

Lesson 1

Meeting the Cube

How To Solve The Rubik's® Cube
Instructional Curriculum



Meeting the Cube

STANDARDS & SKILLS: LESSON 1 (FOR COMPLETE DETAILS, SEE STANDARDS & SKILLS BOOK)

	COMMON CORE	NATIONAL
KINDERGARTEN	<p>K.CC.5 - ANSWER "HOW MANY" QUESTIONS.</p> <p>K.MD.1 - MEASURABLE ATTRIBUTES OF OBJECTS.</p> <p>K.G.1 - NAMES OF SHAPES.</p> <p>K.G.3 - IDENTIFY SHAPES AS TWO-DIMENSIONAL.</p> <p>K.G.4 - COMPARE TWO- AND THREE-DIMENSIONAL SHAPES.</p>	<p><u>NUMBER AND OPERATIONS</u></p> <ul style="list-style-type: none"> RECOGNIZE "HOW MANY" IN SETS OF OBJECTS. UNDERSTAND MULTIPLICATION, UNDERSTAND AND REPRESENT COMMON FRACTIONS, <p><u>ALGEBRA</u></p> <ul style="list-style-type: none"> SORT, CLASSIFY, AND ORDER OBJECTS BY PROPERTIES, RECOGNIZE AND DESCRIBE PATTERNS, ANALYZE HOW PATTERNS ARE GENERATED, USE CONCRETE AND PICTORIAL REPRESENTATIONS TO UNDERSTAND SYMBOLIC NOTATION, <p><u>GEOMETRY</u></p> <ul style="list-style-type: none"> RECOGNIZE, NAME, BUILD, DRAW, COMPARE, AND SORT TWO- AND THREE-DIMENSIONAL SHAPES, DESCRIBE ATTRIBUTES AND PARTS OF TWO- AND THREE-DIMENSIONAL SHAPES, CREATE MENTAL IMAGES OF GEOMETRIC SHAPES.
GRADE 1	<p>1.MD.3 - TELLING TIME.</p> <p>1.G.1 - DEFINING ATTRIBUTES OF SHAPES.</p>	<ul style="list-style-type: none"> RECOGNIZE SHAPES FROM DIFFERENT PERSPECTIVES. RELATE IDEAS IN GEOMETRY. RECOGNIZE GEOMETRIC SHAPES IN THE ENVIRONMENT. <p><u>MEASUREMENT</u></p> <ul style="list-style-type: none"> RECOGNIZE ATTRIBUTES OF LENGTH, VOLUME, WEIGHT, AREA, AND TIME. MEASURE USING NONSTANDARD AND STANDARD UNITS. MEASURE WITH APPROPRIATE TOOLS. USE TOOLS TO MEASURE. <p><u>DATA AND ANALYSIS</u></p> <ul style="list-style-type: none"> SORT AND CLASSIFY OBJECTS ACCORDING TO THEIR ATTRIBUTES.
GRADE 2	<p>2.MD.1 - MEASURE LENGTH OF AN OBJECT USING APPROPRIATE TOOLS.</p> <p>2.MD.7 - TELLING TIME.</p> <p>2.G.2 - PARTITION A RECTANGLE INTO ROWS AND COLUMNS OF SAME SIZE SQUARES.</p>	<p><u>NUMBER AND OPERATIONS</u></p> <ul style="list-style-type: none"> UNDERSTAND FRACTIONS AS PARTS OF UNIT WHOLE. UNDERSTAND MULTIPLICATION. <p><u>GEOMETRY</u></p> <ul style="list-style-type: none"> IDENTIFY ATTRIBUTES OF TWO- AND THREE-DIMENSIONAL OBJECTS; DEVELOP VOCABULARY TO DESCRIBE THE ATTRIBUTES. UNDERSTAND RELATIONSHIPS AMONG ANGLES, SIDE LENGTHS, PERIMETERS, AREA, AND VOLUME. DESCRIBE OBJECTS AND PATTERNS. BUILD A THREE-DIMENSIONAL OBJECT FROM TWO- DIMENSIONAL OBJECT. USE GEOMETRIC MODELS FOR MEASUREMENT PROBLEMS. RECOGNIZE GEOMETRIC IDEAS AND APPLY THEM IN THE CLASSROOM AND EVERY DAY LIFE.
GRADE 3	<p>3.MD.1 - TELLING TIME.</p> <p>3.G.1 - SHAPES IN DIFFERENT CATEGORIES SHARE ATTRIBUTES.</p>	<p><u>MEASUREMENT</u></p> <ul style="list-style-type: none"> UNDERSTAND ATTRIBUTES SUCH AS LENGTH, AREA, WEIGHT, AND VOLUME. SELECT APPROPRIATE UNITS AND TOOLS TO MEASURE LENGTH, AREA, VOLUME, WEIGHT, TIME. DETERMINE SURFACE AREA AND VOLUME.
GRADE 4	<p>4.G.1 - IDENTIFY ANGLES, PERPENDICULAR AND PARALLEL LINES IN TWO-DIMENSIONAL FIGURES.</p>	<p><u>GEOMETRY</u></p> <ul style="list-style-type: none"> PRECISELY DESCRIBE TWO- AND THREE-DIMENSIONAL OBJECTS USING THEIR ATTRIBUTES. USE TWO-DIMENSIONAL REPRESENTATIONS OF THREE-DIMENSIONAL OBJECTS TO SOLVE VOLUME AND SURFACE PROBLEMS USE NETWORKS TO REPRESENT AND SOLVE PROBLEMS. USE NETWORKS TO REPRESENT AND SOLVE PROBLEMS. RECOGNIZE AND APPLY GEOMETRIC IDEA OUTSIDE THE MATHEMATICS CLASSROOM. <p><u>MEASUREMENT</u></p> <ul style="list-style-type: none"> UNDERSTAND BOTH METRIC AND CUSTOMARY SYSTEMS OF MEASUREMENT. SELECT APPROPRIATE UNITS TO MEASURE PERIMETER, AREA, SURFACE AREA, AND VOLUME.
GRADE 5	<p>5.NF.4b - AREA OF A RECTANGLE USING UNIT SQUARES</p> <p>5.MD.3 - VOLUME OF A CUBE</p> <p>5.G.3 - ATTRIBUTES OF TWO-DIMENSIONAL FIGURES</p> <p>5.G.4 - CLASSIFY TWO-DIMENSIONAL FIGURES.</p>	
GRADE 6	<p>6.G.2 - VOLUME OF A RIGHT RECTANGULAR PRISM.</p> <p>6.G.4 - REPRESENT THREE-DIMENSIONAL FIGURES USING NETS.</p>	



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You CAN Do the Rubik's Cube

HOW TO SOLVE THE RUBIK'S CUBE
INSTRUCTIONAL CURRICULUM
by Amber Baur
in collaboration with Susan Seider

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HOW TO SOLVE THE RUBIK'S CUBE

LESSON 1 - MEETING THE CUBE

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21ST CENTURY LEARNING SKILLS:

FOR COMPLETE DETAILS, SEE STANDARDS & SKILLS BOOK

LEARNING & INNOVATION SKILLS:

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication and Collaboration

LIFE & CAREER SKILLS:

- Flexibility and Adaptability
- Initiative and Self Direction
- Social and Cross-Cultural Skills
- Productivity and Accountability
- Leadership and Responsibility

MEDIA LITERACY:

- Information Literacy

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Acknowledgments:

The "How To Solve the Rubik's Cube" lesson plans are intended as a comprehensive instructional guide for teachers and educators based on the You CAN Do The Rubik's Cube solution guide. We wish to thank all our friends in the Rubik's community for their support and inspiration.

This lesson can be divided into two parts.
If you are teaching Lesson 1 - Meeting the Cube as a two-part lesson, follow the prompts in the gray boxes.

Lesson

OVERVIEW

The Focus of this lesson, Meeting the Cube is to acclimate students to the basics of the Rubik's Cube.

OBJECTIVES

By the end of the class period, students will be able to:

- Identify the common parts of the Rubik's Cube, including the faces, edges, corners and color pairs.
- Recognize the letter representations for the faces of the Rubik's Cube and employ them with respect to cube manipulation.
- Know the meanings of important instructional words relating to solving the Rubik's Cube and their application to basic geometrical concepts.

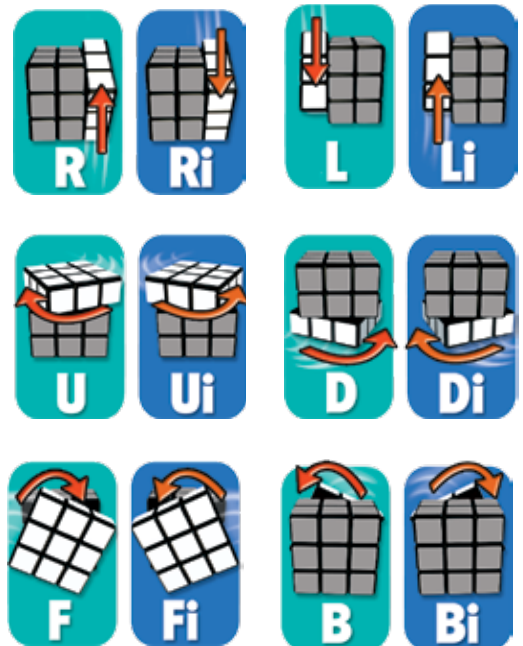
MATERIALS

- Class set of Rubik's Cubes and Solution Guides
- Crayons/Markers/Colored Pencils
- Scissors and Tape
- Rulers (cm/in)
- Appendix 1.Ta and 1.Tb (from Differentiation Activities)
- (Optional) Method for viewing PowerPoint
- (Optional) "Meeting the Cube" PowerPoint file

SOLUTION GUIDE

This lesson correlates with **STAGE 1** of the *You CAN Do The Rubik's Cube Solution Guide*.

GOAL



WHOLE CLASS LESSON

*This lesson can be divided into two parts.
If you are teaching Lesson 1 - Meeting the Cube as a two-part lesson, follow the prompts in the gray boxes.*

Lesson 1 calls for students to work with a solved cube. If the cubes are unsolved, any reference to color, with the exception of the center piece color, will vary. For example, the RED face will still be the RED face but the pieces surrounding the RED center piece will be a variety of colors. You may wish to use removable color stickers to cover the pieces around the center and pretend the cube is solved. Upon completion of Lesson 1, the stickers should be removed.

