JEE-ADVANCED-2012-P1-Model

Time: 3:00 Hrs. **IMPORTANT INSTRUCTIONS** Max Marks: 210

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 10)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N : 11 – 15)	Questions with Multiple Correct Choice	4	0	5	20
Sec – III(Q.N : 16 – 20)	Questions with Integer Answer Type	4	0	5	20
Total				**20**	**70**

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 21 – 30)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N : 31 – 35)	Questions with Multiple Correct Choice	4	0	5	20
Sec – III(Q.N : 36 – 40)	Questions with Integer Answer Type	4	0	5	20
Total				**20**	**70**

MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 41 – 50)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N : 51 – 55)	Questions with Multiple Correct Choice	4	0	5	20
Sec – III(Q.N : 56 – 60)	Questions with Integer Answer Type	4	0	5	20
Total				**20**	**70**

PHYSICS **Max.Marks:70**

SECTION – I

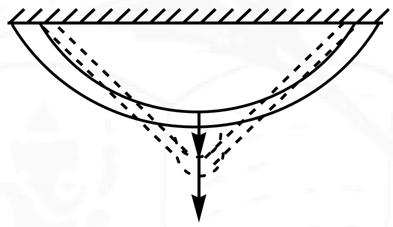
(SINGLE CORRECT CHOICE TYPE)

This section contains 10 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 pendulum whose cord makes an angle of $\theta_o = 53^o$ with vertical is released from rest. Magnitude of minimum acceleration of the bob during its subsequent motion is : $\left[\tan 53^o \approx 4/3\right]$

A) $\frac{2g}{5}$ B) $\frac{3g}{5}$ C) $\frac{4g}{5}$ D) $\frac{\sqrt{13}g}{5}$

2. A rope is hanging from the ceiling as shown in figure. If lower part of the rope is pulled down slowly as shown in figure, centre of gravity of the rope [Neglect deformation of the rope]



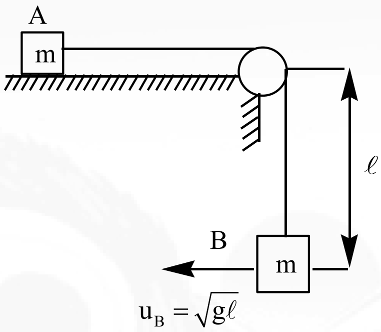
A) moves down

B) rises up

C) First moves down and then rises up

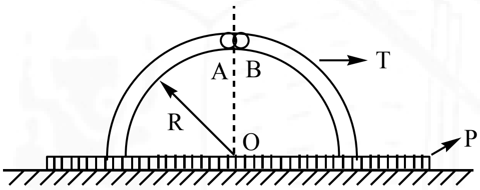
D) First rises and then moves down

3. Two small objects A and B of mass 'm' each are arranged as shown in figure. Initially, A is at rest, B is at a distance ℓ below the pulley. The block B is given an initial velocity of $u_B = \sqrt{g\ell}$ horizontally as shown and the system is left free. Friction is neglected everywhere. Acceleration of the block B at the same instant is:



A) zero
B) g vertically upwards
C) g vertically downwards
D) g/2 vertically upwards

4. A massless cylindrical tube (T) which is bent into a semicircle is attached to a massless horizontal platform P. The configuration is kept on a horizontal surface. Two identical small balls, A & B that fit just loosely inside the tube are simultaneously released from the top inside tube as shown.



Neglect size of the balls as compared to radius 'R' of the tube. Find angular displacement of the ball 'A' with respect to 'O' when the platform 'p' breaks-off the horizontal surface

A) $\pi/3$
B) $\cos^{-1}(2/3)$
C) $\pi/2$
D) 'P' never bounces off the horizontal

5. Two particles A and B of masses $m_A = 10kg$ and $m_B = 1kg$ carry charges $q_A = q_B = 10\mu C$. They are initially kept at a separation $'r_0'$. Consider the following three cases:

Case-1: 'A' is fixed and B moves out to a separation of $'2r_0'$ from A.

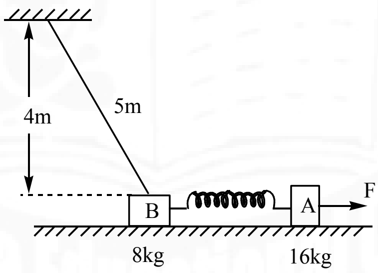
Case-2: B is fixed and A moves out to separation of $'2r_0'$ from B.

