

SCAVENGER HUNT



ANGLE BISECTORS AND THE INCENTER

Half or Whole?

Angles at the incenter · the cards check the answers

FREE

ANSWER

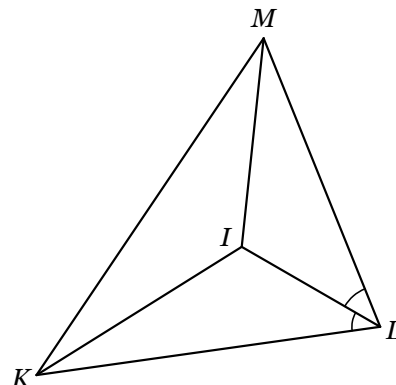
33°

I is the incenter.

$$m\angle KLM = 76^\circ$$

What is $m\angle ILM$?

The line from a corner to I cuts that angle into two equal parts.



M

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1. **Tape the 16 cards around the room**, in any order. Each card has a large letter in its bottom left corner. Start each group at a *different* one of these eight cards: *M Q B F A G J P*.
2. **Say this once:** *“The line from each corner to I cuts that angle into two equal parts. Before you add or subtract, write each half on the drawing. Eight right answers bring you back to your first card.”*
3. **Each group finds the angle, then walks to the card with that number at the top.** Nothing else is needed.

16 cards	pages 3–10, one copy. There are two cards on each sheet. Cut the whole stack once.
Record sheet	page 11, one per student. It shows the incenter as two small marked drawings.
Answers	pages 12–13, for you only. Do not put them up in the room.

Every card shows a triangle with its incenter I. The incenter is where the three angle bisectors meet, so each segment from a corner to I cuts that corner's angle into two equal parts. There are four kinds of card. A whole angle is given and one part is asked: halve it. One part is given and the whole angle is asked: double it. Two whole angles are given and the angle at I between their two lines is asked: in that small triangle the two corner angles are halves, so take both halves from 180° . Two whole angles are given and a part of the third angle is asked: find the third angle from 180° , then halve it.

Eight of the sixteen cards make the ring. A group reaches the other eight only by a wrong answer, but all the cards look the same. The most common mistake is to use a whole angle where a part is needed, or a part where the whole is needed. On every ring card, that mistake gives the number at the top of one of the eight other cards. The group does that card, and its answer sends the group back to the card it got wrong. If the group makes the same mistake there, it goes one more card back and still does not reach the ring.

The check is the length of the group's list. A clean run is **eight lines**. Each wrong answer adds two. Every card has a line in small type under the question. It tells a group that arrived by a wrong answer what to check. A group that arrived by a right answer skips it. If a group keeps coming back to the same cards, do not give the answer. Ask: *“Which angle does the question name? Is it a whole angle or one part?”*



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ANSWER

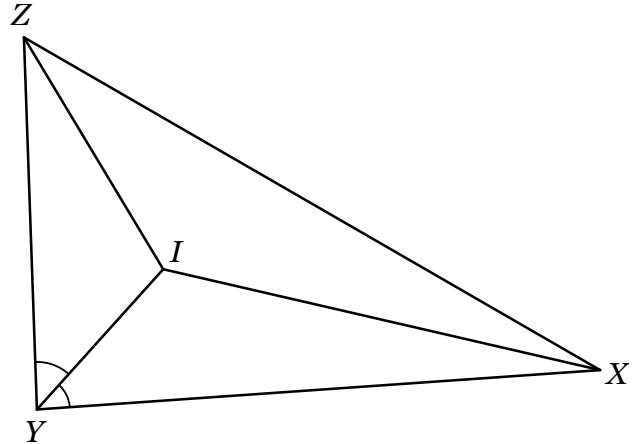
28°

I is the incenter.

$$m\angle XYZ = 88^\circ$$

What is $m\angle IYX$?

One part of an angle is smaller than the whole angle.



