

WHY SHOULD I TAKE A
BATH? I'M JUST GOING
TO GET DIRTY AGAIN.



WHY SHOULD I BRUSH
MY TEETH? I'M JUST
GOING TO EAT AGAIN.



WHY SHOULD I COMB MY
HAIR? IT'S JUST GOING
TO GET MESSED UP AGAIN.



I'D RATHER BE
EFFICIENT THAN
HYGIENIC.



SO YOUR TEACHER DIDN'T
KNOW YOU'D RIPPED YOUR
PANTS, AND SHE MADE YOU
DO A PROBLEM AT THE CHALK-
BOARD?



THAT
SUMS
IT UP.
HOW AWFUL!
WHAT DID YOU DO??



I DIDN'T HAVE A CHOICE.
I MOONED THE WHOLE CLASS.



THAT'S WHY
YOU'RE HOME
EARLY?
THREE TEACHERS
AND THE
PRINCIPAL
COULDNT RESTORE
ORDER.



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On a piece of paper...

What is an energy band?

What does it represent?

What is the k-vector in an energy band diagram?

What is the Brillouin zone?

What is the physical significance of the Brillouin zone?

What is the Fermi surface?

Pass the paper to the end of the row. Discuss your answers with your neighbor.

Review from last time

Question #1

How far does an electron travel between
“collisions”?

- B) Tens of Angstroms
- C) Angstroms
- D) Thousands of Angstroms
- E) Hundreds of Angstroms

Review from last time

Question #2

What fraction of the valence electrons contribute to electrical conductivity

- A) Less than 1% of them.
- B) About half of them
- C) All of them

Review from last time

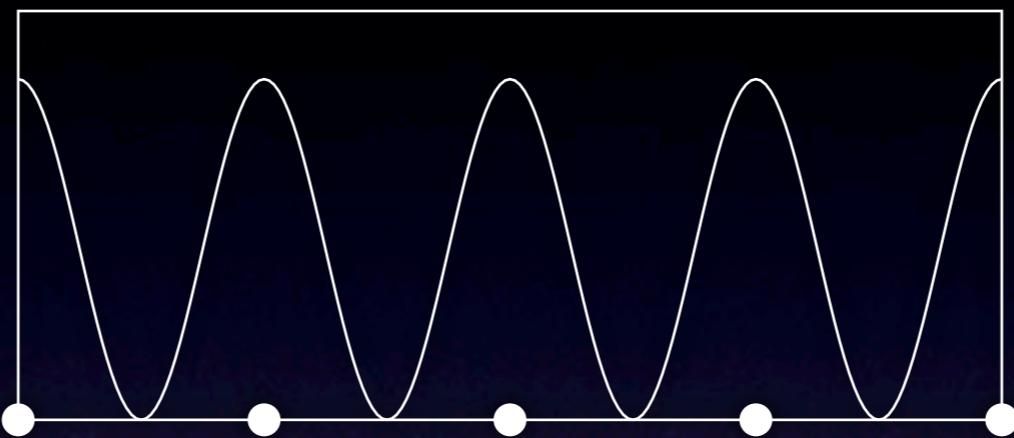
Question #3

At room temperature, which electrons are in excited states?

- A) All of them
- B) None of them.
- C) Only the electrons in states near the Fermi surface.
- D) Only the electrons in the lowest lying states.

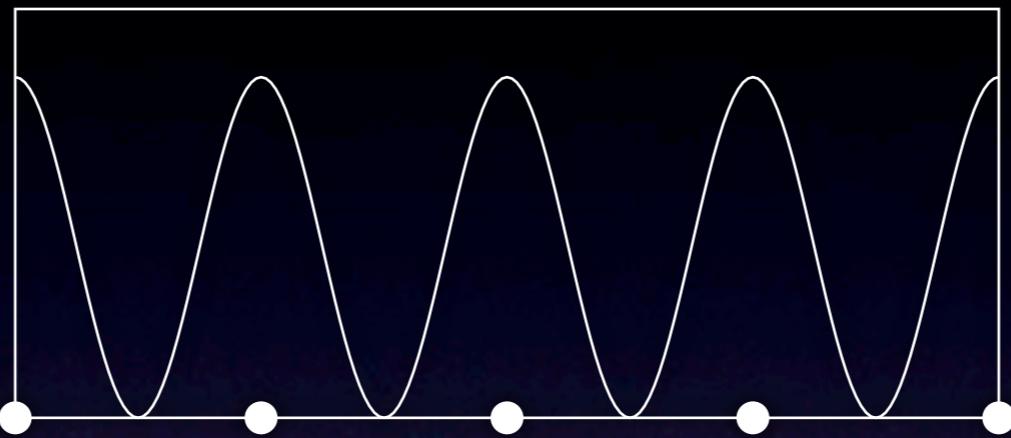
Probability density

$$|\psi_1|^2 = 4A^2 \cos^2(\pi x/a)$$

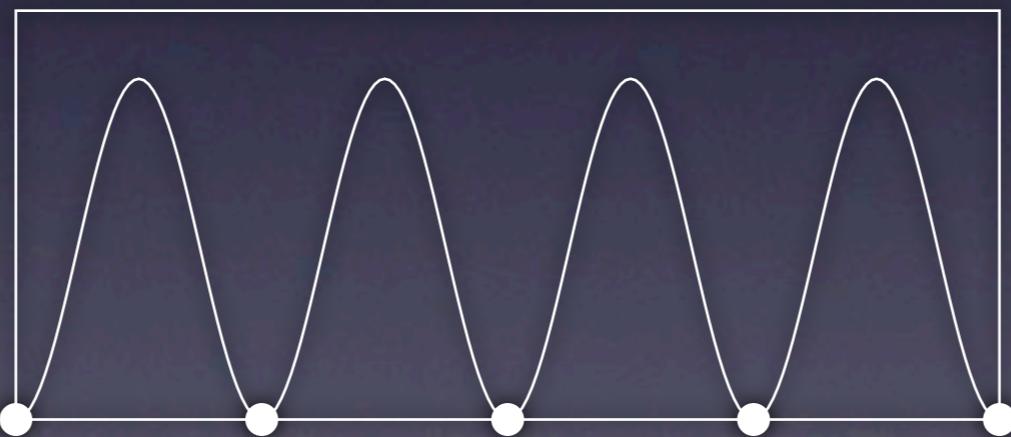


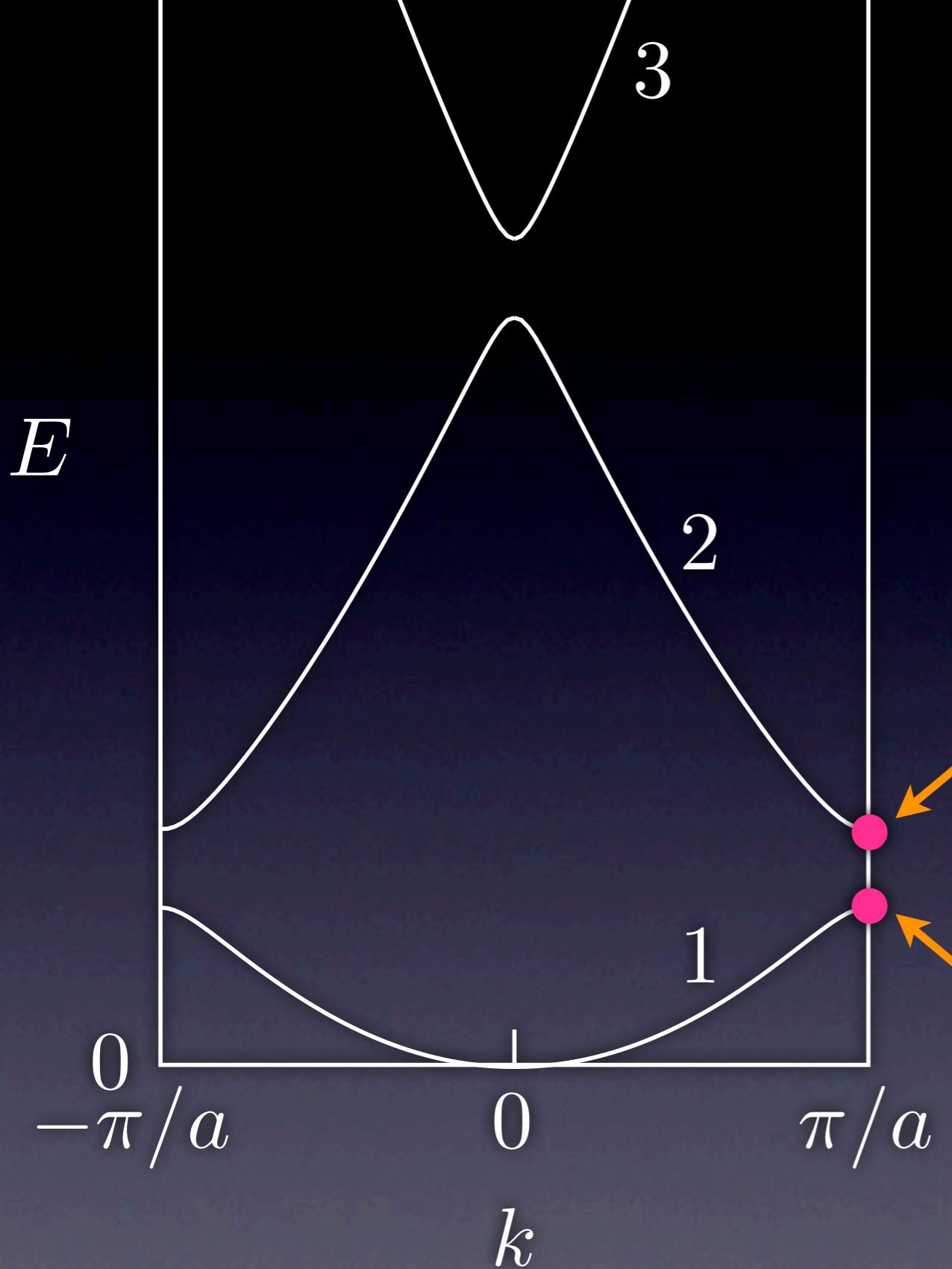
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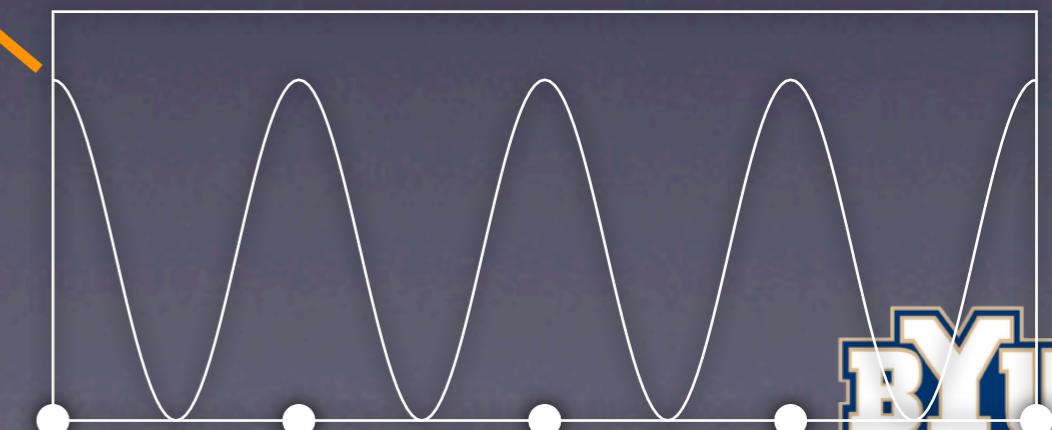


