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1. In triangle ABC prove that

a.  $\sin A = \sin (B + C)$

b  $\sin 2A = -\sin (2B + 2C)$

c.  $\cos A = -\cos (B + C)$

d  $\tan \left( \frac{A+B}{2} \right) = \cot \frac{C}{2}$

**Sol.** (a)  $\sin A = \sin (\pi - (B + C)) = \sin (B + C)$

(b)  $\sin 2A = \sin (2\pi - (2B + 2C)) = -\sin (2B + 2C)$

(c)  $\cos A = \cos (\pi - (B + C)) = -\cos (B + C)$

(d)  $\tan \left( \frac{A+B}{2} \right) = \tan \left( \frac{\pi-C}{2} \right) = \tan \left( \frac{\pi}{2} - \frac{C}{2} \right) = \cot \left( \frac{C}{2} \right)$

2. Prove that  $\sin (-420^\circ)(\cos 390^\circ) + \cos (-660^\circ)(\sin 330^\circ) = -1$ .

**Sol.**  $\sin (-420^\circ)(\cos 390^\circ) + \cos (-660^\circ)(\sin 330^\circ)$

$= -\sin (420^\circ)(\cos 390^\circ) + \cos (660^\circ)(\sin 330^\circ)$

$= -\sin (360^\circ + 60^\circ)\cos (360^\circ + 30^\circ) + \cos (720^\circ - 60^\circ)\sin (360^\circ - 30^\circ)$

$= -\sin 60^\circ(\cos 30^\circ) - (\cos 60^\circ)(\sin 30^\circ) = -\frac{\sqrt{3}}{2} \frac{1}{2} - \frac{1}{2} \frac{\sqrt{3}}{2} = -\frac{\sqrt{3}}{2}$

3. Prove that


a.  $\tan 720^\circ - \cos 270^\circ - \sin 150^\circ \cos 120^\circ = \frac{1}{4}$

b  $\sin 780^\circ \sin 480^\circ + \cos 120^\circ \sin 150^\circ = \frac{1}{2}$

**Sol.** a.  $\tan 720^\circ - \cos 270^\circ - \sin 150^\circ \cos 120^\circ = 0 - 0 - (\sin 30^\circ)(-\cos 60^\circ) = \frac{1}{2} \frac{1}{2} = \frac{1}{4}$

b.  $\sin 780^\circ \sin 480^\circ + \cos 120^\circ \sin 150^\circ$

$= \sin (720^\circ + 60^\circ)\sin (360^\circ + 120^\circ) + \cos (180^\circ - 60^\circ)\sin (180^\circ - 30^\circ)$

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$$= \sin(60^\circ)\sin(120^\circ) - \cos(60^\circ)\sin(30^\circ)$$

$$= \frac{\sqrt{3}}{2} \frac{\sqrt{3}}{2} - \frac{1}{2} \frac{1}{2} = \frac{3}{4} - \frac{1}{4} = \frac{1}{2}$$

4. If  $\alpha = \frac{\pi}{3}$ , prove that  $\cos \alpha \cos 2\alpha \cos 3\alpha \cos 4\alpha \cos 5\alpha \cos 6\alpha = -\frac{1}{16}$ .

**Sol.**  $\cos \alpha \times \cos 2\alpha \times \cos 3\alpha \times \cos 4\alpha \times \cos 5\alpha \cos 6\alpha$

$$= \cos \frac{\pi}{3} \times \cos \frac{2\pi}{3} \times \cos \pi \times \cos \frac{4\pi}{3} \times \cos \frac{5\pi}{3} \times \cos \frac{6\pi}{3} = \frac{1}{2} \times \left(-\frac{1}{2}\right) (-1) \left(-\frac{1}{2}\right) \frac{1}{2} 1 = -\frac{1}{16}$$

5. Find the value of  $\tan \frac{\pi}{20} \tan \frac{3\pi}{20} \tan \frac{5\pi}{20} \tan \frac{7\pi}{20} \tan \frac{9\pi}{20}$ .

