11. A series L-R circuit is connected to a battery of emf  $V$ . If the circuit is switched on at  $t = 0$ , then the time at which the energy stored in the inductor reaches  $\left(\frac{1}{n}\right)$  times of its maximum value, is :

(1)  $\frac{L}{R} \ln \left( \frac{\sqrt{n}-1}{\sqrt{n}} \right)$       (2)  $\frac{L}{R} \ln \left( \frac{\sqrt{n}}{\sqrt{n}+1} \right)$   
 (3)  $\frac{L}{R} \ln \left( \frac{\sqrt{n}}{\sqrt{n}-1} \right)$       (4)  $\frac{L}{R} \ln \left( \frac{\sqrt{n}+1}{\sqrt{n}-1} \right)$

12. The driver of a bus approaching a big wall notices that the frequency of his bus's horn changes from 420 Hz to 490 Hz, when he hears it after it gets reflected from the wall. Find the speed of the bus if speed of the sound is  $330 \text{ ms}^{-1}$ .

(1)  $91 \text{ kmh}^{-1}$       (2)  $71 \text{ kmh}^{-1}$   
 (3)  $81 \text{ kmh}^{-1}$       (4)  $61 \text{ kmh}^{-1}$

13. Two identical cylindrical vessels are kept on the ground and each contain the same liquid of density  $d$ . The area of the base of both vessels is  $S$  but the height of liquid in one vessel is  $x_1$  and in the other,  $x_2$ . When both cylinders are connected through a pipe of negligible volume very close to the bottom, the liquid flows from one vessel to the other until it comes to equilibrium at a new height. The change in energy of the system in the process is :

(1)  $gdS (x_2 + x_1)^2$       (2)  $\frac{3}{4}gdS(x_2 - x_1)^2$   
 (3)  $\frac{1}{4}gdS(x_2 - x_1)^2$       (4)  $gdS(x_2^2 + x_1^2)$

14. A circular coil has moment of inertia  $0.8 \text{ kg m}^2$  around any diameter and is carrying current to produce a magnetic moment of  $20 \text{ Am}^2$ . The coil is kept initially in a vertical position and it can rotate freely around a horizontal diameter. When a uniform magnetic field of  $4 \text{ T}$  is applied along the vertical, it starts rotating around its horizontal diameter. The angular speed the coil acquires after rotating by  $60^\circ$  will be :

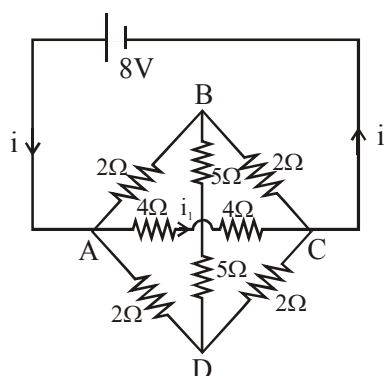
(1)  $10 \text{ rad s}^{-1}$                       (2)  $20 \pi \text{ rad s}^{-1}$   
(3)  $10 \pi \text{ rad s}^{-1}$                       (4)  $20 \text{ rad s}^{-1}$

15. A particle of charge  $q$  and mass  $m$  is subjected to an electric field  $E = E_0 (1 - ax^2)$  in the  $x$ -direction, where  $a$  and  $E_0$  are constants. Initially the particle was at rest at  $x = 0$ . Other than the initial position the kinetic energy of the particle becomes zero when the distance of the particle from the origin is :

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

16. A cube of metal is subjected to a hydrostatic pressure of  $4 \text{ GPa}$ . The percentage change in the length of the side of the cube is close to : (Given bulk modulus of metal,  $B = 8 \times 10^{10} \text{ Pa}$ )
- (1) 0.6      (2) 1.67      (3) 5      (4) 20

17. The value of current  $i_1$  flowing from A to C in the circuit diagram is :



- (1) 5A      (2) 2A      (3) 4A      (4) 1A

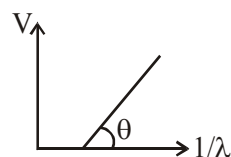
18. A body is moving in a low circular orbit about a planet of mass  $M$  and radius  $R$ . The radius of the orbit can be taken to be  $R$  itself. Then the ratio of the speed of this body in the orbit to the escape velocity from the planet is :

