NORTHERN VALLEY SCHOOLS CONSORTIUM
OFFICE OF CURRICULUM AND INSTRUCTION

SCIENCE CURRICULUM GUIDE

6 – 8

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NORTHERN VALLEY SCHOOLS CONSORTIUM

Office of Curriculum and Instruction

Member Districts

Closter
Demarest
Harrington Park
Haworth
Northvale
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Bergen County, NJ

Northern Valley Schools
Science Curriculum Guide

6 - 8

Office Of Curriculum And Instruction
Northern Valley Schools
Curriculum Center
Demarest, New Jersey 07627

Ms. Kathleen O'Flynn, Director

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Grades 6-12 Science Curriculum Committee

2015-2016

Amy Kenny
Tenakill School, Closter

Ellen Monaghan
Tenakill School, Closter

Joanne Werner
D. M. S., Demarest

Claire Draijer
Harrington Park

Robert Leichte
Harrington Park

Nicole Carnicelli
Haworth

Kristen Doramajian
Northvale School, Northvale

Seth Links
Norwood School, Norwood

Kathy Snyder
Norwood School, Norwood

Krissy Mueller
C. D. W., Old Tappan

Steve Ryan
Northern Valley Demarest
Northern Valley Regional

Kelly Tisosky
Northern Valley Demarest
Northern Valley Regional

Marlene Almonte
Northern Valley Demarest
Northern Valley Regional

Dr. Mary Ann Lovelace
Northern Valley Old Tappan
Northern Valley Regional

Regina Smilon
Northern Valley Old Tappan
Northern Valley Regional

John Hughes
Northern Valley Old Tappan
Northern Valley Regional

Jennifer Cusmano
Supervisor of Science
Northern Valley Regional

Dr. Robert J. Price
Director of Curriculum and Instruction, Northern Valley Schools Consortium

Preface and Acknowledgments

Continuing a long tradition, the Northern Valley Schools have collaboratively worked to revise curriculum based on NJDOE approved standards. Teams of teachers and other school leaders have come together to look at the needed changes and supporting resources. This process has been the connection that brings educators from throughout the Valley to a common understanding of what students need to learn.

In each writing cycle it has been recognized that the process of curriculum writing must be collaborative and continuous. Change is constantly affecting the areas of professional learning for teachers, technology use and resources in education, and shifts in mandates from state and federal departments of education. The districts of the Northern Valley Schools are to be commended for their commitment to high quality instruction and their determination to devote resources to teacher learning and collaboration.

The NVCC looks forward to continuing the comprehensive collaborative review and revision of curriculum to meet the needs of all students. The office is confident that the work of educators and the documents produced, contribute to the goal of improving student achievement throughout the Northern Valley Schools.

Acknowledgments

A special expression of gratitude is extended to our administrative assistants and secretaries in the office of Curriculum and Instruction for their efforts in the preparation of this guide for publication.The numerous hours working on the collation of information and their attention to detail and technology skills are most evident in the final product.

Kathleen O'Flynn
Director of Curriculum and Instruction

Northern Valley Curriculum Guide

Accommodations and Modifications for Students

New Teacher Academy and Professional Learning Opportunities:

All teachers new to the Northern Valley participate in the New Teacher Academy. This comprehensive sequence of workshops is designed to support Northern Valley educators with the resources to meet the needs of all learners including English language learners, students receiving special education services, students at risk of failing and students identified for gifted and talented services. In year one of employment educators attend "Getting off to a Great Start and Instructional Skills Seminar," which is a five-day learning experience with the intent of meeting the instructional needs of all learners. First year teachers also attend "Classroom Leadership" which is a one-day professional development offering designed to teach classroom management skills.

During year two of employment Northern Valley educators attend "Assessment: Strategies for Design" with the goal of honing assessment practices for effective differentiation of learning. This group also attends "Student Collaboration: Supporting Success with NJ Student Learning Standards." Educators in their second year also select a workshop from our instructional strategies, curriculum connections, social and emotional, or technology strands that best suits their pedagogical needs.

During year three of employment Northern Valley educators attend "Meeting Students Where They Are & Strategies for Growth" which is a full day learning experience that examines instructional strategies to ensure all learners can access skills designated in the New Jersey Student Learning Standards. Third year teachers also engage in one full day elective from the instructional strategies, curriculum connections, social and emotional, or technology strands and engage in an action research activity tailored to the needs of student learning and engagement.

Northern Valley also provides an award winning professional learning program. We offer over 80 full day workshops that take place during the school year. Our workshops allow for varied experiences in the areas of Instructional Strategies, Content Specific, Technology and Social-Emotional Wellbeing. All teachers in Northern Valley are offered a minimum of two full day learning experiences that align with their own professional goals.

Benchmark Assessments:

Teachers of the Northern Valley create grade level and department level assessments - several are utilized for Student Growth Objective target assessments. These assessments are rigorous and include multiple measures from Webb's Depth of Knowledge chart. Assessments may include portfolios, rubrics, journal assignments, literacy evaluations (i.e. Fountas & Pinnell, Independent Reading Level Assessment), projects, unit tests, or end of course exams. The Northern Valley is also committed to Criterion Reference Tests across schools and in multiple grades.

Special Education:

Throughout the Northern Valley Region special needs students receive a high quality specialized education to meet their individual social, emotional and educational needs. Within each individual school district there are programs designed to meet the needs of students in the "least restrictive environment". These programs, from least restrictive to most restrictive, include; In-Class-Support, whereby a special education teacher or instructional aide is assigned to assist special education students in the general education classroom and Resource Room replacement, whereby students are pulled from their general education class for Math or Language Arts to a separate room for small group instruction with a special education teacher. The students who require this level of support, in some cases, receive modified curriculum and differentiated instruction, study guides, extended time on assessments, assistive technology in the form of an iPad or computer programs such as co-writer/word predictor to assist with written assignments. All modifications are stated specifically in a student's Individual Education Plan or IEP to ensure that each student consistently receives the appropriate level of support.

In addition to the programs within the mainstream and/or resource room setting, throughout Northern Valley, districts utilize Region III Regional Programs and Services to meet the needs of special education students with a variety of disabilities. Self-Contained Programs include; Little Tots/Slice, for Pre-School age students, Valley, for primary and upper students on the autistic spectrum, TIP, for students who require social emotional and academic support, ACCESS Program– NVD, Bridge– NVD, and STEP – NVOT. Each school district in Northern Valley is encouraged to support the Regional Program model to ensure that all students receive a high quality, consistent level of education and services. Additional services include occupational therapy, physical therapy, speech therapy, behavior consultation, social skills, and counseling (individual and/or group). These "related services" are provided by Region III specialists certified in their respective fields.

For those students who are more significantly impaired, and a program cannot be provided by their school district or Regional Programs, there are specialized Out- of-District Programs, or "Private Schools". For these few students programs are researched and suggested by the Child Study Team, CST, in conjunction with the parent(s), to ensure that individual student needs are being met. In

most cases these students receive transportation to and from school, specialized equipment, if necessary and all related services as per their IEP at no cost to the parent(s).

English Language Learners

All English Language learners receive instruction in accordance to the state adopted WIDA standards which are as follows:

- English Language Development Standard 1: English language learners communicate for Social and Instructional purposes within the school setting
- English Language Development Standard 2: English language learners communicate information, ideas and concepts necessary for academic success in the content area of Language Arts
- English Language Development Standard 3: English language learners communicate information, ideas and concepts necessary for academic success in the content area of Mathematics
- English Language Development Standard 4: English language learners communicate information, ideas and concepts necessary for academic success in the content area of Science
- English Language Development Standard 5: English language learners communicate information, ideas and concepts necessary for academic success in the content area of Social Studies

https://wida.wisc.edu/resources

Growth for these standards are measured annually using the state mandated ACCESS for ELLs assessment.

In general, ELL and ESL students have the following accommodations:

- Use of a paper bilingual dictionary during class and during assessments
- Extended time for all assessments
- Word banks for tests and quizzes,
- Access to teacher-created PowerPoints and notes
- Simplification of requirements (for example, accepting a 2-page paper rather than 5, or Accepting a PowerPoint vs. paper)

In High School, ELL students take their midterms and final exams in the ESL room, where they can get extra time, access to dictionaries and clarification of directions and questions. Alternate assessment locations are also made available as appropriate at the elementary and middle school levels. Finally, the ESL teacher will work out accommodations, in collaboration with the classroom teacher, on a case-by-case basis, depending on the level of the student. For example, for students in need of greater supports, teachers may allow those students to use their notes during an assessment, or to take their tests with the ESL teacher in the ESL

room so instructions and the expectation for particular questions can be explained. In the case of students with more intensive literacy support, the ESL teacher may actually read the questions and answer choices out loud to students.

The accommodations for NJSLA are much more complex and are spelled out in detail in the NJSLA manual: https://nj.mypearsonsupport.com/resources/manuals/NJSLASpring2019AFA.pdf

Gifted and Talented:

The Northern Valley differentiates learning for our high achieving students by providing a specialized setting in each district for students identified as eligible for Gifted and Talented Programming services through the Northern Valley Screening/Identification Process.

In addition to in-district specialized programming, each district also provides out-of-district specialized settings through Outreach or multi-district convocation experiences. For example, all 7th, 8th and 9th grade Northern Valley Gifted and Talented students have the opportunity to participate in the Valley Interdisciplinary Approach Program: Explorations in Team Problem Solving. Other examples may include “Invengineering Expo”, Bergen Brain Busters, Evolution Earth/World Game, Blokus Event, Dare to Fly, etc.

Each district supports their own schedule of Outreach Programming, which may include districts within the Northern Valley, County, or State. Northern Valley administrators and the Northern Valley Curriculum Center provide opportunities for Gifted and Talented staff to work together to develop and implement these curricula.

During the development process, appropriate standards are referenced from the New Jersey Student Learning Standards and the National Association for Gifted Children Gifted Program Standards Pre-K - Grade 12.

Gifted opportunities are also a part of the AP and Honors programs, as well as coursework that comes with awarding of college credits and CapStone Projects. Independent study projects are created for the gifted in need of specialized academic opportunities. Specialized co- curricular activities such as Math League, Science Team and Debate Club also allow for extensions of the gifted program.

Students in Danger of Failing

The purpose of the Intervention and Referral Team (I&RS) is to provide in-house professional assistance to an administrator or teacher for a pupil who demonstrates social, emotional or educational problems. The Principal is the chair and primary faculty contact for the I&RS team.

The I&RS committee provides assistance in understanding the pupil's problem(s) in developing strategies, which will, hopefully, help the pupil overcome the problem. The I&RS committee consists of a standing membership panel including the Principal, Assistant Principal, classroom teacher(s), Guidance Counselor, School Nurse, Child Study Team member(s) or any other professional assigned to the building who may have pertinent information regarding a specific student. Parent(s) and/or the student may be asked to participate where it is determined advisable.

When a child encounters a problem, the teacher, after in-class interventions and ongoing parental contact/conferences, may submit a student referral form to the I&RS Committee. The I&RS Committee will convene to review the form and determine if follow-up is warranted. Some or all of the following factors will be considered:

1. Mental Capacity
    a) Ability
    b) Expectancy
2. Academic
    a) Strengths and weaknesses b) Test results
    c) Functional levels d) Class work and participation
    e) Homework f) Learning style
    g) Rate and degree of learning h) Abstract thinking
    i) Recall ability
3. Emotional
    a) Personality b) Needs
    c) Motivation d) Overt behavior

e) Cognition as influenced by affective factors

4. Social

a) Interpersonal relationships b) Participation

c) General behavior in school, home and community

5. Physical

a) Visual and auditory acuity b) General medical history

6. Work and Study

a) Classroom behavior b) Task orientation/ completion

c) Independent functioning d) Attending behavior

e) Class participation f) Quality of work

g) Following directions h) Organizing work

Intervention and Referral Service Procedure

1. The teacher identifies a student with academic or behavioral difficulties. The teacher communicates concerns to the parents. After informal interventions in the classroom do not appear to be successful, the teacher refers the child to the I&RS Committee.

2. The Principal schedules the first I&RS Committee meeting and notifies attendees: Committee members, parents/guardians, teacher(s), and designated staff.

3. The Principal gathers information from teachers/staff who have information relevant to the identified problem, including the prior year's teacher where relevant.

4. The teacher collects work samples and anecdotal notes to bring to the meeting to illustrate the problem. (Textbooks may also be brought). The teacher will be asked to discuss all interventions/accommodations attempted to date and their results/outcomes.

5. The Principal chairs the scheduled meeting and outlines its purpose: to develop strategies, interventions, and/or accommodations to assist the student in the classroom and/or at home. A time frame to monitor and evaluate student progress with the interventions, strategies, and accommodation is designated. Staff responsible for implementing the intervention, strategies, and accommodations is determined and documented.

6. The Principal will notify the parents/guardians of the meeting outcomes. The teacher and responsible staff will notify/update the Principal within the designated time period about the progress of the interventions. Updates will be shared with Committee members at a follow-up meeting. Parents/guardians may be invited to attend.

I&RS meetings follow a specific format: First, the student's background is reviewed and a main problem is identified. Discussion and analysis of the problem follows its identification. Subsequently, the members of the I&RS Committee list strategies to remedy or alleviate the problem(s). If the parents do not attend the meeting, the intervention plan is subsequently discussed with them.

Problem Solving Model

1) Problem Identification
    a) Teacher tentatively identifies the problem
    b) Observation by CST member or Guidance Counselor where appropriate
2) Data is collected
    a) Samples of work depicting problem areas
    b) Discussion
    c) Problem is clarified
3) Intervention
    a) Brainstorming of interventions
    b) Development of an intervention plan
    c) Implementation of the plan
4) Teacher evaluation of plan
    a) Decision regarding further meetings/intervention

After the plan has been in effect for a reasonable amount of time, the I&RS Committee may recommend continuation of the recommended strategies or consider additional/alternative strategies. The student may be referred to the Child Study Team after all building resources have been exhausted and the student continues to demonstrate significant social, emotional, and/or educational difficulties.

If the intended action is a referral to the Child Study Team, Parents are notified and are provided with Notice of Referral, Parental Rights in Special Education and a copy of the strategies already attempted. All information gathered by the I&RS is included in the referral packet.

All questions regarding the I&RS process may be directed to the Principal and/or Committee Chairperson.

Assessments to Support and Monitor the Northern Valley Curriculum

To support the implementation of the curriculum and the monitoring of student learning across each grade level, districts will develop and collect appropriate assessments aligned to state standards.

Locally created formative and summative benchmark assessments are used at all grade levels.

To support this curriculum guide, assessments may include the use of the following but are not limited to this list:

- District level classroom assessments aligned to specific standards.
- Reading Benchmark assessment tools (ie: Fountas & Pinnell, TCRWP reading level assessments, Reading A-Z, Scholastic Independent Reading Assessment)
- Criterion Referenced Tests available to district schools through the Northern Valley Curriculum Center.
- Formative assessments from the NJ DOE support materials (i.e. Model Curriculum)
- Performance assessments from the Teachers College Reading and Writing Project
- (Northwest Evaluation Association) and the related MAP assessments
- Renaissance Learning and Assessment

Districts are encouraged to collect assessment items that support standards and utilize these educator assessment resources.

NVCC: Next Generation Science Statement

New Jersey has approved the Next Generation Science Standards as the framework for science teaching and learning for all schools in the state. Resources related to the newest Science standards exist in abundance. It is recommended that all educators explore several resources to gain a deeper understanding of the NGSS. Inherent in this shift is the need for a change in pedagogy. The expectations for science learning have been redefined by the new standards.

The **National Science Teachers Association** has explained this with the following.

The *Next Generation Science Standards* aim to eliminate the practice of "teaching to the test." Instead, they shift the focus from merely memorizing scientific facts to actually doing science—so students spend more time posing questions and discovering the answers for themselves.

Often, students can answer specific questions about concepts they covered in class, but can't translate that knowledge in applied situations. The standards avoid this disconnect by combining knowledge with practice, teaching students to develop ideas and evaluate them according to scientific principles.

An additional goal is the integration of science into the entire school curriculum. This necessitates the broadening the scope of science learning across several dimensions.

The "Three Dimensions of the Next Generation Science Standards (NGSS)" include, scientific and engineering practices, disciplinary core ideas, and crosscutting concepts. For more detailed information download the pdf.

http://nstahosted.org/pdfs/ngss/ThreeDimensionsOfNGSS.pdf

Finally, the NVCC recommends that all teachers of science visit the National Science Teachers Association's, NGSS@NSTA website, for resources and learning about the new standards. This site contains videos of classroom instruction, articles related to standards use, and implementation and professional learning resources.

http://ngss.nsta.org/

Northern Valley Schools Consortium
Science
Curriculum Guide
Grades 6-8

Grade 6 Science

Unit 1: Forces and Motion	20 Days
Unit 2: Earth and the Solar System	20 Days
Unit 3: Earth Systems 1	30 Days
Unit 4: Earth Systems 2	30 Days
Unit 5: The History of Planet Earth	20 Days
Unit 6: Ecosystem Dynamics	20 Days

*****Each unit should be implemented at the discretion of an individual district*
Please refer to Accommodations and Modifications for students as needed

*Each unit assessment is designed at the discretion of the district.
Please refer to local districts for specific assessment guidelines and examples.
Additional info can be found in the preface of this guide.*

Materials used for units are determined and budgeted for by individual districts.

Grade 6: Curriculum Connections

Interdisciplinary Connections (see further interdisciplinary connections within each unit)	**ELA:** (RI.6.1 - RI.6.10 SL.6.1 - SL.6.6)	**Math:** Geometric Figures, Angle Measure, Area, Surface Area, Volume (6.G.1, 6.G.2, 6.G.3, 6.G.4)	**Social Studies:** US History, scientific discoveries (6.2.8.C.1.b, 6.2.8.D.1.c, 6.2.8.C.3.c)
Integration of 21st Century Standards NJSLS 9:	**9.1.8.A.2:** Relate how career choices, education choices, skills, entrepreneurship, and economic conditions affect income. **9.1.8.A.3:** Differentiate among ways that workers can improve earning power through the acquisition of new knowledge and skills. **9.2.8.B.3:** Evaluate communication, collaboration, and leadership skills that can be developed through school, home, work, and extracurricular activities for use in a career. **9.2.8.B.4:** Evaluate how traditional and nontraditional careers have evolved regionally, nationally, and globally. **9.2.8.B.7:** Evaluate the impact of online activities and social media on employer decisions.		
Integration of Technology Standards NJSLS 8:	**8.1.8.A.1:** Demonstrate knowledge of a real world problem using digital tools. **8.1.8.A.4:** Graph and calculate data within a spreadsheet and present a summary of the results **8.1.8.A.5:** Create a database query, sort and create a report and describe the process, and explain the report results.		
Career Ready Practices	**CRP1:** Act as a responsible and contributing citizen and employee. **CRP2:** Apply appropriate academic and technical skills. **CRP4:** Communicate clearly and effectively within reason. **CRP5:** Consider the environmental, social, and economic impacts of decisions. **CRP7:** Employ valid and reliable research strategies. **CRP8:** Utilize critical thinking to make sense of problems and persevere in solving them. **CRP11:** Use technology to enhance productivity. **CRP12:** Work productively in teams while using cultural global competence.		
Core Instructional Materials	See “Suggested Strategies and Resources” list for each unit of study.		
Accommodations and Modifications:	*Students with special needs:* Support staff will be available to aid students related to IEP specifications. 504 accommodations will also be attended to by all instructional leaders. Extra time, alternative assessments, manipulatives and scaffolding strategies will be used to support this learning. The use of Universal Design for Learning (UDL) will be considered for all students as teaching strategies are considered. *ELL/ESL students:* Students will be supported according to the recommendations for “can do’s” as outlined by WIDA - https://www.wida.us/standards/CAN_DOs/		

	Students at risk of school failure: Formative and summative data will be used to monitor student success at first signs of failure student work will be reviewed to determine support this may include parent consultation, basic skills review and differentiation strategies. *Gifted and Talented Students:* Students excelling in mastery of standards will be challenged with complex, high level challenges in the creative design process that extends the science curriculum. Students engage in learning experiences that allow them to use their creativity, problem solving, critical thinking and logical reasoning skills. They are given the opportunity to successfully interact with others in activities that expose them to a broad array of academic, social, cultural and technological topics. Projects should aim to focus on questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

Unit Lesson Plan - Forces and Motion			
Grade	6	**Suggested Pacing:**	**20** Days
Subject:	**Middle School Science**		

NGSS/DCI MS-PS2: Forces and Interactions	● **For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)** ● **The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)** ● **All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)** http://www.nextgenscience.org/msps2-motion-stability-forces-interactions
Instructional Objective: MS-PS2-1.	**Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.**
Instructional Objective: MS-PS2-2.	**Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.**

Essential Question
1. How can understanding various factors affecting motion be useful in understanding common occurrences?
Guiding Questions: o What causes motion to occur? o What do motion graphs look like for objects moving with constant velocity? o What do graphs look like for objects that are accelerating? o How is the speed of an object calculated? o How is speed similar / different from velocity?

