$$\mathbf{b}_1 = 2\pi \frac{\mathbf{a}_2 \times \mathbf{a}_3}{\mathbf{a}_1 \cdot (\mathbf{a}_2 \times \mathbf{a}_3)}$$

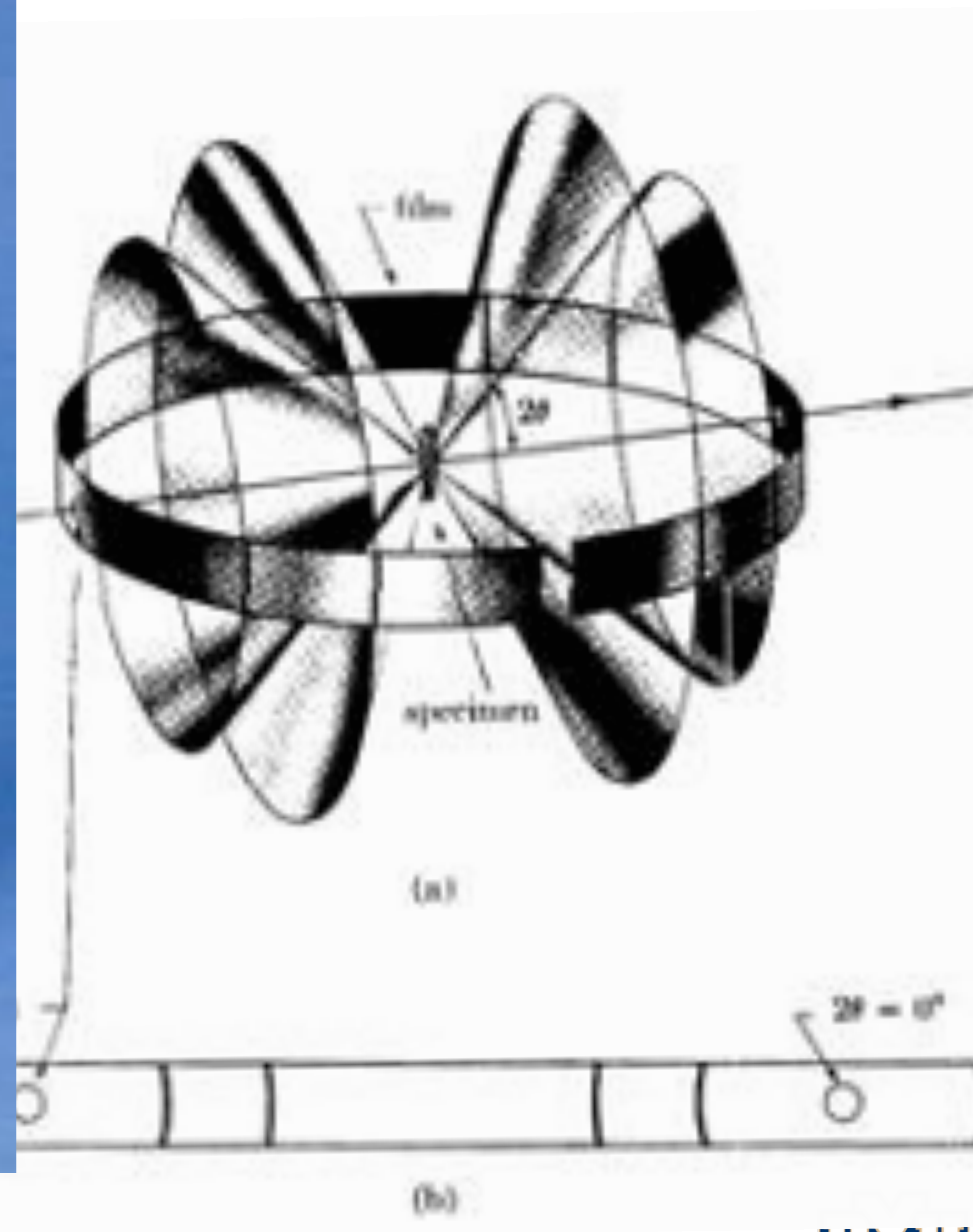
$$\mathbf{b}_2 = 2\pi \frac{\mathbf{a}_3 \times \mathbf{a}_1}{\mathbf{a}_2 \cdot (\mathbf{a}_3 \times \mathbf{a}_1)}$$

$$\mathbf{b}_3 = 2\pi \frac{\mathbf{a}_1 \times \mathbf{a}_2}{\mathbf{a}_3 \cdot (\mathbf{a}_1 \times \mathbf{a}_2)}$$

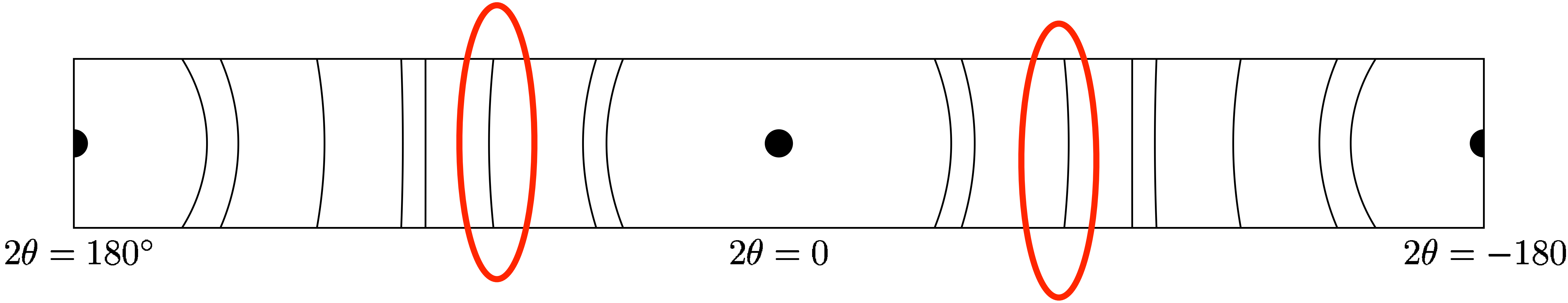
1. Identify the lattice (unit cell)
2. Determine the reciprocal lattice.
3. Apply Bragg's law in reciprocal space. $G = 2k \sin\theta$
4. Assemble the structure factor.
5. Enumerate all (h,k,l) constrained by the result of the structure factor, and solve for each theta.

$$\sum_{\mathbf{r}_p} f_{ap}(\theta) e^{i\mathbf{r}_p \cdot \Delta\mathbf{k}}$$

Powder Diffraction



Using Table 2.1, which planes are responsible for the diffraction line that is circled?

