# Energy, Work, and Power

I. Energy
- kinetic and potential
- conservation

II. Work
- dot product
- work-energy relations

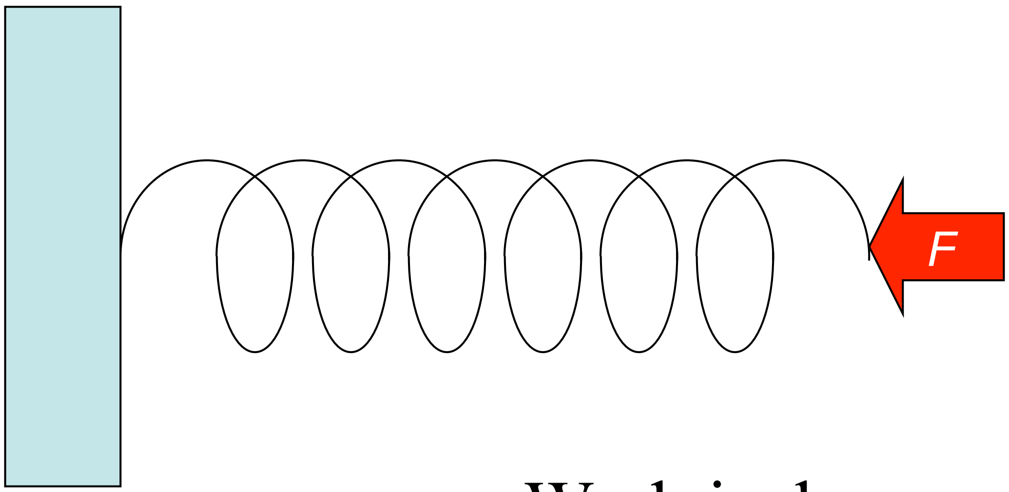
**III. Springs**

IV. Power
- machines and efficiency

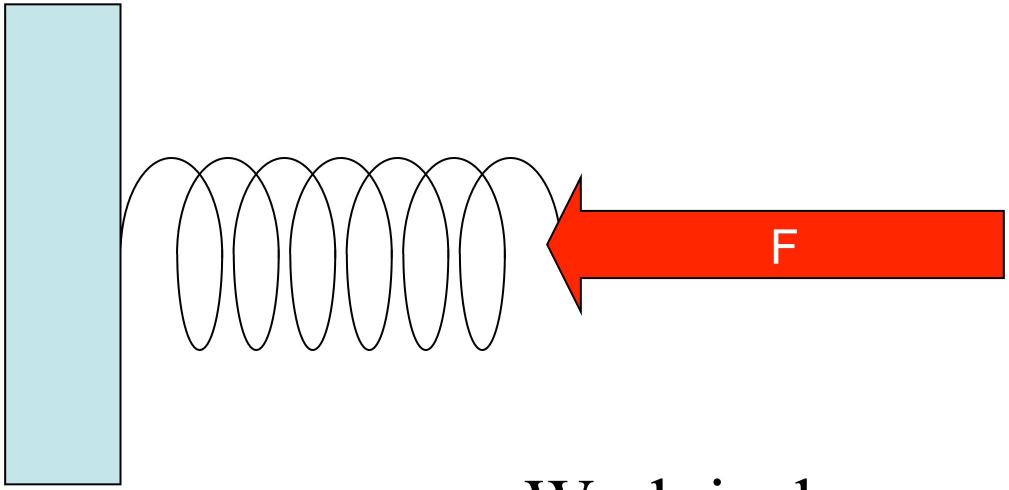
| | The student will be able to: | HW: |
|---|---|---|
| 1 | Define and apply the concepts of kinetic and potential energy and use the conservation of energy to explain physical phenomena. | ✓ 1 – 7 |
| 2 | Calculate mechanical kinetic energy and gravitational potential energy (in Joules) and use conservation of energy to solve related problems. | ✓ 8 – 16 |
| 3 | Define and calculate work and solve related problems. | ✓ 17 – 23 |
| 4 | Relate and equate work and energy and solve related problems. | ✓ 24 – 30 |
| 5 | Solve problems involving work and energy for a mass attached to a spring. | 31 – 33 |
| 6 | Define and calculate power (in Watts or horsepower) and solve related problems. | 34 – 41 |
| 7 | Solve problems involving machines and efficiency. | 42 – 45 |

# Work, Energy, and Springs

- As a spring stretches the force increases. (Hooke's Law: $F = k \cdot x$)
- Work must be done on the spring to stretch it.
- The stretched spring can do work on an object as it returns to equilibrium.
- A stretched or compressed spring has **elastic potential energy**.




Work is done on the spring by an increasing applied force.

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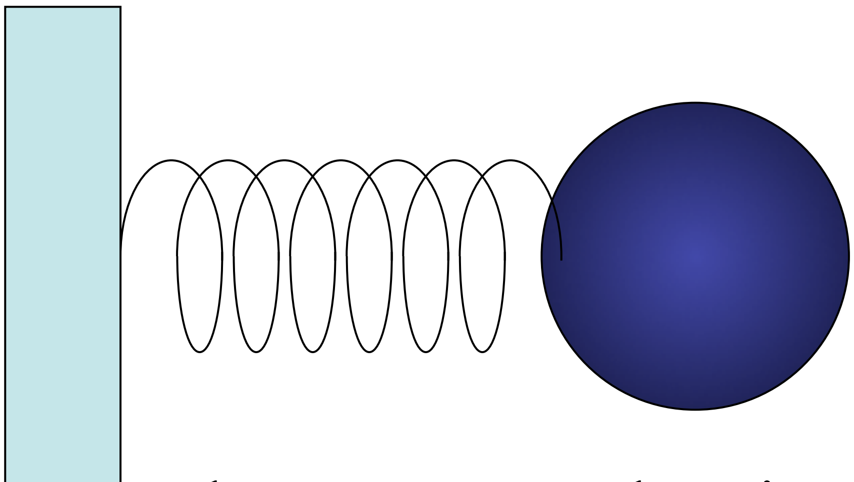
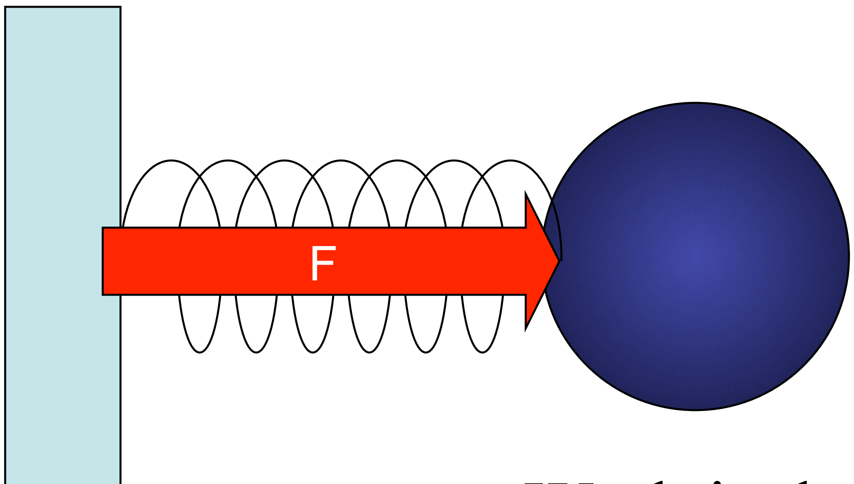
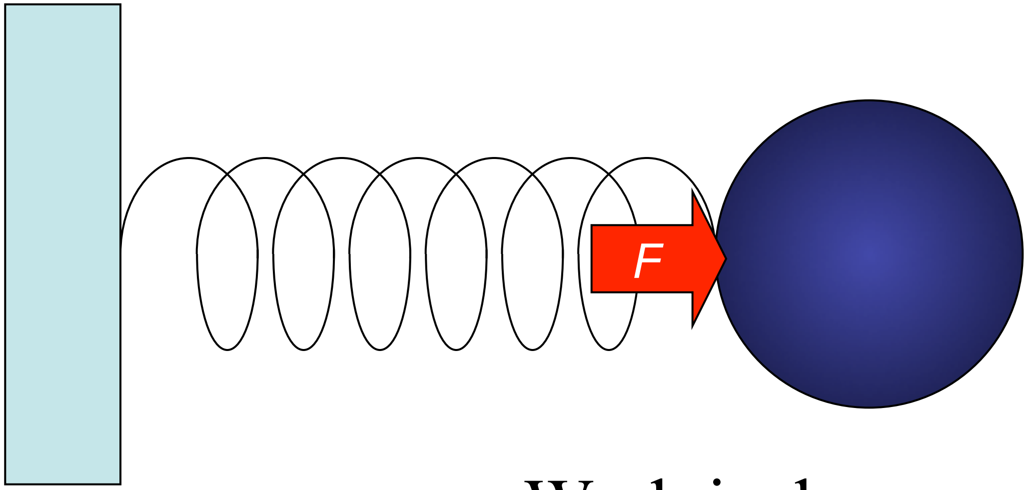


The compressed spring represents potential energy.

