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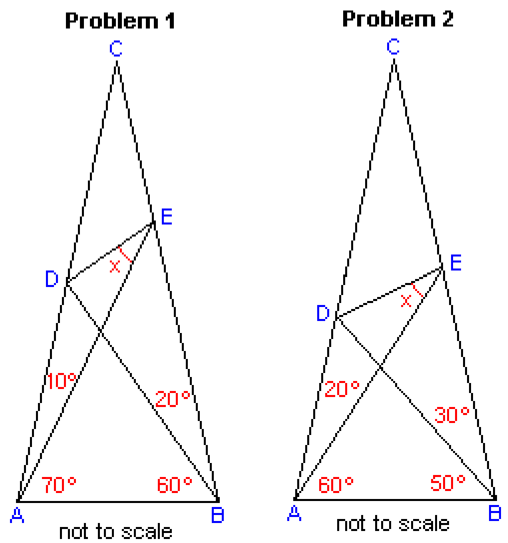
World's Hardest 'Easy Geometry' Problem

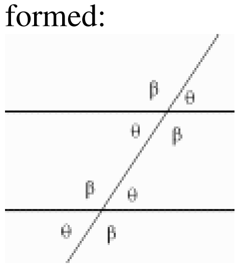
Another puzzle: Can you solve this frog riddle (a math probability problem)?

Here are the World's Hardest Easy Geometry Problem, as found on Keith Enevoldsen's Think Zone web page:



Solutions to both of these problems can be found far below -- so be careful how far you scroll below if you don't want to see the answer.

What makes these geometry problems so interesting (and 'hard') is that only elementary geometry is allowed (no trigonometry). Like, basic rules about parallel and intersecting lines and the angles formed:

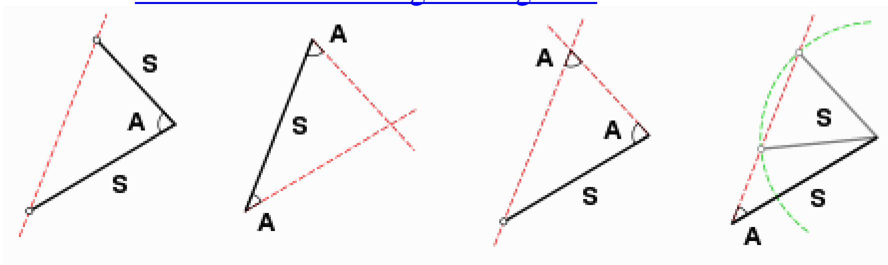


as well as simple triangle facts:

- the sum of interior angles of a triangle add up to 180°

- isosceles triangle theorem about two equal angles/sides
- an equilateral triangle has three 60° angles and three equal length sides

as well as what makes two triangles congruent:



The solutions below are by design *not rigorous proofs*, but rather provide just enough information to make the true solution very obvious to most readers.

You must click to find the images associated with these solutions -- so as to not spoil the fun for those that want to try to find the solution for themselves first.

Problem One Solution

Solution One Image

1. Calculate some known angles:

- $\angle$ACB = 180-(10+70)-(60+20) = 20°
- $\angle$AEB = 180-70-(60+20) = 30°

2. Draw a line from point D parallel to AB, labeling the intersection with BC as a new point F and conclude:

- ΔDCF $\sim$ ΔACB
- $\angle$CFD = $\angle$CBA = 60+20 = 80°
- $\angle$DFB = 180-80 = 100°
- $\angle$CDF = $\angle$CAB = 70+10 = 80°
- $\angle$ADF = 180-80 = 100°
- $\angle$BDF = 180-100-20 = 60°

3. Draw a line FA labeling the intersection with DB as a new point G and conclude:

- $\Delta ADF \cong \Delta BFD$
- $\angle AFD = \angle BDF = 60°$
- $\angle DGF = 180-60-60 = 60° = \angle AGB$
- $\angle GAB = 180-60-60 = 60°$
- ΔDFG (with all angles 60°) is equilateral
- ΔAGB (with all angles 60°) is equilateral

4. ΔCFA with two 20° angles is isosceles, so FC = FA

5. Draw a line CG, which bisects $\angle ACB$ and conclude:

- $\Delta ACG \cong \Delta CAE$
- FC-CE = FA-AG = FE = FG
- FG = FD, so FE = FD

6. With two equal sides, ΔDFE is isosceles and conclude:

- $\angle DEF = 30+x = (180-80)/2 = 50$

Answer: x = 20°

Problem Two Solution

Solution Two Image

1. Calculate some known angles:

- $\angle ACB = 180-(10+70)-(60+20) = 20°$
- $\angle AEB = 180-60-(50+30) = 40°$

2. Draw a line from point E parallel to AB, labeling the intersection with AC as a new point F and conclude:

- $\Delta FCE \sim \Delta ACB$
- $\angle CEF = \angle CBA = 50+30 = 80°$
- $\angle FEB = 180-80 = 100°$
- $\angle AEF = 100-40 = 60°$
- $\angle CFE = \angle CAB = 60+20 = 80°$
- $\angle EFA = 180-80 = 100°$

3. Draw a line FB labeling the intersection with AE as a new point G

and conclude:

- ΔAFE $\cong\Delta$BEF
- $\angle$AFB = $\angle$BEA = 40°
- $\angle$BFE = $\angle$AEF = 60°
- $\angle$FGE = 180-60-60 = 60° = $\angle$AGB.
- $\angle$ABG = 180-60-60 = 60°

4. Draw a line DG. Since AD=AB (leg of isosceles) and AG=AB (leg of equilateral), conclude:

- AD = AG.
- ΔDAG is isosceles
- $\angle$ADG = $\angle$AGD = (180-20)/2 = 80°

5. Since $\angle$DGF = 180-80-60 = 40°, conclude:

- ΔFDG (with two 40° angles) is isosceles, so DF = DG

6. With EF = EG (legs of equilateral) and DE = DE (same line segment) conclude:

- ΔDEF $\cong\Delta$DEG by side-side-side rule
- $\angle$DEF = $\angle$DEG = x
- $\angle$FEG = 60 = x+x

Answer: x = 30°