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

19. A quantity  $x$  is given by  $(IFv^2/WL^4)$  in terms of moment of inertia  $I$ , force  $F$ , velocity  $v$ , work  $W$  and Length  $L$ . The dimensional formula for  $x$  is same as that of :

- (1) Planck's constant  
(2) Force constant  
(3) Energy density  
(4) Coefficient of viscosity

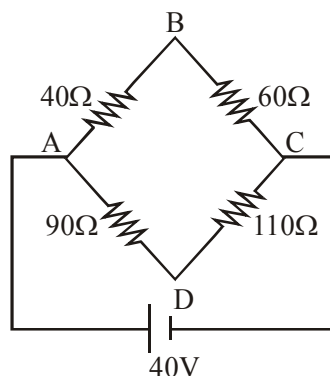
20. In a photoelectric effect experiment, the graph of stopping potential  $V$  versus reciprocal of wavelength obtained is shown in the figure. As the intensity of incident radiation is increased :



- (1) Slope of the straight line get more steep  
(2) Straight line shifts to left  
(3) Graph does not change  
(4) Straight line shifts to right

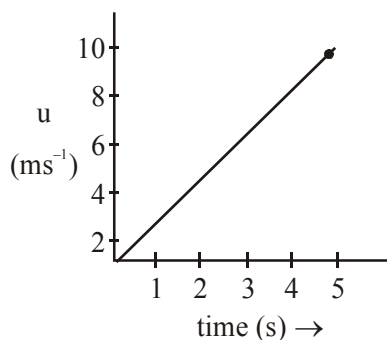
21. Orange light of wavelength  $6000 \times 10^{-10}$  m illuminates a single slit of width  $0.6 \times 10^{-4}$  m. The maximum possible number of diffraction minima produced on both sides of the central maximum is \_\_\_\_\_.

23.



Four resistances  $40\Omega$ ,  $60\Omega$ ,  $90\Omega$  and  $110\Omega$  make the arms of a quadrilateral ABCD. Across AC is a battery of emf 40V and internal resistance negligible. The potential difference across BD is V is \_\_\_\_\_.

22. The speed versus time graph for a particle is shown in the figure. The distance travelled (in m) by the particle during the time interval  $t = 0$  to  $t = 5$  s will be \_\_\_\_\_ :



24. The distance between an object and a screen is 100 cm. A lens can produce real image of the object on the screen for two different positions between the screen and the object. The distance between these two positions is 40 cm. If the power of the lens is close to  $\left(\frac{N}{100}\right)D$  where N is an integer, the value of N is \_\_\_\_\_.
25. The change in the magnitude of the volume of an ideal gas when a small additional pressure  $\Delta P$  is applied at a constant temperature, is the same as the change when the temperature is reduced by a small quantity  $\Delta T$  at constant pressure. The initial temperature and pressure of the gas were 300 K and 2 atm respectively. If  $|\Delta T| = C|\Delta P|$  then value of C in (K/atm) is \_\_\_\_\_:



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CHEMISTRY	TEST PAPER WITH ANSWER & SOLUTION
<p>1. If the equilibrium constant for <math>A \rightleftharpoons B+C</math> is <math>K_{eq}^{(1)}</math> and that of <math>B+C \rightleftharpoons P</math> is <math>K_{eq}^{(2)}</math>, the equilibrium constant for <math>A \rightleftharpoons P</math> is :-</p> <p>(1) <math>K_{eq}^{(2)} - K_{eq}^{(1)}</math>                      (2) <math>K_{eq}^{(1)}K_{eq}^{(2)}</math></p> <p>(3) <math>K_{eq}^{(1)} / K_{eq}^{(2)}</math>                      (4) <math>K_{eq}^{(1)} + K_{eq}^{(2)}</math></p>	<p>4. The crystal Field stabilization Energy (CFSE) of <math>[CoF_3(H_2O)_3](\Delta_0 &lt; P)</math> is :-</p> <p>(1) <math>-0.8 \Delta_0</math>                      (2) <math>-0.4 \Delta_0 + P</math></p> <p>(3) <math>-0.8 \Delta_0 + 2P</math>                      (4) <math>-0.4 \Delta_0</math></p>
<p>2. Five moles of an ideal gas at 1 bar and 298 K is expanded into vacuum to double the volume. The work done is :-</p> <p>(1) <math>C_v(T_2 - T_1)</math>                      (2) <math>-RT \ln V_2/V_1</math></p> <p>(3) <math>-RT(V_2 - V_1)</math>                      (4) zero</p>	<p>5. The mechanism of action of "Terfenadine" (Seldane) is :-</p> <p>(1) Activates the histamine receptor</p> <p>(2) Inhibits the secretion of histamine</p> <p>(3) Inhibits the action of histamine receptor</p> <p>(4) Helps in the secretion of histamine</p>
<p>3. The process that is NOT endothermic in nature is :-</p> <p>(1) <math>Ar_{(g)} + e^- \rightarrow Ar_{(g)}^-</math>                      (2) <math>H_{(g)} + e^- \rightarrow H_{(g)}^-</math></p> <p>(3) <math>Na_{(g)} \rightarrow Na_{(g)}^+ + e^-</math>                      (4) <math>O_{(g)}^- + e^- \rightarrow O_{(g)}^{2-}</math></p>	<p>6. An alkaline earth metal 'M' readily forms water soluble sulphate and water insoluble hydroxide. Its oxide MO is very stable to heat and does not have rock-salt structure. M is :-</p> <p>(1) Ca                      (2) Be                      (3) Mg                      (4) Sr</p>

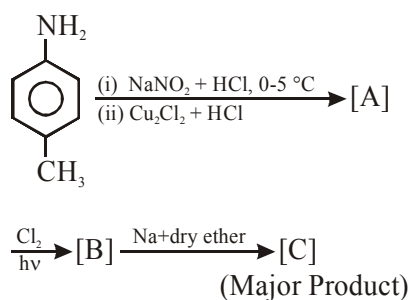
7. The reaction in which the hybridisation of the underlined atom is affected is :-

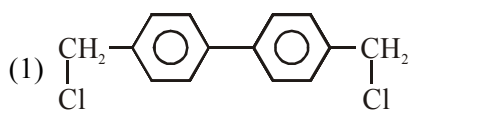
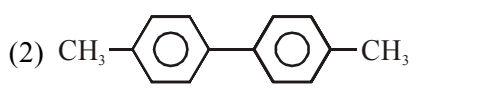
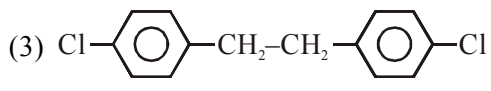
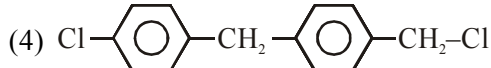
- (1)  $\underline{\text{N}}\text{H}_3 \xrightarrow{\text{H}^+}$
- (2)  $\underline{\text{Xe}}\text{F}_4 + \text{SbF}_5 \rightarrow$
- (3)  $\text{H}_2\underline{\text{S}}\text{O}_4 + \text{NaCl} \xrightarrow{420 \text{ K}}$
- (4)  $\text{H}_3\underline{\text{P}}\text{O}_2 \xrightarrow{\text{Disproportionation}}$

8. The one that can exhibit highest paramagnetic behaviour among the following is :-  
gly = glycinate; bpy = 2, 2'-bipyridine

- (1)  $[\text{Pd}(\text{gly})_2]$
- (2)  $[\text{Ti}(\text{NH}_3)_6]^{3+}$
- (3)  $[\text{Co}(\text{OX})_2(\text{OH})_2]^- (\Delta_0 > P)$
- (4)  $[\text{Fe}(\text{en})(\text{bpy})(\text{NH}_3)_2]^{2+}$

