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முன்னோடிப் பரீட்சை -2015

கல்விப் பொதுத் தராதரப் பத்திர(உயர் தர) முன்னோடிப் பரீட்சை - 2015

General Certificate of Education (Adv. Level) Pilot Examination - 2015

Combined Mathematics I
இணைந்த கணிதம் I

10 E I

Three hours
மூன்று மணித்தியாலம்

Q1). Let $f(n)=10^{2n-1}+1$. show that $f(P+1)-f(P)=99.10^{2p-1}$ where $P\in\mathbb{Z}^+$. using the **principle of mathematical induction**, show that $10^{2n-1}+1$ divisible by 11 for all $n\in\mathbb{Z}^+$

Q2). Find the number of combinations that can be made using all the letters in the word **MERSALaAYITTEN**. Among these combiniations, how many of them contain the word **AILa** together.

Q3). Find all the real vales of x satisfying the inequality $\dfrac{12}{x-3} < x+1$

Q4). For $m,n \in \mathbb{Z}^{+}$ in the expansion of $(1+x)^{m}(1-x)^{n}$, the coefficients of x and x^{2} are $3,-6$ respectively. Find m,n.

[*see the page. 3*

Q5). Show that $\displaystyle\lim_{x\to\frac{\pi}{3}} \frac{\sqrt{3}\cos x-\sin x}{\left(\sqrt{\frac{\pi}{3}}-\sqrt{x}\right)\left(\cos x+\sqrt{3}\sin x\right)}=2\sqrt{\frac{\pi}{3}}$

………

Q6). Find the euquation of the tangent drawn to the curve $y=x^2+x+1$ at the point $(1,3)$. Show that the area of the shape enclosed by this curve, this tangent and the lines $x+1=0, y=0$ is $\frac{7}{6}$ square units.

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[see the page. 4

Q7). The coordinates of vertices of a triangle are $(a\cos t, a\sin t), (b\sin t, -b\cos t), (1,0)$ respectively. Here t is a parameter. show that the locus of the centroid of this triangle is a circle and find its centre and radius.

Q8). Show that The line $(2+3\lambda)x+(3-\lambda)y-5-2\lambda=0$ passes through a fixed point and find that point.

Q9). Show that the equations of the circles touching the coordinate axes and the line $x = a$ are

$$4\left(x^2 + y^2\right) - 4ax \pm 4ay + a^2 = 0$$

Q10). Let $f(x) = \dfrac{\sin x}{\sqrt{1-\cos^2 x}} + \dfrac{\cos x}{\sqrt{1-\sin^2 x}} + \dfrac{\tan x}{\sqrt{\sec^2 x - 1}} + \dfrac{\cot x}{\sqrt{\cos ce^2 x - 1}}$ Find the minimum value of $f(x)$ for $x \in \mathbb{R}$ find the value of x for which it is attained.

[see the page.7

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General Certificate of Education (Adv. Level) Pilot Examination - 2015

Combined Mathematics I
இணைந்த கணிதம் I

10	E	I

Part B *** Auswer five questions only.**

Q11) a. Let α,β be the roots of the equation $x^2+2px+q^2=0$ and γ,δ be the roots of the equation $x^2+2mx+n^2=0$ where $b,c,m,n\in\mathbb{R}$.

$(\mathbf{i})$ If $\alpha+\gamma=\beta+\delta$ then $p^2+n^2=q^2+m^2$

$(\mathbf{ii})$ If $\alpha\gamma+\beta\delta=0$ then $q^2n^2=p^2n^2+q^2m^2$

Let the points where the curve $y=x^2+(2x+3)-k$ cut the axis be A and B and the points where the curve $y=x^2+2(2x+k)-3$ cut the x axis be *P* and *Q*.

