Competishun

52/6, Opposite Metro Mas Hospital, Shipra Path, Mansarovar

Date: 18/11/2024

Time: 3 hours **Max. Marks:** 180

PRATHAM-1 (24-25)-ACT-4-PAPER-2

Physics

MTC-SCQ

Q1 Consider a system of particles (it may be rigid or non rigid). In the column-I some condition on force and torque is given. Column-II contains the effects on the system. (Letters have usual meaning)

Column-I	Column-II
(P) $\vec{F}_{res} = 0$	(1) $\vec{P}_{system}$ will be constant
(Q) $\vec{\tau}_{res} = 0$	(2) $\vec{L}_{system}$ will be constant
(R) External force is absent	(3) total work done by all forces will be zero
(S) No nonconservative force acts	(4) total mechanical energy will be constant.

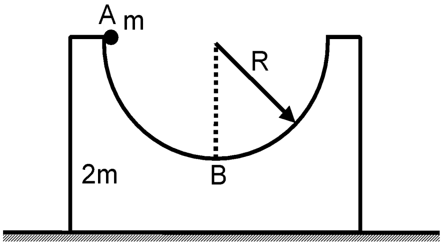
a) P→1 Q→2 R→1,2 S→4

b) P→2 Q→1,2 R→2 S→3

c) P→3 Q→1 R→2 S→1,2

d) P→1 Q→2 R→4 S→1,2

Q2 In the system shown m is released from rest from A. Suppose potential energy of m at A w.r.t. B is E. dimension of m is negligible and all surfaces are smooth. When m reaches at B,



List-I	**List-II**
(P) Kinetic energy of m	(1) $\frac{E}{3}$
(Q) Kinetic energy of 2m	(2) $\frac{2E}{3}$
(R) Momentum of m	(3) $\sqrt{\frac{4mE}{3}}$
(S) Momentum of 2m	(4) $\sqrt{\frac{2mE}{3}}$

a) P→1 Q→2 R→3 S→3 **b)** P→2 Q→1 R→3 S→3 **c)** P→1 Q→2 R→4 S→3
d) P→2 Q→1 R→4 S→3

Multiple Choice Question

Q3 Which of the following is true about moment of inertia (I) :

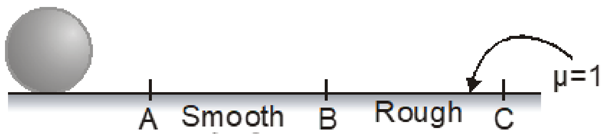
a) If I about an axis is minimum, then it must pass through centre of mass

b) All axis passing through centre of mass have same I

c) Perpendicular axis theorem can't be applied for 3 dimensional body

d) Parallel axis theorem can be applied for 3 dimensional body

Q4 A rigid body undergoing pure rolling encounters horizontal rigid tracks AB and BC as shown. AB is smooth surface and BC is rough surface with μ = 1. Which of the following statements is/are **correct** :



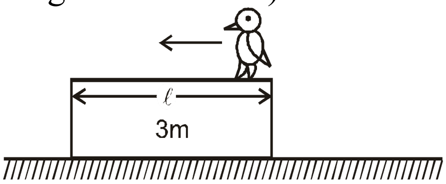
a) Angular momentum of the rigid body is conserved only about a point on the horizontal surface.

b) Angular momentum of the rigid body is conserved about every point in space.

c) In part BC, there will be no frictional force on the rigid body.

d) In part BC, frictional force will act opposite to velocity of rigid body.

Q5 A penguin of mass m stands at the right edge of a sled of mass 3m and legnth . The sled lies on frictionless ice. The penguin starts moving towards left, reaches the left end and jumps with a velocity u and at an angle θ relative to ground. (Neglect the height of the sled)



a) Till the penguin reaches the left end, the sled is displaced by $\frac{\ell}{4}$

b) Till the penguin reaches the left end, the sled is displaced by $\frac{\ell}{3}$

c) After jumping, it will fall on the ground at a distance $\frac{4}{3}\frac{u^2 \sin 2\theta}{g}$ from the left end of the sled.

d) After jumping, it will fall on the ground at a distance $\frac{3}{4}\frac{u^2 \sin 2\theta}{g}$ from the left end of the sled.