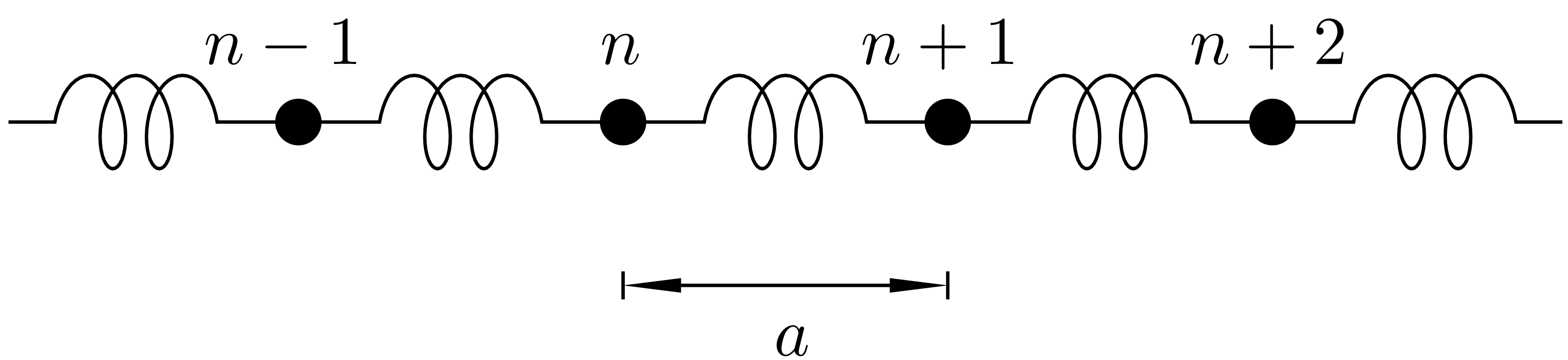


Question #1

A. (001)
B. (311)
C. (111)
D. (210)
E. (110)

Lattice Waves

Question #2



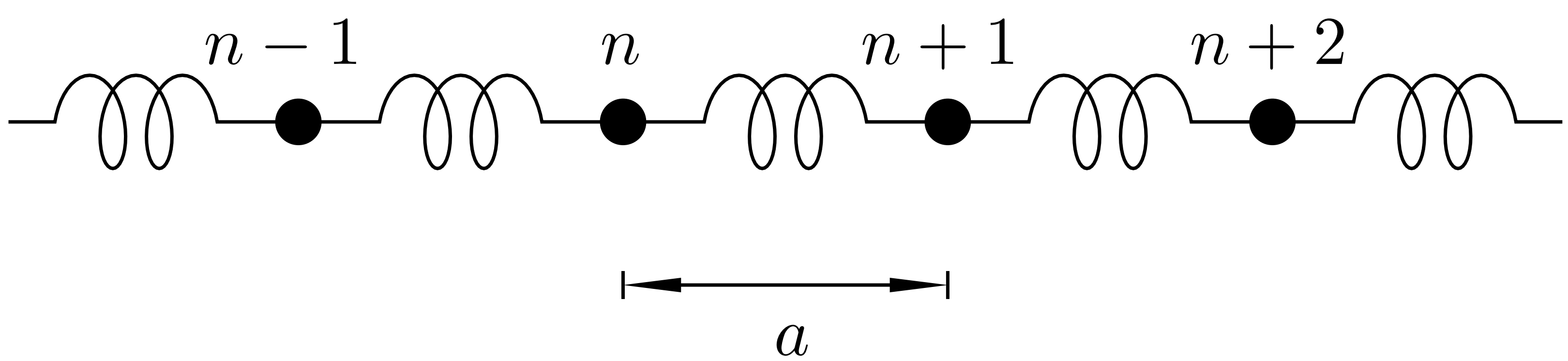
Which particle's motion is described by the function above?

a) The nth one
b) The first one
c) The last one
d) All but the last one.

Lattice Waves

Question #2

$$u_n = A\sin(kx_n - \omega t)$$

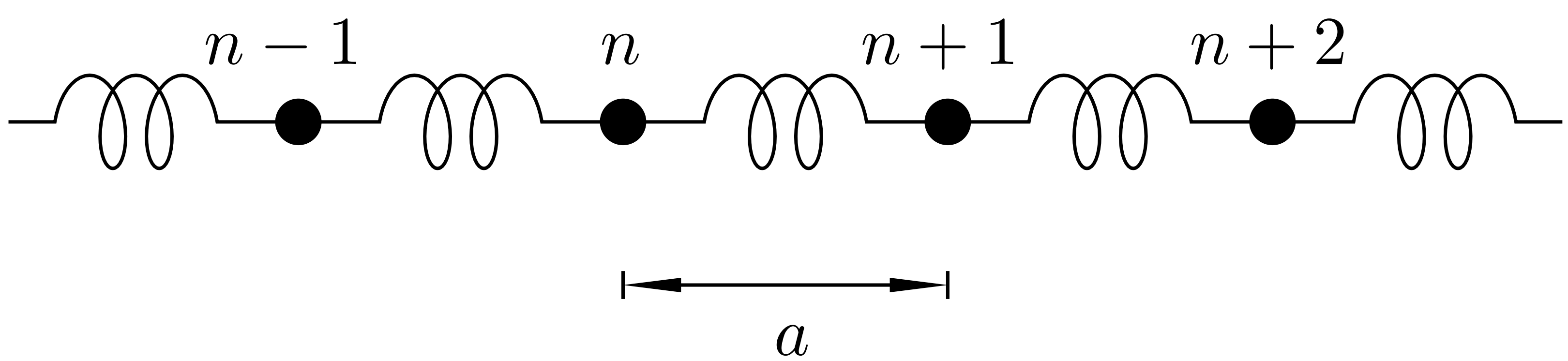


Which particle's motion is described by the function above?

a) The nth one
b) The first one
c) The last one
d) All but the last one.

