299 Market Street Saddle Brook, NJ 07663 (800) 822-1080 www.measuringupresearch.com

Measuring Up Express

RESEARCH BASE

Measuring Up *EXPRESS*™ *for the TAKS*

Peoples Education®
(800) 822-1080 ● PeoplesEducation.com
299 Market St. Saddle Brook, NJ 07663

www.PeoplesEducation.com

Measuring Up Express

www.measuringupresearch.com

Peoples Education®
(800) 822-1080 ● PeoplesEducation.com
299 Market St. Saddle Brook, NJ 07663

www.PeoplesEducation.com

INTRODUCTION

In January 2002, President George Bush signed into law the No Child Left Behind Act of 2001. Under this law, educational programs and materials paid for by federal funding must be based on sound, widely accepted educational research that supports the materials' design, thus increasing the likelihood that the materials will help students achieve the desired learning outcomes. This law, commonly known as NCLB, thus requires educators to be aware of the body of research that supports the design of any materials they are considering for use with their students.

Since its inception in 1990, Peoples Education has built and revised our student learning products based on continual review of the scientific research literature. The foundation of Peoples Education's Measuring Up® program is a set of principles derived from the soundest current theory and research on reading and language arts, mathematics, writing, science, social studies, assessment, and literacy. These principles are based specifically on the student learning standards of the state for which the materials are designed.

This document serves both to provide information about Measuring Up *EXPRESS*™ for Texas and to explain the research on learning theory on which the series is based. Consequently, this document is organized to be useful to educators who are considering the soundness and the practical uses of the materials in classrooms.

First, each principle that supports the design of the materials is articulated. Second, a paragraph discussing the best-known and most respected educational research substantiating the principle is given. Third, a discussion of the way the Measuring Up *EXPRESS*™ materials specifically embody both the principle and its research-based foundation helps prospective educators see how the materials can be used to help teachers collect information about their students' strengths and weaknesses and help students explore their own understandings of the standards-based information they are likely to encounter on the Texas Assessment of Knowledge and Skills (TAKS).

THE CHALLENGE

Today's educators, schools, and districts face a daunting challenge: how to raise student achievement in an increasingly rigorous, standards-based environment. This dilemma is particularly critical because the No Child Left Behind Act requires that:

- Each state adopt challenging academic content standards and challenging student academic achievement standards;
- Each state educational agency implement a set of high-quality, yearly student academic assessments that include, at a minimum, academic assessments in mathematics, reading or language arts, and science that will be used as the primary means of determining the yearly performance of children and discerning whether they meet the state's challenging academic standards.

Measuring Up *EXPRESS*™

Measuring Up *EXPRESS*™ is a supplemental series of student worktexts that focuses on just the tested state curriculum standards and performance objectives. An assessment component is part of the program in the form of Diagnostic Practice Tests that permit diagnosis and prescription and offer the option of assessment-based instruction.

RESEARCH-BASED PEDAGOGY OF Measuring Up *EXPRESS*™

The Texas state version of the Measuring Up *EXPRESS*™ series is completely customized, and has been designed to support and enhance best practices for effective teaching of the *tested* Texas Essential Knowledge and Skills (TEKS). There are some research-based unifying pedagogical principles, summarized below, that are common across Texas Essential Knowledge and Skills (TEKS) standards and that form the foundation of the Measuring Up *EXPRESS*™ design. These standards, their research bases, and the educational application of the standards have been revised and updated through a collaborative effort among Empirical Education Inc., MarketingWorks, and Peoples Education.

See the Appendix for Measuring Up *EXPRESS*™ sample lessons illustrating each Research Principle applied.

Research Principle 1:
Challenging Standards

Educational programs must be based on challenging academic content standards in academic subjects, the teaching of advanced skills, and challenging student academic achievement standards.
(PL 107–110, the No Child Left Behind Act of 2001)

Research Basis for Principle 1

The most extensive and best-known research about the effects of expectations is addressed by Rhona S. Weinstein (2002) in her book, *Reaching Higher: The Power of Expectations in Schooling*, a landmark in support of the results that high standards and expectations can produce. Weinstein's book takes as its thesis that "If . . . we are interested in the development of all children, we must link higher standards to effective teaching strategies for diverse learners. Our assessments of achievement must inform the next steps of instruction, rather than simply hold children accountable for what they may not have been taught."

Research Principle 1 Applied

The implication of Weinstein's statement is that assessment must help teachers understand what students know and need to know. The Measuring Up *EXPRESS*™ materials can be used with students to help teachers know in advance where gaps in student understanding lie. Teachers can then begin to think about filling in those gaps for all learners. The TEKS demand high achievement for all learners, and the Measuring Up *EXPRESS*™ program can be seen first as an aid to student learning toward those goals and second as a step toward positive assessment results. The Measuring Up *EXPRESS*™ program provides materials that can be used with all students of all abilities; they allow all teachers of all students to see where their students need help in approaching the TEKS and even allow teachers to work differently with different students to make necessary progress. In other words, using the program allows teachers to enact the principle that high standards can result in higher achievement for all students by using the assessment materials to inform the next steps of instruction.

All tested Texas Essential Knowledge and Skills (TEKS) are addressed in Measuring Up *EXPRESS*™.

See the Appendix for a sample correlation chart from Measuring Up *EXPRESS*™, Mathematics, Level E, Table of Contents.

Research Principle 2:
Learning mathematics from multiple perspectives

"Students develop a much richer understanding of mathematics and its applications when they can view the same phenomena from multiple mathematical perspectives."
(NCTM, 2000)

Research Basis for Principle 2

NCTM explains: "Mathematical ideas can be represented in a variety of ways: pictures, concrete materials, tables, graphs, number and letter symbols, spreadsheet displays, and so on. The ways in which mathematical ideas are represented is fundamental to how people understand and use those ideas." The notion of multiple perspectives grows out of social constructivism (Gergen, 1995) and builds on the related concepts of metacognition. (Schoenfeld, 1992) Flexibility in choosing the appropriate representation is important for learning to solve unfamiliar problems.

Research Principle 2 Applied

The Measuring Up *EXPRESS*™ program allows students to use current mathematical understandings to solve what might at first seem to be unfamiliar problems. In addition, working closely with the program allows a teacher added insight into students' current understandings and potential misunderstandings. Having students "talk through" their understandings of problems-and the ways in which these problems are like or unlike problems they have encountered previously-can help mathematics learners use a strategy most mathematicians themselves use in approaching an unfamiliar problem: Students can be encouraged to represent problems in ways that make the most sense to them. Thus, students will be using real mathematical techniques for problem-solving, teachers will gain additional insight into how their students are thinking about problems, and students will have one more tool for approaching the mathematics section of the TAKS.

Measuring Up *EXPRESS*™ incorporates examples, test-taking strategies and test practice into every lesson, so students become increasingly aware of the connections being made among various mathematical topics. Practice items match the TAKS format to help students build test-taking confidence.

See the Appendix for a sample lesson from Measuring Up *EXPRESS*™, Mathematics, Level E, Lesson 32.

Research Principle 3: Inquiry in science

Teaching science should be consistent with the nature of scientific inquiry and should reflect scientific values.

Research Basis for Principle 3

National organizations such as the National Research Council (1995) and the American Association for the Advancement of Science (1994) have advocated for the importance of inquiry. When students engage in scientific inquiry, they find themselves in a process that "leads to asking questions, making discoveries, and rigorously testing those discoveries in the search for new understanding. Inquiry . . . should mirror as closely as possible the enterprise of doing real science." (National Science Foundation, 1998) The position is supported empirically by the meta-analysis conducted by Shymansky, Hedges, and Woodworth (1990) that found that science curricula based on inquiry principles were more effective than the traditional textbook programs across a number of different measures of student understanding of science.

Research Principle 3 Applied

As a supplemental worktext, Measuring Up *EXPRESS*™ for science provides opportunities for teachers to reinforce scientific concepts, vocabulary, and experiences. Students conduct real-world investigations at the end of each chapter. Clusters at the end of each chapter test multiple student expectations and multiple choice and gridded-response items mimic those found on the TAKS to build test-taking confidence.

See the Appendix for a sample lesson from Measuring Up *EXPRESS*™, Science, Level H, Lesson 22.

RESEARCH PRINCIPLE 4:
Test preparation

Teachers are responsible for teaching the skills, knowledge, and behaviors essential to answering test questions, as well as preparing their pupils for the formal assessments.

RESEARCH BASIS FOR PRINCIPLE 4

Gulek (2003) writes that adequate and appropriate test preparation plays an important role in helping students demonstrate their knowledge and skills in high-stakes testing situations. Becker (1990) conducted an extensive meta-analysis of the research and concluded that, on average, helping students understand how to approach test questions can help increase SAT scores. Sloane & Kelly (2003) write that "Students can be effective instruments in their own learning if the teacher is clear on the learning goals and the students are informed of their current performance and given clear steps for remediation. . . . The task for teachers is to know and understand their state's standards, and then translate this knowledge to continuously help students learn and self-assess to meet those standards."

RESEARCH PRINCIPLE 4 APPLIED

Working specifically through questions ("What, exactly, is the question asking?" "What kind of answer will you be looking for?" "Why did you choose the answer you chose?") can be a fruitful practice in reasoning.

The cognitive skills required for understanding and answering test questions are higher-order thinking skills; making these skills overt for students can improve their understanding of the many tasks in their lives that will involve reading and answering questions, well beyond the demands of the TAKS.

To this end, Measuring Up *EXPRESS*™ provides assessment activities embedded in each lesson of the student worktexts and Diagnostic Practice Tests (DPTs) to provide practice on applying curriculum standards in the format of the TAKS. Each question in the DPTs is linked to the TEKS, objectives of the TAKS, and Measuring Up *EXPRESS*™ lesson so that the educator can provide targeted direct instruction for those areas that are weak. This means that teachers use Measuring Up *EXPRESS*™ to help students familiarize themselves with the tested TEKS and experience test questions that resemble those that appear on the TAKS.

See the Appendix for a sample DPT from Science Measuring Up® Diagnostic Practice Test, Level H.

RESEARCH PRINCIPLE 5: Formative assessment

"A major purpose of evaluation is to help teachers better understand what students know and make meaningful decisions about teaching and learning activities." (Zemelman et al., 1998)

RESEARCH BASIS FOR PRINCIPLE 5

Assessment comes in two forms: formative and summative. Standardized tests like the TAKS are summative assessment, or testing that occurs at the end of a given amount of instruction. Formative assessment occurs throughout a unit of instruction; because it occurs more frequently, and because its purpose is to inform further instruction, students receive more immediate feedback on their learning. "Formative assessments . . . are essential. They permit the teacher to grasp the students' preconceptions, understand where the students are in the 'developmental corridor' from informal to formal thinking, and design instruction accordingly." (Bransford et al., 2000)

RESEARCH PRINCIPLE 5 APPLIED

Together, teacher observation and Measuring Up *EXPRESS*™ Diagnostic Practice Tests (DPTs) enable teachers to define and implement a Personal Prescriptive Path™ of instruction for all students, no matter how diverse. The Measuring Up *EXPRESS*™ also provides teachers with the opportunity to document how they are teaching to standards and evidence of their students' learning of those standards.

In addition, students' approaches to and solutions of questions provide teachers with extra information about what their students know and how they think. Formative Assessments (FAs) included with the Teacher Edition as blackline masters allow teacher to monitor students' progress and redirect instruction in Measuring Up *EXPRESS*™.

See the Appendix for a sample FA from Mathematics Measuring Up *EXPRESS*™ Level E.