- How is acceleration calculated?
- How do unbalanced forces affect the motion of an object?
- How does friction affect an object when at rest or in motion?
- What are the biggest factors that affect the force of gravity?
- How is weight calculated?
- What does Newton's 1st law state about objects at rest or in motion?
- How does the mass of an object and the force acting on that object affect the object's acceleration?
- How can Newton's 3rd law of motion be used to explain the motion of a rocket?
- What factors affect the momentum of an object?
- How is momentum different from inertia?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The causes of motion. ● The basic difference between speed and velocity. ● Unbalanced forces cause acceleration. ● The larger the force the larger the acceleration. ● The inverse relationship between mass and acceleration. ● Newton's 3rd law acts in force pairs.	By the end of this unit, students will be able to: ● Interpret motion graphs ● Calculate speed. ● Calculate Weight. ● Calculate Force. ● Explain any moving object using Newton's Laws. ● Calculate momentum. ● Calculate basic sum of force problems. ● Describe field vs. contact forces. ● Identify the factors that affect the strength of electric, gravitational, and magnetic forces.
Suggested Resources	
1) Analyzing Crash Sites Understanding Car Crashes Forensic Engineering-Vehicular Accident Reconstruction Lessons from the gridiron Local Police Department and Insurance Companies	

2) NFL Helmet Challenge
3) Inspector Detector

http://nj.pbslearningmedia.org/resource/mss13.sci.engin.design.detect/inspectordetectorchallenge/#support-materials

4) Scooter Lab
5) Design a car challenge. You are a new Uber driver and you would like to deliver as many people as possible in the one day's time in order to achieve the most money possible. You need to design a vehicle with the greatest average speed in order to achieve this.

Phenomenon:
Why would you travel faster down a ski slope than me? Olympic Events videos
Why are wide receivers less massive football players than the defensive linemen? Sports Science (NBC Learn)

**Pacing guide is based on 40 minute class periods, you will need to adjust based on your school's schedule.

Unit Lesson Plan – Earth and the Solar System			
Grade:	**6**	**Suggested Pacing:**	20 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-ESS1.A: The Universe and Its Stars** **MS-ESS1.B: Earth and the Solar System**	● **Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)** ● **Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)** ● **The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2), (MS-ESS1-3)** ● **The model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)** ● **The solar system appears to have formed from a disk of dust and gas drawn together by gravity. (MS-ESS1-2)** http://www.nextgenscience.org/msess1-earth-place-universe
Instructional Objective: MS-ESS1-1.	**Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.**
Instructional Objective: MS-ESS1-2.	**Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.**
Instructional Objective: MS-ESS1-3.	**Analyze and interpret data to determine scale properties of objects in the solar system.**

Essential Questions
1. How can observations from Earth be used to explain the motion of planets and stars? 2. What are the relationships among the sun, planets and moons?
Guiding Questions: o What different types of objects can be found in our solar system? o Why do the objects in our solar system follow a curved path around our Sun? o What effects do the Moon and Sun have on us here on Earth?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● Characteristics of various celestial bodies, including the Sun and the Moon ● What causes the tides, solar/lunar eclipses, and seasons	By the end of this unit, students will be able to: ● Describe the celestial bodies in our solar system ● Explain what effects the motions of the Earth, Sun and Moon have on us (particularly the Tides, Eclipses, and Seasons).
Suggested Resources	
(What is the sequence of activities, learning experiences, etc, that will lead to desired results (the plan)?	
1) Earth, Sun, Moon Phenomena: Seasons, Lunar Cycles, and Tides **http://digitalcommons.trinity.edu/cgi/viewcontent.cgi?article=1114&context=educ_understandings** **2) Our World in Space** **http://digitalcommons.trinity.edu/cgi/viewcontent.cgi?article=1062&context=educ_understandings** **3) NSTA Science Scope** **http://www.nsta.org/exhibitsadv/2013mediakit/sample_issue/sc_jan_12_issue.pdf** **4) Gravity & Orbital Motion** **http://www.carolinacurriculum.com/premium_content/eBooks/Earth+Space/pdfs/Lesson_15.pdf** **5) My Place in Space** **http://phoenix.lpl.arizona.edu/pdf/lesson_1.pdf** **6) Mobile Mars** **http://mars.nasa.gov/mobile/info/** **7) Space Systems Supplemental Material** https://www.middletownschools.org/uploaded/Curriculum/Curriculum_Office/Files/Gr_5-EMS.pdf **8) The Martian Movie**	

Culminating Activity *Designing Space Subsystem https://www.nasa.gov/pdf/475492main_HEP_II_MS_7.pdf
Phenomenon: **What happens to old/unused space crafts when they become obsolete?** **Can we have a recycling program where we launch garbage into space?**

***Daily pacing guides are based on 40 minute periods, you may need to adjust to fit your school's schedule.

Unit Lesson Plan – Earth's Systems 1			
Grade:	**6**	**Suggested Pacing:**	30 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-ESS2.C: The Roles of Water in Earth's Surface Processes**	• **Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)** • **The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)** • **Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)** • **Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)** • **Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)** • **Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.** (MS-ESS3-1)
Instructional Objective: MS-ESS2-2.	**Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.**
Instructional Objective: MS-ESS2-4.	**Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.**
Instructional Objective: MS-ESS3-1:	**Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.**

Essential Questions
1. How and why is Earth constantly changing?
Guiding Questions: o How do the materials in and on Earth's crust change over time? o How does water cycle through Earth and shape Earth's surface?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● Stages of the water cycle, including relevant vocabulary. ● What causes global movement of water. ● How differences in temperature and salinity form a global pattern of currents. ● How weathering and erosion caused by water's movement change the lands features.	By the end of this unit, students will be able to: ● Describe the water cycle and the forces that drive it. ● Explain the impact of sunlight and gravity on global movements of water. ● Identify the global pattern of interconnected ocean currents. ● Describe the difference between weathering and erosion along with their impact on landforms.
Suggested Resources	
(What is the sequence of activities, learning experiences, etc, that will lead to desired results (the plan)?	
1) Earth's systems science - http://serc.carleton.edu/earthlabs/climate/1.html 2) The Rock Cycle Brochure 3) The Rock Cycle Interactive Site http://www.learner.org/interactives/rockcycle/change.html 4) The Rain Man - Water cycle http://www.srh.noaa.gov/jetstream/atmos/ll_rainman.html 5) Water Cycle Interactives http://interactivesites.weebly.com/clouds--water-cycle.html (contains multiple) http://www.discoverwater.org/blue-traveler/ 6) Survivor activity - http://pmm.nasa.gov/education/lesson-plans/survivor-earth	

➢ Students are on a “Survivor” show where they are competing. They have to determine what natural benefits their landscapes provide as well as any disadvantages of that location. Additionally, they are to perform the following tasks: design a device to purify water, choose a location that would provide ideal shelter, and determine what natural materials are present in that environment that they could utilize to harvest food.
Phenomenon: **Why is there dew in the morning predominantly in the summer and not during other seasons?** **Why are our beaches in NJ different from beaches in other places you have vacationed?**

***Pacing guide is based on 40 minute class periods, you may need to adjust based on your school’s schedule.

Unit Lesson Plan – Earth's Systems 2			
Grade:	**6**	**Suggested Pacing:**	30 Days
Subject:	**Middle School Science**		
NGSS/DCI **MS-ESS2.A: Earth's Materials and Systems**	● **All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms (MS-ESS2-1)** ● **The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future (MS-ESS2-2)** http://www.nextgenscience.org/msess2-earth-systems		
MS-ESS2.B: Plate Tectonics and Large-Scale System Interactions	**Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart (MS-ESS2-3)** http://www.nextgenscience.org/msess2-earth-systems		
Instructional Objective: MS-ESS2-2:	**Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.**		
Instructional Objective: MS-ESS2-3:	**Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.**		
Essential Question:			
1. How and why is Earth constantly changing?			
Guiding Questions: o Have the Earth's continents always looked the way they do today? o What causes Earth's continents to move? o In what ways do Earth's plates interact? What happens at these plate boundaries? o What causes earthquakes, tsunamis and volcanoes?			

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● Earth's continents were once all connected in one supercontinent ● Earth's plates continue to move still today as a result of convection currents in the mantle ● Earth's plates meet at convergent, divergent and transform boundaries ● Convergent boundaries create mountain ranges ● Divergent boundaries cause seafloor spreading ● Transform boundaries can result in earthquakes ● Tsunamis are caused by underwater earthquakes ● Volcanoes can form at both convergent and divergent plate boundaries	By the end of this unit, students will be able to: ● Explain how fossil records provide scientists with evidence of continental drift and Pangaea ● Relate the convection currents in the mantle to the motion of the tectonic plates on the surface ● Identify the three types of plate boundaries and explain how plate interactions reshape Earth's surface

Suggested Resources
(What is acceptable evidence to show desired results (rubrics, exam, etc.)? Attach Copy
1) Modeling Tectonic Plates Lab Activity: Model the 3 tectonic plate boundaries using materials (icing, graham crackers, Rice Krispee Treat) 2) Explore: Side by Side Comparison – Layers of the Earth to Milky way Candy Bar – Students will be given a snack size Milky Way bar which they will cut in half with their table partner. They will have a couple of minutes to make observations about each layer in side of the candy bar. They will share out their observations. Then using their background knowledge students and a word bank, students will try to match each layer of the candy bar to a layer of the earth. 3) Building Pangaea Gizmo (ExploreLearning.com): Using the computer simulation students will explore various pieces of data (fossil records, rock types, etc.) that scientists have collected to form the theory of plate tectonics. 4) NSTA - Plate Boundaries Group Activity https://www.nsta.org/conferences/docs/2015SummerInstituteSecondary/PlateBoundariesStudentHandout.pdf 5) Interactives http://www.learner.org/interactives/dynamicearth/slip3.html 6) Videos https://www.youtube.com/watch?v=FN6QX43QB4g https://www.youtube.com/watch?v=9i7w7eJh3kQ 7) General Resource for Your information http://www.teachinggeography.org/Plate%20Tectonics%20Rocks.pdf

CULMINATING ACTIVITY
River Planning
http://pals.sri.com/tasks/5-8/Riverplan/directs.html
Helpful Resources:
Hoover Dam
http://science.howstuffworks.com/engineering/structural/hoover-dam-broke.htm
Phenomenon:
Why do people in California have cement walls to enclose their backyards instead of fencing?

