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(Department of Education).

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LEAVING CERTIFICATE EXAMINATION, 1942.

APPLIED MATHEMATICS—Honours.

THURSDAY, 18th JUNE—AFTERNOON 4 TO 6.

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

Mathematical Tables may be obtained from the Superintendent.

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1. A warship steaming due North at 20 knots is observed by a submarine 6 sea-miles North-West of her. The submarine has a speed of 15 knots. In what direction should the submarine steer to close in on the warship as soon as possible? If she follows that course how long will it take her to get within one sea-mile of her quarry?

[One knot=one sea-mile per hour.]

2. Three particles whose masses are in the ratio 1: 2: 3 are in motion in a plane. Referred to rectangular axes in the plane, their co-ordinates are $(2+t+t^2,\ 1+t)$; $(4-2t+t^2,\ 3-t+3t^2)$; $(3+5t-t^2,\ 2+t-2t^2)$ respectively at time t. Find the co-ordinates of the centre of gravity of the particles at time t and show that it is moving with constant velocity.

3. How far will a body travel if projected horizontally along ice at an initial velocity of 5 metres per second, the coefficient of friction being $\frac{1}{20}$?

If after 4 seconds the body collides directly and combines with a similar body of equal mass resting on the ice, how far will the joint masses proceed together after coalescing?

[Answer in each case to the nearest metre.]

4. (*a*) Show how the centre of gravity of a uniform lamina in the form of a quadrilateral can be found by geometrical construction.

(*b*) A heavy rod 3 feet long has its centre of gravity 1 foot from one end and is suspended by a string 6 feet long attached to its ends and passing over a smooth peg. Find, graphically or otherwise, the inclination of the rod to the horizontal in the position of equilibrium.

5. A ball was kicked so as to leave the ground at 60 feet per second and struck a bar which was 10 feet high and 50 feet away. Find the two possible values of the angle of projection of the ball.

6. Explain the terms *amplitude, period, phase* as applied to Simple Harmonic Motion.

Show that a point moving in a straight line and whose distance x, at time t, from a fixed point in the line is given by $x=a\cos wt$, where a, w are constants, is in S.H.M. Show that the velocity is greatest at the fixed point and find an expression for the period.

7. When a particle is moving in a circle with uniform speed v, prove that its acceleration is $\frac{v^2}{r}$ towards the centre of the circle.

A swing is made up of a seat of 4 lb. wt. supported by two ropes each 6 ft. long. When the swing is carrying a boy of 5 stone wt. through an angle of 60° on each side of the vertical find the tension in each rope (i) at the highest, (ii) at the lowest position of the seat.

[Neglect weight of ropes.]

8. The engine of a ton lorry is 30 H.P. When the lorry is travelling at 25 miles per hour up an incline of 1 in 10 it is accelerating at the rate of 2 ft./sec.^{2}; find the total frictional resistances to the motion. At what rate does the lorry accelerate when travelling down an incline of 1 in 20 at 30 miles per hour, assuming that the frictional resistances are the same and that the engine is working at full power in both cases ?