Lattice Waves

Question #3



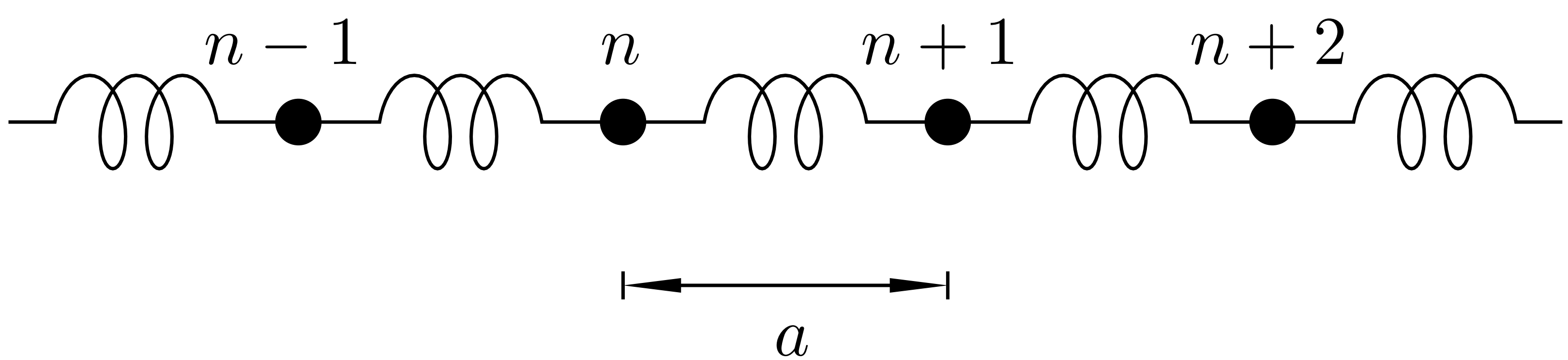
What is the meaning of the variable x_n?

a) Position of particle n from origin.
b) Displacement of particle n from equilibrium
c) Equilibrium location of particle n.
d) Position of peak of lattice wave.

Lattice Waves

Question #3

$$u_n = A\sin(kx_n - \omega t)$$

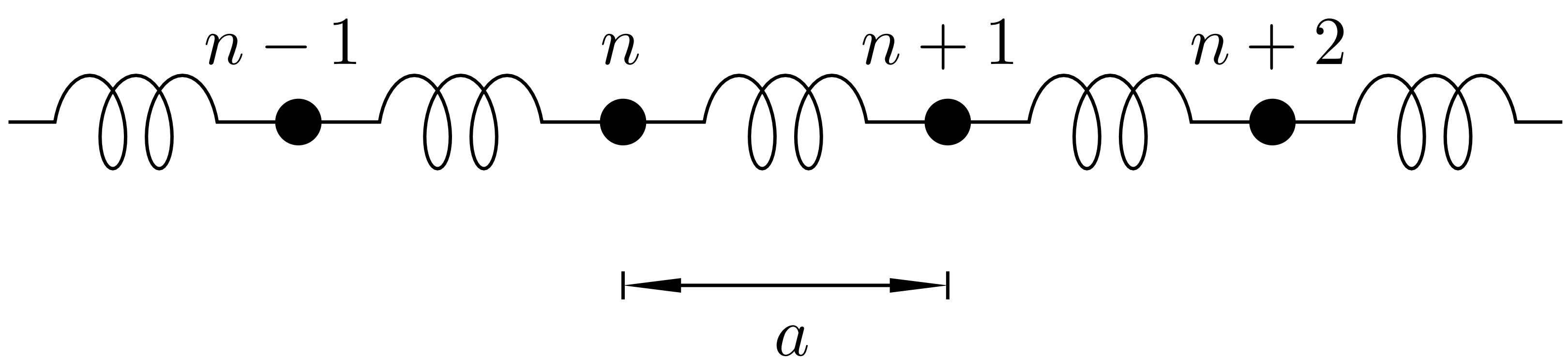


What is the meaning of the variable x_n?

a) Position of particle n from origin.
b) Displacement of particle n from equilibrium
c) Equilibrium location of particle n.
d) Position of peak of lattice wave.

Lattice Waves

Question #4



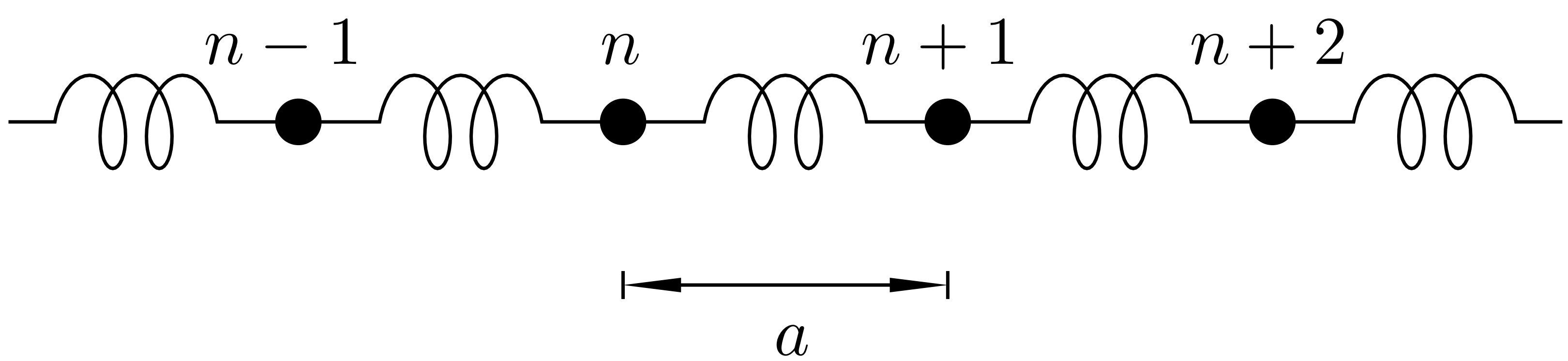
What is the meaning of the variable u_n?

a) Position of particle n from origin.
b) Position of peak of lattice wave.
c) Equilibrium location of particle n
d) Displacement of particle n from equilibrium

Lattice Waves

Question #4

$$u_n = A\sin(kx_n - \omega t)$$

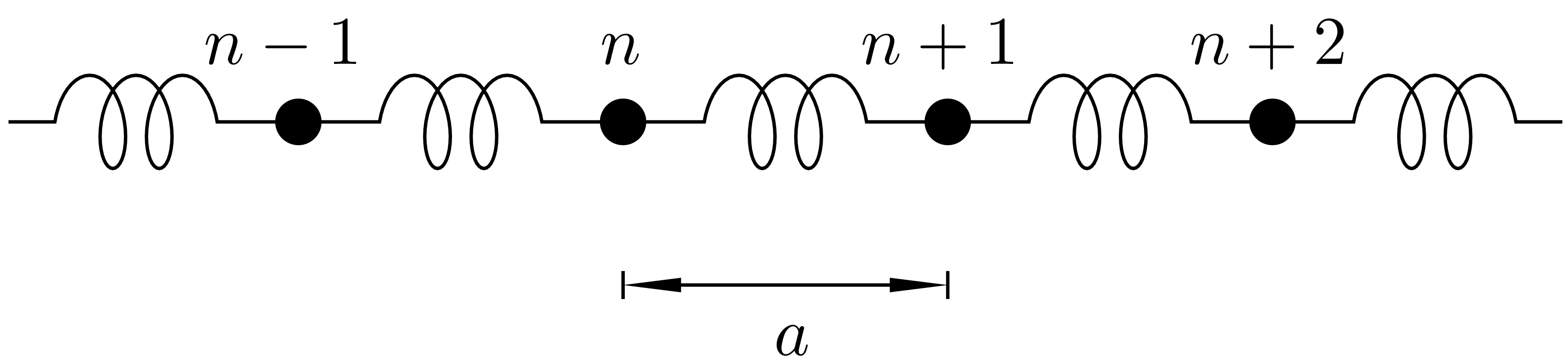


What is the meaning of the variable u_n?

a) Position of particle n from origin.
b) Position of peak of lattice wave.
c) Equilibrium location of particle n
d) Displacement of particle n from equilibrium

Lattice Waves

Question #5



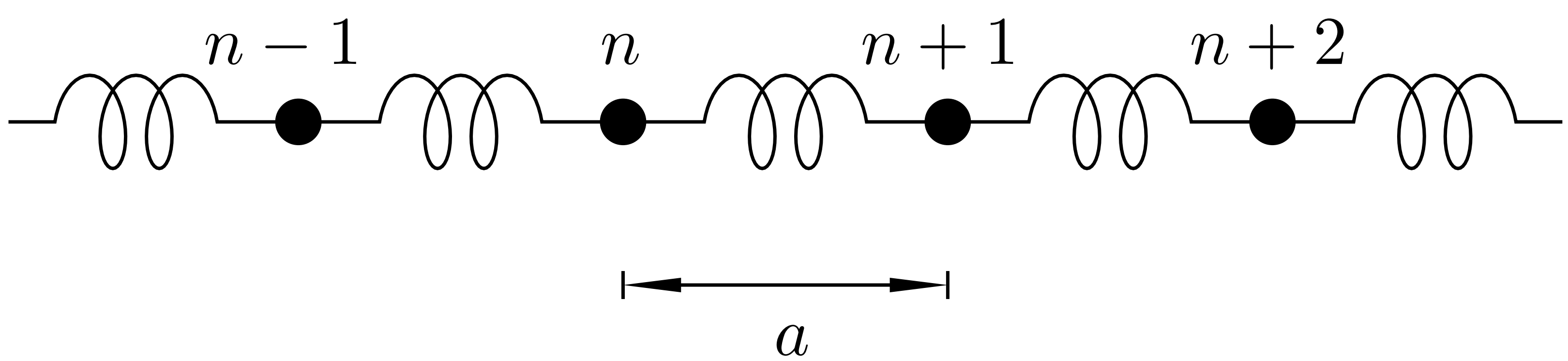
What is the meaning of the variable k?

a) Wave number of lattice wave.
b) Period of lattice wave.
c) Wavelength of lattice wave.
d) Frequency of lattice wave.

