

**RITS-16**  
**JEE MAINS-2020**  
**ANSWER KEY**  
**Code: 127488**

<b>MATHEMATICS</b>		<b>PHYSICS</b>		<b>CHEMISTRY</b>	
1	2	1	2	1	3
2	1	2	3	2	1
3	4	3	4	3	1
4	3	4	2	4	4
5	4	5	2	5	2
6	2	6	4	6	1
7	2	7	1	7	2
8	4	8	2	8	4
9	3	9	1	9	3
10	1	10	3	10	3
11	2	11	3	11	3
12	4	12	2	12	4
13	1	13	1	13	4
14	1	14	1	14	4
15	4	15	2	15	2
16	3	16	2	16	4
17	4	17	4	17	2
18	2	18	3	18	3
19	4	19	2	19	2
20	2	20	4	20	2
1	2	1	6	1	8
2	1	2	8	2	2
3	3	3	5	3	6
4	9	4	2	4	5
5	4	5	5	5	5

## SOLUTION

1. **Ans. (2)**

$$g(x) = f^{-1}(x) \text{ and } h(x) = k^{-1}(x)$$

$$f(g(x)) = x \text{ and } k(h(x)) = x$$

$$f(g(h(k(x)))) = x$$

and differentiation is 1

2. **Ans. (1)**

$$f(x) = \left( \cos^{-1}(\cos x) - \frac{1}{2} \right)^2 - \frac{1}{4}$$

Maximum value when  $\cos^{-1}(\cos x) = 0$

$$\text{or } \cos^{-1}(\cos x) = \pi$$

$$f(x) = \frac{1}{4} - \frac{1}{4} = 0$$

$$f(x) = \left( \pi - \frac{1}{2} \right)^2 - \frac{1}{4} = \pi^2 - \pi$$

3. **Ans. (4)**

$$f'(x) = \text{RHD at } x = 1 \text{ is } 1$$

$$\text{LHD at } x = 1 \text{ is } 1$$

Function must be continuous at  $x = 1$

$$f(1) = \lim_{h \rightarrow 0} f(1-h)$$

$$a = -4$$

4. **Ans. (3)**

$$\lim_{x \rightarrow \infty} \frac{3x^3(e^{1/x} - 1)}{x^2} + \frac{1}{x} = \frac{3(e^{1/x} - 1)}{(1/x)} + 0 = 3$$

5. **Ans. (4)**

$$(1) \quad 1 \leq 1 + |\cos x| \leq 2$$

$$\cos^{-1}(\cos t) = t \text{ if } 1 \leq t \leq 2$$

$$(2) \quad \sin^4 x + \cos^4 x = 1 - \frac{\sin^2 2x}{2}$$

$$\frac{1}{2} \leq 1 - \frac{\sin^2 2x}{2} \leq 1$$

$$\sin^{-1}(\sin t) = t \text{ if } \frac{1}{2} \leq t \leq 1$$

$$(3) \quad -\frac{\pi}{2} < \sin^{-1} x < \frac{\pi}{2}$$

$$\tan^{-1}(\tan t) = t \text{ when } -\frac{\pi}{2} \leq t \leq \frac{\pi}{2}$$

$$(4) \quad 2 \leq x^2 - 2x + 3 < \infty$$

$\tan^{-1}(\tan t) = t$  not always true.

6. **Ans. (2)**

$$(1) \quad f(x) = (x+1) \text{ for } -2 \leq x \leq 0$$

$$(2) \quad f(x) = -(x+1) \text{ for } -2 \leq x \leq 0$$

$$(3) \quad f(x) = \begin{cases} (x+1) & ; -1 \leq x \leq 0 \\ -(x+1) & ; -2 \leq x \leq -1 \end{cases}$$

$$(4) \quad f(x) = \begin{cases} -(x+1) & ; -2 \leq x \leq -1 \\ (x+1) & ; -1 \leq x \leq 0 \end{cases}$$

