B.Tech Degree I & II Semester Examination in Marine Engineering, June 2010

MRE 101 ENGINEERING MATHEMATICS I

Time : 3 Hours Maximum Marks : 100

I.

(a) Verify Rolle's theorem for $\frac{Sin\,x}{e^x}$ in $(0,\pi)$. (6)

(b) Evaluate $\underset{x\to 0}{Lt}\ \frac{x\,e^x - \log(Hx)}{x^2}$. (6)

(c) Find the values of a and b such that $\underset{x\to 0}{Lt}\ \frac{x(1+a\,Cos\,x)-b\,Sin\,x}{x^3}=1$ (8)

OR

II.

(a) Show that the radius of curvature at any point of the cardioid $r = a(1-Cos\ \theta)$ varies as $\sqrt{r}$. (6)

(b) Find the n[th] derivative of $e^x(2x+3)^3$. (5)

(c) If $y = e^{a\,Sin^{-1}x}$, prove that $(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - (n^2+a^2)y_n = 0$. Hence find the value of y_n when $x = 0$. (7 + 2 = 9)

III.

(a) If $u(x+y) = x^2+y^2$, prove that $\left(\frac{\partial u}{\partial x} - \frac{\partial u}{\partial y}\right)^2 = 4\left(1-\frac{\partial u}{\partial x}-\frac{\partial u}{\partial y}\right)$. (6)

(b) If $v = f(y-z, z-x, x-y)$ prove that $\frac{\partial v}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial v}{\partial z}=0$. (6)

(c) Verify Euler's theorem for $Sin^{-1}\left(\frac{x}{y}\right)+\tan^{-1}\left(\frac{y}{x}\right)$. (8)

OR

IV.

(a) Determine the points where the function x^2y+xy^2-axy has a maximum or a minimum. (6)

(b) If $x = u^2 - v^2$, $y = 2uv$, obtain $\frac{\partial(x,y)}{\partial(u,v)}$. (6)

(c) The period T of a simple pendulum of length l is given by $T = 2\pi\left(\frac{l}{g}\right)^{\frac{1}{2}}$. Find

(i) the error (ii) percent error made in computing T by using $l = 2\,ft$ and $g = 32\,ft/\sec^2$, if the true values are $l = 1.95\,ft$ and $g = 32.2\,ft/\sec^2$. (8)

(Turn Over)

V. (a) Derive the standard equation of the parabola $y^2 = 4ax$. (6)

(b) Find the vertex, focus, directrix, axis and latus – rectum of the parabola $y^2 = 5x + 4y + 1$. (8)

(c) Find the equations of the tangents to the ellipse $9x^2 + 16y^2 = 144$ from the point $(2,3)$ (6)

OR

VI. (a) Find the equation of the hyperbola whose focus is $(2,2)$, eccentricity is 3 and directerix is $3x - 4y = 10$. (6)

(b) Find the asymptotes of the hyperbola $2x^2 + 5xy + 2y^2 + 4x + 5y = 0$ and find its centre. (6)

(c) Show that the tangent to a rectangular hyperbola terminated by its asymptotes is bisected at the point of contact and encloses a triangle of constant area. (8)

VII. (a) Find a reduction formula for $\int e^{ax} \sin^n x\, dx$. Hence evaluate $\int e^x \sin^3 x dx$. (10)

(b) Find the area common to the parabola $y^2 = ax$ and the circle $x^2 + y^2 = 4ax$. (10)

OR

VIII. (a) Evaluate $\int_0^5 \int_0^{x^2} x\left(x^2 + y^2\right) dx\, dy$. (6)

(b) Evaluate $\int_{-1}^{1} \int_0^{z} \int_{x-z}^{x+z} (x + y + z)\, dx\, dy\, dz$. (7)

(c) Calculate by double integration, the volume generated by the revolution of the cardioid $r = a(1 - Cos\,\theta)$ about its axis. (7)

IX. (a) Show that the components of a vector $\overline{B}$ along and perpendicular to a vector $\overline{A}$, in the plane of $\overline{A}$ and $\overline{B}$ are $\frac{\overline{A}.\overline{B}}{A^2}$ and $\frac{\left(\overline{A} \times \overline{B}\right) \times \overline{A}}{A^2}$. (8)