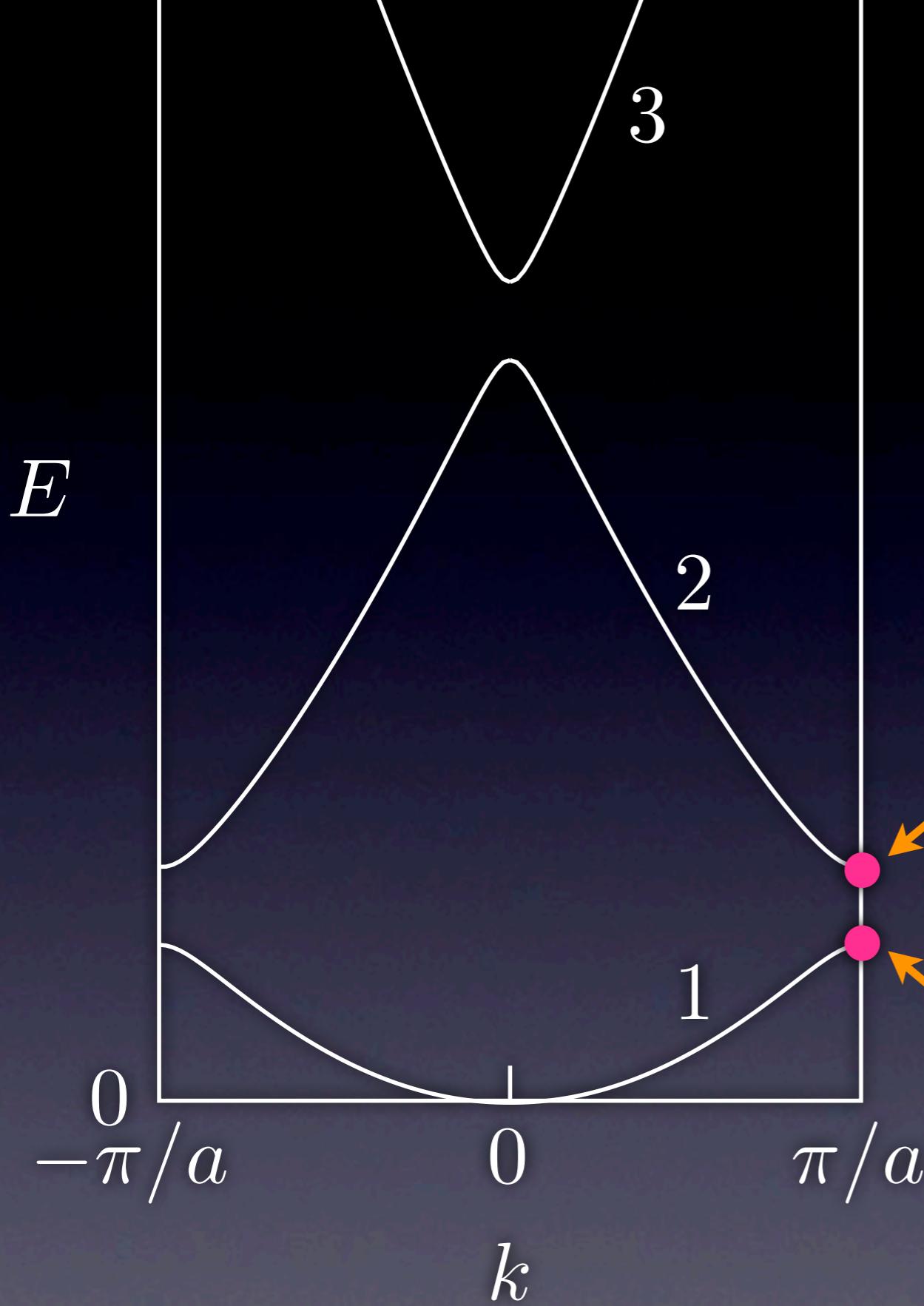
$$|\psi_2|^2 = 4A^2 \sin^2(\pi x/a)$$



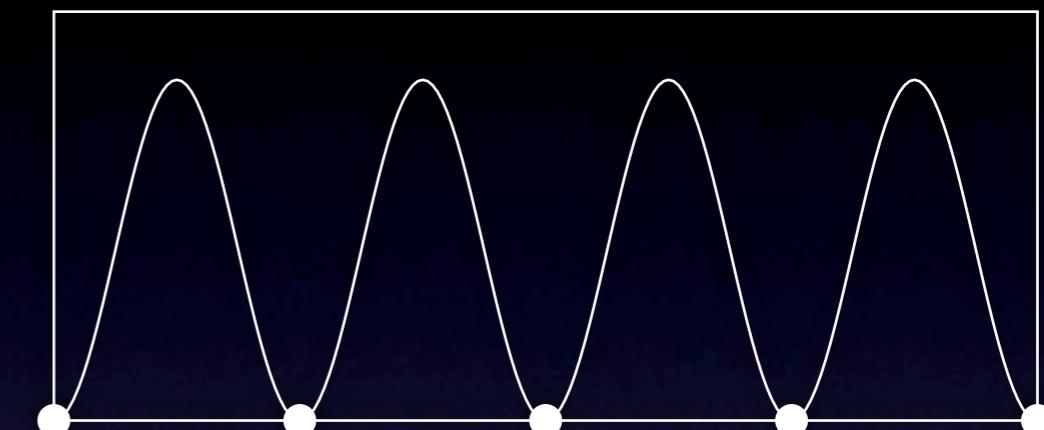


$$|\psi_1|^2 = 4A^2 \cos^2(\pi x/a)$$

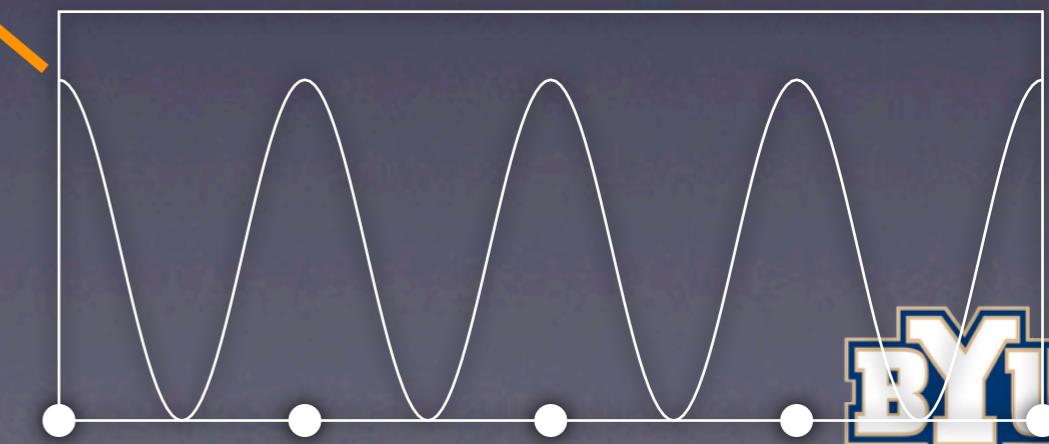


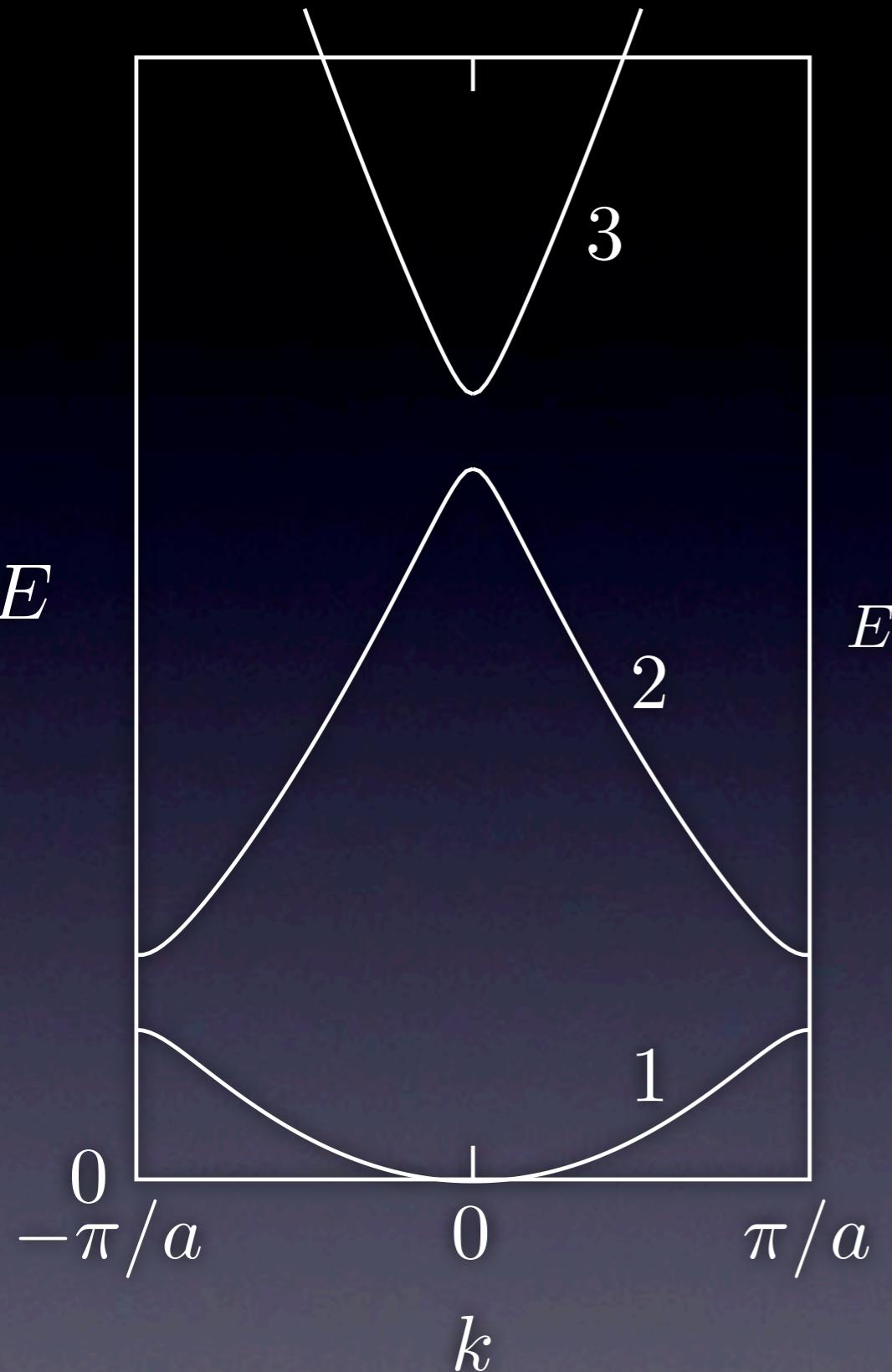
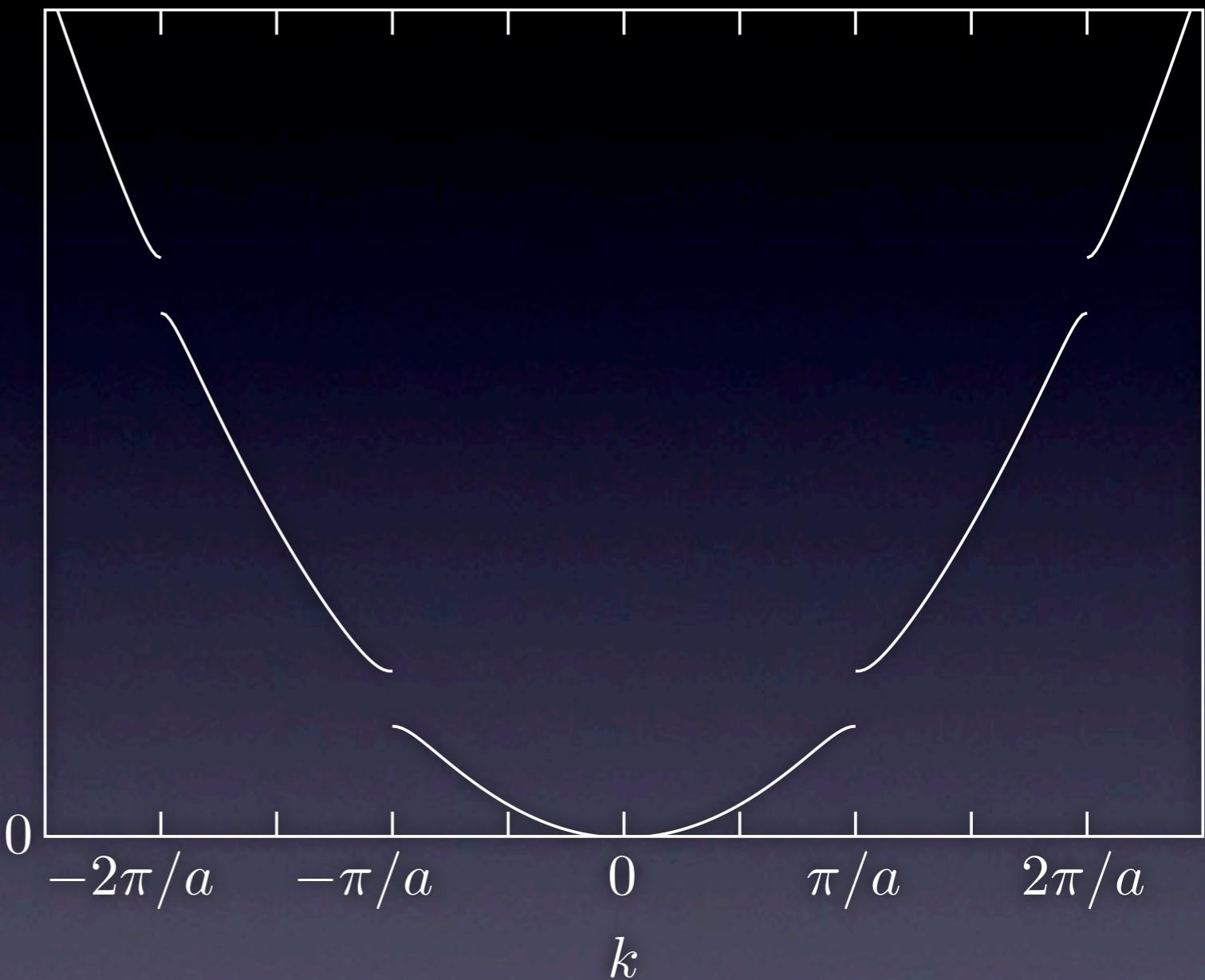


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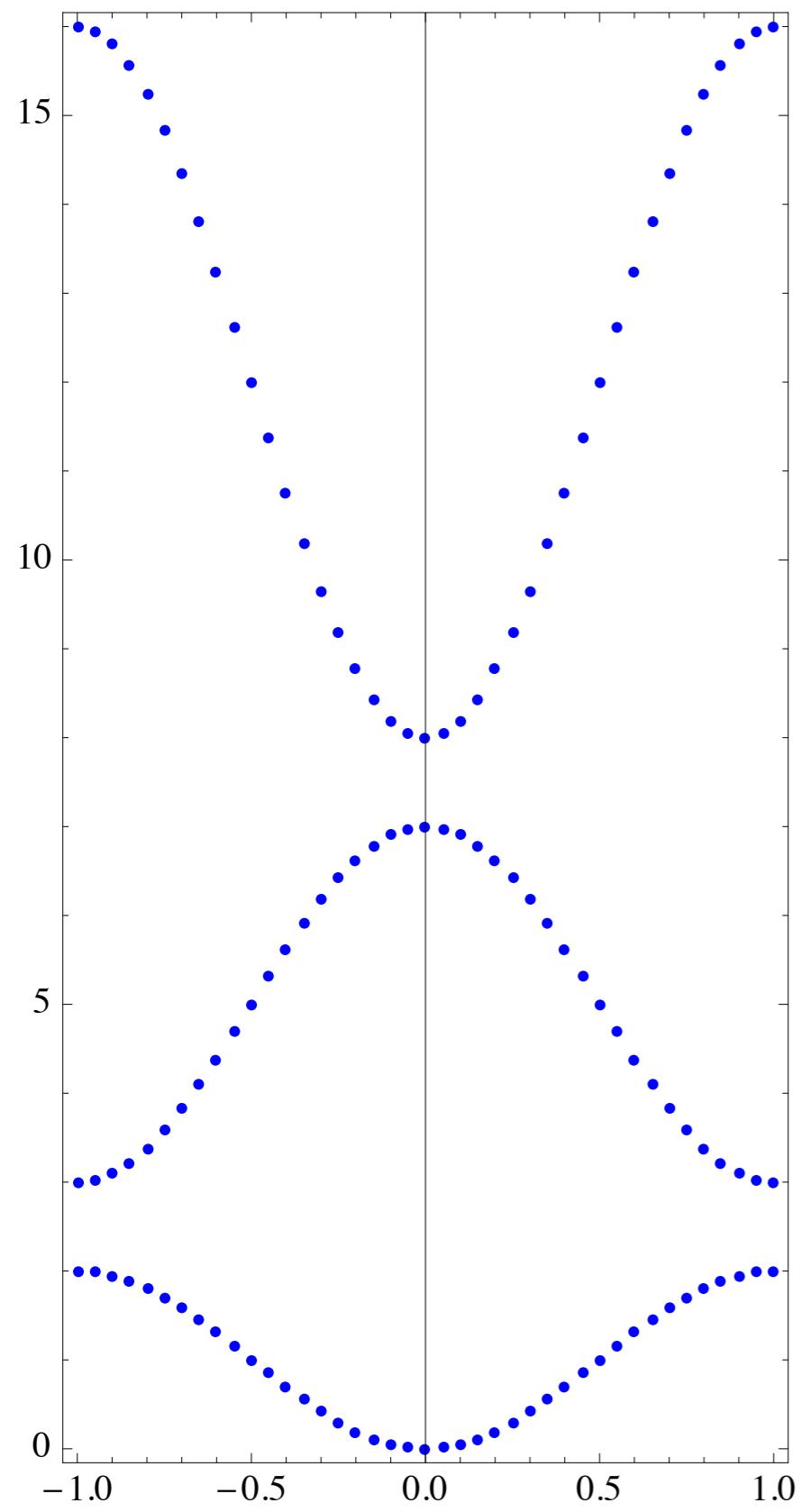