If $AB=PQ$ find k

b. Let $f(x)=x^4-2x^2+6$. using remainder theorem, show that $f(x)$ has no factor in the form $(x-\alpha)$ Find the range of *x* such that $f(x)\geq 30$

b,c are real costants such that $g(x)=3f(x)+bx^3+cx$ If $(x-1)$ and $(x-2)$ are the factors of $g(x)$. Find the values of *b* and *c.* Find the range of *x* such that $g(x)\geq 0$

Q12) a. Let the r^{th} term of the series $\frac{4}{1.2.3}\left(\frac{1}{3}\right)+\frac{5}{2.3.4}\left(\frac{1}{3}\right)^2+\frac{6}{3.4.5}\left(\frac{1}{3}\right)^3+\ldots\ldots\ldots\ldots$ be U_r and for $r\in\mathbb{Z}^+$ let $S_n=\sum_{r=1}^{n}U_r$ for $r\in\mathbb{Z}^+$.find the values of the constants *A,B* such that

$$\frac{U_r}{\left(\frac{1}{3}\right)^r}=\frac{A}{r(r+1)}+\frac{B}{(r+1)(r+2)}$$

Hence, for $n\in\mathbb{Z}^+$ show that $S_n=\frac{1}{4}-\frac{1}{(n+1)(n+2)}\left(\frac{1}{3}\right)^n$

the infinite series $\sum_{r=1}^{\infty}U_r$ convergence? Justify your answer.

[see the page. 8

b. Clearly stating all the axioms used draw the graph of $y = x^2 - b$,where $b > 0$. **Hence** draw the graph of $y = \left|x^2 - b\right|$, draw the graphs of $y = \left|x^2 - 1\right|, y = \left|x^2 - 7\right|$ on same diagram. Shade he region $\left\{(x, y): \left|x^2 - 7\right| \geq y \geq \left|x^2 - 1\right|\right\}$ and find the area of shaded region.

Q13) a. Let $\mathbf{A} = \begin{pmatrix} 3 & 2 \\ 1 & 1 \end{pmatrix}$ be a 2×2 matrix.

For $a, b \in \mathbb{R}$ find the values of a, b such that $a\mathbf{I} + b\mathbf{A} + \mathbf{A}^2 = \mathbf{O}$.Here $\mathbf{I}$ is 2×2 identity matrix and $\mathbf{O}$ is 2×2 zero matrix.

Hence, find $\mathbf{A}^{-1}$. Let $\mathbf{B} = \begin{pmatrix} 3 & 2 \\ 5 & -3 \end{pmatrix}$ be a 2×2 matrix. By considering that $\mathbf{B}^{-1}$ is in the form of $\mathbf{B}^{-1} = \begin{pmatrix} p & q \\ r & s \end{pmatrix}$ find $\mathbf{B}^{-1}$. Find the 2×2 matrix $\mathbf{C}$ such hat $\begin{pmatrix} 3 & 2 \\ 1 & 1 \end{pmatrix} \mathbf{.C.} \begin{pmatrix} 3 & 2 \\ 5 & -3 \end{pmatrix} = \begin{pmatrix} 2 & 4 \\ 3 & -1 \end{pmatrix}$

b. Using the **principle of mathematical induction**, show that $(1+i)^n = 2^{\frac{n}{2}}\left(\cos\frac{n\pi}{4} + i\sin\frac{n\pi}{4}\right)$

for a non zero positive integer *n*. By considering the binomial expansion of $(1+x)^n$. Find $\text{Re}\left\{(1+i)^n\right\}, \text{Im}\left\{(1+i)^n\right\}$

Hence, for $n \in \mathbb{Z}^+$ deduce that $\tan\frac{n\pi}{4} = \frac{{}^nC_1 - {}^nC_3 + {}^nC_5 - {}^nC_7 + \dots\dots\dots}{1 - {}^nC_2 + {}^nC_4 - {}^nC_6 + \dots\dots\dots\dots}$

Q14) a. Let $f(x) = \frac{x^2 - 6x + 4}{x^2 + 2x + 4}$ Show that $f'(x) = \frac{8(x-2)(x+2)}{\left(x^2 + 2x + 4\right)^2}$ and deduce that the curve has turning points at $(-2, 5)$ and $\left(2, -\frac{1}{3}\right)$ .Draw a tough sketch of the curve $y = f(x)$ showing the turing points and asymptotes.

