Science DesCartes: Concepts and Processes – Nature of Science

Skills: Understand Scientific Inquiry and Develop Critical Thinking Skills

Students:	DesCartes Skills: (Highlight the skills related to your chosen standard/concept)
	RIT 231-240: • Recognizes why it is important for scientific observations to be repeated before drawing conclusions • Classifies a given experiment as an example of replication when given the conditions and purpose of the experiment • Recognizes that when results differ, it is necessary to judge whether the differences are trivial or significant, and further study may be needed to determine this • Recognizes that when an observation does not agree with accepted scientific theory, it may be because the observation is mistaken or fraudulent, or it may be because the theory is wrong • Recognizes that any conclusion can be challenged by new evidence • Recognizes that all scientific knowledge, regardless of age, can be reviewed, criticized, and if necessary, discarded • Explains that because theories are models, they may be revised as more data becomes available • Recognizes that scientific knowledge accumulates most rapidly after the acceptance of a major new theory • Recognizes that as scientific theories are continually reevaluated, minor and major shifts in scientific thinking may occur • Recognizes that scientific ideas that are supported by large amounts of data and observation are unlikely to change in the future • Recognizes that when there is insufficient data to answer the question, multiple scientific explanations may exist simultaneously • Explains that when data is incomplete, new data can resolve competing theories • Recognizes that in areas of limited understanding, it may not be possible to determine which explanation is correct • Explains why areas of science with incomplete data are areas of opportunity • Recognizes that the purpose of scientific inquiry is not the discovery of absolute truth • Explains how the use of logical arguments distinguishes science from other disciplines • Explains how the use of skepticism distinguishes science from other disciplines • Evaluates pseudoscientific claims in the media • Defines scientific paradigm • Explains how theories, laws, and facts are used to answer questions • Explains why explanations about the natural world that are based on personal beliefs, religious values, superstition, and/or authority cannot be considered science • Identifies the dependent variable in a given experimental setup
	RIT 221-230: • Recognizes why it is important for scientific observations to be repeated before drawing conclusions • Recognizes why other scientists must be able to replicate results of an experiment • Recognizes that an idea must be tested multiple times before being accepted or rejected • Recognizes that uncertainty in measurement can produce results that differ slightly from experiment to experiment • Recognizes that slight changes in an experimental method can produce changes in the result of an investigation • Recognizes that slight differences in the things being investigated can produce differences in the result • Recognizes that when results differ, it is necessary to judge whether the differences are trivial or significant, and further study may be needed to determine this • Explains variations in the data recorded during an investigation • Explains limitations in the data recording during an experiment • Explains why a controlled experiment will produce reproducible results • Explains why repeating an investigation multiple times may increase the reliability of the data collected • Explains that before experimental results are generalized to a wider set of conditions, it is important to repeat the experiment using these conditions (e.g., drug tests, use of model organisms) • Explains why scientific ideas may change over time • Recognizes that despite the tentative nature of science, most core ideas of science have been confirmed through much observation and experimentation • Recognizes that when an observation does not agree with accepted scientific theory, it may be because the observation is mistaken or fraudulent, or it may be because the theory is wrong • Recognizes that any conclusion can be challenged by new evidence • Recognizes that all scientific knowledge, regardless of age, can be reviewed, criticized, and if necessary, discarded • Explains that because theories are models, they may be revised as more data becomes available • Explains that as new theories develop, previous data is not discarded but is reevaluated • Explains how experimental results may cause modification of a theory or hypothesis • Recognizes that scientific knowledge accumulates most rapidly after the acceptance of a major new theory • Recognizes that as scientific theories are continually reevaluated, minor shifts in scientific thinking may occur • Recognizes that as scientific theories are continually reevaluated, major shifts in scientific thinking may occur • Recognizes that scientific ideas that are supported by large amounts of data and observation are unlikely to change in the future • Gives examples of changes in scientific knowledge that have resulted from the appearance of new evidence • Recognizes that when there is insufficient data to answer the question, multiple scientific explanations may exist simultaneously • Explains that when data is incomplete, new data can resolve competing theories • Recognizes that when data is incomplete, great opportunity for advancement exists • Recognizes that when little understanding of an area exists, scientists may interpret data and theory differently

