Part - A

Answer **all** questions.

01. Prove that, $3^{n+1}+4^{2n-1}$ is a multiple of 13 for all $n \in \mathbb{Z}^+$ by using the principle of Mathematical Induction

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02. Sketch the graphs of $y=|x-1|$ and $y=\left|\frac{1}{2}x+1\right|+1$ in the same diagram. **Hence** find all real values of x satisfying the inequality $|2x-1|-|x+1|<1$. Deduce the greatest integral value in the solution set.

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03. Sketch, the loci of points representing complex numbers z satisfying

i. $Arg(z+2+3i) = \tan^{-1}\left(\frac{3}{2}\right)$ ii. $|z-3| = \frac{9}{\sqrt{13}}$ on the same Argand diagram

Hence find the complex numbers repented by the points of intersection of these loci,

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04. Let $n \in \mathbb{Z}^+$. The coefficient of x^{n-1} in the expansion $\left(3+\frac{5}{x}\right)(1+x)^n$ is 126 . Find the value of n

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05. Find the value of a such that $\lim_{x\to 0}\dfrac{\tan^2 ax}{x\left(1-\sqrt{1+x}\right)}=-8$

06. Show that the volume of the solid generated by rotating the area enclosed by the curves $y=\sqrt{\dfrac{1}{5+\sin x}}, y=0, x=0$ and $x=\dfrac{\pi}{2}$ about the axis by 2π radians is given by $\pi\left[\dfrac{\pi}{4}-\tan^{-1}\left(\dfrac{1}{2}\right)\right]$

07. A curve in the xy plane is given in terms of a real parameter θ by $x=3+\cos 2\theta$ and $y=4\sin\theta$. Show that the equation of the normal to the curve at $\theta=\frac{\pi}{4}$ .is $x-\sqrt{2}y+1=0$. Hence, show that the normal at $\theta=\frac{\pi}{4}$ intersects the curve at another point.

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08. The coordinates of the base N of the perpendicular line drawn to the straight line l from the origin O are (a,b). Find the equation of l. l intersects x and y axes at A and B respectively. $OAN\,\Delta=3OBN\,\Delta$ show that $3a^2=b^2$.

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09.i. $ax^2+by^2+(a+b-4)xy-ax-by-20=0$ represents a circle. Find the values of a and b. Hence, find the radius of the circle.

ii. Show that the quadratic equation. $(x-a)(x-c)+(y-b)(y-d)=0$ represents a circle passing through the points $(a,b),(c,d)$ and (a,d).

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10. Let $3\sin\theta+7\cos\theta=6$ for $0^0 \le \theta \le 90^0$. Show that $-7 \le 3\cos\theta-7\sin\theta \le 3$. Further, find the value of $3\cos\theta-7\sin\theta$

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General Certificate of Education (Adv. Level) Examination, 2023 (2024)

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Part -B

Answer **Five** questions only.

11.a.i. Let $p,q,r \in \mathbb{R}^+$, $0<p<2$. Given that $|p-2|,q,r$ are consecutive terms of a **geometric series,** show that the equation $|p-2|x^2+2qx+r=0$ has coincident real roots . Also show that $2r<q^2<0$.

ii. Let α and β are the roots of the equation $x^2-2cx+c=0$. Here $(c\neq 1)$ If roots of the quadratic equation $g(x)=0$ are $\frac{\alpha^2+1}{\beta-1}$ and $\frac{\beta^2+1}{\alpha-1}$, show that $g(x)=(c-1)x^2+4(c-1)x+c^2-2c+5$.

Deduce that the graph of $y=g(x)$ is symmetrical about the line $x=-2$.

b. Let $f(x)=x^3-ax^2-2b$ and $g(x)=x^4-ax^3+5bx^2-c$. Here $a,b,c\in\mathbb{R}$. If $(x+1)$ is a **common factor** of $f(x)$ and $g(x)$, show that . $a=-(1+2b)=\frac{-3-2c}{3}$.

If $h(x)=-x^4+ax^3+4x^2+5cx-2$, show that $g(x)+h(x)\geq\frac{-45}{4}$, when $C=3$

12.a. A signaler on a mountain top sends messages to a near by town by hanging different coloured flags on a horizontal rod. The message is read according to the order in which the flags are arranged. The signaler has 4 green flags, 3 red flags, 1 white flag and 2 blue flags. All flags are identical except for the colour. Find the number of messages he can send in following situations.

i. Using all the flags

ii. If for a special message, green flags cannot be used and only 5 flags can be hanged.

b. **i.** Let $Ur=\frac{4(2r+3)}{(r+1)(r+2)(r+3)}$ for $r\in\mathbb{Z}^+$. Also for $r\in\mathbb{Z}^+$, $f(r)=\frac{A}{(r+1)}+\frac{B}{(r+2)}$. Here A and B are real constants. Determine the value of A and B such that $Ur=f(r)-f(r+1)$ for $r\in\mathbb{Z}^+$. State $f(r)$ with above values of A and B. **Hence,** show that for $n\in\mathbb{Z}^+$ $\sum_{r=n}^{2n}Ur=\frac{8n^2+19n+12}{(n+1)(n+2)(2n+3)}$. Also find, $\sum_{r=1}^{n}Ur$ and show that the infinite series $\sum_{r=1}^{\infty}Ur$ is convergent and find it's sum.

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13.a. $A=\begin{pmatrix} a & 0 & a-1 \\ 0 & 1 & 0 \end{pmatrix}, B=\begin{pmatrix} 1 & a & 1 \\ 1 & a-1 & 0 \end{pmatrix}, C=\begin{pmatrix} b & b-2 \\ b-2 & b-3 \end{pmatrix}$ are matrices such that $AB^T=C$. Here $(a,b\in\mathbb{R})$. Show that $a=3$ and $b=5$. Write down C^{-1} and show that $C+C^{-1}=7I$. Here I is the identity matrix of order 2. Let $P=\frac{1}{3}(C-2I)$. Find the matrix Q such that, $C(Q+P)+AA^T=C+C^{-1}$.

b. Let $z=\cos\theta+i\sin\theta;0<\theta<\frac{\pi}{2}$ show that $z+z^2=2\cos\frac{\theta}{2}\left(\cos\left(\frac{3\theta}{2}\right)+i\sin\left(\frac{3\theta}{2}\right)\right)$.

Hence write down

i. $Arg\left(z+z^2\right)$

ii. $\left|z+z^2\right|$

in an Argand diagram the points A,B and C denotes the complex numbers z,z^2 and $z+z^2$. Show that positions of A,B and C .Show that $OABC$ is a rhombus . (O is the origin) Also when $\theta=\frac{\pi}{6}$, show that $z+z^2=\left(\frac{\sqrt{3}+1}{2}\right)(1+i)$. Hence deduce that $\cos\left(\frac{\pi}{12}\right)=\frac{\sqrt{6}+\sqrt{2}}{4}$.

c. Let $z=r(\cos\alpha+i\sin\alpha)$; Here $r\in\mathbb{R}$ and $-\pi<\alpha<\frac{\pi}{2}$. Using **De Moiver's theorem,** show that $z^n+\bar{z}^n=2r^n\cos n\alpha$ Here $n\in\mathbb{Z}^+$.

Hence show that $(1+i)^n+(1-i)^n=\left(2\sqrt{2}\right)^n\cos\left(\frac{n\pi}{4}\right)$.

14.a. Let $f(x)=\frac{x^2-a}{(x-b)^3}$. Here $a,b\in\mathbb{R}$ are constants to be a determined. Given that $f(x)$ has one of the turning point at $x=3$ and a vertical asymptote at $x=0$. Determine the constants a and b . Given further $f''(x)=\frac{2(x^2-18)}{x^5}$; sketch the graph of $y=f(x)$ indicating intercepts on x,y axes, asymptotes, turning points and points of inflexion.

b. Further deriving the asymptotes, intercepts, turning points of $g(x)=\frac{1}{f(x)}$, sketch the graph of $g(x)$.

c. Water streams out of a faucet at a rate of $3cm^3s^{-1}$ on to a flat surface at a constant rate, forming a circular puddle that is $\frac{1}{27}$ cm deep. Determine the rate at which the area of the puddle grows. Find the rate at which the radius r of the circle grows, when radius is 10 cm .