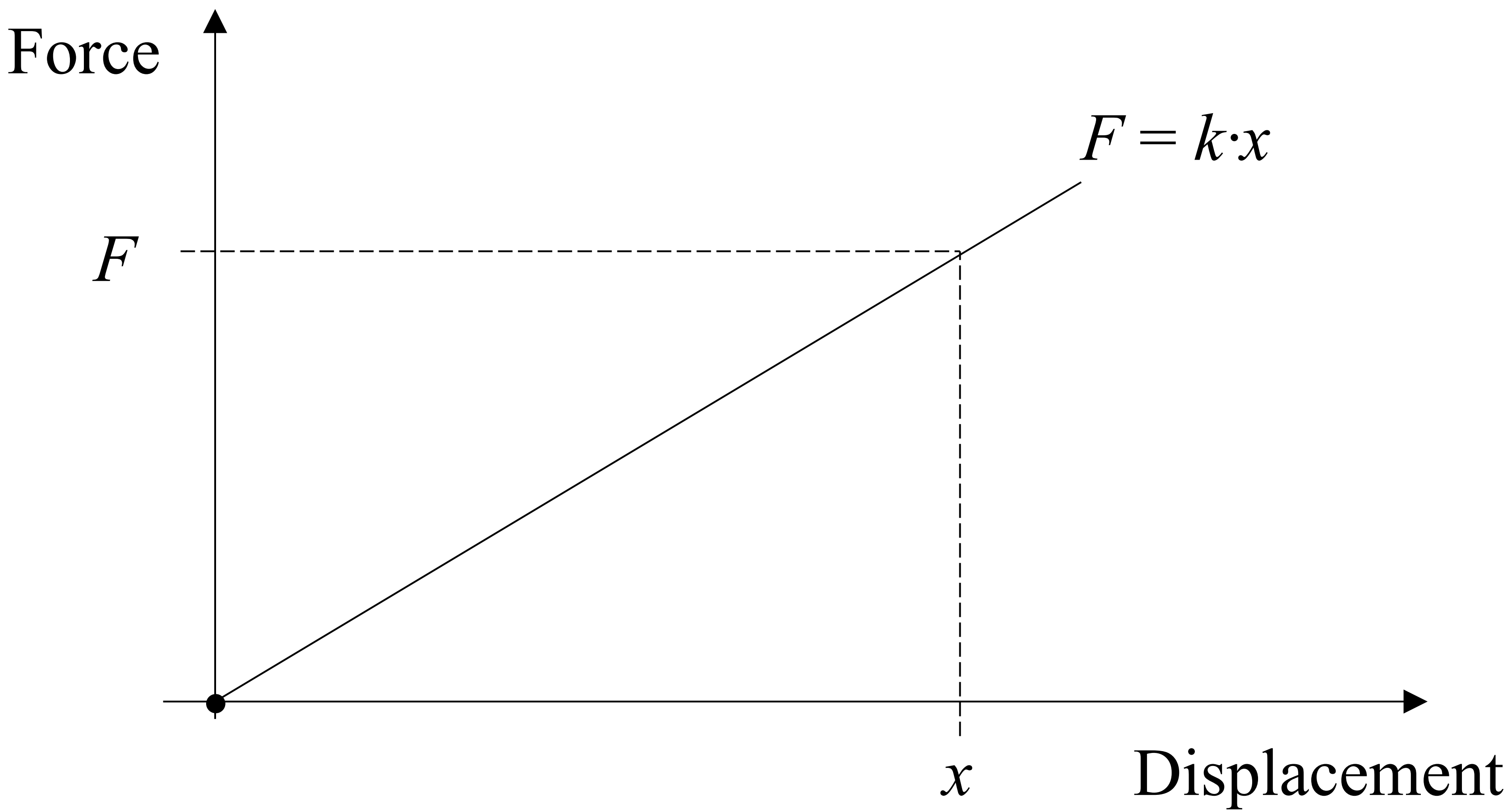



Work is done on the ball by a decreasing spring force.




Work is done on the ball by a decreasing spring force.