Hence, find he number of solutions of the equation $\left(x^2 - 6x + 4\right) = \left(x^2 + 2x + 4\right).\left(e^x - e^{-x}\right)$

b. The total surface area of a closed right circular cylinder is $2\pi\mathbf{m}^2$. show that its volume is $V = \pi\left(r - r^3\right)\mathbf{m}^3$ Here *r* is the radius of the cylinder. When *r* varies, show that the maximum volume of the cylinder is $\frac{2\pi}{3\sqrt{3}}\mathbf{m}^3$

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[see the page. 9

Q15) **a.** using a suitable substitution, show that $\int_0^{\pi} \frac{1}{4-3\sin x}\,dx = \frac{\pi}{\sqrt{7}} + \frac{2}{\sqrt{7}}\tan^{-1}\left(\frac{3}{\sqrt{7}}\right)$

b. Let $f(x) = \frac{Ax+B}{x^2+1}$ where $A, B \in \mathbb{R}$ find A, B such that $f(x) + f'(x) = \frac{x^3-x+2}{\left(x^2+1\right)^2}$

Using intergraion by parts, find the value of $\int_0^{\pi} e^x . \frac{x^3-x+2}{\left(x^2+1\right)^2}\,dx$

c. Let $I = \int_0^1 \frac{1}{\sqrt{4-x^2-x^3}}\,dx$

For $x \in (0,1)$. Show that $4-2x^2 < 4-x^2-x^3 < 4-x^2$. and deduce that $\frac{\pi}{4\sqrt{2}} > I > \frac{\pi}{6}$

Q16) **a.** Show that the equation of a straight line passing through a fined point (x_1, y_1) can be expressed in the parametric form $\frac{x-x_1}{\cos\theta} = \frac{y-y_1}{\sin\theta} = r$ Here $\tan\theta$ is the gradient r of that line. r is parameter. identify this parameter.

This line posses through the point $A(-5,-4)$ and meet the straight lines $x+3y+2=0,\ 2x+y+4=0,\ x-y-5=0$ at the poins B,C,D respectively. Show that $\left(\frac{15}{AB}\right) = \cos\theta + 3\sin\theta$ and find $\left(\frac{10}{AC}\right)$ and $\left(\frac{6}{AD}\right)$ in terms of θ

Hence, If $\left(\frac{15}{AB}\right)^2 + \left(\frac{10}{AC}\right)^2 = \left(\frac{6}{AD}\right)^2$ find the equation of that straight line.

b. If the two circles $x^2+y^2+2gx+2fy+c=0$, and $x^2+y^2+2g'x+2f'y+c'=0$ intersect orthogonally, show that $2gg'+2ff'=c+c'$

Let $\boldsymbol{S} \equiv x^2+y^2-8x-6y+21=0$ and $\boldsymbol{S'} \equiv x^2+y^2-2y-15=0$ Show that $\boldsymbol{S}=0$ and $\boldsymbol{S'}=0$ intersect orthogonally. Find the equation of the circle which posses through the poins of intersection of these two circles the centre of $\boldsymbol{S}=0$

Q17) a. Let $f(x)=\dfrac{1+\tan x}{\cos x+\tan x.\sin x}$ for $-\dfrac{5\pi}{4}\leq x\leq\dfrac{3\pi}{4}$

Express $f(x)$ in the form $A\sin(x+\alpha)$ Here $A(>0)$ and $\alpha\left(0<\alpha<\dfrac{\pi}{2}\right)$ are constants to be determined. Draw the rough sketch of the graph $y=f(x)$

Hence, solve the equation $\sin x+\cos x=\dfrac{4\sqrt{2}}{\pi}x$

b. If $x=a^2\cos^2\theta+b^2\sin^2\theta$ show that $x=\dfrac{1}{2}\left(a^2+b^2\right)+\dfrac{1}{2}\left(a^2-b^2\right)\cos 2\theta$ While *a,b* are positive constants and θ varies in the range $0\leq\theta\leq\dfrac{\pi}{4}$,

Let $y=\sqrt{a^2\cos^2\theta+b^2\sin^2\theta}+\sqrt{b^2\cos^2\theta+a^2\sin^2\theta}$. using the above result or otherwise,

show that $y^2=a^2+b^2+2\sqrt{\dfrac{1}{4}\left(a^2+b^2\right)^2-\left\{\dfrac{1}{2}\left(a^2+b^2\right)-x\right\}^2}$

Hence, show that $(a+b)\leq y\leq\sqrt{2\left(a^2+b^2\right)}$

Find the range of $\sqrt{1+\sin^2\theta}+\sqrt{1+\cos^2\theta}$

END OF QUESTIONS

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General Certificate of Education (Adv. Level) Pilot Examination - 2015

Combined Mathematics II
இணைந்த கணிதம் II

10 E I

Three hours
மூன்று மணித்தியாலம்

Q1). A particle is thrown vertically upwards from the ground with a velocity u. The time taken to reach a height h from the ground is t. By drawing a velocity time graph, show that $h = ut - \frac{1}{2}gt^2$

Deduce the time taken to reach the ground again.