7. **Ans. (2)**

$$\text{Let } f(x) = a \Rightarrow x = f^{-1}(a)$$

$$f(1-x) = (3-a) \Rightarrow 1-x = f^{-1}(3-a)$$

$$f^{-1}(a) + f^{-1}(3-a) = 1$$

$$I = \int_{(1+x)}^{(2-x)} f^{-1}(t) dt \quad \dots(i)$$

$$I = \int_{(1+x)}^{(2-x)} f^{-1}(3-t) dt \quad \dots(ii)$$

$$(i) + (ii) \Rightarrow 2I = \int_{(1+x)}^{(2-x)} (f^{-1}(t) + f^{-1}(3-t)) dt$$

$$I = \frac{(1-2x)}{2}$$

8. **Ans. (4)**

$$\sum_{r=1}^n \sin\left(\frac{r}{n}\right) \left(\cos\frac{r}{n}\right)^2 \cdot \frac{1}{n}$$

$$\int_0^1 \sin x \cos^2 x dx$$

$$\text{Let } \cos x = t \Rightarrow -\sin x dx = dt$$

$$-\int_1^{\cos 1} t^2 dt = \frac{1}{3} (t^3)_{\cos 1}^1 = \frac{1}{3} (1 - \cos^3 1)$$

9. Ans. (3)

$$I = \int_0^{\pi/2} (\tan^{-1}(\sin x) - \tan^{-1}(2 \cos x)) dx$$

$$= \int_0^{\pi/2} \tan^{-1} \left( \frac{\sin x - 2 \cos x}{1 + \sin 2x} \right) dx = I$$

10. Ans. (1)

$$a^2 - 4b < 0 \Rightarrow \operatorname{sgn}(a^2 - 4b) = -1$$

$$\cot^{-1} \left( \frac{1}{a^2 - 4b} \right) = \pi + \tan^{-1}(a^2 - 4b)$$

11. Ans. (2)

$$\int \frac{\ln(1+x^{2/3})^3}{x^{1/3}(x^{2/3}+1)} dx$$

$$3 \int \frac{\ln(1+x^{2/3})x^{-1/3}}{(1+x^{2/3})} dx$$

$$\text{Let } \ln(1+x^{2/3}) = t$$

$$\frac{2}{3} \frac{x^{-1/3}}{(1+x^{2/3})} dx = dt$$

$$\frac{9}{2} \int t dt = \frac{9}{4} t^2 + C$$

$$= \frac{9}{4} (\ln(1+x^{2/3}))^2 + C$$

12. Ans. (4)

Continuity occurs when

$$x^2 = x + 2$$

$$x^2 - x - 2 = 0$$

$$(x-2)(x+1) = 0$$

Continuous at two points.

13. Ans. (1)

$$\int_0^{\pi/3} e^{(\sec x + x)} (\sec x \tan x + 1) dx$$

$$+ \int_0^{\pi/3} e^{(\sec x + x^2)} (\sec x \tan x + 2x) dx$$

$$\text{Let } \sec x + x = t_1 \Rightarrow (\sec x \tan x + 1) dx = dt_1$$

$$\left( e^{(\sec x + x)} \right)_0^{\pi/3} + \left( e^{(\sec x + x^2)} \right)_0^{\pi/3}$$

$$e^{\left(2 + \frac{\pi}{3}\right)} + e^{\left(2 + \frac{\pi^2}{9}\right)} - 2$$

14. Ans. (1)

$$f(x) = \left( |x-3|^{\log_{|x-3|} e} \right) = e^3$$

$$f'(x) = 0$$

15. Ans. (4)

$$x > \sin x \Rightarrow \frac{x}{\sin x} > 1$$

$$\int_0^{1/2} dx = \frac{1}{2}$$

16. Ans. (3)

$$\sin^{-1} \left( \frac{3}{5} \right) = \theta \Rightarrow \frac{3}{5} = \sin \theta$$