Case-3: Both A and B are allowed to move out until the separation between them becomes $'2r_0'$.

Let W_1, W_2 and W_3 be the total works done by electric interaction between A and B in case 1,2 and 3 respectively. Then,

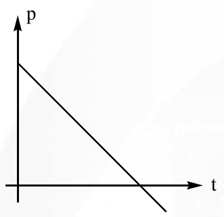
A) $W_1 < W_3 < W_2$ B) $W_2 < W_3 < W_1$ C) $W_1 = W_2 < W_3$ D) $W_1 = W_2 = W_3$

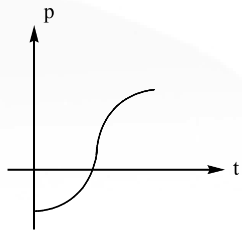
6. Two blocks having masses $m_A = 16kg$ and $m_B = 8kg$ are connected to the two ends of a light spring. The system is placed on a smooth horizontal floor. An inextensible string also connects B with ceiling as shown in figure. Length of the string is 5m and is just taut at the initial moment. Initially, the spring has its natural length. A constant horizontal force of magnitude F is applied to the heavier block as shown. The maximum value of F so that the block 'B' does not loose contact with the ground is:

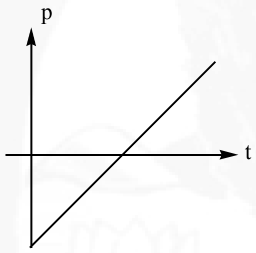


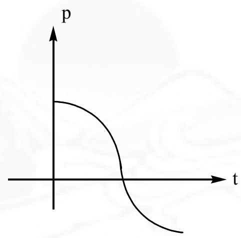
A) 120N B) 60N C) 30N D) infinitely large

7. A projectile is thrown with a velocity u at an angle 'θ' with horizontal. The graph showing the correct variation of instantaneous power due to gravity on the particle will be:

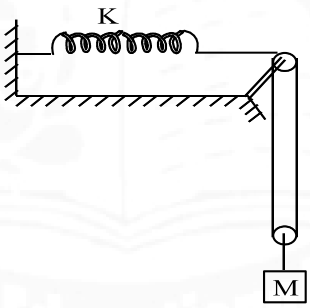
A) 

B) 

C) 

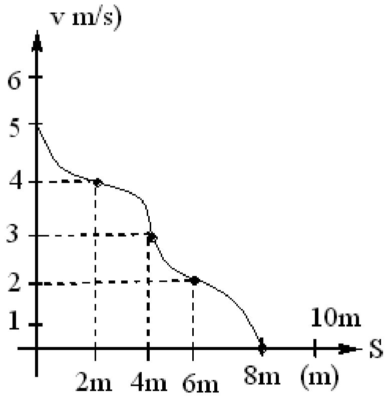
D) 

8. Block of mass M in the figure is released from rest when the extension in the spring is $x_0\left(<\frac{Mg}{2k}\right)$. The maximum downward displacement of the block is



A) $\frac{Mg}{2k}-x_0$ B) $\frac{Mg}{2k}+x_0$ C) $\frac{2Mg}{k}-x_0$ D) $\frac{2Mg}{k}+x_0$

9. On a rough horizontal surface, coefficient of friction is not uniform. A small disk is projected with an initial speed of $u_1 = 5m/s$ which stops after covering 8m on the surface. Variation of speed v with distance(s) covered is shown in figure. When the disk is projected with an initial speed of $u_2 = 4m/s$ from the same initial point along the same path, how much distance will it cover before it stops?



A) 2m B) 4m C) 6m

D) Can not be determined with the given information

10. A cyclist is riding a bicycle on a circular track in horizontal plane with maximum possible speed on the track. Coefficient of friction between the track and the cycle tyres is μ. On seeing a cat on the track, the cyclist applies brakes so hard that the tyres of the cycle stop rotating abruptly. Let $\vec{a}_1$ and $\vec{a}_2$ be the accelerations of the bicycle just before and just after the brakes are applied , then $|\vec{a}_2 - \vec{a}_1|$ is

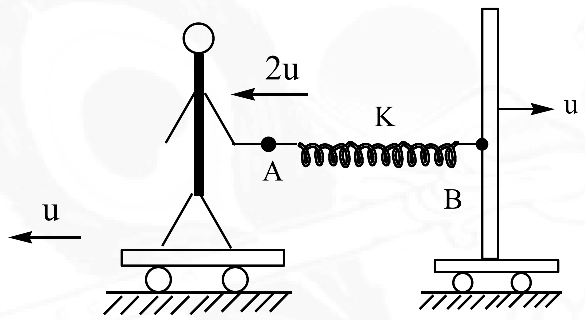
A) μg B) $2\mu g$ C) zero D) $\sqrt{2}\mu g$

