MI 132: Unit 6
Part II
Radiographic Exposure Technique

RHSHS Medical Imaging Program

2022-2023

Prime Factors:

mAs
kVp

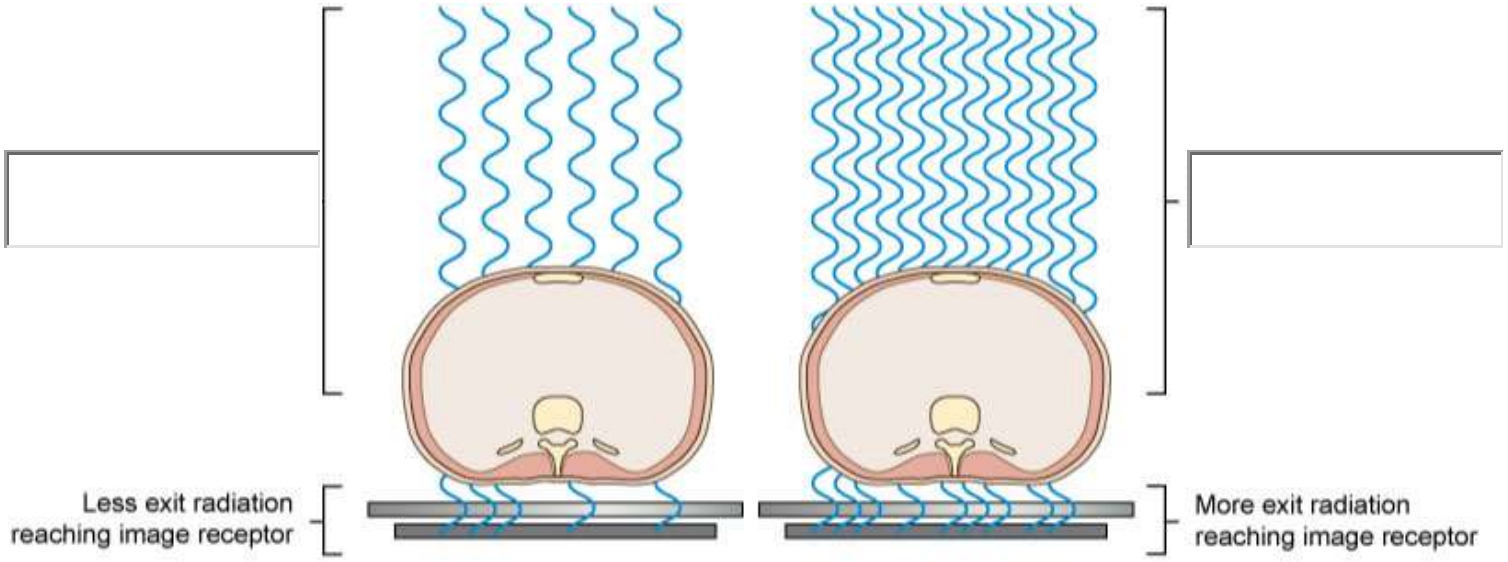
Milliamperage and Exposure Time

- Many variables can affect the amount of mAs needed to produce a diagnostic image.
  - Generator type
  - Grid usage
  - Pathology
  - Type of IR
  - SID
  - Filtration
  - Patient thickness

Milliamperage and Exposure Time

#1 - Explain the relationships between:

a. mAs and radiation quantity
b. mAs and patient dose
c. mAs and receptor exposure
d. mA and exposure time in order to maintain mAs



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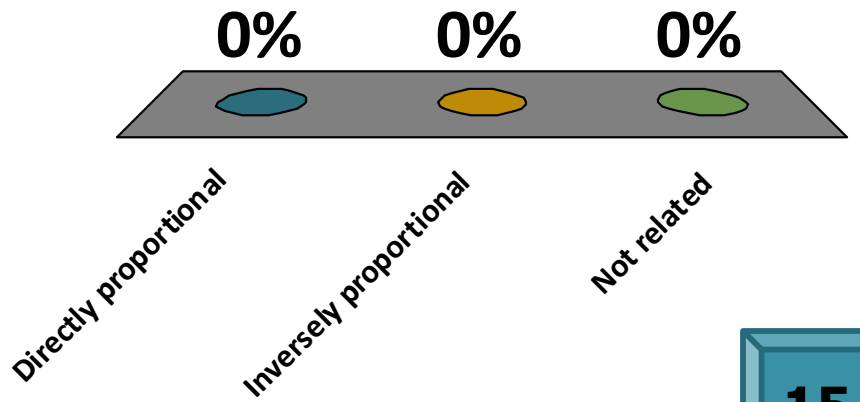
What type of relationship does mAs have with receptor exposure?

A. Directly proportional
B. Inversely proportional
C. Not related



Calculating mAs

#2 - What formula is used to calculate mAs?

- *Complete #1 on worksheet*

Doubling/Halving mAs

- If mA and exposure time are separate functions, how could you double or halve mAs?

- *Complete #2 and #3 on worksheet*

Maintaining mAs with mA and time Reciprocity Law

- as long as mAs is the same, any combination of mA and time can be used to produce the same quantity of radiation

  - Example: 200 mA and .5 s = **100 mAs**

    Double exposure time and halve mA …

    - 100 mA and 1s = **100 mAs**

    Double mA and halve time…

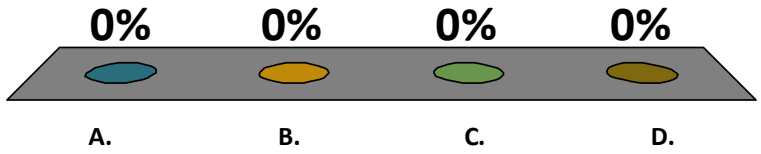
    - 400 mA and .25 s = **100 mAs**

  - Example:
    - 300 mA and .5 s = **150 mAs**
    - 400 mA and .375 s = **150 mAs**
    - 600 mA and .25 s = **150 mAs**

- *Complete #4-#6 on Worksheet*

Which of the following will produce the greatest receptor exposure?

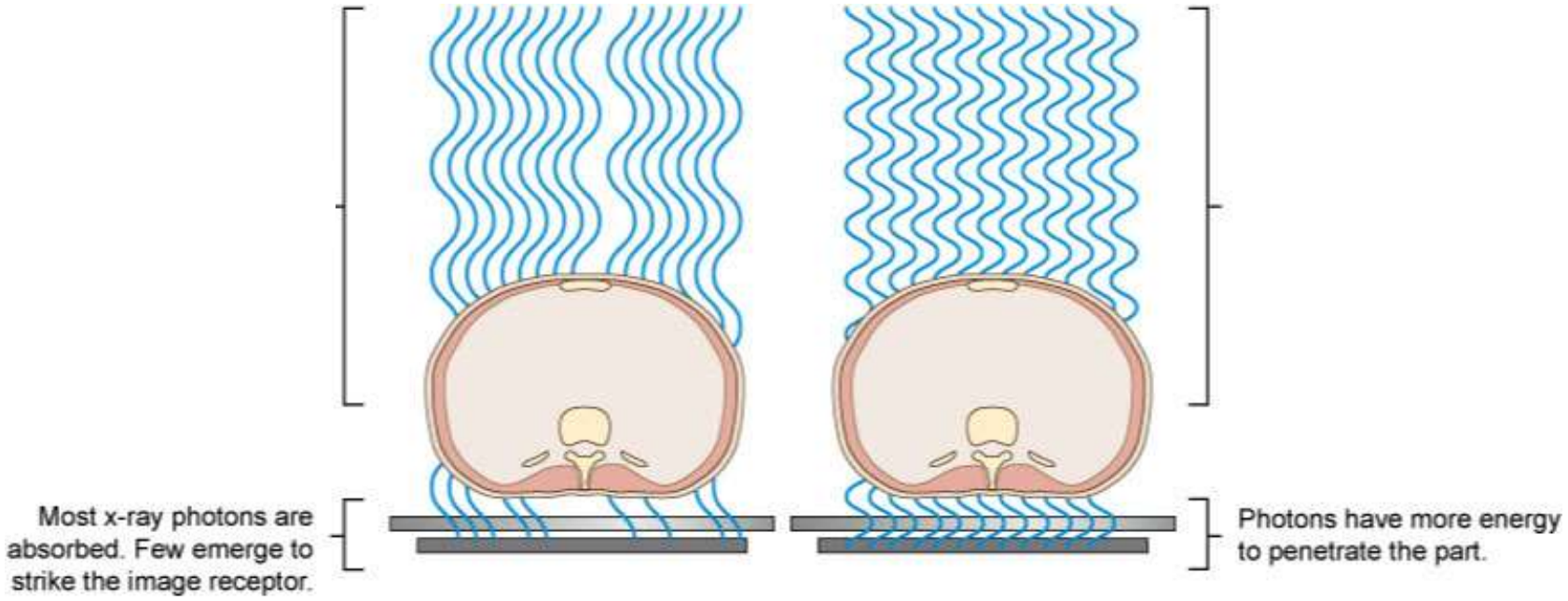
A. 100 mA, 20 ms
B. 200 mA, 40 ms
✓ C. 400 mA, 50 ms
D. 600 mA, 30 ms



Kilovoltage-peak (kVp)

#3 - Explain the relationship between:

a. kVp and radiation quantity
b. kVp and radiation quality
c. kVp and patient dose
d. kVp and receptor exposure



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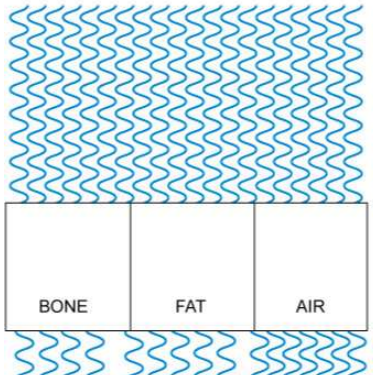
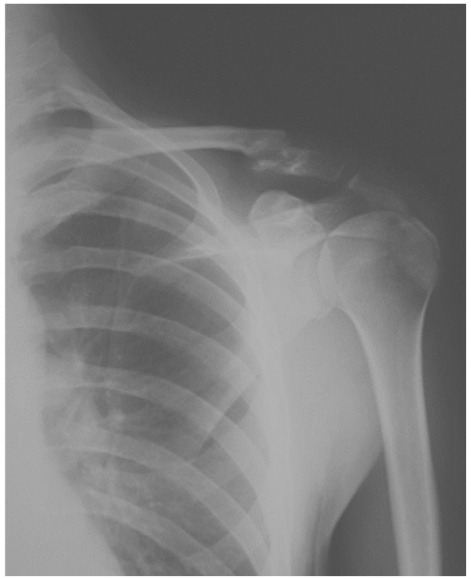
kVp and Subject Contrast

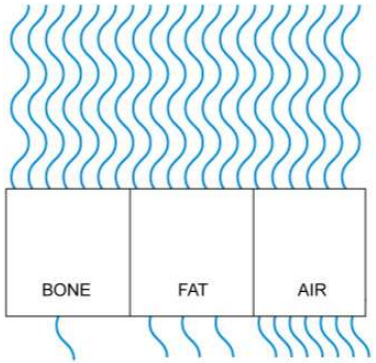
#4 - Explain how a higher kVp affects:

a. Penetrating power of the beam
b. Absorption
c. Transmission
d. Differential absorption
e. Subject contrast

kVp and Subject Contrast







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Determining kVp Values
Minimum vs Optimum kVp