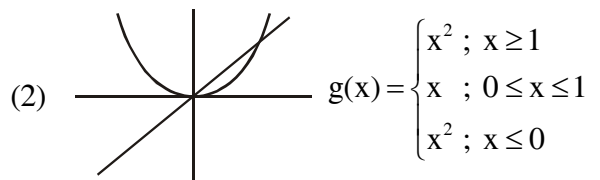
$$\cos 3\theta = 4 \cos^3 \theta - 3 \cos \theta$$

$$= 4 \left( \frac{4}{5} \right)^3 - 3 \left( \frac{4}{5} \right)$$

$$= \frac{256}{125} - \frac{12}{5} = -\frac{44}{125}$$

17. Ans. (4)

(1) Non-differentiable and discontinuous at  $x = 4$  &  $x = -4$



(3) Non differentiable at  $x = 1, -1$

(4) Non differentiable at  $x = 0, 1, -1$

18. Ans. (2)

$$(x+y)^3 - 3xy(x+y) = t^3 + \frac{1}{t^3}$$

$$\left( t + \frac{1}{t} \right)^3 - 3xy \left( t + \frac{1}{t} \right) = t^3 + \frac{1}{t^3}$$

$$xy = 1 \Rightarrow y = \frac{1}{x} \Rightarrow \frac{dy}{dx} = -\frac{1}{x^2}$$

19. Ans. (4)

(1)  $f(x)$  is discontinuous at  $x = 1, -1$

(2)  $f(x)$  is non periodic function

(3)  $f(x)$  is not a bounded function because

$$\lim_{x \rightarrow \infty} f(x) \rightarrow \infty$$

$$(4) f(x) = x^5 \cos\left(\frac{x}{5}\right) \quad \dots(i)$$

$$f(-x) = -x^5 \cos\left(\frac{x}{5}\right) \quad \dots(ii)$$

$$(i) + (ii) \Rightarrow f(x) + f(-x) = 0$$

$$\text{Similarly } f(x) = x|x| \quad \dots(i)$$

$$f(-x) = -x|x| \quad \dots(ii)$$

$$(i) + (ii) \Rightarrow f(x) + f(-x) = 0$$

function is an odd function.

**20. Ans. (2)**

$$\int \sqrt{1 - \sin x} dx = \int \left( \cos \frac{x}{2} - \sin \frac{x}{2} \right) dx$$

$$= 2 \left( \sin \frac{x}{2} + \cos \frac{x}{2} \right) + C$$

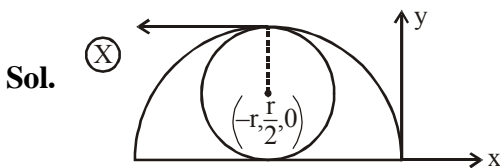
$$= 2\sqrt{1 + \sin x} + C$$

$$= 2\sqrt{2 - g(x)} + C$$

- |    |   |
|----|---|
| 1. | 2 |
| 2. | 1 |
| 3. | 3 |
| 4. | 9 |
| 5. | 4 |

## PART B - PHYSICS

31. Ans. (2)



32. Ans. (3)

Sol.  $\frac{r}{T} = \frac{mv}{qB} \times \frac{v}{2\pi r} \propto v$

33. Ans. (4)

Sol.  $R = \frac{mv}{qB}$

In (1) :  $|\vec{B}_1| = |\vec{B}_2|$       In (2) :  $|\vec{B}_1| > |\vec{B}_2|$

In (3) :  $|\vec{B}_1| < |\vec{B}_2|$

34. Ans. (2)

Sol.  $\frac{K(2Q - q)}{r} - \frac{kq}{2r} = \frac{dq}{dt} R$ ;

$$\int \frac{K}{rR} dt = \int \frac{dq}{2Q - \frac{3q}{2}}; 4Q - 3q = Qe^{-\frac{3kt}{2rR}}$$

Differentiating w.r.t time

$$-\frac{3dq}{dt} = -\frac{3}{2} \frac{KQ}{rR} e^{-\frac{3kt}{2rR}}; i = \frac{Q}{8\pi\epsilon_0 rR} e^{-\frac{3kt}{8\pi\epsilon_0 rR}}$$

