IIT-JEE-2012-P2-Model

Time:2:00 PM to 5:00 PM **IMPORTANT INSTRUCTIONS** Max Marks: 198

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 8)	Questions with Single Correct Choice	3	-1	8	24
Sec – II(Q.N : 9 – 14)	Questions with Comprehension Type (3 Comprehensions : 2+2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 15 – 20)	Questions with Multiple Correct Choice	4	0	6	24
Total				**20**	**66**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 21 – 28)	Questions with Single Correct Choice	3	-1	8	24
Sec – II(Q.N : 29 – 34)	Questions with Comprehension Type (3 Comprehensions : 2+2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 35 – 40)	Questions with Multiple Correct Choice	4	0	6	24
Total				**20**	**66**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : (41 – 48)	Questions with Single Correct Choice	3	-1	8	24
Sec – II(Q.N : (49 – 54)	Questions with Comprehension Type (3 Comprehensions : 2+2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 55 – 60)	Questions with Multiple Correct Choice	4	0	6	24
Total				**20**	**66**

PHYSICS: **Max. Marks : 66**

SECTION – I

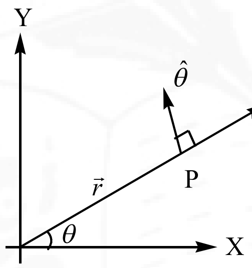
(SINGLE CORRECT CHOICE TYPE)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct**

1. A particle is describing a uniform circular motion centered at (0,0,5m). At the instant when the particle is located at P(3m, 4m,5m), it is observed to have a linear velocity of $\vec{V} = (8\hat{i} - 6\hat{j})m/s$. Find the angular velocity of the particle at the same instant, with respect to a fixed point $Q(3m, 3m, 4m)$

A) $\sqrt{41}rad/s$ B) $\sqrt{26}rad/s$ C) $5\sqrt{2}rad/s$ D) $10rad/s$

2. In the figure shown, p is a point in x-y plane whose position vector is $\vec{r}$. $\hat{r}$ and $\hat{\theta}$ are the unit vectors along $\vec{r}$ and perpendicular to $\vec{r}$ respectively in x-y plane as shown.



Then, $\left| \hat{r} \times \hat{\theta} + \frac{d\hat{r}}{d\theta} \times \frac{d\hat{\theta}}{d\theta} + \frac{d^2\hat{r}}{d\theta^2} \times \frac{d^2}{d\theta^2}\hat{\theta} + ... + \frac{d^{10}}{d\theta^{10}}\hat{r} \times \frac{d^{10}}{d\theta^{10}}\hat{\theta} \right| =$

A) zero B) 1 C) 10 D) 11

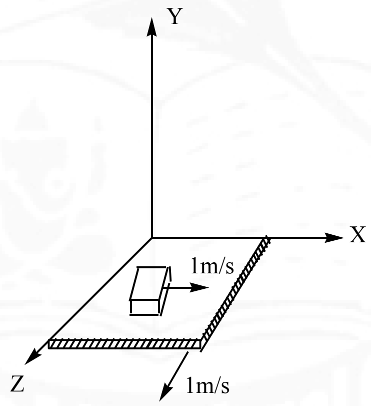
3. A block of mass 12kg is located on a horizontal surface (XY-plane) at a point (10m, 0,0). Coefficient friction between the block and the horizontal is $\mu = 0.4$. The region also consists of a conservative force field of potential energy $\left(g = 10m/s^2\right)$.

$U\left(x\right) = -x^3 + 75x - 234$ for $\left|x\right| \le 6$ = zero for $\left|x\right| > 6$

Find the minimum kinetic energy with which the block must be projected towards the origin so that the block can reach the origin.

A) 16J B) 336J C) 256J D) 300J

4. A block of mass 1kg is kept over a plank of 2kg and the whole system is kept on a xz-plane, which is horizontal. The block is being moved with a constant velocity $\vec{u}_1 = \hat{i}\ m/s$ and the plank is moved with a constant velocity $\vec{u}_2 = \hat{k}\ m/s$. If the coefficient of friction between the block and the plank is $\mu = 0.1$. The rate at which mechanical energy is being dissipate at the interface of block and plank is $\left(\vec{g} = -10\hat{j} m/s^2\right)$:

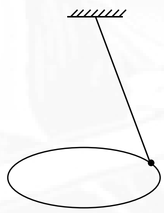


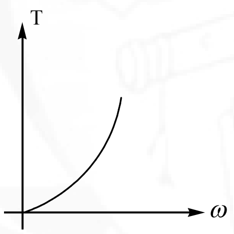
A) 1J/s B) 2J/s C) $\sqrt{2} J/s$ D) $\frac{1}{\sqrt{2}} J/s$