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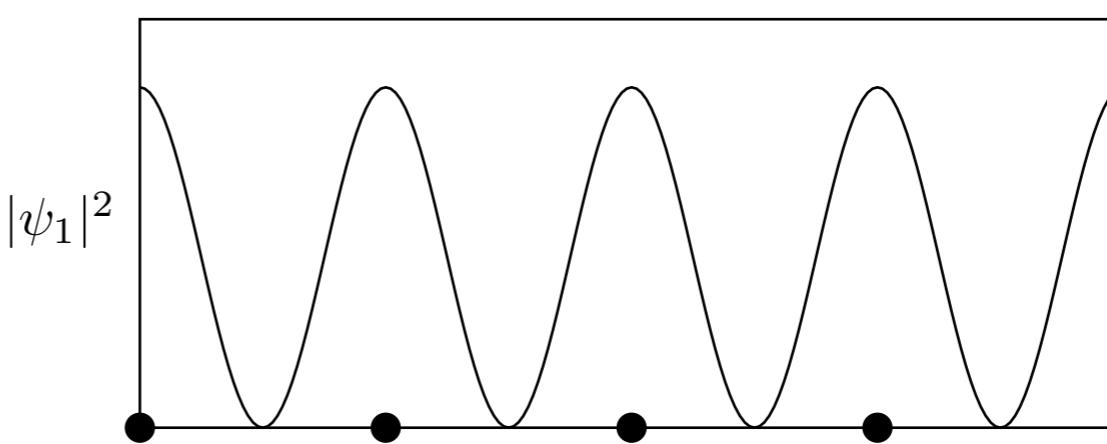
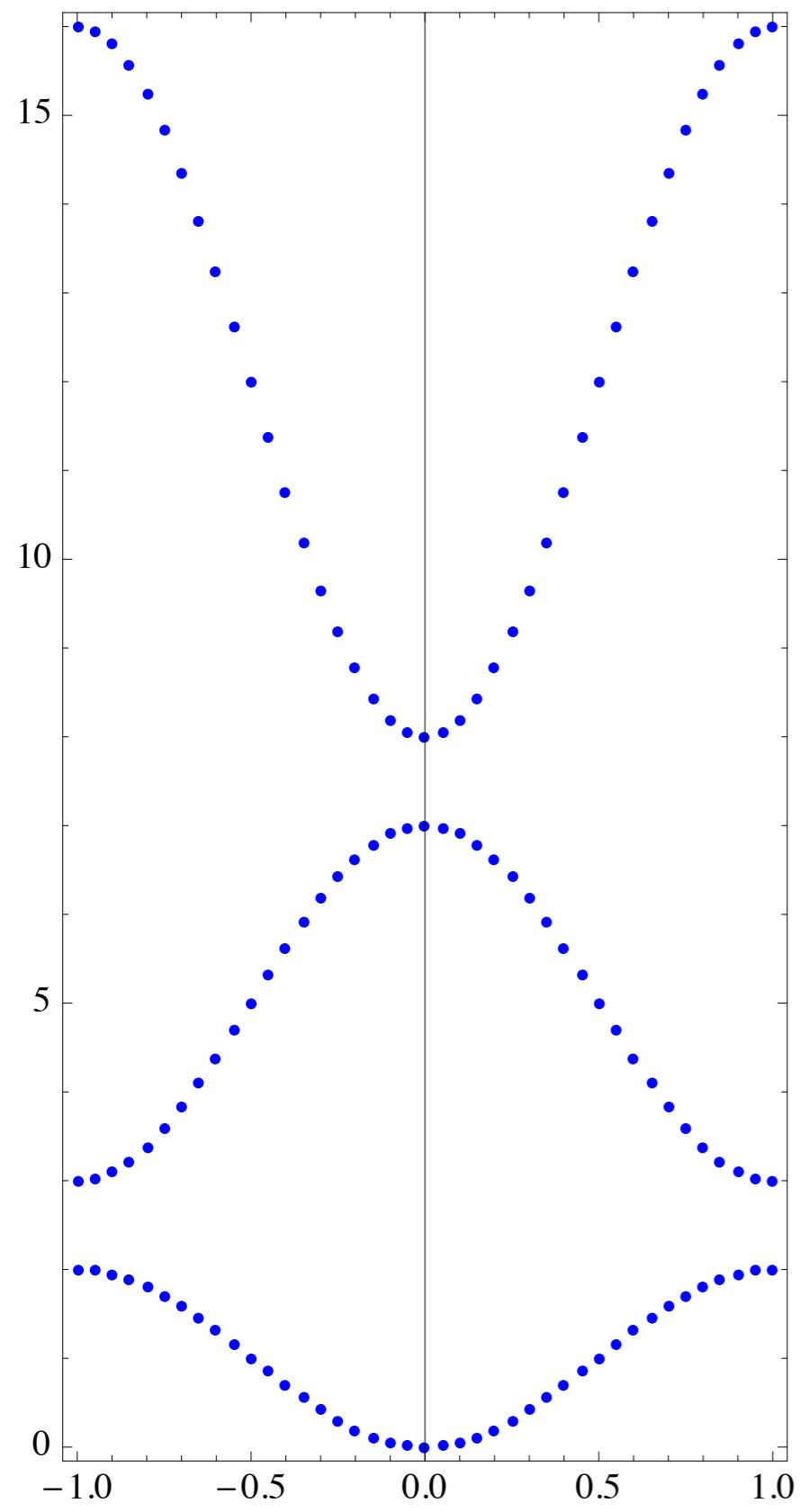


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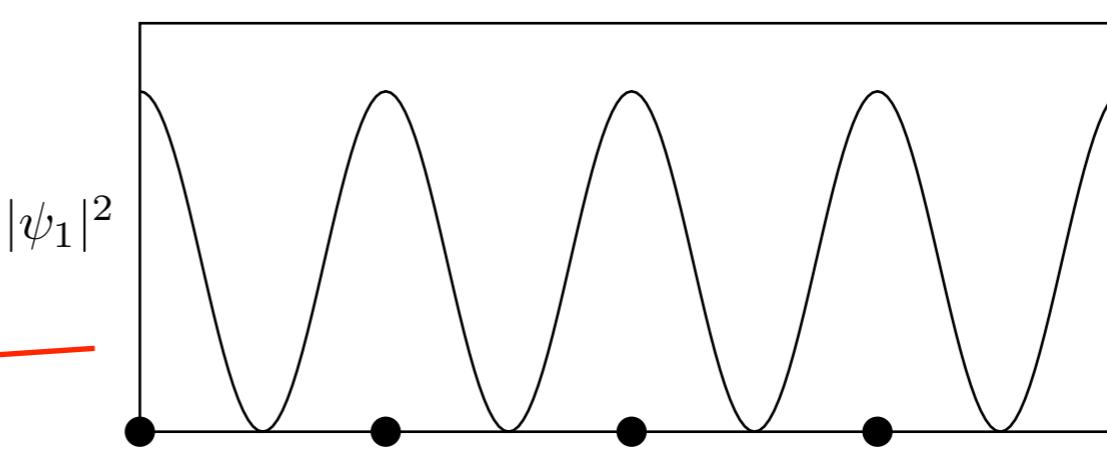
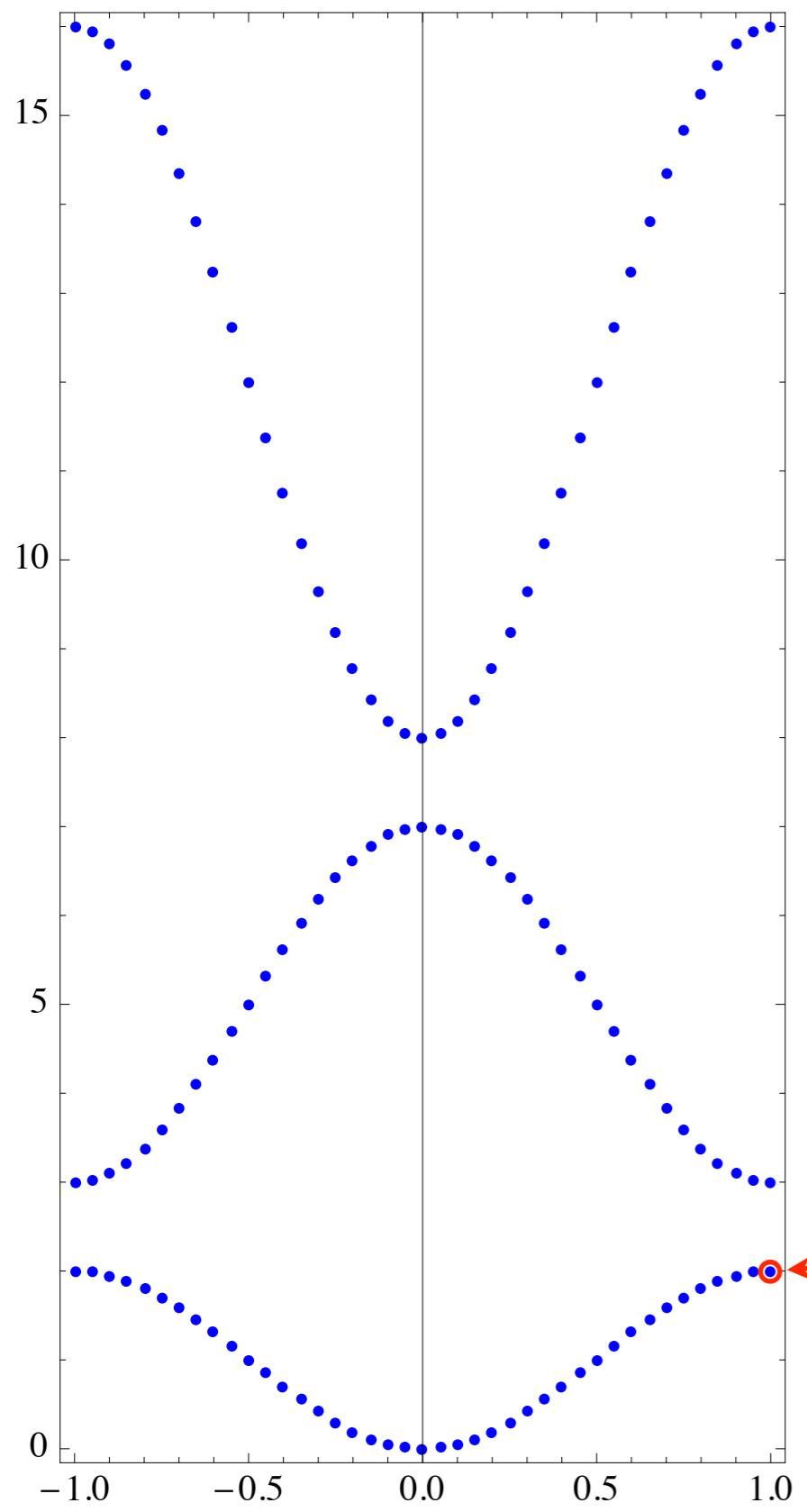
Energy