# How much work is done on/by the spring?



The work is done by a force that varies from 0 to $F$, the average of which is $F/2$:

$$W = \mathbf{F}\cdot\mathbf{d} = (F/2)\cdot x = \tfrac{1}{2} Fx$$

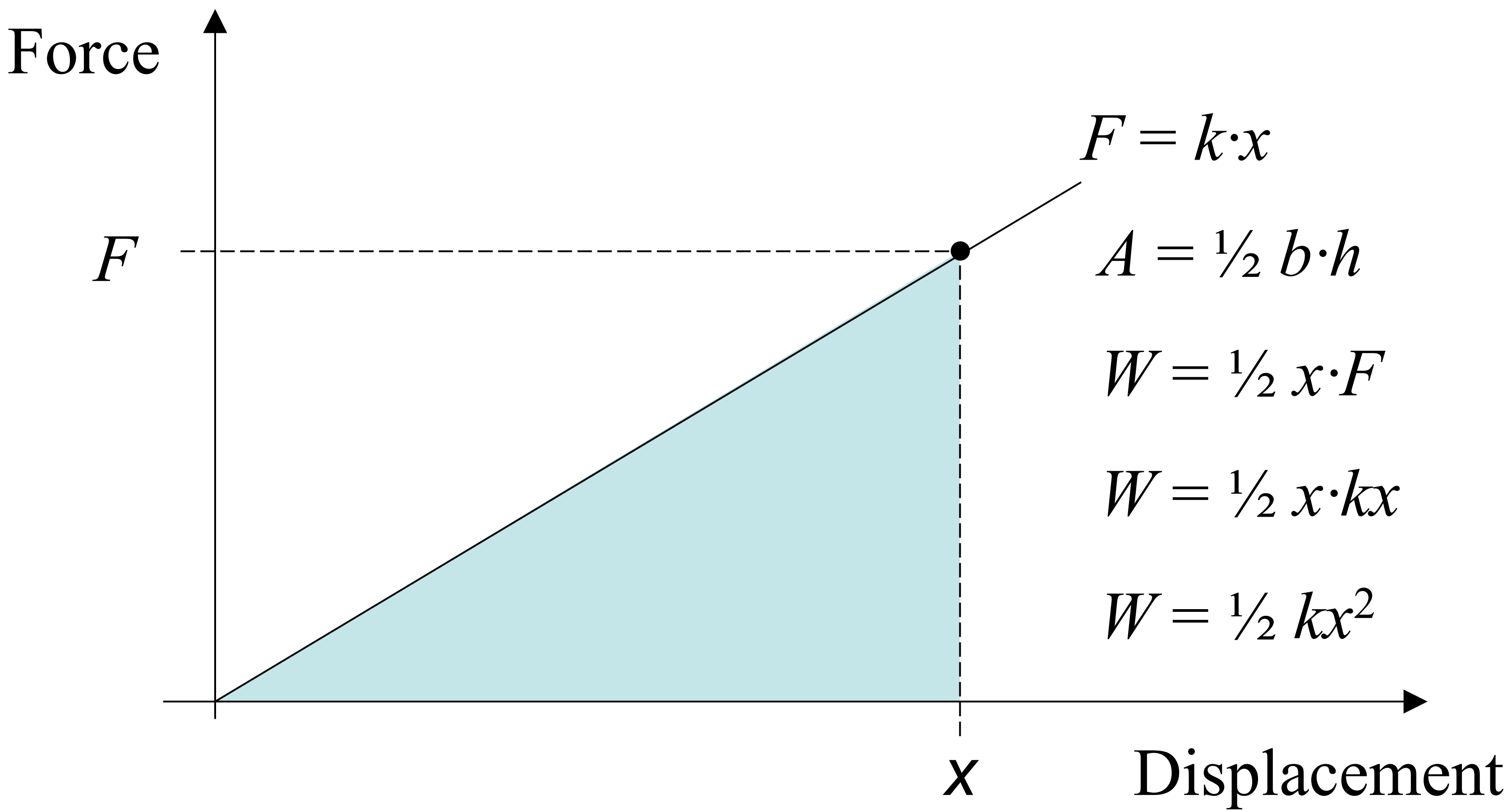
$$F = k\cdot x$$

$$W = \tfrac{1}{2} (kx)x$$

$$W = \tfrac{1}{2} kx^2$$ Work done on spring

$$EPE = \tfrac{1}{2} kx^2$$ Energy in spring

Work can also be found by area under the curve.




$A = \frac{1}{2}\, b \cdot h$

$W = \frac{1}{2}\, x \cdot F$

$W = \frac{1}{2}\, x \cdot kx$

$W = \frac{1}{2}\, kx^2$