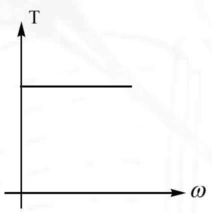
5. A block of mass $m = 1kg$ connected at one end of long spring of force constant $k = 100N/m$ is placed on a rough floor. Coefficient of kinetic friction between the floor and the block is $\mu_k = 0.47$. Now the free end of the spring is pulled horizontally away from the block by gradually increasing force and at the moment when the block starts sliding, the end of spring being pulled is stopped and is held at rest thereafter. The block stops after sliding a distance of $s = 6mm$. Then coefficient of static friction between the block and the floor is : $\left[g = 10m/s^2\right]$

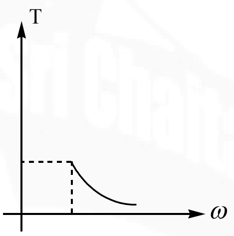
A) 0.5 B) 0.6 C) 0.62 D) 0.64

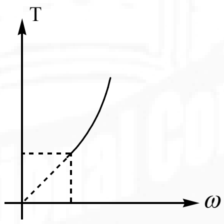
6. In a conical pendulum, the bob is rotated with different angular velocities (ω) and tension (T) in the string is calculated for different values of 'ω' which of them is correct graph between T and ω?



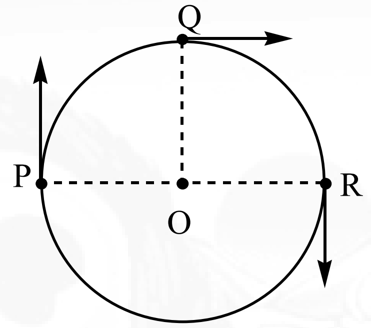
A) 

B) 

C) 

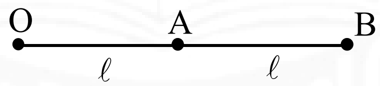
D) 

7. Three point particles, P,Q,R move in a circle of radius 'r' with different but constant speeds. They start moving at t=0 from their initial positions as shown in the figure. The angular velocities of P,Q, and R are $5\pi \text{rad/s}$, $2\pi \text{rad/s}$ and $3\pi \text{rad/s}$ respectively. The time interval after which they are at same angular position is



A) $2/3$ sec B) $1/6$ sec C) $1/2$ sec D) $3/2$ sec

8. In the figure shown, particles A and B are momentarily located on a straight line OB, where 'O' is a fixed point. At the instant shown, angular velocity of A with respect to 'O' is ω_1 in counter-clockwise direction and angular velocity of 'B' with respect to 'O' is ω_2 in clockwise direction. Then, find the angular velocity of B with respect to A at the same instant shown.



A) $\omega_1+\omega_2$ B) $\omega_1-\omega_2$ C) $\omega_1+2\omega_2$ D) $2\omega_1+\omega_1$

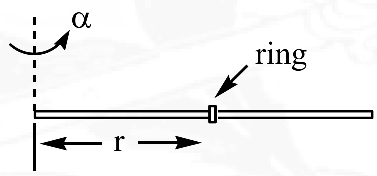
SECTION - II

(COMPREHENSION TYPE)

This section contains **6 multiple choice questions** relating to three paragraphs with two questions on each paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE is correct.**

Paragraph for Questions 9 and 10

A rod of circular cross-section is mounted on a vertical axle passing through the end 'O' of the rod. A ring of mass 'm' is just fitted through onto the rod as shown in figure. Coefficient of friction between the ring and the rod is μ. Initially, the system is at rest and at time t=0, the rod starts rotating in horizontal plane with a constant angular acceleration 'α'. Consider the following two cases:



Case-1: Inner cross-section of the ring is a circle of diameter slightly more than that of cross-section of the rod.

Case-2: Inner cross-section of the ring is a square of edge length slightly more that the diameter of cross-section of the rod.

9. In case 1, the time at which the ring slips on the rod is

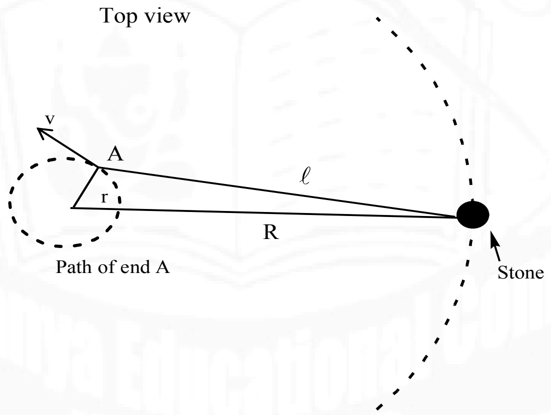
A) $\sqrt{\frac{\mu}{\alpha^2 r}\sqrt{\left(g^2+(r\alpha)^2\right)}}$ B) $\sqrt{\frac{\alpha^2 r}{\mu}\sqrt{\left[g^2+(r\alpha)^2\right]}}$ C) $\sqrt{\frac{\mu}{\alpha^2 r}[g+r\alpha]}$ D) $\sqrt{\frac{\alpha^2 r}{\mu}[g+r\alpha]}$

