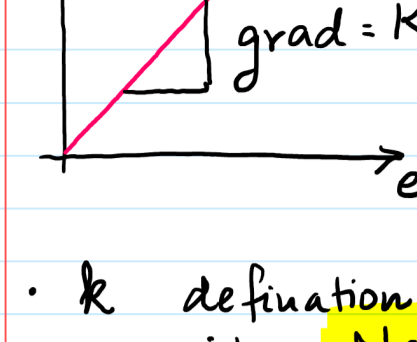


Hook's Law

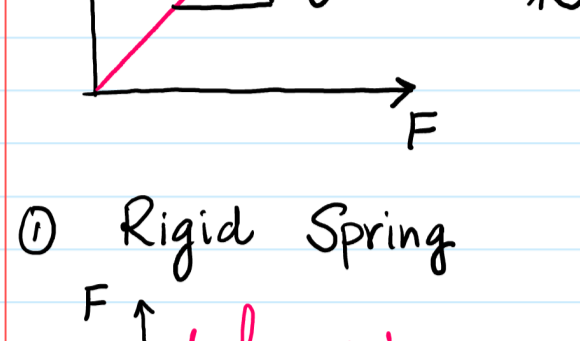
F ∝ e (until the limit of proportionality (P) is reached)



$F = ke$ where k is a constant which is known as **force constant** or **Spring constant***

k definition: $k = \frac{F}{e}$ [force per unit extension]
units: Nm^{-1}

* $k = 50 Nm^{-1}$ How to convert into Nm^{-1}
(multiply by 100 [to convert Ncm^{-1} into Nm^{-1}])
 $k = 5000 Nm^{-1}$



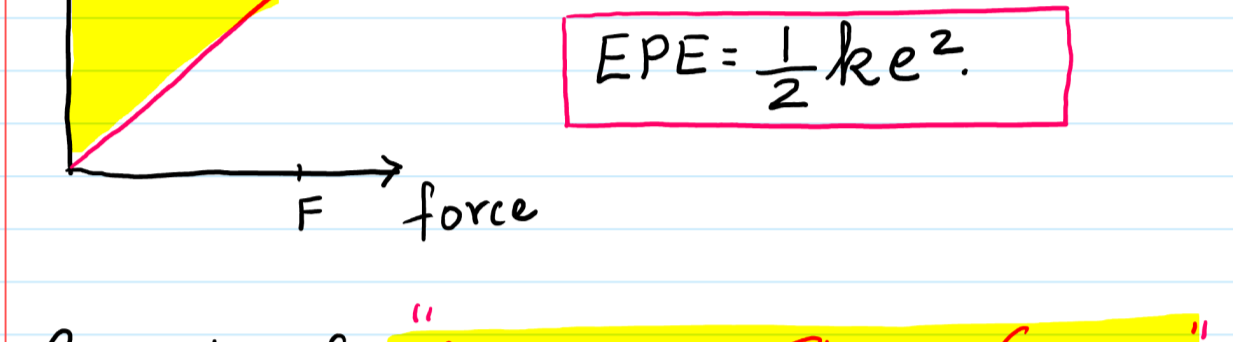
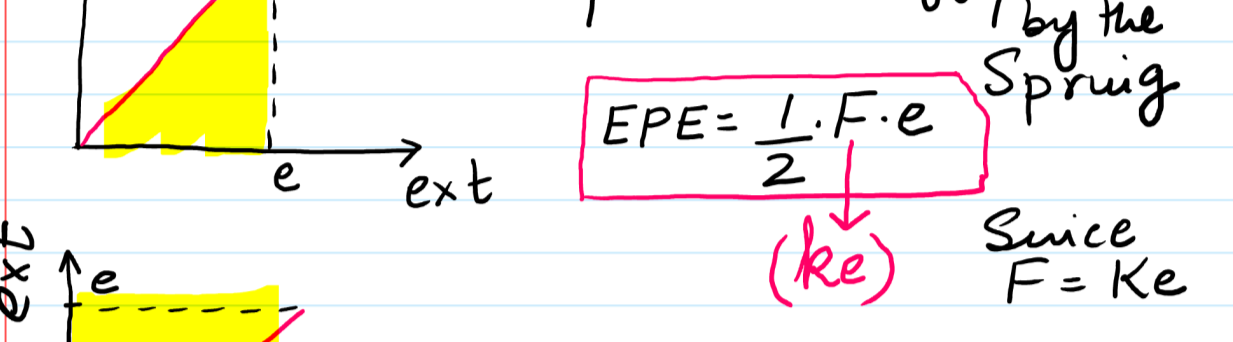
① Rigid Spring $k = \text{high steep}$ ② Flexible Spring $k = \text{LOW less steep}$

