COURSE TITLE

Amusement Parks and Bridges

LENGTH

One Semester

DEPARTMENT

STEM Department

SCHOOL

Union Middle School

DATE

September 10, 2018

Initial BOE Approval Date (Born on): 4/4/2016

Amusement Parks and Bridges

I. Introduction/Overview/Philosophy

In this class, students will explore structures as they are related to amusement park rides and bridges. Half of the course will be students exploring the forces involved in physical science by researching, building and measuring various amusement park rides (loops, Ferris wheels, and roller coasters). The other half of the class will focus on the construction of bridges. After researching the background and physics behind designing bridges, students will then build and test their own bridge.

II. Objectives

Course Outline:

1. Intro to Course – Engineering Practices
    a. Team building
    b. Column strength
    c. Distinguish between amusement parks and carnivals.
    d. Newton/ Galileo principles
    e. Physics terms force, G-force, gravity, friction, acceleration, air-resistance.
    f. Computerized simulations
    g. Bounce height simulations
2. Building Rides
    a. Examine rides
    b. Simulate rides with K'Nex
3. Constructing gravity machines
    a. Building paper coasters or "marble run".
    b. Investigate gravity, potential energy, kinetic energy, and friction.
4. Investigate tensile strength and gravity.
    a. Build bungee jump actions figures and test.
5. Constructing efficient bridges
    a. Build with Knex and test strength
    b. Build to resist compression and tension forces.
    c. Build with file folders and glue and test strength.
    d. Build with recyclable materials and test.
    e. Build on Tinkercad and print 3-D bridges.

Student Outcomes:

After successfully completing this course, the student will:

- Understand how roller coasters work.
- Use physics to explain how a roller coaster model works.
- Discuss the effect of gravity and friction in the context of their designs.
- Use the principle of conservation of energy to explain design and layout.
- Identify maximum kinetic and potential energy.

- Use g-forces to explain why a person will feel thrills during changes in forces.
- Identify acceleration and deceleration.
- Build simulations of roller coasters.
- Construct an efficient bridge related to mass.
- Evaluate and improve upon prior designs.
- Calculate efficiency.
- Use engineering practices.

New Jersey Student Learning Standards

CAREER READY PRACTICES

CRP1 Act as a responsible and contributing citizen and employee.

Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

CRP2 Apply appropriate academic and technical skills.

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation

CRP4 Communicate clearly and effectively and with reason.

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP6. Demonstrate creativity and innovation.

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

CRP7. Employ valid and reliable research strategies.

Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

CRP11. Use technology to enhance productivity.
Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

CRP12. Work productively in teams while using cultural global competence.
Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

TECHNOLOGY

Standard 8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
Strand E: Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
8.1.8.E.1- Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem.
Standard 8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
Strand A. The Nature of Technology: Creativity and Innovation Technology systems impact every aspect of the world in which we live.
8.2.8.A.2- Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system.
8.2.8.A.3- Investigate a malfunction in any part of a system and identify its impacts.
Strand C. Design: The design process is a systematic approach to solving problems.
8.2.8.C.4- Identify the steps in the design process that would be used to solve a designated problem.
Strand D. Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
8.2.8.D.3- Build a prototype that meets a STEM-based design challenge using science, engineering, and math principles that validate a solution.

21ST CENTURY LIFE AND CAREERS

9.2 Career Awareness, Exploration, and Preparation
Strand B: Career Exploration
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.

9.3 Career and Technical Education

Cluster: Science, Technology, Engineering & Mathematics Career Cluster

9.3.ST-ET.1-Use STEM concepts and processes to solve problems involving design and/or production.
9.3.ST-ET.2-Display and communicate STEM information.
9.3.ST-ET.3-Apply processes and concepts for the use of technological tools in STEM.
9.3.ST-ET.4-Apply the elements of the design process.
9.3.ST-ET.5-Apply the knowledge learned in STEM to solve problems.

COMPANION STANDARDS FOR SCIENCE AND TECHNICAL SUBJECTS

RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
RST.6-8.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.
RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
RST.6-8.10. By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.
WHST.6-8.6. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.
WHST.6-8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
WHST.6-8.8. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
WHST.6-8.10. Write routinely over extended time frames (time for research, reflection, metacognition/self-correction, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

NEW JERSEY STUDENT LEARNING STANDARDS- SCIENCE

MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
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. [
MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces
MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
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.