9. In the following reaction sequence, [C] is :-



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

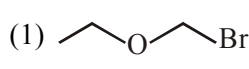
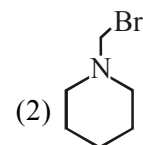
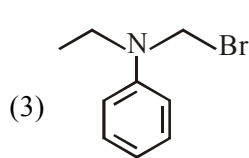
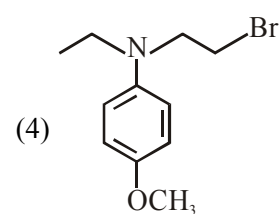
10. A sample of red ink (a colloidal suspension) is prepared by mixing eosin dye, egg white, HCHO and water. The component which ensures stability of the ink sample is :-

- (1) HCHO
- (2) Eosin dye
- (3) Egg white
- (4) Water

11. The processes of calcination and roasting in metallurgical industries, respectively, can lead to :-

- (1) Global warming and acid rain
- (2) Photochemical smog and ozone layer depletion
- (3) Global warming and photochemical smog
- (4) Photochemical smog and global warming

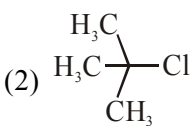
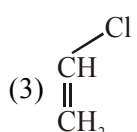
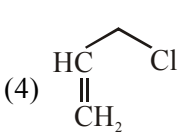
12. Which of the following compounds will form the precipitate with aq.  $\text{AgNO}_3$  solution most readily ?

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

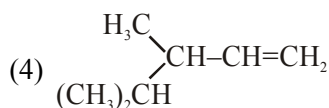
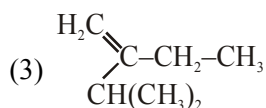
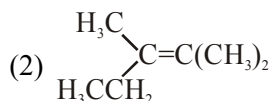
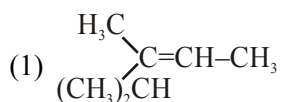
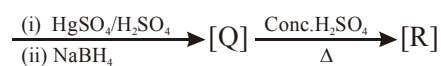
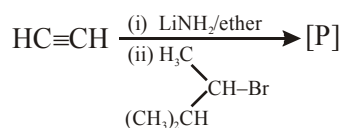
13. The molecule in which hybrid MOs involve only one d-orbital of the central atom is :-

- (1)  $[\text{Ni}(\text{CN})_4]^{2-}$                       (2)  $[\text{CrF}_6]^{3-}$   
 (3)  $\text{BrF}_5$                                 (4)  $\text{XeF}_4$

14. Among the following compounds, which one has the shortest C—Cl bond ?

- (1)  $\text{H}_3\text{C}-\text{Cl}$                       (2)   
 (3)                       (4) 

15. The major product [R] in the following sequence of reactions is :-



16. The incorrect statement(s) among (a) - (c) is (are) :-

- (a) W(VI) is more stable than Cr(VI).  
 (b) in the presence of HCl, permanganate titrations provide satisfactory results.  
 (c) some lanthanoid oxides can be used as phosphors.

- (1) (a) and (b) only      (2) (a) only  
 (3) (b) and (c) only      (4) (b) only

17. 250 mL of a waste solution obtained from the workshop of a goldsmith contains 0.1 M AgNO<sub>3</sub> and 0.1 M AuCl. The solution was electrolyzed at 2 V by passing a current of 1 A for 15 minutes. The metal/metals electrodeposited will be :-

$$\left( E_{\text{Ag}^+/\text{Ag}}^0 = 0.80\text{V}, E_{\text{Au}^+/\text{Au}}^0 = 1.69\text{V} \right)$$

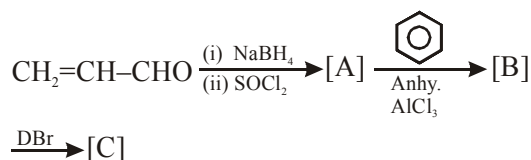
- (1) only silver  
 (2) only gold  
 (3) silver and gold in equal mass proportion  
 (4) silver and gold in proportion to their atomic weights

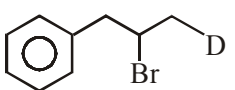
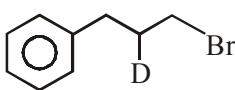
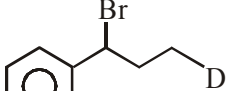
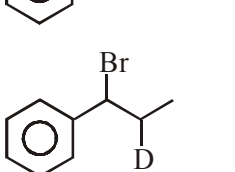
18. The major product [B] in the following reactions is :-



