Code: Phy/NLM-II/S/001

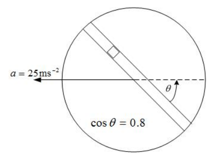
Newton's Laws of Motion - II: Subjective Questions (Typical)

No of Questions:10 *Time Allotted: 1 Hours*

All questions are compulsory

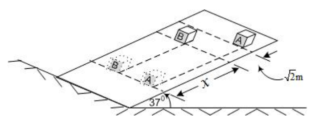
Q-01

A circular disc with a grove along its diameter is placed horizontally. A block of mass 1 kg is placed as shown in Figure. The coefficient of friction between block and all surfaces of groove in contact is $\mu = 0.4$. The disc has an acceleration of 25m.s^{-2}.[Given $g = 10\text{m.s}^{-2}$]. Find acceleration of the block w.r.t. the disc.



Q-02

Two identical blocks A and B are placed on a rough inclined plane at an inclination of 45°. The coefficient of friction between block A and plane is 0.2 and that between block B and the plane is 0.3. The initial separation between the blocks is $\sqrt{2}$ m. The blocks are released from rest. $g = 10\text{m.s}^{-2}$. Find -

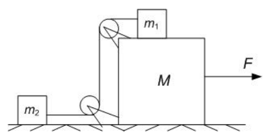


(a) Time after which front when both blocks come in line.

(b) Distance moved by each block for attaining position at (a) above

Q-03

In the given figure masses m_1, m_2 and M are 20 kg, 5 kg and 50 kg respectively. The coefficient of friction between m_1 and M, and between m_2. and ground is 0.3. The pulleys and the string are massless. The string is perfectly horizontal between m_1 and pulley P_1, and between m_2 and P_2. Whereas string is perfectly vertical between P_1 and P_2. An external force F is applied horizontally on mass M. Take $g = 10\text{m.s}^{-2}$.



(a) Draw a free body diagram for mass M, clearly showing all forces.

(b) Let the magnitude of the force of friction between m_1 and M be f_1 and m_2 and ground be f_2. For a particular force F it is found that $f_1 = 2 \times f_2$. Find f_1 and f_2. Write equation of motion of all masses. Find F, tension in the string and acceleration of masses.

Q-04

Two blocks of mass $m_1 = 10$ kg and $m_2 = 5$ kg connected to each other by a massless in-extensible string of 0.3 m, are placed along diameter of a turn-table. The coefficient of friction between the table and m_1 is 0.5 while there is no friction between m_2 and the table. The table is rotating with an angular velocity of 10 rad/sec about its vertical axis passing through its centre. Masses are so placed that they are on either side of centre with m_1 at a distance 0.124 m from the centre. The masses are observed to be at rest w.r.t. an observer on the turntable.

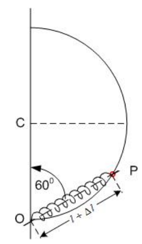
(a) Calculate the frictional force on m_1

(b) What should be the minimum angular speed of the turn table so that masses will start slipping from their positions?

(c) How should the masses be placed with the string remaining taut, so that there is no frictional force acting on the mass m_1?

Q-05

A smooth semicircular wire-track of radius R is fixed in a vertical plane. One end of a massless spring of natural length $\frac{3R}{4}$ and spring constant $K = \frac{mg}{R}$ is attached to the lowest point O of the wire-track. A small ring of mass m, which can freely slide on the track, is attached to other end of the spring.The ring is held stationary at point P such that the spring makes an angle of 60° with the vertical. The instant when spring is released from point P -



(a) Draw free body diagram of the ring

(b) Find tangential acceleration of the ring and the normal reaction

Q-06

A hemispherical bowl, with frictionless inner surface, of radius $r = 0.1$ m is placed with its axis vertical. The bowl is set in rotation with an angular velocity ω. A particle of mass 10^{-2} kg is. placed on inner surface of the bowl and it is stationary w.r.t. bowl. Find -

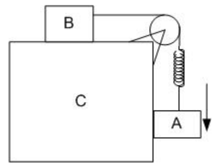
(a) Height h of the particle as function of ω.

(b) What is the minimum value of ω in order to have h a non-zero value?

(c) It is desired to measure g (acceleration due to gravity) using this experimental set-up, by measuring h; assuming that r and ω are known. The least-count in measurement of h is 10^{-4}. What is the minimum possible error in measured value of g, i.e. Δg

Q-07

Two blocks A and B are connected to each other by massless string, spring and pulley as shown in the figure. Block B slides over the horizontal top surface of a stationary block C, and block A slides along the vertical side of block C. Both blocks A and B are sliding with uniform speed. Coefficient of friction between surfaces of the blocks is 0.2. Force constant of spring is $K = 1960$ N/m. If mass of the block A is 2 kg, calculate - **a** mass of the block B and **b** energy stored in the spring, [Given that $g = 9.8$ m·s^{-2}]



<table>
<tr><td>Q-08</td><td>In figure (a)and (b) AC, DG and GF are fixed inclined planes. Further, BC=EF=x and AB=DE=y. A small block of mass M is released from point A and reaches C with a speed V_C. The same block is released from D at a state of rest and reaches point F with speed V_F. Coefficient of friction between the block and both the surfaces AC and DGF are μ. Calculate V_C and V_F.-

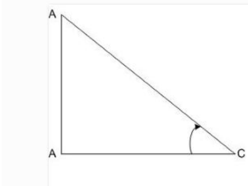
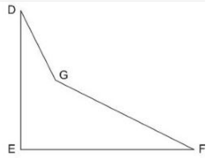


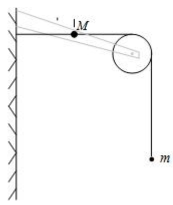
Figure-(a)



Figure(b)</td></tr>
<tr><td>Q-9</td><td>A bullet of mass M is fired up with a velocity of 50 m$\cdot$ s^{-1} at an angle θ with horizontal. At the highest point of its path, it collides with a bomb of mass $3M$ suspended from a massless string of length $\dfrac{10}{3}$ m and gets embedded in the bob. After collision, the bob moves through an angle of 120°. , until string remains stretched, after which it starts collapsing. [Given that $g = 10$ m.s^{-2}]

(a) The angle θ.

(b) Horizontal and Vertical coordinates of the initial position of the bob w.r.t. the point of firing of bullet.</td></tr>
<tr><td>Q-10</td><td>An in-extensible string with one end fixed on a rigid wall, passing over a fixed frictionless pulley at a distance of 2 m from the wall, has a point mass $M = 2$ kg attached to it at a distance 1 m from the fixed end. A mass $m = 0.5$ kg at the free end of the string attached at free end of the string is held such that that string is horizontal between wall and pulley. What will be the speed with the mass M will hit the wall when mass m will be released? [Given $g = 9.8$M$\cdot$s^{-2}]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