Concept of "Energy stored by a Spring"

Whenever a spring is either **stretched** or **compressed**, it stores energy.

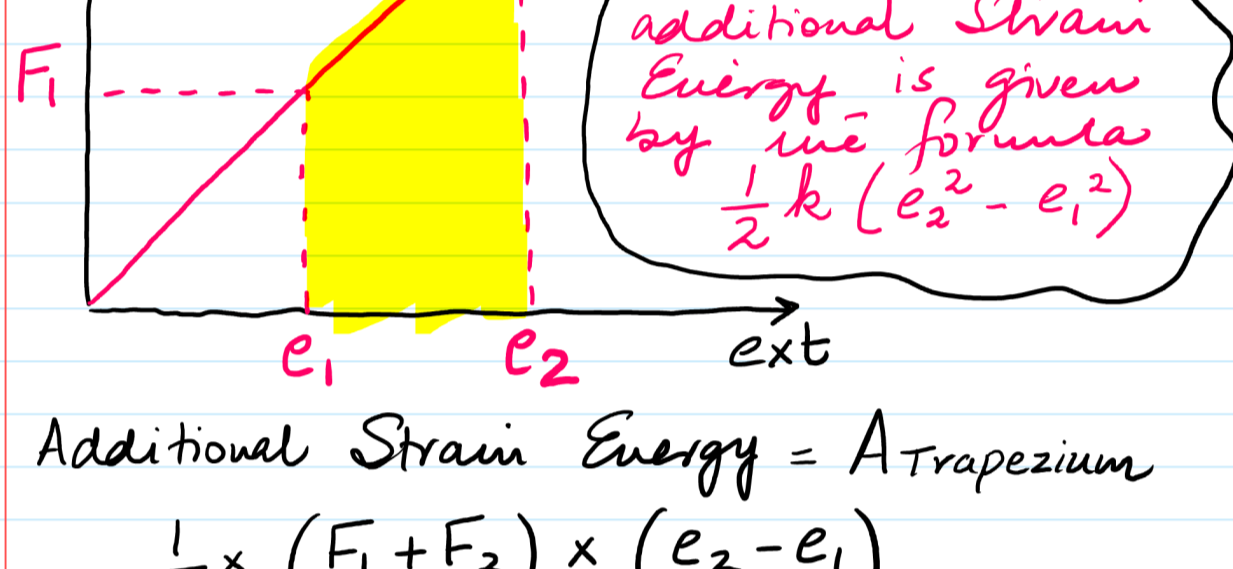
This energy is called **Elastic Potential Energy**, **Strain Energy** or **Work done by the spring**.

This energy can be obtained from the **Area b/w the graph and the extension axis**



Concept of "Additional Strain Energy"

Consider a material which has undergone an initial extension e_1 when a force of F_1 has been applied. If the force increases to F_2 & the corresponding extension is represented by e_2 , then the energy stored **ONLY** during the **SECOND STAGE** is given a special name i.e. **Additional Strain Energy**.