- **Minimum kVp** – lowest kVp that still provides some degree of penetration through ALL tissues of interest
- **Optimum kVp** – the level of kVp **<u>well above the minimum</u>** required for sufficient penetration
  - Strikes appropriate balance between reducing patient dose and preventing excessive scatter

Procedure	Minimum kVp for Sufficient Penetration	Recommended Optimal kVp for Digital Imaging
Hand/Wrist/Digits	54	64
Elbow/Forearm/Foot	62	72
Ankle/Leg	66	76
Knee/Humerus	70	80
Mandible	70	76
Femur/Shoulder/Sinus/Ribs	76	86
Cervical/Thoracic Spines	76	86
Iodine Procedures (IVU)	76	80
Abd/Pelvis/Lumbar Spines	80	90
Non-Grid Chest	80	86
Skull	80	90
Air Contrast Ba Studies	92	100
Esophagram	92	92
Solid Ba Studies	110	120
Grid Chest (fixed unit)	120	120

Quinn B. Carroll; Radiography in the Digital Age

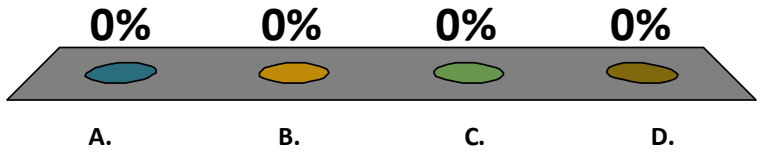
kVp and Technique Manipulation

#5 - How does kVp need to be adjusted in order to:

- double receptor exposure?
- halve receptor exposure?

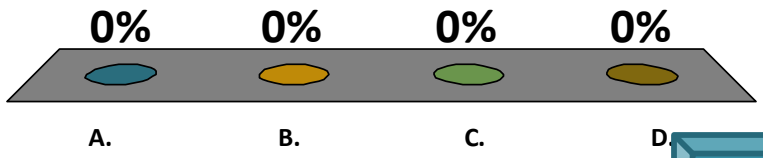
If you increase kVp by 15%, then receptor exposure:

A. Increases by 15%
B. Increases by 30%
✓ C. Doubles
D. Will decrease



Exposure factors of 8 mAs and 80 kVp were used. Which of the following changes would result in twice the exposure to the IR?

A. 4 mAs
B. 16 mAs
C. 160 kVp
D. 68 kVp



15

kVp and Maintaining IR Exposure

#6 - To maintain receptor exposure, how does mAs need to be adjusted if kVp is increased from 70 kVp to 80 kVp?

#7 - To maintain receptor exposure, how does mAs need to be adjusted if kVp is decreased from 70 kVp to 60 kVp?

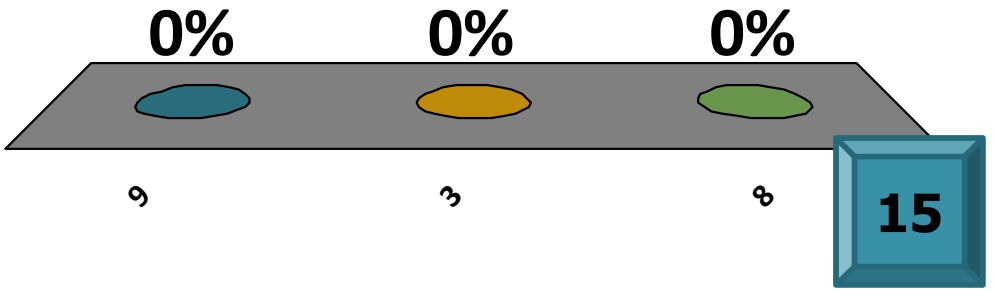
***Complete #9 - #13 on worksheet*

If you use 6 mAs with 50 kVp and then change to 58 kVp…what mAs will you need to maintain the original exposure (EI)?

A. 9

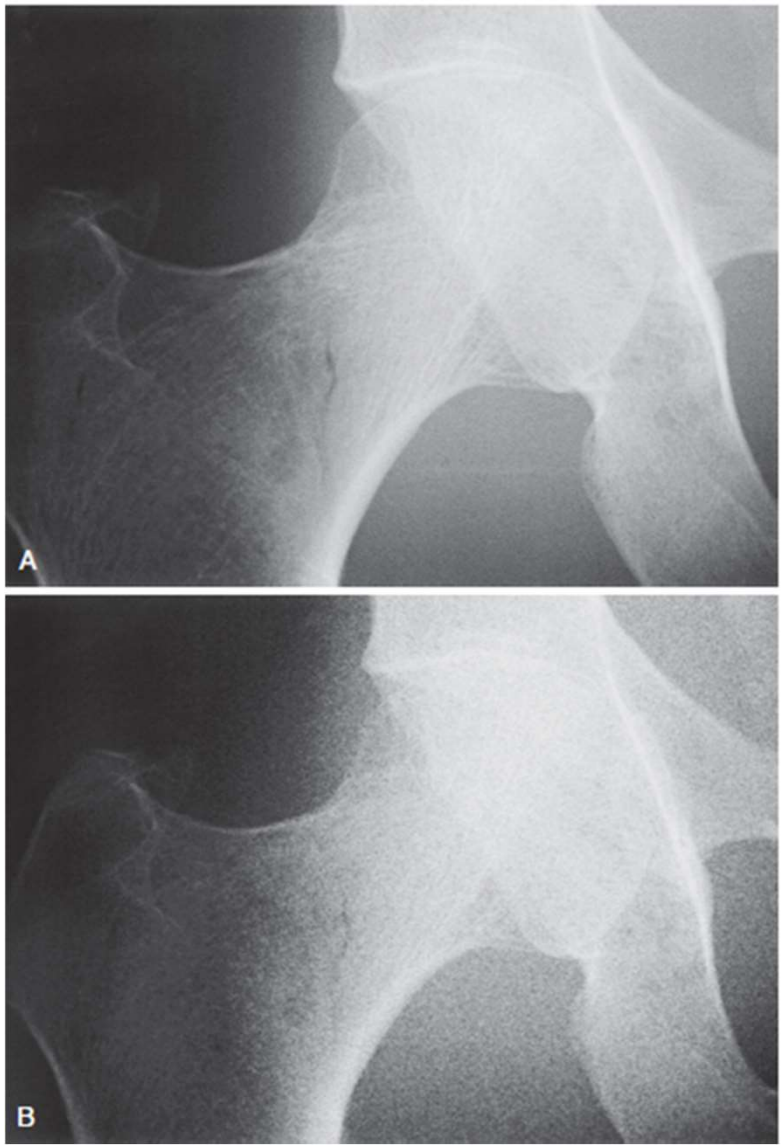
✓ B. 3

C. 8



Technique Error Effects on Image Appearance

#8 - What is the consequence of too low of a technique (mAs/kVp) on image quality?


A
B

Technique Effects on Image Appearance

#9 - What is the consequence of too high of a technique (mAs/kVp) on image quality?

mAs and Repeat Images

#10 - If an image needs repeated due to exposure errors, what is the typical change to mAs required to correct the error?

- *Complete #14 on worksheet*

kVp and Repeat Images

- *Contrast errors*
- *Scatter*
- *Radiation Protection*

kVp and Scatter

mAs and kVp

	Receptor Exposure	Spatial Resolution	Distortion
mAs			
kVp			
Focal Spot Size			
SID			
OID			
Grid			
Tube filtration			
Beam restriction			
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)			

Secondary Factors

- **Focal spot size**
- **Source-to-image receptor distance (SID)**
- **Object-to-image receptor distance (OID)**
- **Central ray–anatomic part–image receptor alignment**
- **Grids**
- **Beam restriction**
- Generator output
- **Tube filtration**
- Compensating filters
- Type of IR
- **Patient factors**

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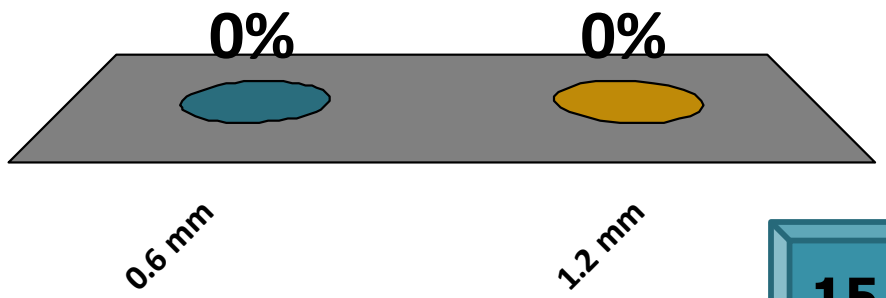
Focal Spot Size

	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size			
SID			
OID			
Grid			
Tube filtration			
Beam restriction			
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)			

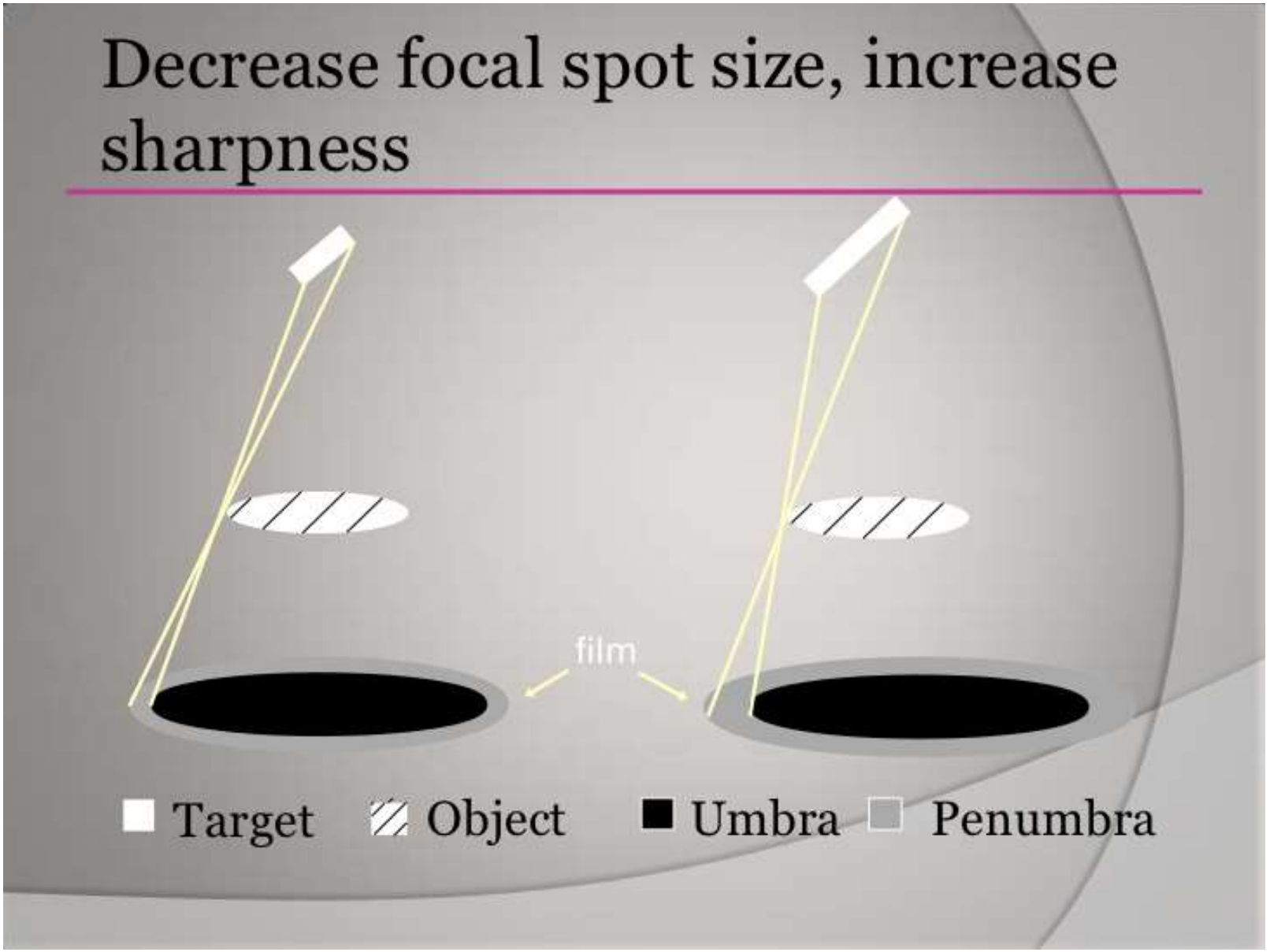
Which focal spot size would give the best spatial resolution?

