1934

Mathematics (3rd Year): Technical School Examinations 1934

Department of Education: Technical Instruction Branch

COURSES IN MECHANICAL ENGINEERING.

AN ROINN OIDEACHAIS.
(Department of Education.)

BRAINSE AN CHEARD-OIDEACHAIS.
(Technical Instruction Branch.)

TECHNICAL SCHOOL EXAMINATIONS.
1934.

MATHEMATICS.
(Third Year.)

Wednesday, May 16th—7 *p.m. to* 10 *p.m.*

Examiner—THOMAS GORMLEY, ESQ., A.R.C.SC.I.

Co-Examiner—PEADAR A. MACCIONNAITH, M.SC., A.C.SC.I.

GENERAL INSTRUCTIONS.

You are carefully to enter on the Answer Book and Envelope supplied your Examination Number and the subject of examination, but you are not to write your name on either. No credit will be given for any Answer Book upon which your name is written, or upon which your Examination Number is not written.

You must not have with you any book, notes or scribbling-paper, except the book of logarithms supplied to you.

You are not allowed to write or make any marks upon your paper of questions.

You must not, under any circumstances whatever, speak to or communicate with another candidate; and no explanation of the subject of the examination may be asked for or given.

You must remain in your place until your answer-book has been taken up, and then leave the examination-room quietly. You will not be permitted to leave before the expiration of twenty minutes from the commencement of the examination, and will not be re-admitted after having once left the room.

If you break any of these rules, or use any unfair means, you are liable to be dismissed from the examination, and your examination may be cancelled by the Department.

Three hours are allowed for this paper. Answer-books, unless previously given up, will be collected at 10 *p.m.*

Instructions.

Read the General Instructions on page 1.

(*a*) You may attempt not more than *six* questions.

(*b*) Equal values are attached to the questions.

(*c*) Answers must be written in *ink;* diagrams may be drawn in *pencil.*

(*d*) Write the number of the question distinctly in the margin of your paper before the answer.

(*e*) Slide-rules, drawing instruments and tables may be used.

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1. The following table gives the speed, v miles per hour, of a motor car which starts from rest, at time t seconds after starting :

v	0	3·9	7·2	9·9	12·1	13·8	15·2	16·2	16·4
t	0	15	30	45	60	75	90	105	120

Plot a graph of v against t.

Find, using Simpson's rule, the distance in yards travelled by the car during these 2 minutes.

2. The bending moment of a certain beam, at a point on it distant x from one end, is $7{\cdot}21x - 0{\cdot}25x^2$ for the part of the beam between $x=0$ and $x=21$. Find by calculation (without the aid of the calculus) the value of x which makes the bending moment a maximum. Also find the value of x for this part of the beam which makes the bending moment half its maximum value.

3. If a loan of £P be paid back in n years by annual instalments of £A, the rate charged being r%, then :

$$P = \frac{A(R^n - 1)}{R^n(R-1)} \text{ where } R = 1 + \frac{r}{100}.$$

To instal new machinery a company secures a loan of £4,000, to be repaid by annual instalments of £250, a charge of 4½% being made. In how many years will the debt be discharged ?

4. The Napierian logarithm of a certain number is 1·125. What is the number ?

The change in entropy when one lb. of air at normal temperature and pressure changes in volume to v cubic feet at an absolute temperature of t°F. is given by :

$$\Phi = 0{\cdot}1691 \log_e \frac{t}{493} + 0{\cdot}0684 \log_e \frac{v}{12.39}.$$

Find Φ when $t=655$ and $v=3$. ($e=2{\cdot}718$.)

5. For a triangle ABC write down (without proof) the value of $\tan \frac{1}{2}(A-B)$ in terms of a, b and $\tan \frac{1}{2}(A+B)$.

Two forces of 16·8 lb. and 13·7 lb. respectively act at a point, the angle between their lines of action being 78°. Use the above formula to find the angle between the resultant and the second of the above forces. Also find the magnitude of the resultant.

6. Write down the expanded form of $\cos(A+B)$. Hence find an expression for $\cos\theta$ in terms of $\sin \frac{1}{2}\theta$.

A body is moving so that at any instant its velocity in a horizontal direction is $a(1-\cos\theta)$ and in a vertical direction is $a \sin\theta$. Shew that the actual velocity of the point is $2a \sin \frac{1}{2}\theta$.

7. State and prove the formulae for $\cos\theta - \cos\alpha$ and $\sin\theta - \sin\alpha$ as products.

A rod PQ moves so that its extremities slide along two perpendicular lines OX and OY. Initially PQ is inclined at an angle α to OX. P moves a distance x along OX towards O while Q moves a distance y along OY away from O, the new inclination of PQ to OX being θ. Prove $x = y \tan \frac{1}{2}(\theta+\alpha)$.

8. In a series of experiments on a right-angled triangular notch, the following corresponding values of the discharge, Q cubic feet per second, and the head, H inches, were noted.

Q	4·75	9·77	17·1	26·9	39·6
H	3	4	5	6	7

Shew that the equation connecting Q and H is of the form $Q = aH^n$, and find numerical values for the constants a and n.

9. If $x = 6\cos\theta$ and $y = 4\sin\theta$, obtain corresponding values of x and y by assigning values to θ from 0° to 360°. Plot y against x, taking 1 inch=2 units as scale on both axes. Measure as accurately as you can the slope of the curve at the point $\theta = 120°$.