Q6 If 1000 droplets of water of surface tension 0.07 N/m. having same radius 1 mm each, combine to from a single drop. In the process the released surface energy is- $\left(\text{Take } \pi = \frac{22}{7}\right)$

a) 7.92×10^{-6}J **b)** 7.92×10^{-4}J **c)** 9.68×10^{-4}J **d)** 8.8×10^{-5}J

Numerical

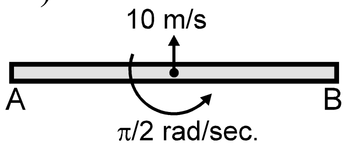
Q7 A steam engine intakes 50g of steam at 100°C per minute and cools it down to 20°C. If latent heat of vaporization of steam is 540 cal g^{-1}, then the heat rejected by the steam engine per minute is $K \times 10^3$ cal. Find value of 2k/31

Q8 The surface of water in a water tank of cross section area 750 cm^2 on the top of a house is h m. above the tap level. The speed of water coming out through the tap of cross section area 500 mm^2 is 30 cm/s. At that instant, $\frac{dh}{dt}$ is $x \times 10^{-3}$ m/s. The value of x will be______.

Q9 The root mean square speed of molecules of a given mass of a gas at 27°C and 1 atmosphere pressure is 200 ms^{-1}. The root mean square speed of molecules of the gas at 127°C and 2 atmosphere pressure is $\frac{100x}{\sqrt{3}}ms^{-1}$. The value of x will be ______.

Q10 The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0 °C without changing the pressure of the gas. The molecules in the gas rotate but do not oscillate. If the ratio of change in internal energy of the gas to the amount of workdone by the gas is $\frac{x}{2}$. Then the value of x (round off to the nearest integer) is ________. (Given R = 8.31 J mol^{-1} K^{-1})

Q11 A uniform rod AB of length 4m and mass 12 kg is thrown such that just after the projection the centre of mass of the rod moves vertically upwards with a velocity 10 m/s and at the same time it is rotating with an angular velocity $\frac{\pi}{2}$ rad/sec about a horizontal axis passing through its mid point. Just after the rod is thrown it is horizontal and is as shown in the figure. Find the acceleration (in m/sec^2) of the point A in m/s^2 when the centre of mass is at the highest point. (Take g = 10m/s^2 and π^2 = 10)

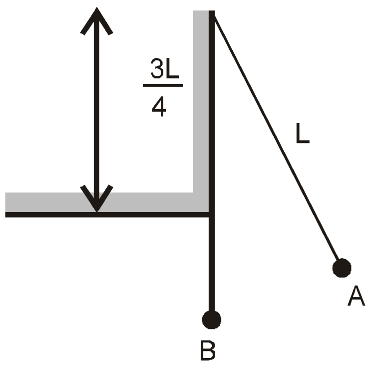


Q12 A signal of 0.1 kW is transmitted in a cable. The attenuation of cable is –5 dB per km and cable length is 20 km. The power received at receiver is 10^{-x} W. The value of x is ______.

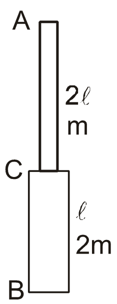
[Gain in dB = 10 $\log_{10}\left(\frac{P_0}{P_i}\right)$]

Q13 The percentage increase in the speed of transverse waves produced in a stretched string if the tension is increased by 4%, will be _______%.

Q14 A pendulum has period T for small oscillations. An obstacle is placed directly beneath the pivot, so that only the lowest one quarter of the string can follow the pendulum bob when it swings to the left of its resting position as shown in the figure. The pendulum is released from rest at a certain point A. The time taken by it to return to that point is $\frac{nT}{4}$. Find the minimum value of n ?



Q15 A composite rod is made of two rods: one of mass m, length 2ℓ and another of mass 2m and length ℓ as shown. When the rod is suspended from A and allowed small oscillation in vertical plane, time period is T. Find the distance (in centimeter) of the point of suspension on other side from the junction so that time period is still the same. Take ℓ = 60 cm. is D, find value of D/10



Q16 A steel rod with $y = 2.0 \times 10^{11}\ Nm^{-2}$ and $\alpha = 10^{-5}\ °C^{-1}$ of length 4 m and area of cross-section 10 cm^2 is heated from 0° C to 400°C without being allowed to extend. The tension produced in the rod is $x \times 10^5$ N where the value of x is ....

Q17 For a certain amount of monoatomic gas undergoes a process for which –
$U^{\beta}\ \alpha\ V$
where U is internal energy and V is volume of gas. It is found that the ratio $\frac{\Delta U}{\Delta Q}$ for the process was $\frac{1}{3}$. What is the value of β.

Q18 At a certain temperature, the degrees of freedom per molecule for gas is 8. The gas performs 150 J of work when it expands under constant pressure. The amount of heat absorbed by the gas will be X J, find value of X/250.

Chemistry

MTC-SCQ

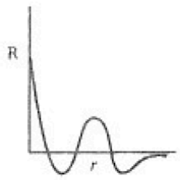
Q19 **Match the following.**

Column I	Column II
(A) The d-orbital which has two angular nodes	(P) $3d_{x^2-y^2}$
(B) The d-orbital with two nodal surfaces form cones	(Q) $3d_{z^2}$
(C) The orbital without angular node	(R) 4 f
(D) The orbital which has three angular nodes	(S) 3 s

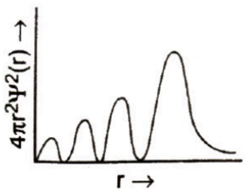
a) A → P, R; B → Q; C → S; D → R
b) A → P, Q; B → Q; C → S, R; D → R
c) A → P, Q; B → Q; C → S; D → R
d) A → P; B → Q; C → S; D → R, S

Q20 **Match the following.**

Column I — Column II

(A) 

(P) 4s

(B) 

(Q) 5py

(C) Angular probability depends upon θ and ϕ — (R) 3s

(D) At least one angular node is present — (S) 6dxy

a) A → P; B → P; C → Q, S; D → Q, S
b) A → P, Q, S; B → P; C → Q, S; D → Q, S
c) A → P, S; B → P, Q, S; C → Q; D → Q, S
d) A → P; B → P, Q, S; C → Q, S; D → Q, S

Multiple Choice Question

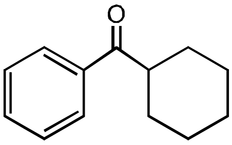
Q21 An amount of 0.2 mol of each $A_2(g)$ & $B_2(g)$ is introduced in a sealed flask and heated to 300K where following equilibrium is established : $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$
At equilibrium, moles of AB(g) is 0.3. At this stage, 0.1 mol of C_2 (g) is added and a new equilibrium is also established as : $A_2(g) + C_2(g) \rightleftharpoons 2AC(g)$; K_P
At the new equilibrium, the moles of AB(g) become 0.24. Select correct option(s) :

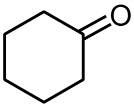
a) Value of K_P is 9.
b) Moles of AC(g) at equilibrium is 0.06 mol.
c) Value of K_P is 18.
d) Moles of AC(g) at equilibrium is 0.12 mol.

