

**(SINGLE CORRECT ANSWER TYPE)**

This section contains 20 multiple choice questions. Each question has 4 options A), B), C) and D) for its answer, out of which ONLY ONE option can be correct.

**Marking scheme: +4 for correct answer, 0 if not attempted and -1 in all other cases.**

1. If  $1 - p$  is a root of the quadratic equation  $x^2 + px + 1 - p = 0$ , then its roots are  
 A) 0, 1                      B) -1, 1                      C) 0, -1                      D) -2, 1
2. If for every  $n \in \mathbb{N}$ , sum of  $n$  terms of an A.P. is  $5n^2 + 7n$  then its 10<sup>th</sup> term is  
 A)  $7/2$                       B) 570                      C) 102                      D) 52
3.  $\frac{1}{2}(\sqrt{3} \cos 23^\circ - \sin 23^\circ)$  is not equal to  
 A)  $\cos 53^\circ$                       B)  $\sin 53^\circ$                       C)  $\sin 37^\circ$                       D)  $\sin 143^\circ$
4. If  $\sum_{i=1}^{21} a_i = 693$ , where  $a_1, a_2, \dots, a_{21}$  are in AP, then the value of  $\sum_{i=0}^{10} a_{2r+1}$  is  
 A) 361                      B) 363                      C) 365                      D) 398
5. If the roots of the equation  $ax^2 + bx + c = 0$  are of the form  $\alpha/(\alpha - 1)$  and  $(\alpha + 1)/\alpha$ , then the value of  $(a + b + c)^2$  is  
 A)  $2b^2 - ac$                       B)  $b^2 - 2ac$                       C)  $b^2 - 4ac$                       D)  $4b^2 - 2ac$
6. The domain of the function  

$$f(x) = \sqrt{x^2 - 3x + 2} + \frac{1}{\sqrt{3 + 2x - x^2}}$$
 is  
 A)  $[-1, 1] \cup [2, 3]$                       B)  $(-1, 1] \cup [2, 3)$   
 C)  $(-\infty, 1]$                       D)  $[2, \infty)$
7. The value of  $\cos^2\left(\frac{3\pi}{5}\right) + \cos^2\left(\frac{4\pi}{5}\right)$  is equal to  
 A)  $3/4$                       B)  $5/4$                       C)  $5/2$                       D)  $4/5$
8. Find the value of  $\frac{2}{1^3} + \frac{2(1+2)}{1^3+2^3} + \frac{2(1+2+3)}{1^3+2^3+3^3} + \frac{2(1+2+3+4)}{1^3+2^3+3^3+4^3} + \dots$  upto  $\infty$  terms :  
 A) 2                      B)  $\frac{1}{2}$                       C) 4                      D)  $\frac{1}{4}$
9.  $\left(\cos^4 \frac{\pi}{24} - \sin^4 \frac{\pi}{24}\right)$  equals :  
 A)  $\frac{1}{\sqrt{2}}$                       B)  $\frac{\sqrt{6} - \sqrt{2}}{4}$                       C)  $\frac{\sqrt{6} + \sqrt{2}}{4}$                       D)  $\frac{\sqrt{3} + 1}{2}$
10. If  $2x^2 + 5x + 7 = 0$  and  $ax^2 + bx + c = 0$  have at least one root common such that  $a, b, c \in \{1, 2, \dots, 100\}$ , then the difference between the maximum and minimum values of  $a + b + c$  is :

- A) 196                      B) 284                      C) 182                      D) 126

11. Let  $a_k = \frac{(k^2 + 1)^2}{k^4 + 4}$ ,  $k \in \mathbb{N}$ , then value of  $a_1^8 a_2^7 \dots a_7^2 a_8$  is equal to

- A)  $\frac{256}{41}$                       B)  $\frac{128}{41}$                       C)  $\frac{64}{41}$                       D)  $\frac{32}{41}$

12. The complete set of values of  $a$  so that equation  $\sin^4 x + a \sin^2 x + 4 = 0$  has at least one real root is:

- A)  $(\infty, -5]$                       B)  $(-\infty, -4] \cup [4, \infty)$   
 C)  $(-\infty, -4]$                       D)  $[4, \infty)$

13. The value of  $\cos 12^\circ \cos 24^\circ \cos 36^\circ \cos 48^\circ \cos 60^\circ \cos 72^\circ \cos 84^\circ$  is:

