MATHS

BOOKS - CHHAYA PUBLICATION MATHS (BENGALI ENGLISH)

TRANSFORMATIONS OF SUMS AND PRODUCTS

Iiiustrative Examples

1. Express in product form:

$\sin 5\alpha + \sin 3\alpha$

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2. Express in product form:

$\cos\theta - \cos 3\theta$

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3. Express as sum or difference:

$$\sin\frac{3\theta}{2}\cos\frac{5\theta}{2}$$

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4. Express as sum or difference:

$$4\sin 20^\circ \sin 35^\circ$$

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5. Prove that

$$\sin 55^\circ - \cos 55^\circ = \sqrt{2}\sin 10^\circ$$

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6. Prove that

$$\sin 16^\circ + \cos 16^\circ = \frac{1}{\sqrt{2}}\left(\sqrt{3}\cos 1^\circ + \sin 1^\circ\right)$$

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7. Prove that

$$\sin 20^\circ + \sin 140^\circ - \cos 10^\circ = 0$$

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8. Prove that

$$\sin 20^\circ \sin 40^\circ \sin 60^\circ \sin 80^\circ = \frac{3}{16}$$

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9. Prove that

$$\cos 80^\circ \cos 40^\circ + \cos 40^\circ \cos 200^\circ + \cos 200^\circ \cos 80^\circ = -\frac{3}{4}$$

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10. Prove that

$$\tan(60^\circ - \theta)\tan(60^\circ + \theta) = \frac{2\cos 2\theta + 1}{2\cos 2\theta - 1}$$

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11. Prove that

$$\frac{\sin 7x - \sin 5x - \sin 3x + \sin x}{\cos 7x - \cos 5x + \cos 3x - \cos x} = \tan 2x$$

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12. Prove that

$$\frac{\sin\theta\sin 9\theta + \sin 3\theta\sin 5\theta}{\sin\theta\cos 9\theta + \sin 3\theta\cos 5\theta} = \tan 6\theta$$

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13. Express $\cos A - \cos B + \cos C - \cos(A + B + C)$ in the product form.

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14. Show that

$4 \sin A \sin B \sin C = \sin(A + B - C) + \sin(B + C - A) + \sin(C + A -$

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15.

$If b \cos(\theta + 120^\circ) = c \cos(\theta + 240^\circ)$, then show that, $b - c = -(b + c)\sqrt{}$

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16.

$If b \sin \alpha = \alpha \sin(\alpha + 2\beta)$, show that $(b + a) \tan \beta = (b - a) \tan(\alpha + \beta)$

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17.

$$If\, a\cos\theta = b\cos\left(\theta + \frac{2\pi}{3}\right) = c\cos\left(\theta + \frac{4\pi}{3}\right), \text{prove that} ab + bc + ca =$$

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18.

$$If\, \sin x - \sin y = a \quad \text{and} \quad \cos x + \cos y = b, \text{show that} \quad \tan\frac{x+y}{2} = \pm$$

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19.

$$If\, a\sin\alpha = b\sin\beta \quad \text{then show that} \quad , b\cot\alpha + a\cot\beta = (a+b)\cot\frac{\alpha+\beta}{2}$$

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20.

$$If \sec A - \text{cosec} A = \text{cosec} B - \sec B, \text{ show that } \tan A \tan B = \tan \frac{A+B}{2}$$

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21. Show that

$$\left(\frac{\sin A + \sin B}{\cos A + \cos B}\right)^n + \left(\frac{\cos A - \cos B}{\sin A - \sin B}\right)^n$$

$= 2\tan^n \frac{A+B}{2}$ when n is an even integer,

0, when n is an odd integer.

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22. Find the value of $\frac{1}{2}\sec 80^\circ - 2\cos 20^\circ$

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23. Find the value of θ for which $\sin \theta \sin(\theta - \frac{\pi}{3})$ is maximum.

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24. $If 0^\circ < A < B < 90^\circ$ show that $\sin A < \sin B$

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25. Prove that

$\sin x \sin y \sin(x - y) + \sin y \sin z \sin(y - z)$

$+ \sin z \sin x \sin(z - x) + \sin(x - y)$

$\sin(y - z) \sin(z - x) = 0$

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Multiple Choice Type Questions

1. sin C + sin D=

A. $2\sin\frac{C+D}{2}\cos\frac{C-D}{2}$

B. $2\cos\frac{C+D}{2}\sin\frac{C-D}{2}$

C. $2\cos\frac{C+D}{2}\cos\frac{C-D}{2}$

D. $2\sin\frac{C+D}{2}\sin\frac{D-C}{2}$

Answer: A

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2. cos C + cos D =

A. $2\sin\frac{C+D}{2}\cos\frac{C-D}{2}$

B. $2\cos\frac{C+D}{2}\sin\frac{C-D}{2}$

C. $2\cos\frac{C+D}{2}\cos\frac{C-D}{2}$

D. $2\sin\frac{C+D}{2}\sin\frac{D-C}{2}$

Answer: B

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3. sin C - sin D =

A. $2\sin\frac{C+D}{2}\cos\frac{C-D}{2}$

B. $2\cos\frac{C+D}{2}\sin\frac{C-D}{2}$

C. $2\cos\frac{C+D}{2}\cos\frac{C-D}{2}$

D. $2\sin\frac{C+D}{2}\sin\frac{D-C}{2}$

Answer: C

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4. cos C - cos D=

A. $2\sin\frac{C+D}{2}\cos\frac{C-D}{2}$

B. $2\ \cos\frac{C+D}{2}\sin\frac{C-D}{2}$

C. $2\cos\frac{C+D}{2}\cos\frac{C-D}{2}$

D. $2\sin\frac{C+D}{2}\sin\frac{D-C}{2}$

Answer: D

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5. $2\sin 40^\circ \sin 10^\circ =$

A. $\cos 30^\circ + \cos 50^\circ$

B. $\cos 30^\circ - \cos 50^\circ$

C. $\cos 50^\circ - \cos 30^\circ$

D. none of these

Answer: B

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6. $2\sin 25^\circ \cos 15^\circ =$

A. $\sin 40^\circ + \sin 10^\circ$

B. $\sin 40^\circ - \sin 10^\circ$

C. $\sin 10^\circ - \sin 40^\circ$

D. none of these

Answer: A

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7. State which of the following is true ?

A. $\cos 10^\circ + \cos 25^\circ$ can be expressed as one cosine only

B. $\cos 20^\circ - \cos 40^\circ$ can be expressed as one sine only

C. cos A cos B can not be expressed as the sum of two cosines

D. sin A cos B can be expressed as the difference of two sines

Answer: B

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8. State which of the following is equal to $\sin\frac{5\theta}{2}\sin\frac{3\theta}{2}$

A. $\frac{1}{2}(\sin 4\theta - \sin\theta)$

B. $\frac{1}{2}(\cos 4\theta - \cos\theta)$

C. $\frac{1}{2}(\cos\theta - \cos 4\theta)$

D. $\frac{1}{2}(\cos\theta + \cos 4\theta)$

Answer: C

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9. State which of the following is equal to $\sqrt{3}\sin 10^\circ$

A. $\sin 40^\circ + \sin 20^\circ$

B. $\cos 50^\circ - \cos 70^\circ$

C. $\cos 50^\circ + \cos 70^\circ$

D. $\sin 70^\circ + \sin 50^\circ$

Answer: B

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Very Short Answer Type Questions

1. Prove that

$$\frac{\sin 3\theta - \sin\theta}{\cos\theta - \cos 3\theta} = \cot 2\theta$$

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2. Prove that

$$\frac{\sin A - \sin B}{\cos A + \cos B} = \tan\frac{A - B}{2}$$

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3. Prove that

$$\frac{\sin\theta + \sin 2\theta + \sin 3\theta}{\cos\theta + \cos 2\theta + \cos 3\theta} = \tan 2\theta$$

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4. Prove that

$$(\cos\alpha - \cos\beta)^2 + (\sin\alpha - \sin\beta)^2 = 4\sin^2\frac{\alpha - \beta}{2}$$

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5. Prove that

$$\cos 10^\circ + \cos 110^\circ + \cos 130^\circ = 0$$

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6. Prove that

$$\sin 85^\circ - \cos 65^\circ + \cos 55^\circ = 0$$

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7. Prove that

$$\sin 18^\circ + \cos 18^\circ = \sqrt{2}\cos 27^\circ$$

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8. Prove that

$$\frac{\sin 75^\circ + \sin 15^\circ}{\sin 75^\circ - \sin 15^\circ} = \sqrt{3}$$

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9. Prove that

$$\frac{\cos 45^\circ - \cos 75^\circ}{\sin 45^\circ + \sin 75^\circ} = 2 - \sqrt{3}$$

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10. Prove that

$$\frac{\cos 20^\circ - \sin 20^\circ}{\cos 20^\circ + \sin 20^\circ} = \tan 25^\circ$$

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11. Prove that

$$\frac{\cos 10^\circ - \sin 10^\circ}{\cos 10^\circ + \sin 10^\circ} = \tan 35^\circ$$

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12. Prove that

$$\frac{\cos 2\alpha - \cos 2\beta}{\sin 2\alpha + \sin 2\beta} = \tan(\beta - \alpha)$$

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13. $If x \cos \alpha + y \sin \alpha = x \cos \beta + y \sin \beta$, show that, $y = x \tan \frac{\alpha + \beta}{2}$

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14.

$$If \quad \cos\alpha + \cos\beta = \frac{1}{3} \quad \text{and} \quad \sin\alpha + \sin\beta = \frac{1}{4}, \text{show that} \quad \tan\frac{\alpha+\beta}{2} =$$

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Short Answer Type Questions

1. Prove that

$$\sin\alpha + \sin(120^\circ + \alpha) + \sin(240^\circ + \alpha) = 0$$

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2. Prove that

$$\sin 5x \cos 2x + \cos 6x \sin 3x = \sin 8x \cos x$$

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3. Prove that

$$\sec\left(\frac{\pi}{4}+\theta\right)\sec\left(\frac{\pi}{4}-\theta\right)=2\sec 2\theta$$

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4. Prove that

$$\cos(\alpha+\beta)+\sin(\alpha-\beta)=2\sin\left(\frac{\pi}{4}+\alpha\right)\cos\left(\frac{\pi}{4}+\beta\right)$$

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5. Prove that

$$1+\frac{\cos 105^\circ+\cos 165^\circ}{\sin 105^\circ+\sin 375^\circ}=0$$

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6. Prove that

$$\sin 10^\circ+\sin 50^\circ-\sin 70^\circ=0$$

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7. Prove that

$$\cos 80^\circ - \cos 40^\circ + \sqrt{3}\cos 70^\circ = 0$$

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8. Prove that

$$\cos(60^\circ + A) + \cos(60^\circ - A) - \cos A = 0$$

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9. Prove that

$$\sin\left(\frac{2\pi}{3} + \theta\right) - \sin\left(\frac{2\pi}{3} - \theta\right) + \sin\theta = 0$$

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10. Prove that

$$\sin 19^\circ + \sin 41^\circ + \sin 83^\circ = \sin 23^\circ + \sin 37^\circ + \sin 79^\circ$$

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11. Prove that

$$\sin 10^\circ + \sin 20^\circ + \sin 40^\circ + \sin 50^\circ = \sin 70^\circ + \sin 80^\circ$$

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12. Prove that

$$\cos\frac{3\pi}{13} + \cos\frac{5\pi}{13} - 2\cos\frac{9\pi}{13}\cos\frac{12\pi}{13} = 0$$

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13. Prove that

$$4\sin 15^\circ \sin 75^\circ = \sqrt{2}(\cos 105^\circ + \sin 75^\circ)$$

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14. Prove that

$$\sin 80^\circ \cos 20^\circ + \sin 45^\circ \cos 145^\circ + \sin 55^\circ \cos 245^\circ = 0$$

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15. Prove that

$$\cos 32^\circ \sin 20^\circ + \cos 144^\circ \cos 2^\circ + \sin 68^\circ \cos 56^\circ = 0$$

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16. Prove that

$$\cos 306^\circ + \cos 234^\circ + \cos 162^\circ + \cos 18^\circ = 0$$

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17. Prove that

$$\cos 10^\circ \cos 20^\circ + \sin 45^\circ \cos 145^\circ + \sin 55^\circ \cos 245^\circ = 0$$

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18. Prove that

$$\cos 24^\circ + \cos 55^\circ + \cos 125^\circ + \cos 204^\circ + \cos 300^\circ = \frac{1}{2}$$

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19. Prove that

$$\cos 20^\circ \cos 40^\circ \cos 80^\circ = \frac{1}{8}$$

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20. Prove that

$$8\sin 20^\circ \sin 40^\circ \sin 80^\circ = \sqrt{3}$$

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21. Prove that

$$\tan 20^\circ \tan 40^\circ \tan 80^\circ = \sqrt{3}$$

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22. Prove that

$$\cos 40^\circ \cos 80^\circ \cos 160^\circ = -\frac{1}{8}$$

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23. Prove that

$$\cos\theta \cos(60^\circ - \theta)\cos(60^\circ + \theta) = \frac{1}{4}\cos 3\theta$$

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24. Prove that

$$4\sin\theta\sin\left(\frac{\pi}{3}+\theta\right)\sin\left(\frac{\pi}{3}-\theta\right)=\sin 3\theta$$

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25. Prove that

$$\cos\alpha\cos(120^\circ+\alpha)\cos(240^\circ+\alpha)=\frac{1}{4}\cos 3\alpha$$

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26. Find the value:

$$\sin 78^\circ-\sin 18^\circ+\sin 30^\circ-\sin 42^\circ$$

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27. Find the value:

$$\sec 20^\circ\sec 40^\circ\sec 80^\circ$$

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28. Find the value:

$\sqrt{3}\cot 20^\circ \cot 40^\circ \cot 80^\circ$

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29. Find the value:

$$\frac{1}{2\sin 10^\circ} - 2\sin 70^\circ$$

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30. Prove the following identities :

$4\sin 23^\circ \sin 37^\circ \sin 83^\circ = \cos 21^\circ$

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31. Prove the following identities :

$$\cos 2A + \cos 4A + \cos 6A + \cos 8A = 4\cos A \cos 2A \cos 5A$$

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32. Prove the following identities :

$$\frac{\sin(A+B) - 2\sin A + \sin(A-B)}{\cos(A+B) - 2\cos A + \cos(A-B)} = \tan A$$

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33. Prove the following identities :

$$\frac{\sin\theta + \sin 3\theta + \sin 5\theta + \sin 7\theta}{\cos\theta + \cos 3\theta + \cos 5\theta + \cos 7\theta} = \tan 4\theta$$

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34. $If 13\theta = \pi \quad \text{show that } \cos 3\theta + \cos 5\theta + 2\cos\theta\cos 9\theta = 0$

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35. $If \sin 2\alpha = 4\sin 2\beta$, show that, $5\tan(\alpha - \beta) = 3\tan(\alpha + \beta)$

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36. $If \sin A = m\sin B$, prove that $\tan\frac{A-B}{2} = \frac{m-1}{m+1}\tan\frac{A+B}{2}$

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37. $If \cos\alpha = k\cos\beta$, show that, $\tan\frac{\alpha+\beta}{2} = \frac{1-k}{1+k}\cot\frac{\alpha-\beta}{2}$

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38. $If \operatorname{cosec} A + \sec A = \operatorname{cosec} B + \sec B$ prove that

$\tan\frac{A+B}{2} = \cot A\cot B$

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39. $If \alpha, \beta, \gamma$ are in A.P. show that $\cot \beta = \dfrac{\sin \alpha - \sin \gamma}{\cos \gamma - \cos \alpha}$

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40.

$If \cot y = \dfrac{\sin(z+x)}{\cos(z-x) - \cos(z+x)}$, show that $\cot x$, $\cot y$ and $\cot z$ are in A

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41.

$If \sin x + \sin y = \sqrt{3}(\cos y - \cos x)$, then show that $\sin 3x + \sin 3y = 0$

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42.

$If \cot \theta = \cos(x+y)$ and $\cot \phi = \cos(x-y)$, show that $\tan(\theta - \phi) = \dfrac{2 s}{\cos^2}$

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Long Answer Type Questions

1. Prove the following identities:

$$\sin 10^\circ \sin 50^\circ + \sin 50^\circ \sin 250^\circ + \sin 250^\circ \sin 10^\circ = -\frac{3}{4}$$

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2. Prove the following identities:

$$\frac{\sin\alpha \sin 11\alpha + \sin 3\alpha \sin 7\alpha}{\sin\alpha \cos 11\alpha + \sin 3\alpha \cos 7\alpha} = \tan 8\alpha$$

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3. Prove the following identities:

$$\tan\theta \tan\left(\frac{\pi}{3} + \theta\right) \tan\left(\frac{\pi}{3} - \theta\right) = \tan 3\theta$$

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4.

$$If \quad a\cos\phi = b\cos\theta, \quad \text{show that} \quad a\tan\theta + b\tan\phi = (a+b)\tan\left(\frac{\theta+\phi}{2}\right.$$

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5.

$$If p\sin\alpha = q\sin(120^\circ + \alpha) = r\sin(240^\circ + \alpha), \text{prove that}, pq + qr + rp =$$

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6. $If \cos\theta = n\cos(\theta + 2\phi) \text{show that} (n+1)\tan(\theta+\phi) = (n-1)\cot\phi$

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7.

$$\text{Prove that}: \quad \sin\alpha + \sin\beta + \sin\gamma - \sin(\alpha+\beta+\gamma) = 4\sin\frac{\alpha+\beta}{2}\sin\frac{\beta+}{2}$$

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8. Express $4\sin A\cos B\cos C$ as the sum of four sines.

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9. Express $\cos\alpha+\cos\beta+\cos\gamma+\cos(\alpha+\beta+\gamma)$ as the product of three cosines.

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10.

$$IfA+B+C=\pi\text{and}\sin\left(A+\frac{C}{2}\right)=n\sin\frac{C}{2}\text{show that}\tan\frac{A}{2}\tan\frac{B}{2}=\frac{n}{n}$$

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11. If $\sin\theta+\sin\phi=a$, $\cos\theta+\cos\phi=b$ prove that

$$\tan\left(\frac{\theta-\phi}{2}\right)=\pm\sqrt{\frac{4-a^2-b^2}{a^2+b^2}}$$

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12. $\frac{1}{\cos\alpha+\cos 3\alpha}+\frac{1}{\cos\alpha+\cos 5\alpha}+\frac{1}{\cos\alpha+\cos 7\alpha}$
$+\ldots.+\frac{1}{\cos\alpha+\cos(2n+1)\alpha}$
$=\frac{1}{2}\text{cosec}\alpha[\tan(n+1)\alpha-\tan\alpha]$

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13. prove that, $\left(\frac{\cos A+\cos B}{\sin A-\sin B}\right)^n+\left(\frac{\sin A+\sin B}{\cos A-\cos B}\right)^n=2\cot^n\frac{A-B}{2}$ or 0 accordingly as n an even or odd integer.

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14.

$If\sin A=\frac{1}{\sqrt{2}}$ and $\sin B=\frac{1}{\sqrt{3}}$, find the value of $\tan\frac{A+B}{2}\cot\frac{A-B}{2}$

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15. Find the value of A for which $\cos A \sin\left(A - \frac{\pi}{6}\right)$ is maximum.

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16.

The two different values of θ, namely θ_1 and θ_2 satisfy $\sin(\theta + \phi) =$

prove that , $\frac{\sin\theta_1 + \sin\theta_2}{\cos\theta_1 + \cos\theta_2} = \cot\phi$

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Multiple Correct Answers Type

1. The value of $\sin 47^\circ + \sin 61^\circ - \sin 11^\circ - \sin 25^\circ$ is-

A. $\sin 83^\circ$

B. $\cos 367^\circ$

C. $\cos 7^\circ$

D. $\sin 97^\circ$

Answer: A::B::C::D

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2. The value of $\left(\frac{\cos\alpha+\cos\beta}{\sin\alpha-\sin\beta}\right)^n+\left(\frac{\sin\alpha+\sin\beta}{\cos\alpha-\cos\beta}\right)^n$ (where n is a whole number) is equal to-

A. 0

B. $2\tan^n\frac{A-B}{2}$

C. $2\cot^n\frac{A-B}{2}$

D. $2\cot^n\frac{A+B}{2}$

Answer: A::C

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3. $\dfrac{\cos 29^\circ + \sin 29^\circ}{\cos 29^\circ - \sin 29^\circ} =$

A. $\tan 74^\circ$

B. $\cot 16^\circ$

C. $\cot 196^\circ$

D. $\tan 254^\circ$

Answer: A::B::C::D

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4.

$If \sin\alpha + \sin\beta = p \text{and} \cos\alpha + \cos\beta = q \text{then the value of } \tan\dfrac{\alpha - \beta}{2}$

will be-

A. $\sqrt{\dfrac{4 - p^2 - q^2}{p^2 + q^2}}$

B. $\sqrt{\dfrac{p^2 + q^2 - 4}{p^2 + q^2}}$

C. $-\sqrt{\frac{4-p^2-q^2}{p^2+q^2}}$

D. $-\sqrt{\frac{P^2+q^2-4}{p^2+q^2}}$

Answer: A::C

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5. $\sin\frac{\pi}{12}\sin\frac{5\pi}{12}=$

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Integer Answer Type

1. $If x\sin\theta = y\sin\left(\theta+\frac{2\pi}{3}\right)=z\sin\left(\theta+\frac{4\pi}{3}\right)$, then the value of xy+yz+zx will be-

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2. The value of $16\cos 10^\circ \cos 30^\circ \cos 50^\circ \cos 70^\circ$ is

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3. $\dfrac{\cos A + \cos 3A + \cos 5A + \cos 7A}{\cos A \cos 2A \cos 4A} =$

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4. $\cos 52^\circ + \cos 68^\circ + \cos 172^\circ =$

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5. $\dfrac{1 - 4\sin 10^\circ \sin 70^\circ}{2\sin 10^\circ} =$

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Comprehension Type

1. $If x\cos\alpha + y\sin\alpha = x\cos\beta + y\sin\beta \text{then}$

$$\tan\frac{\alpha+\beta}{2} =$$

A. $\frac{y}{x}$

B. $\frac{x}{y}$

C. $\frac{x+y}{y}$

D. $\frac{x-y}{y}$

Answer: A

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2. $If x\cos\alpha + y\sin\alpha = x\cos\beta + y\sin\beta \text{then}$

$$\frac{2(1-\cos(\alpha-\beta))}{(\cos\beta-\cos\alpha)^2} =$$

A. $\frac{x^2-y^2}{y^2}$

B. $\frac{x^2+y^2}{y^2}$

C. $\frac{x+y}{y}$

D. $\frac{x-y}{y}$

Answer: B

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3. $If x\cos\alpha + y\sin\alpha = x\cos\beta + y\sin\beta \text{then}$

$$\frac{\sin\alpha - \cos\alpha - \sin\beta + \cos\beta}{\sin\alpha + \cos\alpha - \sin\beta - \cos\beta} =$$

A. $\frac{y+x}{y-x}$

B. $\frac{y-x}{y+x}$

C. $\frac{x-y}{x+y}$

D. $\frac{x+y}{x-y}$

Answer: D

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4. A,B,C are three angles of a triangle and $\sin\left(A+\frac{c}{2}\right)=n\sin\frac{C}{2}$

$\tan\frac{A}{2}\tan\frac{B}{2}=$

A. $\frac{n+1}{n-1}$

B. $\frac{1-n}{1+n}$

C. $\frac{n-1}{n+1}$

D. $\frac{1+n}{1-n}$

Answer: C

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5. A,B,C are three angles of a triangle and $\sin\left(A+\frac{c}{2}\right)=n\sin\frac{C}{2}$

$\frac{\sin\frac{C}{2}}{\cos\frac{A-B}{2}}=$

A. n

B. $-n$

C. $\frac{1}{n}$

D. $-\frac{1}{n}$

Answer: C

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6. A,B,C are three angles of a triangle and $\sin\left(A+\frac{c}{2}\right)=n\sin\frac{C}{2}$

$$\frac{\sin\frac{C}{2}}{\cos\frac{A}{2}\cos\frac{B}{2}}=$$

A. $\frac{2}{n+1}$

B. $\frac{1}{n+1}$

C. $-\frac{2}{n+1}$

D. $\frac{1}{n+1}$

Answer: A

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