INTRODUCTION PP2

Rubik's Cube Description

Ask students to describe the Rubik's Cube (Responses will vary)

Possible probing questions:

- What is the shape of the object? (*cube*)
- What is the shape of each side of the cube? (*square*)
- What angle is each corner? (*90 degrees*)
- What are the colors? (*Red, Yellow, Blue, Green, White and Orange*)
- Do you notice anything special about the colors? (*Red is opposite Orange, etc...*)
- How many units (squares) across is the cube (length)? (*three units*)
- How many units (squares) down is the cube (width)? (*three units*)
- How many units (squares) around the edges of one color (perimeter)? (*eight units*)
- How many squares does it take to cover a whole face (one whole color)? (*nine cubes*)
- What is three units down times three units across? (*nine units*).
- About how much does it weigh? More than an apple? Less than a carton of milk? Etc.
- Add your own questions:



Relationship to Measurement

(Optional - suggested for small groups or upper grade level groups). Use cm/in rulers.

- Are all the lengths of the faces of a cube the same? (*Yes*)
- What is the measure of the length in inches? Centimeters? Millimeters?
- What is the angle measure of each corner of each face? (*90 degrees*)
- The Rubik's Cube is 3 units (mini-squares) across. How many units make up the area ($A=lw$) of each face? (*9 units*)
- How many units make up the volume? ($V = Bh$ or $V = lwh$)
- You can add your own questions:

LESSON VOCABULARY PP3

After each instruction, walk around and check to be sure students have completed the instruction accurately.

BASIC VOCABULARY

FACE – Faces are the flat area of the cube. The color of the face is based on the color of the center square.

Tell students:

- Point to the face covered in **BLUE**. *Say: This is the **BLUE** face.*
- Point to the face covered in **RED**. *Say: This is the **RED** face.*
- Point to the face covered in **GREEN**. *Say: This is the **GREEN** face.*
- Point to the face covered in **YELLOW**. *Say: This is the **YELLOW** face.*
- Point to the face covered in **ORANGE**. *Say: This is the **ORANGE** face.*
- Point to the face covered in **WHITE**. *Say: This is the **WHITE** face.*

Ask students: How many colors are there? (Six)

Ask students: How many faces are there? (Six)

Ask students if they know what the term opposite means? (the other side, the other face, etc.)

With the BLUE face facing front (facing toward the student):

*Ask students: Which color is opposite the **BLUE** face? (**GREEN** face)*

Tell students: The **BLUE** and **GREEN** faces are always opposite each other.

Tell students (demonstrate while telling): Twist the top row of the Rubik's Cube so that the **BLUE** top row is on the **GREEN** face and the **GREEN** top row is on the **BLUE** face.

*Ask students: Are the **GREEN** and **BLUE** colors still opposite each other? (Yes)*

Tell students: Twist the top row around so that the **BLUE** and **GREEN** are back to their original faces.



With the RED face facing front (facing toward the student):

*Ask students: Which color is opposite the **RED** face? (**ORANGE** face)*

Tell students: The **RED** and **ORANGE** faces are always opposite each other.

Tell students (demonstrate while telling): Twist the top row of the Rubik's cube so that the **RED** top row is on the **ORANGE** face and the **ORANGE** top row is on the **RED** face.

*Ask students: Are the **ORANGE** and **RED** colors still opposite each other? (Yes)*

Tell students: Twist the top row around so that the **RED** and **ORANGE** are back to their original faces.



With the WHITE face facing front (facing toward the student):

*Ask students: Which color is opposite the **WHITE** face? (**YELLOW** face)*

Tell students the **WHITE** and **YELLOW** faces are always opposite each other.

Tell students (demonstrate while telling): Twist the top row of the Rubik's cube so that the **WHITE** top row is on the **YELLOW** face and the **YELLOW** top row is on the **WHITE** face.

*Ask students: Are the **YELLOW** and **WHITE** colors still opposite each other? (Yes)*

Tell students: Twist the top row around so that the **WHITE** and **YELLOW** are back to their original faces.



BASIC VOCABULARY...

CENTER – Center pieces are pieces that have only one color.

PP4

They are found in the center of each cube

Tell students:

- Find the **BLUE** face and point to the center piece.
*Say: This is the **BLUE** center piece; it DOES NOT MOVE; it represents the **BLUE** face.*
- Find the **RED** face and point to the center piece.
*Say: This is the **RED** center piece; it DOES NOT MOVE; it represents the **RED** face.*
- Find the **ORANGE** face and point to the center piece.
*Say: This is the **ORANGE** center piece; it DOES NOT MOVE; it represents the **ORANGE** face.*
- Find the **GREEN** face and point to the center piece.
*Say: This is the **GREEN** center piece; it DOES NOT MOVE; it represents the **GREEN** face.*
- Find the **YELLOW** face and point to the center piece.
*Say: This is the **YELLOW** center piece; it DOES NOT MOVE; it represents the **YELLOW** face.*
- Find the **WHITE** face and point to the center piece.
*Say: This is the **WHITE** center piece; it DOES NOT MOVE; it represents the **WHITE** face.*

Ask students: How many center pieces are on the Rubik's Cube? (Six, the same number as faces and colors)



EDGE– Edge pieces are where two faces (where two colors) meet.

PP5

(It is important to do the following three steps in order, as they will have significance when solving the Rubik's Cube in subsequent lessons)

With the WHITE face facing up and BLUE face facing front (facing toward the student):

Tell students:

- Place your thumb and index finger on the **WHITE** and **GREEN** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **WHITE** and **RED** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **WHITE** and **BLUE** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **WHITE** and **ORANGE** edge. *Say: This is an edge.*

With the YELLOW face facing up and BLUE face facing front (facing toward the student):

Tell students:

- Place your thumb and index finger on the **YELLOW** and **GREEN** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **YELLOW** and **RED** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **YELLOW** and **BLUE** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **YELLOW** and **ORANGE** edge. *Say: This is an edge.*

With the WHITE face facing up and BLUE face facing front (facing toward the student):

Tell students:

- Place your thumb and index finger on the **BLUE** and **RED** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **RED** and **GREEN** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **BLUE** and **ORANGE** edge. *Say: This is an edge.*
- Place your thumb and index finger on the **ORANGE** and **GREEN** edge. *Say: This is an edge.*

Ask students: How many edges are on the Rubik's Cube? (Twelve)

BASIC VOCABULARY...



**CORNER – Corner pieces have three colors
and form a point where the three colors meet.**

PP6

With the WHITE face facing up and the BLUE face facing to the front (facing toward the student):

Tell students:

- Place your left thumb, index finger, and middle finger on the **BLUE, RED, and WHITE** corner.
Say: This is a corner.
- Place your left thumb, index finger, and middle finger on the **BLUE, RED, and YELLOW** corner.
Say: This is a corner.
- Place your left thumb, index finger, and middle finger on the **RED, GREEN, and WHITE** corner.
Say: This is a corner.
- Place your left thumb, index finger, and middle finger on the **RED, GREEN, and YELLOW** corner.
Say: This is a corner.
- Place your right thumb, index finger, and middle finger on the **BLUE, ORANGE, and WHITE** corner.
Say: This is a corner.
- Place your right thumb, index finger, and middle finger on the **BLUE, ORANGE, and YELLOW** corner.
Say: This is a corner.
- Place your right thumb, index finger, and middle finger on the **ORANGE, GREEN, and WHITE** corner.
Say: This is a corner.
- Place your right thumb, index finger, and middle finger on the **ORANGE, GREEN, and YELLOW** corner.
Say: This is a corner.

Ask students: How many corners are on the Rubik's Cube? (Eight)

DIRECTIONAL VOCABULARY

Tell students whenever we move a part of the cube, we only move it a quarter turn at a time.

A quarter turn can also be called: $\frac{1}{4}$ turn or 90 degree turn.

"R" = RIGHT face – RIGHT face of the cube

PP7



Tell students:

- From now on, the **RIGHT** face of the cube will be represented with a capital **"R"**.
- The **RIGHT** face is always the face on the **RIGHT**, where the **RIGHT** palm touches, regardless of the color that is on the **RIGHT** face.

With the BLUE face facing front and the ORANGE face facing right:

- Twist the **right** face of the cube with your **right** hand (**right** palm to the **ORANGE** face) so that the three **BLUE** pieces of the **right** face are facing **up**.

Say: This is a $\frac{1}{4}$ turn rotation. This is also a 90 degree turn.



Tell students:

- The **"R"** means that the **RIGHT** face always moves $\frac{1}{4}$ turn clockwise.

Ask students: Does anyone know what direction clockwise is? (The way the hands on the clock move)

Show students: A clockwise $\frac{1}{4}$ turn of the **RIGHT** face.

Check to be sure all students have successfully turned the **RIGHT** face $\frac{1}{4}$ turn clockwise.

Tell students: Return the **RIGHT** face to its original position by using a counter-clockwise $\frac{1}{4}$ turn. The result should be a solved Rubik's Cube.

Ask students: Does anyone know what direction counter-clockwise is? (The opposite way the hands on the clock move)

Show students: A counter-clockwise $\frac{1}{4}$ turn of the **RIGHT** face.

Check to be sure all students have successfully turned the **RIGHT** face $\frac{1}{4}$ turn counter-clockwise.



Tell students:

- **"Ri"**, which means **RIGHT INVERTED**, represents this $\frac{1}{4}$ turn move in the opposite direction.

Ask students: Does anyone know what inverted means? (Opposite)

Explain to students:

- An **"i"** after a letter means an inverted or counter-clockwise move when looking at the face directly.
- If **"R"** means a $\frac{1}{4}$ turn clockwise (demonstrate a $\frac{1}{4}$ turn clockwise again), then **"Ri"** means a $\frac{1}{4}$ turn counter-clockwise (demonstrate a $\frac{1}{4}$ turn counter-clockwise again), therefore **"Ri"** is opposite of **"R"**.
- An **"Ri"** move will undo an **"R"** move and an **"R"** move will undo an **"Ri"** move.

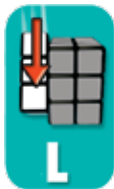
"L" = LEFT face – LEFT face of the cube

PP8



Tell students:

- From now on, the **LEFT** face of the cube will be represented with a capital **"L"**.
- The **LEFT** face is always the face on the **LEFT**, where the **LEFT** palm touches, regardless of the color on the **LEFT** face.



Tell students:

- The **"L"** means that the **LEFT** face always moves $\frac{1}{4}$ turn clockwise.
- Repeat the direction of clockwise? (the way the hands on the clock move)

Show students a clockwise $\frac{1}{4}$ turn of the **LEFT** face.

Check to be sure all students have successfully turned the **LEFT** face $\frac{1}{4}$ turn clockwise.