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.
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

III. Proficiency Levels

Amusement Parks and Bridges is a semester elective course appropriate for all grade 7 and 8 students.

IV. Methods of Assessment

Student Assessment
The teacher will provide a variety of assessments during the course of the year. The assessment may include but is not limited to: research projects, portfolios, projects, participation, group work, and other teacher-developed methods of assessment.

Curriculum/Teacher Assessment
The teacher will provide the subject area supervisor with suggestions for changes on an ongoing basis.

V. Grouping

This is a middle school elective course offered to students in grade 7 and grade 8.

VI. Articulation/Scope & Sequence/Time Frame

Course length is one semester.

VII. Resources

Texts/Supplemental Reading/References

Resources include but are not limited to:

1. www.brainpop.com/technology/scienceandindustry/bridges/
2. http://www.physicsgames.net/game/Bridge_Builder.html
3. https://www.brainpop.com/science/motionsforcesandtime/acceleration/
4. https://www.learner.org/interactives/parkphysics/parkphysics.html
5. https://www.teachengineering.org/view_activity.php?url=collection/duk_/activities/duk_rollercoaster_music_act/duk_rollercoaster_music_act.xml

6. http://www.learner.org/interactives/parkphysics/freefall2.html
7. http://discoverykids.com/games/build-a-coaster/
8. https://www.youtube.com/watch?v=_DzxvF9UnHE
9. http://www.coasterforce.com/coasters/technical-info/physics-of-a-coaster
10. Attached optional activities

VIII. Suggested Activities

Appropriate activities are listed in the curriculum map.

IX. Methodologies

The following methods of instruction are suggested: lecture, group projects, demonstration, hands-on applications, and class presentations.

X. Interdisciplinary Connections

The primary focus of this course is to allow students to connect concepts learned in the regular science classroom to activities and situations in the real world. Applications to math, English/language arts, writing, and social studies will be made on a daily basis through a variety of projects and explorations.

XI. Differentiating Instruction for Students with Special Needs: Students with Disabilities, Students at Risk, English Language Learners, and Gifted & Talented Students

Differentiating instruction is a flexible process that includes the planning and design of instruction, how that instruction is delivered, and how student progress is measured. Teachers recognize that students can learn in multiple ways as they celebrate students' prior knowledge. By providing appropriately challenging learning, teachers can maximize success for all students.

Differentiating in this course includes but is not limited to:

Differentiation for Support (ELL, Special Education, Students at Risk)

- Peer mentoring on problems
- Differentiated teacher feedback on assignments
- Modeling out problems on whiteboard
- Visual aids as we project problems on whiteboard
- Study guides
- Tiered assignments
- Scaffolding of materials and assignments
- Re-teaching and review
- Guided note taking
- Exemplars of varied performance levels
- Multi-media approach to accommodating various learning styles

Differentiation for Enrichment

- Supplemental reading material for independent study

- Flexible grouping
- Tiered assignments
- Topic selection by interest
- Enhanced expectations for independent study
- Elevated questioning techniques using Webb's Depth of Knowledge matrix

XII. Professional Development

The teacher will continue to improve expertise through participation in a variety of professional development opportunities.

XII. Curriculum Map/Pacing Guide

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
Intro to Course – Engineering Practices • Team building • Column strength • Distinguish between amusement parks and carnivals. • Newton/ Galileo principles • Physics terms force, G-force, gravity, friction, acceleration, air-resistance. • Computerized simulations • Bounce height simulations	1 week	*For Support:* Heterogeneous grouping. Project rubrics. Scaffolding and modeling of ideas and challenge objectives. *For Enhancement:* Additional projects and simulations provided.	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4 MS-PS2-1 MS-PS2-2 MS-PS2-3 MS-PS2-4 MS-PS2-5 MS-PS3-3 MS-PS3-4 MS-PS3-5 CRP1,2,4,6,7,8,11,12 8.1.8.E.1 8.2.8.A.2,3 8.2.8.C.4 8.2.8.D3 9.3.ST-ET.1-5 RST.6-8.1,2,4,9,10 WHST.6-8.6,7,8,10	*Formative Assessment:* Ed Puzzle video, questioning, daily 4 C's evaluation ***Creativity, Collaboration, Critical Thinking, Communication*** *Summative Assessment:* Lab report
Building Rides • Examine rides • Simulate rides with K'Nex	1 week	*For Support:* Heterogeneous grouping Blueprints and instructions manuals to provide step-by-step procedures.	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4 MS-PS2-1	*Formative Assessment:* Daily 4 C's evaluation, group interaction, meeting with students.

