Experimental Design with Force (Springs)

Time of Lesson: 50- 60 minutes

Content Standards Addressed in Lesson:

TEKS6.8A compare and contrast potential and kinetic energy (Reporting Category 2 – Supporting Standard)

NSES (1996) **Grades 5-8 – Content Standard B**

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

Scientific Investigation and Reasoning Skills Addressed in Lesson:

TEKS6.2A plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology

TEKS6.2B design and implement experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology;

TEKS6.2E analyze data to formulate reasonable explanations, communicate valid conclusions supported by data and predict trends

TEKS6.3B use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature

TEKS6.3C identify advantages and limitations of models such as size, scale, properties, and materials

TEKS6.4A use appropriate tools to collect, record and analyze information, including computers

NSES (1996) **Grades 5-8 – Content Standard A**

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

I. Student Prerequisite Skills/Understandings

1. A force is a push or a pull.
2. Ability to distinguish between distance and displacement.
3. Definition and examples of independent and dependent variables.

II. Objectives: Students will be able to

1. Predict and justify results from an experiment.
2. Observe the pattern that forces of springs are proportional to the distance they stretch or compress.
3. Explore how the potential and kinetic energy of an object changes as it is in motion and in different environments.

III. Supplies Needed

Engage: per group of four

- One popper toy

Explore: per group of four:

- One spring
- Three masses (two with known mass, one without known mass)
- One ruler
- One paperclip to be used to attach masses to spring

Elaborate: per pair

- One laptop

5E Organization

Engage (5 minutes)

Content Focus: Springs can be used for scientific investigations.

Teacher passes out one popper toy for each group of four and allows students to play with toy for two minutes. Teacher explains that springs can be used in many tasks.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What are the parts of the toys in front of you? • What part is responsible for the release of the toy?	• What objects can you name that use springs to make them work or move? • How do these objects use springs?

Teacher introduces the **Question of the Day**: "How can we use a spring to determine the mass of an object?

- ✓ **Checkpoint:** Students can describe different practical uses of springs. All popper toys are collected.

Explore – Hands-on Investigation (20 minutes)

Content Focus: Independent and dependent variables, importance of a fair test
Investigation and Reasoning Skills: plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology, design and implement experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology, analyze data to formulate reasonable explanations, communicate valid conclusions supported by data and predict trends, use appropriate tools to collect, record and analyze information

Teacher shows students the materials they will be given in the lab (ruler, spring and blocks) and asks the students to describe how they could use the materials to answer the Question of the Day. Teacher reviews displacement, fair test and independent and dependent variables. Students explain what the dependent and independent variables will be for their investigation. Teacher passes out investigation sheets. After students complete #1-6 on their sheets, teacher passes out materials.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What could you use the spring for in our investigation for today? • What could you use the blocks for? • What could you use the ruler for? • In our investigation, what will we be changing? • What is your prediction? • What can you observe about the behavior of your spring as you place the object on it?	• If I have the measurement of the spring without the object and then I attach the object to the spring what is the displacement? • What are the independent and dependent variables for our experiment? • Why do you think it is important to conduct a fair test? • How does the displacement of the spring relate to the mass of the object attached? • Why do you think the spring bounces for a short time then stops? What does that tell you about the spring? • How did you find the mass of your unknown? • If you were to do this experiment again, what would you change? Why?

✓ **Checkpoint:** Students have completed their investigation. Students notice relationship between the displacement of a spring and the mass of an object. Materials are collected.

Explain (10 minutes)

Content Focus: compare and contrast potential and kinetic energy
Reasoning: analyze data to formulate reasonable explanations, communicate valid conclusions supported by data and predict trends

Teacher leads discussion on students' results from their investigations. Teacher calls on group members to detail their procedure. Students discuss limitations of their experiment and how they could improve their experiment. Teacher relates potential and kinetic energy to the motion of an object when placed on a spring. Students describe how the potential and kinetic energy of the object changed as the object was in motion.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What were your predictions? • What was your procedure? • What did you keep constant? • What are a few limitations of your experiment? • What is a variable that we didn't consider? • What is the energy that an object has while it is in motion? • What is the energy that an object has because of its position?	• What variables did you keep the same to make it a fair test? • How did you measure the effect of the independent variable on the dependent variable? • What was your conclusion? • When do you think knowing that a spring stretches longer with an object with a larger mass attached would be important to know? • How would you improve your experiment in the future? • When did the object possess the most potential energy? Kinetic?

✓ **Checkpoint:** Students can explain the results of their investigation and describe how the potential and kinetic energy changes as the object was in motion on the spring.