Additional Strain Energy = $\frac{1}{2} \times (F_1 + F_2) \times (e_2 - e_1)$

Since $F = ke$ (Hook's Law) $\therefore F_1 = ke_1$ & $F_2 = ke_2$ replace

$\frac{1}{2} \times (ke_1 + ke_2) \times (e_2 - e_1)$ Simplify the brackets to get

Additional Strain Energy = $\frac{1}{2} k (e_2^2 - e_1^2)$

Ex.1 Spring $k = 30 Nm^{-1}$ [$k = 3000 Nm^{-1}$]
 $e = 5cm$ to $e = 7cm$
 $e = 0.05m$ to $e = 0.07m$

Cal Additional Strain Energy
 $\frac{1}{2} k (e_2^2 - e_1^2)$
 $\frac{1}{2} (3000) (0.07^2 - 0.05^2)$
 $= + 3.6 J$ Energy Gain

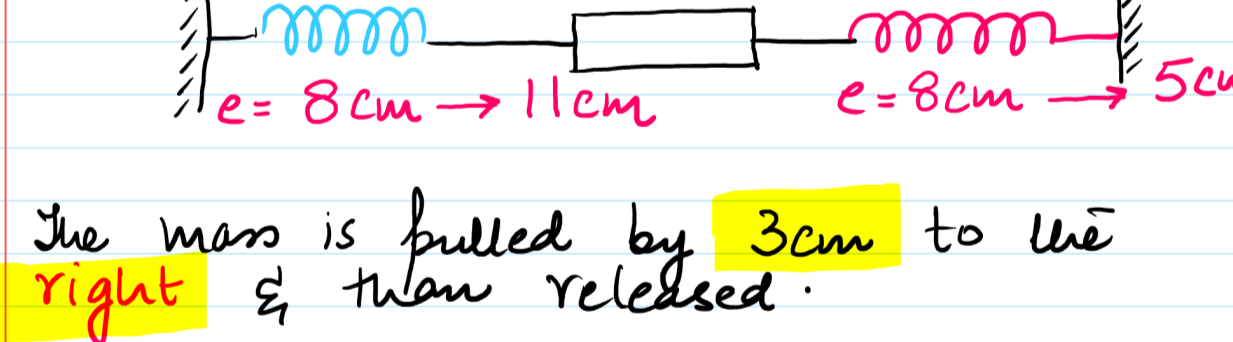
Ex.2 Spring $k = 40 Nm^{-1}$
 $e = 6cm$ to $e = 4cm$

Can we still use the term additional Strain Energy?

Yes, although keep in mind that your answer will turn out to be **negative**?

What is the significance of negative answer?

Additional Strain Energy = $\frac{1}{2} \times (4000) (0.04^2 - 0.06^2)$
 $= - 4 J$ Energy released.



The mass is pulled by **3cm** to the **right** & then released.

Cal the Total Change in E.P.E?

$\frac{1}{2} \times 6000 \times (0.11^2 - 0.08^2)$ (BLUE) = + 17.1 J
 $\frac{1}{2} \times 6000 \times (0.05^2 - 0.08^2)$ (RED) = - 11.7 J

Net Gain in E.P.E = 5.4 J

Given that all of this energy is converted into the **K.E** of the block, Cal the initial speed with which this block begins to move

$\frac{1}{2} mv^2 = 5.4 J$
 $\frac{1}{2} (2) v^2 = 5.4$
 $v = 2.3 m/s$

Describe the motion of this object?

Oscillatory motion about its mean position.

Q:	Spring P	Spring Q
	F	F
	k	3k
	$e = \frac{F}{k}$	$e = \frac{F}{3k}$

find Ratio of
Strain Energy in P = $\frac{1}{2} \times F \times \frac{F}{k}$
Strain Energy in Q = $\frac{1}{2} \times F \times \frac{F}{3k}$
Strain Energy = $\frac{1}{2} F \cdot e$ or $\frac{1}{2} ke^2$ = $\frac{3}{1}$ Ans.

Q:	Spring P	Spring Q
	5F	7F
	3K	8K
	$e = \frac{5F}{3K}$	$e = \frac{7F}{8K}$

Ratio of Strain Energy in P = $\frac{1}{2} \times 5F \times \frac{5F}{3K}$
Strain Energy in Q = $\frac{1}{2} \times 7F \times \frac{7F}{8K}$
either use $\frac{1}{2} F \cdot e$ or $\frac{1}{2} ke^2$
 $= \frac{25}{6} \times \frac{16}{49}$
 $= \frac{200}{147}$ Ans.