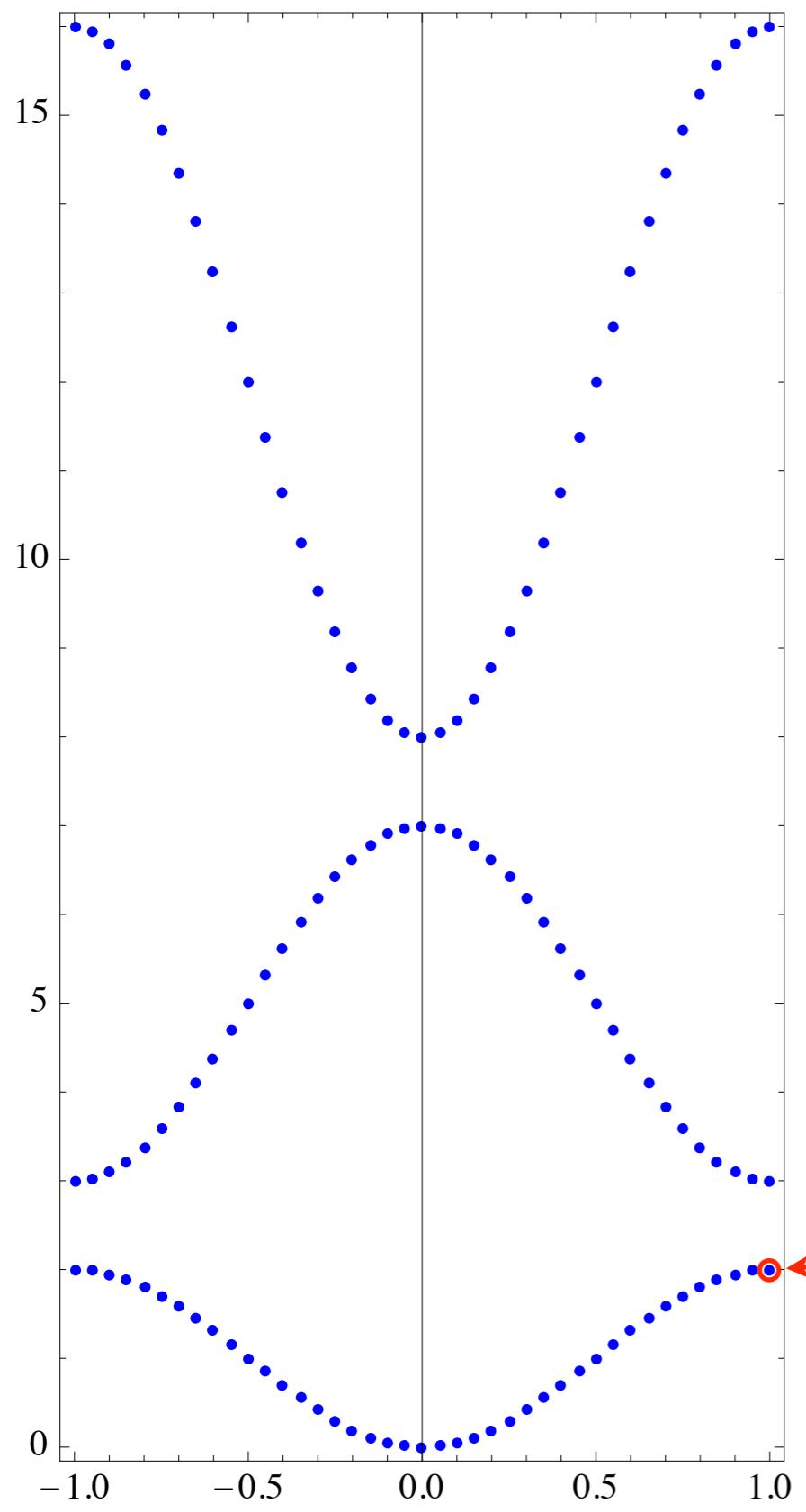
Energy



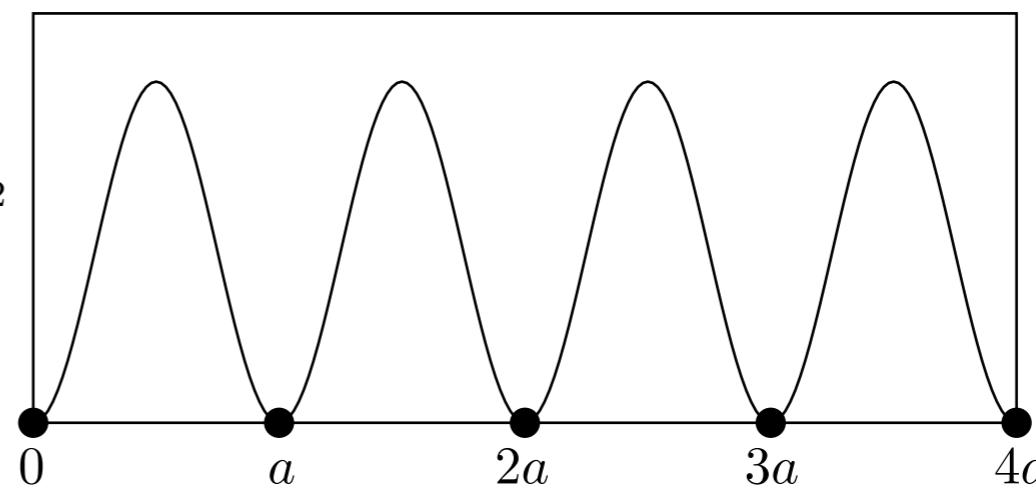
Energy



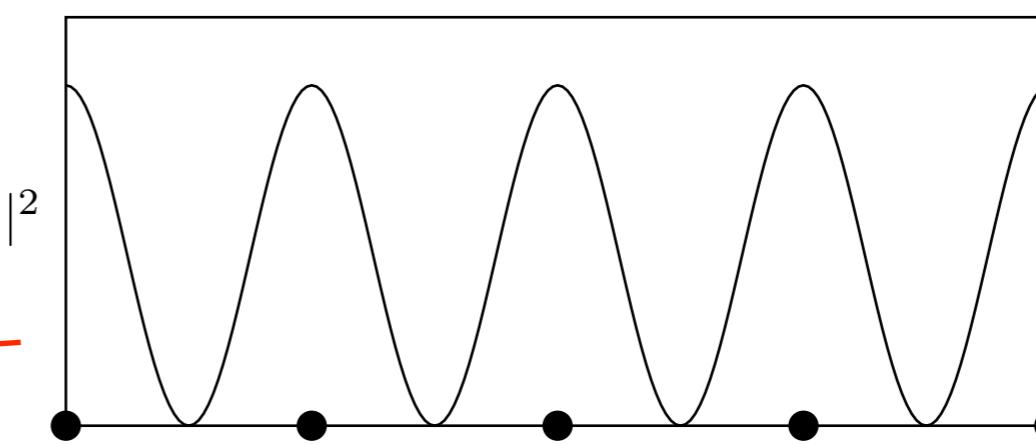
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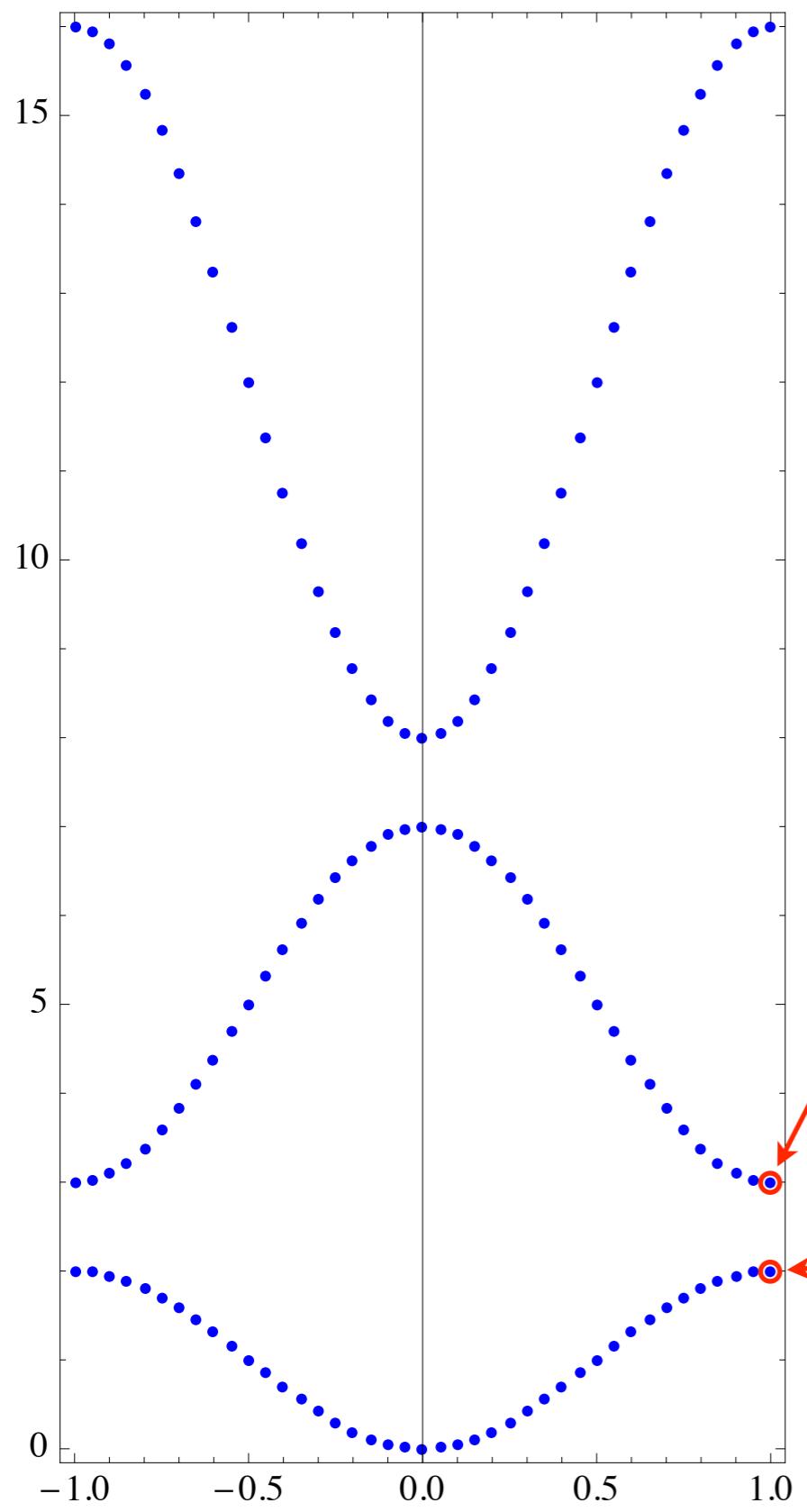
$$|\psi_2|^2$$