35. Ans. (2)

Sol.  $U_i = \frac{KQ^2}{2a} + \frac{KQ^2}{4a} + \frac{KQ^2}{2a} = \frac{5KQ^2}{4a}$  and

$$U_f = \frac{K(2Q)^2}{4a} = \frac{KQ^2}{a}$$

$$\Rightarrow \text{Heat produced} = U_i - U_f = \frac{KQ^2}{4a}$$

36. Ans. (4)

Sol. Here  $f = 0.5$  HZ;  $N = 100$ ,  $A = 0.1$  m<sup>2</sup> and  $B = 0.01$  T. Employing eq.

$$\begin{aligned} e_0 &= NBA (2\pi v) \\ &= 100 \times 0.01 \times 0.1 \times 2 \times 3.14 \times 0.5 \\ &= 0.314 \text{ V} \end{aligned}$$

The maximum voltage is 0.314 V

We urge you to explore such alternative possibilities for power generation.

37. Ans. (1)

Sol. For two conductors in series, their potential differences are proportional to their resistances. For two capacitors in series, their potential differences are inversely proportional to their capacitances. Hence, A and B are at the same potential and no charge will flow between them.

38. Ans. (2)

Sol. During time ' $t_2$ ' capacitor is discharging with the help of resistor 'R'

$$\begin{aligned} \therefore q &= q_0 e^{-t/RC} \\ V &= V_0 e^{-t/RC} \quad [\because Q = CV] \end{aligned}$$

$$\text{As } V_0 = \frac{2V}{3}; V = \frac{V}{3}$$

$$t_2 = RC \ln 2$$

During time ' $t_1$ ' capacitor is charging with the help of battery.

$$\therefore q = q_0 (1 - e^{-t/RC}) \text{ or } V = V_0 (1 - e^{-t/RC})$$

$$\text{as } V_0 = \frac{2V}{3}; V = \frac{V}{3}$$

$$t_1 = RC \ln 2$$

$$T = t_1 + t_2 = 2RC \ln 2$$

39. Ans. (1)

Sol. current =  $\left(\frac{V}{d} \times S\right) \times \sigma = \frac{VS}{\rho d} \quad \therefore \sigma = \frac{1}{\rho}$

40. Ans. (3)

Sol. The oscillator frequency should be same as proton's cyclotron frequency.

$$\begin{aligned} B &= 2\pi m v/q \\ &= 6.3 \times 1.67 \times 10^{-27} \times 10^7 / (1.6 \times 10^{-19}) \\ &= 0.66 \text{ T} \end{aligned}$$

Final velocity of protons is

$$v = r \times 2\pi v = 0.6 \text{ m} \times 6.3 \times 10^7 = 3.78 \times 10^7 \text{ m/s.}$$

$$E = \frac{1}{2} m v^2 = 1.67 \times 10^{-27} \times 14.3 \times 10^{14} / (2 \times 1.6 \times 10^{-13}) = 7 \text{ MeV}$$

41. **Ans. (3)**

**Sol.** When the current through the element is very small, heating effects can be ignored and the temperature  $T_1$  of the element is the same as room temperature. When the toaster is connected to the supply, its initial current will be slightly higher than its steady value of 2.68 A. But due to heating effect of the current, the temperature will rise. This will cause an increase in resistance and a slight decrease in current. In a few seconds, a steady state will be reached when temperature will rise no further, and both the resistance of the element and the current drawn will achieve steady values. The resistance  $R_2$  at the steady temperature  $T_2$  is

$$R_2 = \frac{230\text{V}}{2.68\text{A}} = 85.8\Omega$$

Using the relation

$$R_2 = R_1 [1 + \alpha (T_2 - T_1)]$$

with  $\alpha = 1.70 \times 10^{-4} \text{ }^\circ\text{C}^{-1}$ , we get

$$T_2 - T_1 = \frac{(85.8 - 75.3)}{(75.3) \times 1.70 \times 10^{-4}} = 820^\circ\text{C}$$

that is,  $T_2 = (820 + 27.0) \text{ }^\circ\text{C} = 847 \text{ }^\circ\text{C}$

Thus, the steady temperature of the heating element (when heating effect due to the current equals heat loss to the surroundings) is  $847 \text{ }^\circ\text{C}$ .