- (1)  $\text{CH}_3-\text{CH}_2-\overset{\text{CH}_3}{\underset{|}{\text{C}}}=\text{CH}_2$   
 (2)  $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}_3$   
 (3)  $\text{CH}_2=\text{CH}_2$   
 (4)  $\text{CH}_3-\text{CH}=\overset{\text{CH}_3}{\underset{|}{\text{C}}}-\text{CH}_3$

19. The major product [C] of the following reaction sequence will be :-



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

20. The shortest wavelength of H atom is the Lyman series is  $\lambda_1$ . The longest wavelength in the Balmer series of  $\text{He}^+$  is :-

(1)  $\frac{5\lambda_1}{9}$

(2)  $\frac{27\lambda_1}{5}$

(3)  $\frac{9\lambda_1}{5}$

(4)  $\frac{36\lambda_1}{5}$

21. A 100 mL solution was made by adding 1.43 g of  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ . The normality of the solution is 0.1 N. The value of x is \_\_\_\_\_.

(The atomic mass of Na is 23g/mol) :-

22. The osmotic pressure of a solution of NaCl is 0.10 atm and that of a glucose solution is 0.20 atm. The osmotic pressure of a solution formed by mixing 1 L of the sodium chloride solution with 2 L of the glucose solution is  $x \times 10^{-3}$  atm.  $x$  is \_\_\_\_\_. (nearest integer) :-
23. The number of chiral centres present in threonine is \_\_\_\_\_.
24. Consider the following equations :
- $$2 \text{Fe}^{2+} + \text{H}_2\text{O}_2 \rightarrow x \text{A} + y \text{B}$$
- (in basic medium)
- $$2\text{MnO}_4^- + 6\text{H}^+ + 5\text{H}_2\text{O}_2 \rightarrow x' \text{C} + y' \text{D} + z' \text{E}$$
- (in acidic medium)
- The sum of the stoichiometric coefficients  $x$ ,  $y$ ,  $x'$ ,  $y'$  and  $z'$  for products A, B, C, D and E, respectively, is \_\_\_\_\_.

25. The number of molecules with energy greater than the threshold energy for a reaction increases five fold by a rise of temperature from 27 °C to 42 °C. Its energy of activation in J/mol is \_\_\_\_\_. (Take  $\ln 5 = 1.6094$ ;  $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$ )

**FINAL JEE–MAIN EXAMINATION – SEPTEMBER, 2020**

**(Held On Friday 04<sup>th</sup> SEPTEMBER, 2020) TIME : 3 PM to 6 PM**

**MATHEMATICS**

**TEST PAPER WITH SOLUTION**

1. The function  $f(x) = \begin{cases} \frac{\pi}{4} + \tan^{-1} x, & |x| \leq 1 \\ \frac{1}{2}(|x| - 1), & |x| > 1 \end{cases}$  is :

- (1) continuous on  $\mathbb{R} - \{1\}$  and differentiable on  $\mathbb{R} - \{-1, 1\}$ .
- (2) both continuous and differentiable on  $\mathbb{R} - \{-1\}$ .
- (3) continuous on  $\mathbb{R} - \{-1\}$  and differentiable on  $\mathbb{R} - \{-1, 1\}$ .
- (4) both continuous and differentiable on  $\mathbb{R} - \{1\}$

2. Let  $\bigcup_{i=1}^{50} X_i = \bigcup_{i=1}^n Y_i = T$ , where each  $X_i$  contains 10 elements and each  $Y_i$  contains 5 elements. If each element of the set  $T$  is an element of exactly 20 of sets  $X_i$ 's and exactly 6 of sets  $Y_i$ 's, then  $n$  is equal to :

- (1) 45
- (2) 15
- (3) 50
- (4) 30

3. Let  $\lambda \neq 0$  be in  $\mathbb{R}$ . If  $\alpha$  and  $\beta$  are the roots of the equation,  $x^2 - x + 2\lambda = 0$  and  $\alpha$  and  $\gamma$  are the roots of the equation,  $3x^2 - 10x + 27\lambda = 0$ ,

then  $\frac{\beta\gamma}{\lambda}$  is equal to :

- (1) 36
- (2) 27
- (3) 9
- (4) 18



4. The solution of the differential equation

$$\frac{dy}{dx} - \frac{y+3x}{\log_e(y+3x)} + 3 = 0 \text{ is :-}$$

(where C is a constant of integration.)

(1)  $x - 2 \log_e(y+3x) = C$

(2)  $x - \log_e(y+3x) = C$

(3)  $x - \frac{1}{2} (\log_e(y+3x))^2 = C$

(4)  $y + 3x - \frac{1}{2} (\log_e x)^2 = C$

6. The distance of the point  $(1, -2, 3)$  from the plane  $x - y + z = 5$  measured parallel to the line

$$\frac{x}{2} = \frac{y}{3} = \frac{z}{-6} \text{ is :}$$

(1) 7                      (2) 1                      (3)  $\frac{1}{7}$                       (4)  $\frac{7}{5}$

5. Let  $a_1, a_2, \dots, a_n$  be a given A.P. whose common difference is an integer and  $S_n = a_1 + a_2 + \dots + a_n$ . If  $a_1 = 1$ ,  $a_n = 300$  and  $15 \leq n \leq 50$ , then the ordered pair  $(S_{n-4}, a_{n-4})$  is equal to :

(1) (2480, 249)                      (2) (2490, 249)

(3) (2490, 248)                      (4) (2480, 248)

7. Let  $f : (0, \infty) \rightarrow (0, \infty)$  be a differentiable function such that  $f(1) = e$  and

$$\lim_{t \rightarrow x} \frac{t^2 f^2(x) - x^2 f^2(t)}{t - x} = 0$$

If  $f(x) = 1$ , then  $x$  is equal to :

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

8. If the system of equations

$$x + y + z = 2$$

$$2x + 4y - z = 6$$

$$3x + 2y + \lambda z = \mu$$

has infinitely many solutions, then :

- (1)  $\lambda - 2\mu = -5$       (2)  $2\lambda - \mu = 5$   
 (3)  $2\lambda + \mu = 14$       (4)  $\lambda + 2\mu = 14$

9. The minimum value of  $2^{\sin x} + 2^{\cos x}$  is :-

- (1)  $2^{1-\frac{1}{\sqrt{2}}}$       (2)  $2^{-1+\sqrt{2}}$   
 (3)  $2^{1-\sqrt{2}}$       (4)  $2^{-1+\frac{1}{\sqrt{2}}}$

10.  $\int_{\pi/6}^{\pi/3} \tan^3 x \cdot \sin^2 3x (2 \sec^2 x \cdot \sin^2 3x + 3 \tan x \cdot \sin 6x) dx$

is equal to :

- (1)  $\frac{9}{2}$       (2)  $-\frac{1}{9}$       (3)  $-\frac{1}{18}$       (4)  $\frac{7}{18}$

11. The circle passing through the intersection of the circles,  $x^2 + y^2 - 6x = 0$  and  $x^2 + y^2 - 4y = 0$ , having its centre on the line,  $2x - 3y + 12 = 0$ , also passes through the point :

- (1)  $(1, -3)$       (2)  $(-1, 3)$   
 (3)  $(-3, 1)$       (4)  $(-3, 6)$

12. The angle of elevation of a cloud C from a point P, 200 m above a still lake is  $30^\circ$ . If the angle of depression of the image of C in the lake from the point P is  $60^\circ$ , then PC (in m) is equal to :
- (1) 400                      (2)  $400\sqrt{3}$   
 (3) 100                      (4)  $200\sqrt{3}$

13. If a and b are real numbers such that  $(2 + \alpha)^4 = a + b\alpha$ , where  $\alpha = \frac{-1+i\sqrt{3}}{2}$ , then a + b is equal to :
- (1) 57      (2) 33      (3) 24      (4) 9

14. In a game two players A and B take turns in throwing a pair of fair dice starting with player A and total of scores on the two dice, in each throw is noted. A wins the game if he throws a total of 6 before B throws a total of 7 and B wins the game if he throws a total of 7 before A throws a total of six The game stops as soon as either of the players wins. The probability of A winning the game is :