***Pacing guide is based on 40 minute class periods, you may need to adjust based on your school's schedule.

Unit Lesson Plan – The History of Planet Earth			
Grade:	**6**	**Suggested Pacing:**	20 Days
Subject:	**Middle School Science**		
NGSS/DCI **MS-ESS1.C: The History of Planet Earth**	**The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)** http://www.nextgenscience.org/msess1-earth-place-universe		
Instructional Objective: MS-ESS2-1:	**Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.**		
Instructional Objective: MS-ESS1-4:	**Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.**		

Essential Question:

1. How and why is Earth constantly changing?

Guiding Questions:

- What materials make up our Earth?
- How can rocks and fossils help us make a chronology of Earth's history?
- How will Earth look in one million years?

Knowledge & Skills

(What skills are needed to achieve the desired results?)

By the end of this unit, students will know:	By the end of this unit, students will be able to:
● The layers of the Earth ● The 3 types of rocks ● The job of paleontologists ● How we can determine the age of objects found within the Earth	● Demonstrate skills similar to those of a paleontologist ● Use rock strata to determine the relative age of fossils ● Demonstrate how radiometric dating can help scientists determine the absolute ages of objects

Suggested Resources
(What is the sequence of activities, learning experiences, etc, that will lead to desired results (the plan)?
Instruction 1) LAB: *Cookie Mining* https://www.populationeducation.org/sites/default/files/mining_for_chocolate.pdf http://teachers.egfi-k12.org/cookie-mining/ http://www.ohio4h.org/sites/ohio4h/files/imce/4h_science/STEMPathwaysCookieProspectingCurriculum515.pdf 2) LAB: *Authentic Landscapes* (Indoor) NSTA Science Scope Magazine (December, 2013) 3) Paleontology Time Capsule http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0ahUKEwjMzaesmsPLAhWGYiYKHa2FA8UQFggqMAI&url=http%3A%2F%2Fwww.antiochne.edu%2Fwp-content%2Fuploads%2F2012%2F08%2Fpaleontology.doc&usg=AFQjCNEOzXqou1JBbM9KYS9GuYHISDYWIA 4) Fossil Dig http://www.amnh.org/exhibitions/petra/promos/for-educators/do-your-own-dig Additional Resources: family tree and Earth history Using a simple three or four generation family tree, students will construct a relatives time tree that mimics the major divisions of the geologic time scale (Precambrian, Paleozoic, Mesozoic, and Cenozoic). GEOLOGY OF DINOSAUR NATIONAL MONUMENT **-** dinosaurs Additional Resources: paleontology national earth science teachers associations fossil sorting paleontology document paleomap Your Planet Earth Earthweek virtual dig CIESE musical plates Fringe Science Fossil Activity

(current events in California - mudslides, drought; OK - fracking; Fukishima)
Phenomenon: **Is the idea behind Jurassic Park that far-fetched?**

***Pacing guide is based on 40 minute class periods, you may need to adjust based on your school's schedule.

Unit Lesson Plan – Ecosystem Dynamics			
Grade:	**6**	**Suggested Pacing:**	20 Days
Subjec:	**Middle School Science**		

NGSS DCI: **MS-LS2.A: Interdependent Relationships in Ecosystems** **MS-LS2.B: Cycle of Matter and Energy Transfer in Ecosystems**	● **Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)** ● **In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)** ● **Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)** ● **Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)**
Instructional Objective: MS-LS2-1	**Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.**
Instructional Objective: MS-LS2-2	**Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.**
Instructional Objective: MS-LS2-4	**Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.**
Instructional Objective: MS-LS2-5	**Evaluate competing design solutions for maintaining biodiversity and ecosystem services.***

Essential Questions
1. How do organisms obtain and use matter and energy? 2. How do matter and energy move through the environment? 3. How do organisms interact with the living and non-living environment to obtain matter and energy?
Guiding Questions: o What are the different levels of ecology? o What are the factors within an ecosystem? o What are the requirements of living things? o How do organisms compete for resources? o What is the effect of predators in an ecosystem? o What are the mutually beneficial relationships in an ecosystem? o What is the relationship among producers, consumers, and decomposers?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The levels of ecological organization. ● The difference between biotic and abiotic factors. ● How competition, predator/prey and mutualism affect populations. ● Various factors that affect population size. ● The roles of producers, consumers and decomposers.	By the end of this unit, students will be able to: ● Give examples of the levels of ecology. ● Give examples of competition, predator/prey and mutualism. ● Describe how organisms depend on their environment. ● Explain how population size changes based on various factors. ● Describe the roles of producers, consumers and decomposers.

Suggested Resources
(What is the sequence of activities, learning experiences, etc., that will lead to desired results (the plan)?
1) Relationships & Interdependence http://www.bsisd.esc18.net/documents/Lesson%20Ideas/LESSONS%20&%20RESOURCES/SCIENCE/8th%20Gr/Science_Grade_08_Unit_12_Exemplar_Lesson_01__Relationships_and_Interdependence.pdf 2) **Design, Build, and Test Your Own Landfill** https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_enveng/cub_enveng_lesson05_activity2.xml

3) The Lorax Movie http://www.scholastic.com/teachers/lesson-plan/lorax-dr-seuss-lesson-plan https://s3.amazonaws.com/NSTA1/1224071/Lorax_and_Sustainable_Development.pdf?AWSAccessKeyId=AKIAIMRSQAV7P6X4QIKQ&Expires=1458136325&Signature=fTbXCJEL3TLx9i8kGrACzUzjiFQ%3d
Phenomenon: **Why are the der, turkey, and fox populations more prominent in our area?** **What affect has the "stink bug" had on ecological relationships?**

***Lessons are based on 40 minute periods and may need to be adjusted to fit the schedule of your school.

Grade 7 Science

Unit 1: Structure, Function and Information Processing	20 Days
Unit 2: Structures and Properties of Matter	17 Days
Unit 3: Growth, Development and Reproduction of Organisms	20 Days
Unit 4: Natural Resources and Human Impact	24 Days
Unit 5: Inheritance and Variation of Traits	27-28 Days
Unit 6: Evidence of Common Ancestry and Diversity	14 days

*****Each unit should be implemented at the discretion of an individual district*
Please refer to Accommodations and Modifications for students as needed

*Each unit assessment (in addition to the grade level Northern Valley Criterion Reference Test "CRT")is designed at the discretion of the district.
Please refer to local districts for specific assessment guidelines and examples.
Additional info can be found in the preface of this guide*.

Materials used for units are determined and budgeted for by individual districts.

Grade 7: Curriculum Connections

Interdisciplinary Connections	**ELA:** (RI.7.1 - RI.7.10 SL.7.1 - SL.7.6)	**Math:** Measurement and Data, Geometry (7.G.6)	**Health:** Wellness, Integrated Skills (2.1.8.A.2, 2.2.8.B.2)
Integration of 21st Century Standards NJSLS 9:	**9.1.8.A.2:** Relate how career choices, education choices, skills, entrepreneurship, and economic conditions affect income. **9.1.8.A.3:** Differentiate among ways that workers can improve earning power through the acquisition of new knowledge and skills. **9.2.8.B.3:** Evaluate communication, collaboration, and leadership skills that can be developed through school, home, work, and extracurricular activities for use in a career. **9.2.8.B.4:** Evaluate how traditional and nontraditional careers have evolved regionally, nationally, and globally. **9.2.8.B.7:** Evaluate the impact of online activities and social media on employer decisions.		
Integration of Technology Standards NJSLS 8:	**8.1.8.A.1:** Demonstrate knowledge of a real world problem using digital tools. **8.1.8.A.4:** Graph and calculate data within a spreadsheet and present a summary of the results **8.1.8.A.5:** Create a database query, sort and create a report and describe the process, and explain the report results.		
Career Ready Practices	**CRP1:** Act as a responsible and contributing citizen and employee. **CRP2:** Apply appropriate academic and technical skills. **CRP4:** Communicate clearly and effectively within reason. **CRP5:** Consider the environmental, social, and economic impacts of decisions. **CRP7:** Employ valid and reliable research strategies. **CRP8:** Utilize critical thinking to make sense of problems and persevere in solving them. **CRP11:** Use technology to enhance productivity. **CRP12:** Work productively in teams while using cultural global competence.		
Core Instructional Materials	See “Suggested Strategies and Resources” list for each unit of study.		
Accommodations and Modifications:	*Students with special needs:* Support staff will be available to aid students related to IEP specifications. 504 accommodations will also be attended to by all instructional leaders. Extra time, alternative assessments, manipulatives and scaffolding strategies will be used to support this learning. The use of Universal Design for Learning (UDL) will be considered for all students as teaching strategies are considered. *ELL/ESL students:* Students will be supported according to the recommendations for “can do’s” as outlined by WIDA - https://www.wida.us/standards/CAN_DOs/		

	Students at risk of school failure: Formative and summative data will be used to monitor student success at first signs of failure student work will be reviewed to determine support this may include parent consultation, basic skills review and differentiation strategies. *Gifted and Talented Students:* Students excelling in mastery of standards will be challenged with complex, high level challenges in the creative design process that extends the science curriculum. Students engage in learning experiences that allow them to use their creativity, problem solving, critical thinking and logical reasoning skills. They are given the opportunity to successfully interact with others in activities that expose them to a broad array of academic, social, cultural and technological topics. Projects should aim to focus on questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

Unit Lesson Plan – Structure, Function & Information Processing			
Subject:	**Middle School Science**	**Suggested Pacing:**	Approximately 20 Days
Grade:	**7**		

NGSS/DCI **MS-LS1.A: Structures and Function** **MS-LS1.D: Information Processing**	● **All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)** ● **Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)** ● **In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)** ● **Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1-8)** http://www.nextgenscience.org/msls1-molecules-organisms-structures-processes
Instructional Objective: MS-LS1-1.	**Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different types of cells.**
Instructional Objective: MS-LS1-2.	**Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute of the function.**
Instructional Objective: MS-LS1-3.	**Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.**
Instructional Objective: MS-LS1-8.	**Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.**

Essential Questions
1. How can one explain the ways cells contribute to the function of living organisms?
Guiding Questions: o What are the building blocks of life? o How does each part of a cell function? o How is the body a system of interacting subsystems composed of groups of cells? o What are fundamental differences between animal and plant cells pertaining to cell reproduction? o How do our sensory receptors send information to our brain?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● All living things are made up of cells, which is the smallest unit that can be said to be alive. ● An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). ● Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. ● In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. ● Cells form tissues, which form organs, which form systems ● Sensory receptors send messages to our brain	By the end of this unit, students will be able to: ● Determine whether something is living or non-living ● Explain how cells are the building blocks of life ● Build models of both a plant and animal cell and be able to demonstrate key characteristics that define both ● Describe how multicellular subsystems interact and work together to form tissue and organs that are specialized to particular body functions. ● Explain the similarities and differences between a chicken wing and a human arm ● Explain how our brain receives messages