Lattice Waves

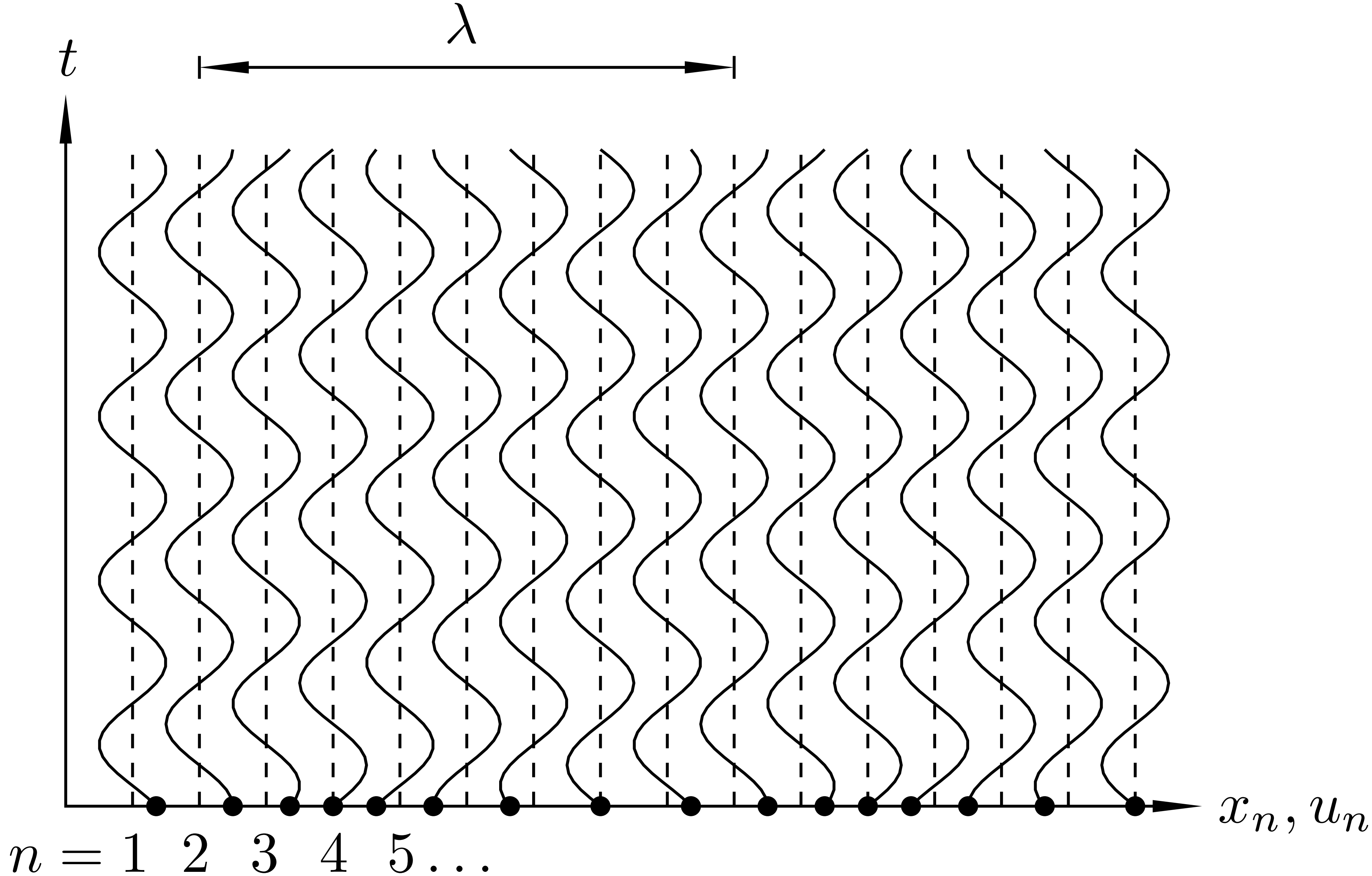
Question #5

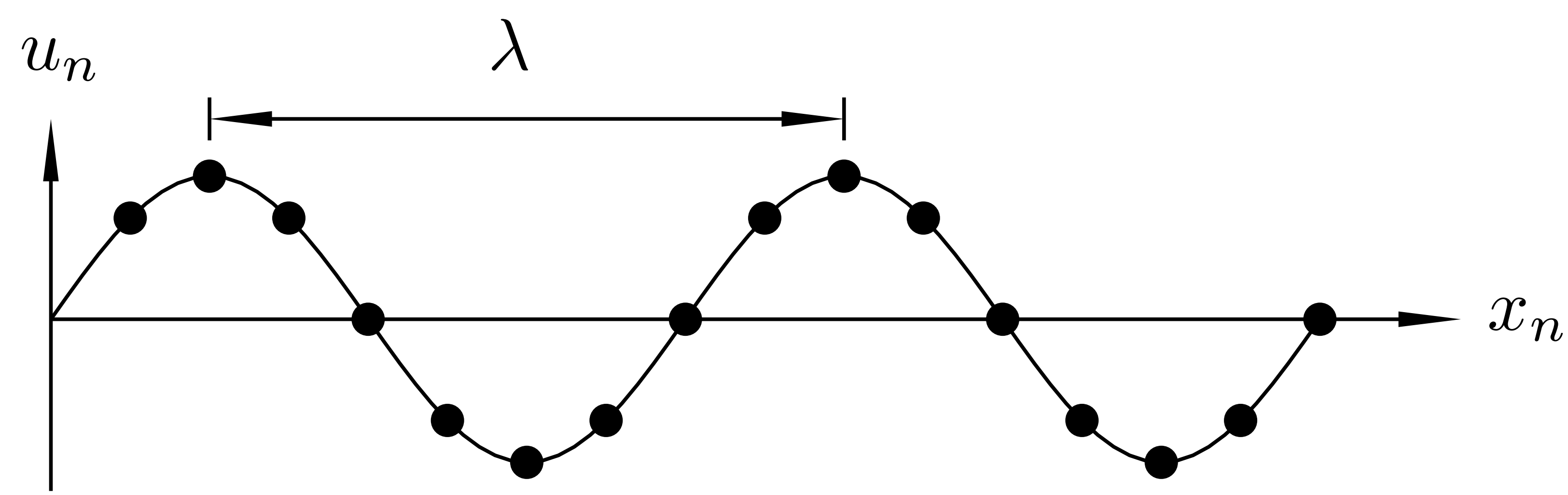
$$u_n = A\sin(kx_n - \omega t)$$

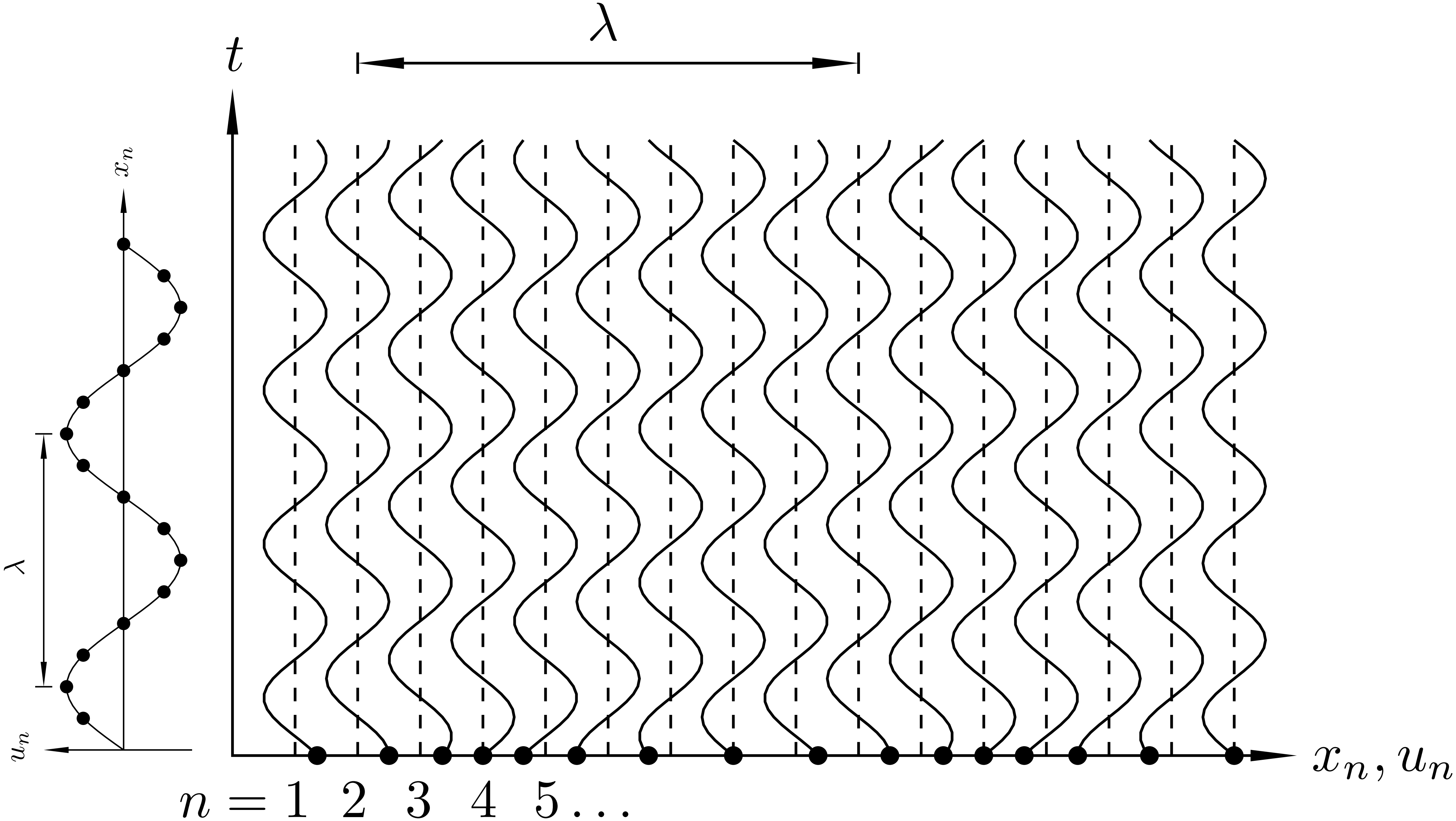


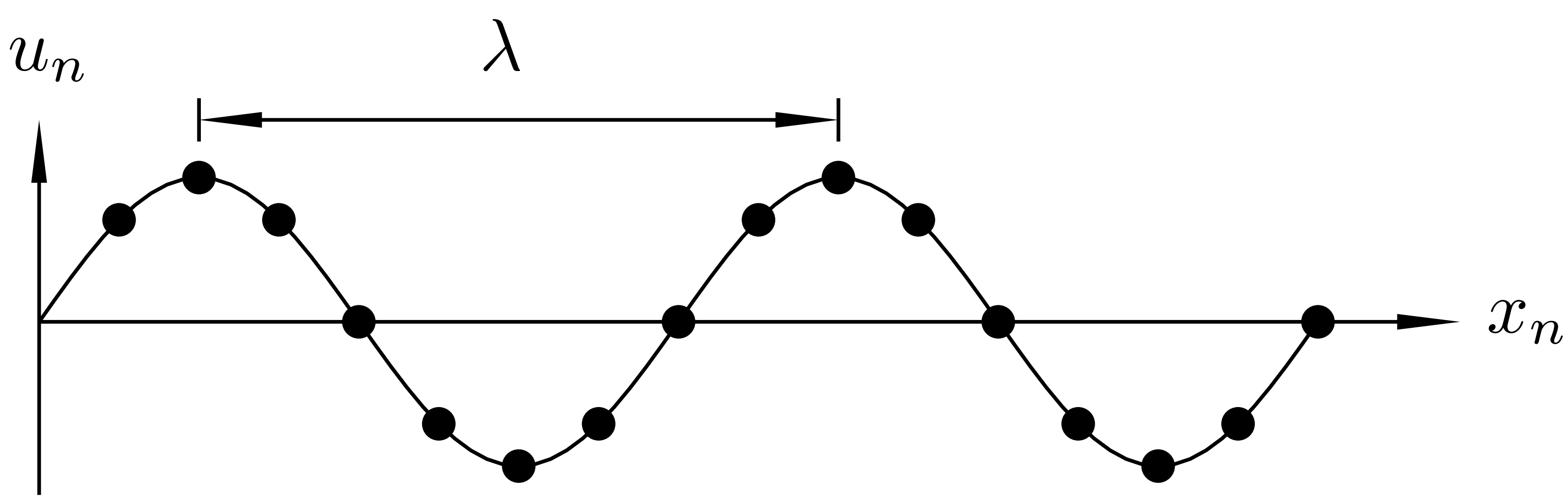
What is the meaning of the variable k?

a) Wave number of lattice wave.
b) Period of lattice wave.
