BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI (RAJ)

Comprehensive Exam (CLOSED BOOK)

FIRST SEMESTER 2016-2017

GENERAL PHYSICS (PHY F112)

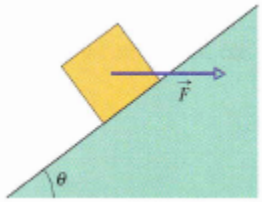
Date: 02-12-2016 Max. Time: 120 minutes Max. Marks: 75

Note: 1) Number all the pages in the answer sheets on the **top right corner.**

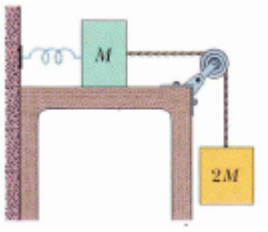
2) **Prepare an index** on page 1 listing the question number attempted and the corresponding page number.

3) Answer all the parts of a question **in continuation.**

Q.1 In Fig, a 5.0 kg block is sent sliding up a plane inclined at $\theta = 37^0$ while a horizontal force F of magnitude 50 N acts on it. The coefficient of kinetic friction between block and plane is 0.30. What are the (a) magnitude and (b) direction (up or down the plane) of the block's acceleration? The block's initial speed is 4.0 m/s. (c) How far up the plane does the block go? (7+2+3)



Q.2 Two blocks, of masses M =2kg and 2M, are connected to a spring of spring constant k =200 N/m that has one end fixed, as shown in Fig. The horizontal surface and the pulley are frictionless, and the pulley has negligible mass. The blocks are released from rest with the spring relaxed. (a) What is the combined kinetic energy of the two blocks when the hanging block has fallen 0.090 m? (b) what is the kinetic energy of the hanging block when it has fallen that 0.090 m? (c) What maximum distance does the hanging block fall before momentarily stopping? (4+4+4)

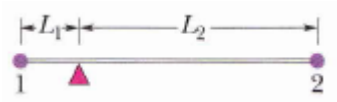


Q.3 A merry-go-round of radius R has moment of inertia I and is rotating freely at angular speed ω.

(a) A boy of mass m_b runs straight toward the center of merry-go-round at speed v_b, and leaps on. Find the angular speed ω_1 of merry-go-round once the boy is seated on its rim. (3)

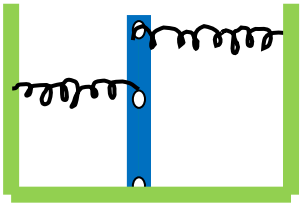
(b) If at the same time, at which the boy of part (a) leaps on, a girl of mass m_g running tangentially at speed v_g in the same direction as the merry-go-round's tangential velocity, also leaps on. Find the new angular speed ω_2 once both children are seated on the merry-go-round's rim. (12)

Q.4 Figure shows particles 1 and 2, each of mass m, fixed to the ends of a rigid mass- less rod of length $L_1 + L_2$, with $L_1 = 20$ cm and $L_2 = 80$ cm. The rod is held horizontally on the fulcrum and then released. What are the magnitudes of the initial accelerations of (a) particle 1 and (b) particle 2? (6+6)



Q.5 A rod of length l and mass m, pivoted at one end, is held by a spring at its midpoint and a spring at its far end, both pulling in opposite directions. The springs have spring constant k, and at equilibrium their pull is perpendicular to the rod.

Find the frequency of small oscillations about the equilibrium position. **(12)**



Q.6 (a) Object of mass 0.2 kg hung from a spring of spring constant 80 N/m. Resistive force $-bv$ acting on the object. If the damped frequency is $\frac{\sqrt{3}}{2}$ times the un-damped frequency, what is the value of b? (4)

(b) The equation for a wave travelling in x-direction on a string is
$y = (3.0\text{ cm})\sin[(3.14\text{cm}^{-1})\,x - 9314\text{s}^{-1})\,t]$.

(i) Find the maximum velocity of a particle of the string (4)

(ii) Find the acceleration of a particle at x = 6.0 cm at time t = 0.11s. (4)