(b) Prove that $\left(\overline{B} \times \overline{C}\right).\left(\overline{A} \times \overline{D}\right) + \left(\overline{C} \times \overline{A}\right).\left(\overline{B} \times \overline{D}\right) + \left(\overline{A} \times \overline{B}\right).\left(\overline{C} \times \overline{D}\right) = 0.$ (6)

(c) Prove that $\left[\overline{B} \times \overline{C}\ , \overline{C} \times \overline{A},\ \overline{A} \times \overline{B}\ \right] = \left[\overline{A}\ \overline{B}\,\overline{C}\right]^2$ (6)

OR

X. (a) If $\overline{R} = x\overline{i} + y\overline{j} + z\overline{k}$. Show that

(i) $\nabla.\overline{R} = 3$ (ii) $\nabla \times \overline{R} = \overline{O}$ (6)

(b) Prove that vector $f(r)\overline{r}$ is irrotational. (6)

(c) Prove that $\nabla^2 f(r) = f''(r) + \frac{2}{r} f'(r)$. (8)

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B. Tech Degree I & II Semester Examination in Marine Engineering, June 2010

MRE 102 ENGINEERING MATHEMATICS II

Time : 3 Hours Maximum Marks : 100

I. (a) Find the rank of $A = \begin{bmatrix} 1 & 2 & -4 & 5 \\ -2 & 4 & 1 & 3 \\ 5 & 2 & -13 & 12 \end{bmatrix}$ by reducing to the Echelon form. (5)

(b) Investigate the values of λ and μ so that the equations $2x+3y+5z=9$, $7x+3y-2z=8$, $2x+3y+\lambda z=\mu$ have (i) no solution (ii) a unique solution (iii) an infinite number of solutions. (6)

(c) Verify Cayley – Hamilton theorem for the matrix $A = \begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$ and find its inverse. Also express $A^5 - 4A^4 - 7A^3 + 11A^2 - A - 10I$ as a linear polynomial in A. (9)

OR

II. (a) Show that the function $f(z) = \sqrt{|xy|}$ is not analytic at the origin, even though Cauchy – Riemann equations are satisfied at that point. (8)

(b) Evaluate $\int_c \frac{z^2}{z-2}\, dz$ where C is the circle $|z| = 3$. (4)

(c) Find the two Laurent series expansions, in powers of z of the function

$$f(z) = \frac{1}{z(1+z^2)}$$ (8)

III. (a) Solve the following :

(i) $x^4 \frac{dy}{dx} + x^3 y = -\sec xy$

(ii) $(1+y^2)dx = (\tan^{-1} y - x)dy$. (2 x 6 = 12)

(b) Apply the method of variation of parameters to solve $\frac{d^2y}{dx^2} + y = \tan x$. (8)

OR

IV. (a) Solve the following :

(i) $(D-2)^2 y = 8(e^{2x} + \sin 2x + x^2)$

(ii) $\frac{d^2y}{dx^2} - 4y = x \sinh x$. (2 x 6 = 12)

(b) Solve the simultaneous equations :

$\frac{dx}{dt} + 5x - 2y = t$, $\frac{dy}{dt} + 2x + y = 0$ being given $x = y = 0$ when $t = 0$. (8)

(Turn Over)

V. (a) Find a Fourier series to represent $x - x^2$ from $x = -\pi \ to \ x = \pi$. (10)

(b) Express $f(x) = \begin{cases} 1 \text{ for } 0 \le x \le \pi \\ 0 \text{ for } x > \pi \end{cases}$ as a Fourier sine integral and hence evaluate $\int_0^\infty \frac{1-\cos \pi\lambda}{\lambda} \sin x\lambda \, d\lambda$. (10)

OR

VI. (a) Express $f(x) = x$ as a half-range cosine series in $0 < x < 2$. (6)

(b) $\beta(m,n) = \frac{\overline{)m} \times \overline{)n}}{\overline{)m+n}}$. (9)

(c) Evaluate $\int_0^{\pi/2} \sqrt{\tan\theta} \, d\theta$. (5)