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15.a. Using a suitable substitution for $\tan^{-1}x$, show that $\int_0^1 \frac{\tan^{-1}x}{1+x^2}dx = \frac{\pi^2}{32}$.

b. Determine the constants λ and μ such that $1-\cos^2 x \equiv \lambda(9-16\cos^2 x)+\mu$. **Hence,** evaluate $\int_0^{\frac{\pi}{2}} \frac{\sin^2 x}{3+4\cos x}dx$.

c. Let $I = \int_0^{\pi} \frac{x^2\cos x}{(1+\sin x)^2}dx$. Using integration by parts, show that $I = -\pi^2 + 2J$; Here $J = \int_0^{\pi} \frac{x}{1+\sin x}dx$. Using $\int_0^a f(x)dx = \int_0^a f(a-x)dx$ evaluate J and show that $I = \pi(2-\pi)$.

16.a. Find the locus of the foot of the perpendicular from the origin to the line of which always passes through a fixed point (α,β).

b.i. Find the requirement for the two circles $x^2+y^2+2gx+2fy+c=0$ and $x^2+y^2+2g'x+2f'y+c'=0$ to intersect orthogonally.

ii. Find the values of a and b for the equation $S \equiv 2a(y-7x)y+2by(4y-4x+3)+(4y-4x+3)(2y-14x)=0$ to represent a circle.

iii. Hence show that for above values of a and b the given equation represents the circumcircle of the OAB triangle. $y=0, y=x-\frac{3}{4}$ and $y=7x$ are the equations of the sides OA, AB and BO respectively. Find the equation of the circle which intersect S **orthogonally** and passing through origin and the point $(0,1)$.

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17.a. Write $\sin 3A$ in terms of $\sin A$. Deduce that $\cos 3A \equiv 4\cos^3 A - 3\cos A$.

Let $T(x) \equiv \sqrt{2}(\cos x - \sin x)(1+2\sin 2x)+1$ for $x \in \mathbb{R}$. Express $T(x)$ in the form $T(x) \equiv \alpha + \beta\cos(3x-\theta)$. Here α, β and $\theta\left(0<\theta<\frac{\pi}{2}\right)$ are real constants to be determined.

Hence, sketch the curve of $y = T(x)$ in the domain $\left[-\pi, \frac{4\pi}{3}\right)$. Also write the new curve $U(x)$ obtained by shifting $y = T(x)$ to right by $\frac{\pi}{4}$ units and 3 units upwards.

b. State the sine rule and cosine rule for a triangle in usual notation. **Deduce** the cosine rule using the sine rule. Let sides of a triangle $ABC(BC<AC<AB)$ lie in an arithmetic progression. If the largest angle of this triangle is **two times** the smallest, show that $\cos A = \frac{a+2d}{2a}$, where d is the common difference of the above arithmetic progression. Using the cosine rule or else find the lengths of the sides of ABC in terms of a . Further **deduce** the **integer** λ such that the largest angle of the triangle is $\tan^{-1}(\sqrt{7}\lambda)$.

c. Solve $\sin^{-1}\left(\frac{2^{x+1}}{1+4^x}\right) - \cos^{-1}\left(\frac{1-4^x}{1+4^x}\right) + \tan^{-1}\left(\frac{2^{x+1}}{1-4^x}\right) = \frac{\pi}{2}$ for $-1 \le x \le +1$

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Part - A

Answer **all** questions.

01. A, B and C are the first 3 particles of n number of particles arranged in a straight line on a smooth horizontal plane. A is given a velocity such that A collides directly with B. the coefficient of restitution between each particle is e, find the velocity of B after the 1st collision. Write the velocity of C, after the collision between B and C. **Hence,** show that the velocity of the n^{th} particle after it's hit by the pervious, is $\frac{2}{2n}(1+e)^{n-1}u$ assuming that the velocity is transferred till the last particle.