Elaborate –*Masses and Springs* PhET Simulation (10 minutes)

Content Focus: compare and contrast potential and kinetic energy, the motion of an object changes in different environments
Investigation Skills: use models to represent aspects of the natural world, identify advantages and limitations of models such as size, scale, properties, and materials, use appropriate tools to collect, record and analyze information, including computers

Teacher posts "Weight on Other Planets" worksheet on the document camera. Teacher guides students to notice that objects have different weights on different planets and the moon. Teacher asks students to hypothesize why they think this is the case. Students move to computer simulation and are given five minutes of open play. After five minutes have passed, teacher projects simulation in front of class and students point out what they have discovered. Students are given 10 minutes to complete the Masses and Springs PhET activity sheet.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What differences do you notice about how the object behaves on the spring in different environments? • What happens to the potential energy of the spring as you switch from different planets or on the moon? • When does the spring have the most kinetic energy? Potential energy?	• On different planets, we have seen that your weight would be different. Do you think your mass would be different? Why or why not? • Why do you think the block hangs lower on Jupiter? • What factors do you think contribute to how far a spring stretches in different environments? • Based on what you know about Pluto, how do you think a spring would be have on it? • How else could you predict how objects behave on Jupiter?

- ✓ **Checkpoint:** Students have completed their investigation sheets and can describe their observations using the terms potential and kinetic energy.

Evaluate

Use evaluations in attached documents.

Name: _____ **Date:** _____

Spring Lab

1. Question for investigation:

How can we use a spring to determine an unknown mass?

2. Prediction (What do you think will happen?):

_____
_____
_____

3. Variables (a variable is anything you use or do in the investigation that can affect the outcome or results of the investigation)

Independent Variable (the variable in this investigation that is being changed by you): _____

Dependent Variable (the variable that is observed): _____

4. Materials used:

- **Spring**
- **Three masses (two with known mass, one with unknown mass)**
- **Ruler**

5. Set up:

Why is the ruler placed where it is? _____

Why are the object attached in the same place? _____

Draw a picture of your setup:

6. Procedure (explain how you are going to do your experiment and write as a series of steps):

_____

_____

_____

STOP – Check with your teacher!

7. You may now begin to set up and test your experiment. Remember to work as a team.

Fill in the table below with your collected data:

Object	Mass	Initial length of spring (cm)	Length of spring with object attached (cm)	Displacement of spring = length with object attached – initial length
#1				
#2				

8. What is the relationship between the displacement of a spring and the mass of an object attached?

_____

_____

_____

9. Now we'll estimate the mass of our unknown!
What is the displacement of the spring with Object #3 attached?

_____

What do you think is the mass of Object #3?

_____

10. Conclusion – What happened? Does your data support your prediction?

_____

_____

_____

_____
_____
_____

11. If you were to do this experiment again, what would you change?

_____
_____
_____

12. What questions do you have now?

_____
_____
_____

Name: _____

Masses and Springs PhET

1) Take 5 minutes to explore how the springs move when masses are put on them. Talk about what you find with your partner.

2) a) **Explore** how the springs and objects behave in different environments.
b) Fill in the table to help describe what you find out.

Place	**What happens to the spring?**
Earth	

5) Fill in the following table and circle if the **potential energy before the spring is released** increases or decreases.

What did you do?	**Potential Energy** - before the spring is released (circle your answer)
Switch from Earth to Jupiter	o Increases o Decreases
	o Increases o Decreases
	o Increases o Decreases
	o Increases o Decreases

3) What do you think affects how the spring stretches on different places?
_____
_____

4) **Draw** three snapshots (moments in time – like a picture!) of the motion of your spring.

What does the spring look like?	**Which is greater?** (circle your answer)
	o Potential Energy o Kinetic Energy
	o Potential Energy o Kinetic Energy
	o Potential Energy o Kinetic Energy

Name: _____

Show off what you know!

1. Which of these is **NOT** a **force** that acts on an object:
    a. Gravity
    b. Friction
    c. Both of these act on an object
    d. None of these act on an object

2. An object is attached to the bottom of a spring hung from the ceiling. Using the following table, determine the mass of the unknown object.

Mass	Length Stretched
10 grams	20 cm
X	30 cm
20 grams	40 cm

    a. 0 grams
    b. 5 grams
    c. 25 grams
    d. 15 grams

Consider the following scenario to answer Questions 3 and 4:

You put an object on a spring and then let it bounce up and down. It stops moving after a few minutes.

3. When did the object have the **most** potential energy?
    a. When it was bouncing.
    b. Before it started bouncing.
    c. When it stopped bouncing.
    d. Both b and c.

4. When did the object have kinetic energy?
    a. When it was in motion.
    b. Before it started bouncing.
    c. When it stopped bouncing.
    d. None of the above. Kinetic energy remains constant.

5. If a spring has an object attached to it on Jupiter, the spring would change shape:
    a. more than on Earth.
    b. less than on Earth.
    c. the opposite direction as on Earth.
    d. The spring wouldn't change shape.

6. Journal Question: A scale you weigh yourself with uses springs. How do you think it works? Why?

_____

_____

Show off what you know!

KEY

1) C

2) D

3) D

4) A

5) A

6) Your scale has a spring inside that is calibrated so that depending on how much you stretch the spring inside will relate to how much you weigh. The more that you weigh the further the spring will stretch on the inside of the scale.

Weight on Other Planets!

Let's assume that you weigh **50 Newtons** on Earth. Here is what your weight would look like on different planets:

Planet	**Weight (N)**
Mercury	18.9
Jupiter	118.2
Saturn	53.2
Uranus	44.4
Neptune	56.2

What conclusion can you draw about your weight on Jupiter compared to Earth?