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Q2). A boot is starting to leave a harbor to catch a ship moving along a straightline with speed u. The shortest distance to the path of the ship from the harbor is a. The boat leaves the harbor when the ship is at a distance b from the harbor. The ship hasn't reached the nearest point yet. Show that the minimum uniform speed required for the boat to reach the ship is $\frac{au}{b}$.

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[see the page. 2

Q3). The mass of a cyclist with his bicycle is M**kg**. If he moves down along a slope of 1 in m with a constant speed v**ms**$^{-1}$ show that he has to work at a rate of $Mg\left(\frac{1}{m}+\frac{1}{n}\right)v$ to move up a slope of 1 in n.

Q4). A particle of mass m is placed at the lowest point of a smooth hollow sphere of radius a and thrown Horizonatally with a velocity $\sqrt{nga}$. If this particle leaves the circular motion when it has turned through $\frac{2\pi}{3}$ show that $n=\frac{7}{2}$

Q5). Let $\mathbf{a}, \mathbf{b}$ be two vectors. Show that $|\mathbf{a}+\mathbf{b}|^2 = |\mathbf{a}|^2 + |\mathbf{b}|^2$ if and only if $\mathbf{a}$ and $\mathbf{b}$ are peperdicular.

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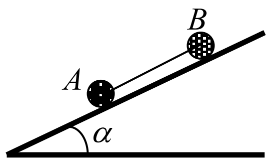
Q6). Two particles *A,B* ofweight w_1, w_2 are attached to the two ends of a light inelastic string and placed a, rough inclined plane inclined at an angle α. the system attain limiting equilibrium such that the string is fault. If the coefficient if friction for *A,B* and the inclined plone are μ_1, μ_2 respectively and $\mu_1 < \tan\alpha < \mu_2$ show that $\tan\alpha = \dfrac{\mu_1 w_1 + \mu_2 w_2}{w_1 + w_2}$



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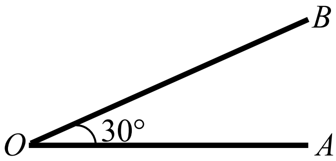
Q7). Two uniform rods OA and OB made of same material are rigidly joined such that $A\hat{O}B = \frac{\pi}{6}$ if $OA = 2a, OB = 2b$ Show that the centre of gravity of the object AOB is at the point with coordinaties $\left(\frac{2a^2 + b^2\sqrt{3}}{2(a+b)}, \frac{b^2}{2(a+b)}\right)$ respective to centre O



Q8). Two dice of different wlours and with six faces are thrown simulataneously. Find the probability for the sum of the two numbers obtained be equal to 7 or 11.

[*see the page. 5*

Q9). a,b are two consecutive integers in the first hundred natural numbers. Find the probability for $\sqrt{a^2+b^2+a^2b^2}$ be an odd integer.

Q10). If the mean and the variance of seven numbers $2,4,10,12,14,x,y$ are 8 and 16 respectively, find x and y.

[see the page.7

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Combined Mathematics II
இணைந்த கணிதம் II

10 E II

Part B * **Answer five questions only.**

Q11) a. A particle dropped from rest, from a height h above the ground at $t=0$ falls under gravity. At the same time, another particle B is thrown vertically upward from a point on the ground with velocity u. Draw the velocity – time graphs for the motion of each particle. Using the velocity – time graph, show that the particulars are at same height from ground at time $\frac{h}{u}$. If this height is $h\left(\frac{n-1}{n}\right)$ deduce that $u=\left(kngh\right)^{k}$ here k is a constant to be determined

b. A smooth wedge of mass M is placed as a smooth horizontal table. A particle of mass m is placed on the smooth face of the wedge inclined at an angle α with the horizontal and thrown upward with the speed v along the highest slope of that face. Show that the acceleration of the wedge is $\frac{mg\sin\alpha\cos\alpha}{M+m\sin^2\alpha}$ and the acceleration of the particle relative to the wedge is $\frac{(m+M)g\sin\alpha}{M+m\sin^2\alpha}$