Tell students: Return the **LEFT** face to its original position using a $\frac{1}{4}$ turn counter-clockwise. The result should be a solved Rubik's Cube.



Tell students:

- **"Li"**, which means **LEFT INVERTED**, represents this $\frac{1}{4}$ turn move in the opposite direction.

Ask students: To repeat the meaning of inverted? (Opposite)

Explain to students:

- An **"i"** after a letter means an inverted or counter-clockwise move when looking at the face directly.
- If **"L"** means a $\frac{1}{4}$ turn clockwise (demonstrate a $\frac{1}{4}$ turn clockwise again), then **"Li"** means a $\frac{1}{4}$ turn counter-clockwise (demonstrate a $\frac{1}{4}$ turn counter-clockwise again), therefore **"Li"** is opposite of **"L"**.
- An **"Li"** move will undo an **"L"** move and an **"L"** move will undo an **"Li"** move.

DIRECTIONAL VOCABULARY...

"U" = UP face – TOP face of the cube

PP9



Tell students:

- From now on, the **UP** face of the cube will be represented with a capital "U".
- The **UP** face is always the face on the top, regardless of the color that is on the **UP** face.
- It does not matter which hand you use to move the **UP** face.



Tell students:

- The "U" means that the **UP** face always moves $\frac{1}{4}$ turn clockwise.
- Repeat the direction of clockwise? (the way the hands on the clock move)

Show students a clockwise $\frac{1}{4}$ turn of the **UP** face.

Check to be sure all students have successfully turned the **UP** face $\frac{1}{4}$ turn clockwise.

Tell students: Return the **UP** face to its original position.



Tell students:

- "Ui", which means **UP INVERTED**, represents this $\frac{1}{4}$ turn move in the opposite direction.

Ask students to repeat the meaning of inverted? (Opposite)

Explain to students:

- If "U" means a $\frac{1}{4}$ turn clockwise (demonstrate a $\frac{1}{4}$ turn clockwise again), then "Ui" means a $\frac{1}{4}$ turn counter-clockwise (demonstrate a $\frac{1}{4}$ turn counter-clockwise again), therefore "Ui" is opposite of "U".
- A "Ui" move will undo a "U" move and a "U" move will undo a "Ui" move.

"D" = DOWN face – BOTTOM face of the cube

PP10



Tell students:

- From now on, the **DOWN** face of the cube will be represent with a capital "D".
- The **DOWN** face is always the face on the bottom, regardless of the color that is on the **DOWN** face.
- It does not matter which hand you use to move the **DOWN** face.



Tell students:

- The "D" means that the **DOWN** face always moves $\frac{1}{4}$ turn clockwise.
- To repeat the direction of clockwise? (the way the hands on the clock move)

Show students a clockwise $\frac{1}{4}$ turn of the **DOWN** face.

Check to be sure all students have successfully turned the **DOWN** face $\frac{1}{4}$ turn clockwise.

Tell students: Return the **DOWN** face to its original position.



Tell students:

- "Di", which means **DOWN INVERTED**, represents this $\frac{1}{4}$ turn move in the opposite direction.

Ask students to repeat the meaning of inverted? (Opposite)

Explain to students;

- If "D" means a $\frac{1}{4}$ turn clockwise (demonstrate a $\frac{1}{4}$ turn clockwise again), then "Di" means a $\frac{1}{4}$ turn counter-clockwise (demonstrate a $\frac{1}{4}$ turn counter-clockwise again), therefore "Di" is opposite of "D".
- A "Di" move will undo a "D" move and a "D" move will undo a "Di" move.

DIRECTIONAL VOCABULARY...**"F" = FRONT face – FRONT face of the cube** PP11

Tell students:

- From now on, the **FRONT** face of the cube will be represented with a capital "F".
- The **FRONT** face is always the face on the **FRONT**, regardless of the color that is on the **FRONT** face.
- It does not matter which hand you use to move the **FRONT** face.



Tell students:

- The "F" means that the **FRONT** face always moves $\frac{1}{4}$ turn clockwise.
- To repeat the direction of clockwise. (the hands on the clock move)

Show students a clockwise $\frac{1}{4}$ turn of the **FRONT** face.

Check to be sure all students have successfully turned the **FRONT** face $\frac{1}{4}$ turn clockwise.

Tell the students to return the **FRONT** face to its original position.



Tell students:

- "Fi", which means **FRONT INVERTED**, represents this $\frac{1}{4}$ turn move in the opposite direction.

Ask students to repeat the meaning of inverted. (Opposite)

Explain to students:

- If "F" means a $\frac{1}{4}$ turn counter-clockwise (demonstrate a $\frac{1}{4}$ turn clockwise again), then "Fi" means a $\frac{1}{4}$ turn counter-clockwise (demonstrate a $\frac{1}{4}$ turn counter-clockwise again), therefore "Fi" is opposite of "F".
- An "Fi" move will undo an "F" move and an "F" move will undo an "Fi" move.

"B" = BACK face – BACK face of the cube PP12

Tell students:

- From now on, the **BACK** face of the cube will be represented with a capital "B".
- The **BACK** face is always the face on the **BACK**, regardless of the color that is on the **BACK** face.
- It does not matter which hand you use to move the **BACK** face.



Tell students:

- The "B" means that the **BACK** face always moves $\frac{1}{4}$ turn clockwise.
- To repeat the direction of clockwise. (the way the hands on the clock move)

Show students a clockwise $\frac{1}{4}$ turn of the **BACK** face.

Check to be sure all students have successfully turned the **BACK** face $\frac{1}{4}$ turn clockwise.

Tell the students to return the **BACK** face to its original position.



Tell students:

- "Bi", which means **BACK INVERTED**, represents this $\frac{1}{4}$ turn move in the opposite direction.

Ask students to repeat the meaning of inverted. (Opposite)

Explain to students:

- If "B" means a $\frac{1}{4}$ turn clockwise (demonstrate a $\frac{1}{4}$ turn clockwise again), then "Bi" means a $\frac{1}{4}$ turn counter-clockwise (demonstrate a $\frac{1}{4}$ turn counter-clockwise again), therefore "Bi" is opposite of "B".
- A "Bi" move will undo a "B" move and a "B" move will undo a "Bi" move.

*If you are dividing Lesson 1 – Meeting the Cube into two lessons, stop here.
Begin the next session with the Review from the gray box on the following page, and then continue with the Lesson Focus.*

If you are dividing Lesson 1 – Meeting the Cube into two lessons, this is the beginning of Lesson 1 – Meeting the Cube, Part 2.

Begin Part 2 with the Review from this gray box, and then continue with the Lesson Focus.

REVIEW FROM MEETING THE CUBE PART 1

REVIEW THE FACES AND CENTER PIECES

Tell students: Point to the **BLUE** face. (The face with the **BLUE** center piece)

Tell students: Point to the **GREEN** face. (The face with the **GREEN** center piece)

Tell students: Point to the **ORANGE** face. (The face with the **ORANGE** center piece)

Tell students: Point to the **RED** face. (The face with the **RED** center piece)

Tell students: Point to the **YELLOW** face. (The face with the **YELLOW** center piece)

Tell students: Point to the **WHITE** face. (The face with the **WHITE** center piece)



REVIEW THE EDGES

Tell students: To place their thumb and first finger on an edge.

Check to make sure placement is accurate.



REVIEW THE CORNERS

Ask students to place their thumb, first finger, and middle finger on a corner.

Check to make sure placement is accurate.



REVIEW THE 1/4 TURNS

Tell students:

- to follow along while you demonstrate the 1/4 turns: "R" 1/4 turn, "Ri" 1/4 turn, "L" 1/4 turn, "Li" 1/4 turn, "U" 1/4 turn, "Ui" 1/4 turn, "D" 1/4 turn, "Di" 1/4 turn, "F" 1/4 turn, "Fi" 1/4 turn, "B" 1/4 turn, and "Bi" 1/4 turn.



*If you are dividing Lesson 1 – Meeting the Cube into two lessons, stop here.
Begin the next session with the Review from gray box on the previous page, and then continue with the Lesson Focus below.*

LESSON FOCUS

Once the $\frac{1}{4}$ turn vocabulary has been introduced, lead students in the following chant to review and practice each $\frac{1}{4}$ turn with its coordinating letter representation.

Part 1

PP13

Tell students: To set their Rubik's Cube aside. **Pass out** copies of Appendix 1.Ta

Ask students: *If anyone knows the chorus of the Military Cadence?* (♪ “LEFT, LEFT, LEFT, RIGHT, LEFT” ♪)

Tell students: Repeat the first part of the cadence after you without making any moves on the cube:

- Teacher – ♪ LEFT, LEFT, LEFT, RIGHT, LEFT ♪
- Students – ♪ LEFT, LEFT, LEFT, RIGHT, LEFT ♪

Ask students: *To look at the handout and follow along with you.*

With the WHITE face UP, the YELLOW face DOWN, and the BLUE face FRONT:

Tell students to repeat the cadence after you, while making the $\frac{1}{4}$ turn moves on the cube:

- PP13
- Teacher – ♪ LEFT, LEFT, LEFT, RIGHT, LEFT ♪
 - Students – ♪ LEFT, LEFT, LEFT, RIGHT, LEFT ♪

Repeat 4x (after 4x the cube should end in the solved position)



Tell students you are going to add to the cadence to make a Rubik's Cube cadence to practice the letter representations.

Tell students to repeat the cadence after you, while making the $\frac{1}{4}$ turn moves on the cube:

- PP14
- Teacher – ♪ UP, UP, UP, DOWN, UP ♪
 - Students – ♪ UP, UP, UP, DOWN, UP ♪

Repeat 4x (after 4x the cube should end in the solved position)



Tell students to repeat the cadence after you, while making the $\frac{1}{4}$ turn moves on the cube:

- PP15
- Teacher – ♪ FRONT, FRONT, FRONT, BACK, FRONT ♪
 - Students – ♪ FRONT, FRONT, FRONT, BACK, FRONT ♪

Repeat 4x (after 4x the cube should end in the solved position)



Repeat Rubik's Cube Cadence if necessary.

Part 2

Pass out copies of Appendix 1.Tb **PP16**

Ask students: To look at the handout and follow along with you.

Tell students: Repeat the names of the moves after you (without the cadence):

- Teacher – LEFT INVERTED, LEFT INVERTED, LEFT INVERTED, RIGHT INVERTED, LEFT INVERTED.
- Students – LEFT INVERTED, LEFT INVERTED, LEFT INVERTED, RIGHT INVERTED, LEFT INVERTED.

