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### Down For The Count - Rumford, That Is

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# Down for the Count -Rumford, that is

Jeff Morgan UNI Physics Department April 1, 2022



# Count Rumford (aka Benjamin Thomson)

Rumford wrote "An Experimental Enquiry Concerning the Source of the Heat which is Excited by Friction" (1798), and argued that heat was not the caloric.

Rumford had observed the frictional heat generated by boring cannon at the arsenal in Munich. Rumford immersed a cannon barrel in water and arranged for a specially blunted boring tool. He showed that the water could be boiled within roughly two and a half hours and that the supply of frictional heat was seemingly inexhaustible.







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PRISMS PLUS for students provides 44 complete learning cycles in four units. Each learning cycle includes original laboratory activities for exploration, concept development, and application plus the concept enhancer and conceptual practice support materials students need to complete their understanding.



### **Unit 1 FORCE AND MOTION**

1 Kinematics

2 Making tracks

**3** Accelerating Tracks

4 Vector Vector, What's My Vector?

5 Relative Motion 6 Static Equilibrium

7 Inertia

8 Newton's Second Law

9 Using Graphs to Understand Newton's Second Law

10 Weight

11 Newton's Third Law

12 Impulse and Change in Linear Momentum

13 Conservation of Linear Momentum

14 Projectile Motion



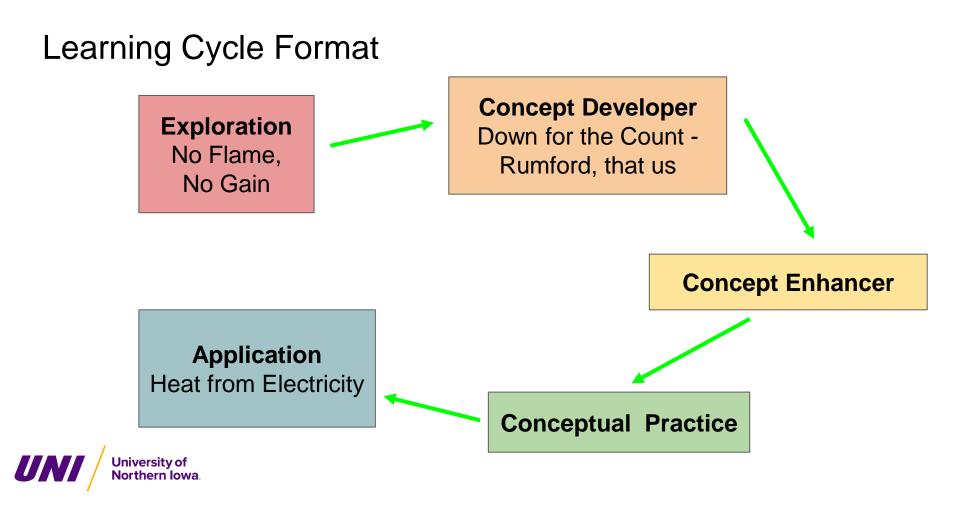
UNIT 2 WORK AND ENERGY	UN
1 Work	1 In Lun
2 Power	2 In
3 Conservation of Energy	
4 Heat and Temperature	3 V Wa
5 Change of Phase	4 S
6 Mechanical Equivalent of Heat	5 Fa
7 Ideal Gas Laws	6 R
8 Solar Energy	7 R
	8 Le
	9 In
	10 I

UNIT 3 WAVES AND OPTICS ncandescence or minescence? nverse Square elocity, Frequency and avelength speed of Sound actors Affecting Frequency Reflection Refraction enses. mage Size and Location Diffraction and Interference 11 Color 12 Polarized Light

UNIT 4 ELECTRICITY. MAGNETISM. AND MODERN PHYSICS 1 Electrostatics 2 Electric Fields **3 Magnetic Fields 4 Electric Circuits** 5 Ohm's Law 6 Capacitors 7 Motors 8 Generator 9 Radioactive Decay