42. **Ans. (2)**

**Sol.**  $\Delta m = Nm_e$

$$= \left( \frac{Q}{e} \right) m_e$$

43. **Ans. (1)**

**Sol.** (1)  $T^2 \propto r^3$ ; (2)  $E = \frac{-GMm}{2r}$  (3)  $v = \sqrt{\frac{GM}{r}}$ ;

$$(4) L = mvr = m\sqrt{GMr}$$

44. **Ans. (1)**

**Sol.**  $\omega L = 90 \times 10^{-3} \times 2\pi \times 1000 = 180\pi$

$$\frac{1}{\omega C} = \frac{1}{0.5 \times 10^{-6}} \times 2\pi \times 1000 = \frac{1000}{\pi}$$

$\Rightarrow$  circuit is inductive  $V_L > V_R$

$\Rightarrow$  voltage leads the current

$$\tan \phi = \frac{\omega L - \frac{1}{\omega C}}{R} = \frac{80\pi}{R}$$

$$R = \frac{80\pi}{\sqrt{3}}$$

at resonance,

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{90 \times 10^{-3} \times 0.5 \times 10^{-6}}}$$

$$= \frac{1}{\sqrt{45 \times 10^{-9}}} = \frac{10^5}{15\sqrt{2}} = \frac{\sqrt{2}}{3} \times 10^4$$

45. **Ans. (2)**

**Sol.** While the slider is in the middle of the potentiometer only half of its resistance ( $R_0/2$ ) will be between the points A and B. Hence, the total resistance between A and B, say,  $R_1$ , will be given by the following expression:

$$\frac{1}{R_1} = \frac{1}{R} + \frac{1}{(R_0/2)}$$

$$R_1 = \frac{R_0 R}{R_0 + 2R}$$

The total resistance between A and C will be sum of resistance between

A and B and B and C, i.e.,  $R_1 + R_0/2$

$\therefore$  The current flowing through the potentiometer will be

$$I = \frac{V}{R_1 + R_0/2} = \frac{2V}{2R_1 + R_0}$$

The voltage  $V_1$  taken from the potentiometer will be the product of current  $I$  and resistance  $R_1$ ,

$$V_1 = I R_1 = \left( \frac{2V}{2R_1 + R_0} \right) \times R_1$$

46. **Ans. (2)**

**Sol.** p.f. =  $\frac{R}{\sqrt{R^2 + \left( \omega L - \frac{1}{\omega C} \right)^2}}$

47. **Ans. (4)**

48. **Ans. (3)**

49. **Ans. (2)**

**Sol.**  $2T \xleftarrow{Q} \bullet \xrightarrow{T_1} T_1$       $T_1 \xleftarrow{2Q} \bullet \xrightarrow{T_2} T_2$

$$T_2 = T + 8T$$

$$T_2 \xleftarrow{4Q} \bullet \xrightarrow{T} T$$

$$= 9T$$

$$T_1 = 3T$$

**50. Ans. (4)**

**Sol.**  $\frac{4}{3}\pi r^3 (\rho_{Hg})g = qE$

**1. 6**

Let the maximum speed be 'v'

$$P = (mg \sin \theta + \mu mg \cos \theta)v$$

$$\Rightarrow v = \frac{P}{mg \sin \theta + \mu mg \cos \theta}$$

**2. 8**

$$F \propto V^2 \text{ and } P = FV; \text{ So, } P \propto V^3$$

**3. 5**

M = mass of complete disc =  $\pi R^2 \sigma$   
 $\sigma$  = mass per unit area.