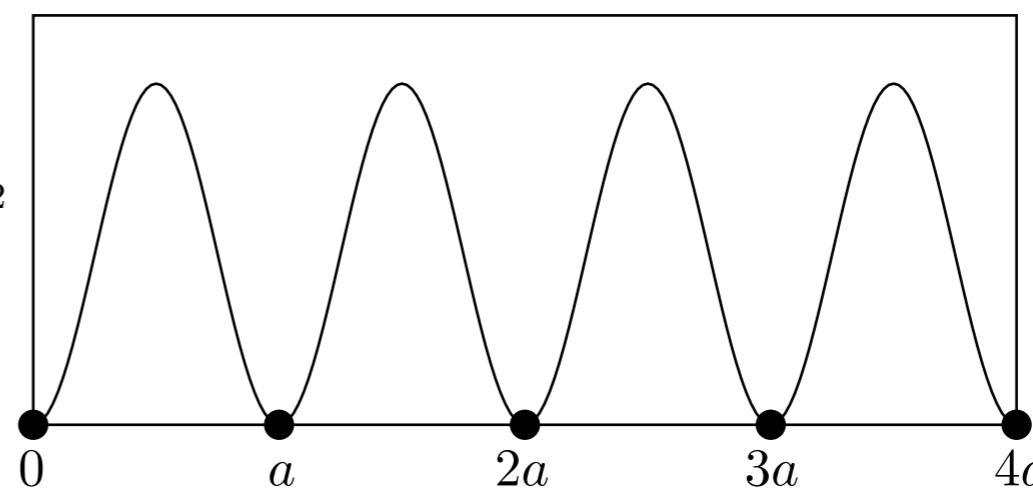
$$|\psi_1|^2$$



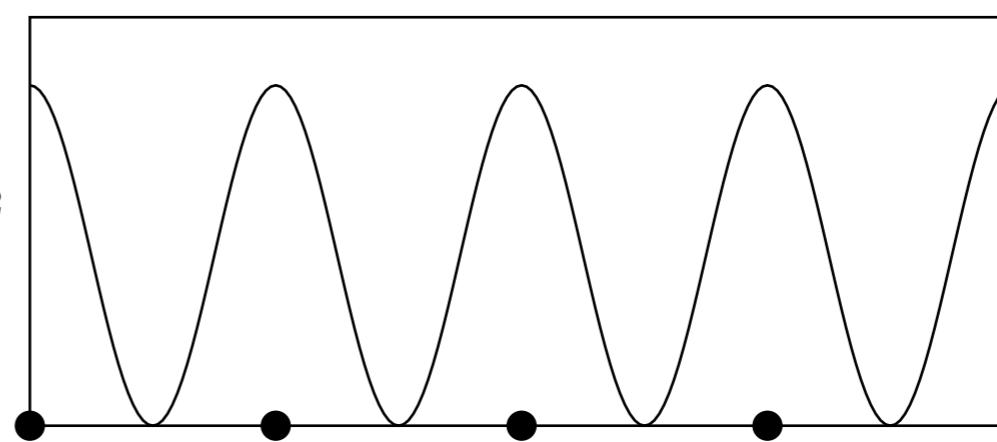
Energy

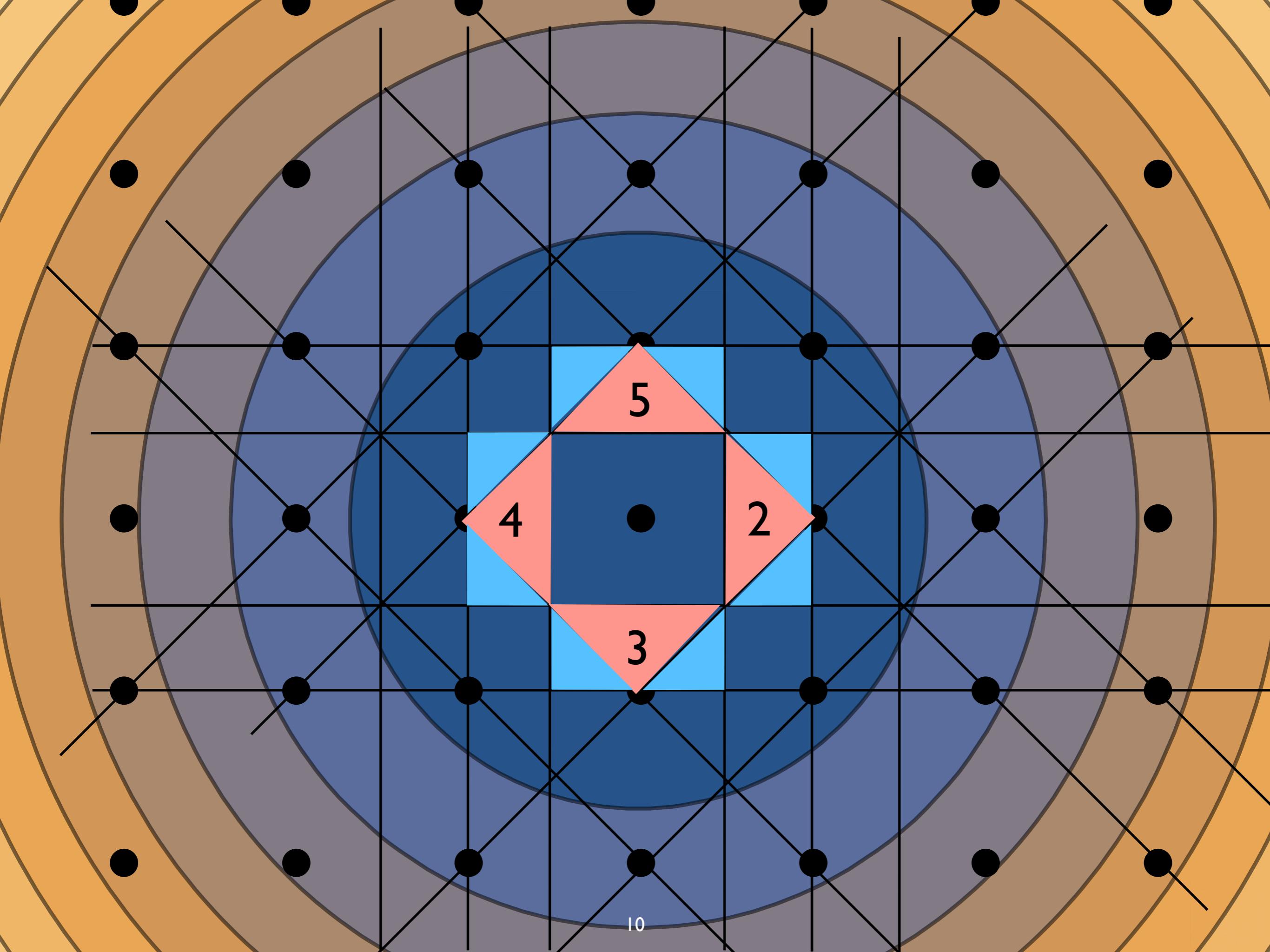


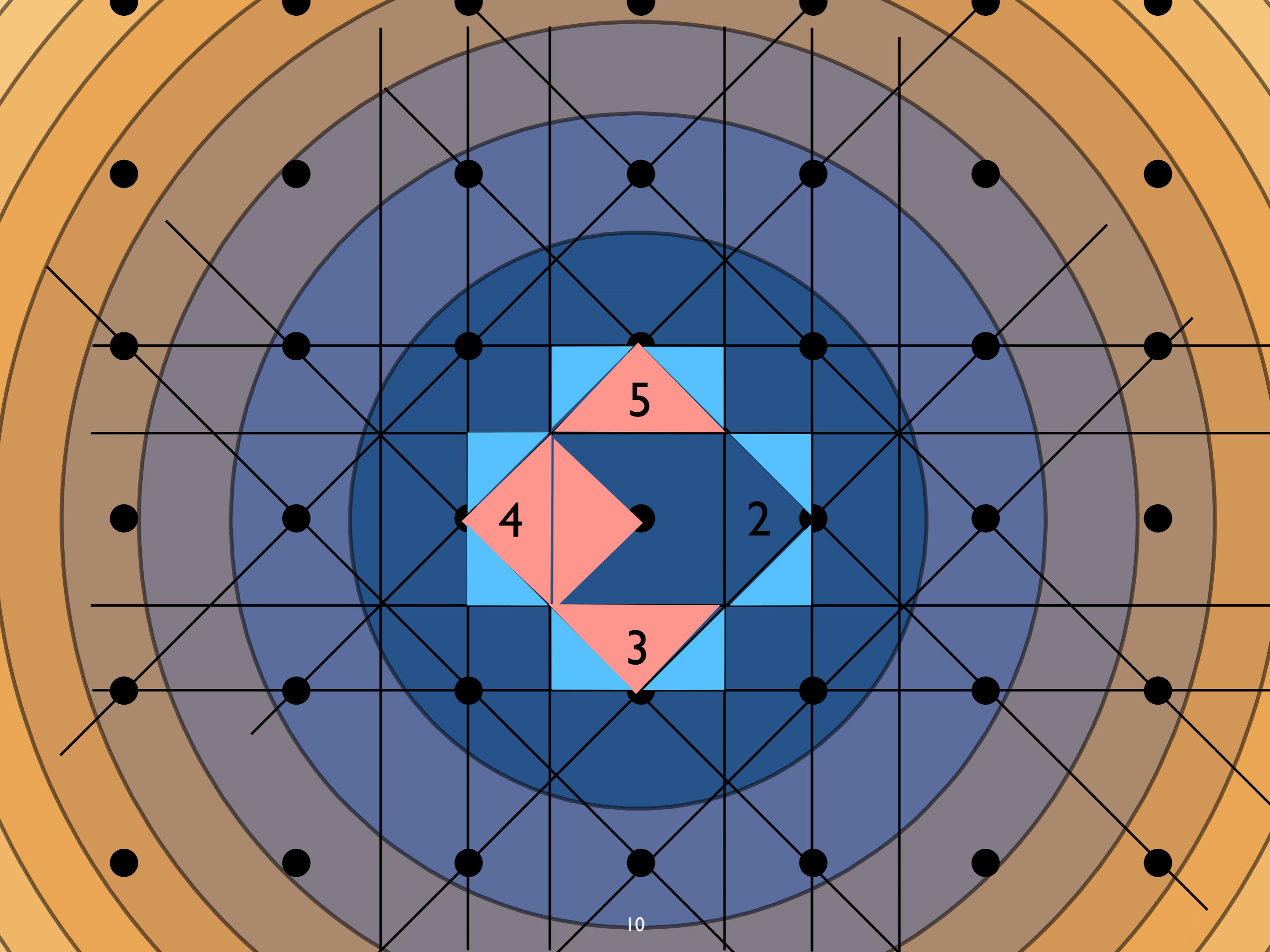
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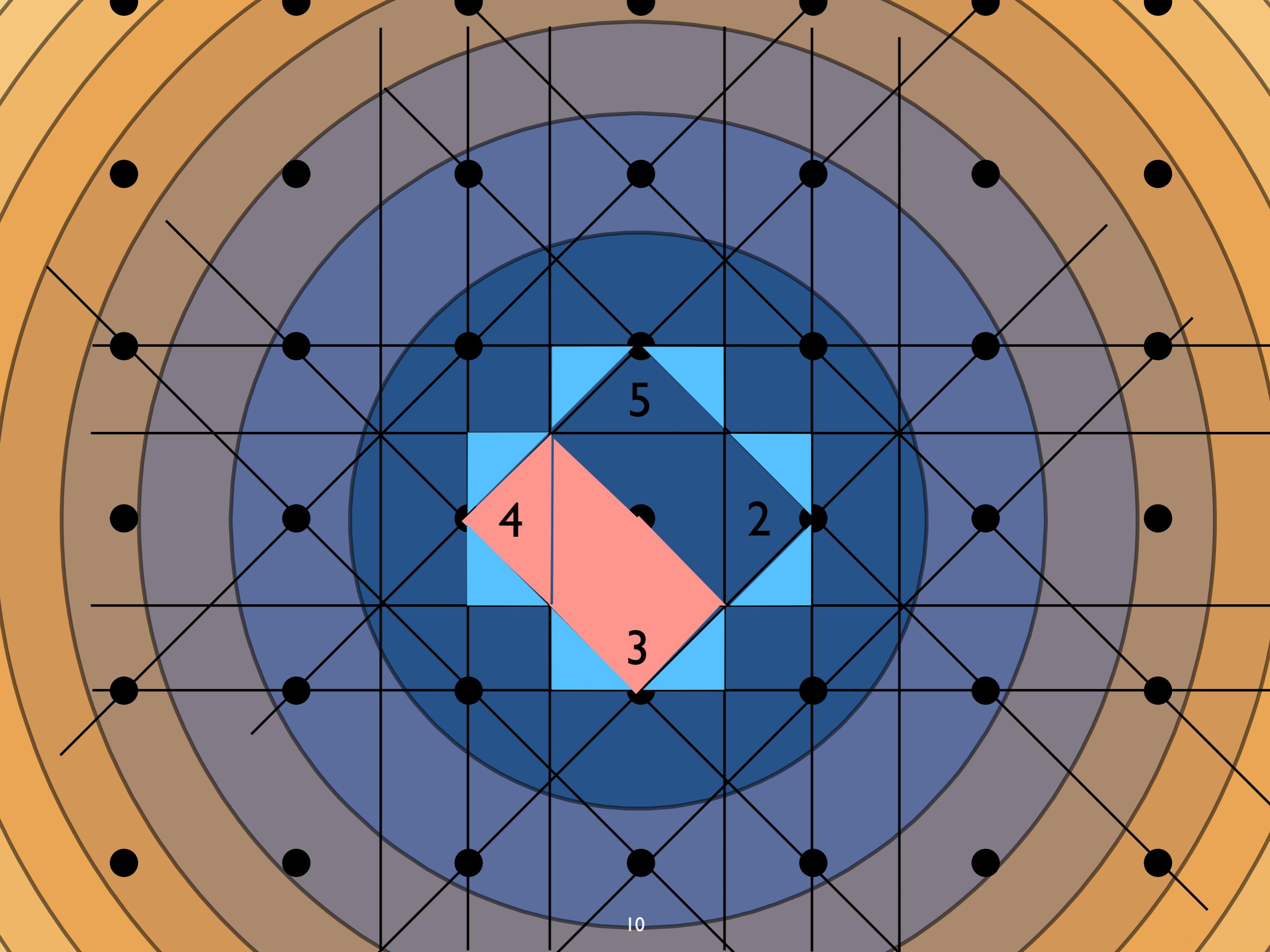


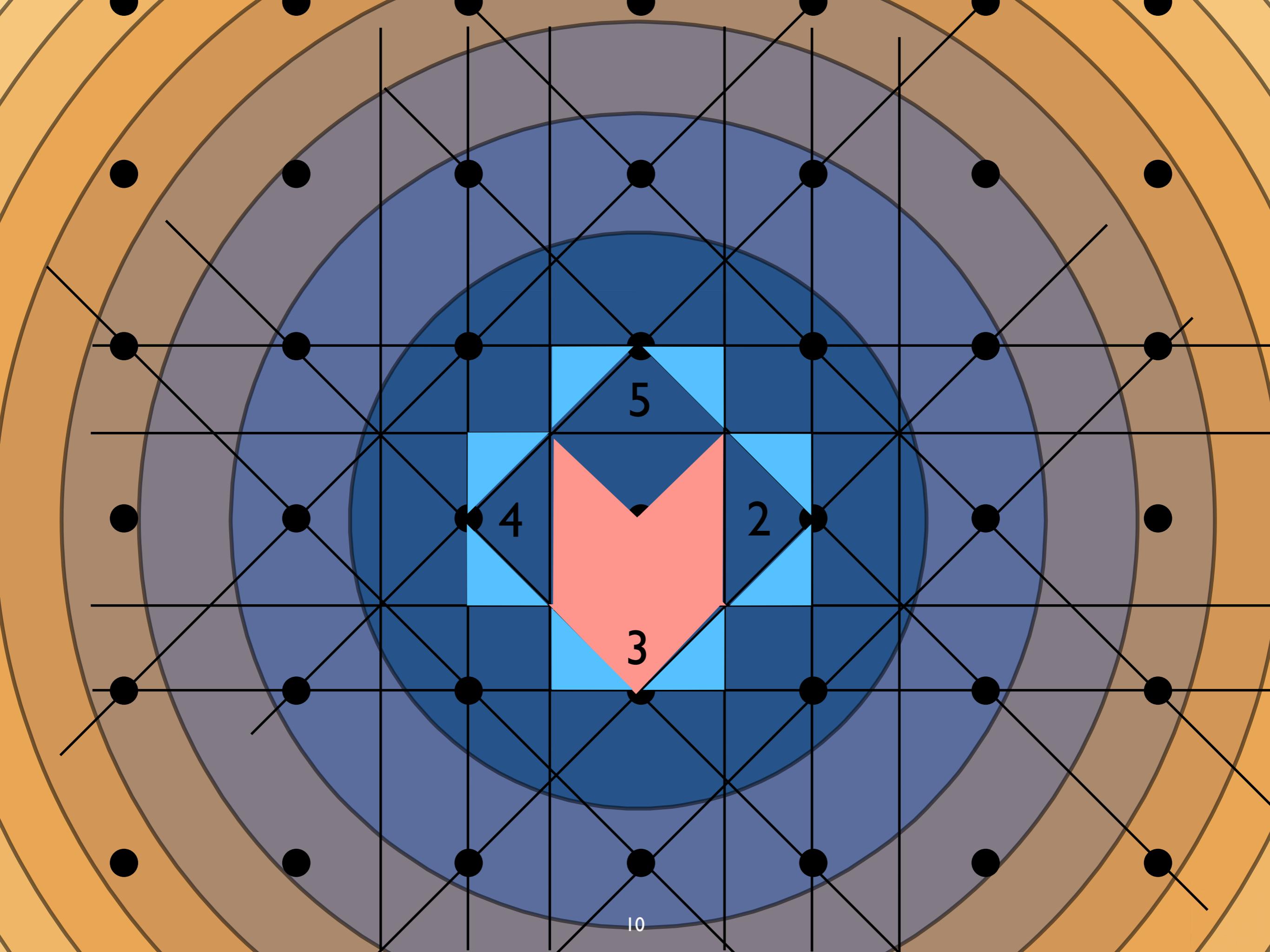
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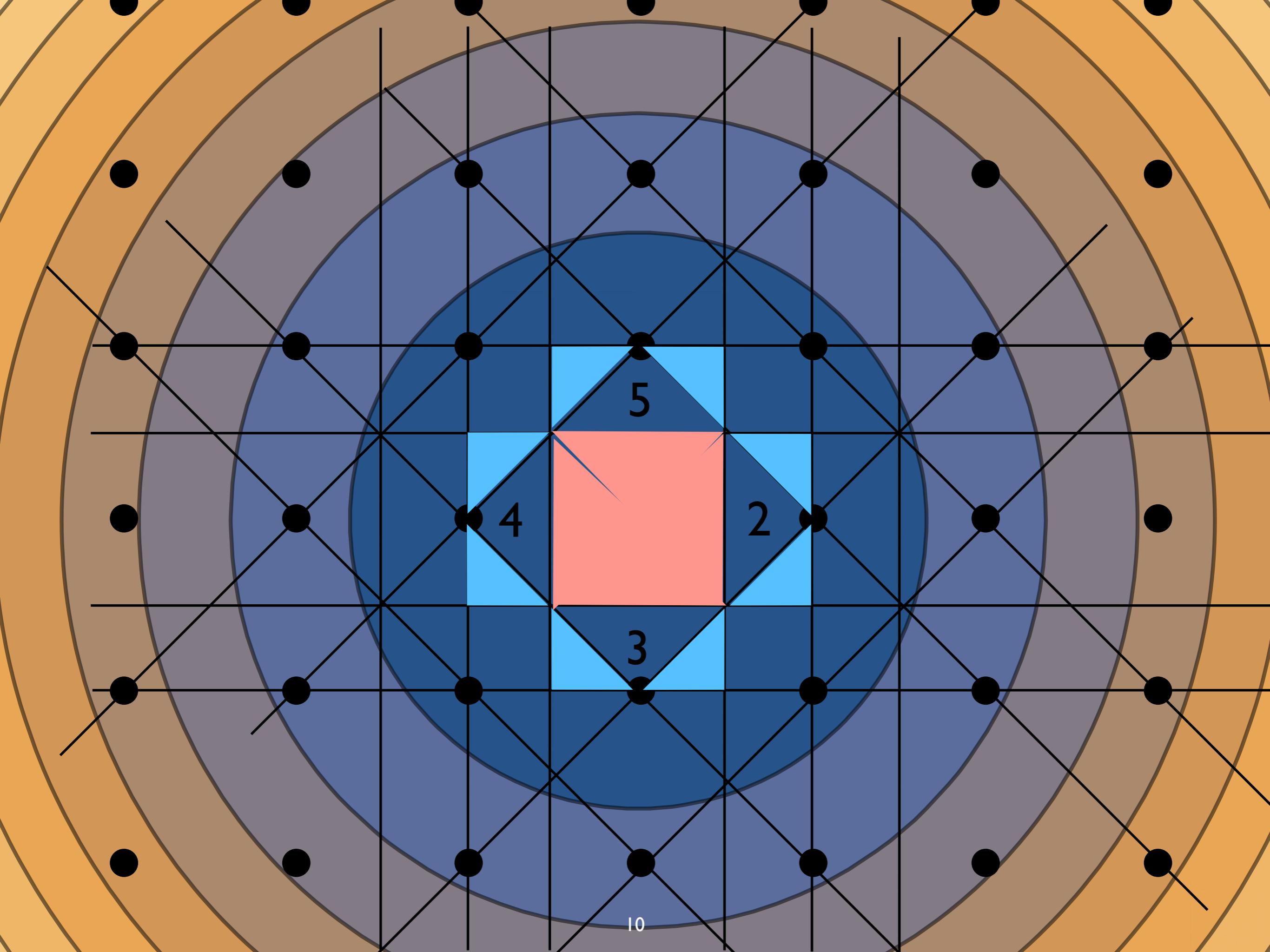


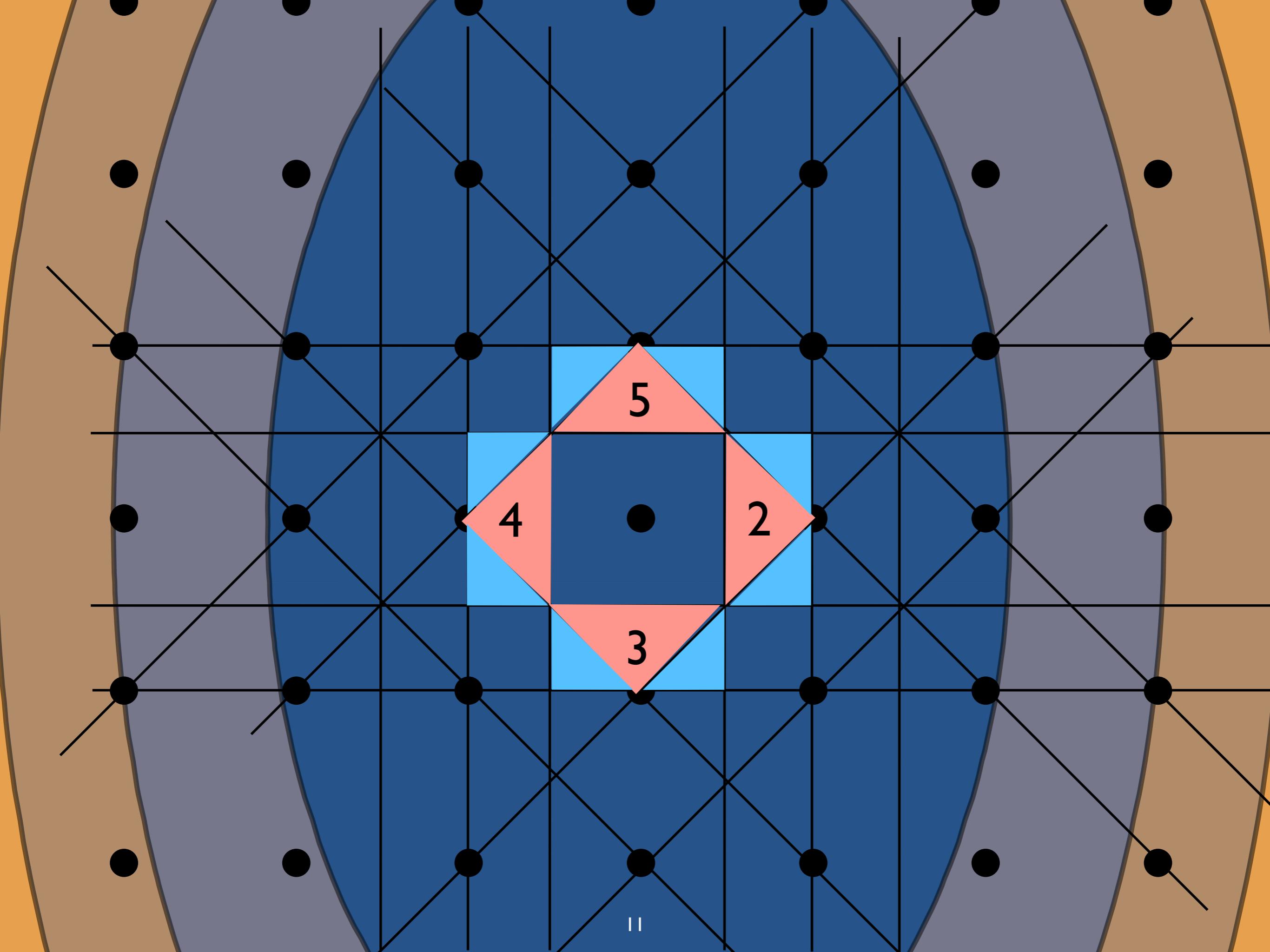








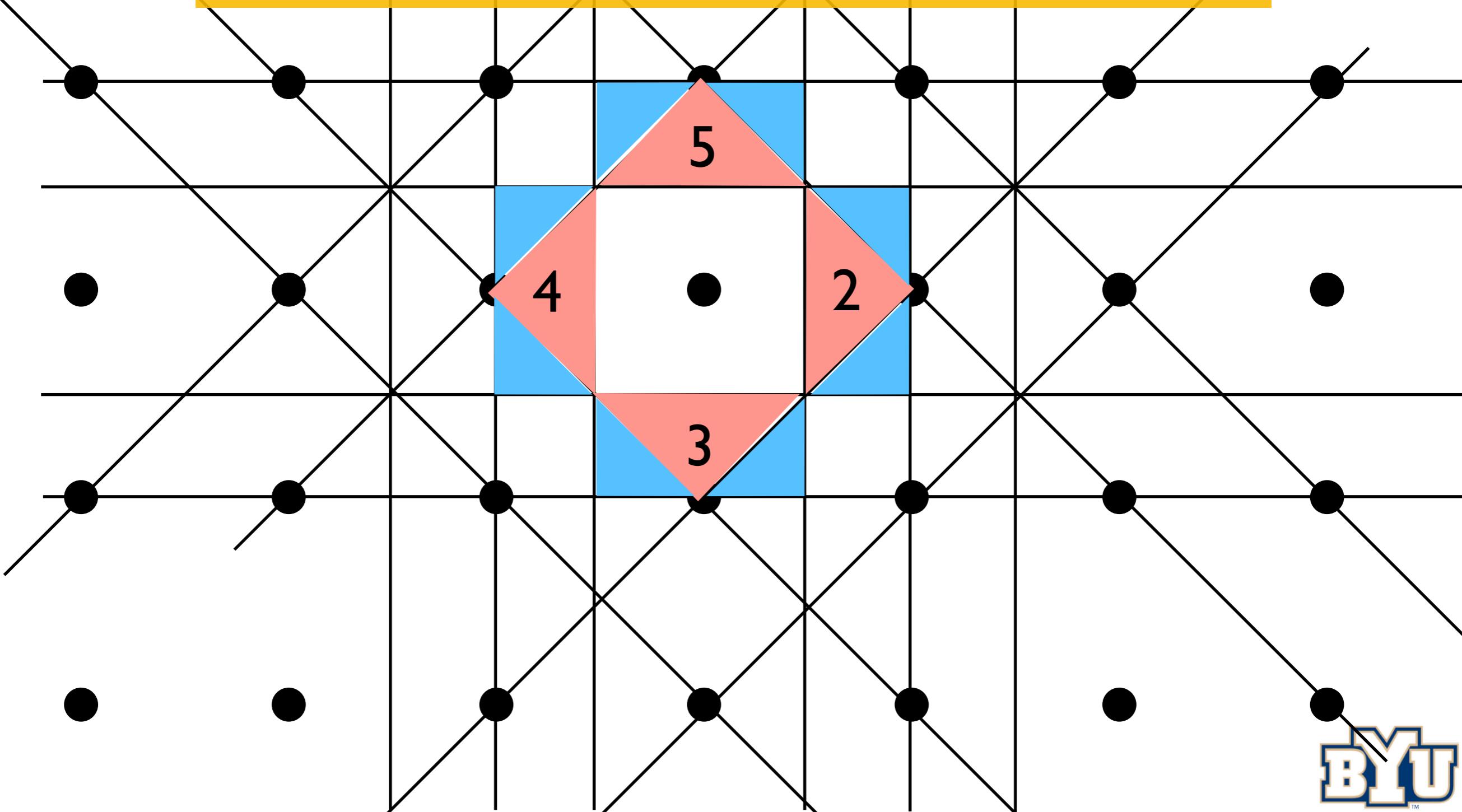




Question #4

Over what range in k-space is the energy function continuous?

- B) everywhere. C) only inside the **first** BZ.
- D) only inside **any** of the BZs.

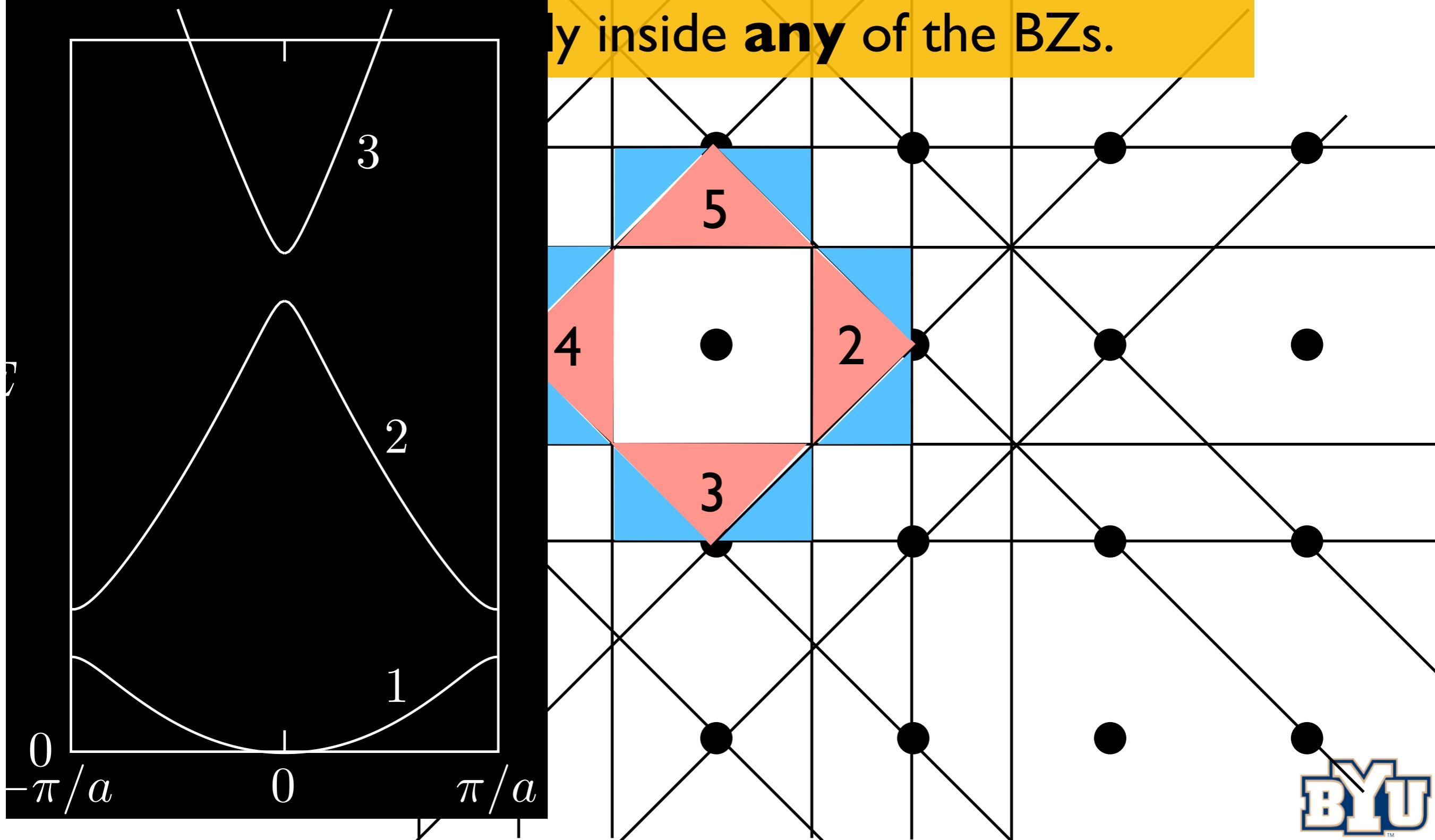


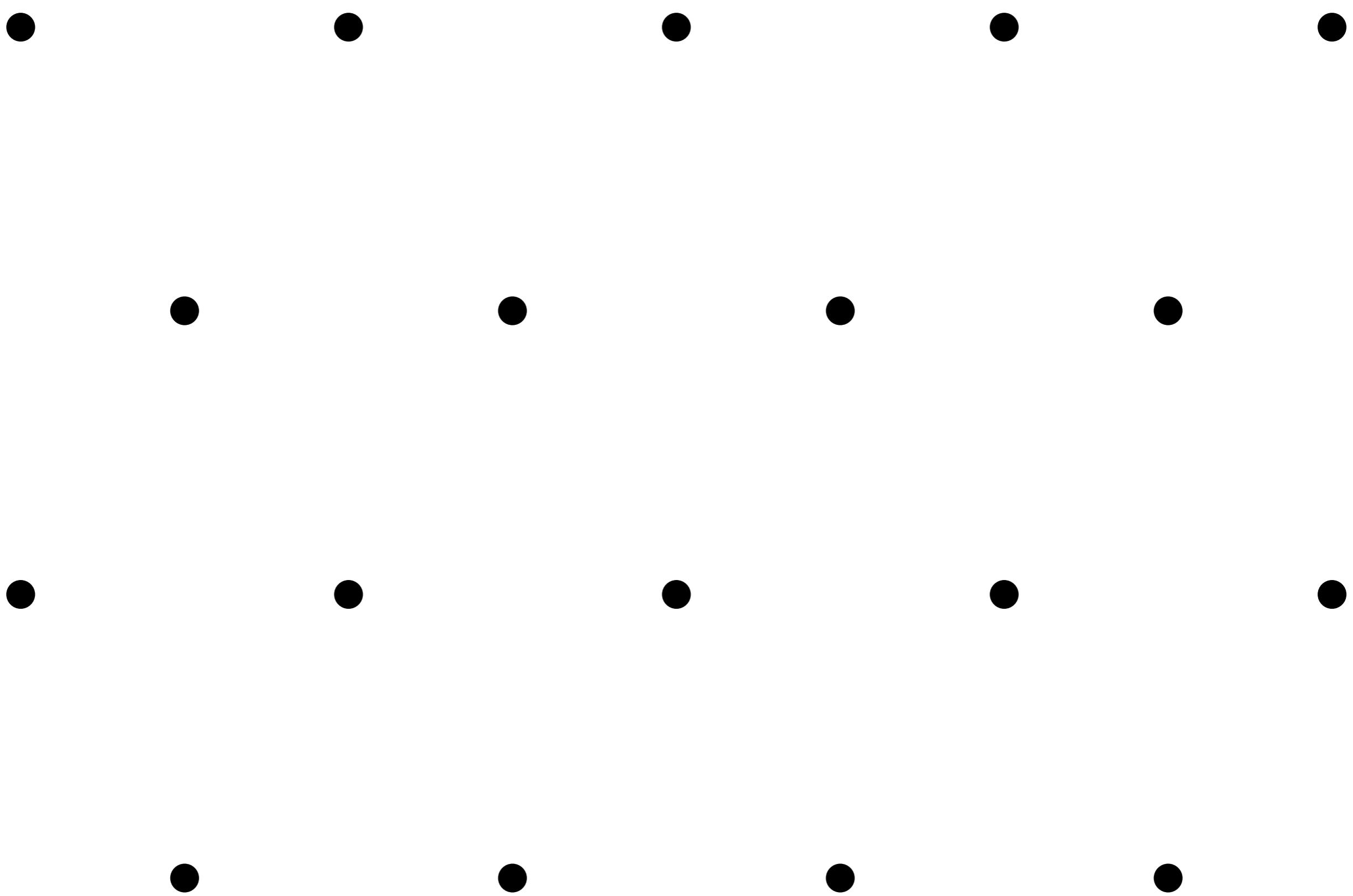
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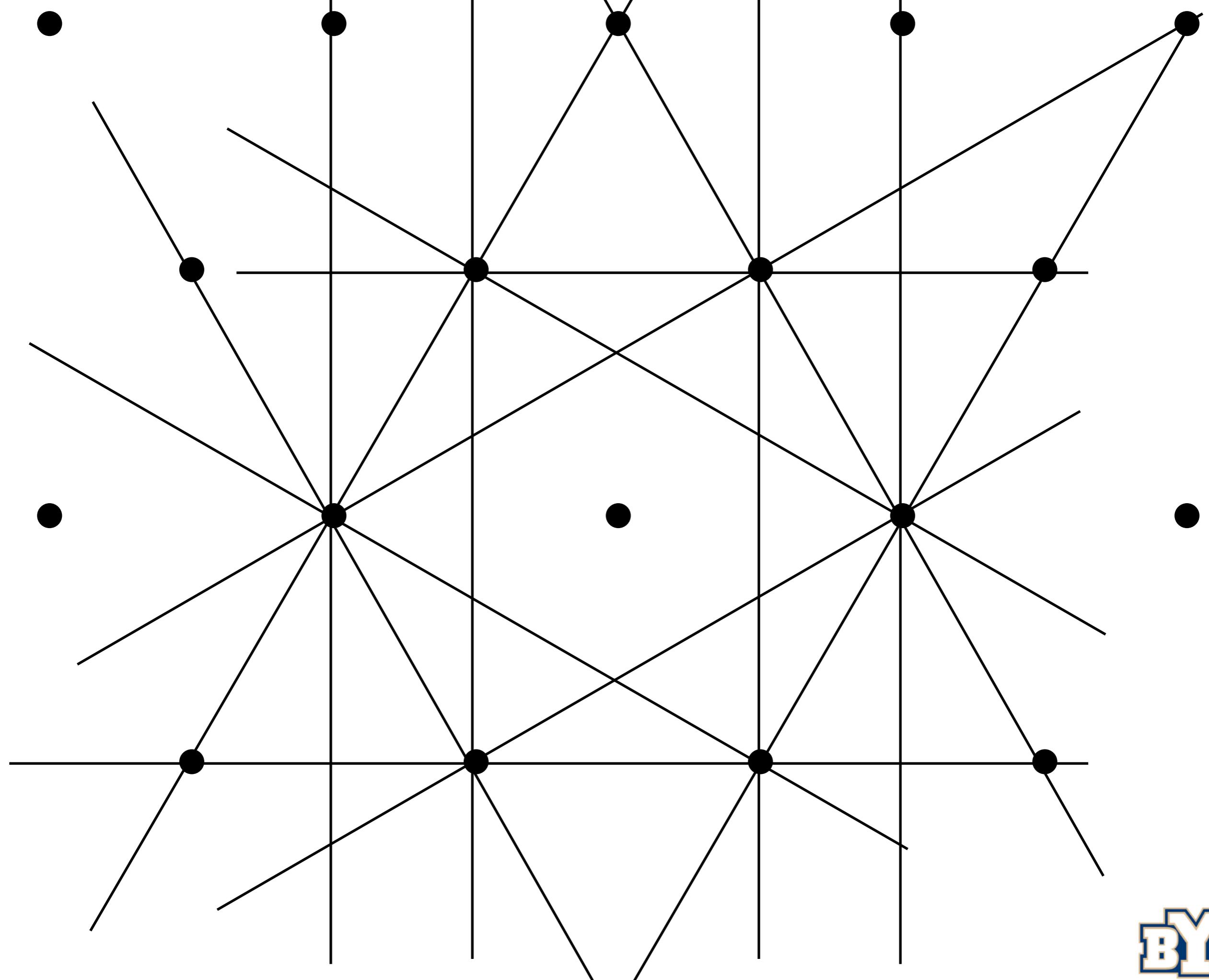
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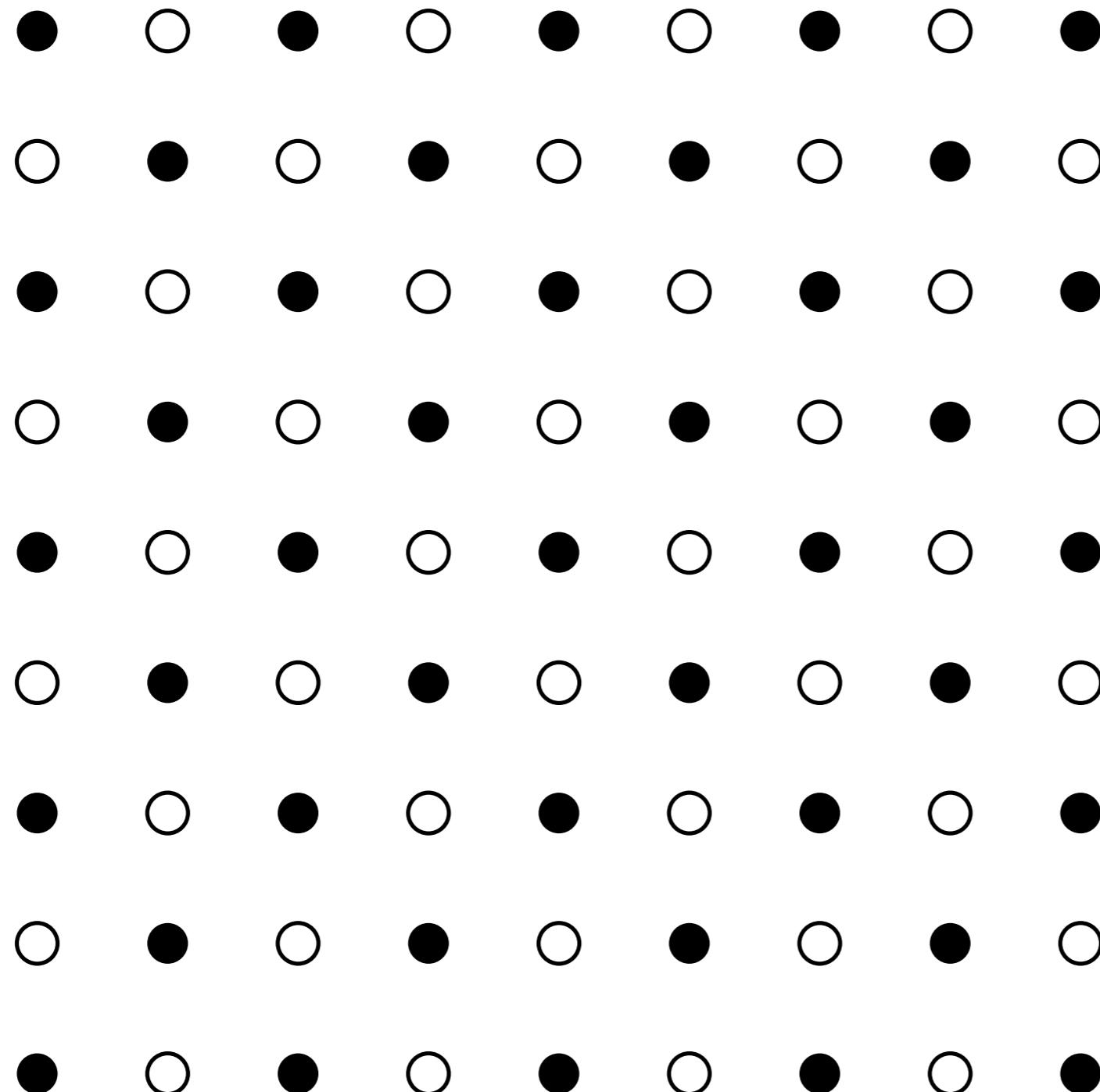
D) only inside **any** of the BZs.







How many energy bands will the electrons fill?



- 5 electrons
- 12 electrons

Question #5

- a) 8.5
- b) 5
- c) 12
- d) 17

$$\mathbf{a}_1 = a(1, 0, 0)$$

$$\mathbf{a}_2 = a(0, 1, 0)$$

$$\mathbf{a}_3 = a(0, 0, 1)$$

$$g(\mathbf{k}) = \frac{2V}{(2\pi)^3}$$

$$\mathbf{b}_1 = \frac{2\pi}{a}(1, 0, 0)$$

$$\mathbf{b}_2 = \frac{2\pi}{a}(0, 1, 0)$$

$$\mathbf{b}_3 = \frac{2\pi}{a}(0, 0, 1)$$

What is the volume of a primitive unit cell in reciprocal space for an sc crystal?

B

$$V_k = \frac{(2\pi)^3}{V_c}$$

C

$$V_k = \frac{V_c}{(2\pi)^3}$$

D

$$V_k = \frac{(2\pi)}{V_c}$$

?

$$N_k = g(\mathbf{k})V_k =$$

Question #6

$$\mathbf{a}_1 = a(1, 0, 0)$$

$$\mathbf{a}_2 = a(0, 1, 0)$$

$$\mathbf{a}_3 = a(0, 0, 1)$$

$$g(\mathbf{k}) = \frac{2V}{(2\pi)^3}$$

$$\mathbf{b}_1 = \frac{2\pi}{a}(1, 0, 0)$$

$$\mathbf{b}_2 = \frac{2\pi}{a}(0, 1, 0)$$

$$\mathbf{b}_3 = \frac{2\pi}{a}(0, 0, 1)$$

What is the volume of a primitive unit cell in reciprocal space for an sc crystal?

B

$$V_k = \frac{(2\pi)^3}{V_c}$$

C

$$V_k = \frac{V_c}{(2\pi)^3}$$

D

$$V_k = \frac{(2\pi)}{V_c}$$

$$N_k = g(\mathbf{k})V_k = \frac{2V}{(2\pi)^3} \frac{(2\pi)^3}{V_c} = 2 \frac{V}{V_c} = 2N_c$$

Question #6

How many energy bands will the electrons fill?

● ○ ○ ● ○ ○ ● ○ ○ ● ○ ○ ●

○ ● ○ ○ ● ○ ○ ● ○ ○ ● ○

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○ ● ○ ○ ● ○ ○ ● ○ ○ ● ○

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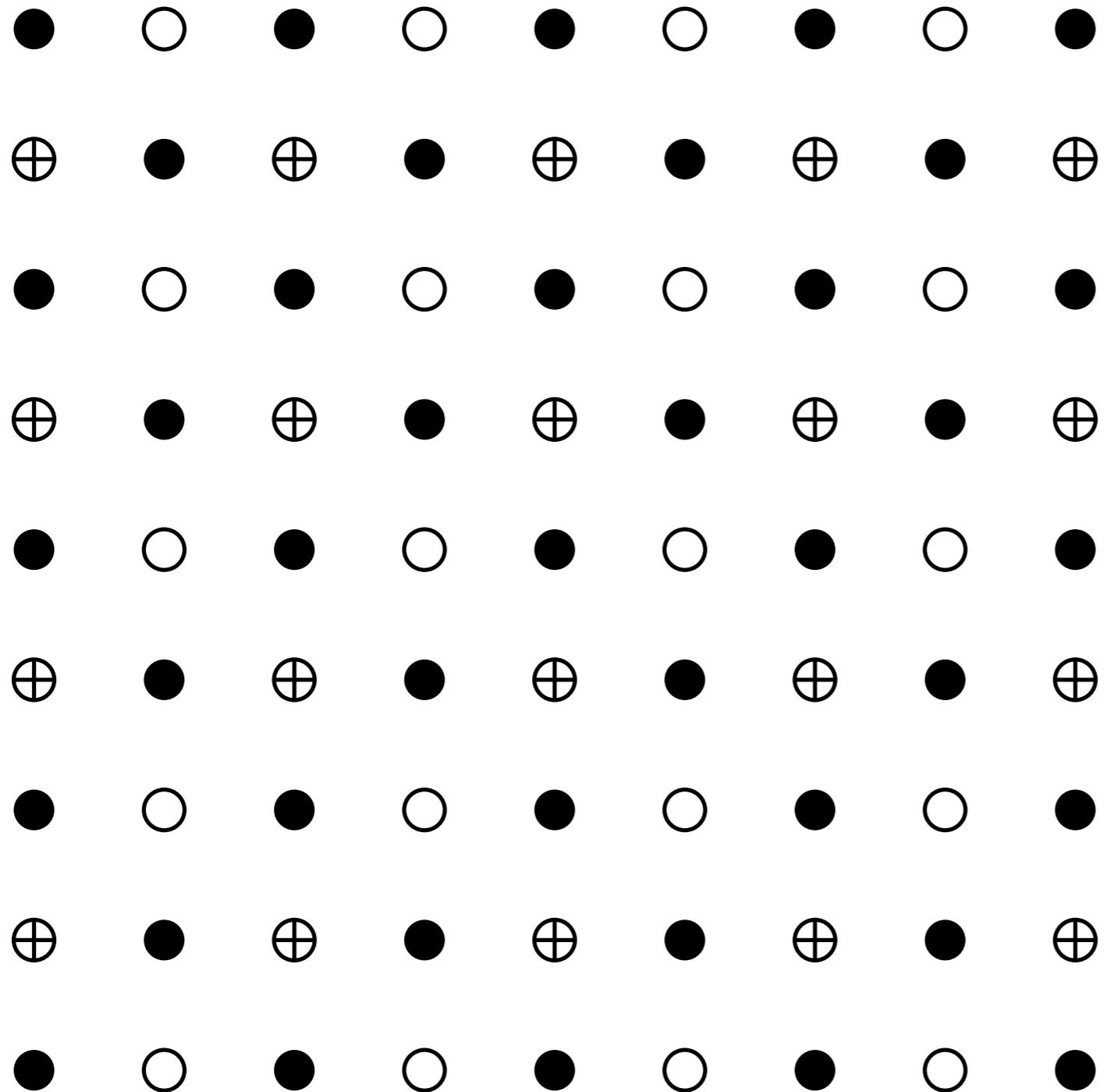
● ○ ○ ● ○ ○ ● ○ ○ ● ○ ○ ●

- 5 electrons
- 12 electrons

Question #7

- a) 8.5 b) 12 c) 14.5 d) 29

How many energy bands will the electrons fill?



- 5 electrons
- ⊕ 12 electrons
- 10 electrons

Question #8

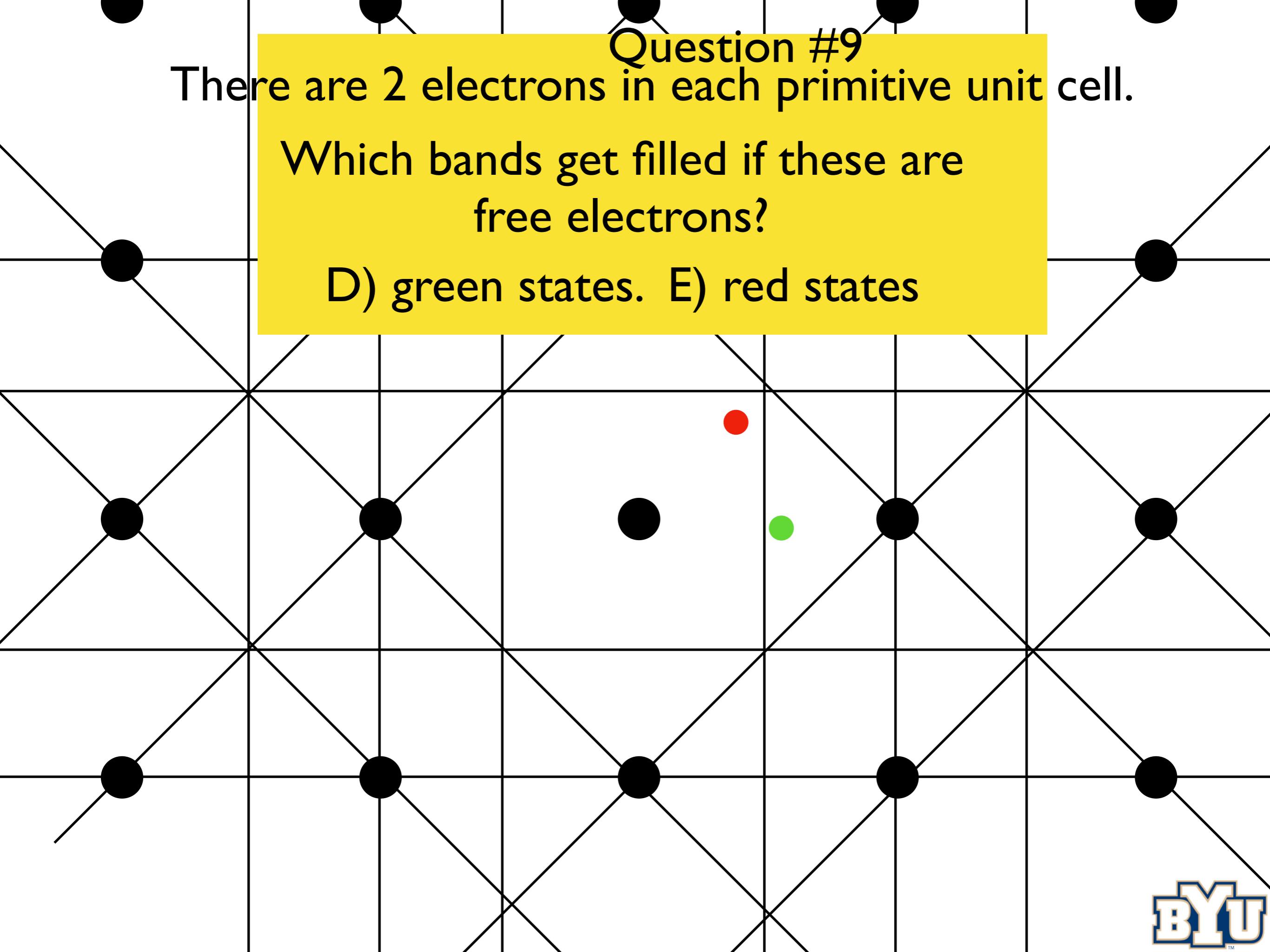
- a) 17 b) 16 c) 32 d) 10

Question #9

There are 2 electrons in each primitive unit cell.