- (1)  $\frac{31}{61}$                       (2)  $\frac{5}{6}$   
 (3)  $\frac{5}{31}$                       (4)  $\frac{30}{61}$

15. Let  $x = 4$  be a directrix to an ellipse whose centre is at the origin and its eccentricity is  $\frac{1}{2}$ .

If P (1,  $\beta$ ),  $\beta > 0$  is a point on this ellipse, then the equation of the normal to it at P is :-

- (1)  $7x - 4y = 1$                       (2)  $4x - 2y = 1$   
 (3)  $4x - 3y = 2$                       (4)  $8x - 2y = 5$

16. Contrapositive of the statement:

'If a function  $f$  is differentiable at  $a$ , then it is also continuous at  $a$ ', is :-

- (1) If a function  $f$  is continuous at  $a$ , then it is not differentiable at  $a$ .
- (2) If a function  $f$  is not continuous at  $a$ , then it is differentiable at  $a$ .
- (3) If a function  $f$  is not continuous at  $a$ , then it is not differentiable at  $a$ .
- (4) If a function  $f$  is continuous at  $a$ , then it is differentiable at  $a$ .

17. The area (in sq. units) of the largest rectangle ABCD whose vertices A and B lie on the x-axis and vertices C and D lie on the parabola,  $y = x^2 - 1$  below the x-axis, is :

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

18. If for some positive integer  $n$ , the coefficients of three consecutive terms in the binomial expansion of  $(1+x)^{n+5}$  are in the ratio  $5 : 10 : 14$ , then the largest coefficient in this expansion is :-

- (1) 792
- (2) 252
- (3) 462
- (4) 330

19. If the perpendicular bisector of the line segment joining the points P (1, 4) and Q (k, 3) has y-intercept equal to  $-4$ , then a value of  $k$  is :-

- (1)  $\sqrt{15}$
- (2)  $-2$
- (3)  $\sqrt{14}$
- (4)  $-4$

20. Suppose the vectors  $x_1$ ,  $x_2$  and  $x_3$  are the solutions of the system of linear equations,  $Ax = b$  when the vector  $b$  on the right side is equal to  $b_1$ ,  $b_2$  and  $b_3$  respectively. If

$$x_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, x_2 = \begin{bmatrix} 0 \\ 2 \\ 1 \end{bmatrix}, x_3 = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, b_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

$$b_2 = \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} \text{ and } b_3 = \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix}, \text{ then the determinant of}$$

$A$  is equal to :-

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

21. A test consists of 6 multiple choice questions, each having 4 alternative answers of which only one is correct. The number of ways, in which a candidate answers all six questions such that exactly four of the answers are correct, is \_\_\_\_\_

22. Let  $PQ$  be a diameter of the circle  $x^2 + y^2 = 9$ . If  $\alpha$  and  $\beta$  are the lengths of the perpendiculars from  $P$  and  $Q$  on the straight line,  $x + y = 2$  respectively, then the maximum value of  $\alpha\beta$  is \_\_\_\_\_

23. Let  $\{x\}$  and  $[x]$  denote the fractional part of  $x$  and the greatest integer  $\leq x$  respectively of a real number  $x$ . If  $\int_0^n \{x\} dx$ ,  $\int_0^n [x] dx$  and  $10(n^2 - n)$ , ( $n \in \mathbb{N}$ ,  $n > 1$ ) are three consecutive terms of a G.P., then  $n$  is equal to \_\_\_\_\_

24. If  $\vec{a} = 2\hat{i} + \hat{j} + 2\hat{k}$ , then the value of  $|\hat{i} \times (\vec{a} \times \hat{i})|^2 + |\hat{j} \times (\vec{a} \times \hat{j})|^2 + |\hat{k} \times (\vec{a} \times \hat{k})|^2$  is equal to \_\_\_\_\_

25. If the variance of the following frequency distribution :

Class	:	10–20	20–30	30–40
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Frequency :	2	x	2
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is 50, then x is equal to \_\_\_\_\_