$$m = \text{mass of removed part} = \frac{\pi R^2}{4} \sigma$$

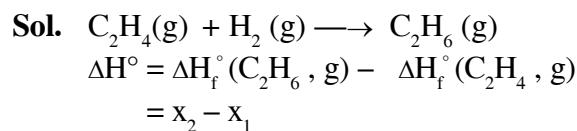
$$x_{cm} = \frac{M \times 0(-m) \left(\frac{R}{2}\right) + (m) \frac{3R}{2}}{M + (-m) + m} = \frac{mR}{M} = 5\text{cm}$$

**4. 2**

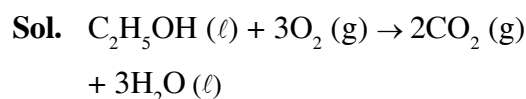
**5. 5**

## PART C - CHEMISTRY

**61. Ans. (3)**



**62. Ans. (1)**



$$\Delta n_g = 2 - 3 = -1$$

$$\text{so } \Delta U = \Delta H - \Delta n_g RT = -q + RT$$

**63. Ans. (1)**

**Sol.**  $-12250x - 13000(1 - x) = -12500$

$$750x = 500 \Rightarrow x = 2/3$$

$$\text{So, required ratio is } = \frac{2}{1}$$

**64. Ans. (4)**

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta H = -33 \times 10^3 \text{ J}$$

$$\Delta S = -58 \text{ J/K}$$

$\Delta G < 0$  for spontaneous reaction

$$\Delta G = -33 \times 10^3 + 58 T \dots\dots\dots(i)$$

from (i) reaction  $\Delta G < 0$

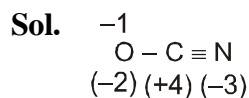
T should be below a certain temperature for -ve value of  $\Delta G$ .

**65. Ans (2)**

**66. Ans. (1)**

**Sol.**  $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1} \Rightarrow 300 \times V^{1/3}$   
 $= T_2 (8V)^{1/3} \Rightarrow T_2 = 150 \text{ K}$   
 $W = nC_v (T_2 - T_1) = 1 \times 3 R (150 - 300)$   
 $= 3 \times 2 (-150) = -900 \text{ cal}$

**67. Ans. (2)**



(ii) is the most stable resonating structure due to least charge and -ve charge on more electronegative atom.

**68. Ans (4)**

**69. Ans. (3)**

**Sol.** meq of  $\text{Na}_2\text{SO}_3 = \text{meq of salt}$   
 $25 \times 0.1 \times 2 = 50 \times 0.1 \times x \Rightarrow x = 1$   
 So, oxidation number of metal decreases by 1.  
 $\therefore$  New oxidation number of metal  
 $= 3 - 1 = 2.$

**70. Ans. (3)**

**71. Ans. (3)**

**72. Ans. (4)**

**73. Ans. (4)**

**74. Ans. (4)**

**75. Ans. (2)**

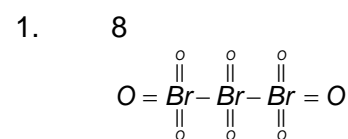
**76. Ans. (4)**

**77. Ans. (2)**

**78. Ans. (3)**

**79. Ans. (2)**

**80. Ans. (2)**



2. 2

3. 6  

$$PH = \frac{1}{2} [PK_{a_1} + PK_{a_2}]$$

4. 5  

$$A \longrightarrow nB \quad k = \frac{2.303}{t} \log \frac{[A]_0}{[A]_t}$$

$$\begin{aligned} 1_0 & \quad o \\ 1_0 - x & \quad nx \\ 1_0 - x + nx & = 3 \\ x(n-1) & = 2 \end{aligned}$$

$$x = \frac{2}{n-1}$$

$$6.93 \times 10^{-4} = \frac{2.303}{1000} \log \frac{1}{1 - \frac{2}{(n-1)}}$$

$$6.93 \times 10^{-4} = \frac{2.303}{1000} \log \frac{n-1}{n-3}$$

$$0.6932 = 2.303 \log \frac{n-1}{n-3}$$

$$\frac{0.6932}{2.303} = \log \frac{n-1}{(n-3)} = \log 2$$

$$\frac{n-1}{n-3} = 2$$

$$n-1 = 2n-6$$

$$n = 5$$

5. 5