A. 0.6 mm

B. 1.2 mm



Focal Spot Size

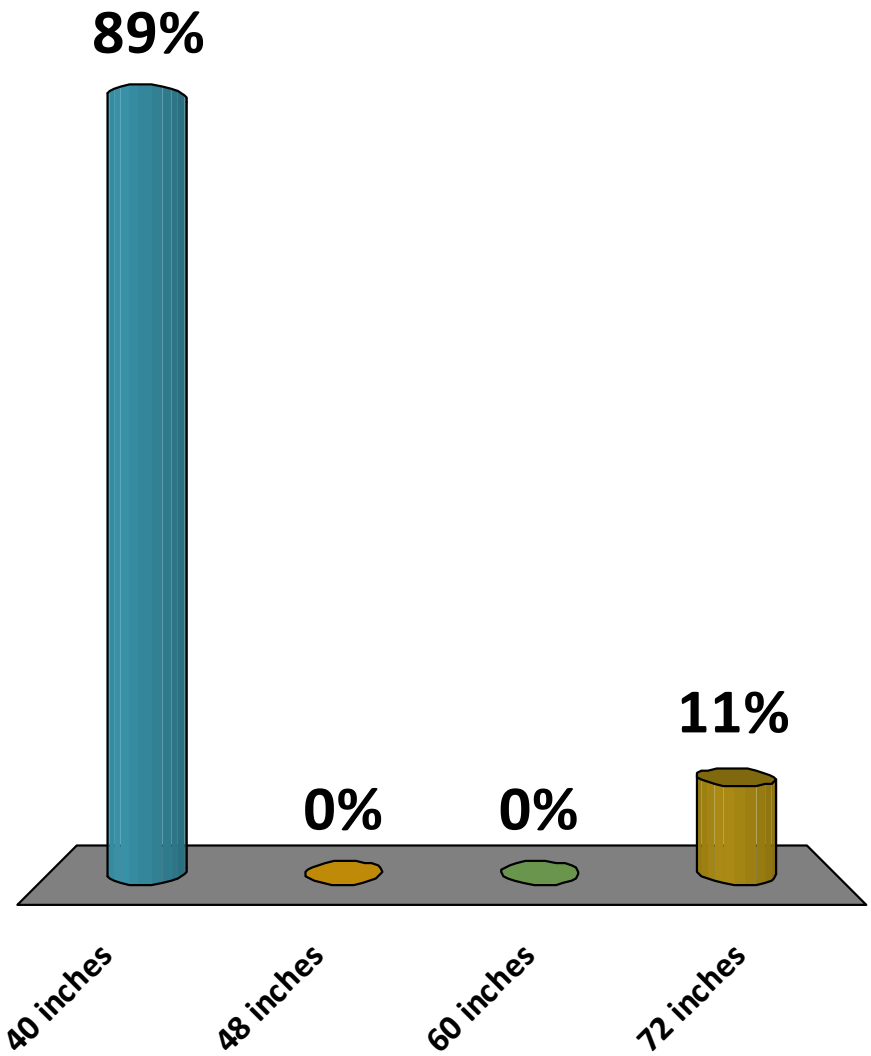


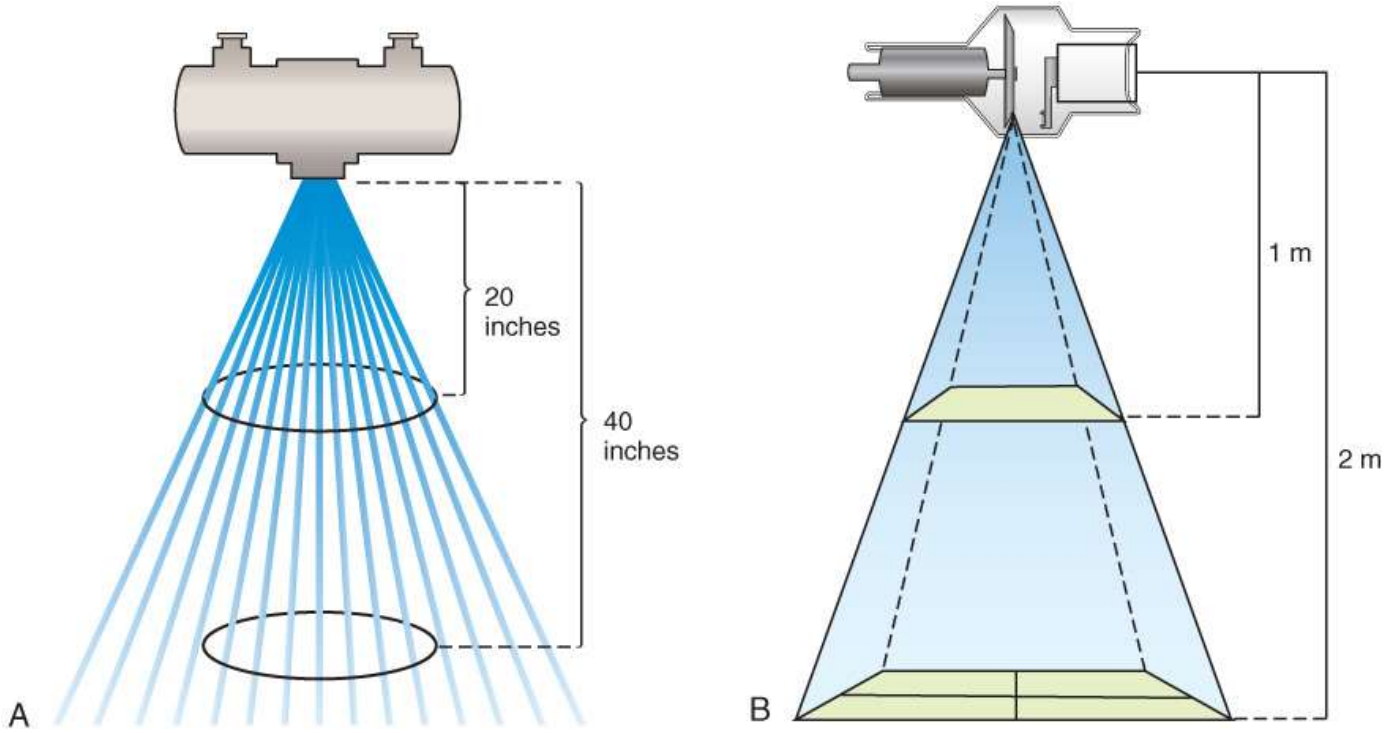
Source-to-Image Receptor Distance (SID)

	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		x	
SID	x	x	size
OID			
Grid			
Tube filtration			
Beam restriction			
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)			

Which of the following SID's would produce the **highest** receptor exposure?

- A. 40 inches
- B. 48 inches
- C. 60 inches
- D. 72 inches





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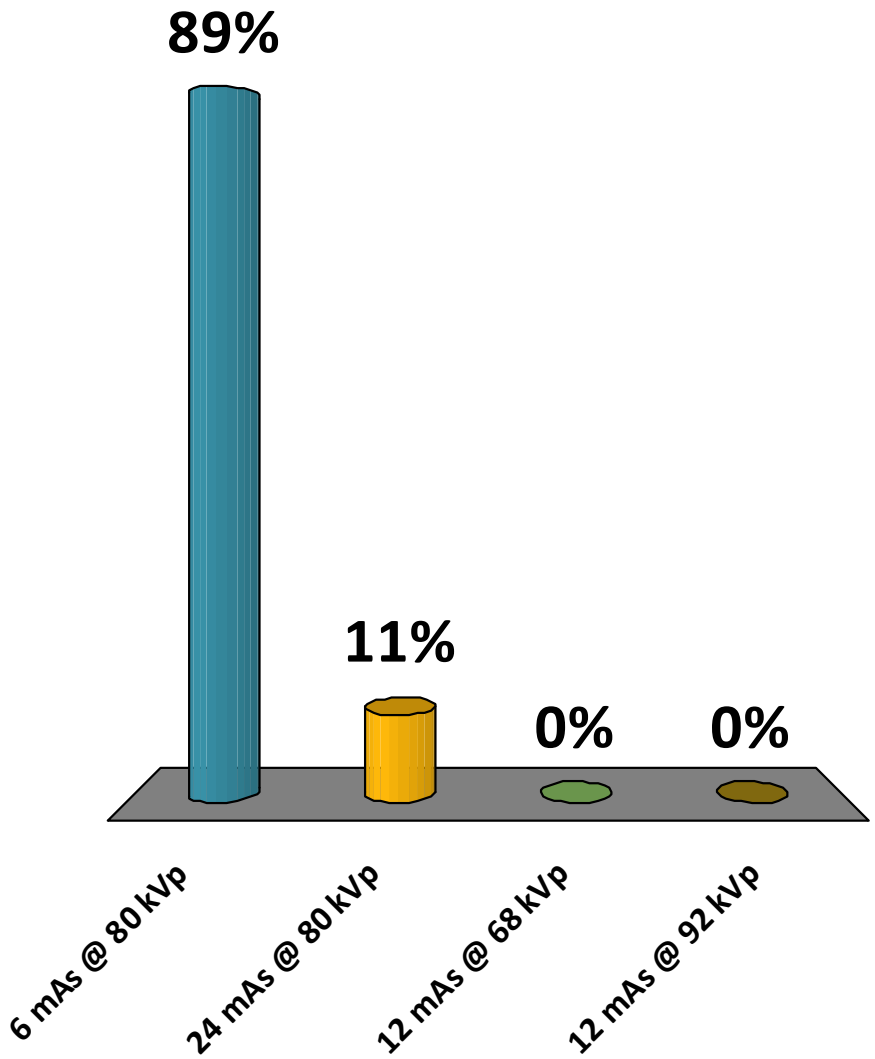
SID and Technique Manipulation

#2 - If SID is greater/lesser than what is required, what formula is used in order to maintain appropriate receptor exposure?