- A)  $\frac{1}{64}$                       B)  $\frac{1}{128}$                       C)  $\frac{1}{256}$                       D)  $\frac{1}{512}$

14. The range of the function  $f(x) = |x - 1| + |x - 2|$ ,  $-1 \leq x \leq 3$  is

- A)  $[1, 3]$                       B)  $[1, 5]$                       C)  $[3, 5]$                       D)  $[1, 5)$

15. If equation  $(r^2 - 2r + 1)x^2 + (r^2 - 3r + 2)x - (r^2 + 4r + 3) = 0$  is an identity in  $x$  then find value of  $r$

- A) 1                      B) 2                      C) -1                      D) No value

16. Let  $(a_1, a_2, a_3, a_4, a_5)$  denote a rearrangement of  $(3, -5, 7, 4, -9)$ , then the equation  $a_1 x^4 + a_2 x^3 + a_3 x^2 + a_4 x + a_5 = 0$  has

- A) at least two real roots                      B) all four real roots  
 C) only imaginary roots                      D) none of these

17. The range of function  $f(x) = 3|\sin x| - 4|\cos x|$  is :-

- A)  $(-4, 3)$                       B)  $[-4, 3]$                       C)  $(-3, 4)$                       D)  $[-3, 4]$

18. Find the greatest value of  $x^2 y^3$  where  $x$  and  $y$  are in the first quadrant and on the line  $3x + 4y = 5$

- A)  $\frac{5}{16}$                       B)  $\frac{9}{16}$                       C)  $\frac{3}{16}$                       D)  $\frac{15}{32}$

19. Let  $-\frac{\pi}{6} < \theta < -\frac{\pi}{12}$ . Suppose  $\alpha_1$  and  $\beta_1$  are the roots of the equation  $x^2 - 2x \sec \theta + 1 = 0$

and  $\alpha_2, \beta_2$  are the roots of the equation  $x^2 + 2x \tan \theta - 1 = 0$ . If  $\alpha_1 > \beta_1$  and  $\alpha_2 > \beta_2$ , then  $\alpha_1 + \beta_2$  equals

- A)  $2(\sec \theta - \tan \theta)$                       B)  $2 \sec \theta$                       C)  $-2 \tan \theta$                       D) 0

20. Let  $H_n = 1 + \frac{1}{2} + \dots + \frac{1}{n}$ , then the sum to  $n$  terms of the series

$$\frac{1^2}{1^3} + \frac{1^2 + 2^2}{1^3 + 2^3} + \frac{1^2 + 2^2 + 3^2}{1^3 + 2^3 + 3^3} + \dots$$

- A)  $\frac{4}{3} H_n - 1$                       B)  $\frac{4}{3} H_n + \frac{1}{n}$                       C)  $\frac{4}{3} H_n$                       D)  $\frac{4}{3} H_n - \frac{2}{3} \frac{n}{n+1}$

(NUMERICAL VALUE TYPE)

This section contains 10 questions. Each question is numerical value type. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

Attempt any five questions out of 10.

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21. Sum of the roots of the equation  $4^x - 3(2^{x+3}) + 128 = 0$
22. A person is to count 4500 currency notes. Let  $a_n$  denote the number of notes he counts in the  $n^{\text{th}}$  minute. If  $a_1 = a_2 = \dots = a_{10} = 150$  and  $a_{10}, a_{11}, \dots$  are in an A.P. with common difference  $-2$ , then the time taken by him to count all the notes is ' $k$ ' minutes. Then, ' $k$ ' is
23. The value of  $\sum_{k=1}^{12} \frac{1}{\sin\left(\frac{\pi}{4} + \frac{(k-1)\pi}{6}\right) \sin\left(\frac{\pi}{4} + \frac{k\pi}{6}\right)}$  is equal to
24. Let  $\langle a_n \rangle$  be an arithmetic progression with common difference  $d (d \neq 0)$  and  $\langle b_n \rangle$  be a geometric progression with common ratio  $q$ , where  $q$  is a rational number and  $0 < q < 1$ . If  $a_1 = d, b_1 = d^2$  and  $\frac{a_1^2 + a_2^2 + a_3^2}{b_1 + b_2 + b_3}$  is a positive integer, then  $q$  is
25. The least integral value of  $m$  for which every solution of the inequality  $1 \leq x \leq 2$  is a solution of the inequality  $x^2 - mx + 1 < 0$  is
26. If  $x_n = 1^2 - 2^2 + 3^2 - \dots + (-1)^{n-1} n^2$  and the sum of digits of  $x_{101}$  is ' $m$ '. Find  $m$ .
27. If  $\alpha, \beta$  are roots of  $x^2 + px + 5 = 0$  and  $\gamma, \delta$  are roots of  $x^2 + px - 4 = 0$  then value of  $|(\alpha - \gamma)(\alpha - \delta)|$  is
28. If the equation  $(m-12)x^4 - 8x^2 - 4 = 0$  has no real roots, then the largest value of  $m$  is
29. If  $\sqrt{\frac{\underbrace{1111\dots 1}_{2n \text{ times}} - \underbrace{(222\dots 2)}_{n \text{ times}}}{n \text{ times}}} = \frac{\underbrace{PPP\dots P}_{n \text{ times}}}{n \text{ times}}$  then  $P =$
30. The harmonic mean of two positive numbers is  $\frac{21}{5}$ , their A.M. ' $A$ ' and G.M. ' $G$ ' satisfy the relation  $3A + G^2 = 36$ . Then the absolute difference of the numbers is