RESEARCH PRINCIPLE 6:

Strengths of computerized technology, particularly in preparing for standardized testing

RESEARCH BASIS FOR PRINCIPLE 6

According to Coley, Cradler, & Engel (1997) "studies show that computer based instruction can individualize instruction and give instant feedback to students, even explaining the correct answer. The computer is infinitely patient and nonjudgmental, thus motivating students to continue." Meta-analyses of computer-based instruction by Kulik (1994) provide support for the effectiveness of technology across many applications. Given the research basis for the effectiveness of test preparation, the fact that technology can give as much feedback as the student needs, on the student's time and at the student's pace, it stands to reason that computer-based instruction based on the TEKS that prepares students for the format and content of the TAKS would provide many students—including those who need more time and may learn more slowly—with special learning opportunities.

RESEARCH PRINCIPLE 6 APPLIED:

Measuring Up e-Path®, a learning system that provides the content of Measuring Up® online with instant feedback, is available to students in the state of Texas. Based on the TEKS, the system allows all learners individualized instruction at their own pace, including explanations for answers to practice questions and practice tests. The questions are provided in the format of the TAKS, thus allowing students opportunities to become familiar with both standards-based content and test format. For many learners, especially those who learn better with more individualized opportunities to self-pace and practice, the online format is both more reinforcing and more motivating than a paper and pencil version would be. Measuring Up e-Path® is a way of increasing the opportunities for standards-based learning and practice for more learners in Texas.

Sources Cited in this Revision

Adams, M. J. (1990). *Beginning to Read: Thinking and Learning About Print*. Cambridge, MA: Massachusetts Institute of Technology Press.

American Association for the Advancement of Science (1994). *Benchmarks for Science Literacy*. Oxford: Oxford University Press.

Becker, B. J. (1990) Coaching for the Scholastic Aptitude Test: Further Synthesis and Appraisal. *Review of Educational Research*, 60 (3) 373–417.

Brown, A. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. In *Metacognition, motivation, and understanding*, F. Weinert & R. Kluwe, (eds) (pp. 65–116). Hillsdale, NJ: Lawrence Erlbaum Associates.

Brown, A. L. & Palinscar, A. S. (1989) Guided cooperative learning and individual knowledge acquisition. In *Knowing Learning and Instruction*, L. Resnick (ed) Hillsdale, NJ: Lawrence Earlbaum Associates.

Brown, R., Pressley, M., Van Meter, P., & Schuder, T. (1996). A quasi-experimental validation of transactional strategies instruction with low-achieving second-grade readers. *Journal of Educational Psychology*, 88(1), 18–37.

Bransford, J. D., Brown, A. L., & Cocking, R. R., eds. (2000). *How People Learn*. Washington, DC: National Academy Press.

Bruer, J. T. (1993). *Schools for Thought: A Science of Learning in the Classroom*. Cambridge, MA: MIT Press.

Bruner, J. (1996). *The Culture of Education*. Cambridge, MA: Harvard University Press.

Cognition and Technology Group at Vanderbilt (1997). *The Jasper Project: Lessons in Curriculum, Instruction, Assessment, and Professional Development*. Mahwah, NJ: Lawrence Erlbaum Associates.

Coley, R. J., Cradler, J & Engel, P. K. (1997). Computers and Classrooms: *The Status of Technology in U.S. Schools* (Policy Information Report). Princeton, NJ: Educational Testing Service.

Gergen, K. J. (1995). Social Construction and Educational process. In *Constructivism and Education*, J. Gale (ed) Hillsdale, NJ: Lawrence Erlbaum Associates.

Gulek, C. (2003). Preparing for high-stakes testing. *Theory into Practice*, 42(1), pp. 42–50.

Hayes, J. R., & Flower, L. (1980). Identifying the organization of the writing process. In *Cognitive processes in writing*, L. W. Gregg & E. R. Steinberg (eds). Hillsdale, NJ: Lawrence Erlbaum Associates.

Kulik, J. (1994). Meta-analytic studies of findings on computer-based instruction. In *Technology Assessment in Education and Training*, Baker, E. L. and O'Neil, H. F., Jr. (eds) (pp. 9–33). Hillsdale, NJ: Lawrence Erlbaum Associates.

Langer, J. A., "Beating the odds: Teaching middle and high school students to read and write well," *American Educational Research Journal*, Winter 2001, 38(4), pp. 837–880.

National Council of Teachers of Mathematics (2000) *Principles and Standards for School Mathematics*. Reston, VA: NCTM.

National Research Council (1995). *National Science Education Standards*, Washington, DC: National Academy Press.

National Science Foundation (1998). *Inquiry Thoughts, Views, and Strategies for the K–5 Classroom*, Arlington VA.

Neuman, S. B., & McCormick, S., eds. (1985). *Single-Subject Experimental Research: Applications for Literacy*. Newark, DE: International Reading Association.

Palinscar, A. S. & Brown, A. L. (1984). Reciprocal teaching of comprehension monitoring activities. *Cognition and Instruction*, 1: 117–175.

Piaget, J. & Inhelder, B. (1969). *The psychology of the child*. New York: Basic Books.

Rosenshine, B., Meister, C., & Chapman, S. (1996). Teaching students to generate questions: A review of the intervention studies. *Review of Educational Research*, 66 (2), 181–221.

Scardamalia, M., Bereiter, C., McLean, R. S., Swallow, J., & Woodruff, E. (1989). Computer-supported intentional learning environments. *Journal of Educational Computing Research,* 5 (1) 51–68.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem-solving, metacognition, and sense making in mathematics. In Handbook of Research on Mathematics Teaching and Learning, D. A. Grouws (ed) pp. 334–370. New York: Macmillan Library Reference Simon & Schuster Macmillan.

Shymansky, J. A., Hedges, L. V. & Woodworth, G. (1990). A reassessment of the effects of inquiry-based science curricula of the 60's on student performance. *Journal of Research in Science Teaching*, 27 (2) 127–144.

Sitko, B. M. (1998). Knowing how to write: Metacognition and writing instruction. In *Metacognition in Educational Theory and Practice*, D. J. Hacker, J. Dunlosky, & A. C. Graesser (eds), (pp. 93–113). Mahwah, NJ: Lawrence Erlbaum Associates.

Slavin R. (1984) Students motivating students to excel: Cooperative incentives, cooperative tasks, and student achievement. *The Elementary School Journal*, 85 (1) 53–63.

Sloane, F. C., & Kelly, A. E. (2003). Issues in high-stakes testing programs. *Theory into Practice*, 42(1), pp. 12–17.

Steen, L. A. (1990). *On the Shoulders of Giants: New Approaches to Numeracy*. Washington, DC: National Academy Press.

Sulzby, E. (1992). Research directions: Transitions from Emergent to conventional writing. *Language Arts*, 69, 290–297.

Tharp, R. G. (1989). Psychocultural variables and constants: Effects on teaching and learning in schools. *American Psychologist*, 44(2) 349–359.

Weinstein, R. S. (2002). *Reaching Higher: The Power of Expectations in Schooling*. Cambridge, MA: Harvard University Press.

Whitehead, A. N. (1929). *The Aims of Education*. New York: MacMillan.

Zemelman, S., Daniels, H. & Hyde, A. (1998). *Best Practices: New Standards for Teaching and Learning in America's Schools*. Portsmouth, NH: Heinemann.

REFERENCES FOR Measuring Up® *TO THE TEXAS ESSENTIAL KNOWLEDGE AND SKILLS*

Below is the state-based research bibliography, which is the foundation for **Measuring Up**®.

Best Practices/Leadership/Standards/Assessment

Airasian, P. W. *Classroom Assessment*. New York: McGraw-Hill, 1991.

Blume, G. W., & Robert F. Nicely, Jr. *A Guide for Reviewing School Mathematics Programs.* Reston, VA: National Council of Teachers of Mathematics. Alexandria, VA: Association for Supervision and Curriculum Development, 1991.

Carpenter, T. P. & Fennema, E. “Cognitively Guided Instruction: Building on the Knowledge of Students and Teachers.” In “Reform of School Mathematics in the United States,” special issue edited by Walter G. Secada. *International Journal of Educational Research,* 17 (1992): 457–70.

Clarke, D. J. *Assessment Alternatives in Mathematics.* Carlton, Victoria [Australia]: Curriculum Corporation, 1989.

Darling-Hammond, L. “Performance-Based Assessment and Educational Equity.” *Harvard Educational Review*, 64 (1994): 5–30.

Eisner, E. W. “Standards for American Schools: Help or Hindrance?” *Phi Delta Kappan*, 76: 10, 758–764: 1995.

Gerberich, J. R., Green, H. A., & Jorgensen, A. N. *Measurement and Evaluation in the Modern School*. New York: David McKay, 1962.

Hart, D. *Authentic Assessment: A Handbook for Educators.* Menlo Park, CA: Addison-Wesley, 1994.

Lajoie, S. P. “Technologies for Extending Statistical Learning.” In *Handbook on Assessment in Statistics Education*, edited by Iddo Gal and Joan Garfield. Unpublished manuscript, n.d.

Lavigne, Nancy C. “Authentic Assessment: A Library of Exemplars for Enhancing Statistics Performance.” Master’s thesis, McGill University, 1994.

Lesh, R. A. & Lamon, S. J. “Trends, Goals, and Priorities in Mathematics Assessment.” In *Assessment of Authentic Performance in School Mathematics,* edited by Richard A. Lesh and Susan J. Lamon, pp. 3–16. Washington, DC: American Association for the Advancement of Science, 1992.

Lesh, R. A. & Lamon, S. J. "Assessing Authentic Mathematical Performance." In *Assessment of Authentic Performance in School Mathematics*, edited by Richard A. Lesh and Susan J. Lamon, pp.17–62. Washington, DC: American Association for the Advancement of Science, 1992.

Marolda, M. R. & Davidson, P. S. "Assessing Mathematical Abilities and Learning Approaches." In *Windows of Opportunity: Mathematics for Students with Special Needs*, edited by Carol A. Thornton and Nancy S. Bley, pp. 83–113. Reston, VA: National Council of Teachers of Mathematics, 1994.

Pandey, Tej. *A Sampler of Mathematics Assessment. California Assessment Program*. Sacramento, CA: California Department of Education, 1991.

PL 107-110, the No Child Left Behind Act of 2001.

Stephens, M. & McCrae, B. "Assessing Problem Solving in a School System: Principles to Practice." *Australian Senior Mathematics Journal* [Australian Association of Mathematics Teachers, Adelaide, South Australia], in press.

Zemelman, S., Daniels, H., & Hyde, A. *Best Practices; New Standards for Teaching and Learning in America's Schools*. Plymouth, NH: Heinemann, 1998.

Mathematics

Lajoie, S. P., Lavigne N. C., Muncie, S., & Wilkie, T. V. "Monitoring Student Progress in Statistical Comprehension and Skill." In *Reflections on Statistics: Agendas for Learning, Teaching, and Assessment in K–12*, edited by Susanne Lajoie. Hillsdale, N.J.: Lawrence Erlbaum, in press.

NCTM's Principles and Standards for School Mathematics, National Council of Teachers of Mathematics, 2000.

Marolda, M. R. & Davidson, P. S. "Assessing Mathematical Abilities and Learning Approaches." In *Windows of Opportunity: Mathematics for Students with Special Needs*, edited by Carol A. Thornton and Nancy S. Bley, pp. 83–113. Reston, VA: National Council of Teachers of Mathematics, 1994.

Mathematical Sciences Education Board, National Research Council. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, DC: National Academy Press, 1989.

Mathematical Sciences Education Board. *Measuring What Counts: A Conceptual Guide for Mathematics Assessment*. Washington, DC: National Academy Press, 1993.

Meisels, S. J., Dichtelmiller, M., Dorfman, A., Jablon, J. R., & Marsden, D. B. *The Work Sampling System Resource Guide*. Ann Arbor, MI: Rebus Planning Associates, 1993.

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics, 1989.

National Council of Teachers of Mathematics. NCTM's Principles and Standards for School Mathematics, National Council of Teachers of Mathematics, 2000.

National Council of Teachers of Mathematics. *Professional Standards for Teaching Mathematics*. Reston, VA: National Council of Teachers of Mathematics, 1991.

Victorian Board of Studies. *Specialist Mathematics Units 3 and 4*, Common Assessment Task 1. Carlton, Victoria [Australia]: Victorian Board of Studies, 1994.

Victorian Board of Studies. *VCE Study Design: Mathematics*. Carlton, Victoria [Australia], 1994.

Wiggins, G. P. *Assessing Student Performance: Exploring the Purpose and Limits of Testing*. San Francisco: Jossey-Bass, 1993.

Science

National Council on Science and Technology Education. Science for All Americans. Washington, DC: American Association for the Advancement of Science, 1989.

Appendix

RESEARCH PRINCIPLE 1: Measuring Up *EXPRESS*™, Mathematics, Level E, Table of Contents, page ii

RESEARCH PRINCIPLE 2: Measuring Up *EXPRESS*™, Mathematics, Level E, Lesson 32

Focus on TEKS

Chapter 2
Lesson 32 Finding Patterns

TEKS 5.5A Describe the relationship between sets of data in graphic organizers such as lists, tables, charts, and diagrams.
TEKS 5.16A Make generalizations from patterns or sets of examples and nonexamples.

Finding a pattern and describing it can help you solve problems.

A **sequence** is an ordered set of numbers, letters, or figures arranged according to a rule. Each item is called a **term**. A **pattern** is the way in which the terms of a sequence are arranged.

Damien's teacher wrote the sequence 3, 6, 9, . . . on the board. What is the value of the fourth term in the sequence? What rule describes how to find the value of any term in the sequence?

Identify the pattern so you can write the rule.

Step 1 Make a table.

Term in the Sequence	1	2	3	4	n
Value of the Term	3	6	9	____	?

Step 2 Starting with the first term in the sequence, note how the value of each term relates to its position. The variable n represents the position of any term in the sequence.

First term: $1 \times 3 = 3$
Second term: $2 \times 3 = 6$
Third term: $3 \times 3 = 9$
Fourth term: $4 \times 3 = 12$

Step 3 Describe the pattern in words.
The pattern is: Multiply the position of the term by 3.

Step 4 Write a rule for the pattern, using the variable n.
The rule is $n \times 3$.

The value of the fourth term in the sequence is 12.
The rule that describes how to find any term in the sequence is $n \times 3$.

TAKS Tip
Patterns
To help find the rule for an input-output table, look for a pattern in the outputs.

Another Example

Write a rule for any output in the table, using the variable n. Find the value of the sixth term.

Input	1	2	3	4	5	n
Output	5	9	13	17	21	?

The rule is $4n + 1$. The sixth term is $4(6) + 1 = 25$.

RESEARCH PRINCIPLE 3: Measuring Up *EXPRESS*™, Science Level H, Lesson 22

Focus on TEKS

Lesson 22 Periodic Table of Elements

TEKS 8.8B Identify the properties of an atom including mass and electrical charge.
TEKS 8.9B Interpret information on the periodic table to understand that [physical] properties are used to group elements.

Identify regions of the periodic table, including metals, nonmetals, and inert gases.

The **atomic number** is the number of protons in the nucleus of an atom.

The **mass number** is the number of protons and neutrons in the nucleus of an atom.

The **periodic table** is an arrangement of elements in a table according to their atomic numbers and physical properties. You can find a periodic table in the back of the book.

A **group** is a set of elements in one column in the periodic table. Elements in the same group have similar properties.

A **chemical symbol** is an abbreviation of the name of an element.

An **ion** is an atom that has gained or lost electrons which gives it a charge. If an atom loses an electron (which has a negative charge), the ion will have a positive charge, and vice versa.

An **isotope** of an element contains the same number of protons but a different number of neutrons.

The **average atomic mass** of an element is the average mass of the mixture of the atom and its isotopes.

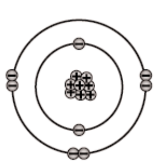
Valence electrons are the outermost electrons in an atom. Elements with the same valence number tend to react in similar ways.

Metal is a category of elements characterized by a shiny surface, the ability to be easily shaped, and high conductivity of electricity and heat. The **alkali metals** (group 1, except for hydrogen) are metals with only one valence electron. These metals are highly reactive and are found in nature only in compounds. The **alkaline earth metals** (group 2) are metals with two valence electrons. These metals are slightly less reactive than the alkali and they are harder. The **transition metals** (groups 3 through 12) are elements that have valance electrons at two different energy levels. These are much less reactive than the alkali and the alkaline metals. **Nonmetal** is a category of elements characterized by a brittle nature, little or no luster, and poor conductivity of electricity and heat. Highly reactive nonmetals are in group 17, called the *halogens*. They have seven valence numbers and easily react with elements with one valence number (group 1). **Semimetal,** also called metalloid, is a category of elements that share some properties of metals, and some of nonmetals. These elements lie on either side of the bold zigzag line in the periodic table. The elements to the left of the zigzag line are metals and those on the right are nonmetals.

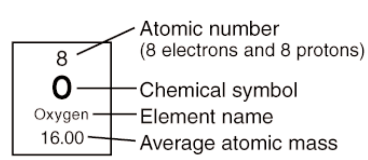
Inert gas, also called **noble gas** (group 18), is a category of elements that contain helium, neon, argon, krypton, xenon, and radon. All have eight valance electrons, except for helium, which has two. These elements tend not to react easily at all.

TAKS Tip

Chemistry Elements with similar properties are in the same column in the periodic table.



Oxygen Atom
2 e⁻ first energy level
6 e⁻ second energy level



RESEARCH PRINCIPLE 4: Science Measuring Up®, Diagnostic Practice Test, Level H, Lesson 22

Measuring Up® ™

Science

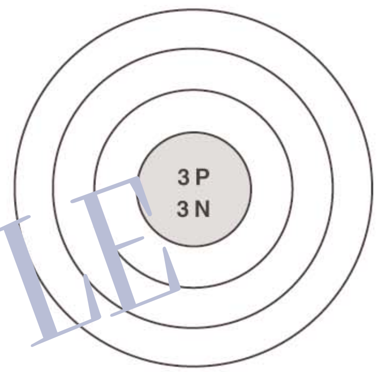
DIRECTIONS
Read each question and choose the best answer. Then circle the letter for the answer you have chosen.

1 Of the following, the activity that is most safe to do in a laboratory is to —

A follow lab rules
B chew gum in the lab
C clean up spilled chemicals with paper towels
D talk with your lab partner while instructions are given

2 When a mosquito bites and feeds on the blood of a human or other animal, the mosquito is acting as a —

F scavenger
G producer
H decomposer
J parasite



Lithium atom

3 The illustration above shows the protons and neutrons of a lithium atom. How many electrons orbit the nucleus?

A 1
B 2
C 3
D 6

GO ON

RESEARCH PRINCIPLE 4: Measuring Up *EXPRESS*™, Mathematics, Formative Assessment, Level E

Name ______________________________ Date __________

Measuring Up Express™
Formative Assessment 2—Lessons 7–11

Read each question and choose the best answer. Then circle the letter of the answer you have chosen.

1. The table to the right shows the elementary schools in Newdale and the number of students in each school. How many elementary school students are there in Newdale?

A. 3,168

B. 3,288

C. 3,398

D. 3,408

Newdale Schools

School	Number of Students
Washington	737
Lincoln	658
Jefferson	691
Van Buren	724
Jackson	588

2. The table to the right shows several of the deepest parts of the Pacific Ocean. How much deeper is the Tonga Trench than the Aleutian Trench?

F. 124 m

G. 3,121 m

H. 3,231 m

J. 3,255 m

Pacific Ocean Depths

Area	Depth in Meters
Aleutian Trench	7,679
Izu Trench	9,695
Mariana Trench	10,924
Peru-Chile Trench	8,064
Tonga Trench	10,800

GO ON