**Complete #15 and #16 on worksheet*

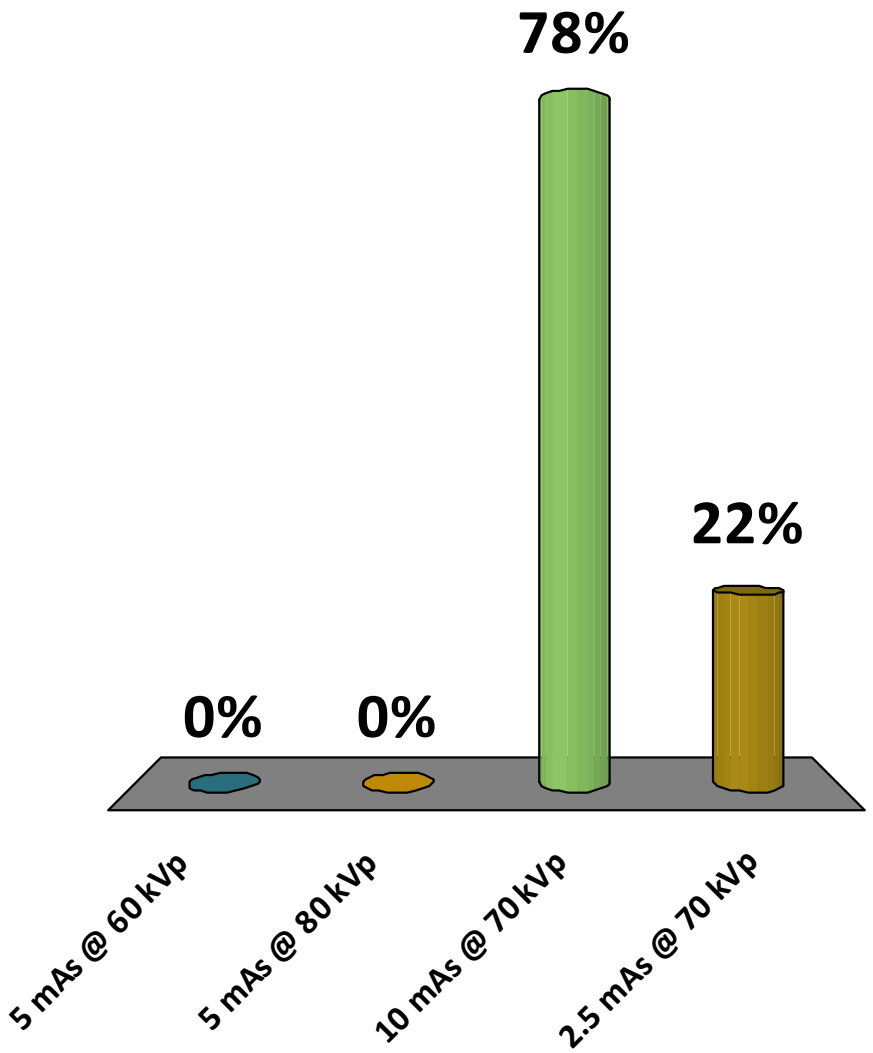
Technique in book is for 72 inch SID, 12 mAs @ 80 kVp. SID obtained is 56 inches. How should technique be adjusted to maintain exposure to IR?

A. 6 mAs @ 80 kVp
B. 24 mAs @ 80 kVp
C. 12 mAs @ 68 kVp
D. 12 mAs @ 92 kVp



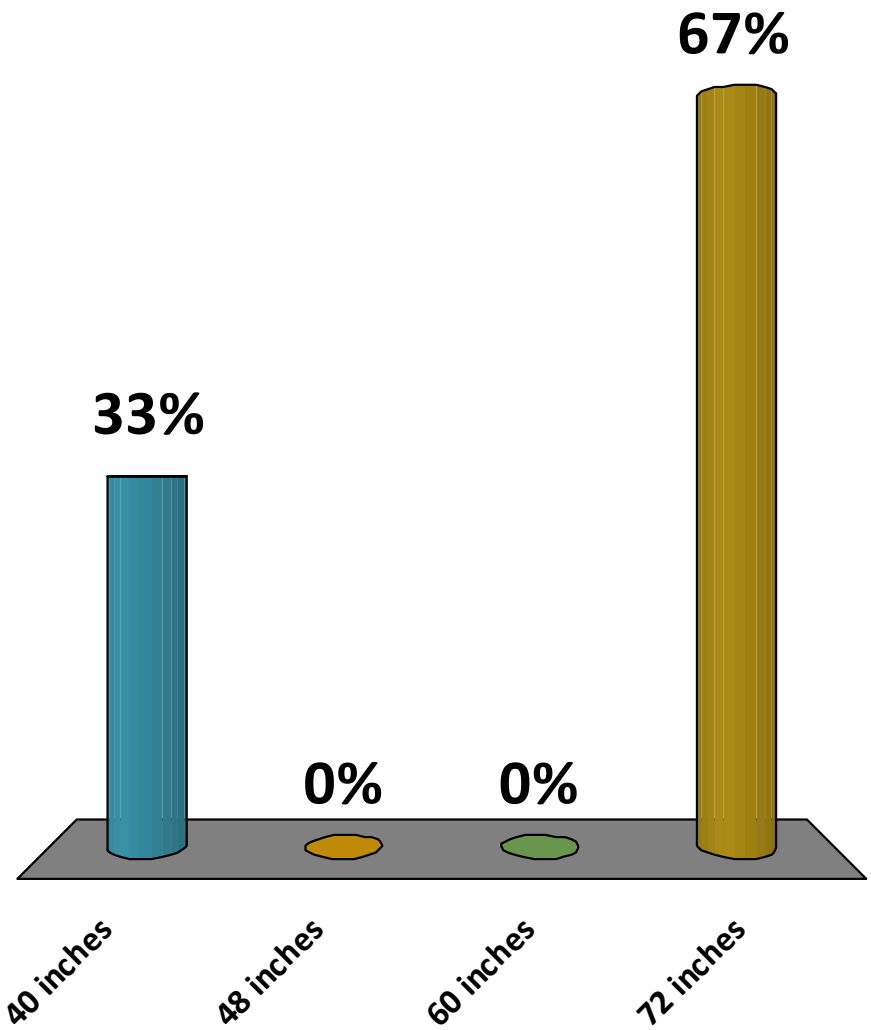
Technique in book is for 40 inch SID, 5 mAs @ 70 kVp. SID obtained is 56 inches. How should technique be adjusted to maintain exposure to IR?

A. 5 mAs @ 60 kVp
B. 5 mAs @ 80 kVp
★ C. 10 mAs @ 70 kVp
D. 2.5 mAs @ 70 kVp

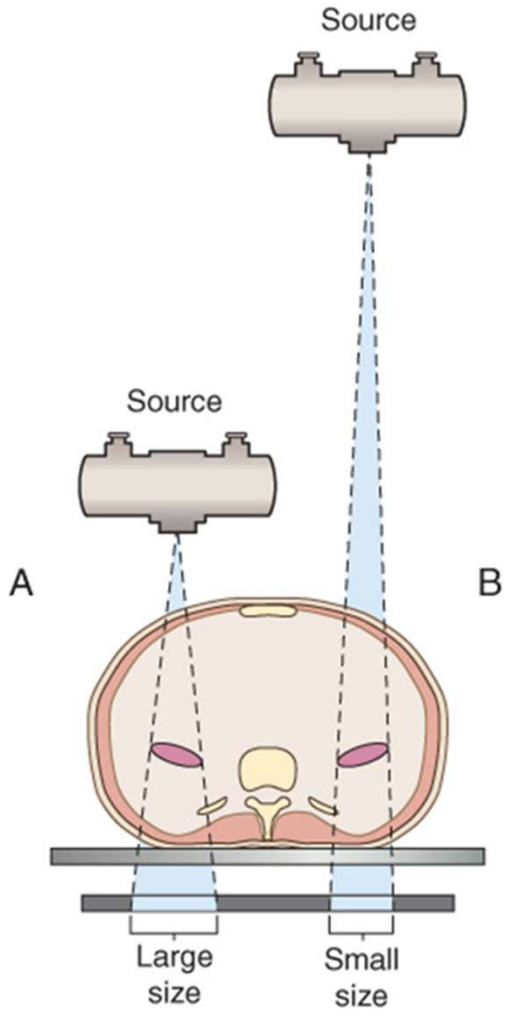


Which of the following SID's would produce the **least** amount of distortion?

A. 40 inches
B. 48 inches
C. 60 inches
D. 72 inches

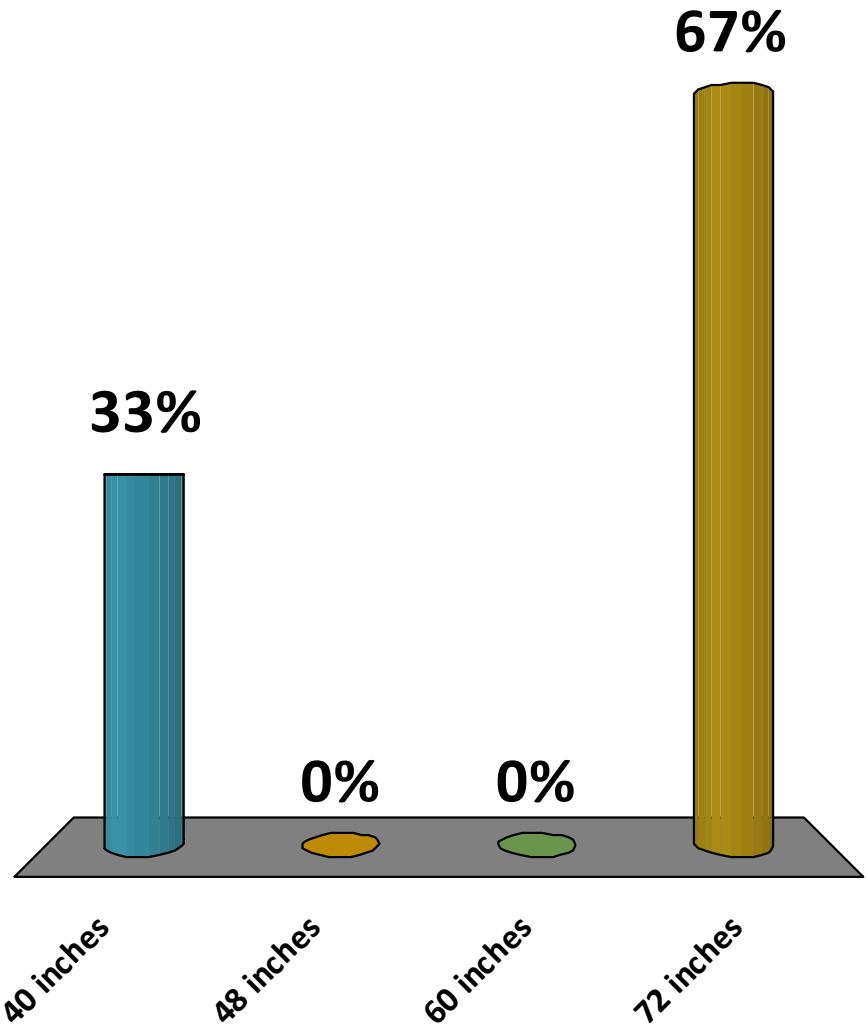


SID and Size Distortion



Which of the following SID's would result in the **best** spatial resolution?

A. 40 inches
B. 48 inches
C. 60 inches
D. 72 inches



SID and Spatial Resolution

Figure 22-1

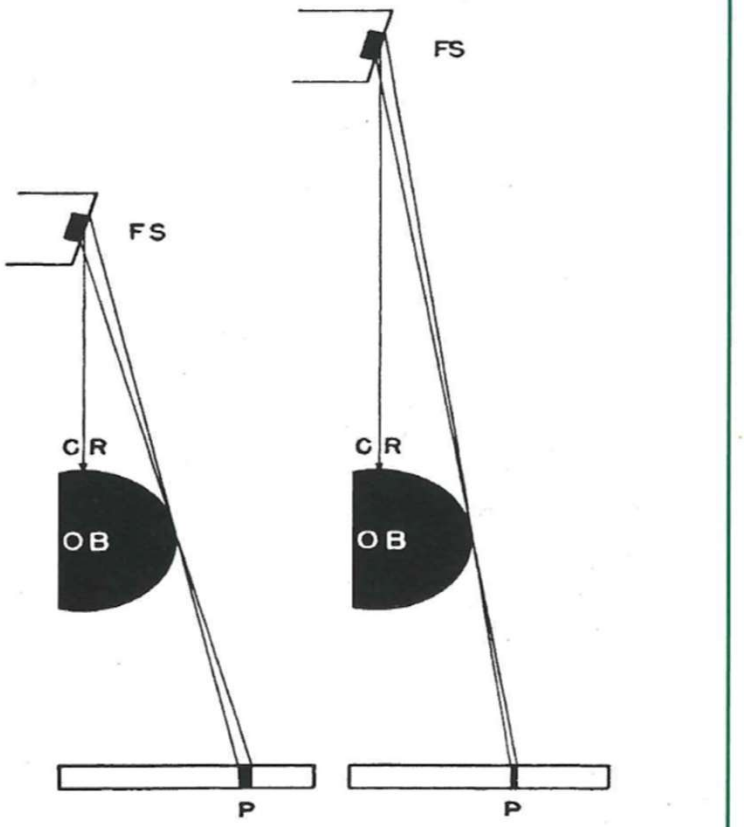


Diagram illustrating that, by projecting the edges of an object with beams more parallel to the CR, a longer SID minimizes penumbral shadows and thus improves sharpness of detail. (From Quinn B. Carroll, *Practical Radiographic Imaging*, 8th ed. Springfield, IL: Charles C Thomas, Publisher, Ltd., 2007. Reprinted by permission.)

SID

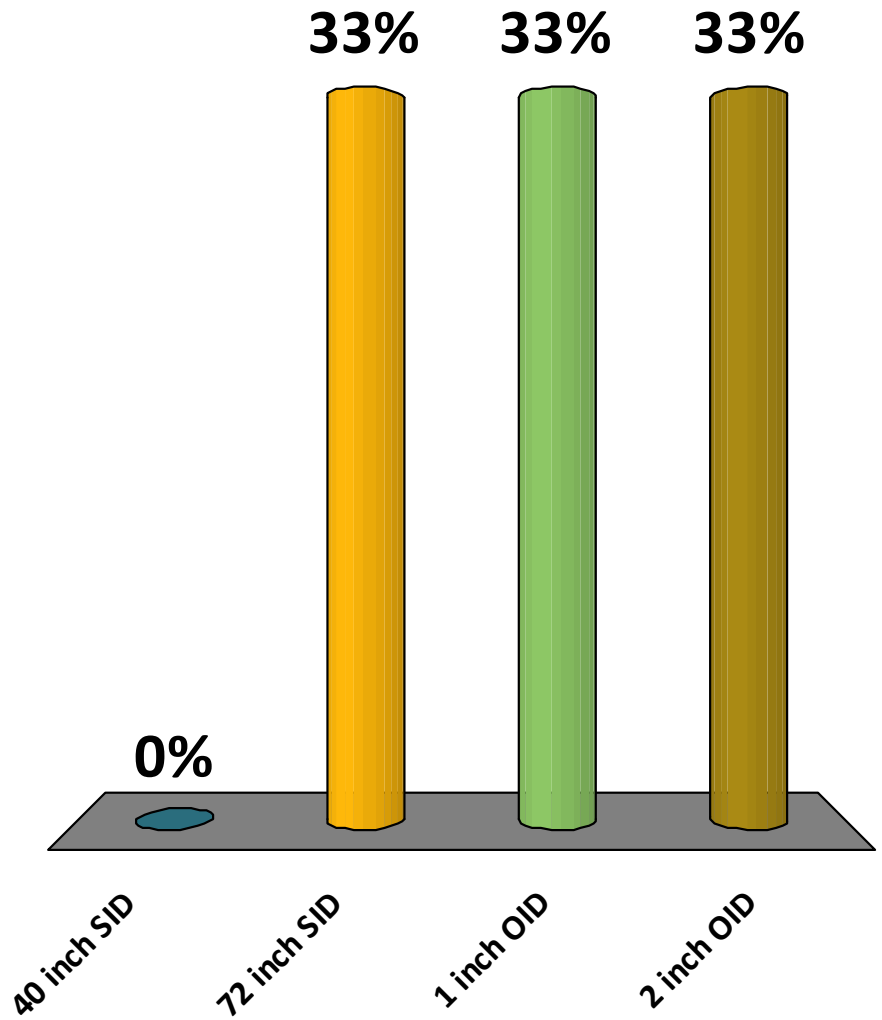
- To summarize:
  - Increased SID:
    - Less size distortion (Mag)
    - Better spatial resolution (Sharpness)
      - Minimized (decreased) unsharpness
    - Less receptor exposure

Object-to-Image Receptor Distance (OID)

	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		x	
SID	x	x	Size
OID	x	x	size
Grid			
Tube filtration			
Beam restriction			
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)			

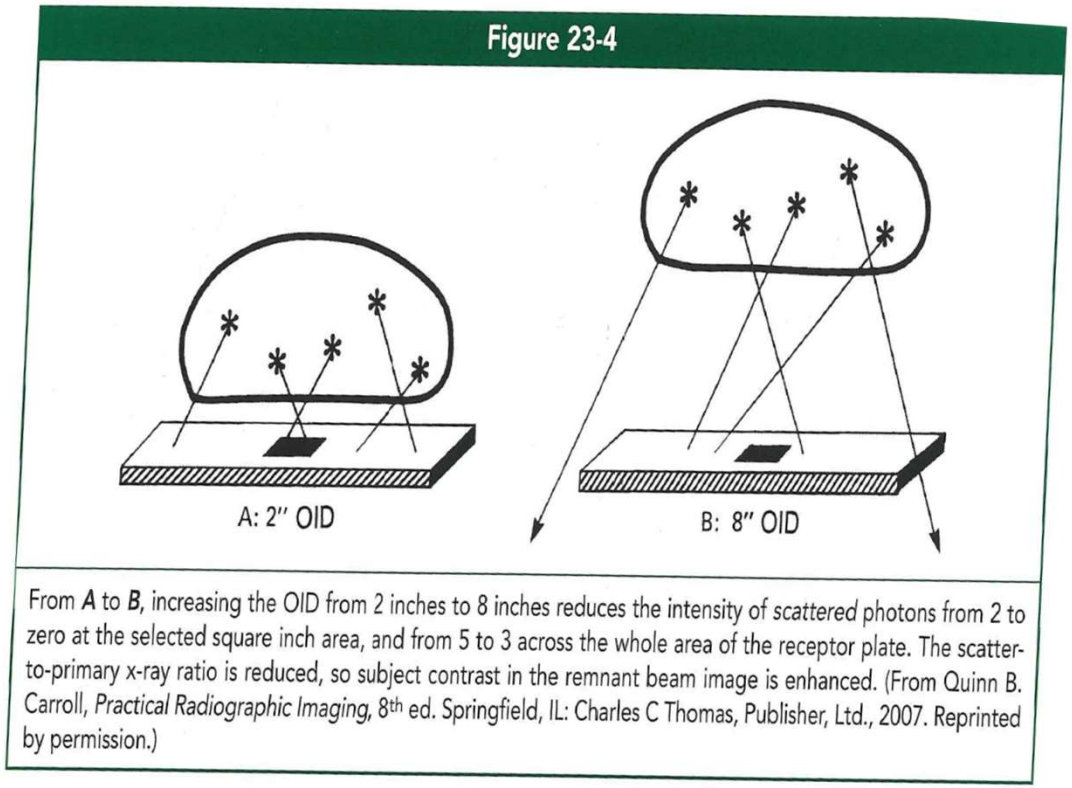
Which of the following would result in the **least** amount of scatter radiation reaching the IR?

A. 40 inch SID
B. 72 inch SID
C. 1 inch OID
D. 2 inch OID



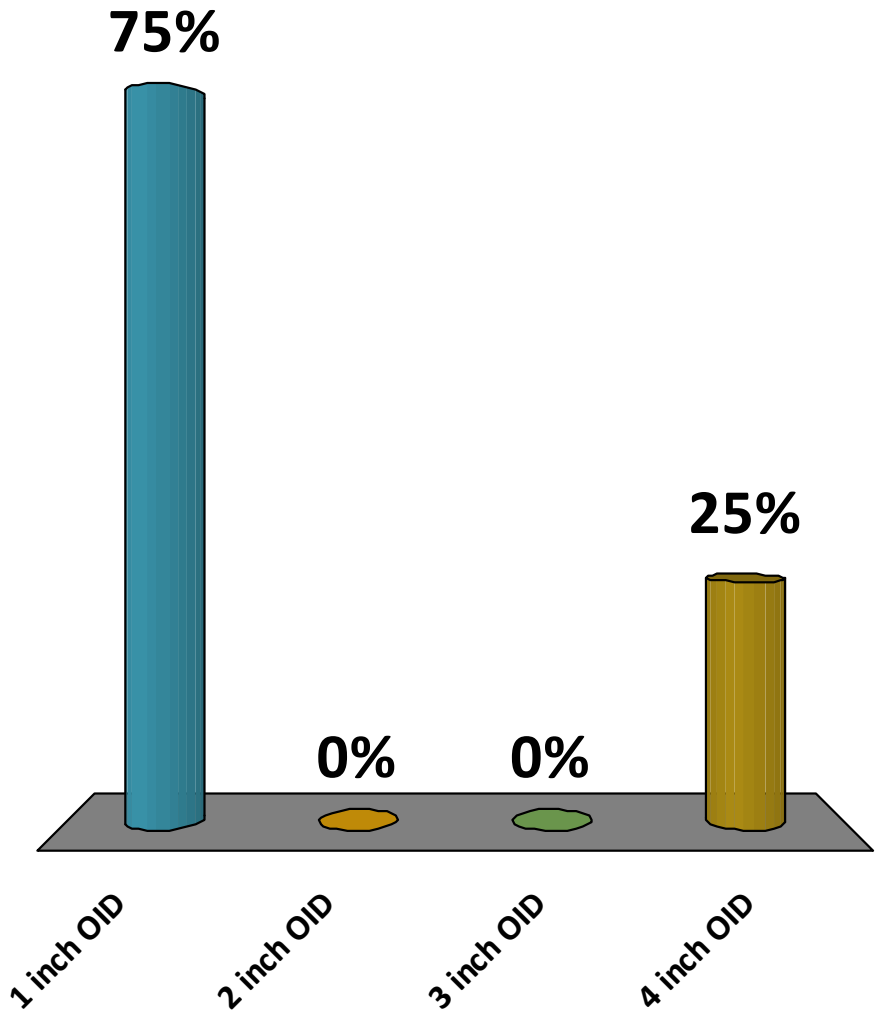
OID, Receptor Exposure, and Scatter

#4 - How does an increased OID effect radiographic contrast?

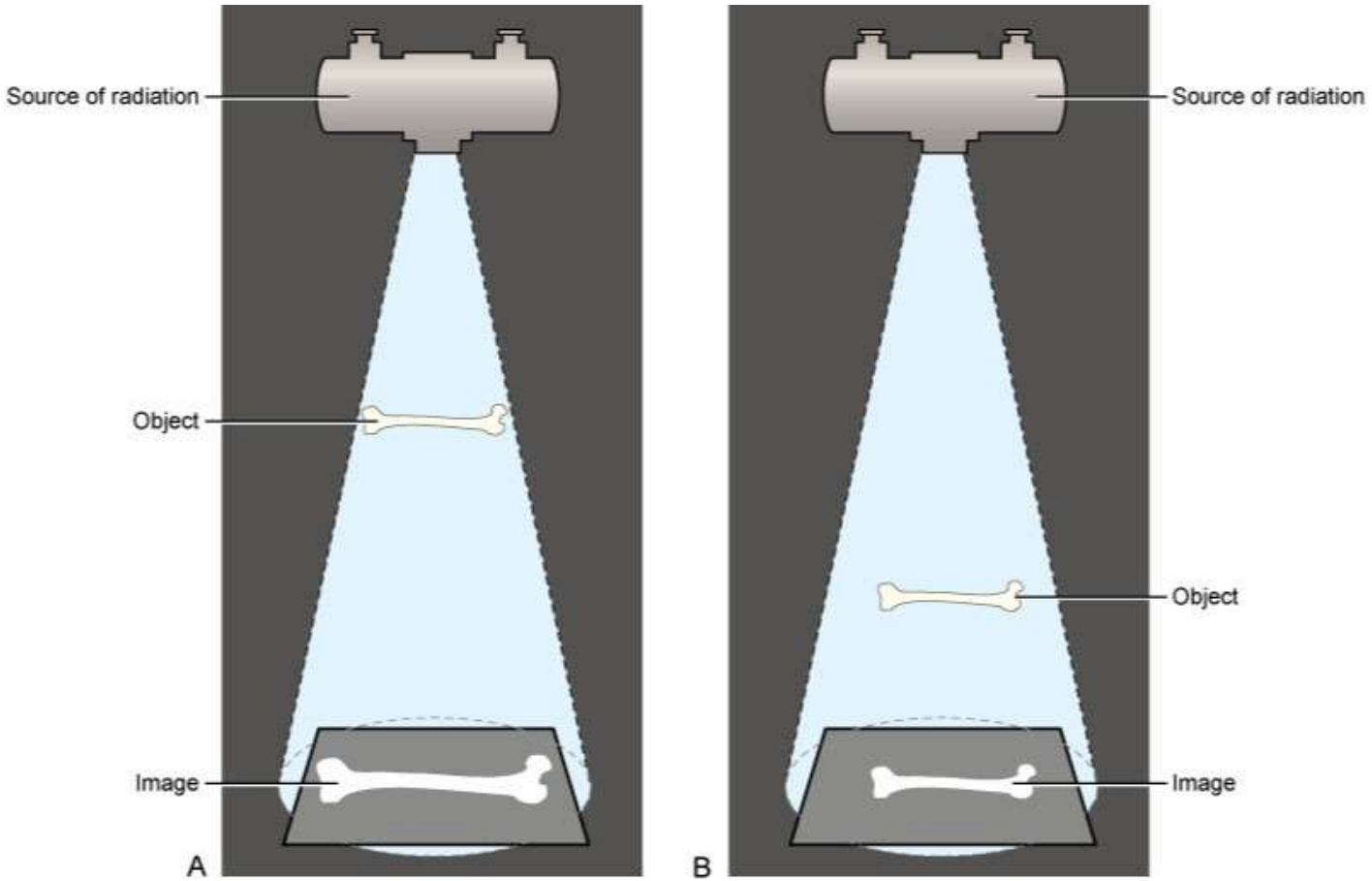


Which of the following would result in the **least** amount of distortion?

- A. 1 inch OID
- B. 2 inch OID
- C. 3 inch OID
- D. 4 inch OID



OID and Magnification



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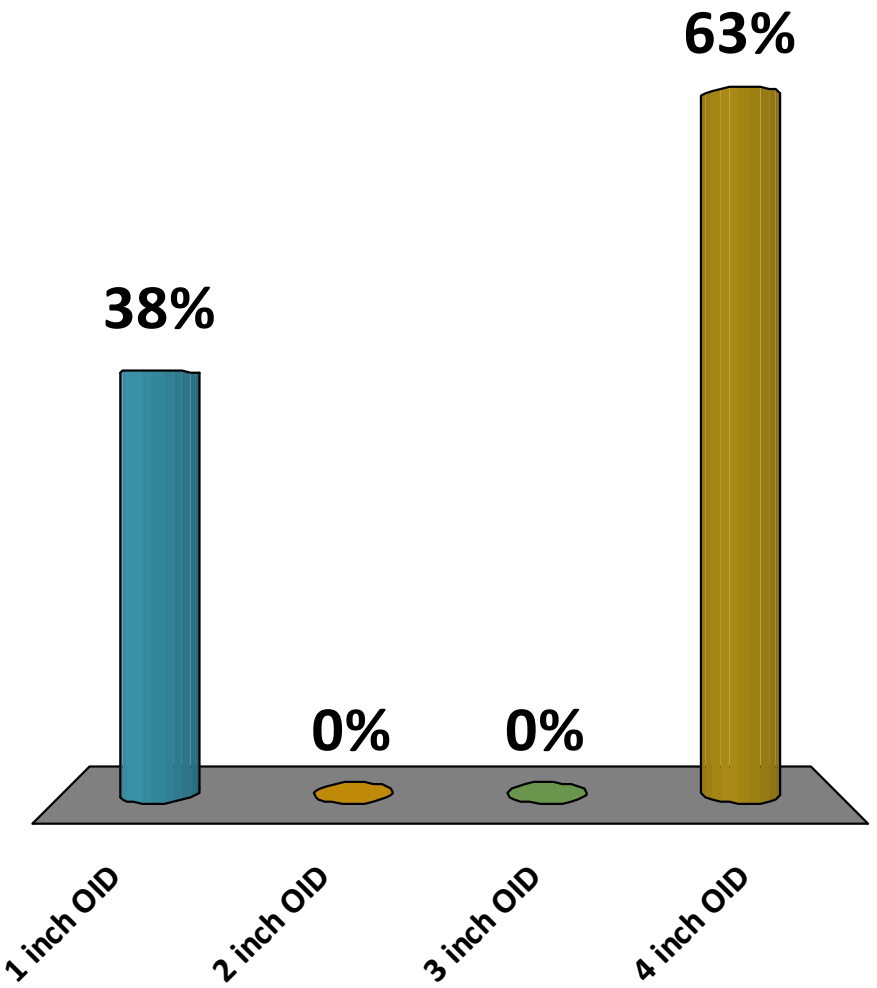
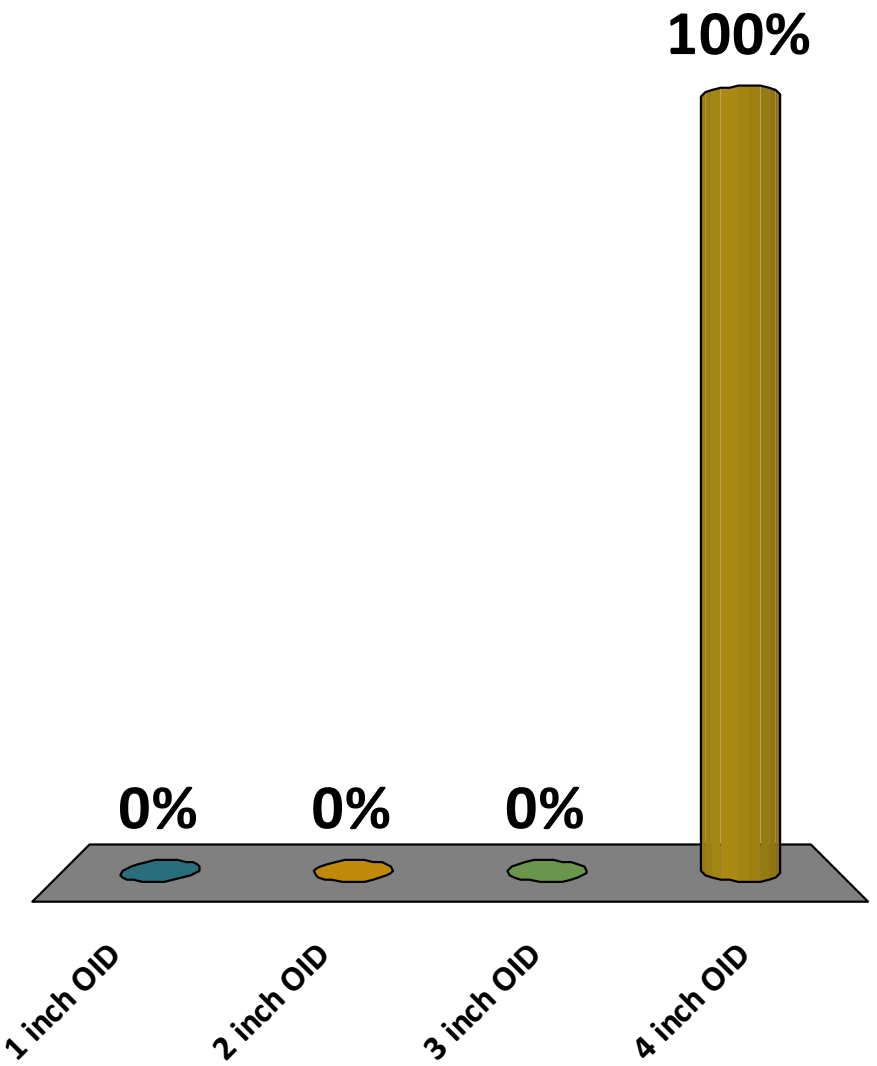
Which of the following would result in the **best** spatial resolution?