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02. A bomb is dropped from a plane flying horizontally with a speed u at a height h from the ground. At the same instant a bullet is projected at an angle α to the horizontal from a point on the ground vertically below the plane. If the bullet hits the bomb and make it explode in the air after time t, show that $t = \frac{h}{u}\cot\alpha$.

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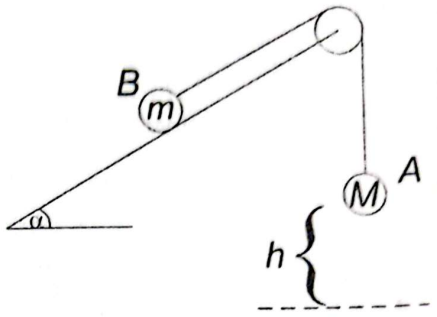
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03. A light inextensible string is attached to a particle A of mass M and is passing over a small smooth pully fixed at the upper edge of a rough, inclined plane. The other end of the string is attached to a particle of mass m which is held on the plane such that particle A hangs freely at a height h above the horizontal floor. If the plane exerts a frictional force F on B, write sufficient equations to find the accelerations of the particle and the tension of the string, when the system is released from rest.



If the particle A comes to an instantaneous rest after colliding with the floor, show that the particle B moves a distance $\frac{mfh}{(F+mg\sin\alpha)}$; where f is the acceleration of B before collision

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04. A lorry with constant power P kW moves upwards along a plane inclined at an angle α to the horizontal. The mass of the lorry is M kg and the trailer attached is of mass m. The road exerts a resistance R on each of the lorry and the trailer. If the lorry moves with a constant speed V, show that $V=\frac{1000P}{2R+(M+m)g\sin\alpha}$. Also find the acceleration of the lorry after the trailer is being detached from the moving lorry.

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05. A particle is placed at a distance r from the center of a **rough** horizontal disk which is rotatable about the center. The disk is given a variable angular velocity ω and the coefficient of friction between the disk and the particle is μ, show that $\omega^2 \leq \frac{\mu g}{r}$ for the particle to move in a horizontal circle.

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06. Define the **scalar product** and the **vector product** of two vectors. The position vectors of the points A and B with respect to the origin O are $\mathbf{a}$ and $\mathbf{b}$ respectively. The position vector of a point C on AB such that $\overrightarrow{AC} = 2\overrightarrow{CB}$ is $\mathbf{c}$. Show that the length of the orthogonal projection of $\overrightarrow{OC}$ on $\overrightarrow{OA}$ is $\frac{1}{3}|\mathbf{a}| + \frac{2}{3}\frac{\mathbf{a}\cdot\mathbf{b}}{|\mathbf{a}|}$.

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07. The center of gravity of a non- uniform rod AB of length $3a$ and weight W, lies at G such that $AG:GB=1:2$. The rod is hanged on a smooth peg with a light inextensible string of length $2l(>3a)$. The rod is kept in equilibrium in a **horizontal position** by applying a **vertical downward** force P at one end of the rod. Show that the magnitude of P is $\frac{1}{3}W$ and the tension of the string is given by $T=\frac{4Wl}{3\sqrt{4l^2-9a^2}}$.

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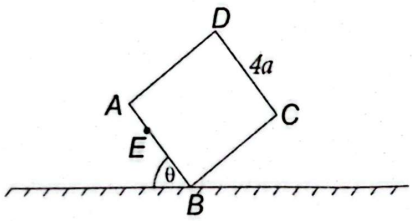
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08. A square lamina with a side of length $4a$ is in equilibrium with B lying on a **rough horizontal** floor and B in contact with a smooth peg E as shown in the figure. AB is at an inclination θ to the horizontal. It is given that $BE=3a$ and $\tan\theta=\frac{1}{3}$. If the coefficient of friction between the lamina and the floor is μ show that $\mu\geq\frac{2}{9}$.



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09. Let A and B are two **exhaustive** events of a sample space Ω. If it is given that $P(B)$ $P(A \cap B') = \frac{3}{5}$, find $P(B)$. Further if it's given that events A and B are **independent**, deduce that A is a definitely occurring event.

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10. 9 and 13 are variance and the mean square of a grouped distribution consisting of distinct positive values. Find the raw mark giving the z value 2.023.

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General Certificate of Education (Adv. Level) Examination, 2023 (2024)

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Combined Mathematics II

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Part -B

Answer **Five** questions only.

11.a. A motor car moving on a straight road with a constant velocity u . observes the red light switching on in the signal post d meters ahead of the car. At the same instance the driver applies break and the car comes to rest at the signal post after moving with a constant retardation. The motor car waits until the green light switches on and starting from rest, moves with a constant acceleration twice the magnitude of retardation.

In a parallel lane of the same road a bus which was moving behind the car with the same uniform velocity u , observes the red signal light after a time t it's switched on, and starts slowing down with the same constant retardation of the car. At the signal post the bus having the velocity $\frac{u}{4}$, starts accelerating without stopping at a uniform acceleration with the same magnitude, as the green light switches on.

Draw the velocity /time graphs of the motion of two vehicles. Starting when the red lights switch on until the motor car passes the bus. Show that the retardation of the car is $\frac{u^2}{2d}$ and show that the bus was $\frac{1}{25}(25ut-d)$ distance behind the car when the red lights were switched on.

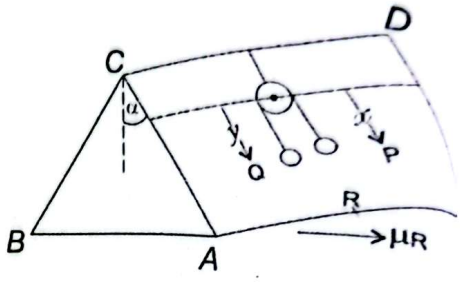
Also show that the velocities of the two vehicles become equal $\frac{2d}{5u}$ time after the green lights switched on. Show that the car passes the bus after $t+\frac{12d}{5u}$ time from when the red lights were on.

b. Three cities A,B,C are located such that B is due east from A at a distance d km while C is 30^0 north of west from B and 60^0 north of east from A. On a certain day, wind blows from north at a constant speed u and flights are scheduled such as directly from A to B and A to B via C. Two planes P_1 and P_2 having the speed $v(2u>v>u)$ in still air are leaving A, P_1 directly to B and P_2 via C to B. Considering P_2 does not land is C, draw the relative velocity triangles in the same diagram. If both planes are required to arrive at B at the same time, show that P_2 should depart from A, $d\left\{\frac{1}{\sqrt{4v^2-u}-\sqrt{3}u}+\frac{\sqrt{3}}{\sqrt{4v^2-3u^2}+u}-\frac{1}{\sqrt{v^2-u^2}}\right\}$ time earlier than P_1 . If the speed of the wind doubled. After P_2 reaching C, show that the pilot of P_2 is unable to reach B, making necessary constructions on the velocity diagram.

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12.a. A horizontal velocity of u ms^{-1} is given to a particle P of mass 1 kg attached to the lowest of a light inextensible string of length l. The other end of the string is fixed to a point O vertically above P such that the string is taut. If the particle has an angular velocity $\sqrt{8}$ rad s^{-1} and if tension of the string is $6N$, by the time OP makes an angle 60^0 with the upward vertical, find the value of l. Also show that the initial velocity u of the particle is given by $\sqrt{92}$ ms^{-1}.

b. The following figure shows a smooth wedge with mass 3 m whose rectangular plane containing AB is kept on a rough horizontal plane with a coefficient of friction μ. On one of it's planes which has an inclination of α to the downward vertical, a pully is fixed. A light inextensible string passes over the smooth pully carrying two particles P and Q weighing 2 m and m respectively such that the string is parallel to the plane. When the system is released from rest,



considering the displacements of P and Q from the level of the pulley as x and y respectively along the plane and the displacement of the wedge along AB as z, show that the acceleration of P with respect to wedge is equal in magnitude and opposite in direction to the acceleration of Q

show that acceleration is P with respect to the wedge is given by $\dfrac{6\mu g}{\sin\alpha+\mu\cos\alpha}$.