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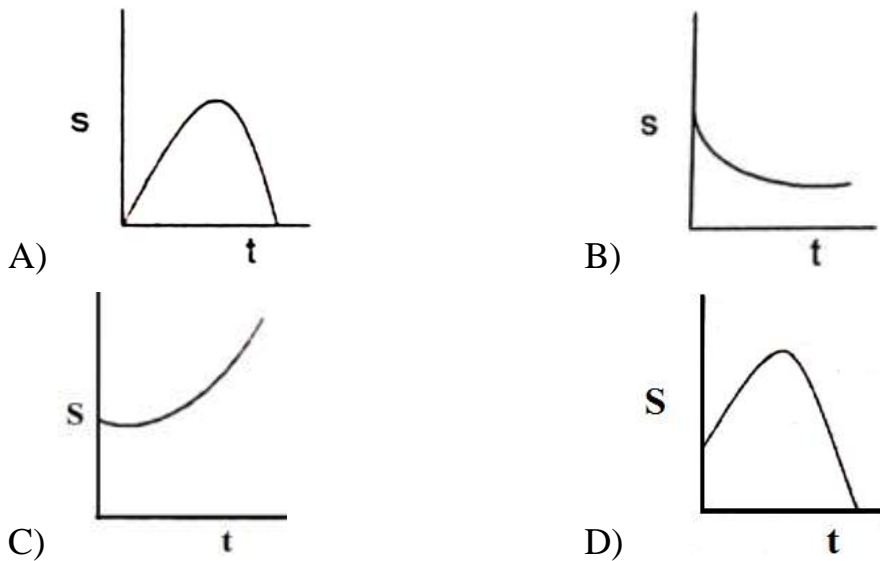
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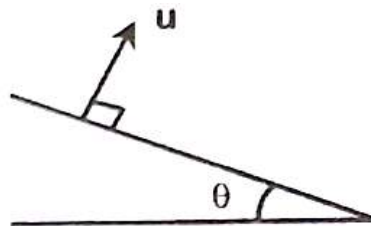
31. If the angle ( $\theta$ ) between velocity vector and the acceleration vector is  $90^\circ < \theta < 180^\circ$ . The body is moving on a:

- A) Straight path with retardation                      B) Straight path with acceleration  
 C) Curvilinear path with acceleration              D) Curvilinear path with retardation

32. The displacement of a particle in a straight line motion is given by  $s = 1 + 10t - 5t^2$ . The correct representation of the motion is



33. A particle is projected perpendicularly to an inclined plane as shown in the adjacent figure. If the initial velocity of the particle is  $u$ , calculate how far from the point of projection does it hit the plane again if the distance is measured along the plane?



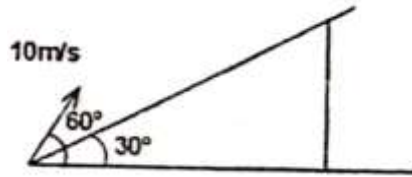
- A)  $\frac{2u^2}{g}$                       B) zero                      C)  $\frac{2u^2}{g} \sin \theta$                       D)  $\frac{2u^2}{g} \tan \theta \sec \theta$

34. The height  $y$  and distance  $x$  along the horizontal for a body projected in the vertical plane are given by  $y = 8t - 5t^2$  and  $x = 6t$ . The initial speed of projection is

- A) 8 m/s                      B) 9 m/s                      C) 10 m/s                      D)  $(10/3)$  m/s

35. A particle is thrown at time  $t = 0$ , with a velocity of 10 m/s at an angle of  $60^\circ$  with the horizontal, from a point on an incline plane, making an angle of  $30^\circ$  with the

horizontal. The time when the velocity of the projectile becomes parallel to the incline is

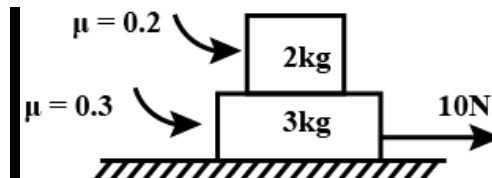


- A)  $\frac{2}{\sqrt{3}}$  sec      B)  $\frac{1}{\sqrt{3}}$  sec      C)  $\sqrt{3}$  sec      D)  $\frac{1}{2\sqrt{3}}$  sec

36. From the top of a tower, two particles A and B are projected simultaneously with speed of 3 m/s and 4 m/s, respectively, in horizontally opposite directions at time  $t = 0$ . At time  $t = (2\sqrt{3}/10)$  sec, the angle between their velocities is

- A)  $60^\circ$       B)  $45^\circ$       C)  $90^\circ$       D)  $30^\circ$

37. Consider the situation as shown in figure, frictional force acting between surface and 3 kg block is

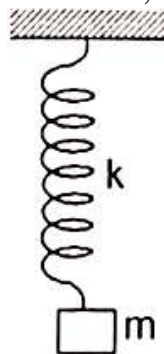


- A) 15 N      B) 10 N      C) 0 N      D) 4 N

38. Two men P & Q of masses  $M$  and  $m (< M)$  hold a light rope passing over a smooth fixed pulley P and Q climb up the rope so that the acceleration of Q upward is double that of P downward. The tension in the rope is

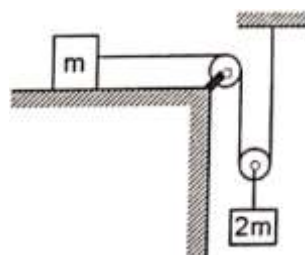
- A)  $\frac{2Mm}{M+m}g$       B)  $\frac{3Mm}{M+2m}g$       C)  $\frac{3Mm}{2(M+m)}g$       D)  $\frac{3Mm}{2M+m}g$

39. The spring mass system shown in the figure is in equilibrium at rest. If the mass is pushed up by a distance  $mg/2k$  and released, its instantaneous acceleration will be



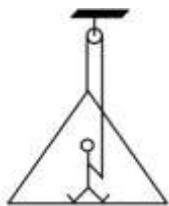
- A)  $g$       B)  $2g$       C)  $g/2$       D) zero

40. Find the acceleration of block of mass  $m$ . Assume pulleys are massless and frictionless.

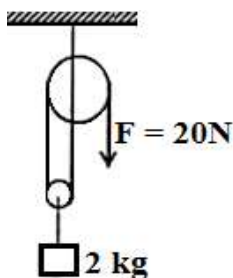


- A)  $g/3$       B)  $2g/3$       C)  $g/2$       D) None of these

41. A man of mass 50 kg stands on frame of mass 30 kg he pulls on a light rope which passes over a pulley. The other end of the rope is attached to the frame. For the system to be in equilibrium what force man must exert on the rope



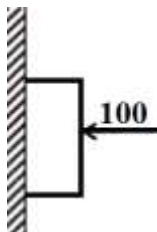
- A) 40 g                      B) 80 g                      C) 30 g                      D) 50 g
42. The acceleration of the 2 kg block if the free end of string is pulled with a force of 20 N as shown is



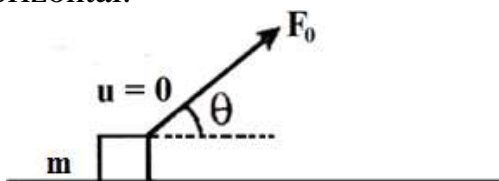
- A) 0                      B)  $10\text{m/s}^2$                       C)  $5\text{m/s}^2$  upward                      D)  $5\text{m/s}^2$  downward
43. A uniform rope of mass  $m$  hangs freely from a ceiling. A monkey of mass  $M$  climbs up the rope with an acceleration  $a$ . The force exerted by the rope on the ceiling is



- A)  $Ma + mg$                       B)  $M(a + g) + mg$   
 C)  $M(a + g)$                       D) Dependent on the position of monkey on the rope.
44. A force of 100 N is applied on a block of mass 2kg as shown in figure. The coefficient of friction between the surface and the block is  $1/4$ . Then friction force acting on block is [ $g=10\text{ m/s}^2$ ]



- A) 10 N                      B) 20 N                      C) 25 N                      D) 30 N
45. Find the speed of the block when it covers a horizontal distance ' $l$ '. It is given that the block never loses contact with the smooth horizontal surface, and the force always acts at an angle  $\theta$  with the horizontal.



A)  $\sqrt{\frac{lF_0 \cos \theta}{m}}$       B)  $\frac{2lF_0 \cos \theta}{m}$       C)  $\sqrt{\frac{2l}{m} F_0 \cos \theta}$       D)  $\frac{lF_0 \cos \theta}{m}$

46. Velocity of a particle at any instant is given by the equation  $\vec{v} = (2t\hat{i} + 3t^2\hat{j})\text{m/s}$ , and radius of the curvature of the path is 2m. Centripetal acceleration of the particle at  $t = 2\text{s}$  is

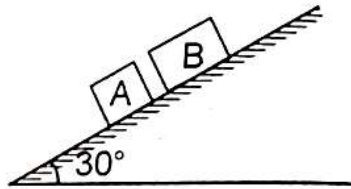
A)  $80\text{m/s}^2$       B)  $160\text{m/s}^2$       C)  $40\text{m/s}^2$       D)  $100\text{m/s}^2$

47. A railway track is banked for a speed  $v$ , by making the height of the outer rail 'h' higher than that of the inner rail. The horizontal separation between the rails is  $d$ . The radius of curvature of the track is 'r' then which of the following relation is true?

A)  $\frac{h}{d} = \frac{v^2}{rg}$       B)  $\tan\left(\sin^{-1}\frac{h}{d}\right) = \frac{v^2}{rg}$

C)  $\tan^{-1}\left(\frac{h}{d}\right) = \frac{v^2}{rg}$       D)  $\frac{h}{r} = \frac{v^2}{rg}$

48. Two weights A and B of 5 kg and 10 kg respectively are sliding down the inclined plane as shown. What is the acceleration with which the weights will slide down?



A) 0.0 g      B) 0.3 g      C) 0.50 g      D) 0.866 g

49. A box is moving up on an inclined plane of inclination  $30^\circ$  with a constant acceleration of  $5\text{m/s}^2$ . A particle is projected with a velocity of  $5\sqrt{3}\text{m/s}$  with respect to box inside a box, at an angle of  $30^\circ$  with the base. Then, the time after which it again strikes the same base of the box is (assume during its flight, particle does not hit any other side of the box)

A) 1 sec      B) 2 sec      C) 1.5 sec      D) data insufficient

50. A man can swim at a speed of 5 km/h w.r.t water. He wants to cross a 1.5 km wide river flowing at 3 km/h. He keeps himself always at an angle of  $60^\circ$  with the flow direction while swimming. The time taken by him to cross the river will be

A) 0.25 hr.      B) 0.35 hr.      C) 0.45 hr.      D) 0.55 hr.

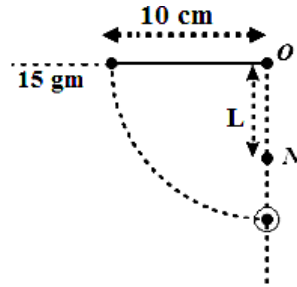
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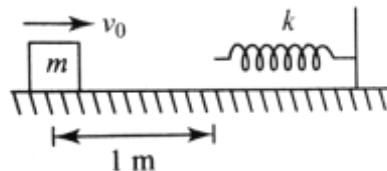
51. A ball weighing 15 gm. is tied to a string 10 cm long. Initially the ball is held in position such that the string is horizontal. The ball is now released. A nail N is situated vertically below the support at a distance L. If the minimum value of L (in cm) such that the string will be wound round the nail is  $600K$ . Find K.



52. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36 kg and 0.72 kg. Taking  $g = 10 \text{ m/s}^2$ , find the work done (in joules) by the string on the block of mass 0.36 kg during the first second after the system is released from rest.



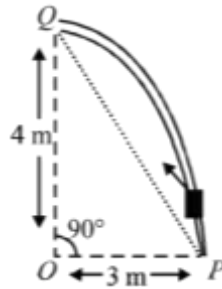
53. Kinetic energy of a block of mass 2 kg is given as  $16t^4$  and the block is moving in a circular path of radius 8 m. Then, find the power generated by the applied force at  $t = 1/3$  sec in watt.
54. A block of mass  $m = 0.14$  kg is moving with velocity  $v_0$  towards a massless spring of force constant  $K = 10 \text{ Nm}^{-1}$ . Coefficient of friction between the block and the ground is  $\mu = 1/2$ .



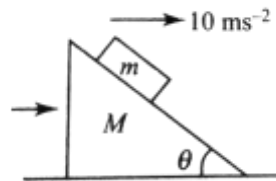
Find the maximum value of compression in the spring (in cm), so that after pressing the spring the block does not return back but stops there permanently.

55. Consider an elliptically shaped rail  $PQ$  in the vertical plane with  $OP = 3\text{m}$  and  $OQ = 4\text{m}$ . A block of mass 1 kg is pulled along the rail from  $P$  to  $Q$  with a force of 18 N, which is always parallel to line  $PQ$  (see figure). Assuming no frictional losses, the kinetic energy of the block when it reaches  $Q$  is  $(5.85h)\text{J}$ . The value of  $n$  is (take acceleration due to gravity  $= 10 \text{ ms}^{-2}$ )

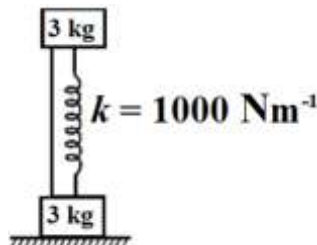




56. In figure, shown all the surfaces are frictionless, and mass of the block is  $m = 100\text{g}$ . The block and the wedge are held initially at rest. Now the wedge is given a horizontal acceleration of  $10\text{ ms}^{-2}$  by applying a force on the wedge, so that the block does not slip on the wedge. Then find the work done in joules by the normal force in ground frame on the block in 1 s. ( $\theta = 45^\circ$ )



57. A position dependent force  $F = 7 - 2x + 3x^2\text{ N}$ , acts on a small body of mass 2 kg and displaces it from  $x = 0$  to  $x = 5\text{m}$ . The work done in Joules is 24.32 K then find the value of K.
58. A system consists of two identical cubes, each of mass 3 kg, linked together by a compressed weightless spring of force constant  $1000\text{ Nm}^{-1}$ . The cubes are also connected by a thread which is burnt at a certain moment. At what minimum value of initial compression  $x_0$  (in cm) of the spring will the lower cube bounce up after the thread is burnt through?



59. A mass connected to a string of length  $\ell_0 = 1\text{m}$  is being revolved in a vertical circle with the least velocity at lowest end to complete circle. The string breaks when the mass reaches the highest point of its path. The mass, then describes a parabolic path. If the horizontal range (in m) of mass w.r.t. the lowest point is 100 K. Find K
60. A man slowly pulls a bucket of water from a well of depth  $h = 20\text{m}$ . The mass of the uniform rope and bucket full of water are  $m = 100\text{g}$  and  $M = 19.9\text{kg}$ , respectively. Find the work done (in kJ) by the man.