c) Wavelength of lattice wave.
d) Frequency of lattice wave.

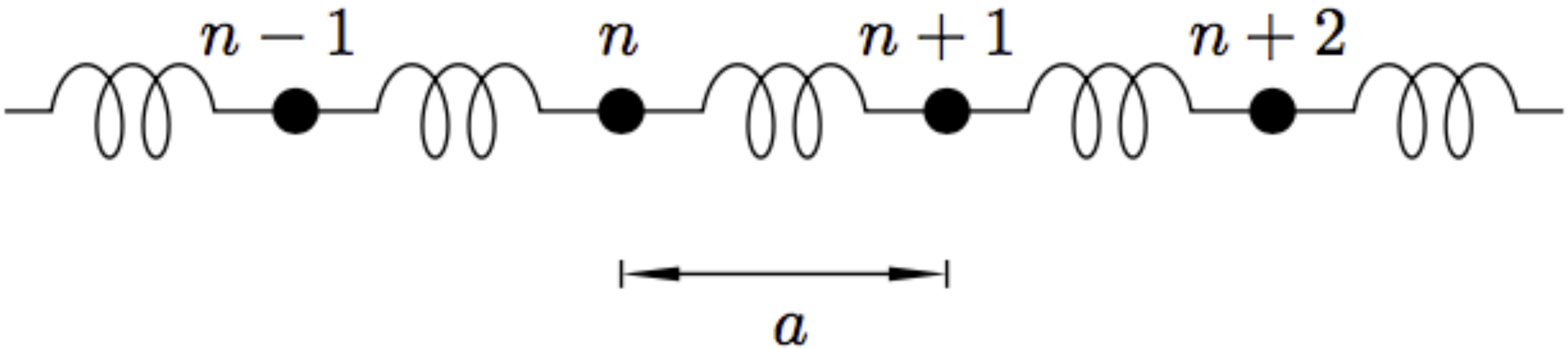

λ
t
x_n, u_n
$n = 1\ \ 2\ \ 3\ \ 4\ \ 5\ldots$


u_n
λ
x_n


λ
t
x_n, u_n
n = 1 2 3 4 5 ...
x_n
u_n
λ


u_n
λ
x_n

Question #6



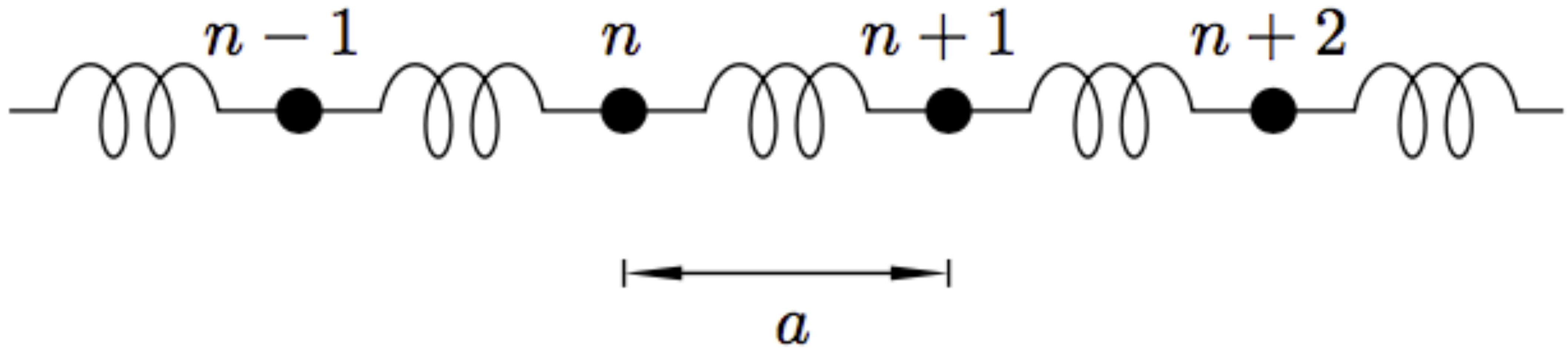
Assuming nearest-neighbor interactions only, what is the net force on particle n?