Repeat 4x (after 4x the cube should end in the solved position)



Tell students: Repeat the names of the moves after you (without the cadence):

PP17

- Teacher – UP INVERTED, UP INVERTED, UP INVERTED, DOWN INVERTED, UP INVERTED.
- Students – UP INVERTED, UP INVERTED, UP INVERTED, DOWN INVERTED, UP INVERTED.

Repeat 4x (after 4x the cube should end in the solved position)



Tell students: Repeat the names of the moves after you (without the cadence):

PP18

- Teacher – FRONT INVERTED, FRONT INVERTED, FRONT INVERTED, BACK INVERTED, FRONT INVERTED.
- Students – FRONT INVERTED, FRONT INVERTED, FRONT INVERTED, BACK INVERTED, FRONT INVERTED.

Repeat 4x (after 4x the cube should end in the solved position)



Repeat Inverted Rubik's Cube Cadence if necessary.

DIFFERENTIATION – LEVELED GROUP ACTIVITIES

Based on your observations and background knowledge of students, divide students into small groups according to the groups below. Within each of the leveled groups, students may be further divided into pairs or mini-groups. The groups should be flexible. Students can move in and out of the leveled groups based on their understanding and mastery of activities within each level. Depending on the number of students, there may be multiple groups within each level. The lettered levels are meant to differentiate activities, not to maintain only four groups.

- **M** – **Modify** the lesson for understanding (Individual or Pairs Suggested)
Use **Appendix 1.M**

Students in this group should:

- Need review of the colors of the Rubik's Cube.
- Need review of the opposite color pairs.
- Need review of the shape and net of a cube.

- **A** – **Apply** the lesson to repeated practice (Groups or Pairs Suggested)
Use **Appendix 1.A**

Students in this group should:

- Have mastered identifying opposite color pairs.
- Be familiar with the directional instructions.
- Be comfortable making $\frac{1}{4}$ turns with the given directional instructions.

- **T** – **Re-Teach** the lesson for mastery (Pairs Suggested)
Use **Appendix 1.Ta** or **Appendix 1.Tb**

Students in this group should:

- Have mastered identifying opposite color pairs.
- Be familiar with the directional instructions. (If students are unfamiliar, they can practice with the Memory Game from the Review Lesson).
- Need more one-on-one explanations of directional instructions and cube manipulation.

- **H** – **Higher level learning** for enrichment
Use **Appendix 1.H**

Students in this group should:

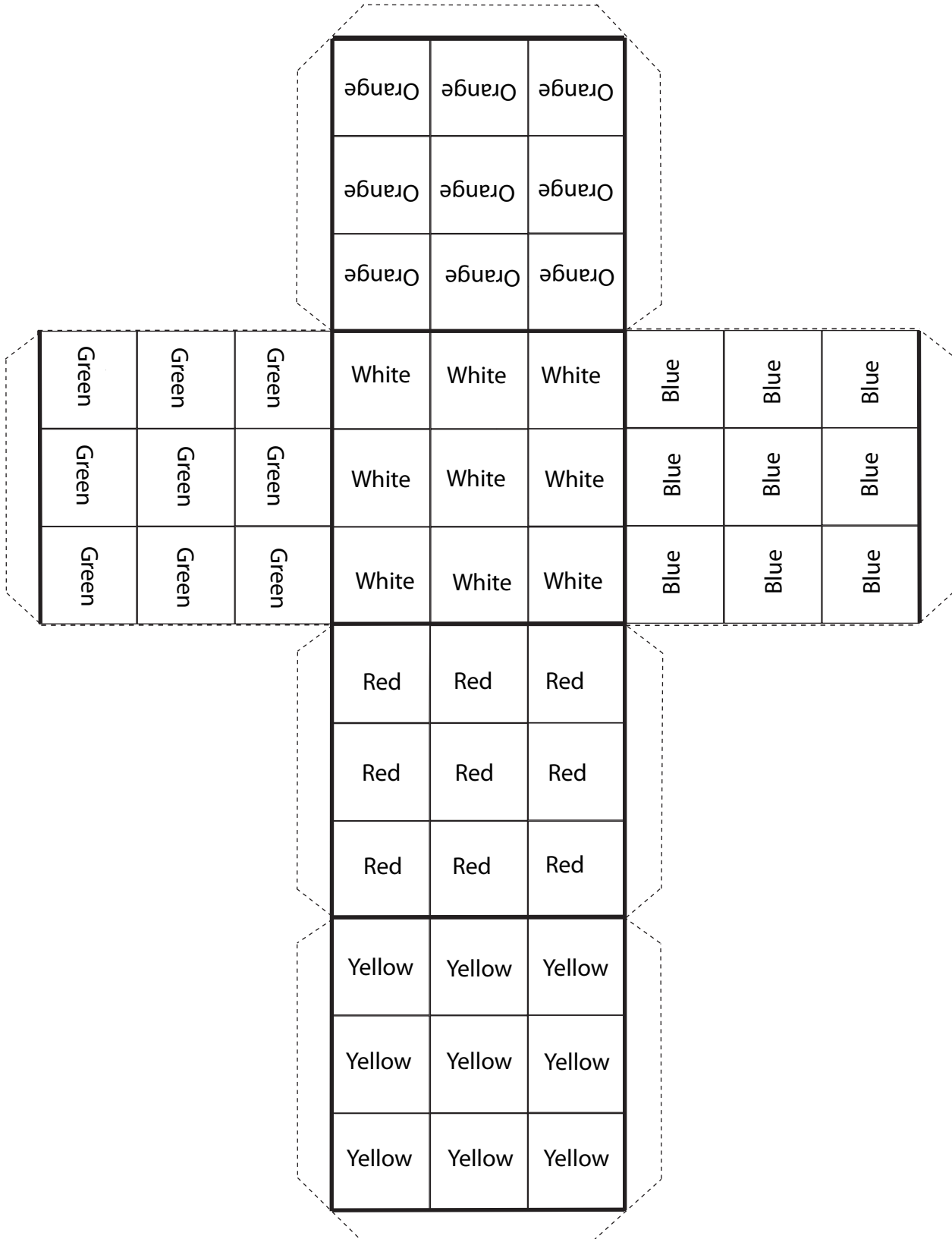
- Have mastered the activities in Group A.
- Be able to work independently.

Appendix 1.M

Rubik's Cube Net

Directions:

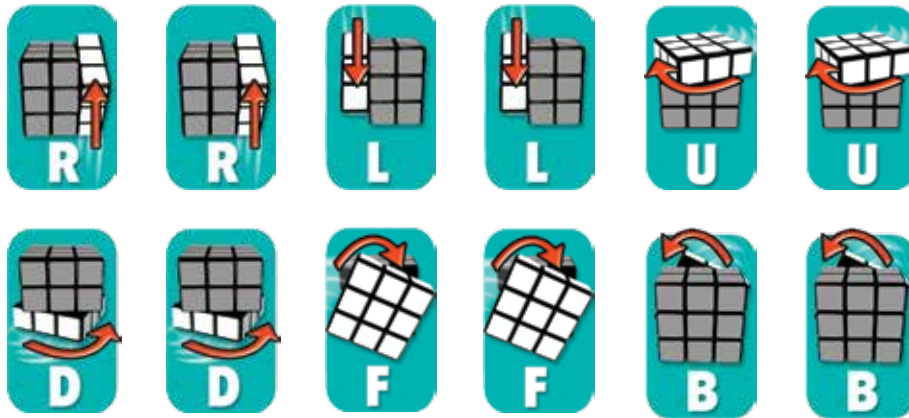
1. Cut along the dotted lines.
2. Fold on the bold lines and fold tabs inward.
3. Tape or glue the edges together using the tabs to form a cube.



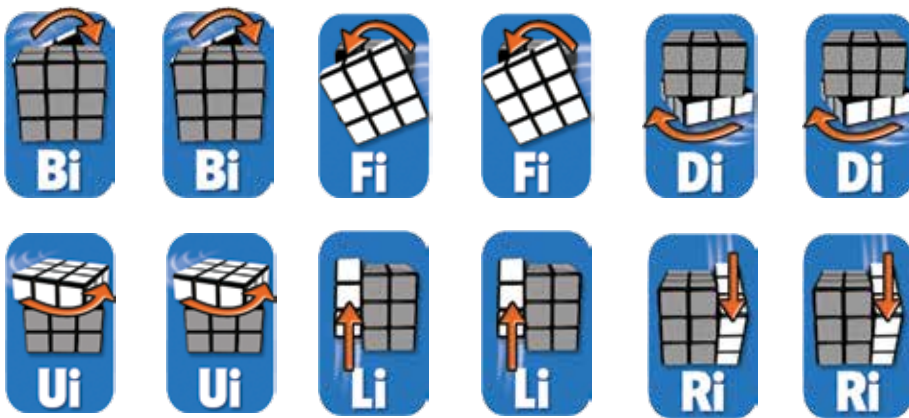
Differentiation Activities

¼ TURN PRACTICE SHEET

Section A Multi-colored Cross



Return to a solved cube:



Section B Square in the Middle



Return to a solved cube:



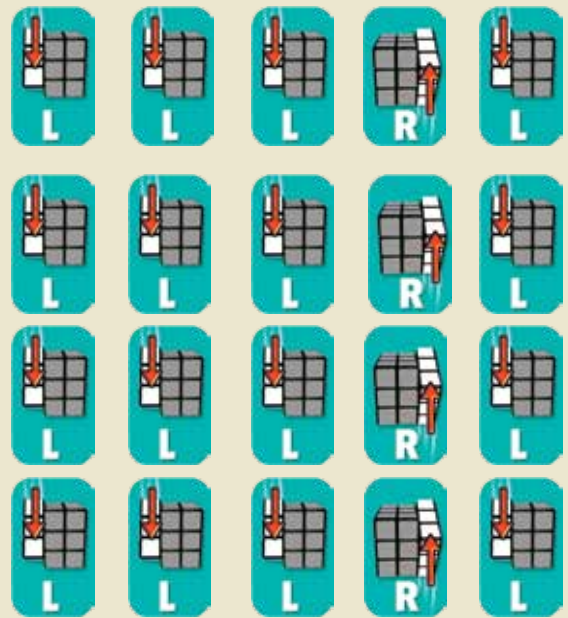
Appendix 1. Ta 1/4 Turn Practice Sheet (Regular Moves)

Differentiation Activities

Start with a solved cube

To practice the **L** and **R** 1/4 turn moves:
Follow the picture instructions. →

You should have a solved Rubik's Cube after completing all 4 rows.



Start with a solved cube

To practice the **U** and **D** 1/4 turn moves:
Use the Military Cadence chant learned in the lesson and follow the picture instructions.

You should have a solved Rubik's Cube after completing the chant 4 times.



Start with a solved cube

To practice the **F** and **B** 1/4 turn moves:
Use the Military Cadence chant learned in the lesson and follow the picture instructions.

You should have a solved Rubik's Cube after completing the chant 4 times.

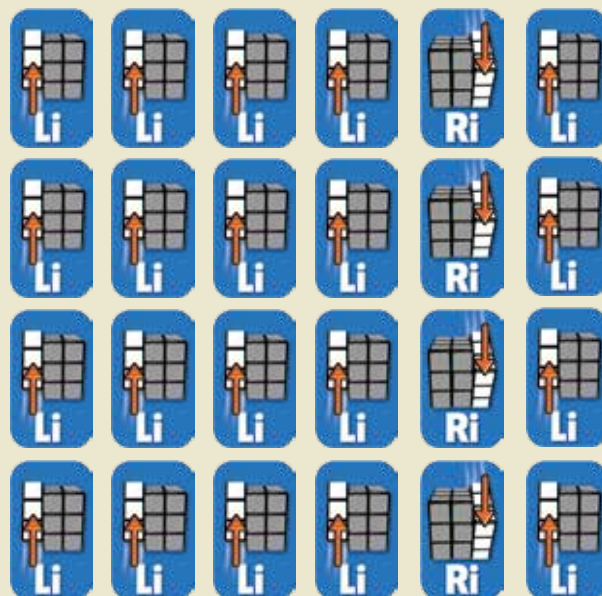


1/4 Turn Practice Sheet (Inverted Moves)

Start with a solved cube

To practice the **Li** and **Ri** 1/4 turn moves:
Follow the picture instructions. ➔

You should have a solved Rubik's Cube after completing the chant 4 times.



Differentiation Activities

Start with a solved cube

To practice the **Ui** and **Di** 1/4 turn moves:
Follow the picture instructions below.

You should have a solved Rubik's Cube after completing the chant 4 times.



Start with a solved cube

To practice the **Fi** and **Bi** 1/4 turn moves:
Follow the picture instructions below.

You should have a solved Rubik's Cube after completing the chant 4 times.



Appendix 1.H

Pattern Creation

Use the following $\frac{1}{4}$ turn moves to design your own pattern on the Rubik's Cube, similar to the multicolored cross and the square in the middle. Write down each move on the lines provided. Your patterns must be reversible to return to a solved cube.



Differentiation
Activities

Pattern:

_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Reverse Pattern:

_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

REVIEW

Review the Faces **PP19** **PP20**

Tell students: Point to the **BLUE** face. (the face with the **BLUE** center piece)

Tell students: Point to the **GREEN** face. (the face with the **GREEN** center piece)

Tell students: Point to the **ORANGE** face. (the face with the **ORANGE** center piece)

Tell students: Point to the **RED** face. (the face with the **RED** center piece)

Tell students: Point to the **YELLOW** face. (the face with the **YELLOW** center piece)

Tell students: Point to the **WHITE** face. (the face with the **WHITE** center piece)

Review the Edges and Corners **PP21** **PP22**

Tell students: To place their thumb and index finger on an edge.

Check to make sure placement is accurate.

Tell students: To place their thumb, index finger, and middle finger on a corner.

Check to make sure placement is accurate.

Review the $\frac{1}{4}$ turns **PP23**

- "R" $\frac{1}{4}$ turn, "Ri" $\frac{1}{4}$ turn
- "L" $\frac{1}{4}$ turn, "Li" $\frac{1}{4}$ turn



- "U" $\frac{1}{4}$ turn, "Ui" $\frac{1}{4}$ turn
- "D" $\frac{1}{4}$ turn, "Di" $\frac{1}{4}$ turn



- "F" $\frac{1}{4}$ turn, "Fi" $\frac{1}{4}$ turn
- "B" $\frac{1}{4}$ turn, and "Bi" $\frac{1}{4}$ turn



RUBIK'S TRIVIA **PP24**

Question: The Rubik's Cube was created in 1974. How old is the Rubik's Cube now?

Answer: As of 2013, the Rubik's® Cube was 39 years old. (In 2014, 40; in 2015, 41...)

EVALUATION

Each student should be able to:

- Identify the faces, edges, and corners by color and position.
- Make and recognize $\frac{1}{4}$ turns with relationship to the $\frac{1}{4}$ turn letter representations (i.e. "R", "Ri", "L", "Li", etc.)
- Understand that the Rubik's Cube is a geometrical cube with 6 faces, 8 corners and 12 edges.
- Understand that each small cube within the cube represents "units" of measurement. Therefore, the Rubik's cube is 3 units long and 3 units wide.

AT HOME CONNECTION

Important Vocabulary

This vocabulary is necessary to understand the instructions to solve the Rubik's Cube.

FACE - Faces are the flat area of one side. The color of the face is based on the color of the center square.

EDGE - Edge pieces are where two faces (where two colors) meet.

CORNER - Corner pieces have three colors and form a point where the three colors meet.

CENTER - Center pieces are pieces that have only one color. They are found in the center of each face.

SIDES - Sides are represented by a specific letter.

R = Right face - Right side of the cube.

L = Left face - Left side of the cube.

U = Up face - Top side of the cube.

D = Down face - Bottom side of the cube.

F = Front face - Front side of the cube.

B = Back face - Back side of the cube.

INVERTED - Opposite.

CLOCKWISE - The direction the hands on a clock move.

COUNTER-CLOCKWISE - The opposite way the hand on a clock move.

WHAT WE LEARNED

The parts of the Rubik's Cube

The letter representations for the sides of the Rubik's Cube

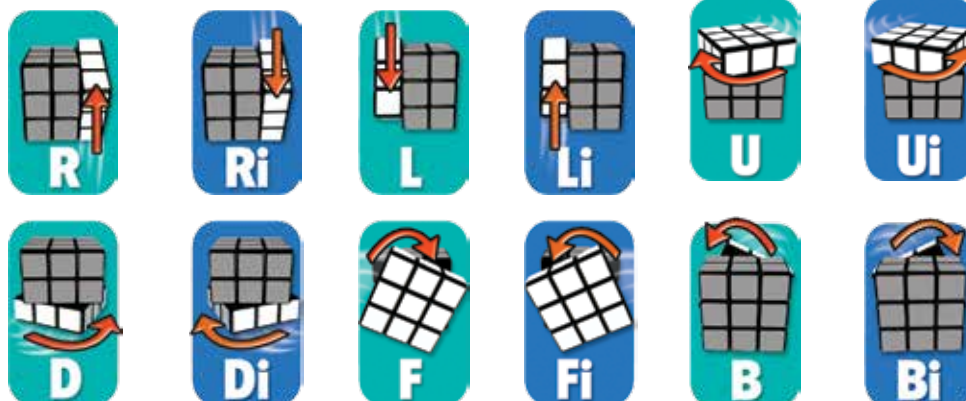
The meaning of mathematics words that are used in the instructions to solve the Rubik's Cube

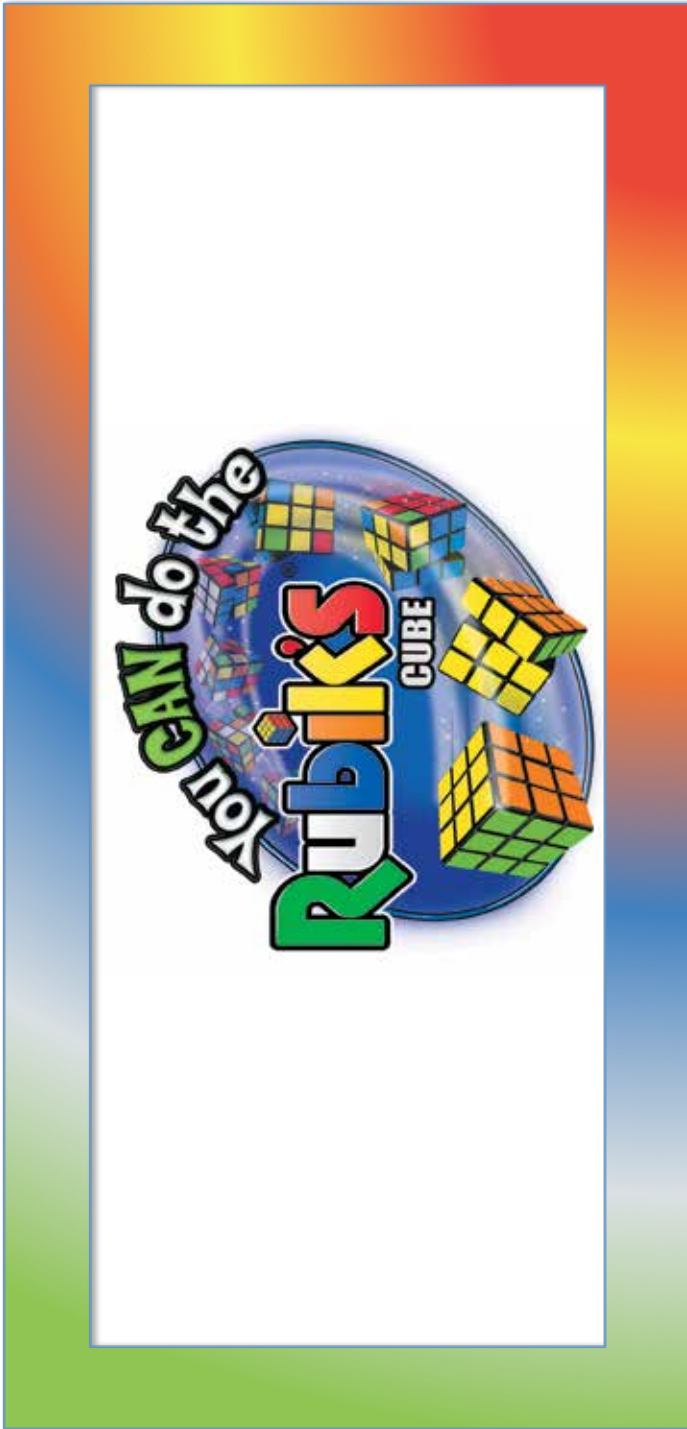
Corner Center Edge



Practice Activity

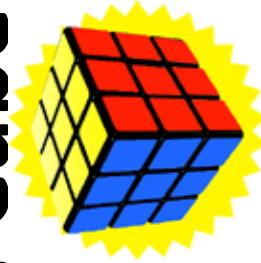
Use the letter representations to make $\frac{1}{4}$ turn rotations on the Rubik's Cube.
(Note: This sequence is meant for $\frac{1}{4}$ turn rotation practice. This sequence will not solve the Rubik's Cube.)