SECTION – II

(MULTIPLE CORRECT CHOICE TYPE)

This section contains 5 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

11. End 'B' of an ideal spring is attached to a wall moving with a constant velocity 'u' towards right. The other end A is held by a man who is travelling on a trolley with a constant velocity 'u' towards left. At time "t = 0", the spring is in relaxed state and the man starts pulling end 'A' towards left with a constant velocity 2u.



Stiffness constant of the spring is $K = {10N}/{cm}$. When deformation in the spring becomes $\Delta\ell = 6\text{cm}$, (Assume no slip between the man and trolley]

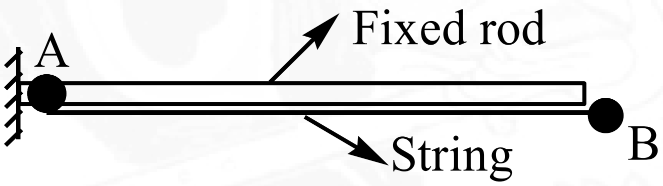
A) work done by man on the spring from t=0 is 1.2 J

B) work done by man on the trolley from $t = 0$ is -0.6J

C) work done by wall on the spring from $t = 0$ is 0.6 J

D) Total work done by the spring is -1.8 J

12. A ball A of mass m=2kg can slide without friction on a fixed horizontal rod which is led through a diametric hole across the ball. There is another ball B of the same mass 'm' attached to the first ball by a thin thread of length $\ell = 1.6\text{m}$. Initially the balls are at rest. The thread is taut and is initially oriented in horizontal direction as shown in figure. Then, the ball B is released with zero initial velocity. At the instant when the string becomes vertical,



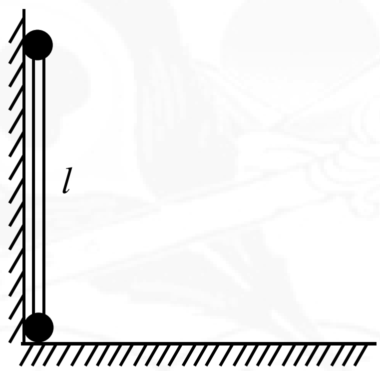
A) velocity of A is $\sqrt{g\ell}$ towards right

B) Acceleration of A is zero

C) Acceleration of B is g in vertically upward direction

D) Tension in the string is 2mg

13. A dumbbell is constructed by fixing small identical balls at the ends of a light rod of length 'l'. The dumbbell stands vertically in the corner formed by a frictionless wall and frictionless floor. When it is slightly disturbed, the dumbbell begins to slide and the lower ball moves towards right. At the instant when the upper ball leaves the wall, (mass of each ball is m)



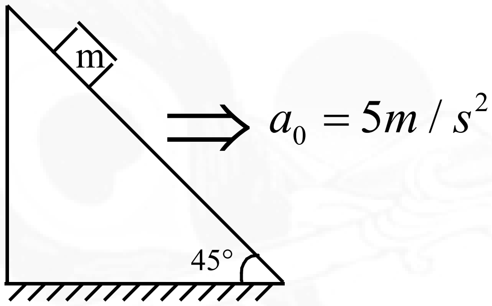
A) tension developed in the connecting rod is $\frac{\sqrt{3}}{7}mg$

B) tension developed in the connecting rod is zero

C) acceleration of the lower ball is $\sqrt{3/7}\,g$

D) acceleration of the upper ball is g

14. A block of mass m = 2kg is kept on a wedge as shown in figure. Coefficient of friction between the block and the incline surface of the wedge is $\mu = 0.2$. At time 't' = 0, the block is at rest and the wedge starts moving towards right, from rest, with a constant acceleration of $a_0 = 5m/s^2$. During the interval t = 0 to 1s