Hence, obtain an expression for the velocity of P with respect to wedge in terms of time t. If is given that P travels a straight distance l along the plane and reach the level AE, show that the time taken by P to reach AE from the beginning is given by $\sqrt{2gl\cos\alpha}\,\dfrac{(\sin\alpha+\mu\cos\alpha)}{6\mu g}$.

13. A particle P of mass m is attached to one end of a light elastic string of natural length l and modules of elasticity mg. A light elastic helical spring of natural length l and modules of elasticity mg is also attached to the particle P. Free end of the string is attaches to a point A on the celling while the free end of the spring is attached to a point B on a horizontal floor at distance $3l$ vertically below A. Maximum compression of the spring is $\dfrac{3l}{4}$.

i. If the particle P is hanging in equilibrium at point C, show that the spring is at it's natural length.

ii. Now if the particle P is **projected vertically upward** with a velocity of $\sqrt{2gl}$ at C, and the extension of the string at time t is x, show that in usual notation $x=\dfrac{-2g}{l}(x-l)$

Assuming the solution of the above equation as $x=l+A\cos\omega t+B\sin\omega t$, determine the values of the constants A, B, ω appropriate for the above motion. Hence, deduce that the elastic string does not become slack. What is the maximum extension of the elastic spring and the time taken by the spring to be it's maximum extension.

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iii. Prove that the time taken by the particle P from the beginning till the extension of the string is $\frac{l}{2}$ in its downward motion for the first time is $\frac{5\pi}{6}\sqrt{\frac{l}{2g}}$.

iv. In the downward motion of particle when P is at a distance y below C, in usual notation show that $\ddot{y} = -\left(\frac{2g}{l}\right).y$ Using the equation $\dot{y}^2 = \frac{2g}{l}\left(a^2 - y^2\right)$, find the amplitude of this simple harmonic motion. Considering the corresponding circular motion find the time from point C to the maximum compression of the spring.

v. If the velocity of the particle P decreases instantly by half after hitting the spring which has the maximum compression, show that the amplitude of the simple harmonic motion decreases to $\frac{\sqrt{43}l}{8}$.

14.a. The position vector of points A and B with respect to the origin are $\mathbf{a}$ and $\mathbf{b}$ respectively. show that for the real constant λ, the position vector of P is given by $\mathbf{P} = \lambda\mathbf{a} + (1-\lambda)\mathbf{b}$,

Hence, show that A, P, B are collinear.

i. Show that the point Q with position vector $\mathbf{q}$ is given by $\mathbf{q} = 3\mathbf{a} - 2\mathbf{b}$ lies on BA produced and find the ratio $QA : QB$.

ii. The point R has position vector $\mathbf{r}$ given by $\mathbf{r} = 3\mathbf{a} + 5\mathbf{b}$. Find the position vector of the point where OR meets AB (produced if necessary)

b. $ABCDEF$ is a regular hexagon of a side 2 m. Forces of magnitude $4, 5, 2, 5$ and 6 newtons act along the sides AB, BC, CD, DE and EF respectively. In the directions indicated by the order of letters. Also another force of magnitude P acts at F in the plane of the hexagon, in a direction making an angle θ of with FC.

i. Determine P and θ such that the system reduces to a couple. Find the magnitude of the couple.