- A. 1 inch OID
- B. 2 inch OID
- C. 3 inch OID
- D. 4 inch OID



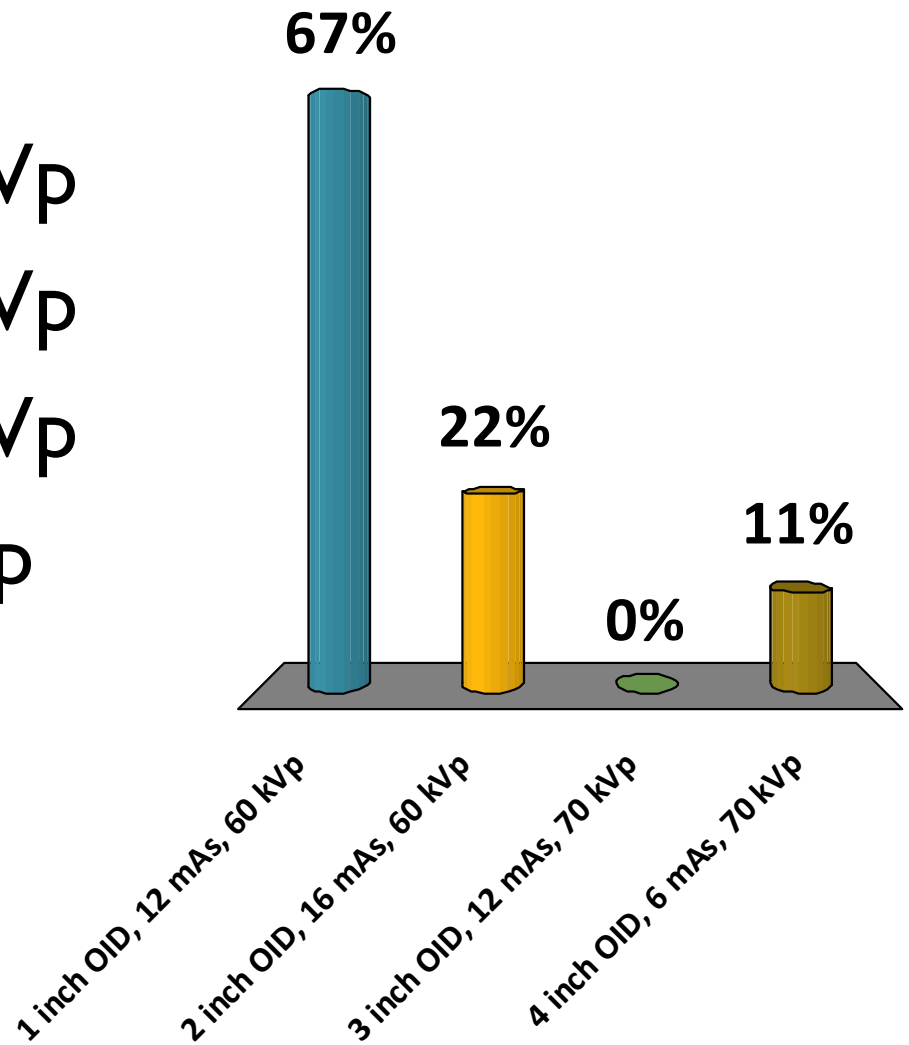
Which of the following would result in the **least** spatial resolution?

A. 1 inch OID
B. 2 inch OID
C. 3 inch OID
D. 4 inch OID



Which of the following would result in the **best** spatial resolution?

- A. 1 inch OID, 12 mAs, 60 kVp
- B. 2 inch OID, 16 mAs, 60 kVp
- C. 3 inch OID, 12 mAs, 70 kVp
- D. 4 inch OID, 6 mAs, 70 kVp



OID and Spatial Resolution

Figure 23-6

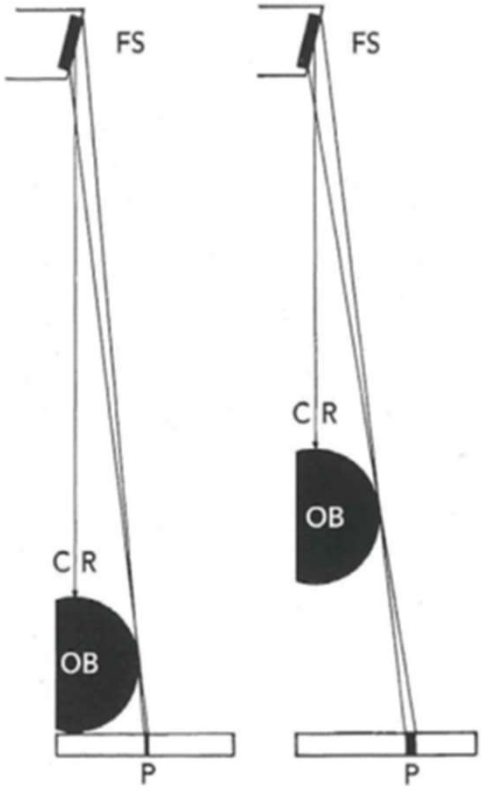


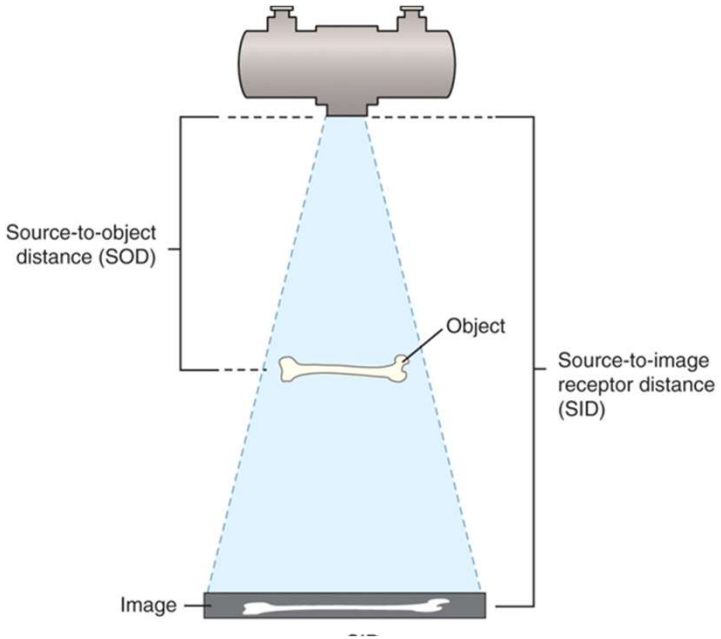
Diagram of the effect of increasing OID (right) on spreading the penumbra, thus reducing sharpness. (From Quinn B. Carroll, *Practical Radiographic Imaging*, 8th ed. Springfield, IL: Charles C Thomas, Publisher, Ltd., 2007. Reprinted by permission.)

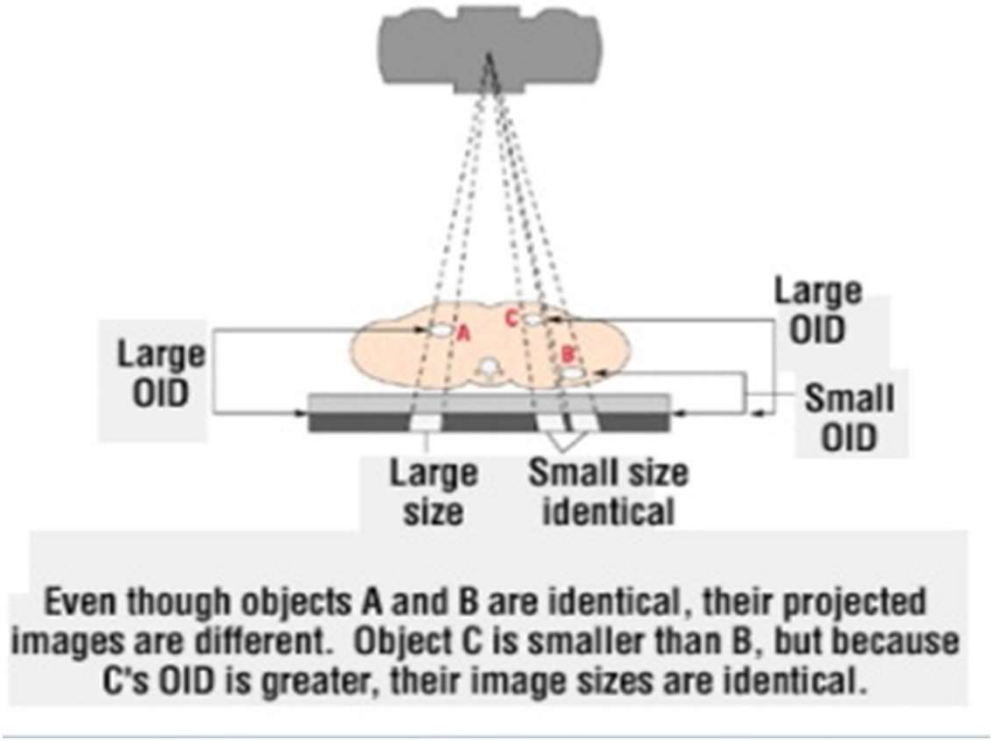
OID

- To Summarize:
  - Increased OID
    - Less receptor exposure (less scatter)
    - Improved radiographic contrast (less scatter)
    - Increased magnification (size distortion)
    - Decreased spatial resolution (greater unsharpness)

Magnification Factor

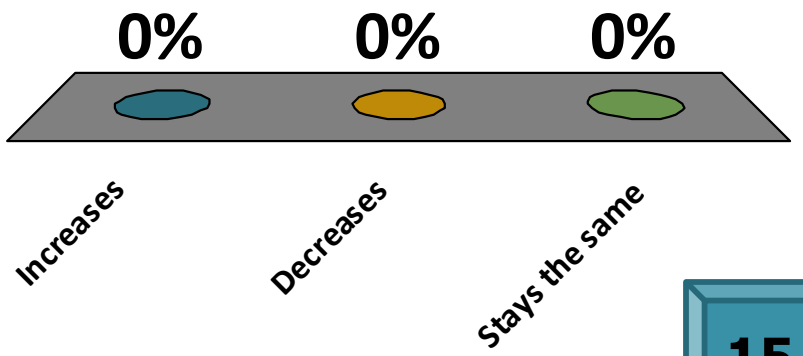
#5 - What does the magnification factor (MF) indicate and how is it expressed mathematically?





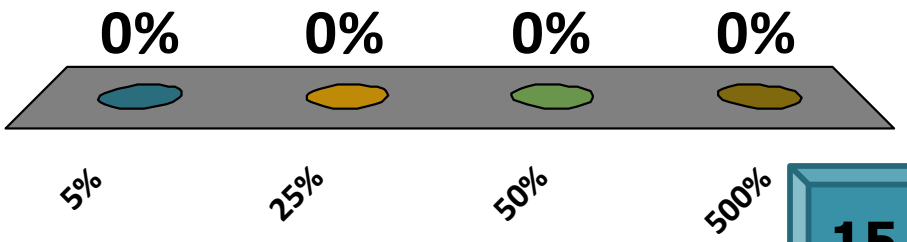
As magnification increases, what happens to spatial resolution?

A. Increases
B. Decreases
C. Stays the same



If an object has an MF equal to 1.5, what percentage of magnification is demonstrated on the image?

A. 5%
B. 25%
C. 50%
D. 500%



True Object Size

#7 - What formula is used to calculate true object size?

**Complete #19 on worksheet*

Projected Image Size

#8 - How could you solve for image size if the object size and MF is known?

**Complete #20 - #22 on worksheet*

Object Percentage of Magnification

#9 - What formula is used to determine % of Magnification?