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	• Recognizes that in areas of limited understanding, it may not be possible to determine which explanation is correct • Recognizes that conclusions that are supported by insufficient data are weak • Explains why areas of science with incomplete data are areas of opportunity • Recognizes that the purpose of scientific inquiry is not the discovery of absolute truth • Recognizes practices of science that distinguish it from other ways of knowing • Explains how the use of logical arguments distinguishes science from other disciplines • Recognizes that reasoning can be distorted by faulty data • Recognizes that scientific understanding is produced through the use of logical arguments • Recognizes that scientific understanding is produced through the use of skepticism • Distinguishes hypotheses from conclusions and observations • Explains why there may be discrepancies between a scientific law and actual observations • Relates scientific theory, generation of hypotheses, and experimentation • Classifies a particular statement as an hypothesis • Compares the terms hypothesis, theory, principle, law, model, paradigm as used by scientists • Contrasts the terms theory and law • Explains how certain factors may bias data • Explains why explanations about the natural world that are based on personal beliefs, religious values, superstition, and/or authority cannot be considered science • Determines which variable (independent or manipulated) is being tested in control setup, when this variable has been purposefully omitted from the setup • Determines which variable (independent or manipulated) is being tested in a given experimental setup • Determines the independent variable by examining data presented as a line graph • Determines the control group in a given experimental set-up • Controls variables so that only the variable being tested changes over time • Evaluates inferences within the context of a scientific investigation • Understands that some tools are used to extend the senses
	RIT 211-220: • Understands that a key part of science is for scientists to confirm each other's findings • Understands that to replicate an experiment, the conditions of the experiment should be as similar to the original as possible • Understands that patterns and trends are easier to see when an experiment is repeated several times, multiple sets of data are collected, or data is averaged • Compares the results produced when an experiment is repeated several times • Recognizes that it can be difficult to determine the sources of error in an experiment • Lists possible reasons for inconsistent results • Recognizes that a controlled experiment will produce reproducible results • Compares controlled and uncontrolled

	experiments in terms of the consistency of data produced • Recognizes that science changes as new theories and evidence arise • Explains that scientific knowledge is tentative and therefore subject to change as new evidence is uncovered • Gives examples of changes in scientific knowledge that have resulted from the appearance of new evidence • Recognizes that when data is incomplete, great opportunity for advancement exists • Recognizes that when little understanding of an area exists, scientists may interpret data and theory differently • Explains that scientists investigate for many differing reasons, but the ultimate purpose is to understand the natural world • Describes characteristics of scientific thinking • Recognizes that reasoning can be distorted by strong emotions • Defines scientific theory • Contrasts the terms hypothesis, theory, principle, law, model, and paradigm as used by scientists • Classifies a particular scientific explanation as a theory • Classifies a particular statement as an hypothesis • Describes factors that produce biased data • Explains that science limits itself to natural phenomena • Explains that scientific explanations limit themselves to natural causes for natural phenomena • Recognizes that a key assumption of science is that the universe is a vast, single system that operates according to a single, consistent set of rules • Recognizes that a key assumption of science is that the rules which govern the universe can be discovered and understood by careful, systematic study • Explains that scientific theories depend on logically consistent arguments • Differentiates among testable and non-testable questions • Recognizes that testable questions are most useful in scientific investigations, as they can be answered by investigating • Determines which information should be collected in an experiment to answer a specific question • Evaluates to determine which procedure will best answer a specific question or solve a specific problem • Evaluates which procedure will best test a given hypothesis • Classifies the objects or persons undergoing a specific portion of an experiment as the control group • Explains the importance of controlling variables in an experiment • Determines which variable should be controlled in an experimental design, when given the problem or question being studied • Determines which variables are being controlled in a given experimental set-up • Understands that measurement of weight on a scale is not dependent on the arrangement of that object on the scale, as long as the entire object is touching only the scale • Classifies example representing specific stages of a specific scientific investigation

