11.1 Notes

- Vibrations and Waves




- A repeated motion, such as an acrobat swinging, is called a periodic motion.
- As you know, a spring always pushes or pulls a mass back toward its original position. This is called the **restoring force**.
- Any periodic motion that is the result of a restoring force is called **simple harmonic motion**.




Hooke's Law

- Spring force = -(spring constant x displacement)
- The negative sign signifies that the direction of the spring force is always opposite the mass's displacement.
- The value of the spring constant is a measure of the stiffness of the spring. The greater the k, the greater the force needed to stretch or compress the spring.
- SI units of k are N/m

Hooke's Law

Force (newtons)

Extension or compression (meters)

$$F = -kx$$

Spring constant (newtons/meters)

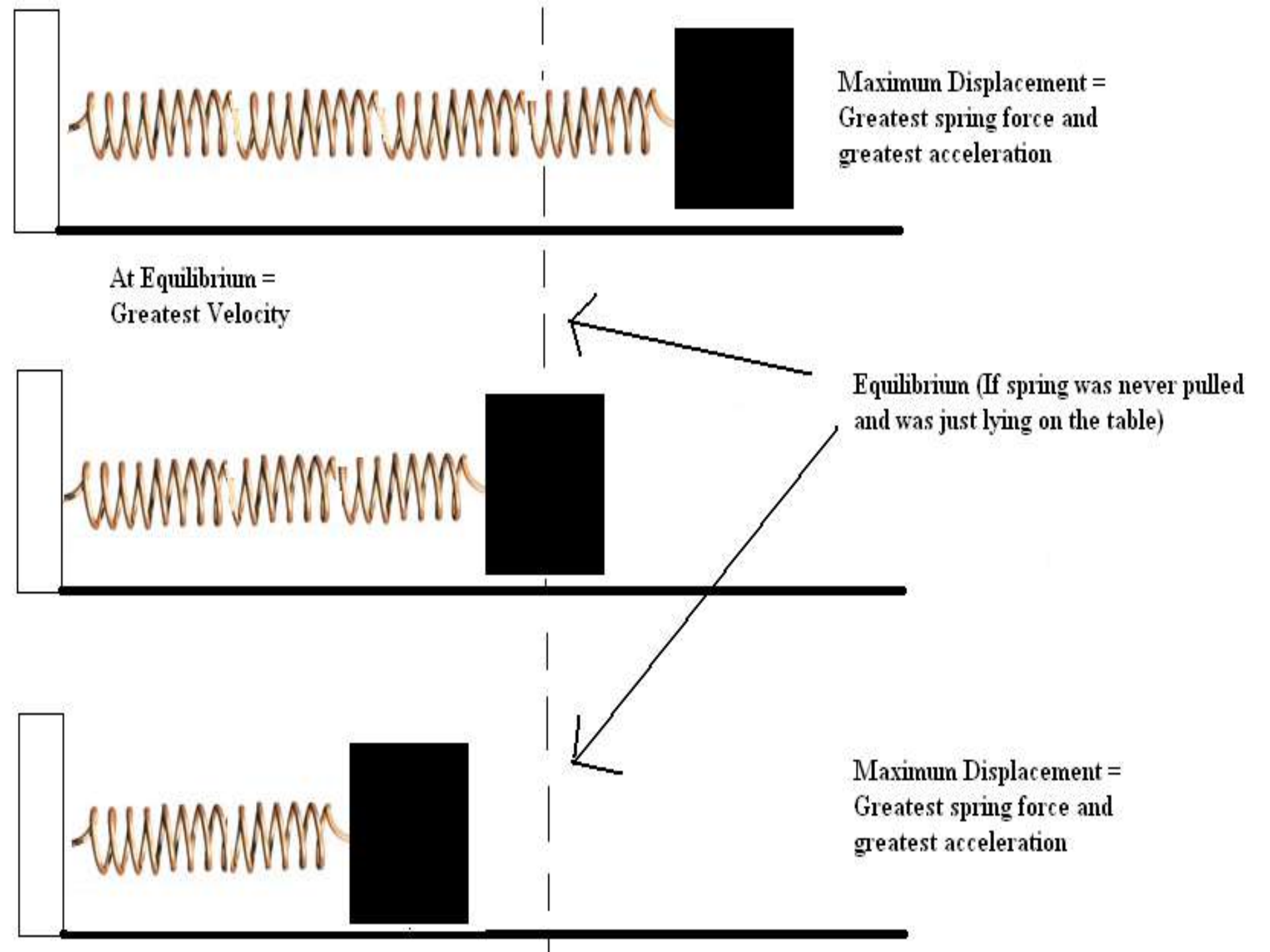
Spring force = -(K x)

- Suppose a spring with a mass of 50 kg is stretched vertically 30 cm. What is the spring constant in this case?




Velocity and Acceleration

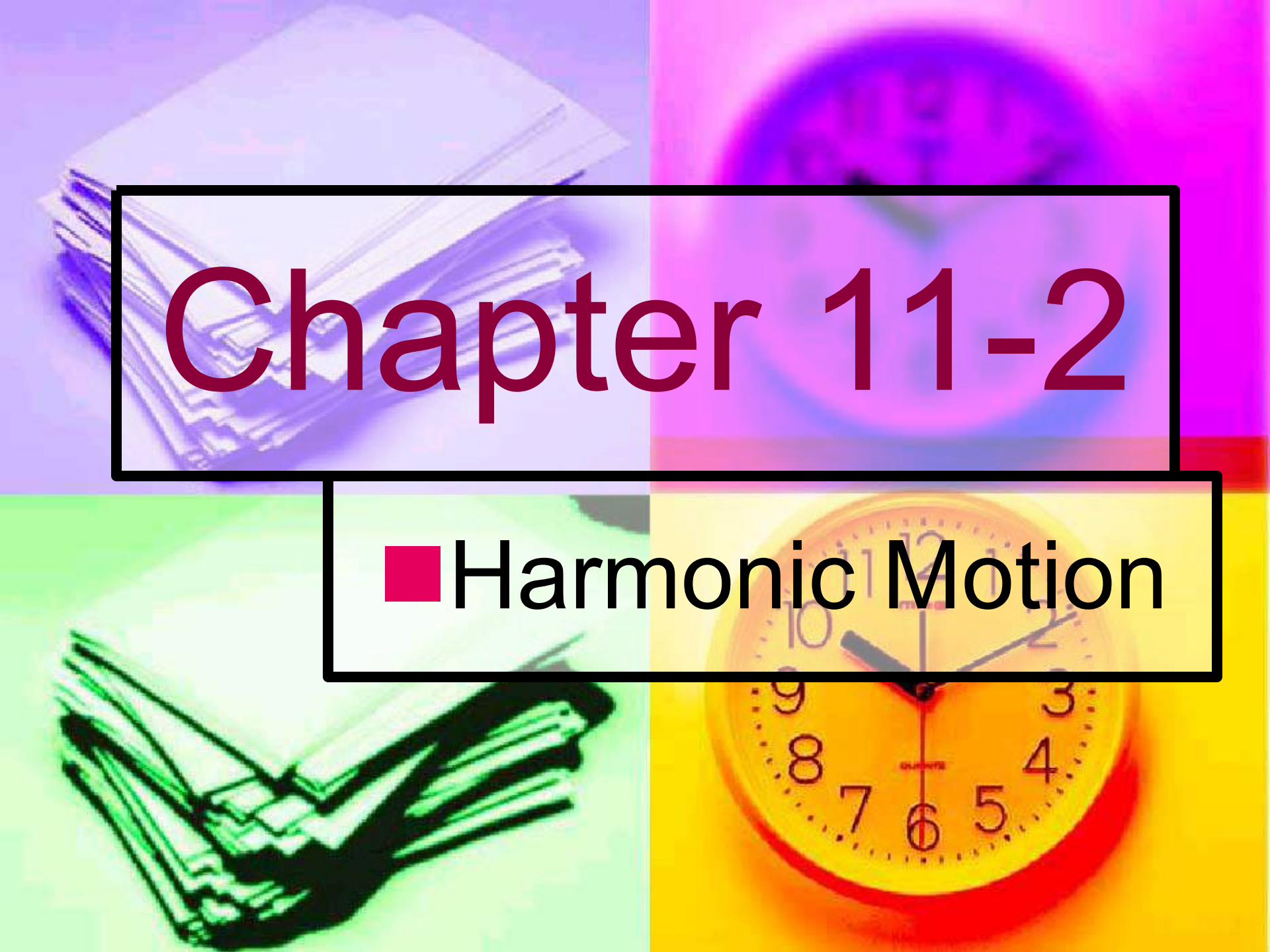
- Imagine you have a spring with a weight connected at the end. We lay the spring and weight flat on a table and pull the weight back and release.
- When the spring is at the equilibrium position, velocity reaches a maximum.
- At maximum displacement, the spring force and acceleration reach a maximum.


Maximum Displacement =
Greatest spring force and
greatest acceleration
At Equilibrium =
Greatest Velocity
Equilibrium (If spring was never pulled
and was just lying on the table)
Maximum Displacement =
Greatest spring force and
greatest acceleration



Simple Pendulum

- A simple pendulum consists of a mass called a bob, which is attached to a fixed string.
- When working with a simple pendulum, we assume the mass of the bob is concentrated at a point and the mass of the string is negligible.
- Also, we disregard friction and air resistance.



Chapter 11-2

- Harmonic Motion

- The maximum displacement from the equilibrium position is called **amplitude**.
- For a mass spring system, the amplitude is the maximum distance stretched or compressed.

- The **period** is the time it takes for a complete cycle.
- Period units = **seconds**
- Period = 1/Frequency




- **Frequency** is the number of complete cycles in a unit of time.
- Frequency units = **Hertz** (Hz)
- Frequency (f) = 1/Period (T)

- The period depends on **string length** and free-fall acceleration (**gravity**).
- Period = $2\pi \sqrt{L/g}$

Period = $2\pi \sqrt{L/g}$

- A trapeze artist swings with a period of 5 s. Calculate the length of the cables supporting the trapeze.




- Mass and amplitude don't affect the period of a pendulum.
- This is similar to objects in free fall, which all have the same acceleration (gravity).

- Period of a mass spring system depends on **mass** and **spring constant**.
- Period = $2\pi \sqrt{m/k}$

Period = $2\pi \sqrt{m/k}$

- A spring of spring constant 30 N/m is attached to a 3 kg mass. Find the period and frequency.




Assignment

- 11.1 and 11.2 Worksheets