VII. Find the Laplace transform of the following :

(i) $e^{-3t}(2\cos 5t - 3\sin 5t)$ (ii) $t^2 \sin at$

(iii) $\frac{1-e^t}{t}$ (iv) $\left(\sqrt{t} - \frac{1}{\sqrt{t}}\right)^3$ (4 x 5 = 20)

OR

VIII. (a) Find the Laplace transform of the function $f(t) = \begin{cases} \sin wt, & 0 < t < \frac{\pi}{w} \\ 0 & , \frac{\pi}{w} < t < \frac{2\pi}{w} \end{cases}$ (10)

(b) Solve by the method of transforms, the equation $y''' + 2y'' - y' - 2y = 0$, given $y(0) = y'(0) = 0$ and $y''(0) = 6$. (10)

IX. (a) Two urns contain respectively 3 black and 2 white balls, 2 black and 3 white balls. One ball is transferred from the second urn to the first and a ball is drawn from the first. What is the probability that it is black? (8)

(b) Evaluate K if the following is a probability density function. Also obtain $P(1 \le x \le 3)$ (6)

X	0	1	2	3
$P(x)$	$\frac{1}{6}$	$\frac{1}{2}$	$\frac{k}{10}$	$\frac{1}{30}$

A random variable x takes values 1 and 2 with corresponding probabilities $\frac{1}{3}$ and $\frac{2}{3}$.

Find the $E(x)$ and $Var(x)$. (6)

OR

X. (a) Bring out the fallacy in the following "The mean of a binomial distribution is 5 and the SD is 3". (5)

(b) Out of 500 items selected for inspection 0.2% are found to be defective. Find how many lots will contain exactly no defective if there are 1000 lots. (7)

(c) The variable X follows a Normal distribution with mean 45 and S.D 10. Find the probability that $40 < x < 56$. (8)

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B. Tech Degree I & II Semester Examination in Marine Engineering, June 2010

MRE 103 ENGINEERING PHYSICS

Time : 3 Hours   Maximum Marks : 100

I. (a) Explain the formation of Newton's rings. (3)

(b) Explain with necessary theory, how to determine the wavelength of a monochromatic light, using Newton's rings set-up. (8)

(c) How will you determine the refractive index of a liquid using Newton's rings experimental set-up? (6)

(d) Newton's rings are formed with reflected light of wavelength 5890 A° with a liquid between a plane glass and a curved surface. The diameter of the 6^{th} ring is 5 mm and the radius of curvature of the curved surface is 10^3 mm. Calculate the refractive index of the liquid. (3)

OR

II. (a) Two optically plane glass plates slightly inclined to each other at an angle θ is illuminated with monochromatic light from the top and observed under a microscope. Discuss the interference phenomenon involved. (3)

(b) With supporting diagrams and theory, obtain an expression for the fringe width β of the interference pattern formed. (10)

(c) How can you determine the thickness of a strand of your hair with the set-up mentioned above? (4)

(d) Two optically plane glass plates of length 0.1 m are placed one over the other with a thin wire at one end separating the two. The fringes formed with light of wavelength 5893 A° are of width 3 mm. Calculate the radius of the wire. (3)

III. (a) Explain the phenomenon of diffraction of light. Write four differences between Fresnel and Fraunhofer diffraction. (6)

(b) What do you mean by resolving power of a plane diffraction grating? Obtain an expression for the resolving power of a grating. (7)

(c) Discuss with necessary diagrams, Rayleigh's criterion for the resolution of two nearby spectral lines. (4)

(d) Calculate the minimum number of lines per cm in a 2.5 cm grating which will just resolve the sodium lines (5890 A° and 5896 A°) in the second order spectrum. (3)

OR

IV. (a) What do you mean by double refraction? (3)

(b) Write *any four* differences between positive and negative crystals. (4)

(c) Explain the construction and working of a Nicol's prism. (6)

(d) Briefly describe the method by which circularly polarized light can be analyzed. (4)

(e) Find the thickness of a quarter wave plate when the wavelength of light used is 5.89×10^{-7} m. Refractive index for ordinary light is 1.55 and for extra ordinary light is 1.54. (3)

(Turn Over)

V.	(a)	Write short notes on spatial and temporal coherence.	(5)
	(b)	What do you mean by population inversion and why is it needed for laser action?	(4)
	(c)	Explain the construction and working of a Helium Neon laser with the help of a neat energy level diagram.	(8)
	(d)	Calculate the coherence length of He-Ne line (1.15 μm), if coherence time is 26.7 ns.	(3)

OR

VI.	(a)	Briefly explain the recording and reproduction of sound using magnetic tapes.	(7)
	(b)	Explain the principle of holography.	(3)
	(c)	Discuss with necessary diagrams, the recording and reconstruction of holograms.	(10)

VII.	(a)	Explain the propagation of light through an optical fiber, discussing how minimum attenuation is attained.	(5)
	(b)	Discuss how optical fibers are classified based on their modes of propagation and refractive index profile.	(9)
	(c)	Write short note on fiber optic sensors.	(3)
	(d)	Calculate the maximum value of the angle of incidence that a ray can make with the axis of a step index fibre such that it gets guided through the fibre for the following fibre parameters, $n_1 = 1.6$; $n_2 = 1.5$. Assume that the outside medium is air.	(3)

OR

VIII.	(a)	What do you mean by numerical aperture of an optical fiber?	(3)
	(b)	Obtain an expression for the numerical aperture of an optical fiber.	(10)
	(c)	A step index fibre has the following parameters, $n_1 = 1.68$; $n_2 = 1.44$. Calculate the numerical aperture, acceptance angle and critical angle.	(3)
	(d)	Briefly explain two applications of optical fibers.	(4)

IX.	(a)	Describe magnetostriction method of producing ultrasonic waves.	(7)
	(b)	Explain the use of ultrasonic waves in the non-destructive testing of materials.	(4)
	(c)	Write short notes on : (i) Gyroscopic effect (ii) SONAR (iii) Dielectrics	(9)

OR

X.	(a)	Briefly explain the BCS theory of superconductivity.	(5)
	(b)	Explain Josephson effect. Distinguish between ac and dc Josephson effect.	(6)
	(c)	Write short notes on : (i) Meissner effect (ii) Isotope effect (iii) SQUID	(9)

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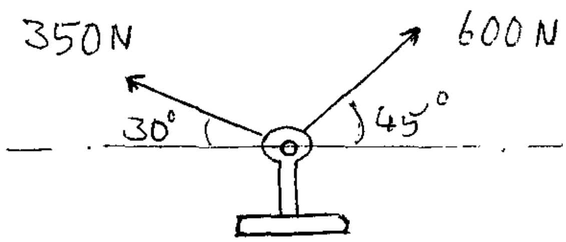
B.Tech Degree I & II Semester Examination in Marine Engineering June 2010

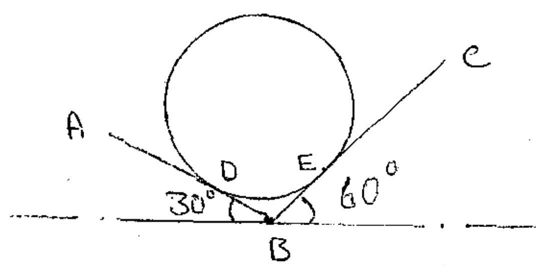
MRE 105 ENGINEERING MECHANICS

Time : 3 Hours Maximum Marks : 100

I. (a) Two forces are applied to an eye as shown in the figure. What is the resultant force? (7)



(b) A ball of weight 12N rests in a right angled Trough as shown. Determine the force exerted on the sides of the Trough at D and E if the surfaces are perfectly smooth. (10)