Meeting the Cube

Lesson 1



Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



PP2



- Cube – Three-Dimensional
- **RED, YELLOW, BLUE, GREEN, WHITE, ORANGE**
- **RED** is opposite **ORANGE**
- **WHITE** is opposite **YELLOW**
- **BLUE** is opposite **GREEN**
- 3 units long; 3 units wide
- 8 units (perimeter of a face)
- 9 units (area of a face)

Shape

Colors

Opposites

Length

Perimeter

Face

Vocabulary

Lesson Focus

Lesson Review

Rubik's Trivia



PP3



Back Face



Right Face



Front Face



Up Face



Down Face



Left Face

FACES

The flat (two-dimensional) square, on each surface of the cube. There are six (6) faces on the cube, each with a directional name.

Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



PP4

WHITE Face



BLUE Face

ORANGE Face



CENTER Pieces

Pieces with one color.
There are six (6) center pieces, one in the center of each face. Center pieces **DO NOT MOVE**. They represent the color of their face.

Vocabulary

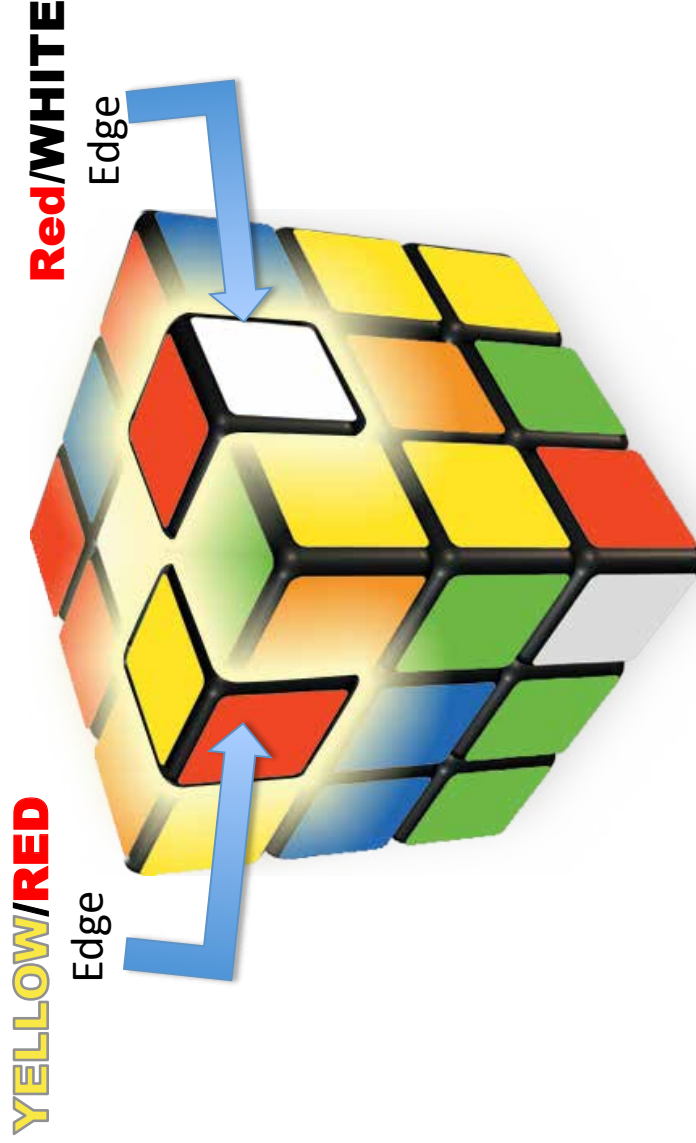
Lesson Focus

Lesson Review

Rubik's Trivia



PP5



EDGE Pieces

Pieces with two colors.
 There are twelve (12) edge pieces located in the middle rows.

Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



PP6



GREEN/ORANGE/YELLOW Corner



CORNER Pieces

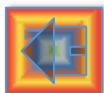
Pieces with three (3) colors.
There are eight (8) corner pieces located on the corners.

Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



RIGHT FACE Move



To “undo” a

- “**R**” $\frac{1}{4}$ turn,
- make a “**Ri**” $\frac{1}{4}$ turn.
- Inverted means opposite.
- By inverting a move, the move can be undone.

Vocabulary

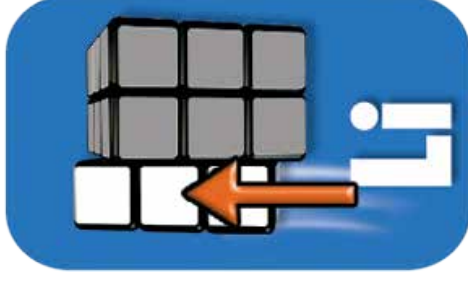
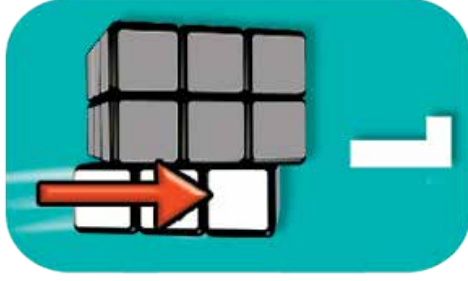
Lesson Focus

Lesson Review

Rubik's Trivia



PP8



LEFT Face Move

To “undo” a

“L” $\frac{1}{4}$ turn,
make a “**Li**” $\frac{1}{4}$
turn.

- Inverted means opposite.
- By inverting a move, the move can be undone.

Vocabulary

Lesson Focus

Lesson Review

Rubik's Trivia



PP9



UP Face Move

To “undo” a

“**U**” $\frac{1}{4}$ turn,
make a “**Ui**” $\frac{1}{4}$
turn.

- Inverted means opposite.
- By inverting a move, the move can be undone.

Lesson Vocab

Lesson Focus

Lesson Review

Rubik's Trivia



PP10



DOWN Face Move

- To “undo” a
“**D**” $\frac{1}{4}$ turn,
make a “**Di**” $\frac{1}{4}$ turn.
- Inverted means opposite.
 - By inverting a move,
the move can be undone.

Vocabulary

Lesson Focus

Lesson Review

Rubik's Trivia



PP11



FRONT Face Move



To “undo” a
 “**F**” $\frac{1}{4}$ turn,
 make a “**Fi**” $\frac{1}{4}$ turn.

- Inverted means opposite.
- By inverting a move, the move can be undone.

Vocabulary

Lesson Focus

Lesson Review

Rubik's Trivia



PP12



BACK Face Move

- To “undo” a
- “**B**” $\frac{1}{4}$ turn,
 - make a “**Bi**” $\frac{1}{4}$ turn.
- Inverted means opposite.
 - By inverting a move, the move can be undone.

Vocabulary

Lesson Focus

Lesson Review

Rubik's Trivia



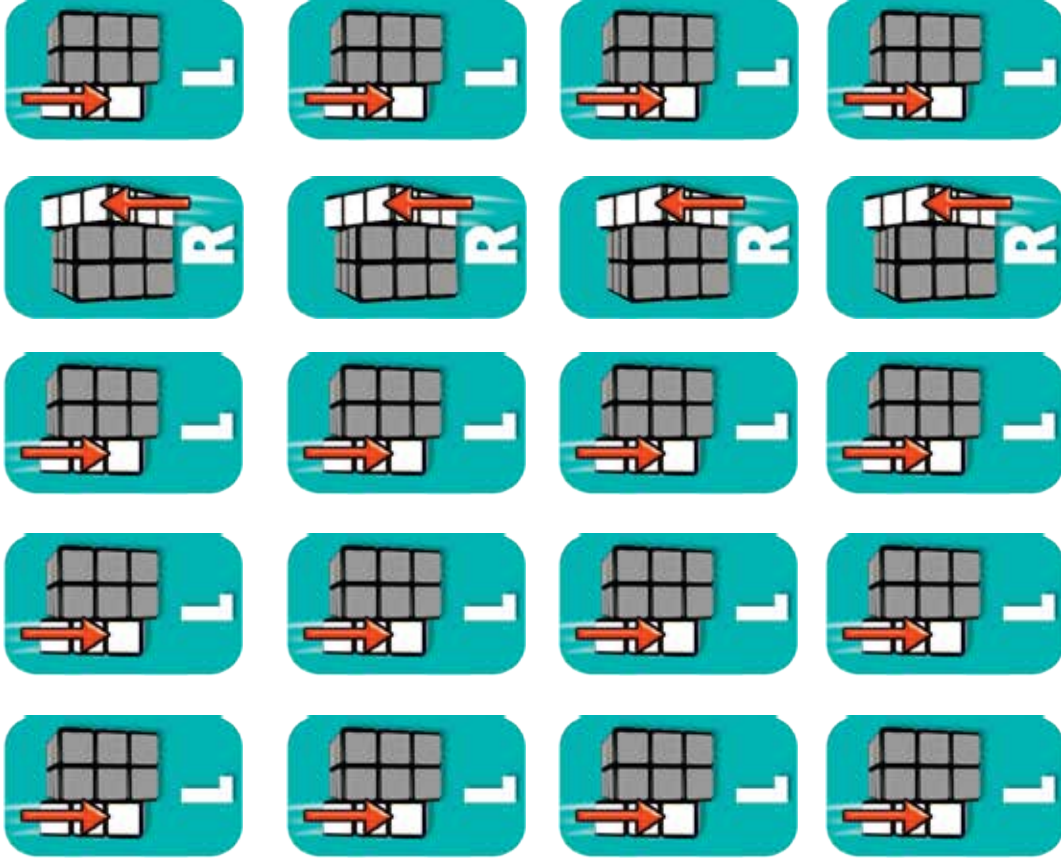
PP13



1/4 turn practice

Start with a solved cube.

Repeat each sequence 4x to return to a solved cube.



Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



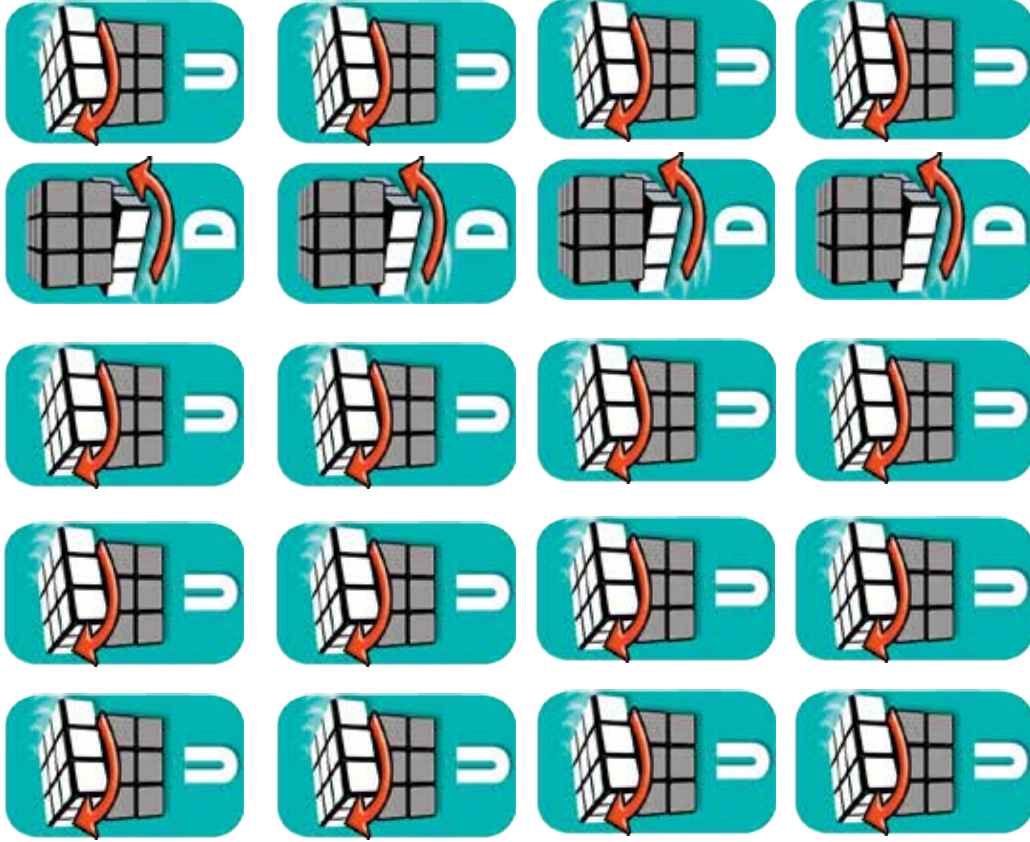
PP14



1/4 turn practice

Start with a solved cube.

Repeat each sequence 4x to return to a solved cube.



Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



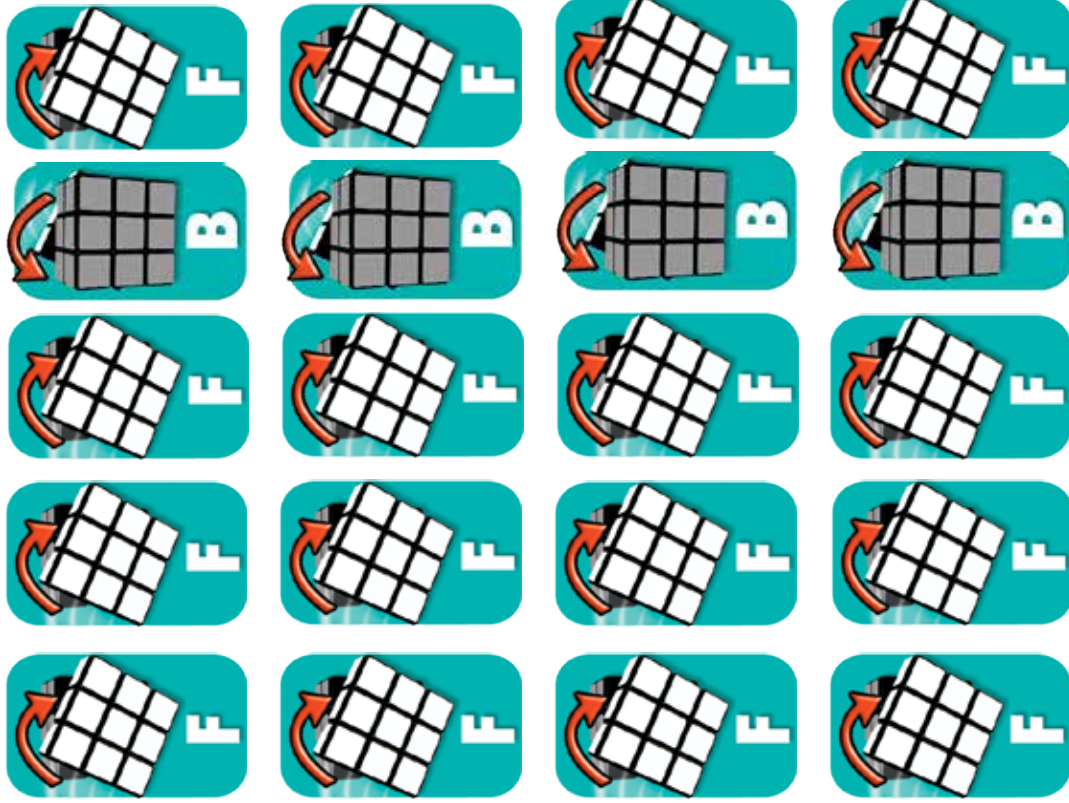
PP15



1/4 turn practice

Start with a solved cube.

Repeat each sequence 4x to return to a solved cube.



Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



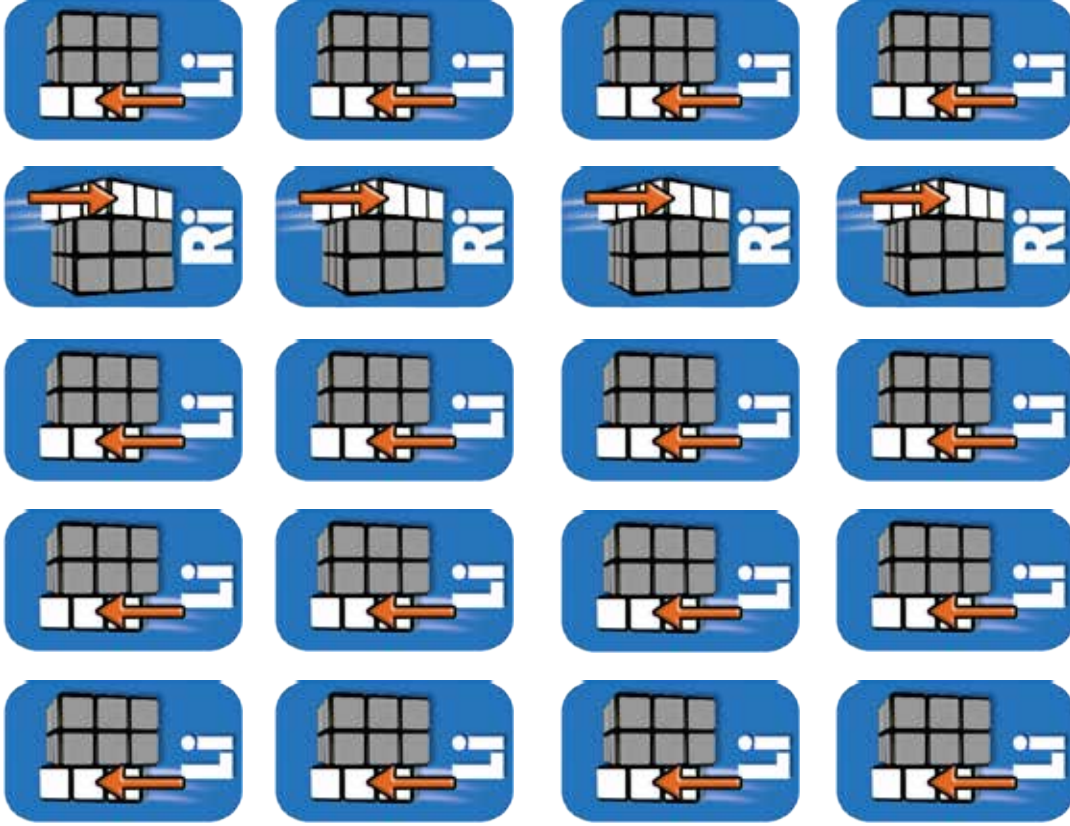
PP16



1/4 turn practice

Start with a solved cube.

Repeat each sequence 4x to return to a solved cube.



Rubik's Trivia

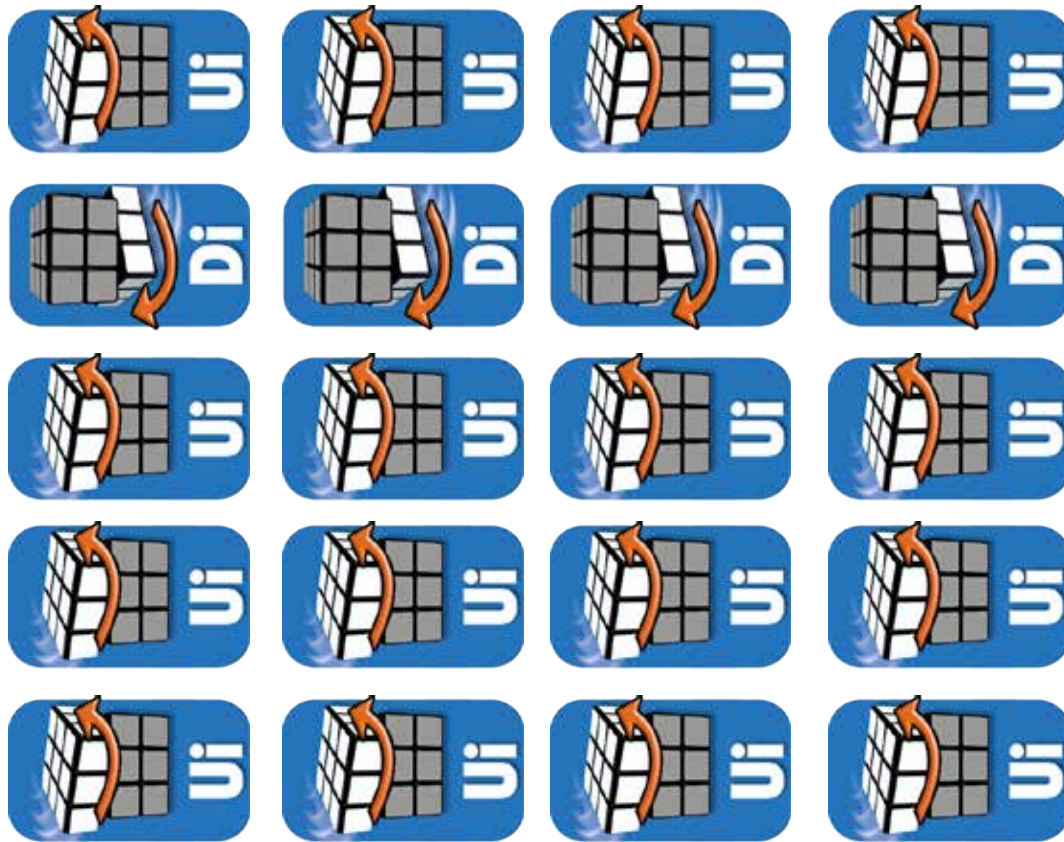
Lesson Review

Lesson Focus

Vocabulary



PP17



¼ turn practice

Start with a solved cube.

