Daily *warm-ups*

GEOMETRY

Thomas Campbell

J. WESTON
WALCH
PUBLISHER
Portland, Maine

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J. Weston Walch, Publisher
321 Valley Street • P.O. Box 658
Portland, Maine 04104-0658

1 2 3 4 5 6 7 8 9 10
ISBN 0-8251-4498-1

P.O. Box 658 • Portland, Maine 04104-0658
www.walch.com
Printed in the United States of America

The *Daily Warm-Ups* series is a wonderful way to turn extra classroom minutes into valuable learning time. The 180 quick activities—one for each day of the school year—review, practice, and teach geometry. These daily activities may be used at the very beginning of class to get students into learning mode, near the end of class to make good educational use of that transitional time, in the middle of class to shift gears between lessons—or whenever else you have minutes that now go unused. In addition to providing students with structure and focus, they are a natural path to other classroom activities involving geometry. As students build their geometry skills and become more adept at geometry, they will be better prepared for the standardized tests, such as the PSAT and SAT, that include geometry problems.

Daily Warm-Ups are easy-to-use reproducibles—simply photocopy the day's activity and distribute it. Or make a transparency of the activity and project it on the board. You may want to use the activities for extra-credit points or as a check on critical-thinking skills that are built and acquired over time.

However you choose to use them, *Daily Warm-Ups* are a convenient and useful supplement to your regular lesson plans. Make every minute of your class time count!

Foreword

At a conference recently, I sat next to a science and math teacher who shared with me that she thought that teaching geometry and especially two-column proof in geometry was a waste of time. "When will they ever use it?" she asked. This book is intended as a partial answer to her question. As I told her, "Geometry is beautiful, and in teaching students how to order their thinking and communicate their thoughts clearly and concisely, we are training them to problem-solve and how to use their minds, something I hope they will do every day of their lives!" The order of the problems in this book is based upon the order of the introduction of the topics in my geometry classroom. If you introduce them in different orders, you will find that you can reorder the activities, puzzles, and problems without much confusion. You may want to replace abbreviations I have used with your own, but these are intended to get the idea across and not be dependent upon the order of presentation in a specific text. I hope that you and your students will find, as I do in geometry classes every year, that geometry problems are wonderfully entertaining puzzles that entice students with their very nature. Many thanks go to Linda Triplett, Peter Barrett, Melanie Trimble, Barr McCutcheon, and Betsy Smith, all of them colleagues from whom I have learned so much about how to create and write geometry problems for students. Thanks, also, to Lori Campbell, without whose active editorial and emotional support, none of my writing projects would get off the ground.

TEC

Portland, Maine August 2002

Go the Distance

When the Ancient Greeks were working with geometry, they did not have the exacting tools that we use today. Instead of a ruler, they used an unruled straight edge. The *cubit*, the length from the tip of the King's middle finger to the tip of his elbow, was the agreed upon measure. We have two systems of measurement that are far more consistent. Measure three objects in inches and in centimeters. See if you can find a conversion factor between inches and centimeters based on your measurements.

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Getting A Good Angle On It

Another tool that the Greeks did not have was the protractor. By placing the center dot on the *vertex* of an angle such that one side of the angle (the *initial side*) coincides with the edge of the protractor, we can measure the angle by seeing where the other side (the *terminal side*) of the angle intersects the arc of the tool. Measure the angles below.

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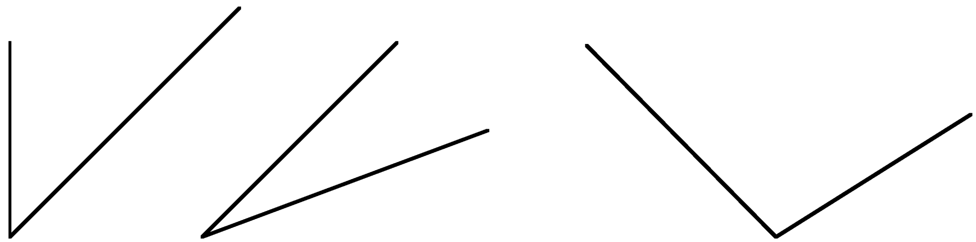

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The Proof is in the Pudding

One method of proof is called a “Paragraph Proof.” In this method, you simply write sentences which indicate your understanding of the problem and the conclusions you can draw. You must also explain *why* you can draw those conclusions. For instance, to explain why knowing that $x - 1 = 3$ allows you to conclude that $x = 4$, you would write something like, “It is given in this problem that $x - 1 = 3$. A basic algebraic premise says that you can add the same value to both sides of an equation and the result will also be an equation. Add 1 to both sides of the equation for $x - 1 + 1 = 3 + 1$. By the inverse property, $-1 + 1 = 0$ and so the equation becomes $x + 0 = 3 + 1$. By the Identity Property, $x + 0 = x$, so our equation becomes $x = 3 + 1$. We have defined $3 + 1 = 4$, so we can conclude $x = 4$.” Oftentimes in proofs, you know exactly what the answer is, but it takes more than you expect to say why. Use a paragraph proof to say why, if $3y = 9$, $y = 3$.