Which bands get filled if these are free electrons?

- D) green states. E) red states

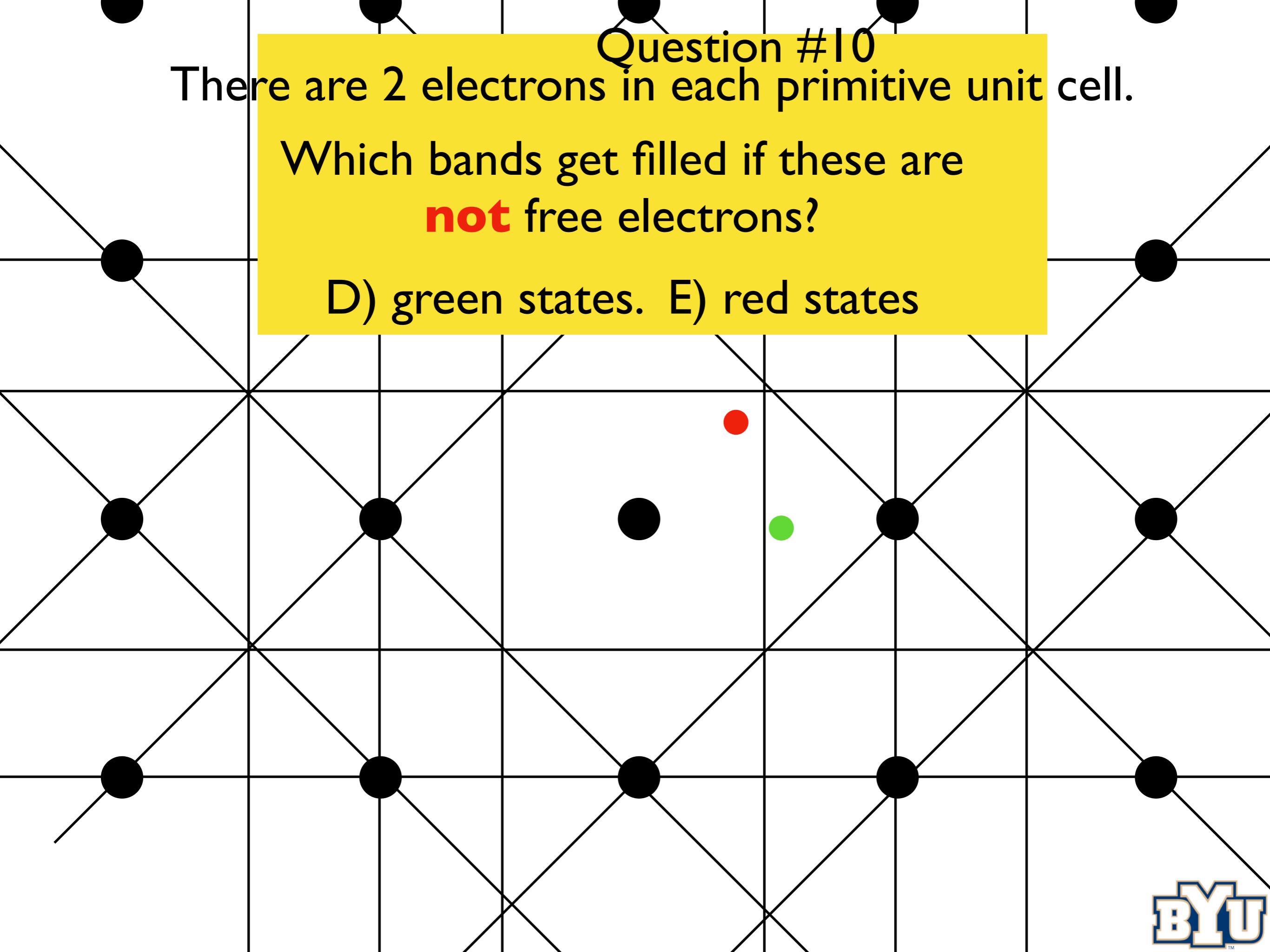


Question #10

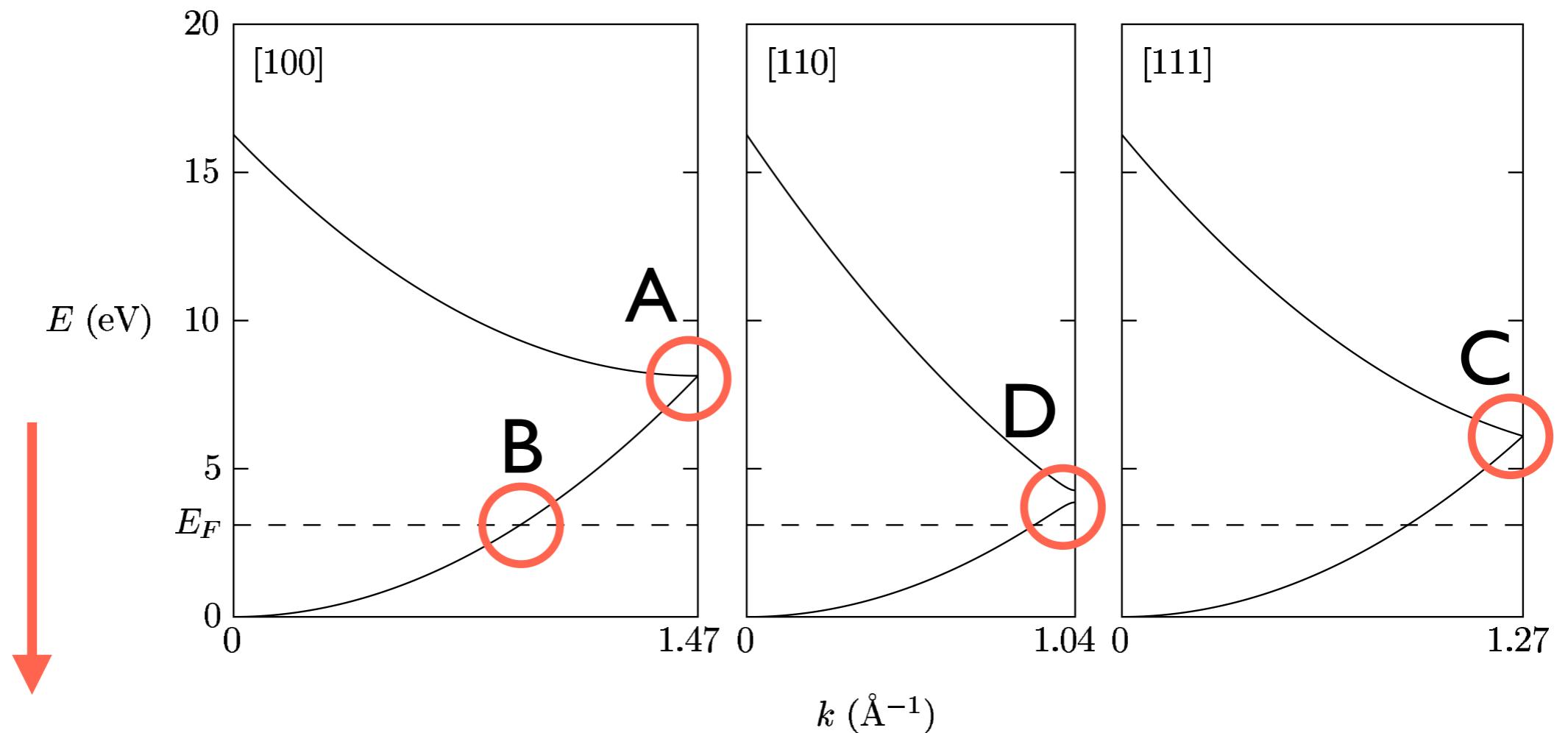
There are 2 electrons in each primitive unit cell.

Which bands get filled if these are
not free electrons?

- D) green states. E) red states

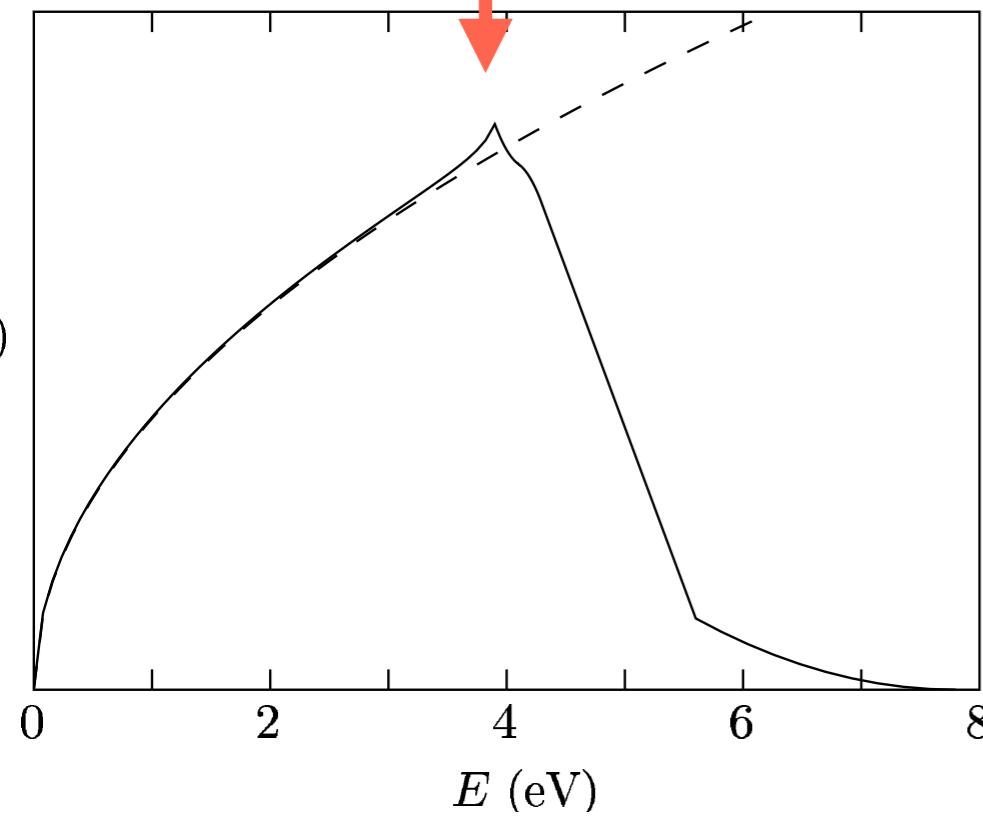
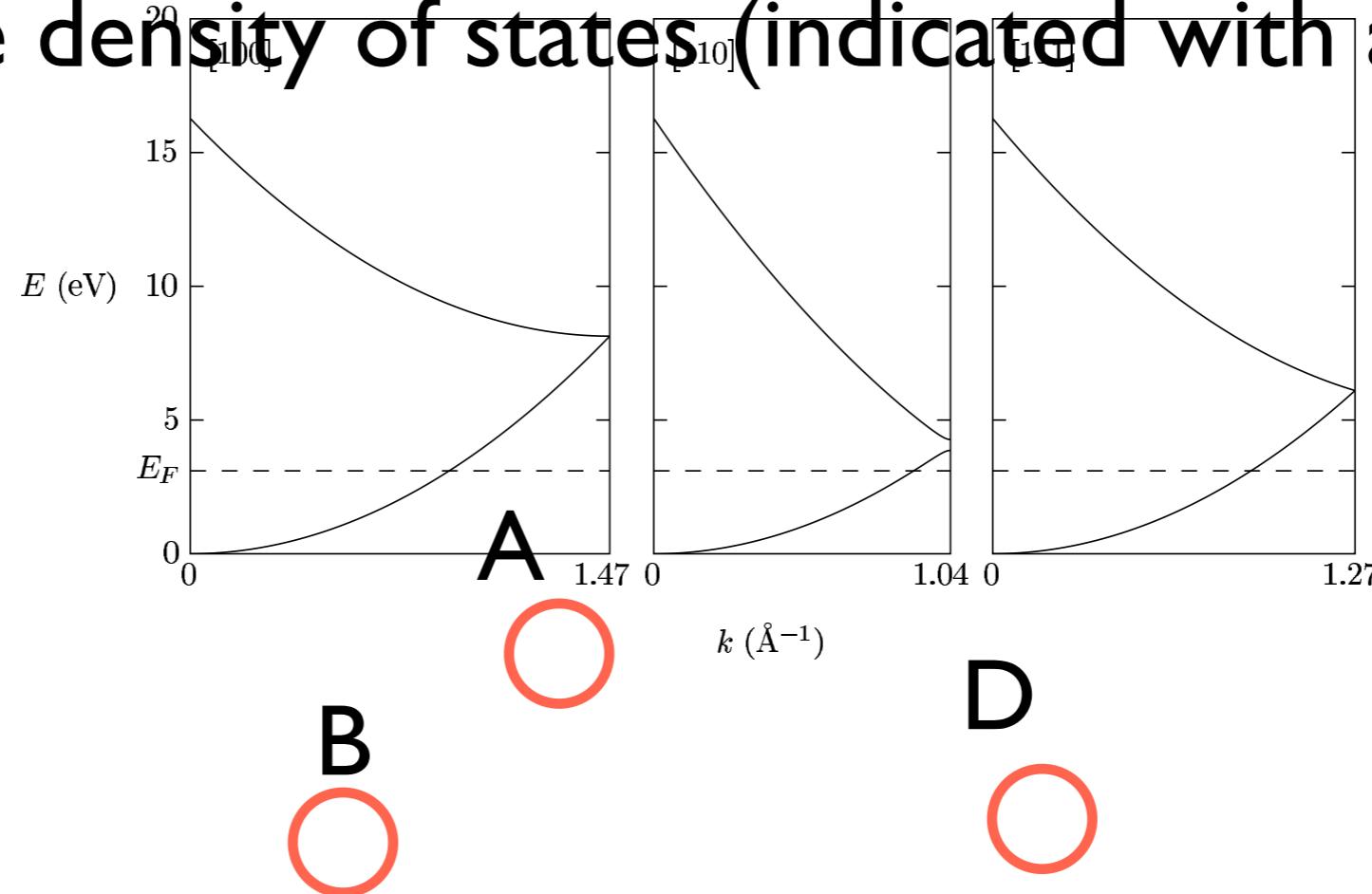


Which part of the band diagram(upper) is responsible for the spike in the density of states (indicated with arrow)?



Question #11

Which part of the band diagram(upper) is responsible for the spike in the density of states(indicated with arrow)?



Question #11

Fermi Surfaces

