Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Forces Notes 5 Block: \_\_\_\_\_\_\_

**Review and Purpose**

Until now we have studied different **forces** that can act on an object. The **force of gravity** $\vec{F\_{g}}$ from the Earth

always acts in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ direction, the **normal force** $\vec{F\_{n}}$ is always at 90○ to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

that is being pushed against, and the **force of friction** $\vec{F\_{f}}$ is always in the direction opposite the \_\_\_\_\_\_\_\_\_\_\_\_\_ of the object.

Purpose: Today we look at a new force that comes from the **distortion** or \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an objects shape called the **restoring force** or the **elastic force.**

 **The Restoring or Elastic Force** $\vec{F\_{s}}$

When you apply a **force** on an object, a push or a \_\_\_\_\_\_\_\_\_\_\_\_\_, the object will **change its shape**. When you remove the force you are applying to the object, a force called the **restoring force** will return the object to its original shape.

Example: A plastic ruler is attached to the top of a desk and a mass is tied to the end.

desk

mass

ruler

equilibrium position

x = distortion

To understand more about the **restoring force** $\vec{F\_{s}}$ lets draw the free-body diagram for the mass attached to the ruler.

Since the mass is not **accelerating** there must be a force balancing the **force of gravity**. This force is called the

**restoring force** and is give the symbol $\vec{F\_{s}}$. The amount the ruler bends from its **original position** is called the

**distortion** $\vec{x}$. **Distortion** has both size and direction and is therefore a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ quantity.

Q1: What would happen to the **distortion** if more mass was added to the ruler?

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Q2: What is the value of the **restoring force** if someone applied an **upwards force** of 15 N to the ruler?

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The **distortion** of any material is directly proportional to the **restoring force**. This just means that the greater

the **distortion** the \_\_\_\_\_\_\_\_\_\_\_\_\_\_the **restoring force**. Since the **restoring force** is always trying to return the

object to its original shape, this force is always in the direction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the **distortion.**

 Hook’s Law: $\vec{F\_{s}}=-k\vec{x}$ k is the **spring constant** for the material and has units of N/m.

\*It is important to note that there is a negative sign, this ensures the distortion is opposite the restoring force.\*

All material have a spring constant (k) and the higher this value the harder it is to distort the material.

Q3: An **elastic band** is distorted 0.35 m with an **applied force** of 35 N. What is the restoring force? Calculate the spring constant for the elastic band.

 (100 N/m)

Q4: An iron bar has a spring constant of 2.5 x 103 N/m, if a force of – 5.00 x 102 N is applied to the bar, what is the restoring force equal to? What is the distortion of the bar? (500 N, -0.02 m)

Q5: A 25 kg mass is hung from a 2.0 m vertical **spring** and distorts the spring -0.45 m. Calculate the spring constant for the spring. Draw a FBD.

 (544.4 N/m)

Q6: For the spring in question 5, what length would the spring stretch to if a 50.0 kg mass was hung from it? (2.9 m)

\*\*Materials are **limited** in how far they can be distorted, if you continue to apply a force to an elastic band you will eventually break it. If you distort it too much, but it doesn’t break, it will not return to its original length.\*\*

**Homework: Do the following questions and show your work using GRASS on lined A4 paper.**

1. A 1.00 kg mass on a horizontal spring is 0.100 m from the spring’s equilibrium position. If the spring constant is 10.0 N/m, what is the **elastic force** acting on the mass?
2. The **restoring force** acting on a 0.50 kg object connected to a horizontal spring is 2.0 N. If the spring constant is 15 N/m, what is the distortion of the spring?
3. The **elastic force** acting on a 0.60 kg object on a horizontal spring is -1.2 N. If the distortion of the spring is 0.025 m, what is the spring constant of the spring?
4. A box with a **weight** of 1.65 N will stretch a vertical spring -0.110 m. What is the spring constant?
5. A mass of 5.0 kg will stretch a vertical spring -3.25 cm. What is the spring constant?
6. A jelly bean with a force of gravity equal to -9.3 N is hung on a vertical spring of length 2.0 m that has a spring constant of 25 N/m. What is the final length of the spring?
7. A 75 g object pulls horizontally at the end of a spring (k = 5.0 N/m). If the maximum displacement of the object is 0.080 m, what is the maximum force from the spring?

**Solutions**

1. -1.00 N 2. -0.13 m 3. 48 N/m 4. 15.0 N/m 5. 1.5 x 103 N/m 6. 2.37 m 7. -0.40 N