(**i**) If the particle tises to a height h above the paint of projection, show that $V=\left(2gh.\frac{M+m}{M+m\sin^2\alpha}\right)^{\frac{1}{2}}$

(**ii**) Show that the particle return to the pant of projection after time $\frac{2V}{(M+m)g}.\left(\frac{M+m\sin^2\alpha}{\sin\alpha}\right)$

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[see the page. 8

Q12) A particle P of mass m is thrown horizontally inside a smooth fixed spherical shell with centre O and radius a at $t=0$ with a speed of $\sqrt{4ga}$ from the lowest point. Show that the speed of the particle when of make an acute angle θ with down ward vertical is $v=2\sqrt{ga}\sqrt{\dfrac{1+\cos\theta}{2}}$ and the reaction exerted by the spherical shell on the particle is $R=mga\left(2+3\cos\theta\right)$. Find the velocity of the particle when it leaves the circular path.

After leaving from circular motion, this particle P move in a trajectory path under gravity. By taking the horizontal and vertically upward axes through the point of leaving L as x and y axes, show that the equation of trajectory path is $y=\dfrac{\sqrt{5}}{2}x-\dfrac{27}{16a}x^2$.

If the particle reach the horizontal level through the centre O of the sphere at point S, show that $OS=\dfrac{\left(4\sqrt{23}-5\sqrt{5}\right)}{27}a$ and the time taken is $\left(\dfrac{a}{g}\right)^{\frac{1}{2}}\left(\dfrac{\sqrt{10}+\sqrt{46}}{3\sqrt{3}}+\ln\left(\sqrt{5}+\sqrt{6}\right)\right)$

Q13) A particle P of mass m is attached to the midpoint of a light elastic string of natural length $2l$ and elastic modulus mg. the two ends of the string are attached to two fixed paints A,B on a smooth horizontal table at a separation $4l$. Initially the particle is thrown with speed $\sqrt{7gl}$ in the direction of $\overrightarrow{AB}$ from its equilibrium point O on the table. If $OP=x$ at time t, show that $\ddot{x}=-\dfrac{2g}{l}x$ for $0\le x\le l$ and find the centre of oscillation and amplitude. Show that its velocity when $x=l$ is $\sqrt{5gl}$.

Show that $\ddot{x}=-\dfrac{g}{l}\left(x+l\right)$ for $l\le x\le 2l$ and show that time taken by it to come to rest for the first time is $\left(\dfrac{l}{g}\right)^{\frac{1}{2}}\left(\cos^{-1}\left(\dfrac{2}{3}\right)+\dfrac{1}{\sqrt{2}}\cos^{-1}\left(\sqrt{\dfrac{5}{7}}\right)\right)$

Q14) **a.** A rectangle $ABCD$ is defined by points $A\left(0,0\right),B\left(5,0\right),C\left(5,3\right),D\left(0,3\right)$ Here lengths are in m. The forces of magnitude $6\mathbf{N},8\mathbf{N},4\mathbf{N},2\mathbf{N}$ along.

(i) Find the resultant of this system of forces.

(ii) Find the angle between the line of action of this resultant force and the x – axis This line of action intersect x – axes at the point $\left(a,0\right)$

(iii) By taking moment about point A, find a Hence, deduce the equation of line of action.

b. A straight line intersect the sides *CA, AB* of a triangle *ABC* internally at *E,F* respectively and produced *BC* at *D* let $\overrightarrow{AB} = \mathbf{b}, \overrightarrow{AC} = \mathbf{c}$. If $\frac{BD}{CD} = p, \frac{CE}{EA} = q, \frac{AF}{FB} = r$

Show that $\overrightarrow{EF} = \frac{r}{(r+1)}\mathbf{b} - \frac{1}{(q+1)}\mathbf{c}$ and $\overrightarrow{DF} = \frac{pr+1}{(p-1)(r+1)}\mathbf{b} - \frac{p}{(p-1)}\mathbf{c}$ hence,