OR

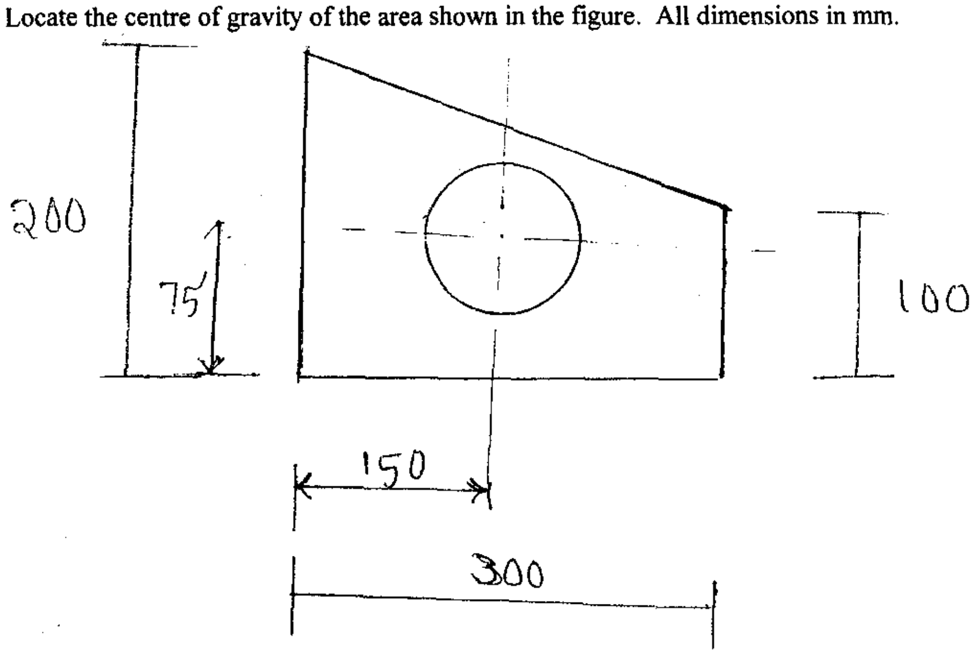
II. (a) The thrust shaft of a ship has 6 collars of 600 mm external diameter and 300mm internal diameter. The total thrust from the propeller is 100kN and the speed of the engine is 90 rev/min. Determine the power lost in friction at the thrust block assuming (8)

(i) Uniform pressure
(ii) Uniform wear

If μk is constant and is equal to 0.12.

(b) A body is resting on a rough horizontal surface requires a pull of 18N inclined at 30^0 to the plane of the surface just to move it. It was found that a push of 22N inclined at 30^0 to the plane just move the body. Determine the weight of the body and coefficient of friction between the surface and body? (9)

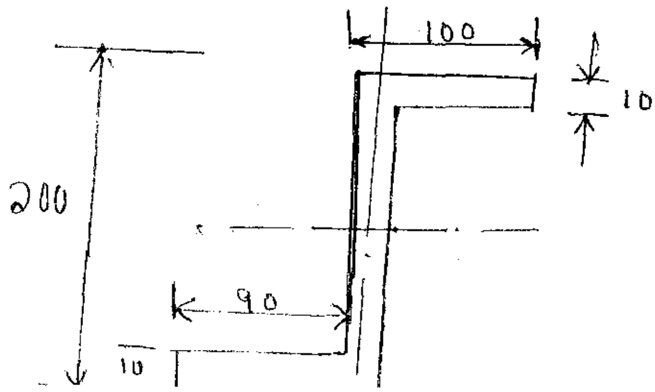
III. (a) Locate the centre of gravity of the area shown in the figure. All dimensions in mm. (9)



(b) Determine the Second Moment of a Semi-circular area of a radius 'r' with respect to (8)
(i) The axis of symmetry of the area
(ii) An axis tangent to the semi-circle and parallel to the axis symmetry.