10. In case 2, the time at which the ring slips on the rod is :

A) $\sqrt{\frac{\mu}{\alpha^2 r}\sqrt{\left(g^2+(r\alpha)^2\right)}}$ B) $\sqrt{\frac{\alpha^2 r}{\mu}\sqrt{\left[g^2+(r\alpha)^2\right]}}$ C) $\sqrt{\frac{\mu}{\alpha^2 r}[g+r\alpha]}$ D) $\sqrt{\frac{\alpha^2 r}{\mu}[g+r\alpha]}$

Paragraph for Questions 11 and 12

To Whirl a stone tied to a cord, one has to hold the free end of the cord and move it in a circular path pulling the stone. Suppose you whirl a stone of mass m in a horizontal circle with the help of a light inextensible cord of length 'l'. For the purpose, you hold the free end A of the cord and move it with a speed 'V' on a horizontal circular path of radius r and the stone moves with the same period on a circular path of radius R. At sufficiently great speed 'V', tension in the cord becomes so large that effect of gravity can be neglected but at this speed, air resistance becomes considerable. Mass of the stone is m and acceleration due to gravity in 'g'.



11. Speed of the particle is :

A) $\frac{V}{r}R$ B) $\frac{V}{r}\sqrt{R^2+\ell^2-r^2}$ C) $\frac{V}{r}\sqrt{R^2+\ell^2-r\ell}$ D) $\frac{V}{r}\sqrt{R^2+r^2}$

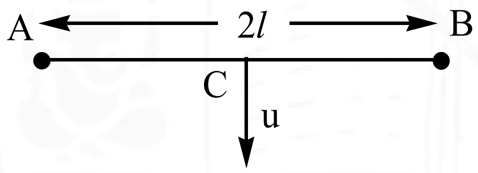
12. If speed of the particle becomes constant, rate of work done by the whirling hand on the free end A is :

A) $\frac{mV^3}{r^3}R^2\sqrt{\frac{4R^2\ell^2}{\left(R^2+\ell^2-r^2\right)^2}-1}$ B) $\frac{mV^3R}{r^3}\sqrt{\left(R^2+\ell^2-r^2\right)\left[\frac{4R^2\ell^2}{\left(R^2+\ell^2-r^2\right)^2}-1\right]}$

C) $\frac{mV^3}{r^3}\sqrt{\left(R^2+\ell^2-r\ell\right)\left[\frac{4R^2\ell^2}{\left(R^2+\ell^2-r^2\right)^2}-1\right]}$ D) $\frac{mV^3R}{r^3}\sqrt{\left(R^2+r^2\right)\left[\frac{4R^2\ell^2}{\left(R^2+\ell^2-r^2\right)^2}-1\right]}$

Paragraph for Questions 13 and 14

Two particles A and B of mass m each are attached to two ends of an ideal string of length 2ℓ and the entire arrangement is placed on a smooth horizontal surface so that the separation between A and B is $2l$, as shown. Now, mid point of the string 'C' is being pulled by an external agent with a force F so that 'C' moves with a constant velocity u which is directed perpendicular to initial orientation of the string.



13. At the moment when A and B are about to collide with each other, find the relative velocity between A and B.

A) u B) 2u C) $\sqrt{2}u$ D) $2\sqrt{2}u$

14. Find the work done by F on the particle A until it collides with B.

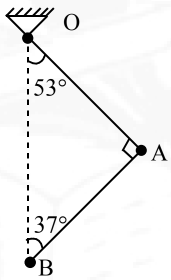
A) mu^2 B) $\frac{1}{2}mu^2$ C) $2mu^2$ D) zero

SECTION – III

(MULTIPLE CORRECT CHOICE TYPE)

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE is/ are correct**

15. In the figure, there are two particles A & B, each of mass 'm'. A is connected to ceiling by a light inextensible thread OA and B is connected to A by a light inextensible thread AB. Initially, B is vertically below 'O' and the strings are taut as shown. If the system is released from rest, immediately after the release, $\left[\tan 37 \approx \frac{3}{4}\right]$