10 Spectra and Energy

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object Construct and interpret graphical displays or data to describe the relationships or kinetic energy to the mass or an object and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and and the speed of an object.] Examples could include riding a bicycle at different speeds, rolling different sizes Students who demonstrate understanding can: interacting at a distance changes, different amounts is on relative amounts of potential energy, not mass separately from kinetic energy and sp ing distances could include: the Earth MS-PS3and to the speed of all energy and the speed of all energy 1. Create a computational model to calculate the change in the energy of one component in a system when the change in and out of the system are known (Clarification Statement: Emphasis) changing the mate's hair. Examples Develop a model to describe that when Greate 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. [Clarification Statement: Emphasis is an explaining the meaning of mathematical expressions used in the model 1 (Assessment Roundant: Assessment is limited to be a system). of potential energy are stored in the sy energy of the other component(s) and energy flows in and out of the system are known. [Ciarincation Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to be an an and to the model and the thermal energy triatic energy to be a subtracted and to the model energy triatic energy to be a subtracted and to the model.] on calculations of potential energy. Exam MS-PS3is on explaining the meaning or mathematical expressions used in the model. J Missessment boundary: Assessment is immediate basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and to thermal energy, kinetic energy, and either a roller coaster cart at varying and/or the energies in gravitational, magnetic, or electric fields.] 2. direction/orientation of a magnet, and a direction/onentation of a magnetization HS-PS3-of models could include representation 2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of particles (chicate) and aparticles and aparticles to the relative positions of particles (chicate) and aparticles (chicate) and apa Assessment is limited to two objects Develop and use models to indistrate that energy at the macroscopic scale can be accounted for as a complication of particles (objects) and energy associated with the relative positions of particles (objects) and energy associated with the relative positions of particles (objects) and energy associated with the relative positions of particles of phonomenon at the macroscopic scale could individe the conversion of kinetic energy associated with the motion or particles (objects) and energy associated with the relative positions or particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic Apply scientific principles to desig **(objects).** [Clamication Statement: Examples of prenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically objects. Examples of models could include discusses drawings descriptions and computer simulations 1 transfer.\* [Clarification Statement: ] energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.] MS-PS3-Assessment Boundary: Assessment HS-PS3-Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy into another form of devices of devi Plan an investigation to determ 3. з. Design, build, and refine a device that works within given constraints to convert one form of energy into another torm of energy.\* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices of devices and departed evaluations of devices. Examples of devices of devices and departed evaluations of devices. Examples of devices and departed evaluations of devices and departed evaluations of devices. change in the average kinetic e energy. [Coamication Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include the of productive of another top of anot MS-PS3-Statement: Examples of experim Could include Hube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to device constructed with materials provided to students 1 same volume of water with the to total output for a given input. Assessment is limited to devices constructed with materials provided to students.] 4. mass as they cool or heat in th HS-PS3-Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of added.] [Assessment Boundar 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 custom (accord laws of thermachinemical). I Classification Statement: Emphasis is an analyzing data two components in the system (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from any descent this to describe the ensure bath quantitatively and personal trained and the system (second law of the system). Construct, use, and presen components in the system (second law or thermodynamics). [Ularmication Statement: Emphasis is on analyzing data indicated thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquide at different initial temperatures or adding chiests at different. transferred to or from the MS-PS3inventory or other represen sudent investigations and using mathematical thinking to describe the energy changes both quantitatively and concerned examples of investigations could include mixing liquids at different initial temperatures or adding objects at different to investigations based on motorial and tools and tools and tools and tools and tools at the investigations based on motorial and tools at the investigation of the inv Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to etudente 1 object.] [Assessment Boun 5. HS-PS3-Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the objects in energy of the objects due to the interaction. Clarification Statement: Examples of models only 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. [Clarification Statement: Examples of models could include drawinge discreme and texts such as drawinge of what happens when two charges of opposite polarity are near each 5. objects and the changes in energy or the objects due to the interaction. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other 174 constraints and texts.] University of UNI Northern lowa



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