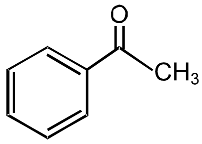
Q22 The enthalpies of two reactions are ΔH_1 and ΔH_2 (both positive) with $\Delta H_2 > \Delta H_1$. If the temperature of reacting system is increased from T_1 to T_2, predict which of the following alternatives is correct? (Here K_1 & K_2 are respectively equilibrium constants for two reactions at T_1 whereas K_1' & K_2' at T_2)

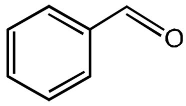
a) $\frac{K_1'}{K_1} = \frac{K_2'}{K_2}$ **b)** $\frac{K_1'}{K_1} > \frac{K_2'}{K_2}$ **c)** $\frac{K_1'}{K_1} < \frac{K_2'}{K_2}$ **d)** $K_1 + K_1' = K_2 + K_2'$

Q23 Which of the following will show tautomerism.

a) 

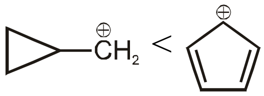
b) 

c) 

d) 

Q24 Which of the followings are incorrect order of stability for the following intermediates ?

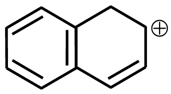
(a) $(CH_3)_3\overset{\oplus}{C} < Ph-\overset{\oplus}{C}(Ph)-CH_3$ (b) $(CH_3)_3\dot{C} < Ph-\dot{C}H-Ph$

(c) $\bar{C}H_3 < (CH_3)_3\bar{C}$ (d) 

a) a & b **b)** b & c **c)** b & d **d)** a & d

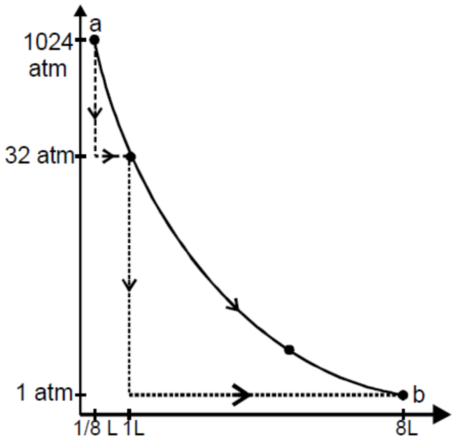
Numerical

Q25 How many total anti bonding electrons are present in O_2^+ ?

Q26 How many resonating structures of  are possible (including given structure) :

Q27 In order to oxidise a mixture of one mole of each of FeC_2O_4, $Fe_2(C_2O_4)_3$, $FeSO_4$ and $Fe_2(SO_4)_3$ in acidic medium, the number of moles of $KMnO_4$ required is

Q28 One mole of a monoatomic ideal gas is taken from a to b by expansion along two paths denoted by the solid and dashed line, as shown in the graph below. If wA is work done along solid line path and wB is work done along dotted line path then find $\frac{|w_A|}{|w_B|}$. Report your answer in terms of nearest integer.



Q29 At temperature above 85 K, decarboxylation of acetic acid becomes a spontaneous process under standard state conditions. What is the standard entropy change (in J/K-mol) of the reaction.

$CH_3COOH(aq) \longrightarrow CH_4(g) + CO_2(g)$

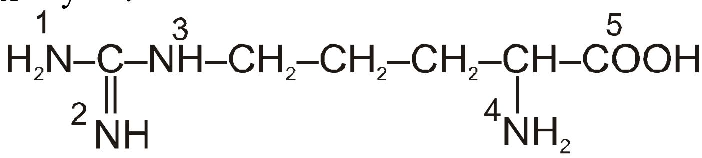
Given : ΔH_f^0 $[CH_3COOH(aq)]$ = – 484 kJ/mole

ΔH_f^0 $[CO_2(g)]$ = – 392 kJ/mole

ΔH_f^0 $[CH_4(g)]$ = – 75 kJ/mole

If your answer is x then what will be the value of $\frac{x}{100}$.

Q30 The groups which undergoes deprotonation & protonation respectively are x & y then x + y = ?



Q31 How many of the following compounds will accept from ammonium ion.

(i) Pyridine (ii) Aniline,
(iii) Pyrrole (iv) Triphenyl amine,
(v) Benzyl amine (vi) Methyl amine,
(vii) Di-methyl amine (viii)Tri-methyl amine

Q32 How many of the following compounds react with $NaHCO_3$ and liberate $CO_2(g)$

1. Salicylic acid 2. Pthalic acid 3. Picric acid
4. Resorcinol 5. Carbolic acid 6. Aspirin
7. Anisol 8. Tarteric acid

Q33 The enthalpy of formation of C_2H_6 is –84 kJ/mol. For C_3H_8, it is –105 kJ/mol. What is the magnitude of enthalpy of formation of n-pentane? If your answer is x then what will be the value of $\frac{2x}{100}$ (Report your answer in terms of nearest integer).

Q34 An organic compound contains C, H and O atoms. One molecule of the compound contains H-atoms equal to 66.67 % of total atoms and mass ratio of C to O is 3:2. If the molecular formula of the compound is $C_xH_yO_z$, what is the value of X + Y + Z. (Given vapour density of compound is 23 g/mol)

Q35 Equilibrium constant for the given reaction is $K = 10^{20}$ at temperature 300 K

$A(s) + 2B\ (aq.) \rightleftharpoons 2C\ (s) + D\ (aq.)\ K = 10^{20}$

Calculate the equilibrium concentration of B (in mol/L) starting with mixture of 1 mole of A and 1/2

mole/litre of B in a container of volume 1L at 300 K

(Give your answer by multiplying it with 10^{11})

Q36 When 10 litre of ozone gas at 1 atm is compressed adiabatically to $1/5^{th}$ of its volume, the pressure becomes 6.5 times of the initial. Find out the work done in the process. (Assuming ideal behaviour for ozone, give your answer in L-atm)

Mathematics

MTC-SCQ

Q37 If α, β are the roots of the equation $x^2 - 4x + 1 = 0$, then

Column-I	Column–II
(P) $\alpha^2 + \beta^2$	(1) 52
(Q) $\alpha^3 + \beta^3$	(2) 4
(R) $\lvert\alpha - \beta\rvert$	(3) 14
(S) $\frac{1}{\alpha} + \frac{1}{\beta}$	(4) $2\sqrt{3}$

a) P→3; Q→4; R→2; S→1 **b)** P→3; Q→1; R→4; S→2

c) P→1; Q→2; R→3; S→4 **d)** P→4; Q→2; R→1; S→3

Q38 **Match the following**

Column-1 Equation	Column-II Possible Solutions
(P) $2\sin\theta - \sqrt{3} = 0$	(1) $n\pi + (-1)^n \frac{\pi}{3}$
(Q) $2\sin 2\theta + \sqrt{3} = 2\sin\theta + 2\sqrt{3}\cos\theta$	(2) $2n\pi - \frac{\pi}{3}$
(R) $\sin 2\theta + \cos 2\theta + 4\sin\theta = 1 + 4\cos\theta$	(3) $2n\pi + \frac{\pi}{3}$
(S) $\cos^2\theta = \frac{1}{4}$	(4) $n\pi + \frac{\pi}{4}$

a) P→1,2,3; Q→1,4; R→2; S→2,3,4 **b)** P→1,2; Q→2,4; R→2,3,4; S→2

c) P→1,3; Q→1,2,3; R→4; S→1,2,3 **d)** P→1,3,4; Q→1,4; R→2,3,4; S→3,4

Multiple Choice Question

Q39 If $p < q$ and $px^2 + 4u\,xy + qy^2 + 4a(x + y + 1) = 0$ represents pair of st. line for some $u \in R$ and $a \neq 0$, then

a) $a \leq p$ or $a \geq q$ **b)** $a \geq p$ or $a \leq q$ **c)** $a \notin (p, q)$

d) the given equation has non zero linear terms

Q40 Let L_1 be a straight line passing through the origin and L_2 be the straight line $x + y = 1$. If the intercepts made by the circle $x^2 + y^2 - x + 3y = 0$ on $L_1$and L_2 are equal, then which of the following equations can represent L_1

a) $x + y = 0$ **b)** $x - y = 0$ **c)** $x + 7y = 0$ **d)** $x - 7y = 0$

Q41 Let $A_n = {}^nC_0{}^nC_1 + {}^nC_1{}^nC_2 + ... + {}^nC_{n-1}{}^nC_n$ and $\frac{A_{n+1}}{A_n} = \frac{15}{4}$ then find the value of n is

a) 2 **b)** 7 **c)** 4 **d)** 1

Q42 Let the pair of tangents drawn from (0, 2) to the parabola $y^2 - 2y + 4x + 5 = 0$ and the normal at the point of contact of tangents form a quadrilateral

a) quadrilateral will be square **b)** tangents drawn are intersecting at 90º

c) quadrilateral will be a rectangle

d) the point (0, 2) lies on the directrix of the parabola

Numerical

Q43 Suppose x, y, z > 0 & different from one and $\ell n\, x + \ell n\, y + \ell n\, z = 0$, then value of $x^{\frac{1}{\ell ny}+\frac{1}{\ell nz}} . y^{\frac{1}{\ell nz}+\frac{1}{\ell nx}} . z^{\frac{1}{\ell nx}+\frac{1}{\ell ny}}$ is e^{-k} then k equals ....

Q44 The number of positive integers satisfying $x + \log_{10}(2^x + 1) = x \log_{10}5 + \log_{10}6$ is ....

Q45 A line through P(λ, 3) meets the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$ at A and D meets the x-axis and y-axis at B and C respectively, so that PA.PD = PB.PC, then | λ | is greater than or equal to ....

Q46 the summation of the following series -
${}^nC_3 + 2.{}^{n+1}C_3 + 3.{}^{n+2}C_3 + ... + n.{}^{2n-1}C_3$ is ${}^{2n}C_5 + {}^nC_5 + (n-k){}^{2n}C_4$ then the value of k is ....

Q47 The sum $\sum_{k=1}^{19} \frac{(-2)^k}{k!(19-k)!}$ as a simple fraction is $\frac{-\lambda}{19!}$ then λ equals

Q48 The value of "a" for which all roots of quadratic equation, $f(x) = (a-2)x^2 + 2ax + a + 3 = 0$ lies in (– 2, 1) belongs to $\left(-\infty, -\frac{1}{4}\right) \cup$ (m, n] then value of n – m is

Q49 If $y = (\sin x + \operatorname{cosec} x)^2 + (\cos x + \sec x)^2$ then minimum value of y ∀ x∈R is

Q50 The sum $\sum_{r=1}^{2009} \cos\left(\frac{r\pi}{6}\right)$ equals

Q51 (1 – cot 1°) (1– cot 2°) (1– cot 3°) … (1 – cot 44°) = 2^n then n = 10 k + k. What is k

Q52 The number of points on hyperbola $xy = c^2$ from which two tangents drawn to ellipse is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ (where $b < a < c$) are perpendicular to each other is ………….

Q53 If 11 A.M.'s are inserted between 28 & 10, then number of integral A.M'.s are ………

Q54 Minimum value of $\frac{3}{x} + \frac{9}{y} + xy$ is 9k find k (x, y, z are positive real numbers)

Answer Key

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**A**	**B**	**A, C, D**	**B, C**	**A, C**	**B**	**2**	**2**	**4**	**5**
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	**5**	**8**	**2**	**3**	**2**	**8**	**3**	**3**	**C**	**D**
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	**C, D**	**C**	**A, B, C**	**B, C, D**	**5**	**7**	**2**	**5**	**2**	**7**
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	**4**	**5**	**3**	**9**	**5**	**9**	**B**	**C**	**A, C, D**	**B, C**
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	**A, C**	**B, C, D**	**3**	**1**	**8**	**0**	**2**	**1**	**9**	**0**
Que.	51	52	53	54						
Ans.	**2**	**0**	**5**	**1**						