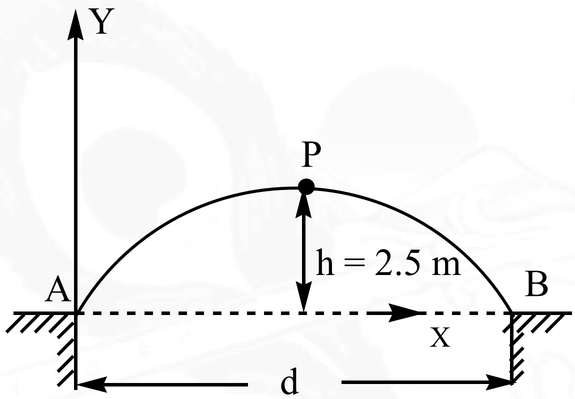
A) tension in the string OA will be $\frac{3mg}{5}$

B) tension in the string AB will be $\frac{4mg}{5}$

C) acceleration of A is equal to $\frac{4g}{5}$

D) acceleration of B is equal to $\frac{3g}{5}$

16. Two banks, A and B of a canal of width d=10m are connected by a bridge whose longitudinal section is a parabolic arc, which is symmetric with respect to A and B. The highest point (P) of the path is h=2.5m above the level of the banks. A car with mass $M = 1000kg$ traverses the bridge at a constant speed of $V = 5\sqrt{2}m/s$. Origin of coordinate system is at 'A'. $\left[g = 10m/s^2\right]$.



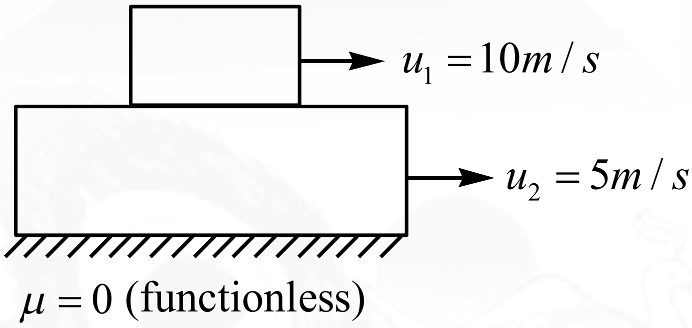
A) Equation of the parabolic track is $y = x - \frac{x^2}{10}$

B) Radius of curvature of the track on the bridge at its highest point P is R=1m

C) Radius of curvature of the track on the bridge at its highest point P is R=5m

D) Normal contact force exerted by the car on the track at P is zero.

17. Consider two blocks made of an exotic material. The friction force between the blocks opposes the relative motion of the blocks and has a magnitude $f = k|\vec{u}_1 - \vec{u}_2|$, where $\vec{u}_1$ and $\vec{u}_2$ are velocities of the blocks. If $k = 2N - s/m$



A) Power delivered by friction 'f' to the upper block is -50W

B) Power delivered by friction 'f' to the lower block is 50W

C) Total power delivered by friction 'f' to the system of blocks is -50W

D) In a frame attached to lower block, power delivered by f to the lower block is -50W

18. In which of the following cases acceleration of the particle must have a constant magnitude during the motion?

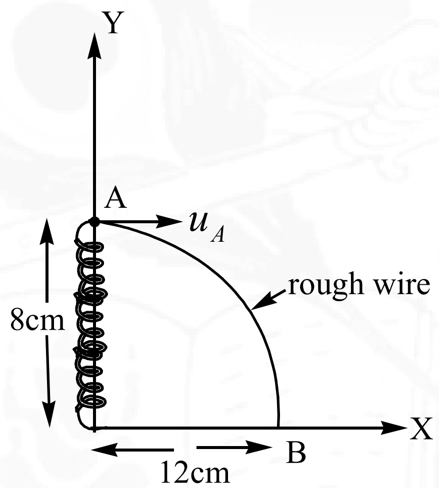
A) A uniform circular path

B) A helical path with constant speed and uniform pitch

C) Spiral path

D) Parabolic path

19. A ring of mass 200g is attached to one end of a light spring of force constant $100N/m$ and natural length 10cm. The ring is constrained to move on a rough wire in the shape of a quarter ellipse of major axis 24cm and minor axis 16cm with its centre at origin. The plane of the ellipse is vertical and wire is fixed at points A and B as shown. Initially, the ring is at A with other end of the spring fixed at origin. The ring is given a horizontal velocity $u_A = 10m/s$ towards right so that it just reaches point B. Then $\left[g = 10m/s^2\right]$



A) work done by friction on the ring is -10J

B) work done by spring is -8J

C) work done by friction on the ring is -10.16J

D) work done by spring on the support at 'O' is zero

20. A boy starts running from rest on a sand beach and increases his speed to 'u' in first 't' second. If mass of the boy is 'm',

A) Average force exerted by sand on the boy is $\frac{mu}{t}$

B) Total work done by the boy in the interval of time is $\frac{1}{2}mu^2$

C) Average force exerted by sand on the boy is greater than $\frac{mu}{t}$

D) Total work done by the boy in the interval of time is greater than $\frac{1}{2}mu^2$