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Two-column Proof

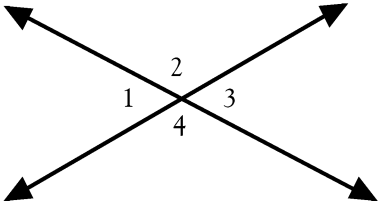
Another format for proofs is to create two columns. In the first column goes the statement that you want to make, and in the second column, on the same line, goes the reason you feel the statement is true.

It is customary to write "QED" after a proof is finished to show that you are finished. QED is an abbreviation of a Latin statement "Quod erat demonstratum" or "thus it is proven."

Use a two-column proof to prove the problem on the previous page, "Given $3y = 9$, prove that $y = 3$."

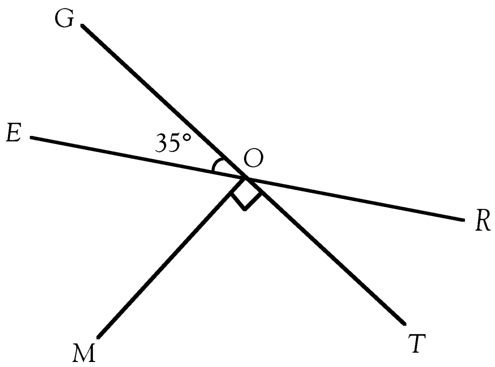
Getting Vertical

When two lines meet at a point, the angles formed at that point, by those two lines, and not sharing a side are called *vertical angles*. In the diagram below, the angles marked 1 and 3 are vertical angles, as are the angles marked 2 and 4. Remembering that straight angles measure 180°, prove that vertical angles have equal measures in a two-column or paragraph proof.



Lines and Angles

In the diagram below, you are given that $\angle GOE = 35°$ and that $\overleftrightarrow{GT}$ and $\overleftrightarrow{ER}$ are straight lines. Note the little square marking $\angle MOT$; this indicates that $\angle MOT = 90°$, or $\overleftrightarrow{MO} \perp \overleftrightarrow{TO}$. Knowing this, see if you can determine the measures of the following angles: $\angle MOE$, $\angle MOR$, $\angle TOR$, and $\angle GOR$.



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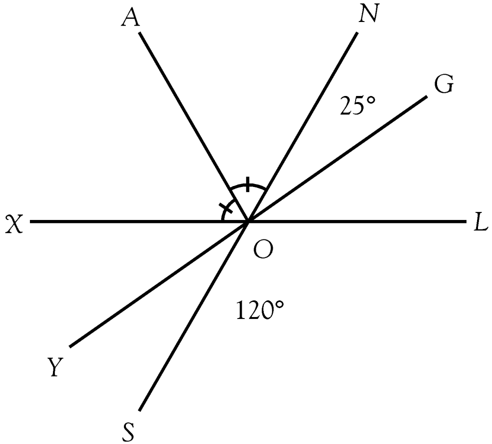
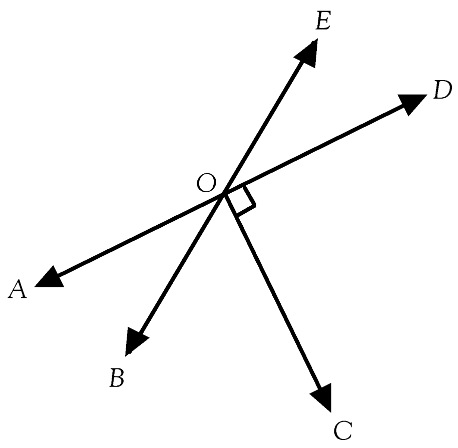
More Lines and Angles

In the diagram below, you are given that the line segment $\overline{AO}$ bisects $\angle XON$, $\angle NOG = 25°$, and $\angle SOL = 120°$. Find the measures of: $\angle SOY$, $\angle LOY$, $\angle LOG$, $\angle NOA$, and $\angle SOA$.



Angles and Lines

In the diagram below, you are given that the measure of $\angle AOB$ is given by the formula $5w + 4$ and the measure of $\angle DOE$ is given by the formula $9w - 12$. Using what you know about angles, determine the value of w and then find the measure of $\angle BOC$.



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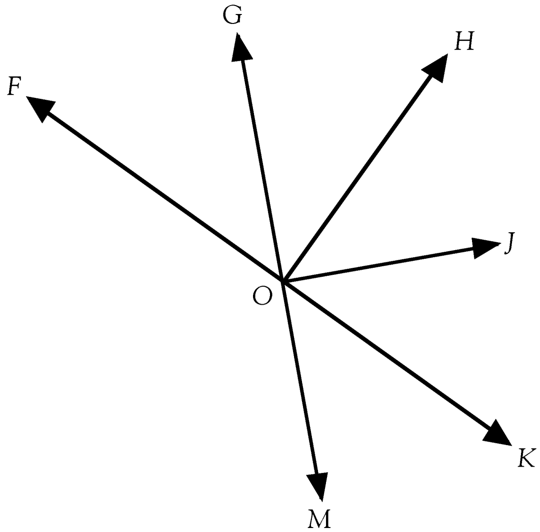
More Angles and Lines

In the figure below, you are given that $\overline{GO}$ bisects $\angle FOH$ and $\overline{JO}$ bisects $\angle HOK$. Two formulas are given for angle measures: $\angle FOG = 3x + 1$ and $\angle HOJ = 5x - 5$.

Use this information to find the value of x and then determine the measure of $\angle FOM$.



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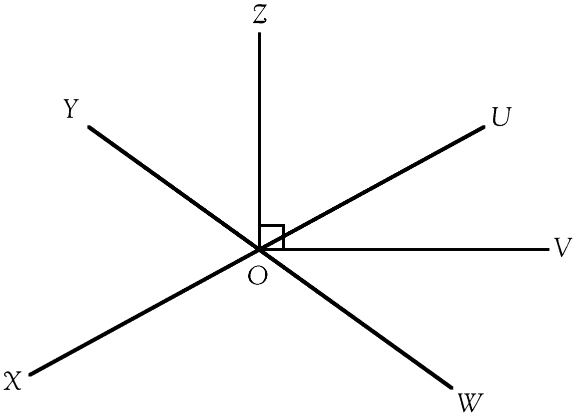
Still More Angles and Lines

In the diagram below, $\overline{OV}$ bisects $\angle UOW$ and $\overline{ZO} \perp \overline{VO}$. In addition, $\angle YOZ = 6a + 2$ and $\angle VOU = 4a + 3$. Use this information to determine the value of a and then find the measure of $\angle XOY$.



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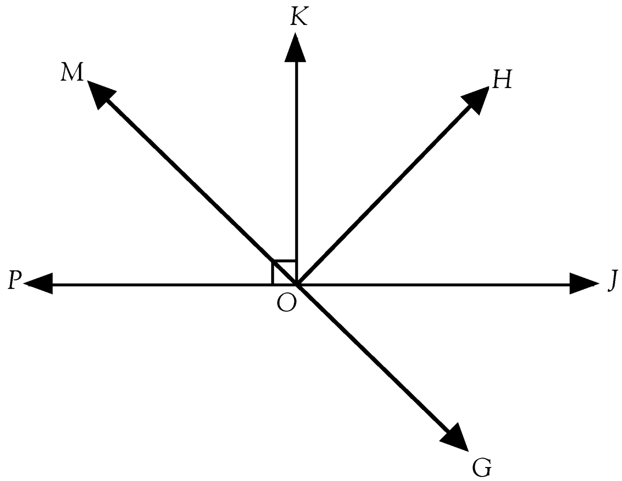
A Proof About Lines and Angles

Using either a two-column proof or a paragraph proof, and given that all lines that look straight are straight, $\overline{PO} \perp \overline{OK}$ and $\angle MOK = \angle HOJ$, prove that in the diagram below, $\overline{HO} \perp \overline{OG}$.



Makin' Copies

Here is a process for copying angles to a new place:

1. Draw a ray to serve as one side of the angle you are copying.

2. Placing the sharp point of your compass at the vertex of the original angle, draw an arc that intersects both sides of that angle.

3. Keeping the same radius on your compass, place the sharp point at the end point of your new ray and draw a semi-circle.

4. Going back to the original angle, place the sharp point of your compass on the point where the arc you drew intersects one of the edges of the angle. Open your compass until the pencil point can be placed on the intersection of your arc with the other side of the angle.

5. Going back to your angle copy, maintain the compass radius of step 4. Place the sharp point of your compass on the point where the semi-circular arc you drew intercepts your ray. Draw an arc intersecting the previously drawn arc.

6. Using your straight-edge, connect the end point of your ray with the point where your two arcs intercept. The angle created is equal in measure to your original angle.

Draw three angles and then copy them.

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The Middle of Things

Draw a line segment *AB*. Use the steps below to bisect $\overline{AB}$.

1. Set your compass to a radius, such that the radius is less than the length of $\overline{AB}$, but more than half that distance.

2. With the sharp point of your compass at *A*, draw a circle around *A* using the compass radius from step 1.

3. Maintaining the radius from step 2, put the sharp point on *B* and draw a circle.

4. The two circles you have drawn intersect at two points (*C* & *D*). Use your straight-edge to connect *C* and *D*.

5. $\overline{CD}$ intersects $\overline{AB}$ at its midpoint M; that is *AM* = *MB*. (Note that it is also the case that $\overline{CD} \perp \overline{AB}$).

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Making the Cut

Draw an angle. Use the steps below to bisect it.

1. Place the sharp point of your compass at the vertex of the angle and draw an arc that intersects the two sides of the angle.

2. Set the radius of your compass to approximately the distance between where the arc meets the sides.

3. Maintaining this radius, place the sharp point of your compass on one of these intersection points and draw an arc inside of your original angle.

4. Maintaining your radius, place the sharp point of your compass on the other point where the arc intersects a side of the angle and draw an arc that intersects the arc you drew in step 3.

5. Connect the vertex point of the original angle to the intersection point created in step 4; this line bisects the original angle.

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