

$$\sin x = 0$$

$$\Rightarrow x = n\pi, n \in \mathbb{I}$$

$$\sin 2x = 0$$

$$\Rightarrow 2x = n\pi$$

$$\Rightarrow x = (n\pi/2), n \in \mathbb{I}$$

$$\sin 3x = 0$$

$$\Rightarrow 3x = n\pi$$

$$\Rightarrow x = (n\pi/3), n \in \mathbb{I}$$

$x = n\pi/2$  does not satisfy the given equation.

Hence, the required solution is  $x = n\pi$  and  $x = n\pi/3$ .

**OR**

In a triangle, ABC, prove that  $\sin A + \sin B + \sin C = 4 \cos A/2 \cos B/2 \cos C/2$

**Solution:**

In any triangle ABC,

$$A + B + C = \pi$$

$$A + B = \pi - C$$

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

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

$$\text{LHS} = \sin A + \sin B + \sin C$$

$$= 2 \sin [(A + B)/2] \cos [(A - B)/2] + \sin C$$

$$= 2 \sin [(\pi/2) - (C/2)] \cos [(A - B)/2] + 2 \sin (C/2) \cos (C/2)$$

$$= 2 \cos (C/2) \cos [(A - B)/2] + 2 \sin (C/2) \cos (C/2)$$

$$= 2 \cos (C/2) [\cos [(A - B)/2] + \sin (C/2)]$$

$$= 2 \cos \left( \frac{C}{2} \right) \left\{ \cos \left( \frac{A - B}{2} \right) + \sin \left( \frac{\pi - (A + B)}{2} \right) \right\}$$

$$= 2 \cos \left( \frac{C}{2} \right) \left\{ \cos \left( \frac{A - B}{2} \right) + \sin \left( \frac{\pi}{2} - \frac{A + B}{2} \right) \right\}$$

$$= 2 \cos \left( \frac{C}{2} \right) \left\{ \cos \left( \frac{A - B}{2} \right) + \cos \left( \frac{A + B}{2} \right) \right\}$$

$$= 2 \cos \left( \frac{C}{2} \right) \left\{ 2 \cos \left( \frac{\frac{A - B}{2} + \frac{A + B}{2}}{2} \right) \cos \left( \frac{\frac{A - B}{2} - \frac{A + B}{2}}{2} \right) \right\}$$

$$= 2 \cos (C/2) [2 \cos (A/2) \cos (-B/2)]$$

$$= 4 \cos (A/2) \cos (B/2) \cos (C/2)$$

$$= \text{RHS}$$

Hence proved.

#### Question 4

Prove that:  $5^{2n} - 1$  is divisible by 24 for all  $n \in \mathbb{N}$ .

[4]

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