A

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ANSWER

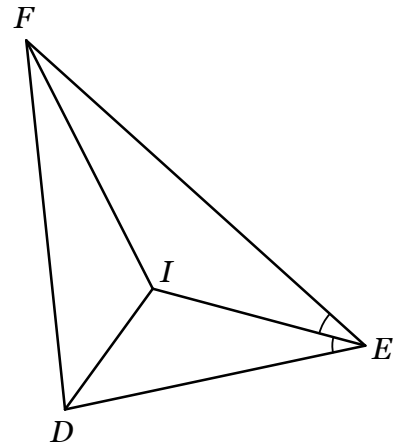
127°

I is the incenter.

$$m\angle IEF = 27^\circ$$

What is $m\angle DEF$?

Two halves make the whole angle at a corner.



B

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ANSWER

88°

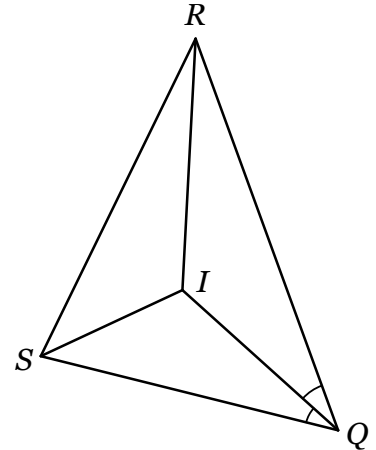
I is the incenter.

$$m\angle QRS = 46^\circ$$

$$m\angle RSQ = 78^\circ$$

What is $m\angle IQR$?

Does your answer fit the angle on the card?



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C

ANSWER

27°

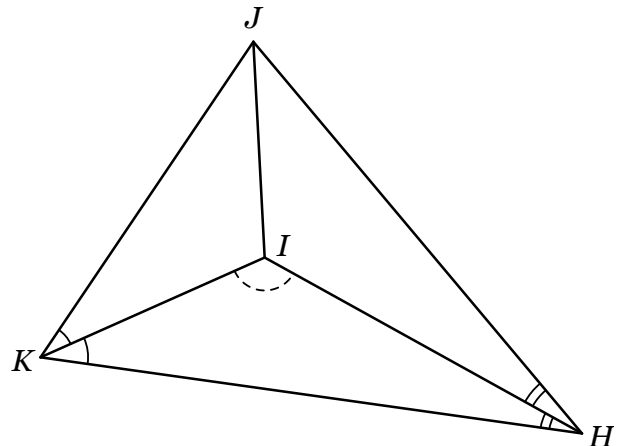
I is the incenter.

$$m\angle JKH = 64^\circ$$

$$m\angle KHJ = 42^\circ$$

What is $m\angle KIH$?

In a small triangle at I, the corner angles are halves.



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D

ANSWER

76°

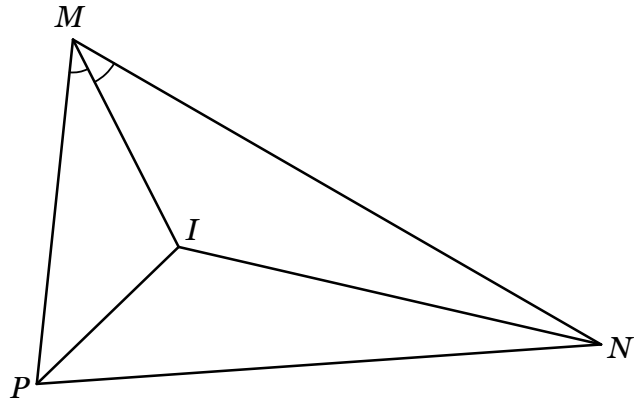
I is the incenter.

$$m\angle MNP = 34^\circ$$

$$m\angle NPM = 80^\circ$$

What is $m\angle IMN$?

Put a finger on the angle in the question. Which arcs does it hold?



E

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ANSWER

54°

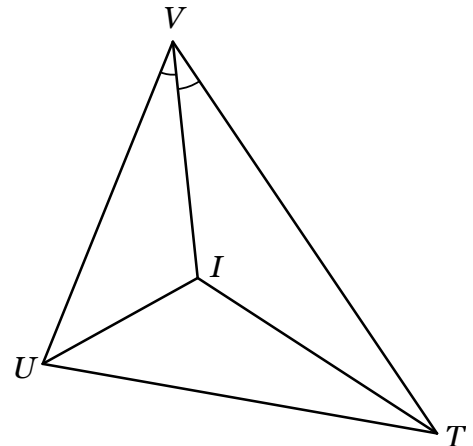
I is the incenter.

$$m\angle VTU = 46^\circ$$

$$m\angle TUV = 78^\circ$$

What is $m\angle IVT$?

Find the third angle of the big triangle first.



F

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ANSWER

44°

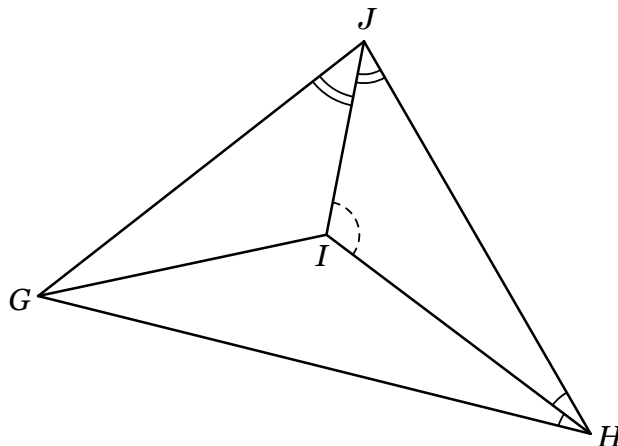
I is the incenter.

$$m\angle GHJ = 46^\circ$$

$$m\angle HJG = 82^\circ$$

What is $m\angle HIJ$?

An angle at I between two of the lines is more than 90° .



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G

ANSWER

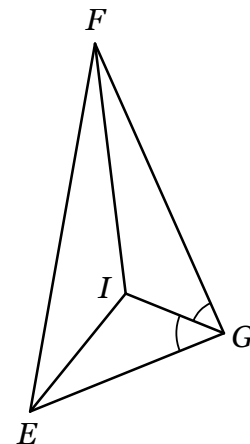
52°

I is the incenter.

$$m\angle FGE = 88^\circ$$

What is $m\angle IGF$?

Halve a whole angle to find one part.



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H

ANSWER

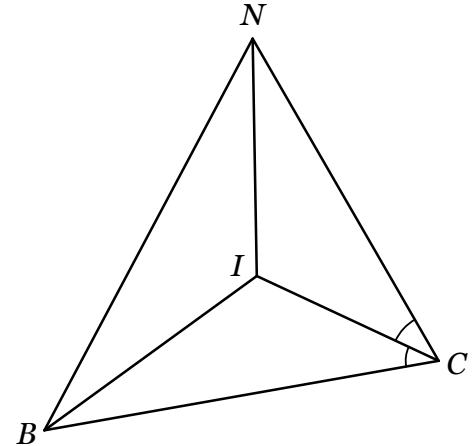
116°

I is the incenter.

$$m\angle ICB = 35^\circ$$

What is $m\angle BCN$?

Look at the letters of the angle. Where is its corner?



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J

ANSWER

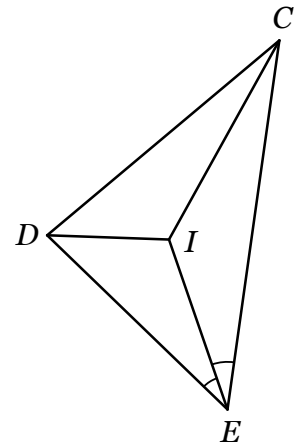
56°

I is the incenter.

$$m\angle IEC = 27^\circ$$

What is $m\angle DEC$?

Check that the two halves add to the whole angle.



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K

ANSWER

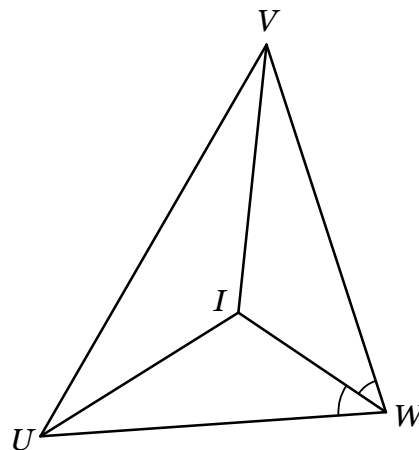
74°

I is the incenter.

$$m\angle VWU = 76^\circ$$

What is $m\angle IWU$?

Is the angle in the question a whole angle or one part?



L

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ANSWER

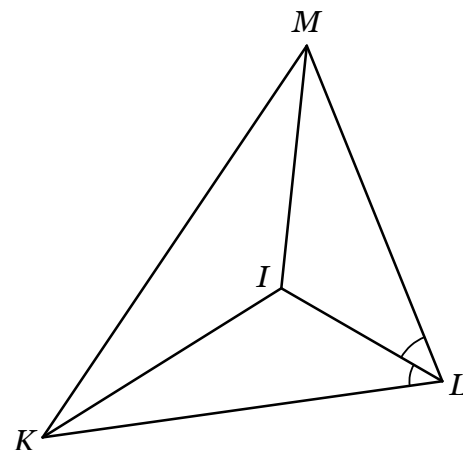
33°

I is the incenter.

$$m\angle KLM = 76^\circ$$

What is $m\angle ILM$?

The line from a corner to I cuts that angle into two equal parts.



M

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ANSWER

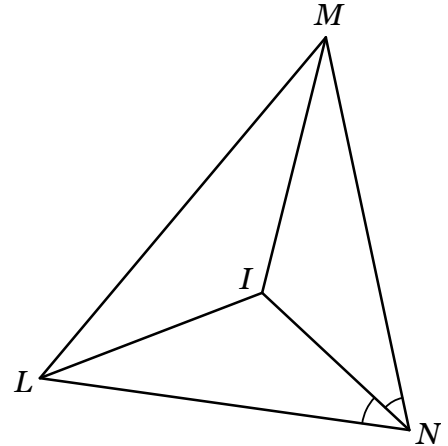
66°

I is the incenter.

$$m\angle INM = 35^\circ$$

What is $m\angle MNL$?

Two parts with the same arcs are the same size.



N

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ANSWER

70°

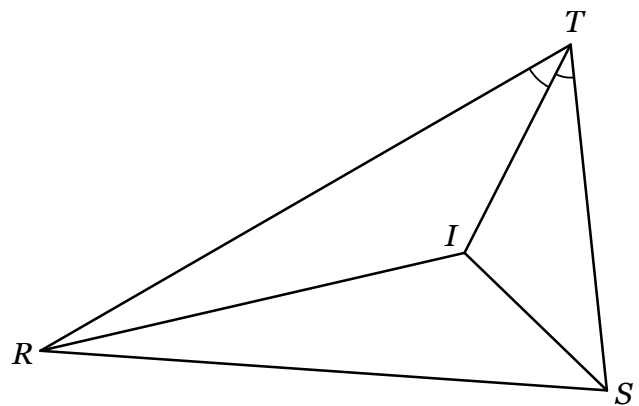
I is the incenter.

$$m\angle TRS = 34^\circ$$

$$m\angle RST = 80^\circ$$

What is $m\angle ITR$?

Read the question again. Which three letters name the angle?



P

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ANSWER

38°

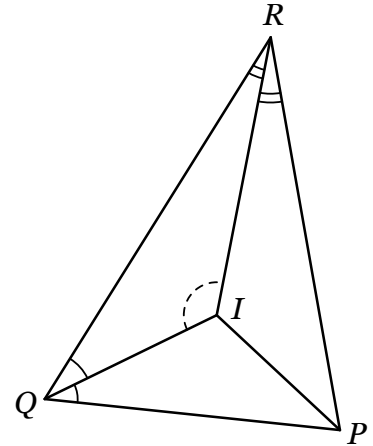
I is the incenter.

$$m\angle PQR = 64^\circ$$

$$m\angle QRP = 42^\circ$$

What is $m\angle QIR$?

Write each half on the drawing before you add.



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Q

ANSWER

35°

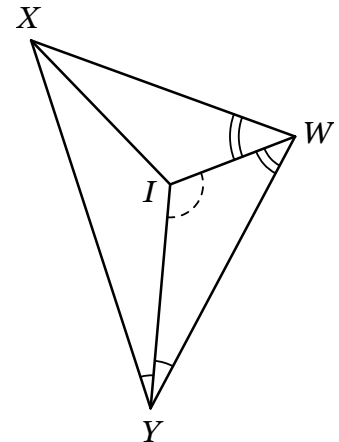
I is the incenter.

$$m\angle XYW = 46^\circ$$

$$m\angle YWX = 82^\circ$$

What is $m\angle YIW$?

The three angles of a triangle add to 180° .



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R

Scavenger Hunt — where I went

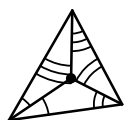
Angles at the incenter

Name _____

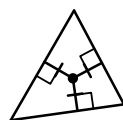
Period _____

Date _____

Do the card you are at. Fill in one line. Then find the card with your answer at the top. **First decide: does the question name a whole angle, or one of its two equal parts?** A clean run is eight lines. Each card has a line in small type under the question. **If you are on a card because you went wrong, its line says what to check. If you were right, skip it.**



The **incenter** is where the angle bisectors meet. Each line from a corner cuts that angle into two **equal halves**.



It is the **same distance from the three sides**. The three angles of a triangle add to 180° .

Card letter	Whole angle or one part?	My answer
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Why is the incenter never left out?

Every number stands for a letter. Write the letter for each of your answers in the box above that number. Leave the other boxes empty. Then read the boxes you filled, left to right. **If they do not spell a word, one answer is wrong.**

$27^\circ = N$ $28^\circ = A$ $33^\circ = L$ $35^\circ = I$ $38^\circ = W$ $44^\circ = A$ $52^\circ = Y$ $54^\circ = Y$ $56^\circ = A$ $66^\circ = S$ $70^\circ = S$ $74^\circ = W$ $76^\circ = L$
 $88^\circ = A$ $116^\circ = I$ $127^\circ = N$

27°	28°	33°	35°	38°	44°	52°	54°	56°	66°	70°	74°	76°	88°	116°	127°



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Scavenger Hunt — answers

For the teacher

The ring in order. A group may begin anywhere on it. Wherever it begins, eight right answers bring it back to that card.

M → Q → B → F → A → G → J → P → M

Why is the incenter never left out? The answer is *ALWAYS IN*. The ring's answers, in the order of the boxes on the record sheet (smallest number first), with their letters: **28° A · 33° L · 38° W · 44° A · 54° Y · 70° S · 116° I · 127° N**.

	Card	Given and asked	Answer, and why	Wrong answer, and where it comes from	Joke letter for the number at its top
1	M	$m\angle KLM = 76^\circ$. Find $m\angle ILM$.	38° . The segment LI cuts the 76° angle at L into two equal parts. $\angle ILM$ is one part: $76 \div 2 = 38$.	76° , from using the whole angle instead of one part	L
2	Q	$m\angle PQR = 64^\circ$, $m\angle QRP = 42^\circ$. Find $m\angle QIR$.	127° . In triangle QIR, the angle at Q is half of 64, which is 32, and the angle at R is half of 42, which is 21. So $180 - 32 - 21 = 127$.	74° , from using the whole angles in the small triangle at I	W
3	B	$m\angle IEF = 27^\circ$. Find $m\angle DEF$.	54° . $\angle IEF$ is one of the two equal parts of the angle at E. The whole angle is two parts: $27 + 27 = 54$.	27° , from giving one part instead of the whole angle	N
4	F	$m\angle VTU = 46^\circ$, $m\angle TUV = 78^\circ$. Find $m\angle IVT$.	28° . The angle at V is $180 - 46 - 78 = 56$. The segment VI cuts it into two equal parts, so the answer is $56 \div 2 = 28$.	56° , from forgetting to halve the third angle	Y
5	A	$m\angle XYZ = 88^\circ$. Find $m\angle IYX$.	44° . The segment YI cuts the 88° angle at Y into two equal parts. $\angle IYX$ is one part: $88 \div 2 = 44$.	88° , from using the whole angle instead of one part	A
6	G	$m\angle GHJ = 46^\circ$, $m\angle HJG = 82^\circ$. Find $m\angle HIJ$.	116° . In triangle HIJ, the angle at H is half of 46, which is 23, and the angle at J is half of 82, which is 41. So $180 - 23 - 41 = 116$.	52° , from using the whole angles in the small triangle at I	A
7	J	$m\angle ICB = 35^\circ$. Find $m\angle BCN$.	70° . $\angle ICB$ is one of the two equal parts of the angle at C. The whole angle is two parts: $35 + 35 = 70$.	35° , from giving one part instead of the whole angle	I
8	P	$m\angle TRS = 34^\circ$, $m\angle RST = 80^\circ$. Find $m\angle ITR$.	33° . The angle at T is $180 - 34 - 80 = 66$. The segment TI cuts it into two equal parts, so the answer is $66 \div 2 = 33$.	66° , from forgetting to halve the third angle	S