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	RIT 201-210: • Understands that when a scientific test is repeated using the same conditions, similar results usually occur • Recognizes that repeating an experiment many times may increase the reliability of the data collected • Explains why an observation must yield consistent, repeated results to be considered accurate • Explains why a scientific investigation will work the same way in different places • Recognizes that scientific ideas are tentative and therefore subject to change • Explains that as scientific knowledge increases, scientific ideas are subject to change • Understands that scientific knowledge is incomplete, and room exists for advancement in our understanding • Describes how scientific knowledge is modified as new information challenges previously held theories • Recognizes that direct observations allow a phenomenon to be confirmed whereas inference and relying on others' opinions do not allow a phenomenon to be confirmed • Understands that theories are based on multiple observations, concepts, principles, and historical perspective • Describes characteristics of theories • Describes factors that produce biased data • Recognizes bias in scientific information • Explains that scientific theories depend on logically consistent arguments • Asks questions that define the problem to be investigated, and which will allow relevant data or information to be collected • Evaluates to determine which procedure will best answer a specific question or solve a specific problem • Infers the problem being investigated in an experiment, given the setup and/or results of the experiment • Determines which variable (independent or manipulated) will be changed in the course of an investigation • Determines which variable should be controlled in an experimental design, when given the problem or question being studied • Determines which variables in a particular experiment must stay the same for results to be considered valid • Determines whether experiments are fair or valid, based on their design • Understands that to be scientific, explanations must be supported with evidence • Orders the stages that are likely to occur in a scientific study • Describes alternative data-gathering strategies that may be used in place of the traditional scientific method • Classifies example representing specific stages of a specific scientific investigation
	RIT 191-200: • Recognizes that repeating an experiment many times may increase the reliability of the data collected • Understands that scientists make the results of investigations public so that others can replicate their work • Recognizes that the accuracy of observations is improved by repeating the observations several times, and by having others replicate results • Recognizes that repeating an observation many times produces data of high quality and accuracy • Explains why an observation must yield consistent, repeated results to be considered accurate • Explains why a scientific investigation will work the same way in different places • Recognizes that science is limited to understanding the physical causes of the physical world • Recognizes that direct observations allow a phenomenon to be confirmed whereas inference and relying on others' opinions do not allow a phenomenon to be confirmed • Describes the criteria used to establish scientific laws and theories • Understands that a key part of the scientific process is accurate communication of procedures and results to others • Asks questions that define the problem to be investigated, and which will allow relevant data or information to be collected • Selects the appropriate research source to answer a specific question (e.g., personal interview, reference book, direct observation, experimental observation) • Differentiates among testable and non-testable questions (terms not used) • Determines which procedure will answer a specific question • Understands that the type of investigation a scientist does depends on the question he or she is answering • Determines which variables in a particular experiment must stay the same for results to be considered valid • Gives examples of tools that extend the senses • Orders the stages that are likely to occur in a scientific study
	RIT 181-190: • Explains why it is important for scientific observations to be accurate • Recognizes that results differ slightly when an experiment is repeated in a different place, at a different time, or by a different person, but the general evidence gathered in an experiment should be replicable by anyone, anywhere • Recognizes that the purpose of scientific inquiry is to better understand the natural world • Describes how theories are developed • Asks questions that define the problem to be investigated, and which will allow relevant data or info to be collected • Understands that magnifying glasses, telescopes and microscopes are used to extend the sense of sight
	RIT 171-180: • Asks questions that define the problem to be investigated, and which will allow relevant data or information to be collected • Understands that tools (such as scales) can measure only physical properties of an object

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Lesson Title:

Standard/Concept for All:

Introduction: (Get Attention; Connect to Prior Knowledge)

For Students Ready for a Challenge:
Lesson/Activity:
Resources:
Means of Assessment:

For Most Students:
Lesson/Activity:
Resources:
Means of Assessment:

For Students Needing Extra Support:
Lesson/Activity:
Resources:
Means of Assessment:

Closure/Summary for All: