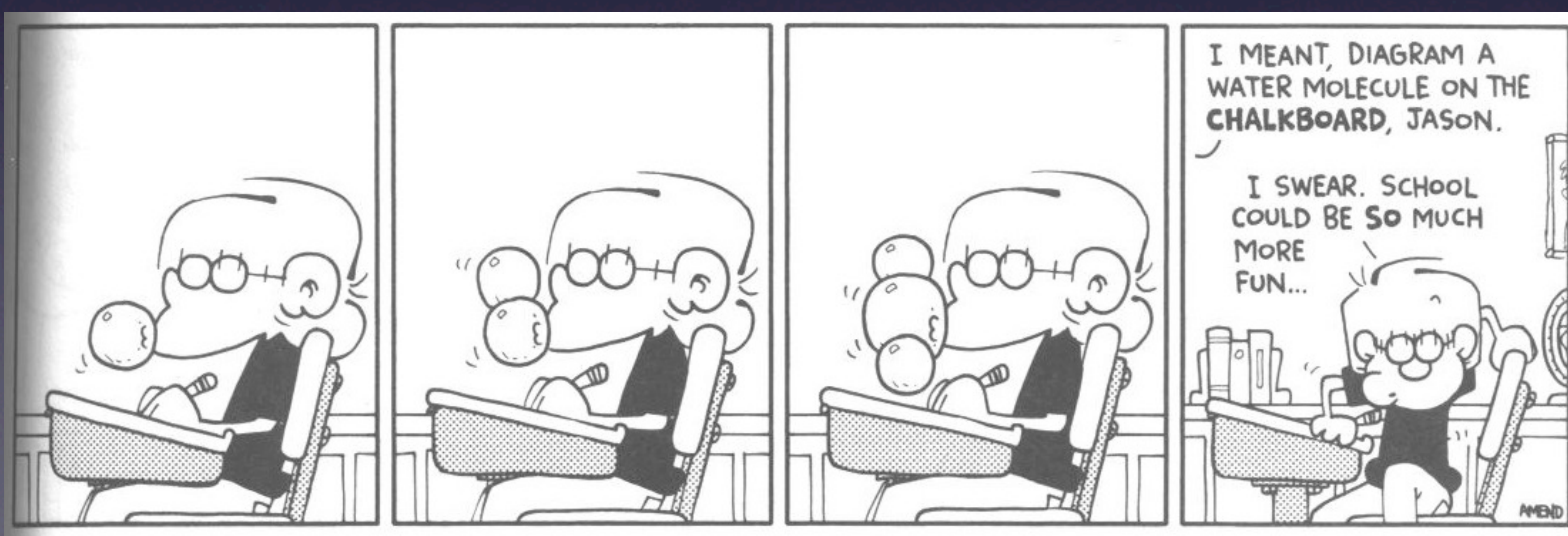

BLECCH! MOM, WHAT IS THIS?!
IT'S MILK.
IT'S SKIM MILK! YOU KNOW I HATE SKIM MILK! I LIKE WHOLE MILK!
THIS IS HEALTHIER FOR YOU.
HEALTHY-SHMEALTHY! I'M NOT DRINKING THIS! I WANT WHOLE MILK!
WHATEVER YOU SAY.
MY POINT WAS THAT OUR WHOLE MILK WAS WAY PAST ITS EXPIRATION.
IT STILL TASTED BETTER.
AMEND


I MEANT, DIAGRAM A WATER MOLECULE ON THE CHALKBOARD, JASON.
I SWEAR. SCHOOL COULD BE SO MUCH MORE FUN...
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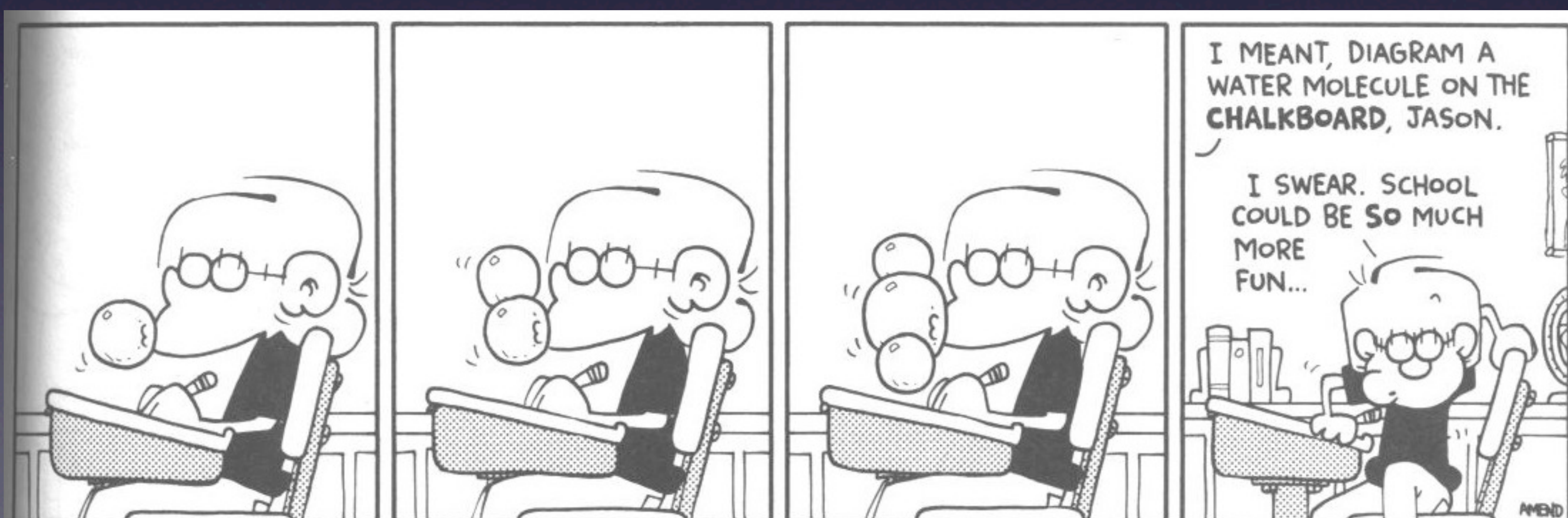
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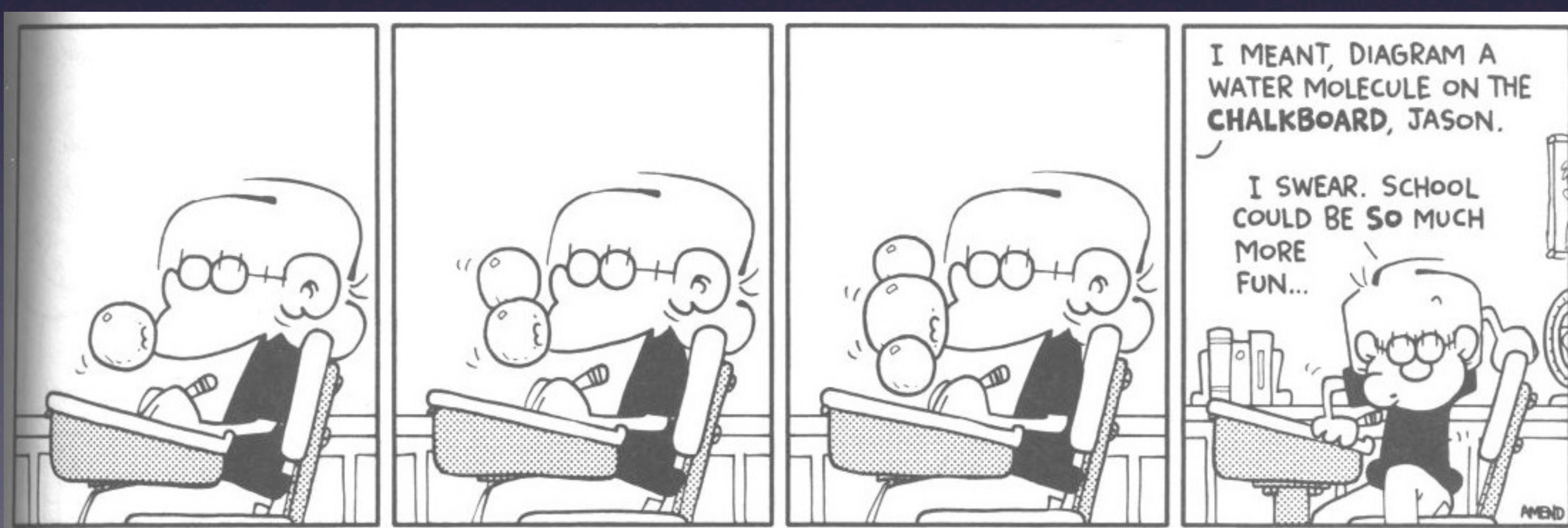

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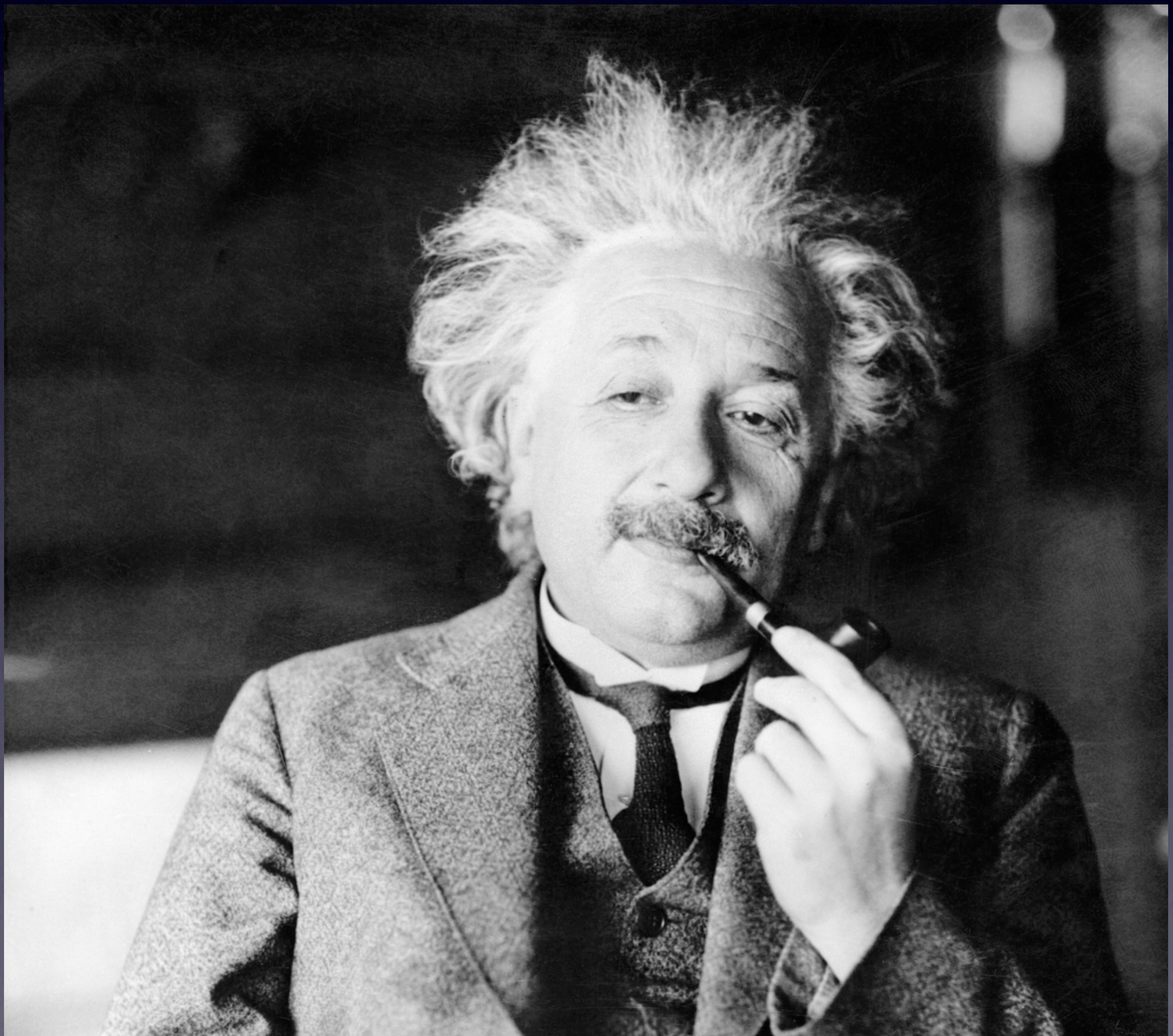
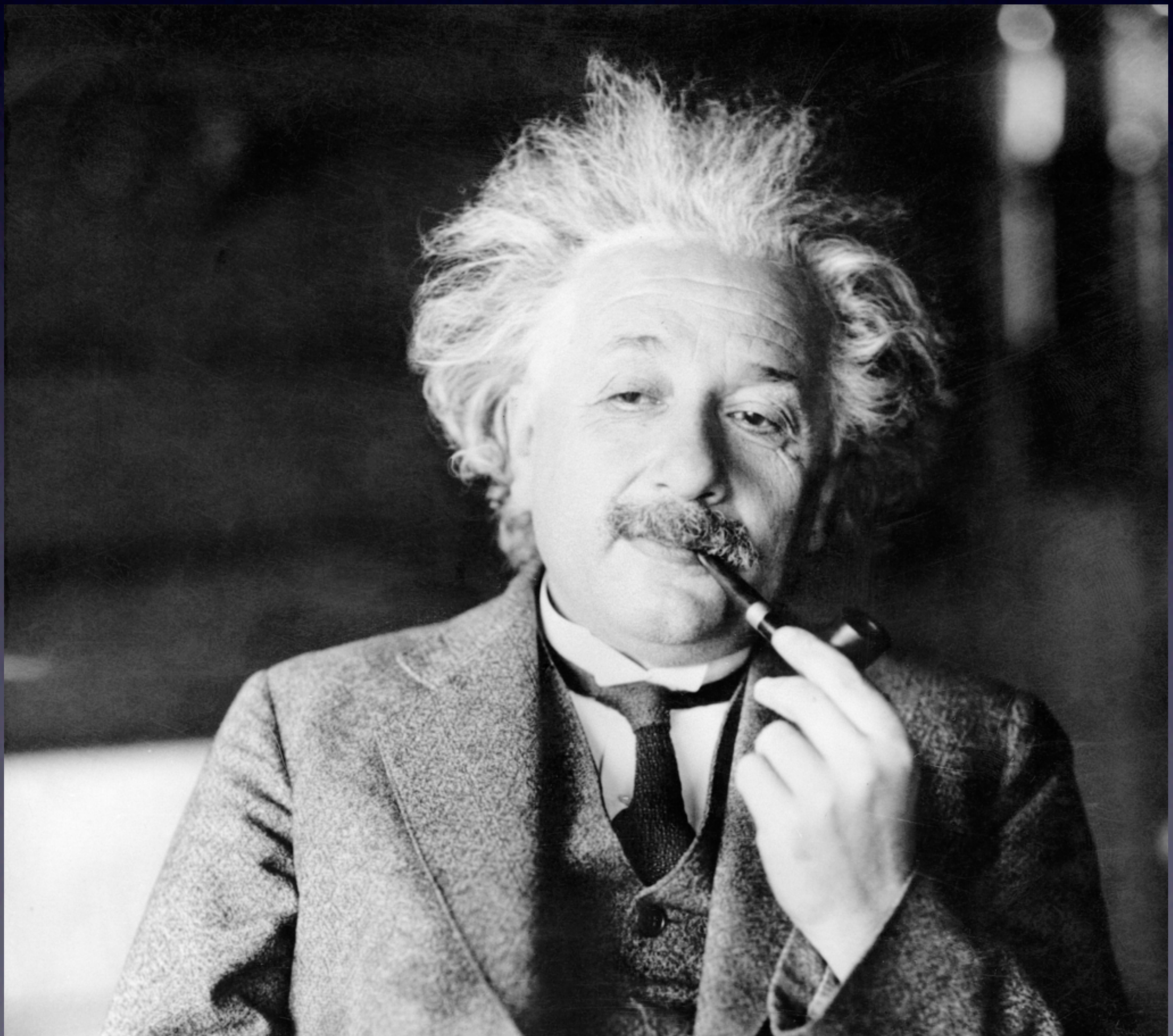
Light is quantized



Light is quantized

What does that mean?



Properties of a photon

$$p = \frac{h}{\lambda} = \hbar k$$

$$E = hf = \hbar\omega$$

$$\omega = ck$$

Compton Effect

Question # 37

In Compton scattering, the wavelength of the scattered photon is
(A) longer than,
(B) shorter than, or
(C) equal to
the wavelength of the incident photon

Lattice waves are quantized

$$\mathbf{p} = \hbar\mathbf{k}$$

$$E = \hbar\omega$$

Lattice waves are quantized

What does that mean?

$$\mathbf{p} = \hbar\mathbf{k}$$

$$E = \hbar\omega$$

Back to 121 with photons

$$\lambda_i = 1.542\,\text{Å}$$

$$\lambda_f = 1.566\,\text{Å}$$

$$E_i = ? \quad E_f = ?$$

$$\omega = ck$$

$$E = \hbar\omega$$

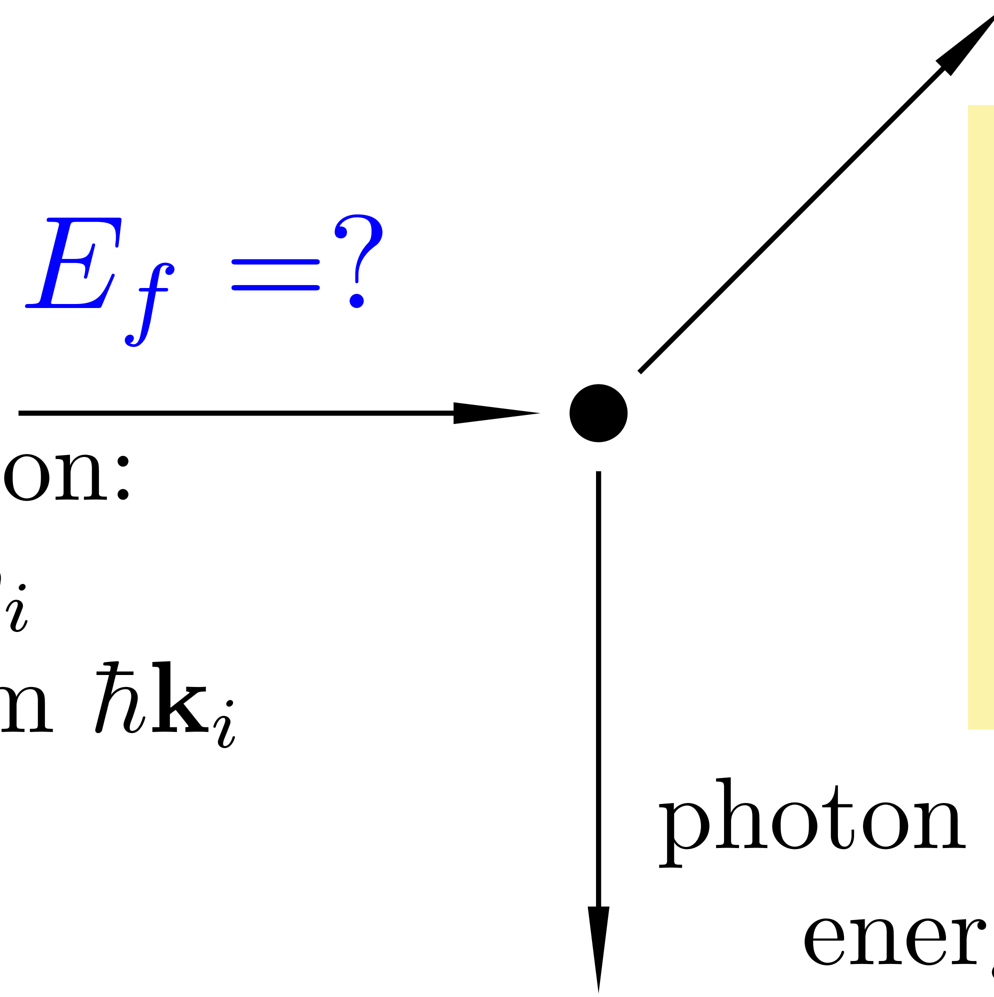


Fig. 5-1. The Compton effect. Collision between a photon and an electron.