a) $\alpha\left(2u_n - u_{n+1} - u_{n-1}\right)$

b) $-\alpha\left(2u_n - u_{n+1} - u_{n-1}\right)$

c) $-\alpha\left(2u_n + u_{n+1} - u_{n-1}\right)$

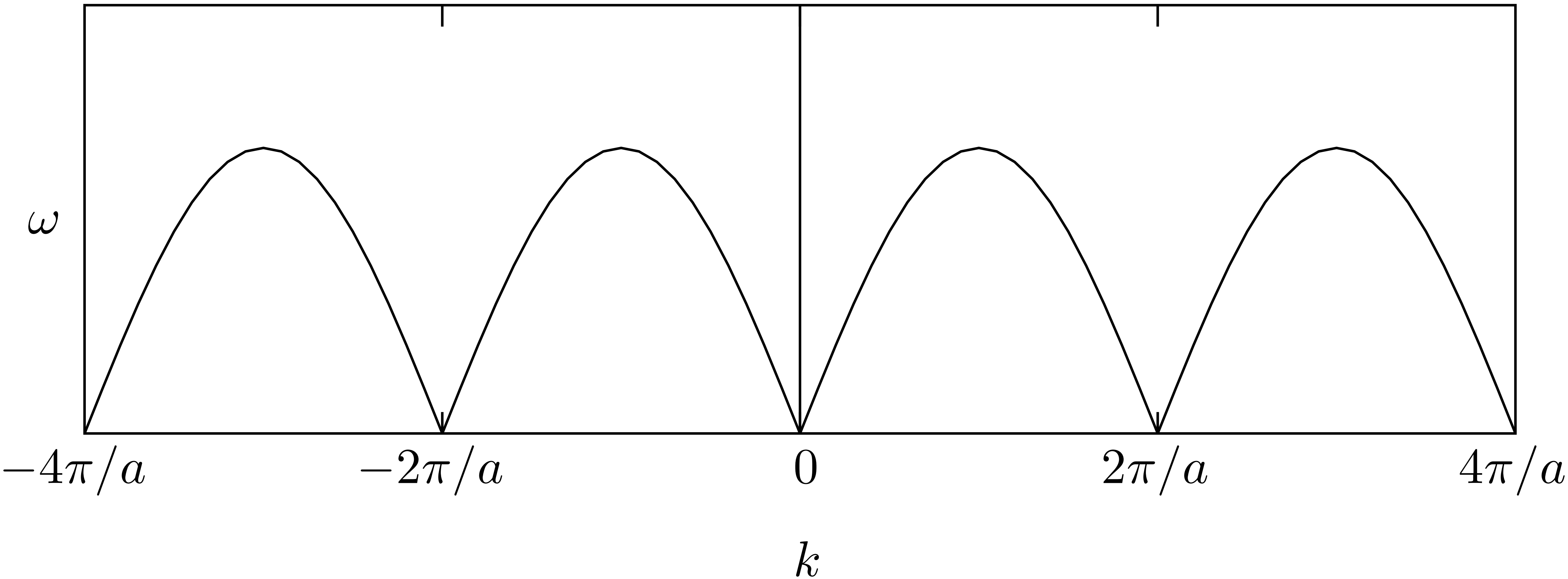
d) $\alpha\left(2u_n + u_{n+1} - u_{n-1}\right)$



$$-\alpha(2u_n - u_{n+1} - u_{n-1}) = m\frac{d^2u_n}{dt^2}$$

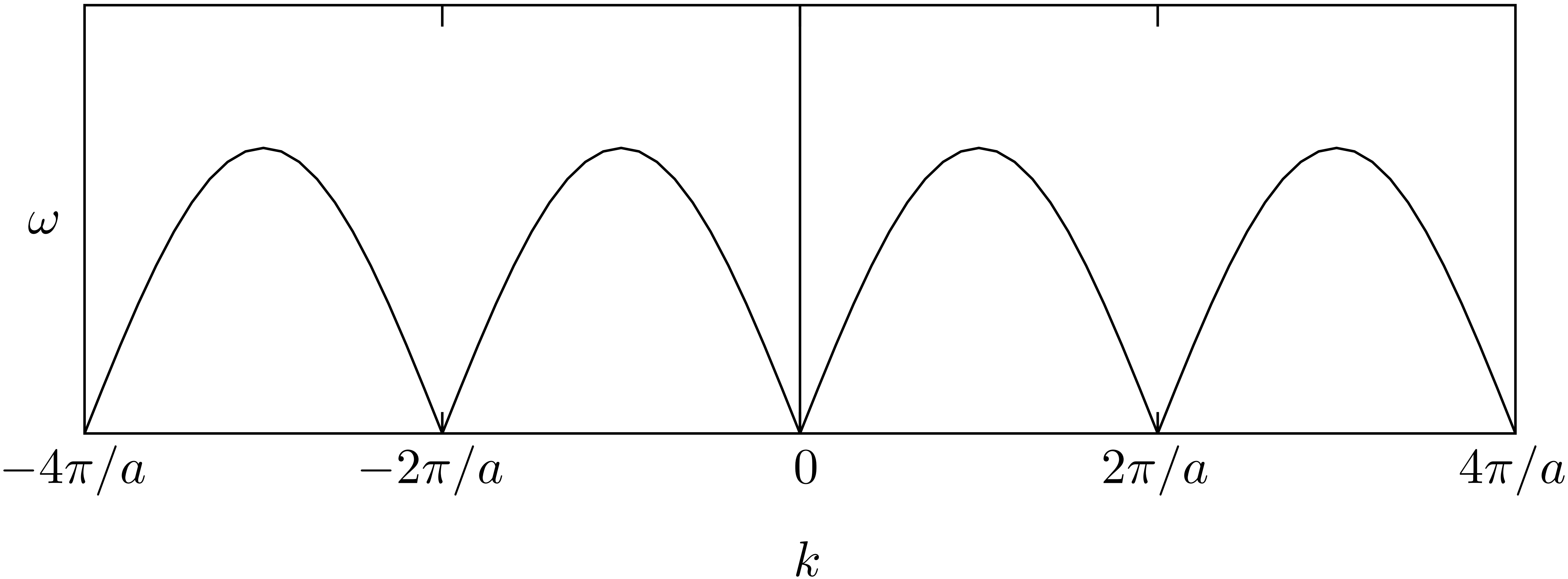
$$u_n = Ae^{ikna-i\omega t}$$

Plug in the function to Newton's second law and solve for omega!