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61. If a mixture containing 3 moles of hydrogen and 1 mole of nitrogen is converted completely into ammonia, the ratio of initial and final volumes under the same temperature and pressure would be:  
 A) 3 : 1      B) 1 : 3      C) 2 : 1      D) 1 : 2
62. Photoelectric emission is observed from a surface for frequency  $\nu_1$  and  $\nu_2$  of the incident radiation ( $\nu_1 > \nu_2$ ). If the maximum kinetic energies of the photoelectrons in the two cases are in the ratio 1 : k, then the threshold frequency  $\nu_0$  is given by:  
 A)  $\frac{\nu_2 - \nu_1}{k - 1}$       B)  $\frac{k\nu_1 - \nu_2}{k - 1}$       C)  $\frac{k\nu_2 - \nu_1}{k - 1}$       D)  $\frac{\nu_2 - \nu_1}{k}$
63. The bond order of  $C_2^+$  is:  
 A) 1      B) 2      C) 3/2      D) 1/2
64. Most common oxidation state of cerium (Ce) is:  
 A) +2, +3      B) +2, +4      C) +3, +4      D) +3, +5
65. 1.94 g of a mixture of KOH(56) and  $K_2CO_3$ (138) is dissolved in water and separated into two equal parts by volume. One part required 50 mL 0.1 M  $H_2SO_4$  to reach the phenolphthalein end point while the other part required 75mL of the same acid to reach the methyl orange end point. The mass percentage of  $K_2CO_3$  in the mixture is  
 A) 35.5%      B) 71%      C) 29%      D) 64.5%
66. The rate of diffusion of two gases X and Y is in the ratio of 1 : 5 and that of Y and Z in the ratio of 1 : 6. The ratio of the rate of diffusion of Z with respect to X is  
 A) 5 : 6      B) 1 : 30      C) 6 : 5      D) 30 : 1
67. If 2 L of  $Cl_2$  gas and 2 L of  $ClF_3$  gas react to form 6 L of a pure gaseous compound at the same conditions of temperature and pressure, what is the molecular formula of the compound formed?  
 A) ClF      B)  $Cl_3F_2$       C)  $Cl_3F_3$       D)  $Cl_2F_3$
68. Cu(II) ions will react with excess  $I^-$  to liberate iodine as  

$$2Cu^{2+} + 2I^- \longrightarrow 2Cu^+ + I_2$$
 The liberated iodine is titrated with standard  $Na_2S_2O_3$  solution  

$$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$$
 A 0.2129 g sample of Cu are required 28.42 mL of 0.0441M  $Na_2S_2O_3$  to titrate the liberated  $I_2$ . What is % of Cu in ore?  
 A) 13.56 %      B) 18.70 %      C) 37.41 %      D) 74.82 %
69. 2.11 mol of  $C_3H_8$  are allowed to burn in the presence of excess  $O_2$  to form  $CO_2$  and  $H_2O$  as  

$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g)$$

The carbon dioxide is isolated from all other gases and stored in a 1.25 L container at 0°C. What is the pressure in this container, if the gas obeys the ideal gas equation?

- A) 18 atm            B) 38 atm            C) 113 atm            D) 1.130 atm

70. Which one of the following is an amphoteric oxide?

- A)  $\text{SO}_2$             B)  $\text{B}_2\text{O}_3$             C)  $\text{ZnO}$             D)  $\text{Na}_2\text{O}$

71. The per cent loss in mass after heating a pure sample of potassium chlorate (molar mass = 122.5) will be:

- A) 12.25            B) 24.50            C) 39.18            D) 49.0

72. Which statement is wrong?

A) Hybridization is the mixing of atomic orbitals prior to their combining into molecular orbitals

B)  $sp^2$ -hybrid orbitals are formed from two  $p$ -atomic orbitals and one  $s$ -atomic orbitals

C)  $dsp^2$ -hybrid orbitals are all at 90° to one another

D)  $d^2sp^3$ -hybrid orbitals are directed towards the corners of a regular tetrahedron

73. 20 mL of a solution containing equal moles of  $\text{Na}_2\text{CO}_3$  and  $\text{NaHCO}_3$  required 16 mL of a 0.16 M HCl solution to reach the phenolphthalein end point. What volume of a 0.10 M  $\text{H}_2\text{SO}_4$  solution would have been required had methyl orange been used as indicator?

- A) 38.40 mL            B) 24.60 mL            C) 19.20 mL            D) 12.30 mL

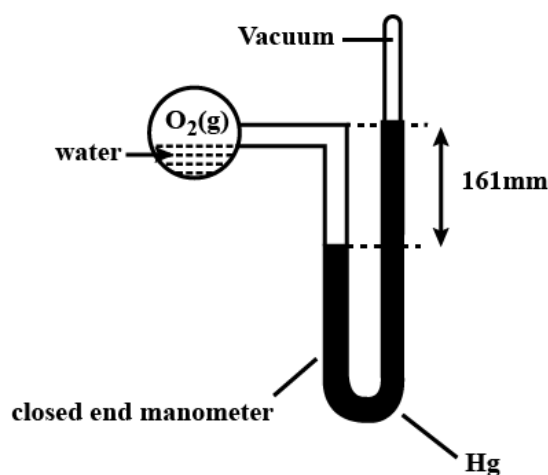
74. Which of the following percentage strength is not possible for a sample of oleum?