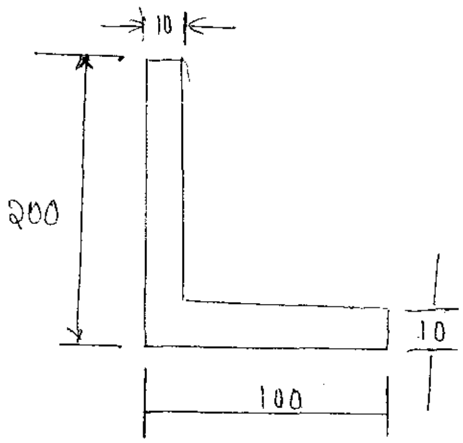
OR

IV. (a) Determine the product of inertia of the area given about x_0 y_0 centroidal axis. (8)



All dimensions in mm

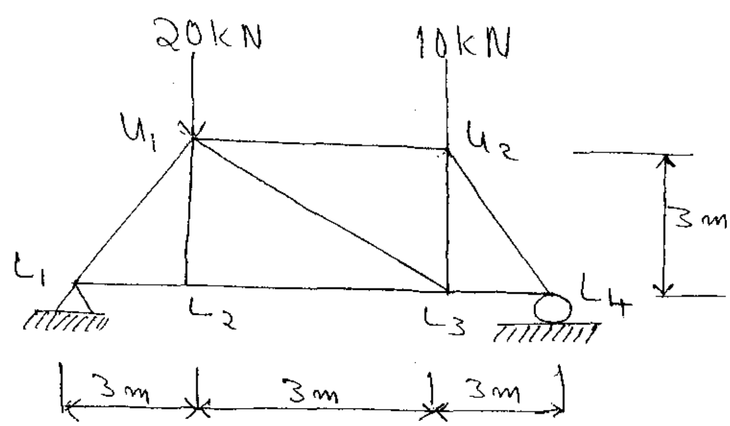
(b)



(9)

Determine $\overline{I}_x, \overline{I}_y$ and $\overline{I}_z$ and also $\overline{K}_x, \overline{K}_y$ and $\overline{K}_z$ for the angle. Section given. All dimensions are in mm.

V.



(17)

find out the forces in all members at the truss by using the method of joints.

OR

VI. A beam ABCDE 10 meter long is hinged at 'A; and freely supported at B and D. AB = 2m; BD = 6m; the over hung DE = 2m. There is a hinge at 'C' mid way between B and D. The loading consist of a point load of 15 kN at the free end E, 20kN at the middle of BC and 40kN at the middle of CD. Evaluate the reactions at the support using principle of virtual work. (17)

VII A particle has a velocity of 5 m/s and it is showing down in such a manner that the relation between 'V' and 't' in meter-second unit is given by (17)

$$V = 5 - t - \frac{1}{6}t^3$$

Calculate the average retardation, average velocity and distance traveled in first two seconds.

OR

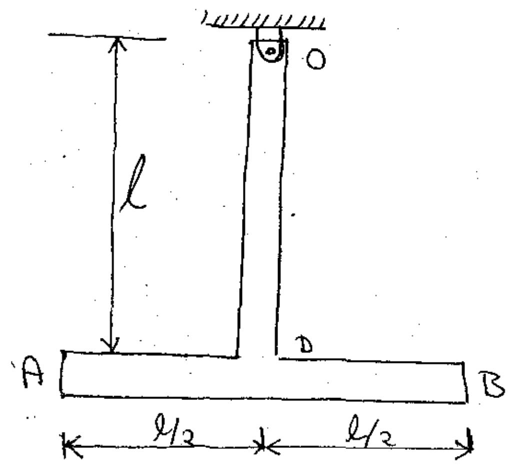
VIII. The piston of a steam engine moves with simple harmonic motion. The crank rotates at 120 rpm and stroke length is 2 meters. Find the velocity and acceleration of the piston, when it is at a distance of 0.75 meters from the centre. (17)

IX. The horizontal range of a bullet when fired at an elevation f 45^0 is 1200 meters. Show that if the bullet is fired with the same velocity and at the same elevation from a lorry moving at 24km/hr, towards the target, the range will be increased by 106 meters. Take g = $9.8 m/s^2$. (16)

OR

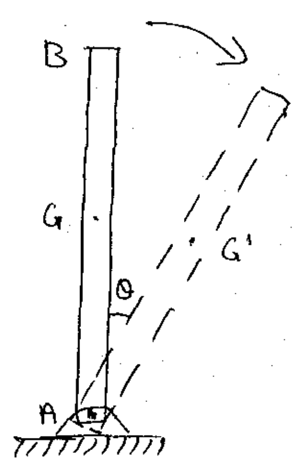
X. A 3 Kg mass is attached at the end of a cord 1m long and whirled in the vertical plane. Determine the maximum and minimum tensions in the cord at 2 rev/second. What is the speed at which the tension just disappear in the cord? (16)

XI. Develop a formula for the period 'T' for small oscillation of the compound pendulum as shown in the figure. AB and OD are identical slender bars of uniform cross section. (16)



OR

XII. A homogeneous slender prismatic bar AB of length 1m and weight 100N is hinged at its lower end and can rotate freely in the vertical plane as shown. If the bar is released from rest in the unstable position and falls under the influence of gravity, calculate the components of reactions at 'A' when $\theta = 30^0$. (16)



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