$$\omega = \omega_m |\sin(ka/2)|$$

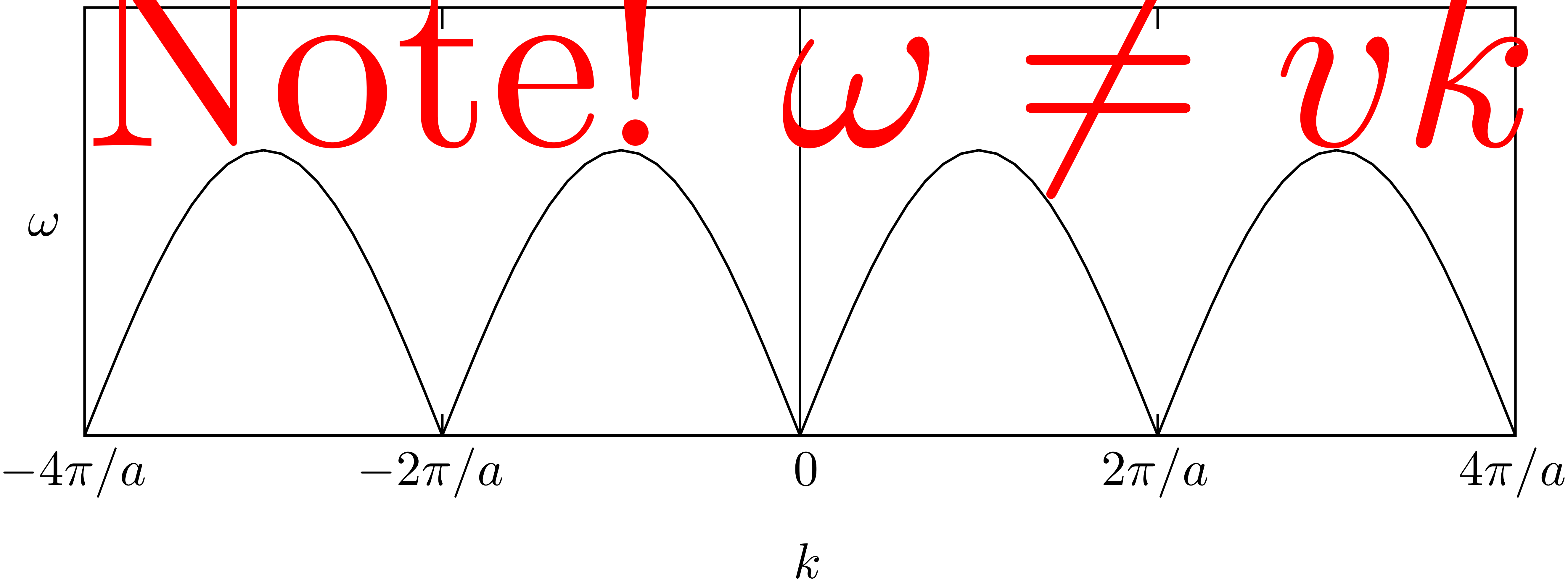
Dispersion relation



$$\omega = \omega_m |\sin(ka/2)|$$

Dispersion relation

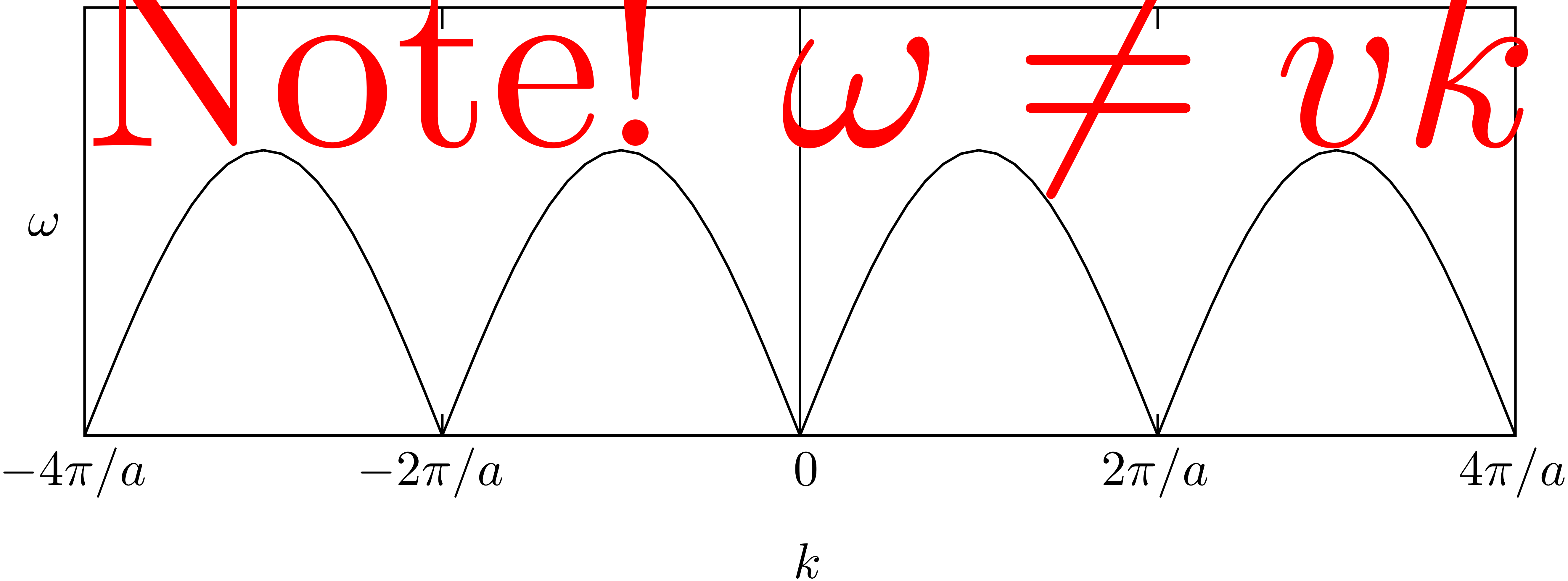
Note! $\omega \neq vk$



$$\omega = \omega_m |\sin(ka/2)|$$

Dispersion relation

$$\text{Note! } \omega \neq vk$$



$$\omega = \omega_m |\sin(ka/2)|$$

No Rainbows without dispersion!