$\lambda_i = 1.542\,\text{Å}$

$\lambda_f = 1.566\,\text{Å}$

7.93 keV

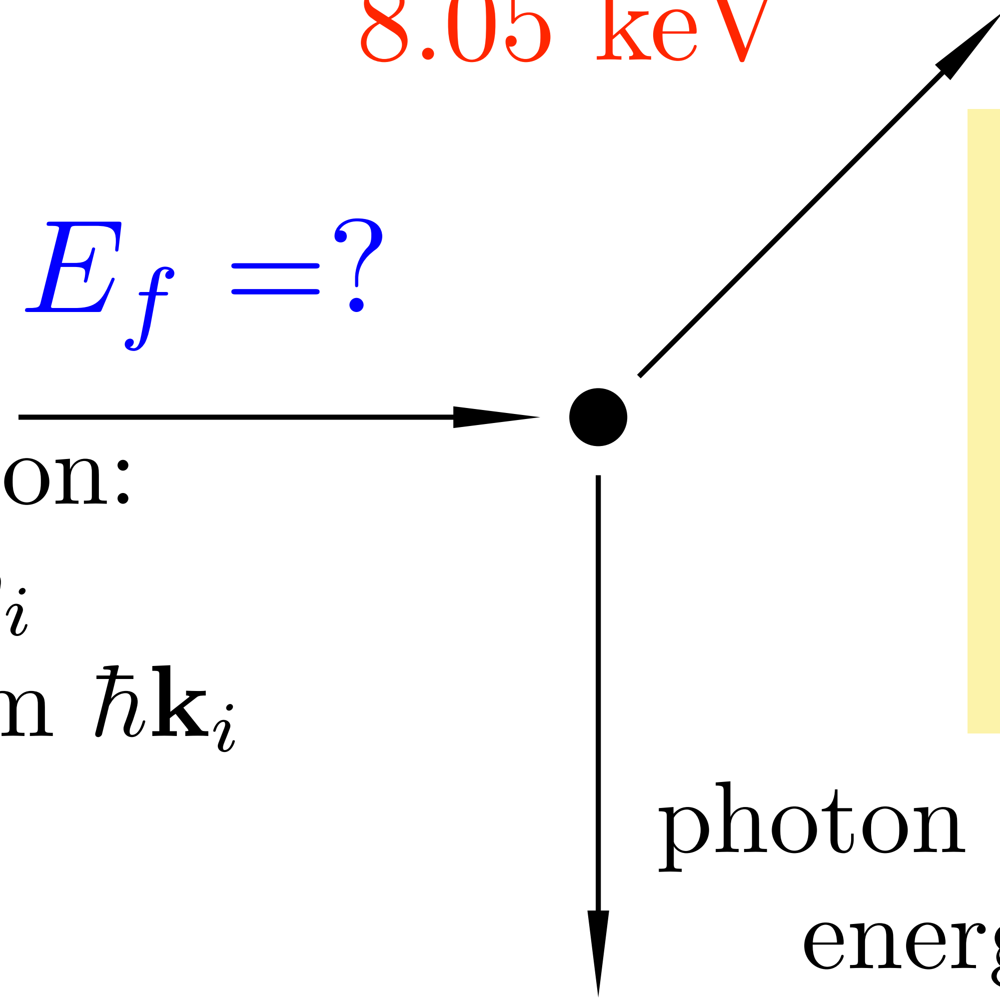
8.05 keV

$E_i = ?$ $\quad E_f = ?$

electron after collision:
energy E
momentum $\mathbf{p}$

$$\omega = ck$$

$$E = \hbar\omega$$



incident photon:
energy $\hbar\omega_i$
momentum $\hbar\mathbf{k}_i$

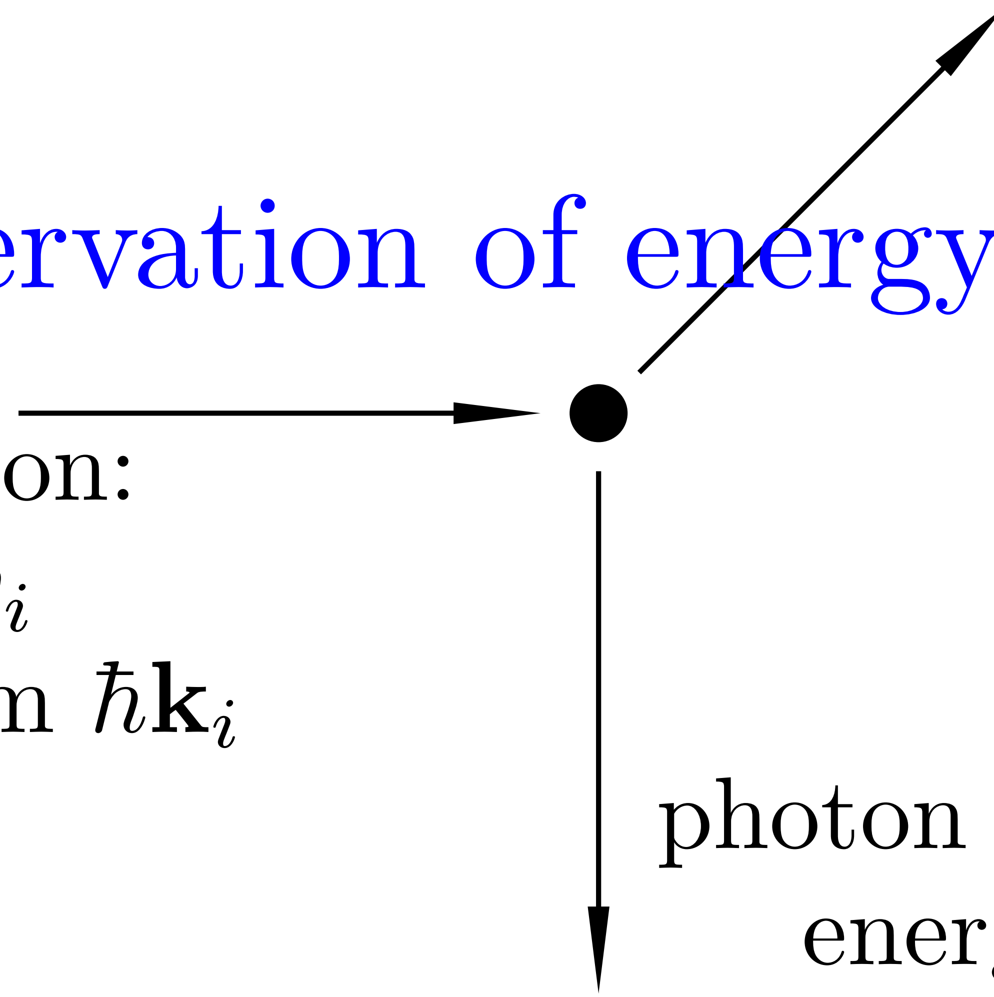
photon after collision:
energy $\hbar\omega_f$
momentum $\hbar\mathbf{k}_f$

Fig. 5-1. The Compton effect. Collision between a photon and an electron.

$$\lambda_i = 1.542\,\text{Å}$$
$$\lambda_f = 1.566\,\text{Å}$$

electron after collision:
energy E
momentum $\mathbf{p}$

Using conservation of energy, $v_e =$?



incident photon:
energy $\hbar\omega_i$
momentum $\hbar\mathbf{k}_i$

photon after collision:
energy $\hbar\omega_f$
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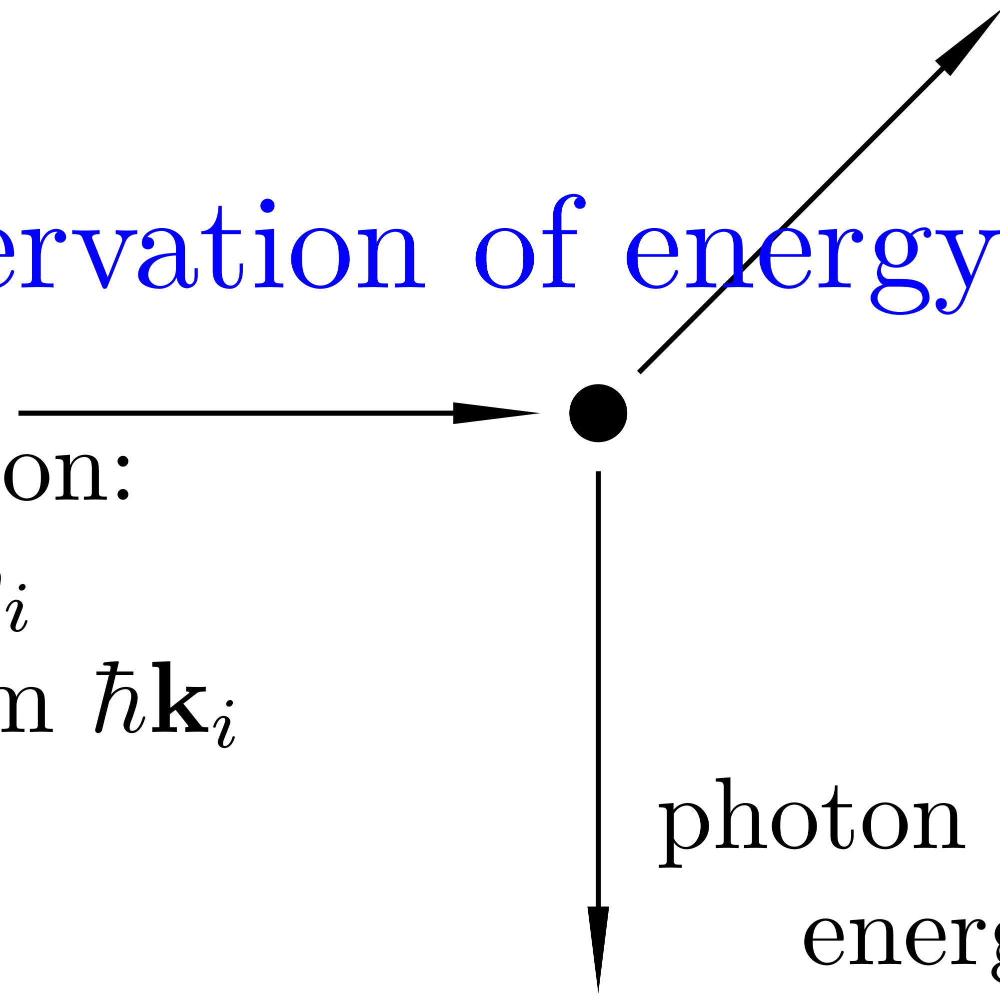
Fig. 5-1. The Compton effect. Collision between a photon and an electron.

$$\lambda_i = 1.542\,\text{Å}$$
$$\lambda_f = 1.566\,\text{Å}$$

electron after collision:
energy E
momentum $\mathbf{p}$

6.6×10^6 m/s

Using conservation of energy, $v_e = ?$



incident photon:
energy $\hbar\omega_i$
momentum $\hbar\mathbf{k}_i$

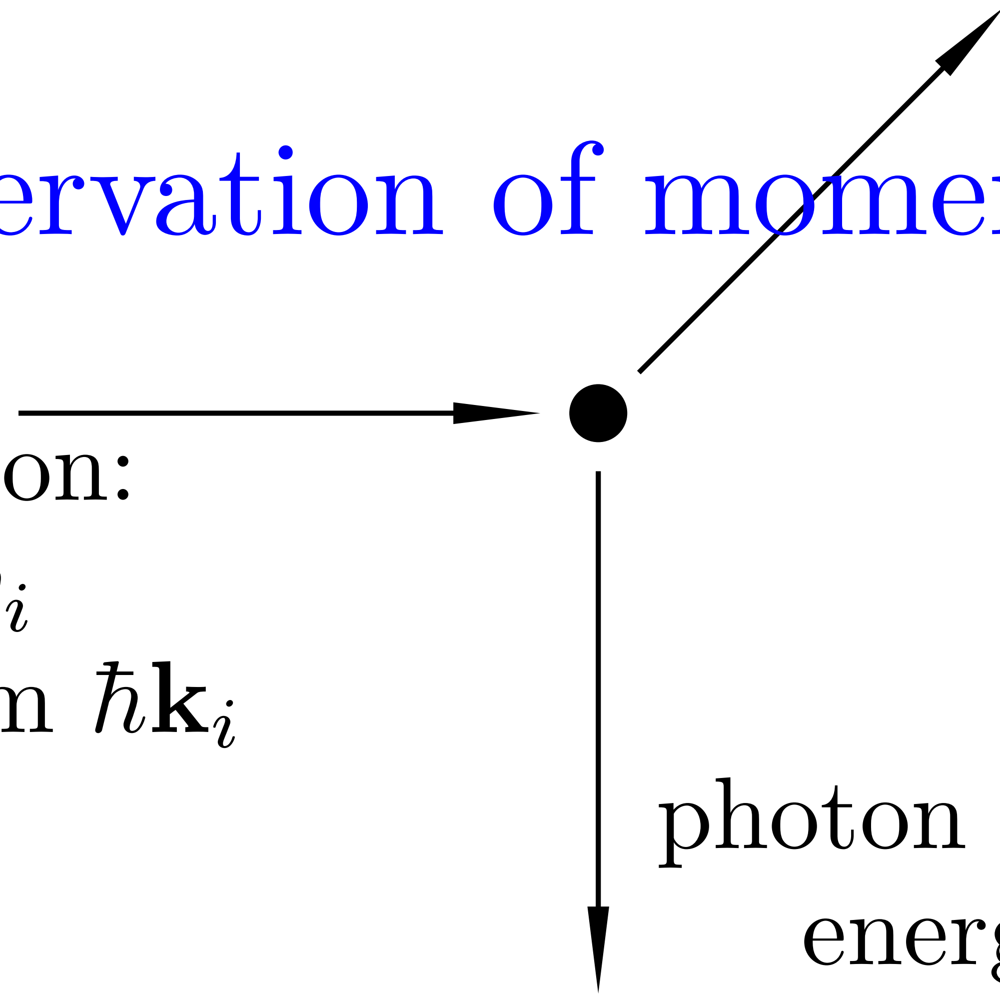
photon after collision:
energy $\hbar\omega_f$
momentum $\hbar\mathbf{k}_f$

Fig. 5-1. The Compton effect. Collision between a photon and an electron.

$$\lambda_i = 1.542\,\text{Å}$$
$$\lambda_f = 1.566\,\text{Å}$$

electron after collision:
energy E
momentum $\mathbf{p}$

Using conservation of momentum, $v_e =?$

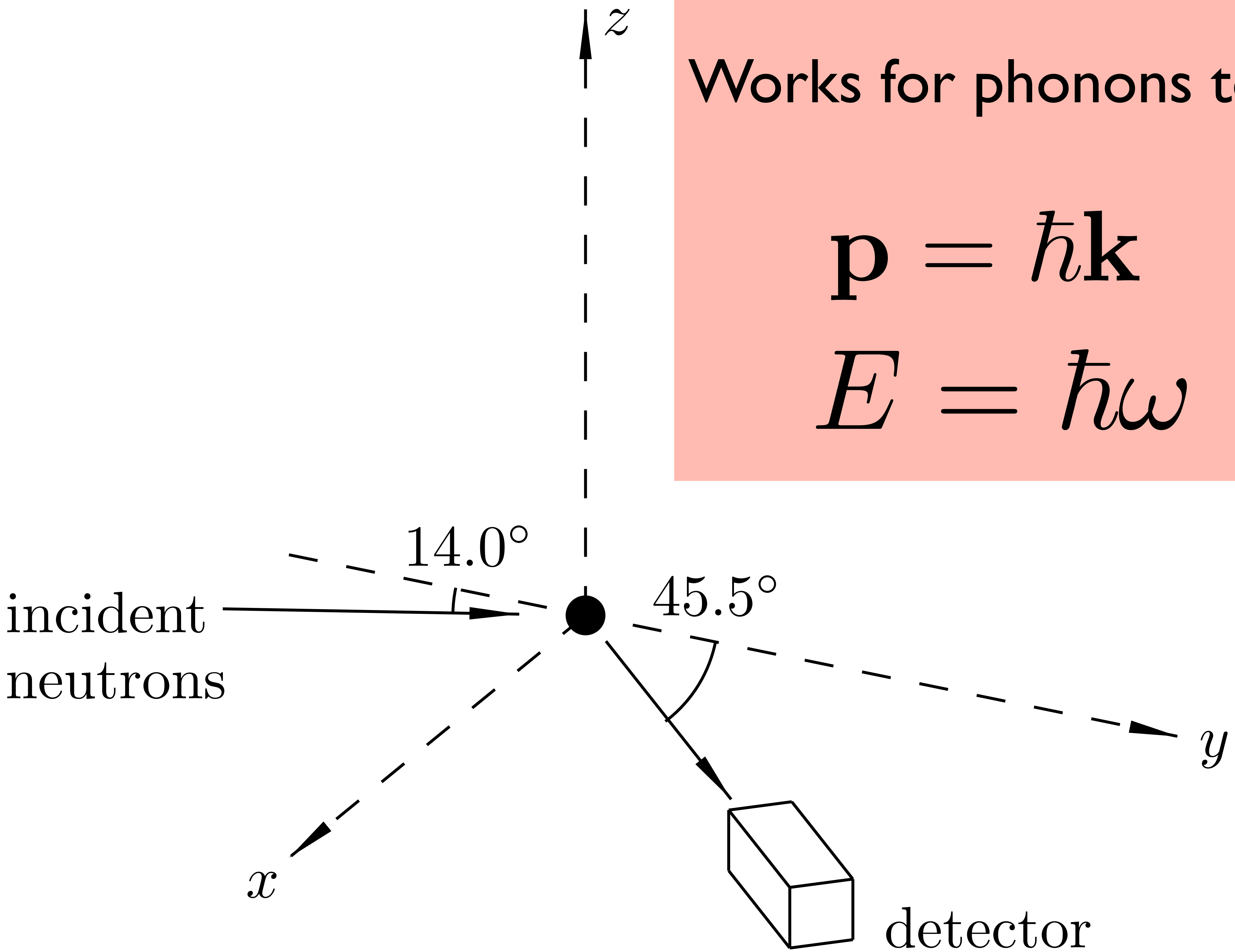


incident photon:
energy $\hbar\omega_i$
momentum $\hbar\mathbf{k}_i$

photon after collision:
energy $\hbar\omega_f$
momentum $\hbar\mathbf{k}_f$

Fig. 5-1. The Compton effect. Collision between a photon and an electron.

Neutron scattering



Works for phonons too.

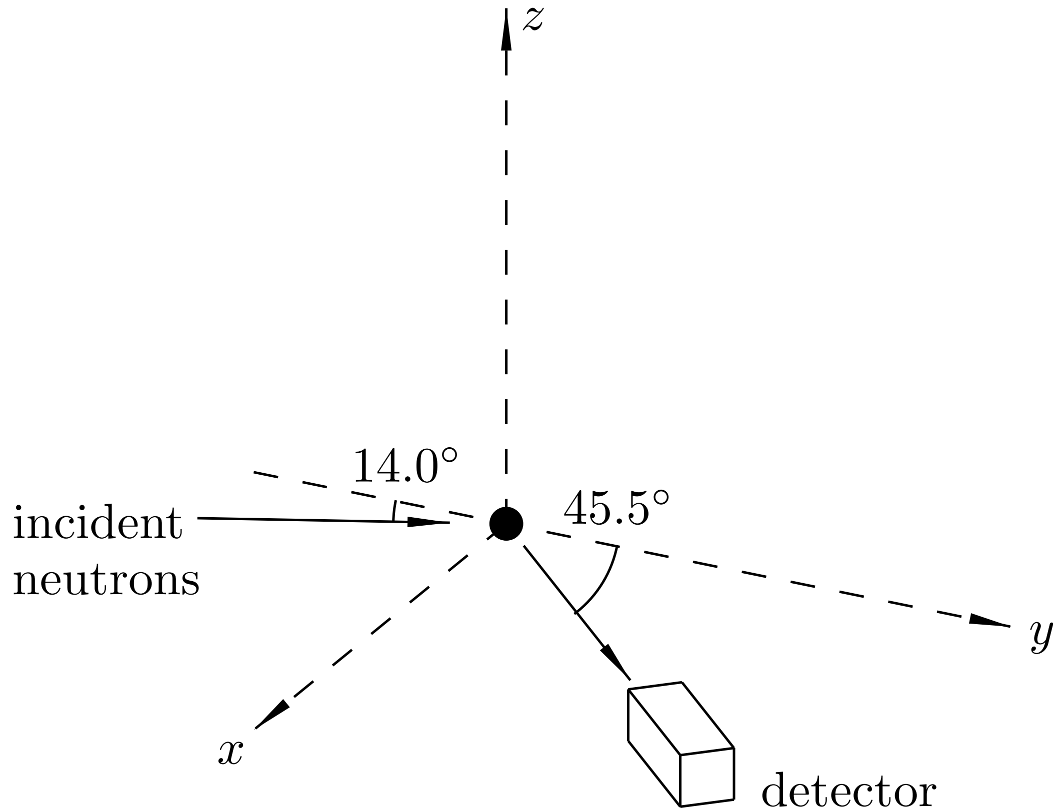
$$\mathbf{p} = \hbar \mathbf{k}$$

$$E = \hbar \omega$$

Neutron scattering

Close your books for this one.

Which equation is the correct statement for conservation of energy if the incident neutron absorbs a phonon?



D $E_f = E_i - \hbar\omega$

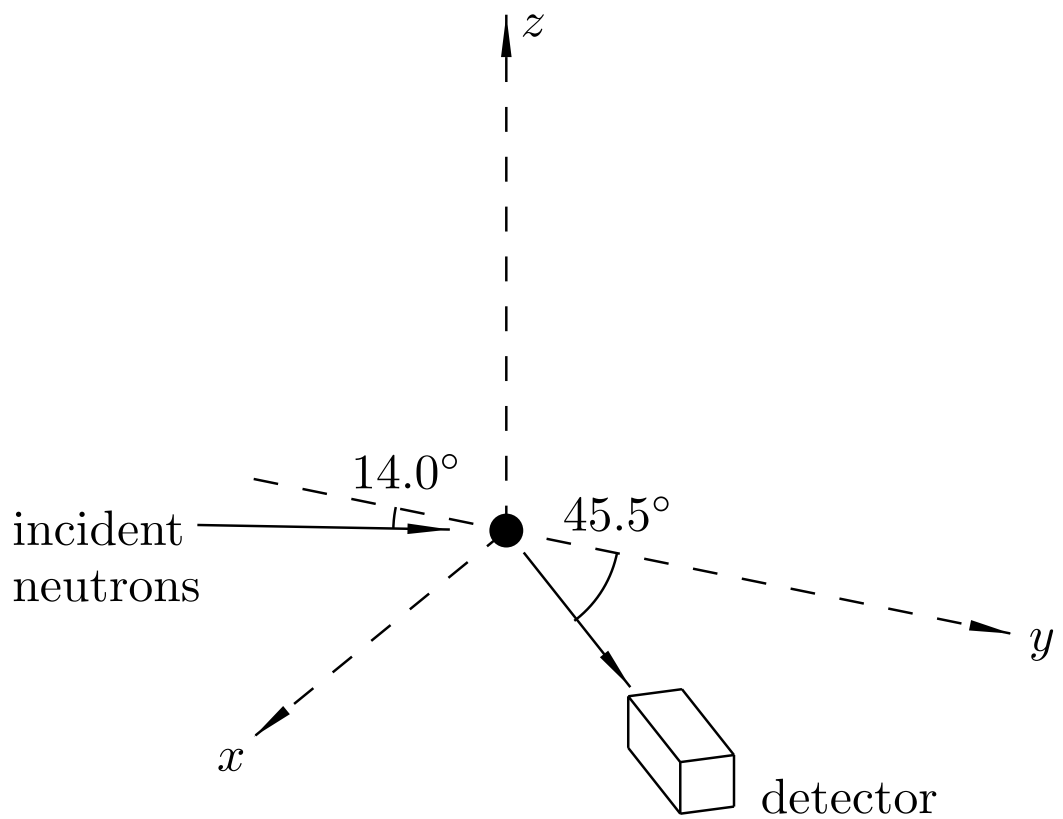
E $E_f = E_i + \hbar\omega$

Question # 39

Neutron scattering

Close your books for this one.

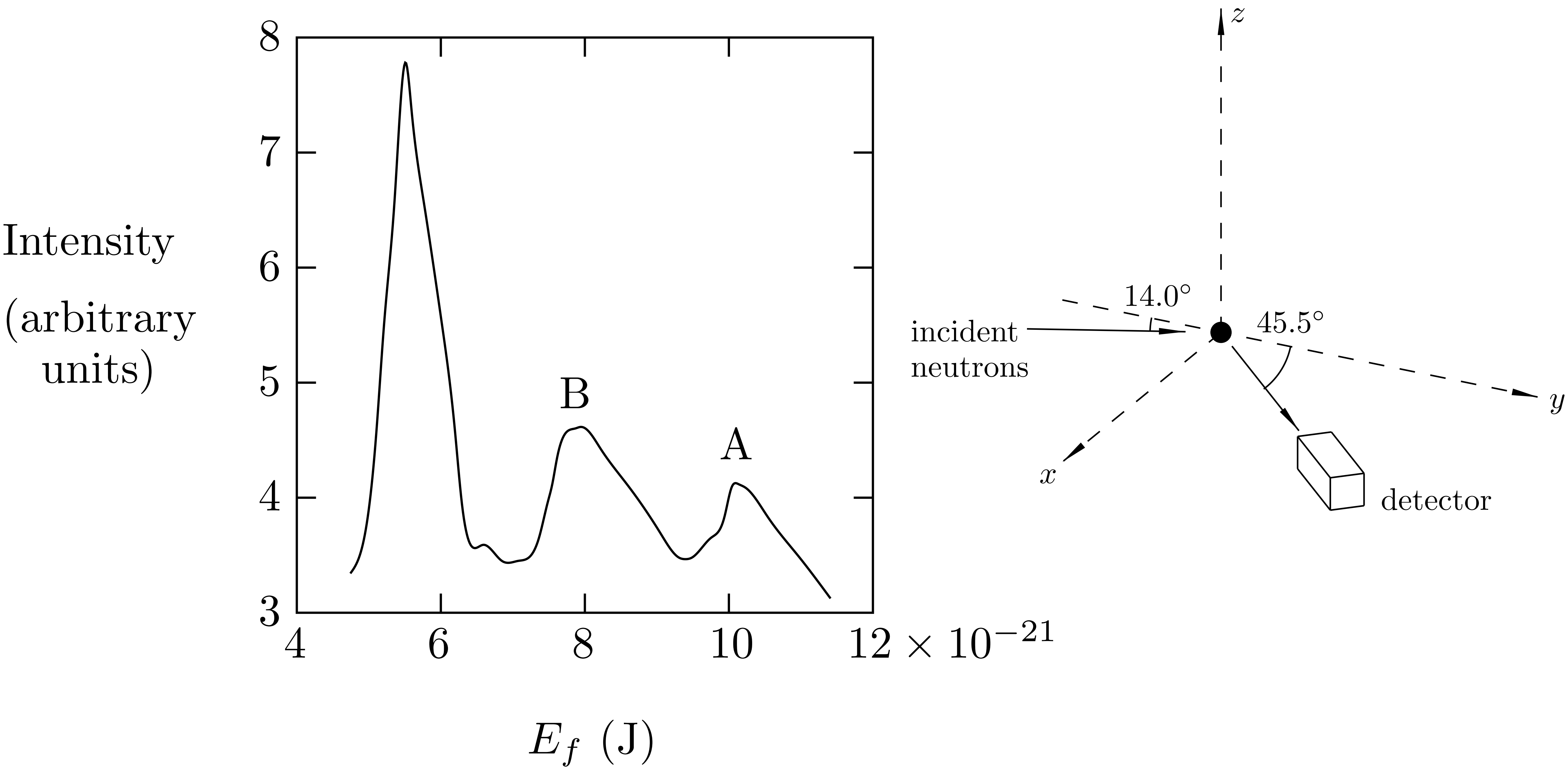
Which equation is the correct statement for conservation of energy if the incident neutron absorbs a phonon?



