HS. Energy

Energy

A Performance Expectations HS.PS3.E

1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS.PS3.1
2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). HS.PS3.2
3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS.PS3.3
4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). HS.PS3.4
5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. HS.PS3.5
6. Analyze data to support the claim that Ohm's Law describes the mathematical relationship among the potential difference, current, and resistance of an electric circuit. HS.PS3.6

B Science and Engineering Practices HS.E.SEP

1. Developing and Using Models HS.E.SEP.1
   a. Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2),(HS-PS3-5) HS.E.SEP.1A
2. Planning and Carrying Out Investigations HS.E.SEP.2
   a. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4) HS.E.SEP.2A
3. Analyzing and Interpreting Data HS.E.SEP.3
   a. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS3-6) HS.E.SEP.3A

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4 Using Mathematics and Computational Thinking HS.E.SEP.4

a Create a computational model or simulation of a phenomenon, designed device, process, or system. (HSPS3-1) HS.E.SEP.4A

5 Constructing Explanations and Designing Solutions HS.E.SEP.5

a Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, studentgenerated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3) HS.E.SEP.5A

C **Disciplinary Core Ideas** HS.E.DCI

1 PS3.A: Definitions of Energy HS.E.DCI.PS3.A

a Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1),(HS-PS3-2) HS.E.DCI.PS3.A.1

b At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS- PS3-2) (HS-PS3-3) HS.E.DCI.PS3.A.2

c These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HSPS3-2) HS.E.DCI.PS3.A.3

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2 PS3.B: Conservation of Energy and Energy Transfer HS.E.DCI.PS3.B

a Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) HS.E.DCI.PS3.B.1

b Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3- 1) HS.E.DCI.PS3.B.2

c The availability of energy limits what can occur in any system. (HS-PS3-1) HS.E.DCI.PS3.B.3

d Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HSPS3-4) HS.E.DCI.PS3.B.4

e (NYSED) Energy exists in many forms, and when these forms change, energy is conserved. (HS-PS3-1),(HS-PS3-3),(HS-PS3-4) HS.E.DCI.PS3.B.5

f (NYSED) Electrical power and energy can be determined for electric circuits. (HS-PS3-6) HS.E.DCI.PS3.B.6

3 PS3.C: Relationship Between Energy and Forces HS.E.DCI.PS3.C

a When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5) HS.E.DCI.PS3.C.1

D Crosscutting Concepts HS.E.CC

1 Patterns HS.E.CC.1

a Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS3-6) HS.E.CC.1A

b Mathematical representations can be used to identify certain patterns. (HS-PS3-6) HS.E.CC.1B

2 Cause and Effect HS.E.CC.2

a Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5) HS.E.CC.2A

3 Systems and System Models HS.E.CC.3

a When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4) HS.E.CC.3A

b Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1) HS.E.CC.3B

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4 Energy and Matter HS.E.CC.4

a Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3) HS.E.CC.4A

b Energy can be transferred between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2),(HSPS3-6) HS.E.CC.4B

5 Influence of Science, Engineering, and Technology on Society and the Natural World HS.E.CC.5

a Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HSPS3-3) HS.E.CC.5A

6 Scientific Knowledge Assumes an Order and Consistency in Natural Systems HS.E.CC.6

a Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1) HS.E.CC.6A