Suggested Activities
(What is acceptable evidence to show desired results (rubrics, exam, etc.)? Attach Copy
Investigate Cells: Use a microscope to view onion cells and human cheek cells Project: Cell City Build an Organ Activity Dissecting a Chicken Wing Organ Systems Activity Quiz 2: Tissues, Organs & Organ Systems Lab 3: Can You Trust Your Senses? Quiz 3: Information Processing medical mystery change blindness disease detectives outbreak no quick fix pbl The Engineering Process Robotic Hand Science Daily See NJCTL Unit on Structure and Function and Information Processing

Unit Lesson Plan – Matter and Its Properties			
Subject:	**Middle School Science**	**Suggested Pacing:**	**Approximately 17** Days
Grade:	**7th Grade**		

NGSS/DCI **MS-PS1-A: Structures and Properties of Matter**	● **Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.(MS-PS1-1)** ● **Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2),(MS-PS1-3)** ● **Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)** ● **In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)** ● **Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)** ● **The changes of state that occur with variations in temperature or pressure can be described and predicted using these models matter. (MS-PS1-4)** http://www.nextgenscience.org/msps1-matter-interactions
Instructional Objective: MS-PS1-1.	**Develop models to describe the atomic composition of simple molecules and extended structures**
Instructional Objective: MS-PS1-2.	**Analyze and interpret data on the properties of substances**
Instructional Objective: MS-PS1-4.	**Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed**

Essential Questions
1. How does the structure of an atom determine its properties? 2. How does matter undergo changes? 3. How do matter and energy interact?
Guiding Questions: o What is matter and how do we measure it? o What is an atom and how is it structured? o How is the Periodic Table of Elements arranged and what does an element's placement tell you about the substance? o What is the difference between a physical and a chemical property and what are some examples of each? o What are the states of matter and what role does thermal energy play in changing matter's state?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● Everything in the universe is made of matter. ● Elements are composed of atoms which are simple substances that can't be broken down into other substances. ● How the Periodic Table is arranged. ● Molecules are combinations of various elements that result in brand new substances. ● Examples of physical and chemical properties of matter and the difference between the two groups. ● How to calculate using the density formula. ● Characteristics of solids, liquids and gases and that thermal energy is responsible for the changes of phases of matter.	By the end of this unit, students will be able to: ● Describe the basic structures of atoms and molecules ● Demonstrate how both mass and volume are measured and then use this information to calculate for density. ● Distinguish between weight and mass. ● Describe the difference between physical and chemical properties and give examples of each. ● Display the ability to read the Periodic Table of Elements and describe elements based on their location in the chart. ● Distinguish between solids, liquids and gases based on distinct characteristics
Suggested Activities	
Measure Matter Build an Atom Identify the patterns in the periodic table Build a Molecule: phet.colorado.edu (build a molecule) Compare/contrast pictures of different types of molecules	

Make a molecule physical activity (pairing, grouping
Physical Properties of Matter / Molecules
Demonstrate a change in phase from solid to gas without electricity
Phase change diagrams
Determining Density
States of Matter / Changes of Matter
Bouncy ball
Science scope oct 2014, wax, toothpicks, metal rod demo: create model of heat entering and exiting a substance
ice cream
Closing activities:
Natural vs. added preservatives/artificial ingredients: non-melting ice cream sandwich - Stella Doro chocolate cookies
Element Baby Book: directions contained in this pptx

Unit Lesson Plan – Growth and Development of Organisms			
Grade:	**7**	**Suggested Pacing:**	**Approximately 20 Days**
Subject:	**Middle School Science**		

NGSS DCI: **LS1.B: Growth and Development of Organisms**	● **Animals engage in characteristic behaviors that increase the odds of reproduction (MS-LS1-4)** ● **Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction (MS-LS1-4)** ● **Genetic factors as well as local conditions affect the growth of the adult plant (MS-LS1-5)** ● **Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring (secondary to MS-LS3-2)** http://www.nextgenscience.org/msls1-molecules-organisms-structures-processes http://www.nextgenscience.org/msls3-heredity-inheritance-variation-traits
Instructional Objective: MS-LS1-4.	**Use an argument based on empirical evidence and scientific reasoning to support am explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants**
Instructional Objective: MS-LS1-5.	**Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms**
Instructional Objective: MS-LS3-2.	**Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation**

Essential Questions
1. How do living organisms pass traits from one generation to the next? 2. How do organisms change over time in response ot changes in the environment?
Guiding Questions: o How do organisms reproduce? o What is the difference between sexual and asexual reproduction? o How can an organism's behavior increase its chance of survival and reproduction? o What structures or mechanisms aid in plant reproduction? o How does the environment contribute to successful reproduction or growth? o How do genetic factors influence the growth of organisms? o How do natural differences in organisms increase survival and reproduction?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The stages of mitosis ● Simple meiosis ● Land and aquatic fertilization strategies ● Asexual and sexual reproduction ● How behavior affects survival and reproduction ● Animal parenting methods ● Flower structure ● How the environment affects growth and reproduction ● Reproductive success is measured in the number of offspring which survive to reproduce	By the end of this unit, students will be able to: ● Show the order of mitosis given pictures, name the function of mitotic structures ● Differentiate between animal types and reproductive strategies ● Identify extreme structures for attracting mates ● Identify behaviors which enhance reproductive success ● Differentiate between aquatic and land fertilization and development of young ● Compare parenting styles of animals ● Compare pollination types ● Dissect and identify flower structures and function ● Distinguish between different types of pollen ● Compare fruits, nuts and seeds ● Identify environmental effects on growth ● Argue the importance of nurture vs. nature

Suggested Activities
Designer baby: debate the pros and cons and generate a public service announcement sharing Designer food & GMO Designer dogs Find the Gene for Whirling Disorder Explore Genetics Create a face lab Human Genetics Harvest of Fear

Unit Lesson Plan: Natural Resources and Human Impact			
Subject:	**Middle School Science**	**Suggested Pacing:**	Approximately 24 Days
Grade:	**7th Grade**		

NGSS/DCI: **MS-ESS3.A: Natural Resources** **ESS3.C: Human Impacts on Earth Systems**	● **Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)** ● **Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)** ● **Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS- ESS3-3),(MS-ESS3-4)** http://www.nextgenscience.org/msess3-earth-human-activity
Instructional Objective: MS-ESS3-1	**Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.**
Instructional Objective: MS-ESS3-3	**Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.**
Instructional Objective: MS-ESS3-4	**Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.**

Essential Questions
1. Is the world today a better place than the world of the past? 2. Will the future world be better than the present world? 3. How can the perspectives of a group affect the use of and impact on the environment?
Guiding Questions: o How are natural resources used in society? What are some examples? o What impacts do humans have on Earth's environment when we gather and use natural resources? o What is the relationship between ecological footprint per capita, human population growth, economic income, and changes in biodiversity? o Identify the human behaviors resulting in ecological overshoot, then assess the global impact. o Explain the importance of local and global sustainable activities, technologies developing a rationale for urging individual efforts in this area.

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● Sources of natural resources in terms of the atmosphere, lithosphere, hydrosphere and biosphere ● How humans use natural resources ● Specific examples of natural resources and their uses ● The distribution of natural resources on the planet varies due to different geological processes ● Changes in population affect natural resource consumption and Earth's environment. ● The major impacts on Earth's environment that occur due to natural resource consumption. ● How humans contribute to ecological footprint per capita ● The relationship between biodiversity, human population growth, ecological footprint per capita and economic income of a given population	By the end of this unit, students will be able to: ● Define natural resources ● Identify forms of natural resources and distinguish between each in terms of their source. ● Describe how natural resources play a role in society ● Explain how the distribution of various natural resources were shaped by past and current geological processes ● Describe the population on natural resource consumption and the Earth's environment. ● Identify and describe specific impacts of human natural resource consumption. Including land depletion through deforestation and agriculture, depletion of aquifers, pollution of land and air via mining, agriculture and burning of fossil fuels and global warming from deforestation and fossil fuel burning. ● Explain how the rate of change in ecological footprint is related to the rate of change in population growth and a country's economic income.

• Why ecological overshoot is not sustainable in the long term • The definition and requirement for sustainability • Examples of sustainable actions that individual and society as a whole can take	• Describe how the planet's biodiversity is linked to human population and ecological footprint per capita. • Explain why long term ecological overshoot is detrimental to the planet and its inhabitants. • Describe what actions people in a society can take to lessen ecological overshoot. • Describe sustainable actions/technologies and identify how it benefits the planet.

Suggested Activities
Natural Resource Activity Mapping Our Human Footprint Activity Ford vs Mann Sustainable Solutions for Cities Project Minimizing Human Impact Research Project Incorporate natural selection/extinction/adaptation through threatened or endangered species protection. http://www.thehenryford.org/education/erb/HumanImpactTeacherPacket.pdf https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Hurricane_Katrina.html#.VqEF6WBi80s https://sites.google.com/a/adams12.org/stem-8-science-and-engineering/home/student-resources/renewable-energy-pbl Showing before and after pictures of California (drought) Sandy's impact on NJ: was any portion preventable? New Orleans/Gulf Coast before and after pictures Fracking causing earthquakes in Oklahoma Increase in hurricanes per year Impact on soil due to human mismanagement: History of the Dust Bowl and relationship to crop management, failure to cycle crops Crash: Tale of Two Species Human Impact on Deep Sea Corals off the Coast of NJ http://questgarden.com/67/72/1/140329091643/ http://www.pbs.org/wnet/nature/crash-a-tale-of-two-species-introduction/592/ http://www.kathysnyderscience.com/savetheraptors.html http://questgarden.com/67/72/1/120224165453/
(What is the sequence of activities, learning experiences, etc, that will lead to desired results (the plan)?