- A) 104 %            B) 108 %            C) 122 %            D) 130 %

75. 16 mL of an oleum ( $\text{H}_2\text{S}_2\text{O}_7$ ) solution (density = 1.25 g/cc) required 445 mL of a 1.0 M NaOH solution for complete neutralisation. Percentage strength of the oleum solution is

- A) 118%            B) 109%            C) 125%            D) 112.5%

76. The system shown in the diagram is at equilibrium at 27°C and volume of the bulb is 150 mL. At this temperature, the vapour pressure of water is 28 millimeters of mercury. If the bulb contains 0.001 mol of  $\text{O}_2(\text{g})$ , volume of the liquid water is approximately



- A) 34 mL            B) 10 mL            C) 30 mL            D) 60 mL

77. Boron cannot form which one of the following anions?  
A)  $\text{BF}_6^{3-}$       B)  $\text{BH}_4^-$       C)  $\text{B(OH)}_4^-$       D)  $\text{BO}_2^-$
78. Insulin contains 3.4% sulphur. The minimum molar mass of insulin is:  
A) 941.176      B) 944      C) 945.27      D) None of these
79. The molecule having three fold axis of symmetry is:  
A)  $\text{NH}_3$       B)  $\text{ClF}_3$       C)  $\text{SO}_2$       D)  $\text{CO}_2$
80. In which of the following  $p\pi - d\pi$  bonding is observed?  
A)  $\text{NO}_3^-$       B)  $\text{SO}_3^{2-}$       C)  $\text{BO}_3^{3-}$       D)  $\text{CO}_3^{2-}$

(NUMERICAL VALUE TYPE)

This section contains 10 questions. Each question is numerical value type. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

**Attempt any five questions out of 10.**

**Marking scheme: +4 for correct answer, 0 if not attempted and 0 in all other cases.**

81. 1.0 mol of  $\text{N}_2\text{H}_4$  loses 14 moles of electrons to form a new compound  $X$ . Assuming that the entire nitrogen appear in the new compound, what is the oxidation state of nitrogen in  $X$ ?

Ans.

82. If 5 g of sulphur is reacted with oxygen to produce 7.5 g of  $\text{SO}_2$ , mass of oxygen must be greater than  $x$  g.  $x$  is

Ans.

83. A transition to the ground state in the hydrogen spectrum has the same wavelength as Balmer transition  $n = 4$  to  $n = 2$  of  $\text{He}^+$  spectrum. The higher orbit number in transition occurring in H-atom is

Ans.

84. If 12.5 mL of He gas takes 5s to effuse through a pinhole, volume of methane gas that would effuse through the same pinhole in 2s under identical conditions is

Ans.

85. Atomic weight of Al on a non-conventional scale is found to be 18 while on conventional scale, it is 27. On the new scale an amu is defined as  $\left(\frac{1}{x}\right)^{\text{th}}$  part by weight of C-12. Here  $x$  is

Ans.

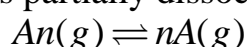
86. A flask has 10 gas molecules out of which four molecules are moving at  $6\text{ms}^{-1}$  and the remaining ones are moving at the same speed of  $x\text{ms}^{-1}$ . If rms of the gas is  $5\text{ms}^{-1}$ , what is  $x$ ?

Ans.

87. A 1.0 g sample containing  $\text{Fe}_3\text{O}_4$  and inert impurity was dissolved and treated chemically to reduce all iron to Fe(II). The final solution required 6 mL of a  $\frac{1}{29}$  M acidified  $\text{KMnO}_4$  solution for complete oxidation of Fe(II). Hence, percentage of  $\text{Fe}_3\text{O}_4$  in the original sample is

Ans.

88. A gaseous substance  $An$  remains partially dissociated as



If the given sample of gas has  $An(g)$  52% dissociated and the equilibrium mixture diffuses 1.25 times slower than pure oxygen gas under identical condition, determine

$\frac{n}{5}$ . Atomic weight of  $A$  is 32.

Ans.

89. A complex compound of iron has molar mass = 2800 and it contains 8% iron by weight. The number of iron atoms in one formula unit of complex compound is

Ans.

90. If  $\text{Cu}_2\text{S}$  is treated with acid solution of  $\text{KMnO}_4$ , it is oxidised completely to  $\text{Cu}^{2+}$  and  $\text{SO}_2$  is liberated. Moles of  $\text{KMnO}_4$  required for complete oxidation of 1.5 mol of  $\text{Cu}_2\text{S}$  is

Ans.