Each wrong answer in the table is the number at the top of a card off the ring. Those cards are on the next page.

Scavenger Hunt — the cards off the ring

For the teacher

A group reaches these eight cards only by a wrong answer. The number at the top of each one is the wrong answer from one ring card. Its right answer is the number at the top of that ring card, so the group goes back to the card it got wrong. If the group makes the same mistake again, it goes to another card off the ring. So a second wrong answer never moves a group forward.

Card	Given and asked	Answer, and why	Wrong answer, and where it comes from	Joke letter for the number at its top
E	$m\angle MNP = 34^\circ$, $m\angle NPM = 80^\circ$. Find $m\angle IMN$.	33° . The angle at M is $180 - 34 - 80 = 66$. The segment MI cuts it into two equal parts, so the answer is $66 \div 2 = 33$.	66°, from forgetting to halve the third angle	L
L	$m\angle VWU = 76^\circ$. Find $m\angle IWU$.	38° . The segment WI cuts the 76° angle at W into two equal parts. $\angle IWU$ is one part: $76 \div 2 = 38$.	76°, from using the whole angle instead of one part	W
D	$m\angle JKH = 64^\circ$, $m\angle KHJ = 42^\circ$. Find $m\angle KIH$.	127° . In triangle KIH, the angle at K is half of 64, which is 32, and the angle at H is half of 42, which is 21. So $180 - 32 - 21 = 127$.	74°, from using the whole angles in the small triangle at I	N
K	$m\angle IEC = 27^\circ$. Find $m\angle DEC$.	54° . $\angle IEC$ is one of the two equal parts of the angle at E. The whole angle is two parts: $27 + 27 = 54$.	27°, from giving one part instead of the whole angle	A
C	$m\angle QRS = 46^\circ$, $m\angle RSQ = 78^\circ$. Find $m\angle IQR$.	28° . The angle at Q is $180 - 46 - 78 = 56$. The segment QI cuts it into two equal parts, so the answer is $56 \div 2 = 28$.	56°, from forgetting to halve the third angle	A
H	$m\angle FGE = 88^\circ$. Find $m\angle IGF$.	44° . The segment GI cuts the 88° angle at G into two equal parts. $\angle IGF$ is one part: $88 \div 2 = 44$.	88°, from using the whole angle instead of one part	Y
R	$m\angle XYW = 46^\circ$, $m\angle YWX = 82^\circ$. Find $m\angle YIW$.	116° . In triangle YIW, the angle at Y is half of 46, which is 23, and the angle at W is half of 82, which is 41. So $180 - 23 - 41 = 116$.	52°, from using the whole angles in the small triangle at I	I
N	$m\angle INM = 35^\circ$. Find $m\angle MNL$.	70° . $\angle INM$ is one of the two equal parts of the angle at N. The whole angle is two parts: $35 + 35 = 70$.	35°, from giving one part instead of the whole angle	S

Other mistakes lead to no ring card. A group might double where it should halve, use one whole angle and one half in the small triangle at I, or copy a given angle. Its answer is then not the number at the top of any ring card.

Guessing does not work. Every simple rule that uses only the printed numbers, such as always halving the first number, answers at most four of the sixteen cards correctly.