Repeat each sequence 4x to return to a solved cube.

Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



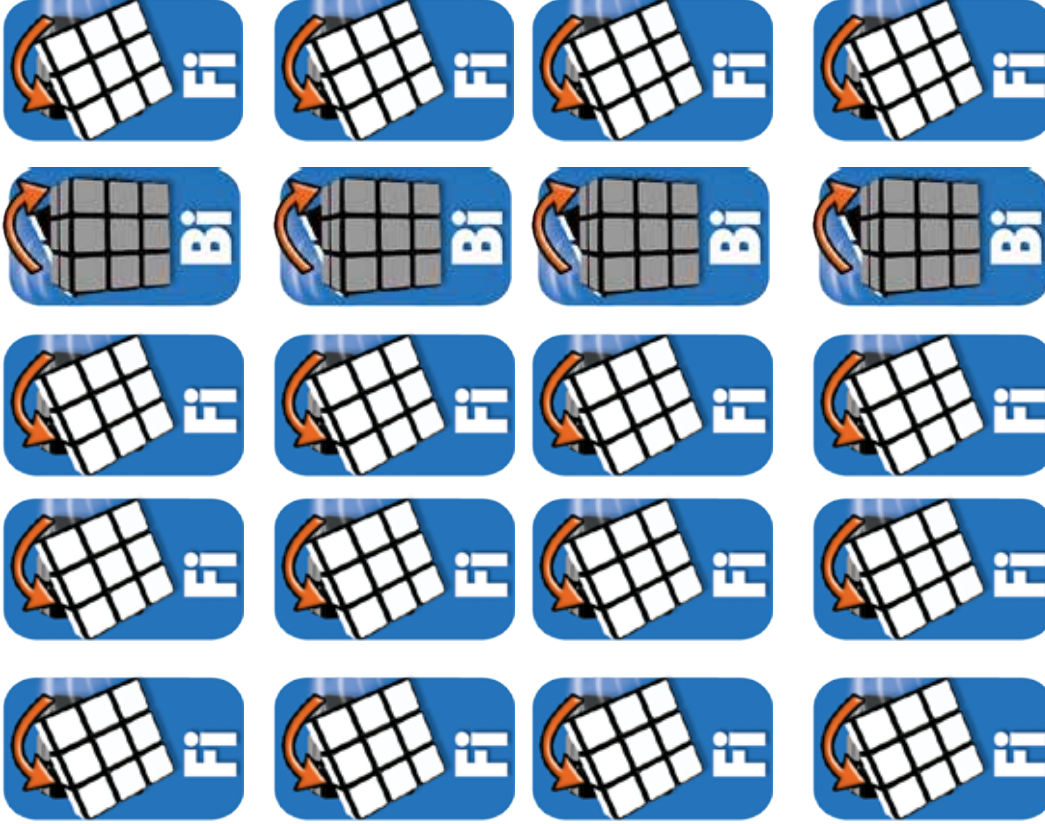
PP18



1/4 turn practice

Start with a solved cube.

Repeat each sequence 4x to return to a solved cube.



Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



PP19



FACES

The flat (two-dimensional) square, on each surface of the cube. There are six (6) faces on the cube, each with a directional name.



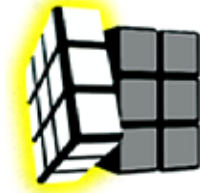
Back Face



Right Face



Front Face



Up Face



Down Face



Left Face

Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



PP20

WHITE Face



ORANGE Face



CENTER Pieces

Pieces with one color.
There are six (6) center pieces, one in the center of each face. Center pieces **DO NOT MOVE**. They represent the color of their face.

Vocabulary

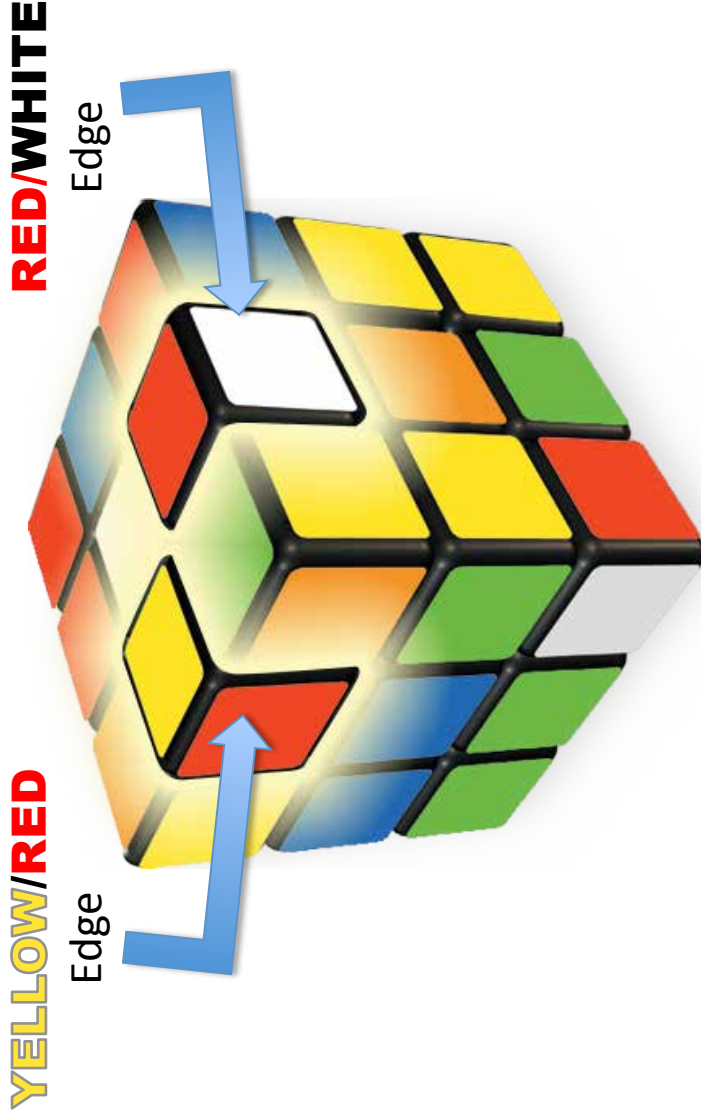
Lesson Focus

Lesson Review

Rubik's Trivia



PP21



EDGE Pieces

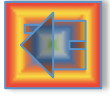
Pieces with two colors.
There are twelve (12) edge pieces located in the middle rows.

Rubik's Trivia

Lesson Review

Lesson Focus

Vocabulary



PP22



GREEN/ORANGE/YELLOW Corner



CORNER Pieces

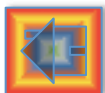
Pieces with three colors.
There are eight (8) corner pieces located on the corners.

Vocabulary

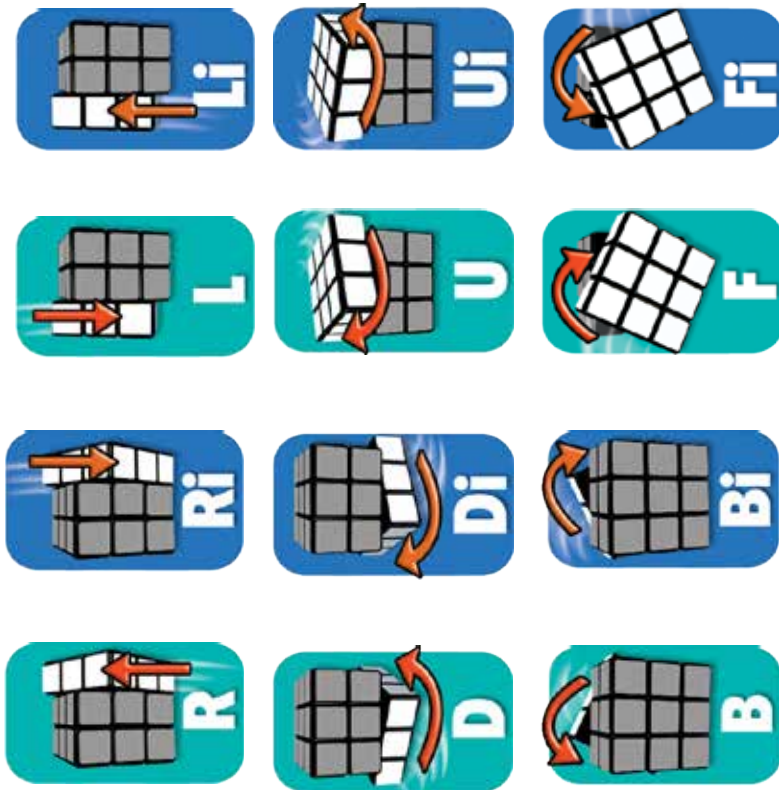
Lesson Focus

Lesson Review

Rubik's Trivia



PP23



¼ Turns

R Ri L Li
 D Di U Ui
 B Bi F Fi

- Inverted means opposite.
- By inverting a move, the move can be undone.

Vocabulary

Lesson Focus

Lesson Review

Rubik's Trivia



PP24

Question: The Rubik's Cube was created in 1974. How old is the Rubik's Cube now?

**Answer: As of 2013, the Rubik's Cube was 39 years old.
(In 2014, 40; in 2015, 41....)**

Vocabulary

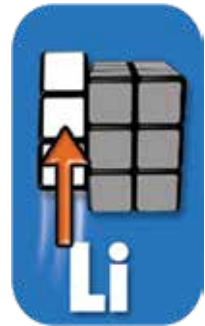
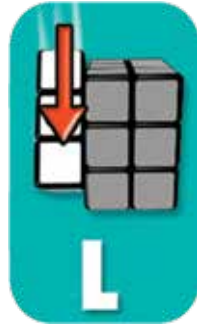
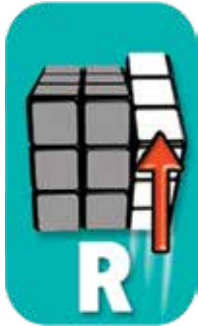
Lesson Focus

Lesson Review

Rubik's Trivia

Meeting the Cube

QUARTER TURN - REFERENCE SHEET





www.YouCanDoTheCube.com