**Ans. (1)**

**Sol.**  $\tan \frac{\pi}{20} \tan \frac{3\pi}{20} \tan \frac{5\pi}{20} \tan \frac{7\pi}{20} \tan \frac{9\pi}{20} = \tan \frac{\pi}{20} \tan \frac{3\pi}{20} \tan \frac{\pi}{4} \tan \left(\frac{\pi}{2} - \frac{3\pi}{20}\right) \tan \left(\frac{\pi}{2} - \frac{\pi}{20}\right)$

$$= \tan \frac{\pi}{20} \tan \frac{3\pi}{20} (1) \cot \left(\frac{3\pi}{20}\right) \cot \left(\frac{\pi}{20}\right) = 1$$

6. Find the value of  $\frac{\cot 54^\circ}{\tan 36^\circ} + \frac{\tan 20^\circ}{\cot 70^\circ}$ .

**Ans. (2)**

**Sol.**  $\frac{\cot 54^\circ}{\tan 36^\circ} + \frac{\tan 20^\circ}{\cot 70^\circ} = \frac{\cot(90-36^\circ)}{\tan 36^\circ} + \frac{\cot(90-70^\circ)}{\cot 70^\circ} = \frac{\tan 36^\circ}{\tan 36^\circ} + \frac{\cot 70^\circ}{\cot 70^\circ} = 2$


7. Prove that  $\sin^2 \frac{\pi}{18} + \sin^2 \frac{\pi}{9} + \sin^2 \frac{7\pi}{18} + \sin^2 \frac{4\pi}{9} = 2$ .

**Sol.**  $\sin^2 \frac{\pi}{18} + \sin^2 \frac{\pi}{9} + \sin^2 \frac{7\pi}{18} + \sin^2 \frac{4\pi}{9} = \sin^2 \frac{\pi}{18} + \sin^2 \frac{\pi}{9} + \sin^2 \left(\frac{\pi}{2} - \frac{\pi}{9}\right) + \sin^2 \left(\frac{\pi}{2} - \frac{\pi}{18}\right)$

$$= \sin^2 \frac{\pi}{18} + \sin^2 \frac{\pi}{9} + \cos^2 \frac{\pi}{9} + \cos^2 \frac{\pi}{18} = \left(\sin^2 \frac{\pi}{18} + \cos^2 \frac{\pi}{18}\right) + \left(\sin^2 \frac{\pi}{9} + \cos^2 \frac{\pi}{9}\right) = 2$$

8. Prove that  $\sec \left(\frac{3\pi}{2} - \theta\right) \sec \left(\theta - \frac{5\pi}{2}\right) + \tan \left(\frac{5\pi}{2} + \theta\right) \tan \left(\theta - \frac{3\pi}{2}\right) = -1$ .

**Sol.**  $\sec \left(\frac{3\pi}{2} - \theta\right) \sec \left(\theta - \frac{5\pi}{2}\right) + \tan \left(\frac{5\pi}{2} + \theta\right) \tan \left(\theta - \frac{3\pi}{2}\right) = -\operatorname{cosec} \theta \operatorname{cosec} \theta + \cot \theta \cot \theta$   
 $= -(\operatorname{cosec}^2 \theta - \cot^2 \theta) = -1$

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9. In any quadrilateral ABCD, prove that

a.  $\sin(A + B) + \sin(C + D) = 0$

b.  $\cos(A + B) = \cos(C + D)$

**Sol.** In quadrilateral ABCD,  $A + B + C + D = 2\pi$ .

a.  $\sin(A + B) + \sin(C + D) = \sin(A + B) + \sin$

$(2\pi - (A + B)) = \sin(A + B) - \sin(A + B) = 0$

b.  $\cos(A + B) = \cos(C + D) = \cos(2\pi - (C + D)) = \cos(C + D)$

