Science DesCartes: Concepts & Processes: Scientific Process: Scientific Knowledge, Nature of Science

Skills: Scientific Knowledge

Students:	DesCartes Skills: (Highlight the skills related to your chosen standard/concept)
	RIT Above 230: • 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 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 • 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 are used to answer questions
	• Explains how laws are used to answer questions • Explains how facts are used to answer questions • Explains why explanations about the natural world that are based on personal beliefs cannot be considered science • Explains why explanations about the natural world that are based on religious values cannot be considered science • Explains why explanations about the natural world that are based on superstition cannot be considered science • Explains why explanations about the natural world that are based on authority cannot be considered science
	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

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	• 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 • 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 • Distinguishes between the ideas of hypothesis, fact, observation, opinion, model, and theory • 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 cannot be considered science • Explains why explanations about the natural world that are based on religious values cannot be considered science • Explains why explanations about the natural world that are based on superstition cannot be considered science • Explains why explanations about the natural world that are based on authority cannot be considered science • Recognizes that scientific explanations are considered valid when they meet multiple criteria (e.g., consistency with the evidence seen in nature, respect for the rules of evidence, openness to criticism, communication of methods used, public communication of results)
			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

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	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 • Distinguishes examples of observations from facts, theories, and hypotheses • 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 • Recognizes that scientific explanations are considered valid when they meet multiple criteria (e.g., consistency with the evidence seen in nature, respect for the rules of evidence, openness to criticism, communication of methods used, public communication of results) • Explains that scientific theories depend on logically consistent arguments
	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 scientific understanding is produced through use of empirical standards (i.e., the use of direct observation and measurement) • 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 • Distinguishes examples of theories from facts, observations, hypotheses • Describes characteristics of theories • Classifies a particular statement as an observation • Distinguishes examples of observations from facts, theories, and hypotheses • Describes factors that produce biased data • Recognizes bias in scientific information • Explains that scientific theories depend on logically consistent arguments • Recognizes that scientific explanations must be based on observations and scientific knowledge
	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 • Recognizes that scientific explanations must be based on observations and scientific knowledge

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	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 • Recognizes that scientific theories depend on evidence

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: