AN ROINN OIDEACHAIS
(Department of Education.)

BRAINNSE AN MHEADHON-OIDEACHAIS
(Secondary Education Branch).

LEAVING CERTIFICATE EXAMINATION, 1945.

APPLIED MATHEMATICS—Honours.

THURSDAY, 21*st* *JUNE.*—Afternoon 4 to 6.

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

Mathematical Tables may be obtained from the Superintendent.

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1. The velocities of two points A and B being known in magnitude and direction, explain with the aid of a diagram how to find the velocity of B relative to A.

A ship A sailing north at 20 miles per hour observes a ship B 10 miles to the north-east which is sailing west at the rate of 16 miles per hour. Calculate when they will be nearest to each other.

2. AB and BC are equal uniform bars, each of weight 10 lb., freely hinged at B ; and A and C are connected by a light cord such that the angle B is 120°. ABC stands in a vertical plane with A and C on a smooth horizontal table and a body of weight 20 lb. is suspended from a point P in AB such that $AP = \frac{2}{3}AB$. Find (i) the reactions of the table at A and at C and (ii) the tension in the cord.

3. State the laws of friction.

Calculate to the nearest pound the least horizontal force which would push a mass of 1 ton up an inclined plane of inclination 16°, the coefficient of friction being 0·3.

4. A cubical box, with lid, is made of uniform thin metal. The lid can turn on hinges of negligible weight along one edge of the top of the box and is fixed in position after having been opened through an angle of 45°.

If the length of the edge of the box is 18″ find the distances of the c.g. from the base of the box and from the vertical plane through the hinges.

If the box is placed on a plane which is slowly tilted about a line which is parallel to the line of the hinges, the latter being at a lower level than the parallel edge at the top of the box, find the inclination of the plane when the box is about to topple. [The plane is assumed to be rough enough to prevent sliding.]

5. How far must a ram weighing 8 cwt. fall freely to drive a pile weighing 6 cwt. 2 inches into the ground against a total average resistance of 6 tons, assuming that the ram moves on with the pile.

6. The bob of a simple pendulum of length 2 feet is projected horizontally from the position of equilibrium with a velocity of $4\sqrt{14}$ ft. per second so that after projection it begins to move in a vertical circle. Find (i) the vertical height of the bob above the point of projection when the string becomes slack and (ii) the greatest height attained by the bob.

7. An engine working at 600 horse-power pulls a train of 200 tons (including the weight of the engine) along a level track, the resistances being 16 lb. per ton. When the velocity is 30 miles per hour find its acceleration.

At what steady speed will the engine pull the train up an incline of 1 in 100 with the same expenditure of power against the same resistances ?

8. A load of W lb. is raised from rest by means of a rope the tension in which is nW. At a certain point the tension ceases so that the load comes to rest h feet above its initial position. Show that the time taken is

$$\left\{ \frac{2nh}{(n-1)g} \right\}^{\frac{1}{2}} \text{secs.}$$

9. Prove that if the acceleration in simple harmonic motion of amplitude a is $-n^2x$, where x is the displacement from the mean position, the velocity is $\pm n(a^2-x^2)^{\frac{1}{2}}$.

A body moving in a straight line with simple harmonic motion has a velocity of 7 ft. per sec. at a distance of 3 feet from its mean position and its greatest velocity is 20 ft. per sec. Find the periodic time and amplitude.