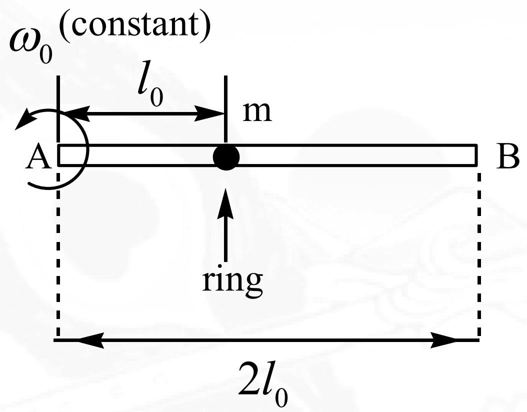
A) Work done by normal contact force acting on the block (from wedge) is 37.5 J

B) Total work done by internal friction between the block and the wedge is 3J

C) Total work done by internal normal contact force between the block and the wedge is zero

D) Mechanical energy dissipated at the interface between the block and the wedge is: 3J

15. A ring of mass 'm' is just loosely fit on a frictionless rod AB of length $2l_0$ which rotates in horizontal plane with a constant angular velocity ω_0. Initially the ring is located at a distance l_0 from the end A. Now, the ring is left free and is allowed to slide along the rod. In the subsequent motion,



A) Component of acceleration of the ring parallel to rod is zero

B) Component of velocity of the ring parallel to rod as a function of its radial distance $r\left(>l_0\right)$ is $v_r = \omega_0\sqrt{\left(r^2 - l_0^2\right)}$

C) Component of acceleration of the ring perpendicular to rod is zero

D) work done by the rod, on the ring when the ring leaves the rod is $\frac{3}{2} m\omega_0^2 l_0^2$

SECTION –III

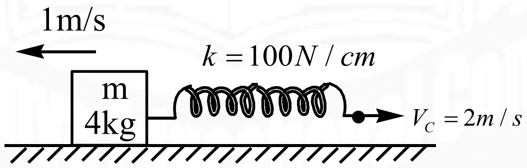
(INTEGER ANSWER TYPE)

This section contains 5 questions . The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened.

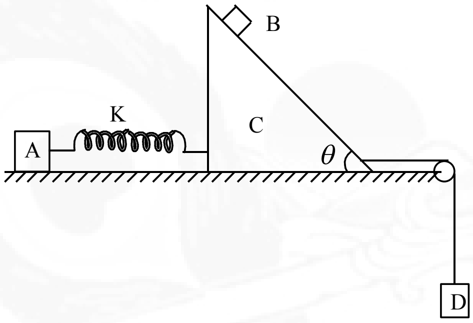
16. Potential energy of a particle of mass 'm' in a two dimensional potential field is expressed by the relation, $U = \dfrac{kx}{(x^2 + y^2)}$. Here K is a positive constant and 'x' and 'y' are position coordinates. At an instant, a particle is located at a point defined by a position vector $\vec{r} = (\hat{i} + \hat{j})$, is observed to be moving perpendicular to $\vec{r}$. At the same time let a_t and a_n be the magnitudes of tangential and normal accelerations of the particle respectively. Then find the ratio of $\dfrac{a_t}{a_n}$

17. A circle of radius $R = \pi m$ is drawn on a fixed board using a piece of chalk. Coefficient of friction between the board and the chalk is $\mu = 0.1$ and the normal force on the board due to the chalk has a constant magnitude of $F_N = 8N$. If 'W' is the magnitude of work done (in joule) by the friction exerted by the chalk on the board, then find $\dfrac{W}{2} + 1$. [Assume $10 \approx \pi^2$]

18. The spring block system lies on a smooth horizontal surface. The free end of the spring is pulled towards right with a constant speed $V_C = 2m/s$. At time t = 0sec, the spring of constant $K = 100N/cm$ is unstretched and the block has a speed of 1m/s to left. The maximum extension of the spring in cm is?



19. Consider a system shown in figure. $m_A = m_B = m_C = m_D = 2kg$. Friction is neglected everywhere and the spring is initially unstretched. The system is released from rest. It is observed that, at an instant when the vertical displacement of block B is 2m the block 'D' descends by 4m and the block 'A' moves towards right by 1m. Given that stiffness constant of the spring is $k = \frac{226}{9} N/m$. Find the total kinetic energy of the system at the same instant. Express your answer in joule $\left(g = 10m/s^2\right)$.



20. A horizontal platform is rotating with a constant angular velocity $\omega_o = 2rad/s$. A particle 'P' of mass m=1kg is revolving around the axis of platform with an angular velocity $\omega = 3rad/s$ in a circle of radius r=1m. An observer 'A' is standing on the platform at a distance r=1m from the axis as shown so that A is always facing the axis of rotation of the platform. Find the centrifugal force acting on the particle 'P' as observed by A in newton.