

# A Book of Abstract Algebra | (2nd Edition)



Chapter 30, Problem 6EC

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### Problem

An angle  $\alpha$  is called *constructible* iff there exist constructible points  $A$ ,  $B$ , and  $C$  such that  $\angle ABC = \alpha$ .

Prove the following:

The following angles are constructible:  $30^\circ$ ,  $75^\circ$ ,  $22\frac{1}{2}^\circ$ .

### Step-by-step solution

#### Step 1 of 5

Here, objective is to prove that, the given angles are constructible.

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#### Step 2 of 5

Constructible angle:

An angle  $\frac{2\pi}{N}$  is constructible if and only if  $N$  is either a power of two or power of two times a set

of Fermat points.

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### Step 3 of 5

Consider the angle  $30^\circ$

$$\frac{360}{12} = 30^\circ$$

$$12 = 2^2 \times 3$$

$2^2$  is a power of two and  $3$  is a Fermat prime.

Hence,  $30^\circ$  is constructible angle.

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### Step 4 of 5

Consider the angle  $75^\circ$

$$75^\circ = 30^\circ + 45^\circ$$

$$45^\circ = \frac{360}{8}$$

$8$  is a power of two

$$30^\circ = \frac{360}{12}$$

$$12 = 2^2 \times 3$$

$2^2$  is a power of two and  $3$  is a Fermat prime.

Then, the angles  $30^\circ$  and  $45^\circ$  are constructible.

Therefore, the angle  $75^\circ$  is constructed by summing of  $30^\circ$  and  $45^\circ$

Hence,  $75^\circ$  is constructible angle.

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**Step 5 of 5**

Consider the angle  $22\frac{1}{2}^{\circ}$

$$22\frac{1}{2}^{\circ} = \frac{45^{\circ}}{2}$$

$$\frac{360}{16} = \frac{45^{\circ}}{2}$$

$$16 = 2^4$$

16 is a power of two

Hence,  $22\frac{1}{2}^{\circ}$  is constructible angle.

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