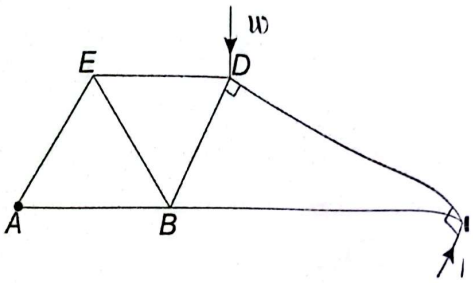
ii. If the force P acts along AF and $P = 7N$, show that the system reduce to a single force and find the distance from A to the point of intersection of the line of action of the above single force and AB. (produced if necessary)

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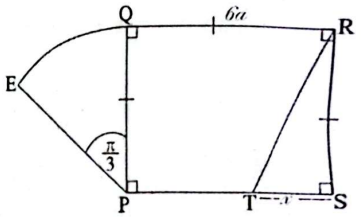
15.a. Three uniform rods AB, BC and CD each of the same length and of weight W are smoothly jointed at B and C. The lower most end A is smoothly hinged to a fixed point. The ends B and D are connected by a light inextensible string. The rods are kept in equilibrium in a vertical plane by a force P applied perpendicular to CD at D, such that each rod is making an acute angle θ with the horizontal. Show that $P = \dfrac{3W\cos\theta}{6\sin^2\theta + 2\cos^2\theta}$ and the tension of the string $T = \dfrac{W\cos^2\theta}{1+2\sin^2\theta}$. given that the length of the string is equal to the length of a rod, **deduce** that $P = \dfrac{\sqrt{3}}{2}W$ and $T = \dfrac{W}{2}$. **Hence,** find the horizontal and vertical components of the reaction at C.

b. The framework shown in the figure is made from light rods AB, BD, BE, DE and AE each of length a, DC perpendicular to BD and BC is in the same horizontal level with AB forming a right angled triangle. The framework is smoothly hinged at A to a fixed point and kept in equilibrium with ABC horizontal by a force P perpendicular to DC at C. There is a load W at B. Find the value of P in terms of W.



Draw a stress diagram using Bow's notation and hence, find the stresses in the rods stating whether they are tensions or thrusts.

16. Show that the center of gravity of a circular sector of radius r subtending an angle 2α at the center, lies at a distance $\dfrac{2r\sin\alpha}{3\alpha}$ on the axis of symmetry from the vertex.



The figure shows a uniform square shaped lamina of a square shape in which a side is $6a$. T is a point on PS such that $TS = x$. Show that the distance from PQ to the center of gravity of the trapezium $PQRT$, is given by $\left(\dfrac{x^2 - 18ax + 108a^2}{3(12a - x)}\right)$. A coplanar lamina $PEQRT$ is made by combining $PQRT$ trapezium with a uniform PQE circular sector of radius $6a$ subtending an angle $\dfrac{\pi}{3}$ at its center with the same surface density' such that PQ edges coincide. Composite object is kept in vertical plane such that PT is in contact with a rough horizontal surface. If the above composite lamina topples in a vertical plane show that $x^2 - 3a(\pi + 6)x + 72a^2 < 0$.

If a force ρP applied in the same vertical plane to avoid topping, show that the minimum value P can take is $2\sqrt{10}a^2 g$. Here ρ is the surface density of lamina and g is the acceleration of gravity.

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17.a. At a certain roundabout a driver is allowed only to turn his vehicle to left, right or go straight forward. The probability of turning left is twice the probability of turning right. If it is given that for every 7 trips, the straight path is taken only once, find the probabilities of turning right and left separately. In each type of above trips the probabilities that the driver getting late are $\frac{1}{12}, \frac{1}{3}$ and $\frac{1}{6}$ respectively.

i. Find the probability of the driver getting late in any trip.
ii. Find the probability that he had taken the right turn at the roundabout on a day he was late.
iii. What is the best route he should take not to get late?

b. Define the mean (μ) and (σ) variance for a grouped distribution.

Following table represents the distances completed by a long distant runner during his 50 days training period. It is given that the median of the distance completed by him is 28.5km .

Distance (km)	1-10	11-20	21-30	31-40	41-50
No of days	f_1	f_2	f_3	f_4	f_4

i. If it is given that the corresponding frequencies of each class $(f_1 < f_2 < f_3 < f_4 < f_5)$ lie in an ascending arithmetic series, determine the values of the frequencies.
ii. Using a suitable transformation determine the mean distance completed by the runner during the training.
iii. Further, evaluate the standard deviation and the skewness of this distribution.

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