D $\mathbf{p}_f = \mathbf{p}_i - \hbar\mathbf{k}$

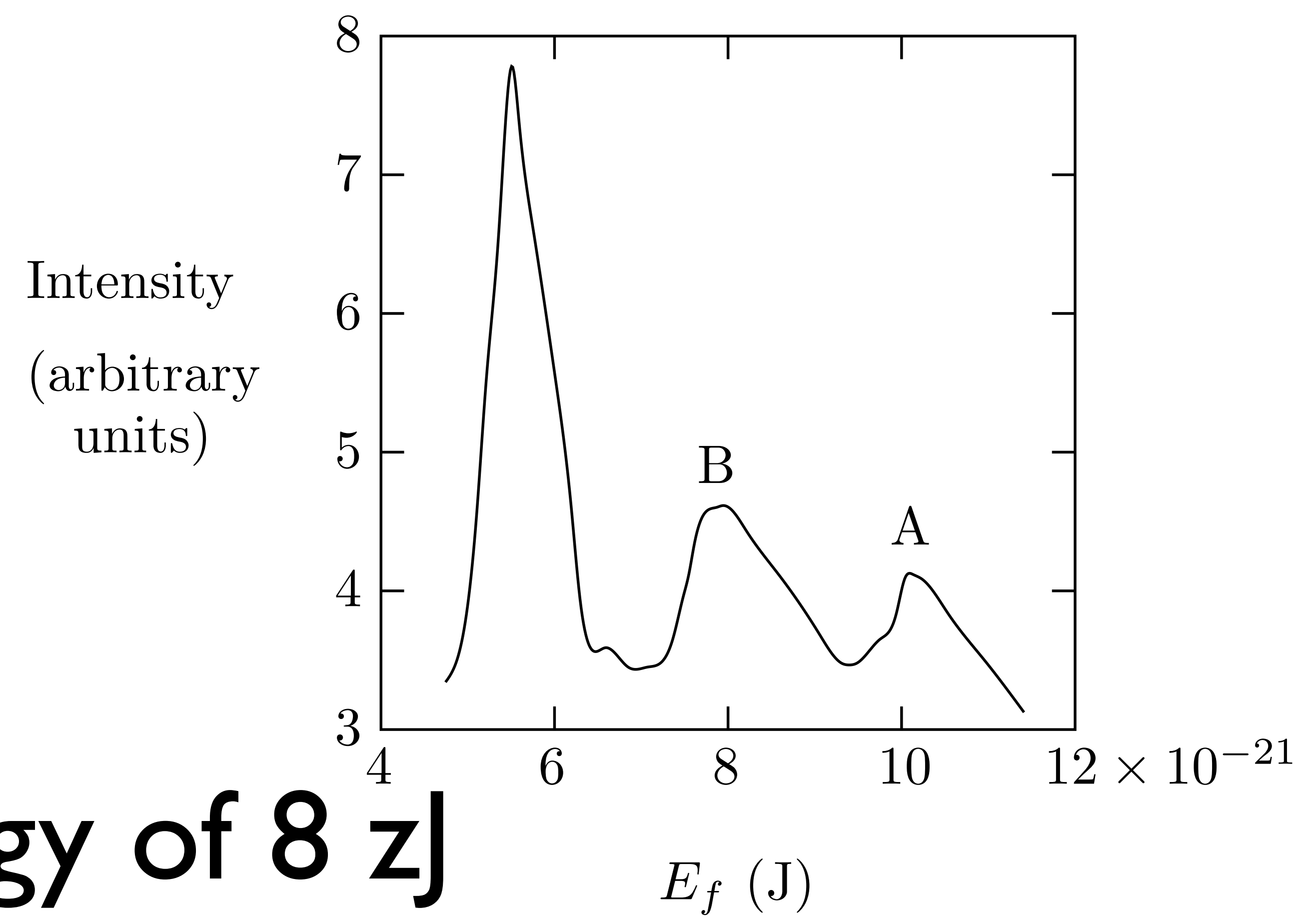
E $\mathbf{p}_f = \mathbf{p}_i + \hbar\mathbf{k}$

Neutron scattering



Neutron scattering

Question #40



Neutrons with an energy of 8 zJ

A. All below are true.

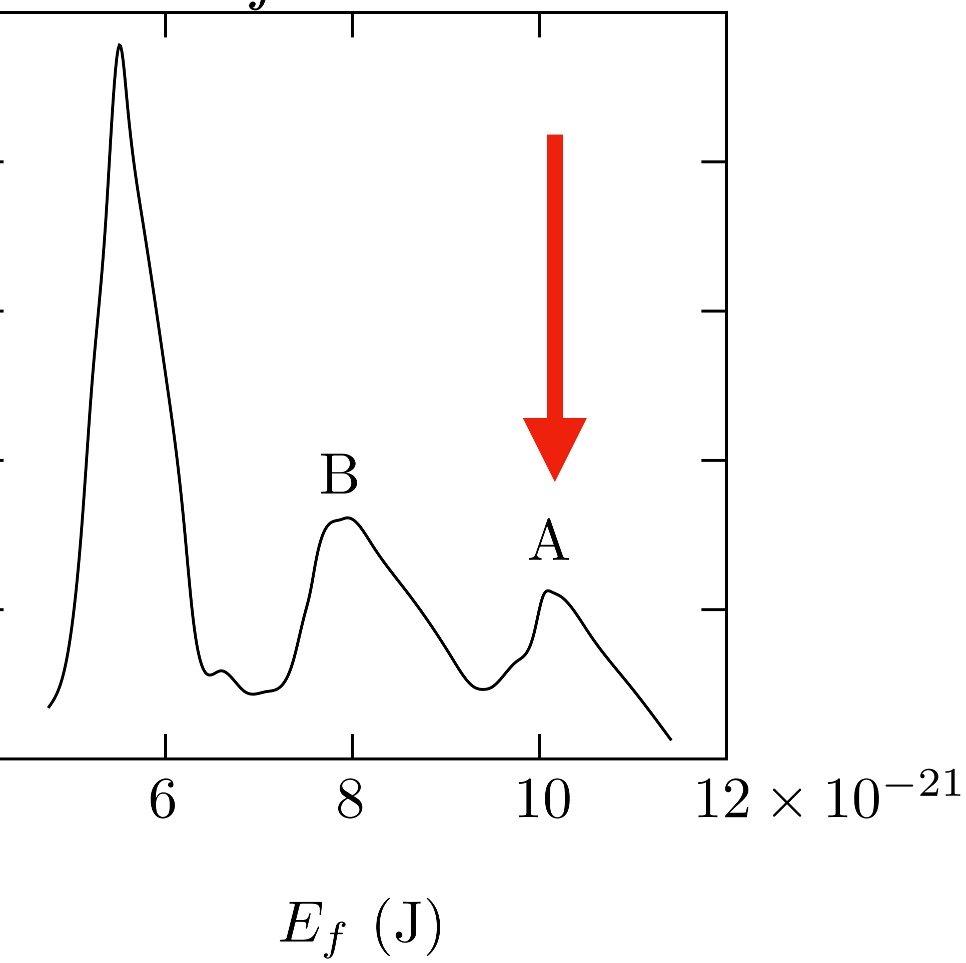
B. scattered elastically off the crystal

C. absorbed a phonon

D. emitted a phonon

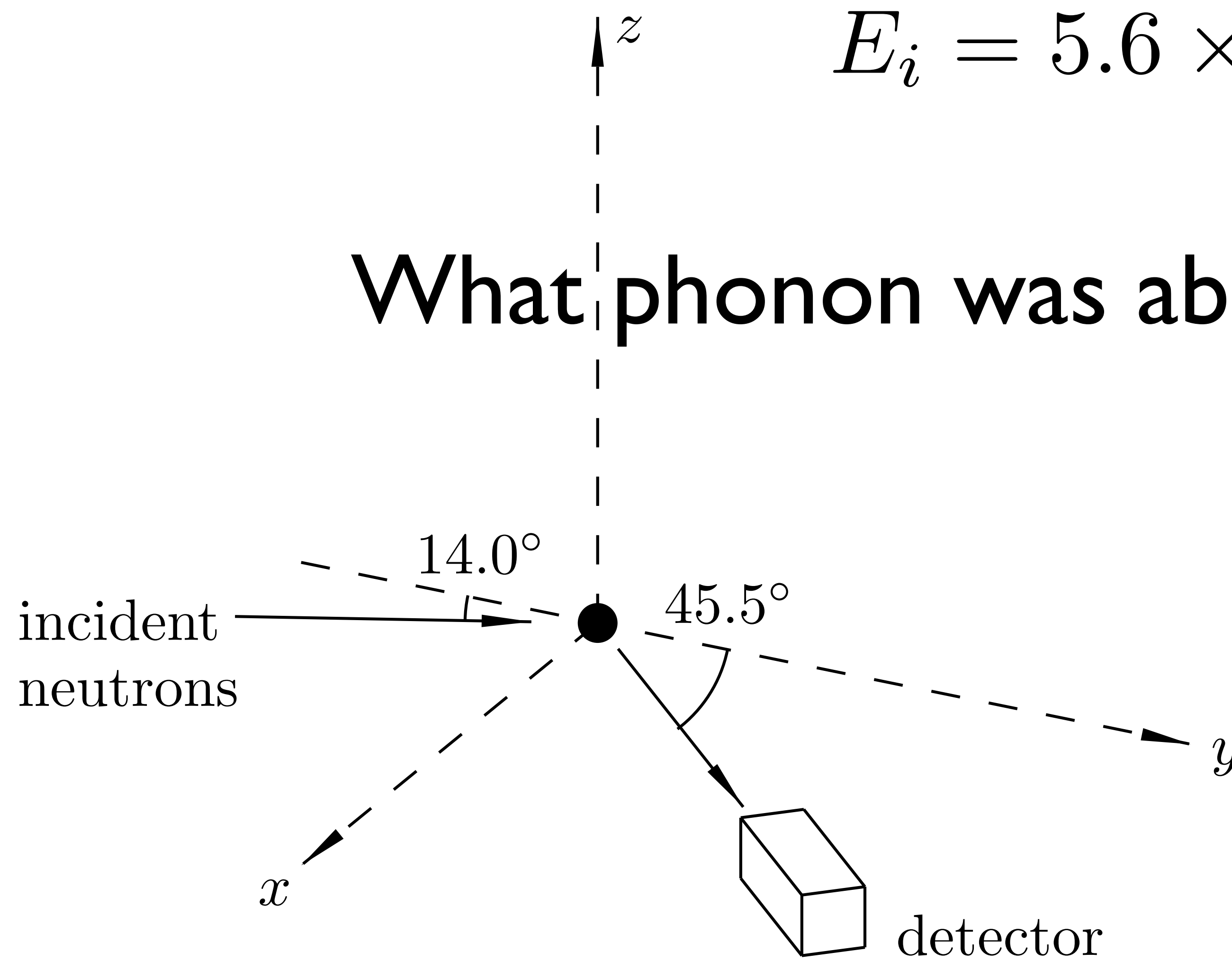
Neutron scattering

$E_f = 10.2 \times 10^{-21}$



$E_i = 5.6 \times 10^{-21}$

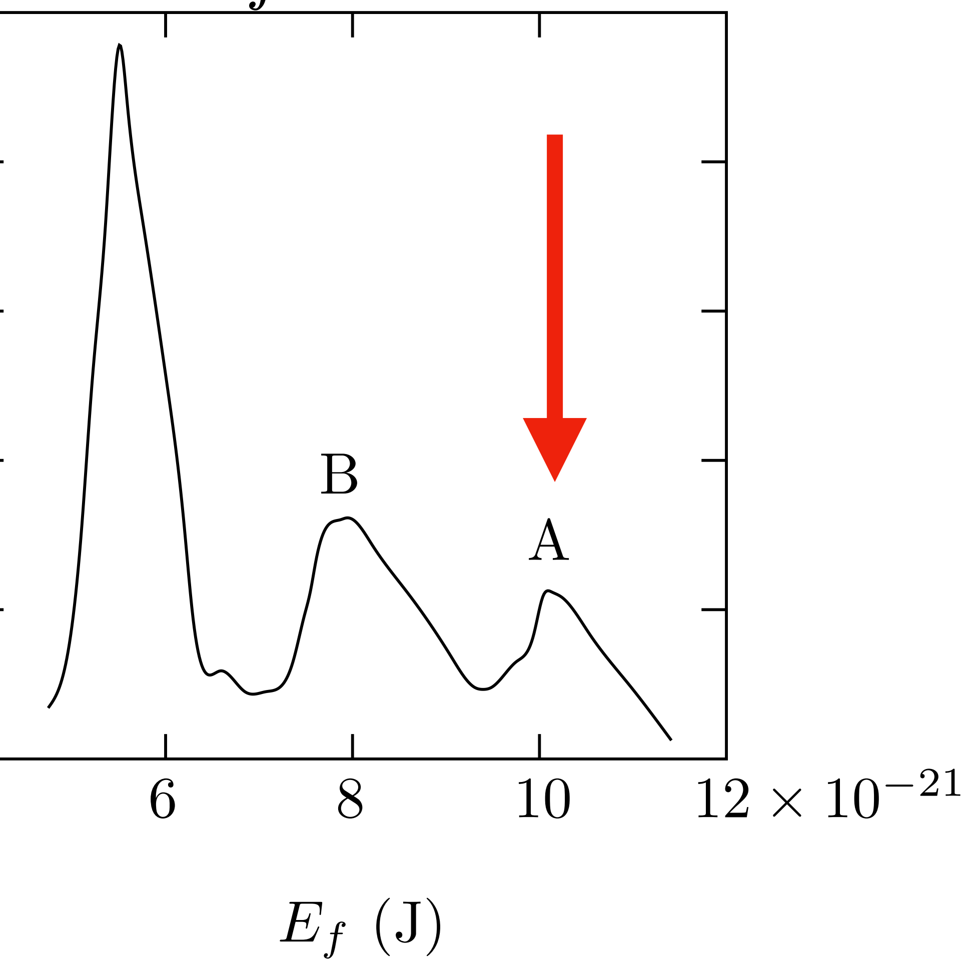
What phonon was absorbed?



Do Problem 5-5 and vote at pollev.com when you are done.

Neutron scattering

$E_f = 10.2 \times 10^{-21}$



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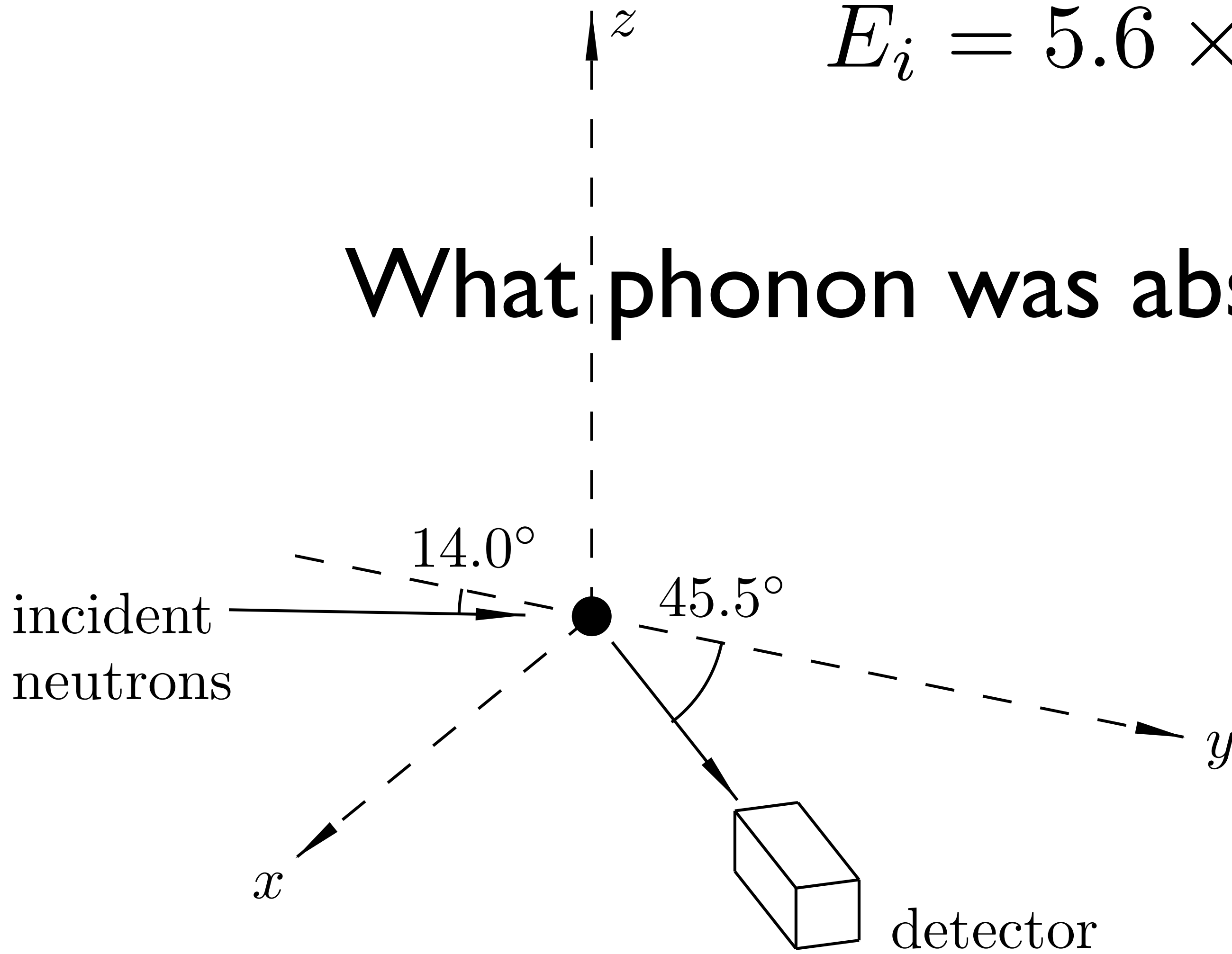
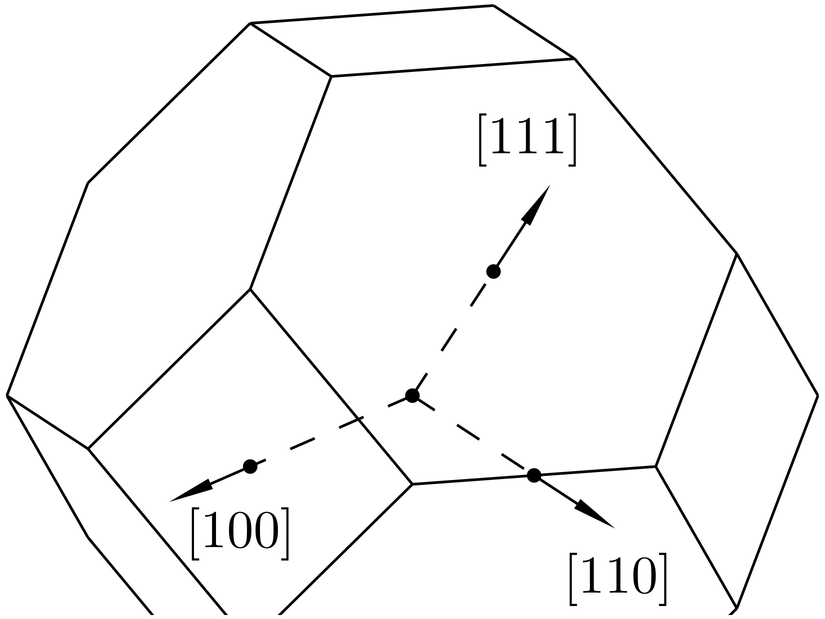
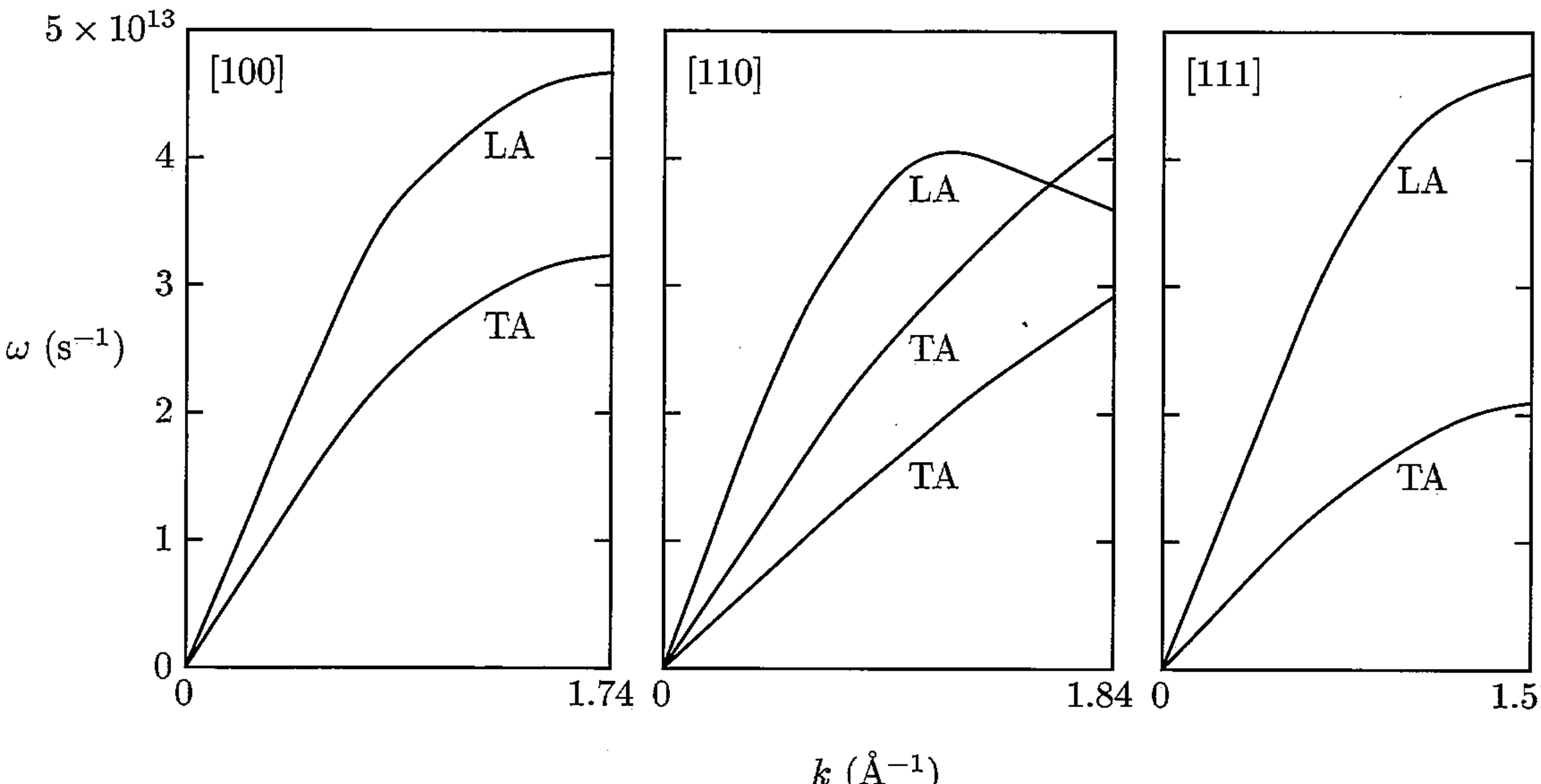


$$\mathbf{k} = 4.9\ \mathring{A}^{-1}\ \hat{i}$$

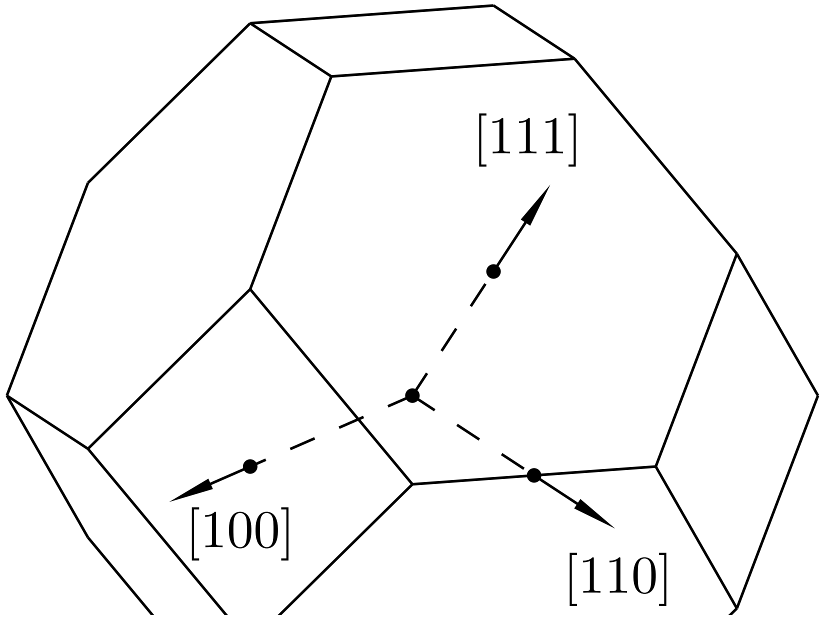
Do Problem 5-5 and vote at pollev.com when you are done.

Dispersion in Cu

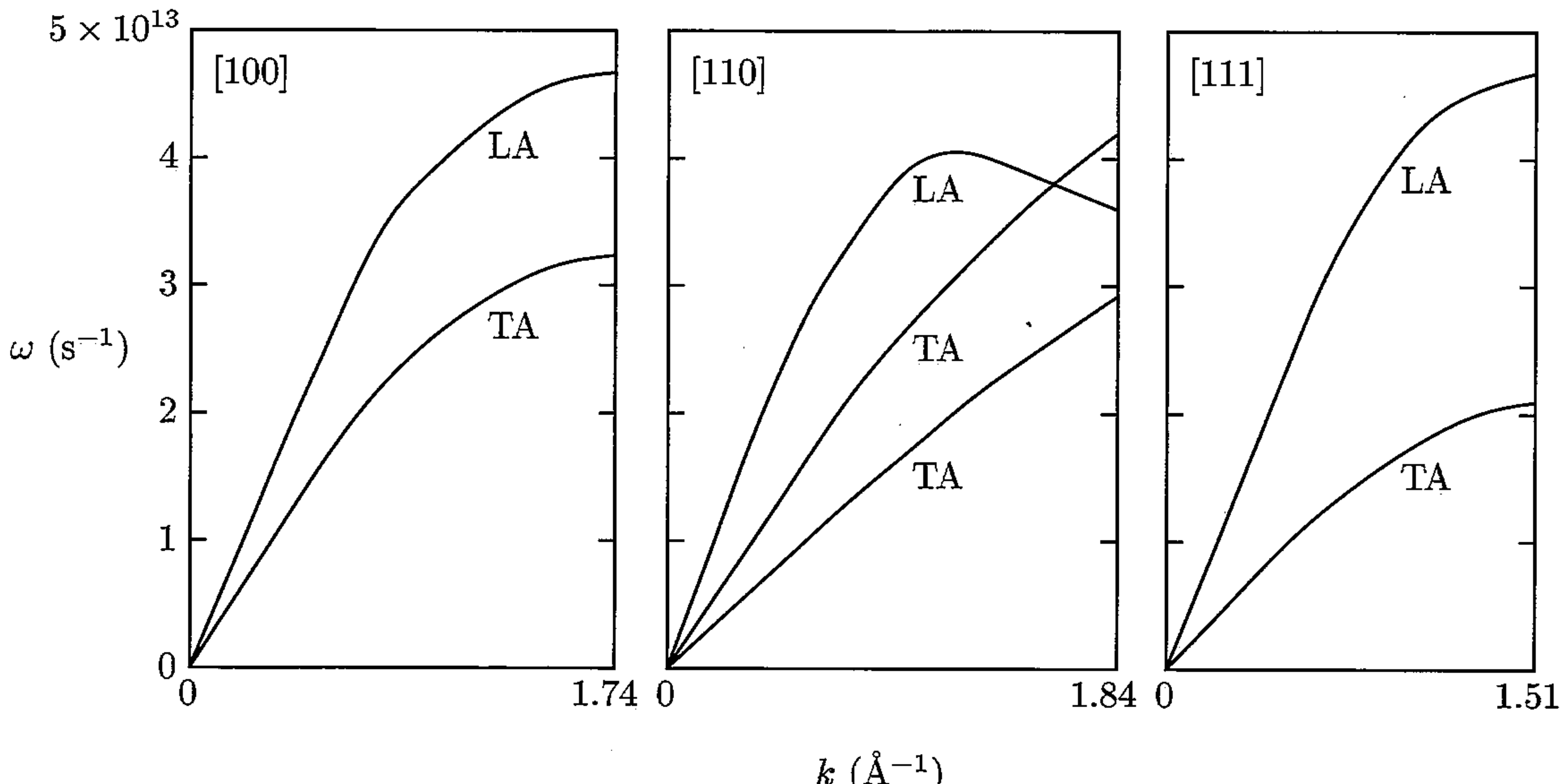




Dispersion in Cu



$$\mathbf{k} = 4.9\ \mathring{A}^{-1}\ \hat{i} - \frac{4\pi}{a} = 1.4\ \mathring{A}^{-1}\ \hat{i}$$



Do Problem 5-7 and vote at pollev.com when you're done.

$$\omega = 2.3 \times 10^{13} s^{-1}$$

$$|k| = 1.1\ \mathring{A}^{-1}$$

$$28^\circ \quad \text{from the} \quad [100] \quad \text{direction}$$

Dispersion in Cu