

CUT & GLUE SORT



RIGID AND NON-RIGID TRANSFORMATIONS

Rigid, Not Rigid, or Cannot Tell?

One measurement settles nothing · one that changed settles it

FREE

A PQ = 5 and P'Q' = 5.	B Every point of the plane moves 100 squares to the right.	C Every point of ABCD stays where it is. So does every other point, except M and N, off ABCD, which swap places.	D Every point is reflected in line m . The image goes round the other way.
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1. **Hand out pages 3 and 4**, one of each per student, and scissors and glue.
2. **Say this once:** *“Rigid means every distance and every angle stays the same. This has to be true for every point of the plane, not just the figure. One number that changed proves it. Numbers that agree prove nothing.”*
3. **Every row gets 4.** A row with more or fewer has a piece in the wrong place. (This is on your page only, not the student's.)

Student sheets	pages 3 and 4, one of each per student. The three properties are printed on the first, with a slide, a mirror image, a stretch and a shear as pictures.
Answers	page 5.

The third row is the hard one: measurements that agree prove nothing. A rigid motion keeps the distance between every pair of points in the plane. A measurement checks only one pair. The four pieces in *cannot tell* show what students often take as proof: one segment that kept its length, the same area, every side and angle of the drawn triangle, and an image that goes the other way round. For each of these, a rigid motion fits, and so does a rule that is not rigid. For example, a stretch can keep one segment the same, and a shear keeps area.

A big or strange move is still rigid. Many students think a move that looks like a big change cannot be rigid. The first row has a slide of 100 squares, a turn of 47° about a point off the page, and a mirror image. All three are rigid. The rule that moves nothing is rigid too.

In the middle row, one change is enough. One piece is a stretch printed *with* a measurement that agrees. The rule decides, not the number. Another piece swaps two points outside the figure. The other two show an angle that changed while a side did not, and a changed distance from a corner to a point outside the figure.

Guessing does not work. A student who sorts by a few key words, or only compares the numbers, gets at most eight of the twelve pieces right.



This is the free lesson this activity came from. The worksheet, the full answers and the lesson plan are on it, at three levels of difficulty.
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Rigid, not rigid, or cannot tell?

What a rigid motion keeps

Name _____

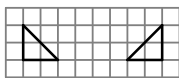
Period _____

Date _____

Cut out the twelve pieces on the next page. Each is what somebody knows about a rule. **For each piece, decide: is the rule rigid, is it not rigid, or can you not tell?** Glue each into its row. A **rigid motion** keeps lines straight. It keeps the distance between *every* two points of the plane the same. It keeps every angle measure the same. Nothing else is on the list. Not position. Not the way round.



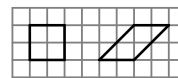
a slide
rigid



a mirror image
rigid, but the other way round



a stretch in one direction
not rigid, though lengths across it
are kept



a shear
not rigid, though the area is kept

A RIGID MOTION — *the rule, for every point, keeps every distance and every angle*

NOT RIGID — *some distance or some angle changes*

CANNOT TELL — *a rigid motion fits what is known, and so does a rule that is not rigid*

The twelve pieces

Cut along the dotted lines

A PQ = 5 and P'Q' = 5.	B Every point of the plane moves 100 squares to the right.	C Every point of ABCD stays where it is. So does every other point, except M and N, off ABCD, which swap places.	D Every point is reflected in line <i>m</i>. The image goes round the other way.
E The image goes round the other way.	F AB and A'B' are the same, 5. The angle at C is 76° and the angle at C' is 63°.	G Every point stays exactly where it is. Nothing moves.	H The image has exactly the same area as the figure it came from.
J Point M is off ABCD. Corner A to M is 4 squares. A' to M' is 6 squares.	K Every point is turned 47° about a point far off the page.	L Every side and every angle of triangle ABC came out the same.	M Every point moves away from line <i>m</i> to double its distance. Along <i>m</i>, PQ = 6 and P'Q' = 6.



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Cut & Glue Sort — answers

For the teacher

A RIGID MOTION	B — A slide keeps every distance and angle. Moving far does not matter.	D — A mirror image keeps every distance and angle. Going the other way round is allowed.	G — Nothing moves, so every distance and angle stays the same.	K — A turn keeps every distance and angle, even about a point far away.
NOT RIGID	C — When M and N swap, the distance from M to a corner changes.	F — The angle at C changed. One change is enough.	J — The distance from A to M changed. M is off the figure, but it still counts.	M — A stretch. PQ along <i>m</i> stays the same, but a segment across <i>m</i> doubles.
CANNOT TELL	A — One pair of points kept its distance. That says nothing about other pairs.	E — A stretched mirror image also goes the other way round, and it is not rigid.	H — A shear keeps area too, and a shear is not rigid.	L — The triangle is only some of the points. Points off it could still change.

One distance or angle that changed proves that a rule is not rigid. Measurements that agree never prove that a rule is rigid. Only a rule that keeps every distance, for every point of the plane, is a rigid motion.