PH 101
Mid-Semester Examination
Indian Institute of Technology Guwahati
Date: 22/09/2017
Time: 120 minutes
Maximum Marks: 30

Your Name:
Your Roll no. :

Submit the question paper and the answer script to the invigilator

PART-I

Put the correct option in the box provided at the end of the question paper
(For your calculations, you can use the answer script)

Each Question from Q.1 to Q. 20 carries 1 mark

1. A block of wood is sliding on the floor of a train. The block comes to rest after sliding 5 m when the train is stationary. When the train is in motion, the block comes to rest after sliding 4 m with respect to a stationary observer. We can conclude that the train is:
   (a) moving at a uniform speed in the direction of the sliding block.
   (b) moving at a uniform speed opposite to the direction of the sliding block.
   (c) accelerating in the the direction of the sliding block.
   (d) accelerating in the direction opposite to the direction of the sliding block.

2. When a body, falls through air, then in addition to the acceleration due to gravity, g, it also suffers a retardation whose magnitude is proportional to the speed, say bv, where b is a constant. Its motion can be represented by the equation: ($\dot{v}$ represents time derivative of v)

   (a) $\dot{v} + bv - g = 0$
   (b) $\dot{v} + bv + g = 0$
   (c) $\dot{v} - bv - g = 0$
   (d) $\dot{v} + bv + g = 0$

3. A long 100 kg plank rests on a smooth sheet of ice. A 50 kg boy is standing on the plank. He begins to walk at a speed of 1.0 m/s towards the end of the plank. His speed relative to an observer standing on earth is
   (a) 1.5 m/s (b) 1.0 m/s (c) 0.5 m/s (d) zero

4. A bowling ball is thrown down a narrow passageway with speed 14 m/s. Initially it slides without rolling, but due to friction it begins to roll. The speed of the ball when it rolls without sliding is (in m/s)
   (a) 14 (b) 10
   (c) 5 (d) 2

5. At t = 0, an elevator departs from the ground with uniform speed. At time t= 2s a child drops a marble through the floor. The marble falls with uniform acceleration $g = 10\ m/s^2$, and hits the ground at time t= 4s. The height of the elevator at time t= 2s is

   (a) 40 m (b) 10 m
   (c) 20 m (d) 2.5 m

6. In a system shown in Fig. 1, take the pulley as a uniform disc of mass 0.4 kg and frictionless, with $m = 2$ kg and $M = 5$ kg. During free fall, the acceleration of 5 kg mass will be:

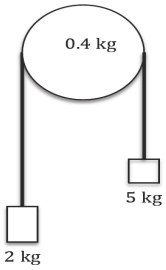

Fig. 1

(a) $3g/7$ (b) $3g/7.2$ (c) $3g/7.4$ (d) $2.8g/7$

7. If the radius of the earth were to shrink by 1%, its mass remaining the same, then g will:
(a) increase by 1% (b) increase by 2%
(c) decrease by 1% (d) decrease by 2%

8. A particle of mass m is moving in a horizontal circle of radius r under a force $\vec{F} = -\frac{k}{r^2}\hat{r}$, where k is a constant. The total energy of the particle is
(a) $-(k/2r)$ (b) $+(k/2r)$ (c) $-(k/r)$ (d) $+(k/r)$

9. A particle P of mass m, which is on the negative x-axis, is moving towards the origin with constant speed u. When P reaches the origin, it experiences the force $F = -Kx^2$ where K is a positive constant. The farthest point along the x-axis reached by the particle is

(a) $x = \left(\frac{2mu^2}{3K}\right)^{1/3}$ (b) $x = \left(\frac{3mu^2}{2K}\right)^{1/3}$ (c) $x = \left(\frac{2mu^2}{3K}\right)^{1/2}$ (d) $x = \left(\frac{3mu^2}{2K}\right)^{1/2}$

10. The rotational moment of inertia of a collapsing star changes to one third of its initial value. The ratio of the new kinetic energy to the initial rotational kinetic energy is
(a) 3:1 (b) 1:3 (c) 9:1 (d) 1:9

11. The displacement-momentum graph of a particle undergoing simple harmonic motion is
(a) a straight line (b) a parabola
(c) an ellipse (d) any curve depending upon initial conditions

12. Two identical particles of mass m move in a circle of radius r , 180^0 out of phase at an angular speed ω about the z-axis in a plane parallel to but a distance h above the x-y plane (Fig.2) The magnitude and the direction of the angular momentum $\vec{L}_O$ relative to the origin is:

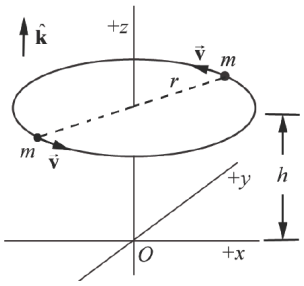

Fig. 2

(a) $-2m\omega rh\hat{k}$ (b)$2m\omega rh\hat{k}$
(c) $-2mr^2\omega\hat{k}$ (d) $2mr^2\omega\hat{k}$

13. A pendulum has period T on the surface of the earth. What is the effect on its period if its point of suspension is moved vertically up with acceleration $g/16$?
(a) pendulum stops oscillating (b) period becomes, $T' = T\frac{\sqrt{17}}{4}$
(c) period becomes, $T' = T\frac{4}{\sqrt{17}}$ (d) period becomes, $T' = T\frac{4}{\sqrt{15}}$

14. A box weighing 100 N is at rest on a horizontal floor. The co-efficient of static friction between the box and the floor is 0.4. What is the smallest force F exerted 30^0 north of east that can start the box in motion?

(a) 139.5 N (b) 37.5 N (c) 41.4 N (d) 60 N

15. An elevator starts from rest with a constant upward acceleration. It moves 2.0 m in the first 0.60 sec. A passenger in the elevator is holding a 3kg package by a vertical string. The tension in the string during the accelerating process is (take, $g = 10$ m/s^2)
(a) 3 N (b) 33 N (c) 63 N (d) 30 N

16. Two Wagons equal in weight are on the same rails. Wagon W_1 is at rest, wagon W_2 comes with a uniform velocity $\vec{v}$ collide with the wagon W_1 elastically. After collision,

(a) The two wagons will move with velocity $\vec{v}/2$
(b) The wagon W_2 will come to rest and wagon W_1 will move with velocity $\vec{v}$.
(c) The wagon W_2 will will move with velocity $-\vec{v}$ and wagon W_1 will move with velocity $+\vec{v}$.
(d) The wagon W_2 will will move with velocity $-\vec{v}/2$ and wagon W_1 will move with velocity $+\vec{v}/2$.

17. A wheel rolls without slipping with constant angular velocity along a horizontal floor. The velocity of a point on the rim
    (a) is maximum at the top and, is zero when in contact with the horizontal floor.
    (b) is constant throughout.
    (c) cannot be determined at any instant.
    (d) is zero at the top and, is maximum when in contact with the horizontal floor.

18. A small marble is at the top of a stationary ball of radius R. It slides down the ball without friction. The marble will leave the surface of the ball, at a height, h , measured from the top, is given by
    (a) $h = R/2$ (b) $h = 3R/5$ (c) $h = R/3$ (d) $h = 2R/5$

19. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to
    (a) $t^{1/2}$ (b) $t^{3/2}$ (c) $t^{3/4}$ (d) t^2

20. A particle is at rest in a rotating frame. The pseudo force or forces acting on the particle in the rotating frame is/are
    (a) zero (b) only the centrifugal force (c) only the Coriolis force
    (d) combination of both centrifugal and the Coriolis force.

PART-II

*[Write your **Final answer** in the box provided in the **Solution Sheet**; you can use supplementary sheets for your detailed calculations]*

1. (a) A rigid rod of length l and mass m is suspended by massless threads of equal length L fastened at its two ends such that the rod is horizontal. If the rod is hanging at rest and suddenly one of the strings is cut, what is the tenstion, $\boldsymbol{T}$, in the other string immediately thereafter?

   3

   (b) A rigid body consists of three equal masses ($m = 1\ kg$) fastened at the positions (a, 0, 0),(0, a, 2a) and (0, 2a, a). Taking a=1m , find the inertia tensor $\boldsymbol{I}$.

   2

2. A block of mass M slides along a horizontal table with speed v_0. At x = 0 it hits a spring with spring constant k and begins to experience a friction force, as indicated in Fig. 3. The coefficient of friction, μ, is variable and is given by $\mu = bx$, where b is a constant. Find the **distance $\boldsymbol{l}$** (in terms of v_0, M, k, b) the block travels before coming to rest.

   5

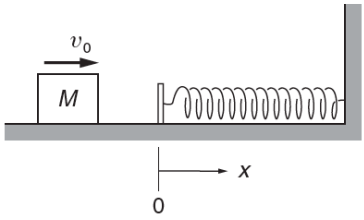

Fig. 3

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Solution- Sheet

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Put the correct option (i.e. *a, b, c* or *d*) in the box against each Question:

1.	**2.**	**3.**	**4.**	**5.**
6.	**7.**	**8.**	**9.**	**10.**
11.	**12.**	**13.**	**14.**	**15.**
16.	**17.**	**18.**	**19.**	**20.**

Part-II

1. (a)

$T =$

1. (b)

$I =$

2.

$l =$