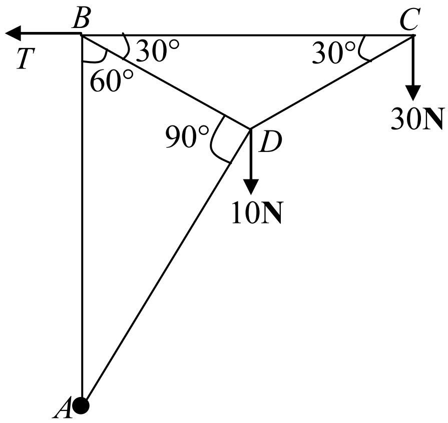
deduce that $pqr = 1$

Q15) **a.** Two uniform rods *AB, AC* of equal lengths and weight w, w' are smoothly jointed at *A* and Hanged from two hinges *B,C* at same level in a vertical plane. Prove that the horizontal component of the reaction at hinge *A* is $\frac{1}{4}\frac{(w+w')a}{h}$ Here $2a$ is the distance *BC* and *h* is the depth of *A* below *BC.* Find the vertical component of the reaction.

b. Five light *rods AB, BC, CD, DA* and *BD* are smoothly jointed at their ends to form a framework as shown in the diagram. Here $D\hat{B}C = B\hat{C}D = 30°, A\hat{B}D = 60°, B\hat{D}A = 90°$

The frame work is smoothly hinged at *A* and carries 30N at *C* and 10N at *D*. The frame work is kept in a vertical plane such that *BC* is horizontal.

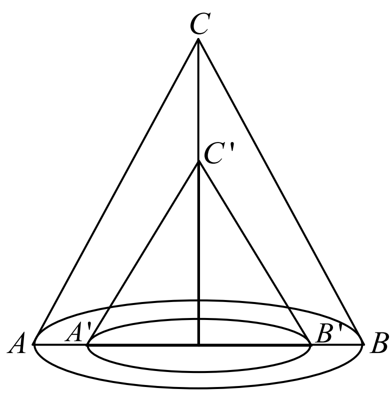
using Bow's notation, draw a stress diagram for the framework and find the stress in all rods disting uishing whether they are tensions or thrusts.



Q16) Using integration, show that centre of gravity of a uniform right circular solid cone of height *h* is at a distance $\frac{1}{4}h$ from the base of cone, on its symmetrical axis

A uniform right circular solid cone $A'B'C'$ of height h' and semi vertex angle α is removed from a uniform right circular solid cone *ABC* of height *h* and semi vertex angle α and the remaining part is shown in the diagram. Show that the centre of gravity of the remaining part *S* is at a distance $\frac{1}{4}.\frac{(h+h')(h^2+h'^2)}{h^2+h'^2+hh'}$ from *AB.*

Hence, deduce the centre of gravity of a uniform hollow cone.



[*see the page. 10*

This object S is hanged from a point on the surface $A'C'$ at a distance $\frac{h'}{4}$ from AB *by* an inelastic string. In this state, If this string make an angle β with AB such that the other parts of it don't touch the cone, show that $3\tan\alpha\tan\beta = \frac{h^3}{h^2h' + hh'^2 + h'^3}$

Q17) **a.** A boy watches **shakth**i channel or **Ten sports** channel every day evening. The probability of watching **Ten sports** channel is $\frac{4}{5}$. If he watches **shakthi** channel, the probability for sleeping is $\frac{3}{4}$. If he watches **Ten Sports** channel the probability for sleeping is $\frac{1}{4}$. In an evening if he sleeps while watching channel find the probability of the event that he was watching **shakhi** channel.

b. The mass of pigs in an agricultural farm are measured to nearest kilogram. The data obtained are shown in the frequency table.

Mass Range	Number of Pigs
$65-70$	3
$75-85$	f_1
$85-95$	20
$95-105$	f_2
$105-115$	7

In the table the frequencies of mass ranges 75 – 85, and 95 – 105 are missing. But the median and mode of the distribution are found to be 90Kg and 87.5 kg.

Find the missing frequencies in the table and hence find the mean and standard deviation of this frequencies distribution.

END OF QUESTIONS