PHYSICS – CLASS XI

Chapter 6 : Systems of Particles and Rotational Motion

PRACTICE PAPER (Chapter-wise Test)

Time : 1½ Hours **Max. Marks : 35**

General Instructions

(a) All questions are compulsory.

(b) There are 17 questions in total. Section A: Q. 1 to 8 carry 1 mark each. Section B: Q. 9 to 12 carry 2 marks each. Section C: Q. 13 to 15 carry 3 marks each. Section D: Q. 16 and 17 carry 5 marks each.

(c) There is no overall choice. An internal choice is given in one 2-mark question (Q. 11), one 3-mark question (Q. 14) and both 5-mark questions (Q. 16, Q. 17). Attempt only one of the given choices.

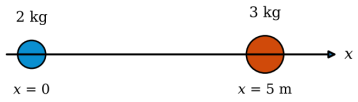
(d) Use of calculators is not permitted. Take g = 10 m s^{-2} unless a different value is given in the question.

(e) Figures are schematic and not drawn to scale. Write the unit with every numerical answer.

SECTION A

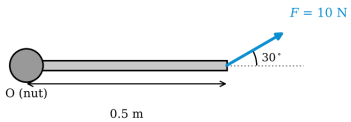
Questions 1 to 8 carry 1 mark each.

1. Two particles of masses 2 kg and 3 kg lie on the x-axis at x = 0 and x = 5 m respectively (figure). The centre of mass of the system is at **(1)**



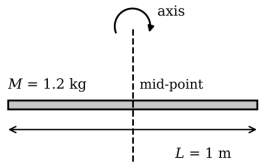
(a) x = 2 m
(b) x = 2.5 m
(c) x = 3 m
(d) x = 3.5 m

2. A force of 10 N is applied at the free end of a spanner of length 0.5 m, at 30° to the spanner (figure). The magnitude of the torque about the nut O is **(1)**



(a) 5 N m
(b) 2.5 N m
(c) 2.5√3 N m
(d) 0.5 N m

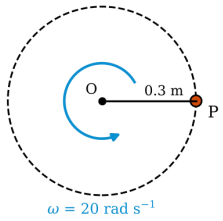
3. A uniform thin rod of mass 1.2 kg and length 1 m rotates about an axis through its mid-point and perpendicular to its length (figure). Its moment of inertia about this axis is **(1)**



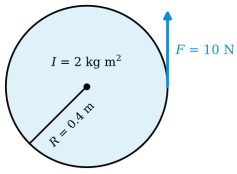
(a) 0.1 kg m²
(b) 0.4 kg m²
(c) 0.3 kg m²
(d) 1.2 kg m²

4. **Assertion (A):** The centre of mass of a body always lies inside the body. **(1)**
Reason (R): The centre of mass of a uniform ring lies at its geometric centre.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

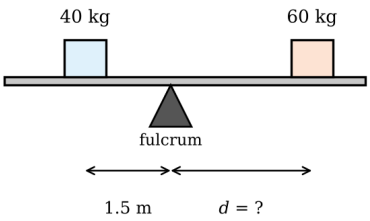
5. A particle P of a wheel is at a distance of 0.3 m from the axis of rotation O, and the wheel rotates at 20 rad s^{-1} (figure). Find the linear speed of P and state the direction of its velocity. **(1)**



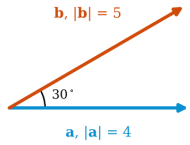
6. A tangential force of 10 N acts on the rim of a wheel of radius 0.4 m and moment of inertia 2 kg m² about its axis (figure). Find the angular acceleration of the wheel. **(1)**



7. A 40 kg child sits 1.5 m from the fulcrum of a light see-saw (figure). At what distance d from the fulcrum must a 60 kg child sit on the other side to balance it? **(1)**



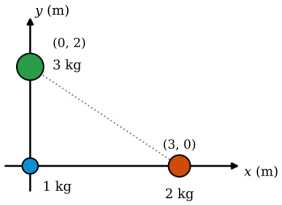
8. Two vectors **a** and **b** of magnitudes 4 and 5 make an angle of 30° with each other, as shown (figure). Find the magnitude of **a** × **b** and state its direction relative to the plane of the page. **(1)**



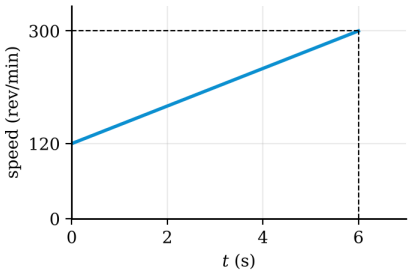
SECTION B

Questions 9 to 12 carry 2 marks each.

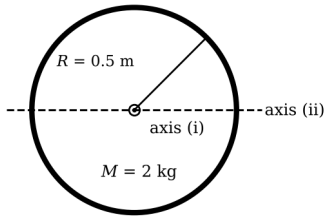
9. Three particles of masses 1 kg, 2 kg and 3 kg are placed at (0, 0), (3 m, 0) and (0, 2 m) respectively (figure). Find the coordinates of the centre of mass of the system. **(2)**



10. The graph shows how the rotational speed of a wheel increases uniformly with time (figure). Find (i) the angular acceleration in rad s^{-2} and (ii) the number of revolutions made in the 6 s. **(2)**



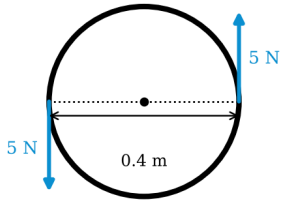
11. A thin ring of mass 2 kg and radius 0.5 m rotates about (i) an axis through its centre perpendicular to its plane, (ii) a diameter (figure). Find the moment of inertia for each axis. **(2)**



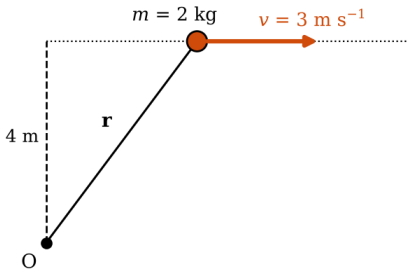
(i) through centre, ⊥ to plane (dot) (ii) along a diameter

OR

Two equal and opposite forces of 5 N each act at the ends of a diameter of a steering wheel of diameter 0.4 m, as shown (figure). Find (i) the net force on the wheel and (ii) the moment of this couple.



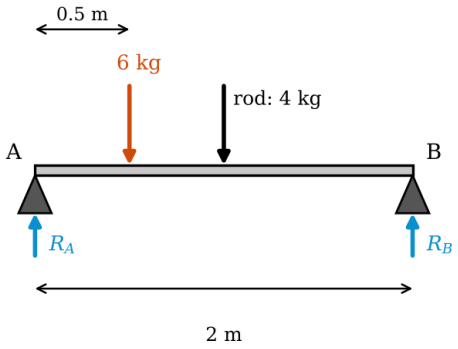
12. A particle of mass 2 kg moves with a constant speed of 3 m s^{-1} along a straight line which is at a perpendicular distance of 4 m from the point O (figure). (i) Find the magnitude of its angular momentum about O. (ii) Does the angular momentum change as the particle moves along the line? Give a reason. **(2)**



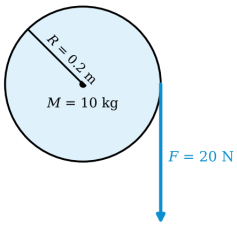
SECTION C

Questions 13 to 15 carry 3 marks each.

13. A uniform rod AB of length 2 m and mass 4 kg rests on two supports at its ends A and B. A load of 6 kg is hung from a point 0.5 m from A (figure). (i) Write the two conditions for mechanical equilibrium of the rod. (ii) Find the reactions R_A and R_B of the supports. **(3)**

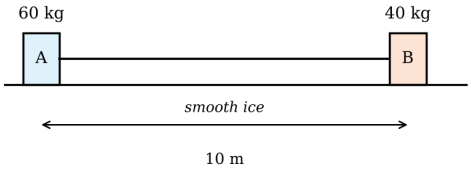


14. A cord of negligible mass is wound round the rim of a flywheel of mass 10 kg and radius 0.2 m, which is mounted on a horizontal axle with frictionless bearings. A steady pull of 20 N is applied on the cord (figure). Treat the flywheel as a uniform disc. Find (i) its angular acceleration, (ii) the work done by the pull when 2 m of the cord has unwound, and (iii) the kinetic energy of the wheel at that instant, starting from rest. **(3)**

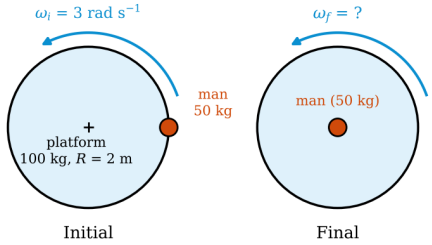


OR

Two skaters A (60 kg) and B (40 kg) stand 10 m apart on smooth ice and pull themselves together along a light rope (figure). (i) Find the position of the centre of mass of the system from A. (ii) Where do the skaters meet? (iii) Give a reason for your answer to (ii).



15. A man of mass 50 kg stands at the rim of a platform of mass 100 kg and radius 2 m, which rotates freely about a vertical axis through its centre at 3 rad s^{-1} (figure). The man walks slowly to the centre. Treat the platform as a uniform disc and the man as a point mass. (i) Find the initial moment of inertia of the system. (ii) Find the final angular speed. (iii) Find the initial and final kinetic energies of rotation. **(3)**



SECTION D

Questions 16 and 17 carry 5 marks each.

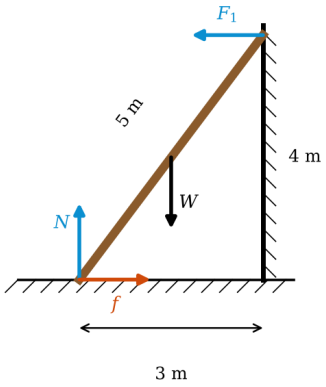
16. A uniform ladder of mass 20 kg and length 5 m rests against a smooth vertical wall with its foot on rough ground 3 m from the wall (figure). The weight acts at the mid-point of the ladder. **(5)**

(a) State the two conditions for the mechanical equilibrium of a rigid body. (1)

(b) Find the normal reaction N of the ground. (1)

(c) Taking moments about the foot of the ladder, find the reaction F_1 of the wall. (2)

(d) Find the minimum coefficient of friction between the ladder and the ground for equilibrium. (1)



OR

A uniform metre stick of mass 200 g is pivoted at the 40 cm mark. A weight W is hung at the 0 cm end and the stick balances horizontally (figure).

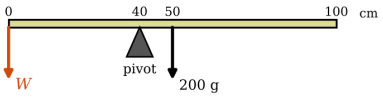
(a) Define the centre of gravity of a body. (1)

(b) At which mark does the weight of the stick act? (1)

(c) Write the principle of moments for this arrangement. (1)

(d) Find W in grams. (1)

(e) Find the reaction of the pivot in newtons. (1)



17. A uniform disc pulley of mass 2 kg and radius 0.2 m can rotate freely about a fixed horizontal axis through its centre. A light string wound round it carries a block of mass 1 kg at its free end (figure). The block is released from rest. The string does not slip. **(5)**

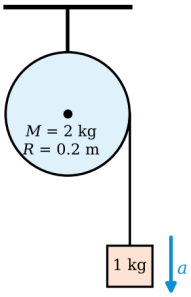
(a) Find the moment of inertia of the pulley about its axis. (1)

(b) Write the equation of motion of the block in terms of T and a. (1)

(c) Write the equation of rotational motion of the pulley in terms of T and a. (1)

(d) Find the acceleration a of the block. (1)

(e) Find the tension T and the angular acceleration of the pulley. (1)



OR

A constant torque of 16 N m is applied to a flywheel (a uniform disc) of mass 10 kg and radius 0.4 m, initially at rest (figure). The wheel reaches 100 rad s^{-1}.

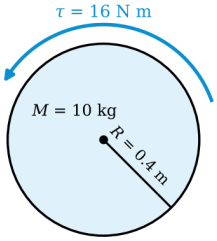
(a) Find the moment of inertia of the flywheel. (1)

(b) Find the angular acceleration. (1)

(c) Find the time taken to reach 100 rad s^{-1}. (1)

(d) Find the work done by the torque and show that it equals the kinetic energy gained. (1)

(e) Find the instantaneous power delivered at 100 rad s^{-1}. (1)



— END OF QUESTION PAPER —