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LEAVING CERTIFICATE EXAMINATION, 1936.

HONOURS.

APPLIED MATHEMATICS.

WEDNESDAY, 24th JUNE.—Afternoon 4 to 6 p.m.

Not more than *six* questions may be answered. All questions are of equal value.

Mathematical Tables may be obtained from the Superintendent.

1. A wheel rolls uniformly on the ground, without sliding, its centre describing a straight line with uniform velocity v. Show that at any instant every point on the rim is turning about the point of contact of the wheel with the ground with an angular velocity equal to that of the wheel about its centre.

2. A 10 ton lorry attains a speed of 15 miles per hour from rest in 24 seconds during which time it travels a distance of 100 yards. If the average resistance to motion over this distance is 30 lbs. per ton—find the average Horse Power required.

3. If the hodograph of the path of a moving point P be drawn, then the velocity of the corresponding point Q in the hodograph represents in magnitude and direction the acceleration of P in its path.

Prove this theorem and use it to determine the magnitude and direction of the acceleration of a point moving in a circle of radius r with a uniform speed v.

4. The bob of a conical pendulum is moving in a horizontal circle with a uniform velocity.

With the aid of a clear diagram indicate the forces acting on it at any instant and analyse the motion.

If the bob makes 60 revolutions per minute, what is the vertical distance of the circle of rotation below the point of suspension of the pendulum?

5. A machine part weighing 10 lbs. has a simple harmonic motion in a straight line. The distance between the end points of its travel is 9 inches and 240 complete to-and-fro movements are made per minute. Calculate:—

(a) the acceleration and the accelerating force when it is 3 inches from its mid-position;

(b) its maximum velocity;

(c) the maximum accelerating force.

6. Neglecting frictional resistance, calculate the least velocity with which a truck must enter the lowest point of a vertical circular track 20 feet in diameter in order to just "loop the loop."

Find also the velocity of the truck and the reaction of the track when half way up.

Weight of truck=40 lbs.

7. Two long pendulums of equal length are suspended so that their bobs just touch when at rest. The masses of the bobs are 4lbs. and 2 lbs. respectively. They are pulled apart in opposite directions—the horizontal displacements from the rest positions being +8 inches and −4 inches respectively—and released simultaneously. On impact they join together and move as one body. The compound mass is found to have a maximum horizontal displacement of +4 inches from the mean position.

On the assumption that the horizontal displacements represent to some scale the velocities of the masses at their mean positions, show that these results verify the Principle of Conservation of Momentum.

Justify this assumption.

8. Over a smooth pulley is passed a light string supporting at one end a mass of 4 lbs. and at the other a pulley of mass 1 lb. A string with masses of 2 lbs. and 3 lbs. attached to its ends passes over the second pulley.

Find the accelerations of each of the moving bodies and of the centre of gravity of the moving system.

9. A box weighing 5 lbs. placed on a plank just slides down when the plank is tilted at an angle of 14° to the horizontal.

The plank is then fixed at an incline of 30° to the horizontal and a weight W lbs. is placed in the box. Find an equation showing the effort P lbs. acting parallel to the incline which will drag the box and weight up the incline at a slow uniform speed.

Write down expressions for the Mechanical Advantage and Efficiency of the arrangement.

10. Two poles AB and AC joined together at their tops and making an angle of 20° with each other are used as shear legs. The ends B and C rest on the level ground and the plane of the triangle ABC is inclined at 60° to the horizontal. A back stay joined to the top A and to a point D on the ground behind the legs is placed symmetrically with respect to them and makes an angle of 30° with the plane of the legs.

Find the forces in the legs and back stay when a load of 10 tons is hung from A.