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
		For Enhancement: Encourage students to build their own rides without instructions.	MS-PS2-2 MS-PS2-3 MS-PS2-4 MS-PS2-5 MS-PS3-3 MS-PS3-4 MS-PS3-5 CRP1,2,4,6,7,8,11,12 8.1.8.E.1 8.2.8.A.2,3 8.2.8.C.4 8.2.8.D3 9.3.ST-ET.1-5 RST.6-8.1,2,4,9,10 WHST.6-8.6,7,8,10	*Summative Assessment:* Completed rides – project grade. 4 C's summative evaluation.
Constructing gravity machines • Building paper coasters or "marble run". • Investigate gravity, potential energy, kinetic energy, and friction.	7 weeks	*For Support:* Heterogeneous grouping Work in small groups with students to provide sample parts of the ride, online tutorials and video. *For Enhancement:* Challenge students to compete for longest "run".	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4 MS-PS2-4 MS-PS2-5 MS-PS3-3 MS-PS3-5 CRP1,2,4,6,7,8,11,12 8.1.8.E.1 8.2.8.A.2,3 8.2.8.C.4 8.2.8.D3 9.3.ST-ET.1-5 RST.6-8.1,2,4,9,10	*Formative Assessment:* Daily 4 C's evaluation. Group interaction. Daily progress and fabrication of basic ride parts. *Summative Assessment:* Project grade. Summative 4 C's evaluation. Time records.

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
			WHST.6-8.6,7,8,10	
Investigate tensile strength and gravity. • Build bungee jump actions figures and test.	1 week	*For Support:* Heterogeneous grouping Modeling construction, sample *projects*. *For Enhancement:* Challenge students to drop from largest heights possible.	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4 MS-PS2-3 MS-PS2-5 MS-PS3-3 MS-PS3-4 CRP1,2,4,6,7,8,11,12 8.1.8.E.1 8.2.8.A.2,3 8.2.8.C.4 8.2.8.D3 9.3.ST-ET.1-5 RST.6-8.1,2,4,9,10 WHST.6-8.6,7,8,10	*Formative Assessment:* Daily 4 C's evaluation. Group interaction. Construction of the bungee jump. *Summative Assessment:* Summative 4 C's evaluation.
Constructing efficient bridges • Build with Knex and test strength • Build to resist compression and tension forces. • Build with file folders and glue and test strength. • Build with recyclable materials and test.	10 weeks	*For Support:* Heterogeneous grouping. Project rubrics. Scaffolding and modeling of ideas and challenge objectives. Small group interaction providing guidance and support. *For Enhancement:* Encourage students to create from scratch without online research. Test for	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4 MS-PS2-3 MS-PS2-4 MS-PS2-5 MS-PS3-3 MS-PS3-4 MS-PS3-5 CRP1,2,4,6,7,8,11,12 8.1.8.E.1	*Formative Assessment:* Daily 4 C's evaluation. Group interaction. Periodic testing of bridges for efficiency calculations. *Summative Assessment:* 4 C's summative assessment. Final bridge testing for efficiency. Tinkercad daily progress. Tinkercad finished bridge

Unit Topic	Time Allocated	Differentiating Instruction for Students with Disabilities, Students at Risk, English Language Learners, & Gifted & Talented Students	Standards	Assessments
• Build on Tinkercad and print 3-D bridges.		efficiency, not just for total strength.	8.2.8.A.2,3 8.2.8.C.4 8.2.8.D3 9.3.ST-ET.1-5 RST.6-8.1,2,4,9,10 WHST.6-8.6,7,8,10	and 3-D printed model.