Unit Lesson Plan – Inheritance and Variation of Traits			
Subject:	**Middle School Science**	**Suggested Pacing:**	Approximately 27-28 Days
Grade:	**7**		

NGSS DCI: **MS-LS1.B: Growth and Development of Organisms** **MS-LS3.A: Inheritance of Traits** **MS-LS3.B: Variation of Traits**	**Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS- LS3-2)** **Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)** **Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)** **In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)** **In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)** http://www.nextgenscience.org/msls3-heredity-inheritance-variation-traits
Instructional Objective: MS-LS3-1	**Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.**

Instructional Objective: MS-LS3-2	**Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.**

Essential Question
1. How are characteristics of one generation passed on to the next?
Guiding Questions: o How do children get traits from their parents? o Why do some people look more like their dad and some look more like their mom? o What is a Punnett Square and how does it help us predict the traits of offspring? o Why do some children show traits that neither of their parents display? o Why are some people born with birth defects or diseases?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● How to properly use a Punnett Square ● Your traits are determined by the dominant and recessive alleles passed to you from your parents ● The difference between genotype and phenotype and how phenotype depends on genotype ● How to perform a test cross to determine the unknown genotype of an organism ● Why a person may end up being born with a birth defect or disease	By the end of this unit, students will be able to: ● SWBAT properly complete a Punnett Square and use it to predict the genes of offspring ● SWBAT use an organism's genotype to describe the physical characteristics of the object ● SWBAT properly perform test crosses to determine an unknown genotype ● SWBAT demonstrate appropriate research skills and teach the class about birth defects and genetic mutations

Unit Lesson Plan – Evidence of Common Ancestry and Diversity			
Grade:	**7**	**Suggested Pacing:**	Approximately 14 Days
Subject:	**Middle School Science**		

Essential Questions:	
1. How do organisms change over time in response to changes in the environment? 2. What evidence shows that different species are related?	
Guiding Questions: o What are fossils and how are they created? o What is the geological timeline? o What is evolution? o What evidence do scientists use to support the theory of evolution from a common ancestor? o How does natural selection drive evolution?	
Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The different eras of the Phanerozoic Era. ● What fossils are and how fossilization occurs. ● The theory of evolution from a common ancestor. ● Different types of evidence that support evolution from a common ancestor (fossil record, homology, embryological development). ● How natural selection drives evolution.	By the end of this unit, students will be able to: ● Describe the Paleozoic, Mesozoic and Cenozoic Eras. ● Determine the relative ages of fossils in rock. ● Explain different types of fossils and how fossilization occurs. ● Explain the theory of evolution from a common ancestor. ● Describe different pieces of evidence that support evolution from a common ancestor (fossil record, homology and embryological development). ● Explain how natural selection drives evolution.

Suggested Activities
Geological Timeline Fossil Cast: http://www.ngsslifescience.com/biology_lesson_plans_natural_selection.html NGSS Life science (evolution and natural selection): http://www.ngsslifescience.com/biology_lesson_plans_natural_selection.html Evolution and Natural Selection Lesson Plans: http://www.ngsslifescience.com/biology_lesson_plans_natural_selection.html Evolution: http://www.biologyinmotion.com/evol/index.html Origin of Species: http://www.pbs.org/wgbh/evolution/darwin/origin/ Lessons from the Galapagos: http://www.bbc.com/travel/story/20120907-the-galapagos-lessons-in-natural-selection Lessons in Natural Selection: http://www.ngsslifescience.com/biology_lesson_plans_natural_selection.html http://video.nationalgeographic.com/video/ecuador_galapagos Evolution by Natural Selection: http://serendip.brynmawr.edu/sci_edu/waldron/pdf/NaturalSelectionProtocol.pdf Evolution Lab: http://www.biologyinmotion.com/evol/index.html Evolution: http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/E/Evolution.html Candy Dish Selection: http://www.ucmp.berkeley.edu/education/lessons/candy_dish.html Incomplete dominance: http://sciencespot.net/Media/gen_spbobincdom.pdf The biology of skin color: http://www.hhmi.org/biointeractive/biology-skin-color Galapagos: environment for evolution and adaptation: http://video.nationalgeographic.com/video/ecuador_galapagos Battle of the Beaks: http://www.ucmp.berkeley.edu/education/lessons/birdbeaks/birdbeaks.html https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_rock/cub_rock_lesson03_activity1.xml-engineering It's About Time: Genetics (fighting hunger through GMO) iat.com Design a Tool to carefully extract a fossil and help document its location.

Grade 8 Science

Unit 1: Electromagnetic Radiation	18 Days
Unit 2: Information Technologies and Instrumentation	10 Days
Unit 3: Wave Properties	15 Days
Unit 4: Weather Climate and Natural Hazards	20 Days
Unit 5: Matter and Energy in Everyday Life	15 Days
Unit 6: Chemical Reactions and Energy	15 Days
Unit 7: Energy of Objects in Motion	18-20 Days
Unit 8: Thermal Energy	20-25 Days

*****Each unit should be implemented at the discretion of an individual district*
Please refer to Accommodations and Modifications for students as needed

*Each unit assessment is designed at the discretion of the district.
Please refer to local districts for specific assessment guidelines and examples.
Additional info can be found in the preface of this guide*.

Materials used for units are determined and budgeted for by individual districts.

Grade 8: Curriculum Connections

Interdisciplinary Connections (see further interdisciplinary connections within each unit)	**ELA:** **LITERACY** RI.8.1 - RI.8.10 SL.8.1 - SL.8.10	**Health:** Interdependence of body systems, safety, nutrition, infections, diseases (2.1.8.A.2, 2.1.8.B.4, 2.1.8.A.3)	**Math:** Physical Models, Transparencies, Geometric Software, Cylinders, Cones, Spheres (8.G.1, 8.G.2, 8.G.9)	**Social Studies:** US History, scientific discoveries (6.1.8.B.5.a, 6.1.12.D.7.a)
Integration of 21st Century Standards NJSLS 9:	**9.1.8.A.2:** Relate how career choices, education choices, skills, entrepreneurship, and economic conditions affect income. **9.1.8.A.3:** Differentiate among ways that workers can improve earning power through the acquisition of new knowledge and skills. **9.2.8.B.3:** Evaluate communication, collaboration, and leadership skills that can be developed through school, home, work, and extracurricular activities for use in a career. **9.2.8.B.4:** Evaluate how traditional and nontraditional careers have evolved regionally, nationally, and globally. **9.2.8.B.7:** Evaluate the impact of online activities and social media on employer decisions.			
Integration of Technology Standards NJSLS 8:	**8.1.8.A.1:** Demonstrate knowledge of a real world problem using digital tools. **8.1.8.A.4:** Graph and calculate data within a spreadsheet and present a summary of the results **8.1.8.A.5:** Create a database query, sort and create a report and describe the process, and explain the report results.			
Career Ready Practices	**CRP1:** Act as a responsible and contributing citizen and employee. **CRP2:** Apply appropriate academic and technical skills. **CRP4:** Communicate clearly and effectively within reason. **CRP5:** Consider the environmental, social, and economic impacts of decisions. **CRP7:** Employ valid and reliable research strategies. **CRP8:** Utilize critical thinking to make sense of problems and persevere in solving them. **CRP11:** Use technology to enhance productivity. **CRP12:** Work productively in teams while using cultural global competence.			
Core Instructional Materials	See "Suggested Strategies and Resources" list for each unit of study.			
Accommodations and Modifications:	*Students with special needs:* Support staff will be available to aid students related to IEP specifications. 504 accommodations will also be attended to by all instructional leaders. Extra time, alternative assessments, manipulatives and scaffolding strategies will be used to support this learning. The use of Universal Design for Learning (UDL) will be considered for all students as teaching strategies are considered.			

	ELL/ESL students: Students will be supported according to the recommendations for "can do's" as outlined by WIDA - https://www.wida.us/standards/CAN_DOs/ *Students at risk of school failure:* Formative and summative data will be used to monitor student success at first signs of failure student work will be reviewed to determine support this may include parent consultation, basic skills review and differentiation strategies. *Gifted and Talented Students:* Students excelling in mastery of standards will be challenged with complex, high level challenges in the creative design process that extends the science curriculum. Students engage in learning experiences that allow them to use their creativity, problem solving, critical thinking and logical reasoning skills. They are given the opportunity to successfully interact with others in activities that expose them to a broad array of academic, social, cultural and technological topics. Projects should aim to focus on questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

Unit Lesson Plan – Electromagnetic Radiation			
Grade:	**8**	**Suggested Pacing:**	18 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-PS4-B Electromagnetic Radiation**	● **When light shines on an object, it is reflected, absorbed or transmitted through the object, depending on the object's material and the frequency (color) of the light.** ● **The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g. air and water, air and glass) where the light path bends.** ● **A wave model of light is useful for explaining brightness, color and the frequency-dependent bending of light at a surface between media.** ● **However, because light can travel through space, it cannot be a matter wave, like sound or water waves.** http://www.nextgenscience.org/*
Instructional Objective: **MS-PS4-2**	**Develop and use a model to describe that waves are reflected, absorbed or transmitted through various materials.**

Essential Questions
1. How do we know that waves carry energy? 2. How do the properties of EM waves determine their use? 3. How are colors perceived in nature and why?
Guiding Questions: o What is radiation? o How are light waves and mechanical waves different? o What is the relationship between wavelength, frequency and energy of electromagnetic radiation? o What are the different types of electromagnetic radiation? o What are the different types of reflection? o How does the absorption of light result in the different colors that we see? o Why do waves refract through different mediums?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● How electromagnetic radiation acts as a wave ● The different types of electromagnetic radiation that compose the electromagnetic spectrum ● The different interactions of radiation with matter, including reflection, absorption and refraction ● How we perceive different colors	By the end of this unit, students will be able to: ● Complete calculations based on wavelength, frequency and energy ● Differentiate between the different properties and uses of electromagnetic radiation ● Compare and contrast specular and diffuse reflection ● Explain how absorption results in changes in temperature of objects and different perceived colors ● Explain how refraction occurs and estimate angles of reflection and refraction

Suggested Activities
Developmental Activities: ● Herschel experiment: http://coolcosmos.ipac.caltech.edu/cosmic_classroom/classroom_activities/herschel_example.html ● EM info website: http://amazingspace.org/resources/explorations/light/makewaves-frames.html (good questions to use knowledge) ● Refraction simulator http://phet.colorado.edu/sims/html/bending-light/latest/bending-light_en.html ● Visible light simulator: http://phet.colorado.edu/sims/html/color-vision/latest/color-vision_en.html Performance Assessment: Solar oven that can reach highest temp
Phenomenon: Is there life outside of Earth? **Optional: Refer to Drake's equation (find on Google)**

Unit Lesson Plan: Information Technologies and Instrumentation			
Grade:	**8**	**Suggested Pacing:**	10 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-PS4.C: Information Technologies and Instrumentation**	**Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information (MS-PS4-3)** http://www.nextgenscience.org/msps4-waves-applications-technologies-information-transfer
Instructional Objective: **MS-PS4-3**	**Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a MORE RELIABLE way to encode and transmit information.**

Essential Questions
1. Why has the world gone digital from analog?
Guided Questions: o What are older, less reliable methods of communication? o What are the advantages of using digitized signals (electromagnetic waves) for communication over older methods? o Why are electromagnetic waves a more reliable method for transmitting information? o Which waves on the electromagnetic spectrum are primarily used for communication? o How are radio and light waves used for communication? What are some examples of items that use these forms of EM waves for communication? o Why is digital communication of information in society?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● Older methods of long distance communication ● Why using EM waves for communication is more reliable ● Identify the waves on the EM spectrum that are used primarily for communication ● Identify items that use EM waves for communication ● The role of communication technology in society	By the end of this unit, students will be able to: ● Describe how the basics of how a telegraph and telephone work ● Explain the advantages of using digital communication over older forms of communication ● Describe how characteristics of EM waves help make it reliable form of communication ● List items that either use radio or light waves for communication ● Explain generally how fiber optics are used for communication ● Analyze the importance of communication technology in society ● Recognize that communication technology is not always positive

Suggested Activities
Developmental Activities: ● Lab 1: Build an Electric Telegraph: http://content.njctl.org/courses/science/8th-grade-science/information-technologies-instrumentation/electric-telegraph-lab/electric-telegraph-lab-2014-07-01.pdf ● Teaching EM waves used in communication Tech http://static.nsta.org/files/ss1402_78.pdf ● Sci. Links – message sending device in classroom Performance Assessment:
Phenomenon: What happens to communication when satellites or cell towers are compromised? Alternate wordings: How devastating would it be if all satellites were destroyed?

Unit Lesson Plan - Wave Properties			
Grade:	**8**	**Suggested Pacing:**	15 Days
Subject:	**Middle School Science**		

MS-PS4. Wave Properties	• **A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)** • **A sound wave needs a medium through which it is transmitted. (MS-PS4-2)**
Instructional Objective: MS-PS4-1.	**Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.**
Instructional Objective: MS-PS4-2.	**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials**

Essential Questions
1. How do you know that waves carry energy? 2. Where do waves come from?
Guided Questions: o What causes a wave? o What are the basic “parts” of a wave? o What are the properties that all waves exhibit? o What is a mechanical wave? o How do pitch and loudness correspond to the structure of a wave? o How does the Human ear detect sound? o What happens to the pitch of a sound wave when the sound source is in motion? **o** What happens to the sound waves of a plane that travels faster than the speed of sound?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The source of waves ● The parts of a wave including wavelength, amplitude, frequency, crest, trough, and equilibrium position. ● The calculation of a wave's velocity. ● How pitch and loudness are a function of a wave's structure. ● The behavior of waves according to the law of reflection. ● The speed and direction of a wave changes when it undergoes refraction. ● Waves spread out as they pass through an opening during diffraction. ● Waves can add up to become stronger and cancel each other out during constructive and destructive interference. ● Sound is caused by a vibrating object and requires a medium to move. ● Smaller objects produce higher pitched sounds. ● Loudness is a measure of the amplitude of a wave and is measured in decibels. ● Sound waves vibrate parts of the ear and the ear sends that information to the brain during hearing. ● The speed of sound varies in air according to the temperature of the air. ● The pitch of a sound wave is affected by a sound source in motion and this is called the Doppler Effect.	By the end of this unit, students will be able to: ● Describe the source of a wave. ● Label diagrams of basic sound waves. ● Calculated the velocity of a wave utilizing the wave equation. ● Label and explain diagrams of refraction. ● Label and explain diagrams of diffraction. ● Sketch and explain constructive and destructive interference. ● Describe the source of a longitudinal sound wave as cause by a vibrating object. ● Label longitudinal waves parts including compressions and rarefactions and relate a vibrating object to the source of each part. ● Relate the frequency of a sound wave to the observed pitch of that wave. ● Relate the amplitude of a sound wave to the observed loudness of that wave. ● Describe the basics of hearing and the structure of the outer, middle, and inner ear. ● Describe how the speed of sound is affected on warmer and cooler days. ● Describe the observed pitch that originates from a moving sound source. ● Describe the arrangement of sound waves produced when a sound source is moving faster than the speed of sound.

Suggested Activities
Developmental Activities: NSTA: Catching a Wave – wave print activity Water glass instruments (amplitude, pitch) Student research and presentation of how different instruments create sounds. Slinky and rope demos Online wave simulator: http://phet.colorado.edu/sims/html/wave-on-a-string/latest/wave-on-a-string_en.html Wave interference: http://phet.colorado.edu/en/simulation/legacy/wave-interference Sound Waves: http://phet.colorado.edu/en/simulation/legacy/sound Make an amplification device for your phone Performance Assessment: ● Create an instrument that illustrates waves and waves properties and record a song with the instrument on software ● Create a tsunami detection system using knowledge of waves: http://www.compadre.org/precollege/items/detail.cfm?ID=11783 ● Create a sound simplification device. (Students are spies. Need to create a sound amplification device that can be concealed in the ear without causing harm) ● Create better headphones for ear health.
Phenomenon: play Hearing Test – Mosquito Ringtone – TeenBuzz – You Tube

Unit Lesson Plan – Weather & Climate and Natural Hazards			
Grade:	**8**	**Suggested Pacing:**	20 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-ESS2.C: The Roles of Water in Earth's Surface Processes** **MS-ESS2.D: Weather and Climate** **MS-ESS3.B: Natural Hazards**	● **The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)** ● **Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)** ● **Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)** ● **The ocean exerts a major influence on weather and climate by redistributing it through ocean currents. (MS-ESS2-** ● **Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)** http://www.nextgenscience.org/msess2-earth-systems http://www.nextgenscience.org/msess3-earth-human-activity
Instructional Objective: MS-ESS2-5.	**Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.**
Instructional Objective: MS-ESS2-6.	**Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.**
Instructional Objective: MS-ESS3-2.	**Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.**

Essential Questions
1. What is the relationship between weather and climate and what affects that relationship? 2. How does climate influence the activities of people?
Guided Questions: o What factors affect weather and climate? o How do meteorologists predict the weather? o What are natural disasters and how are they predicted?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The effect that various factors have on weather and climate. ● How atmospheric and oceanic circulation occurs. ● What probability forecasting is and how it is used. ● What natural disasters are how they are predicted.	By the end of this unit, students will be able to: ● Describe the effects that factors and locations have on weather and climate. ● Describe how circulation transports heat and moisture around the Earth. ● Translate information on a weather map into a weather forecast. ● Create a weather map based on information. ● Explain how natural disasters can be predicted.

Suggested Activities
Suggested Activities: ● Weather and Climate ● Observation and forecasting ● Build a weather station: http://ciese.org/curriculum/weatherproj2/en/activities.shtml ● Climate and Temperature: http://www.earthsciweek.org/classroom-activities/climate-and-temperature ● Circulation activity (red hot and blue cold water) ● Natural Hazards: http://www.pbslearningmedia.org/resource/ess05.sci.ess.earthsys.lp_nathazards/natural-hazards/

Performance Assessment:

- Create a weather forecast using data from a certain region
- Create Survival Kits for several natural hazards
- Global preparedness summit: groups are assigned natural hazards. They must collect data that includes frequency, location, magnitudes, weather (temp, precipitation, etc) preceding the event. Create a presentation to inform fellow attendees as to how accurate of a prediction can be made for your assigned hazard.

Phenomenon: Show a weatherman joke or a forecast that was off

Unit Lesson Plan – Matter & Energy in Everyday Life		
Grade	**8**	**Suggested Pacing:** 15 Days
Subject:	**Middle School Science**	

NGSS DCI: **LS1.C: Organization for Matter and Energy Flow in Organisms** **PS3.D: Energy in Chemical Processes and Everyday Life**	**Plant, algae (including phytoplankton), and many microorganisms use energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)** **Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth or to release energy. (MS-LS1-7)** **The chemical reactions by which plants produce complex food molecules (sugars) requires energy input (i.e., from sunlight) to occur. In this reaction carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (secondary to MS-LS1-6)** **Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (MS-LS1-7)** http://www.nextgenscience.org/msls1-molecules-organisms-structures-processes
Instructional Objective: MS-LS1-6.	**Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.**
Instructional Objective: MS-LS1-7.	**Develop a model to describe how food is rearranged through chemical reactions to forming new molecules that support growth and/or release energy as this matter moves through an organism.**

Essential Question:
How are photosynthesis and cellular respiration dependent on each other and necessary for all living things?
Guided Questions: o What is photosynthesis? o Why is photosynthesis important to all living things? o Where is the energy needed to perform photosynthesis created? o In what organisms does photosynthesis occur? In what cell structures does photosynthesis occur? o What is cellular respiration? o What materials are needed to perform photosynthesis? Cellular Respiration? o What materials are produced by photosynthesis? Cellular Respiration? o In what organisms does respiration occur? In what cell structures does respiration occur? o What is the relationship between Photosynthesis and Cellular Respiration?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: Photosynthesis uses carbon dioxide and water to store the energy of water in plants. It creates glucose and releases oxygen as a waste product. Photosynthesis gets its energy from the sun and occurs in the chloroplast of plants. Cellular respiration is the opposite of Photosynthesis. It releases the energy stored in glucose by combining it with oxygen to give off energy and releases carbon dioxide and water as waste products. This occurs in the mitochondria. These two cycles are a system that helps keep many organisms on Earth alive.	By the end of this unit, students will be able to: ● Model the processes of Photosynthesis and Cellular Respiration ● Explain that the energy to power photosynthesis comes from the sun. ● Construct a scientific explanation based on evidence for the role of photosynthesis in cycling matter and flow of energy in organisms. ● Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

Suggested Activities
Materials and resources: ● Investigating photosynthesis (nsdl.oercommons.org/courses/investigating-photosynthesis-discovering-what-plants-need-for-photosynthesis/view) ● Photosynthesis formula game (http://www.ellenjmchenry.com/homeschool-freedownloads/lifesciences-games/photosynthesisformula.php ● Island of photosynthesis (https://archive.njctl.org/courses/science/7th-grade-science/matter-energy-in-everyday-life/island-of-photosynthesis-lab/ ● Effects of light and CO2 on photosynthesis (www.biotopics.co.uk/plants/psfac2.html) ● Cell respiration lab: http://images.pcmac.org/SiSFiles/Schools/AL/HooverCity/BumpusMiddle/Uploads/DocumentsCategories/Documents/Cellular%20Respiration%20Activity.pdf ● Cellular Respiration and Photosynthesis http://content.njctl.org/courses/science/7th-grade-science/matter-energy-in-everyday-life/photosynthesis-and-cellular-respiration-project/photosynthesis-and-cellular-respiration-project-2014-09-10.pdf Performance Assessment ● Claims, evidence, reasoning based on graph showing pre and post populations of animals when an industrial farm is established in a untouched ecosystem. ● https://www.teachchemistry.org/content/aact/en/classroom-resources/middle-school/reactions/photosynthesis/building-blocks-of-photosynthesis.html ● http://www.bio.indiana.edu/community/faculty/ICE_files/Photosynthesis-All.pdf ● http://www.nclark.net/RespirationvsPhotosynthesis.pdf

Unit Lesson Plan Chemical Reactions and Energy			
Grade:	**8**	**Suggested Pacing:**	15 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-PS1-B: Chemical Reactions** **MS-PS3-A: Definitions of Energy** **ETS1.B: Developing Possible Solutions** **ETS1.C: Optimizing the Design Solution**	• **Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1 2),(MS-PS1-3),(MS-PS1-5)** • **The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)** • **Some chemical reactions release energy, others store energy. (MS-PS1-6)** • **A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6)** • **Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6)** • **The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (secondary to MS-PS1-6)** http://www.nextgenscience.org/msps1-matter-interactions
Instructional Objective: MS-PS1-2.	**Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.**
Instructional Objective: MS-PS1-3.	**Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.**
Instructional Objective: MS-PS1-6.	**Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.**

Essential Question:
1. How does matter undergo changes and how can that be expressed in a chemical equation?
Guiding Questions: o What happens when substances react chemically? o What happens to atoms of the original substances when a reaction occurs? o Will the properties of the substance that is produced as part of a reaction be the same as those of the original substances? o What happens to the total mass of all atoms as a reaction takes place? o How does the amount of stored energy change during a chemical reaction?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● How to determine if a chemical reaction has occurred. ● How atoms can rearrange and combine to form new substances. ● Key, easily observable properties of chemical substances ● That properties of substances may change during a chemical reaction. ● That total mass in a reaction must be conserved ● That some reactions can absorb energy ● That some reactions can release energy	By the end of this unit, students will be able to: ● Describe observable cues that a chemical reaction has occurred. ● Distinguish between chemical substances based on observable properties. ● Develop an atomic level model to explain how atoms rearrange to form new substances during a chemical reaction. ● Distinguish between reactions that absorb energy and reactions that release energy
Suggested Activities	
Developmental activities: ● Identifying powders (chem vs phys changes) http://cbsd.org/cms/lib010/PA01916442/Centricity/Domain/1563/White%20Before%20Your%20Eyes.pdf ● Atomic Rearrangement Lab https://njctl.org/courses/science/7th-grade-science/chemical-reactions-and-energy/attachments/atomic-rearrangement-lab/ ● Use legos to model rearrangement of atoms ● Law of Conservation of Mass http://www.nclark.net/conservation_of_matter_lab.pdf	

- Law of Conservation of Mass http://www.troup.org/userfiles/929/My%20Files/Science/MS%20Science/8th%20Science/Matter/conservation_matter/conservation_mass_lab4.pdf?id=8054
- Evidence of reactions: http://chemistry.about.com/od/chemistryexperiments/a/aa062204a.htm
- Making plastics sustainable: http://www.auburn.edu/~cgs0013/Schnittka_Bell_Richards_2010.pdf

Assessment:

- Innovation Design Challenge https://njctl.org/courses/science/7th-grade-science/chemical-reactions-and-energy/attachments/energy-transfer-lab/

Phenomenon: When weight is lost, where does it go?

Unit Lesson Plan - Energy of Objects in Motion			
Grade:	**8**	**Suggested Pacing:**	About 18-20 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-PS3.A:Definitions of Energy** **MS-PS3.B: Conservation of Energy and Energy Transfer**	● **Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)** ● **A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3 2)** ● **When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)** http://www.nextgenscience.org/msps3-energy
Instructional Objective: MS-PS3-1.	**Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.**
Instructional Objective: MS-PS3-2.	**Develop a model to describe that when the arrangements of objects interacting at a distance changes, different amounts of potential energy are stored in the system.**
Instructional Objective: MS-PS3-5.	**Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.**

Essential Questions:
1. How can you determine if something has energy? 2. What limits the efficiency of a machine?
Guiding Questions: o What is work? o What types of energy make up mechanical energy? o How is mechanical energy transferred from one form to another?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The difference between mechanical and non-Mechanical energy. ● The variables that kinetic energy depend upon. ● The variables that gravitational potential energy depend upon. ● The variables that elastic potential energy depend upon. ● The Law of Conservation of Energy states that energy can be transferred from one type to another, but cannot be created or destroyed. ● The difference between renewable and non-renewable energy sources. ● How different types of energy resources convert mechanical energy into electrical energy.	By the end of this unit, students will be able to: ● Calculate when work is done on a system. ● Calculate kinetic energy. ● Calculate gravitational potential energy . ● Calculate elastic potential energy. ● Demonstrate understanding of mechanical energy transfer via diagrams.
Suggested Activities	
http://www.physicsclassroom.com/mmedia/energy/se.cfm Roller Coasters and Energy Energy transformation in Downhill skiing http://concord.org/projects/engineering-energy#curriculum (energy efficient house model) Energy in a Roller Coaster: PBS Developmental Activities: ● **KINETIC AND POTENTIAL ENERGY** ● http://dep.disney.go.com/sodi_app/ (design a roller coaster) ● Rube Goldberg device ● 2 different balls on same ramp knocking down cups of increasing masses	

- Same ball on different height ramps knocking down cups (to show increasing velocity)
- Use this to introduce potential energy
- crumbled paper launcher: design a device to launch a crumbled piece of paper the farthest (the further the
- rubber band is stretched the more potential energy it has, thus more kinetic and farther distance)

Assessment (performance or paper-based)

Projects:

- Design a roller coaster to
    - show that potential energy is dependent on the distance between 2 objects
    - shows how potential energy transfers to kinetic energy

Phenomenon: Redneck looping water slide video on YouTube. Why is the first hill always the biggest on a roller coaster?

Unit Lesson Plan: Thermal Energy			
Grade:	**8**	**Suggested Pacing:**	About 20-25 Days
Subject:	**Middle School Science**		

NGSS/DCI **MS-PS3.A: Definitions of Energy**	● **Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)** ● **The term "heat" as used in everyday language refers both to thermal motion (the motion of atoms or molecules within a substance) and radiation (particularly infrared and light). In science, heat is used only for this second meaning; it refers to energy transferred when two objects or systems are at different temperatures. (secondary to MS-PS1-4)** ● **The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecules (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4)**
MS-PS3.B: Conservation of Energy and Energy Transfer	● **The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)** ● **Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)**
MS-PS3.C: Relationship Between Energy and Forces	● **When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)**
	http://www.nextgenscience.org/msps3-energy

Instructional Objective: MS-PS3-3	**Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.**
Instructional Objective: MS-PS3-4	**Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.**
Instructional Objective: MS-PS3-5	**Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.**
Instructional Objective: MS-PS1-4.	**Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.**
Instructional Objective: MS-PS1-5.	**Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.**

Essential Questions:
1. How can the perception of temperature be subjective? 2. How does the transfer of heat affect decisions in human society?
Guiding Questions: o How is temperature related to kinetic energy? o What are three scales commonly used to measure temperature and how do they relate to on another? o Why do things feel hot or cold? o What is the definition of thermal energy and how does it relate to heat? o How do conductors and insulators differ? o What are the 1st and 2nd laws of thermodynamics? o What to heat engines do? o How does the everyday definition of “heat” differ from the scientific definition? o When does heat transfer between two objects? o How are temperature and energy related?

Knowledge & Skills	
(What skills are needed to achieve the desired results?)	
By the end of this unit, students will know: ● The temperature of a substance is proportional to the *average* kinetic energy of the substance's molecules . ● Things expand when heated and contract when cooled due to the increase/decrease in kinetic energy. ● The three common scales to measure temperature (Kelvin, Celsius, and Fahrenheit) ● The difference between temperature and thermal energy ● Three methods of heat transfer: convection, conduction and radiation ● How conductors and insulators differ ● The direction of heat flow and the 2nd law of thermodynamics. ● The variables that affect temperature change in an object. ● The definition of specific heat (capacity). ● The 1st law of thermodynamics and how it relates to energy ● What heat engines do ● That heat is transferred from an object at higher temperature to an object at lower temperature. ● That heat transfer stops when the objects reach the same temperature.	By the end of this unit, students will be able to: ● Relate the motion and spacing of a substance's particles to the substance's temperature. ● Describe why object's expand or contract in terms of the temperature change of the object as well as the motion of the object's particles. ● Measure a substance's temperature using a standard thermometer and convert between Kelvin, Celsius and Fahrenheit. ● Relate thermal expansion/contraction to how thermometers work. ● Identify when substances can have the same temperature but possess different amounts of thermal energy. ● Differentiate between examples of convection, conduction and radiation. ● Use their knowledge of conductors and insulators to maximize and minimize thermal energy transfer. ● Determine temperature changes between two objects that exchange thermal energy. ● Be able to describe what happens to usable energy in a system. ● Describe the relationship between energy transferred, type/amount of matter, and temperature. ● Use the thermal energy/specific heat equation to calculate: temperature change, heat added or lost, mass of objects, and specific heats. ● Determine qualitatively the relative temperature of objects given a heat input and the objects' specific heat capacity. ● Describe examples of the 1st law of thermodynamics ● Identify examples of heat engines, specifically an internal combustion engine. ● Explain when heat will transfer between two objects and in which direction the heat will flow.

Suggested Activities
Developmental Activities ● Make a thermometer (www.energyquest.ca.gov/projects/thermometer.html) ● Diffusion in hot/cold water (www.sciencekids.co.nz/videos/experiments/changingplaces.html) ● The Difference between thermal energy and temperature ● https://njctl.org/courses/science/7th-grade-science/chemical-reactions-and-energy/attachments/temperature-thermal-energy-lab/ THERMAL TRANSFER: ● Heat transfer http://www.bgreen.kyschools.us/userfiles/1134/Classes/35116/Thermal%20Equilibrium%20Lab%2014-15-0.doc. ● heat transfer house (https://www.teachingchannel.org/videos/stem-lesson-ideas-heat-loss-project) ● test/observe the classroom/school to see where heat is being lost and create a energy audit for the board of ed ● Egg in a bottle (www.stevespanglerscience.com/lab/experiments/egg-in-bottle/) ● Hot and cold can competition (http://www.teachengineering.org/view_activity.php?url=collection/duk_/activities/duk_heattransfer_smary_act/duk_heattransfer_smary_act.xml) ● Shaking sand (cup of sand, take temperature, shake for time, re-take temperature) (mrmanlabs.blogspot.com/2010/09/sand-shake-lab.html) Assessment: ● Design a device to prevent a liquid from changing temperature in extreme conditions (hot and cold) ● Design an air conditioner (http://www.huffingtonpost.com/supercompressor/how-to-make-a-diy-air-con_b_7698632.html) ● Save the Penguins http://www.auburn.edu/~cgs0013/Schnittka_Bell_Richards_2010.pdf
Phenomenon: Why are the ice caps melting?