**Complete #23 - #24 on worksheet*

Decreasing Magnification

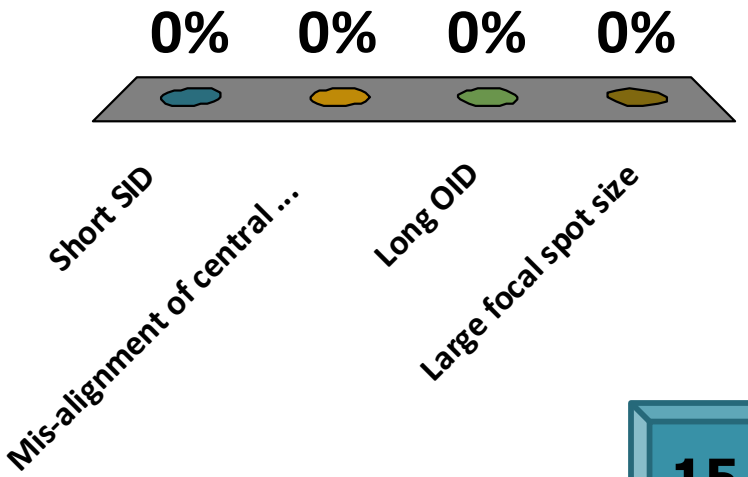
#10 - If a large OID is unavoidable, what can be done to decrease magnification and increase resolution?

Angle – Tube/Part/Receptor

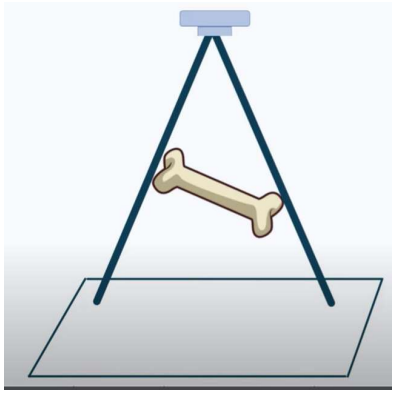
	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		X	
SID	X	X	Size
OID	X	X	Size
Grid			
Tube filtration			
Beam restriction			
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)			

Shape distortion is caused by:

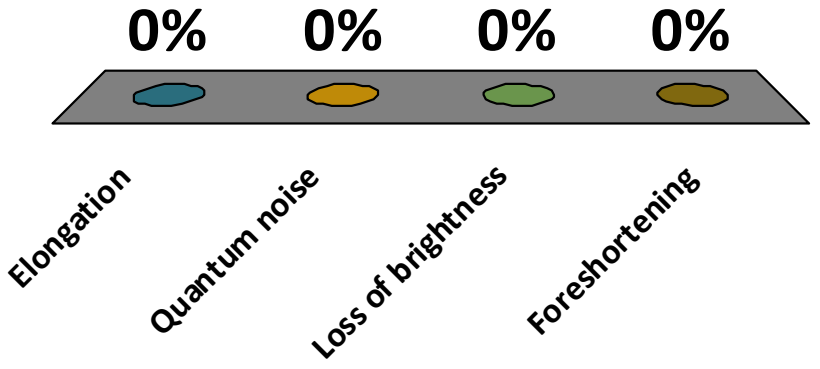
A. Short SID
B. Mis-alignment of central ray, part and/or IR
C. Long OID
D. Large focal spot size



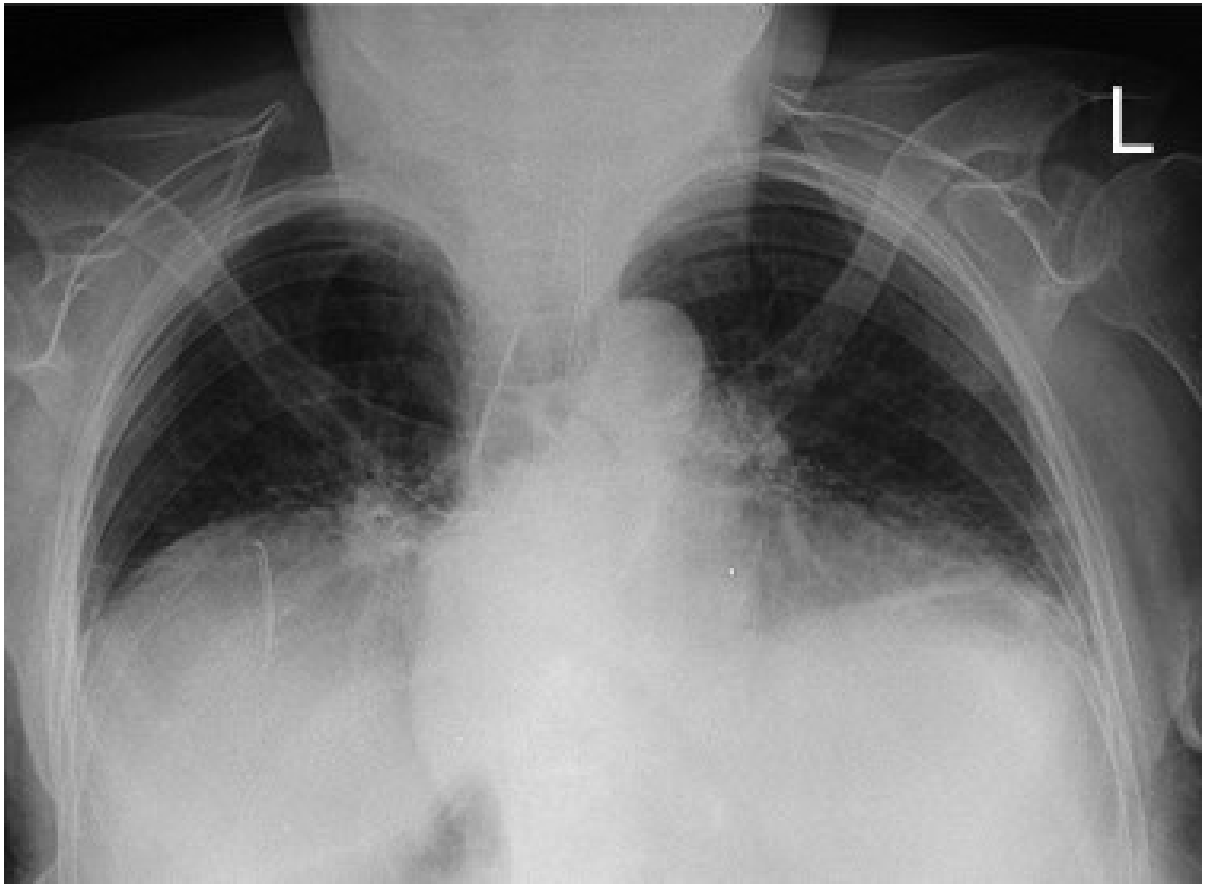
The picture below would result in:



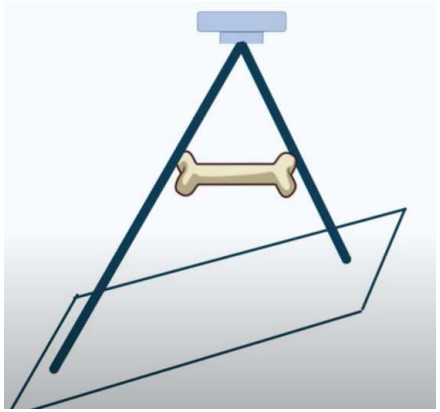
A. Elongation
B. Quantum noise
C. Loss of brightness
D. Foreshortening



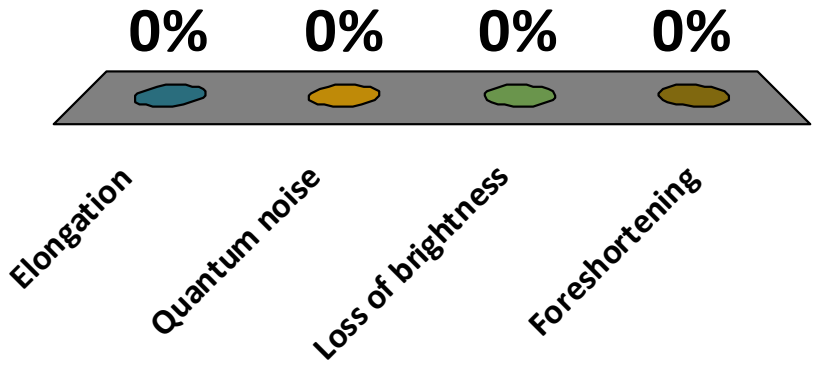
Foreshortening



The picture below would result in:

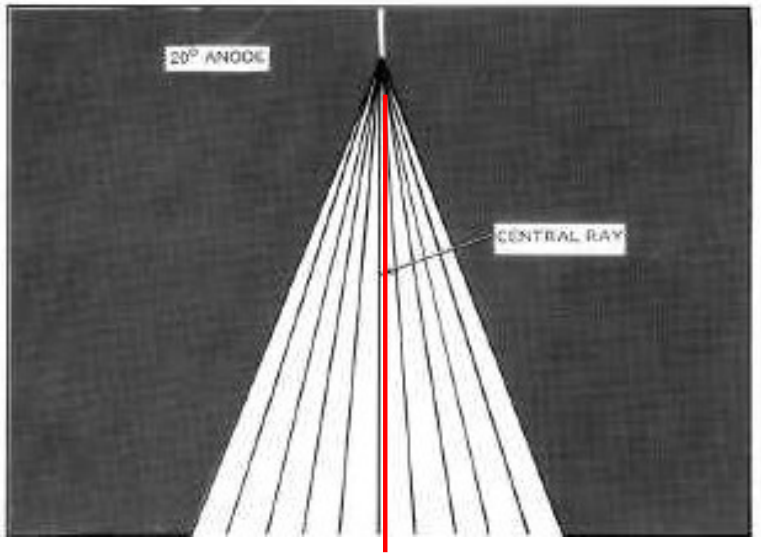


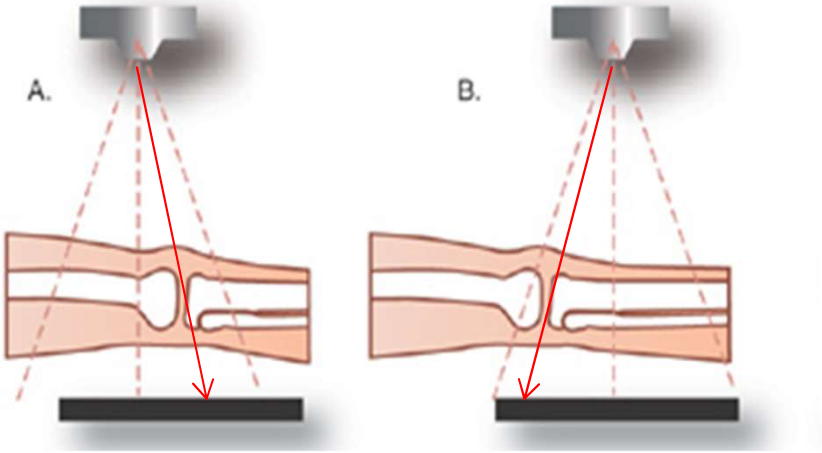
- A. Elongation
- B. Quantum noise
- C. Loss of brightness
- D. Foreshortening



Central Ray and Distortion

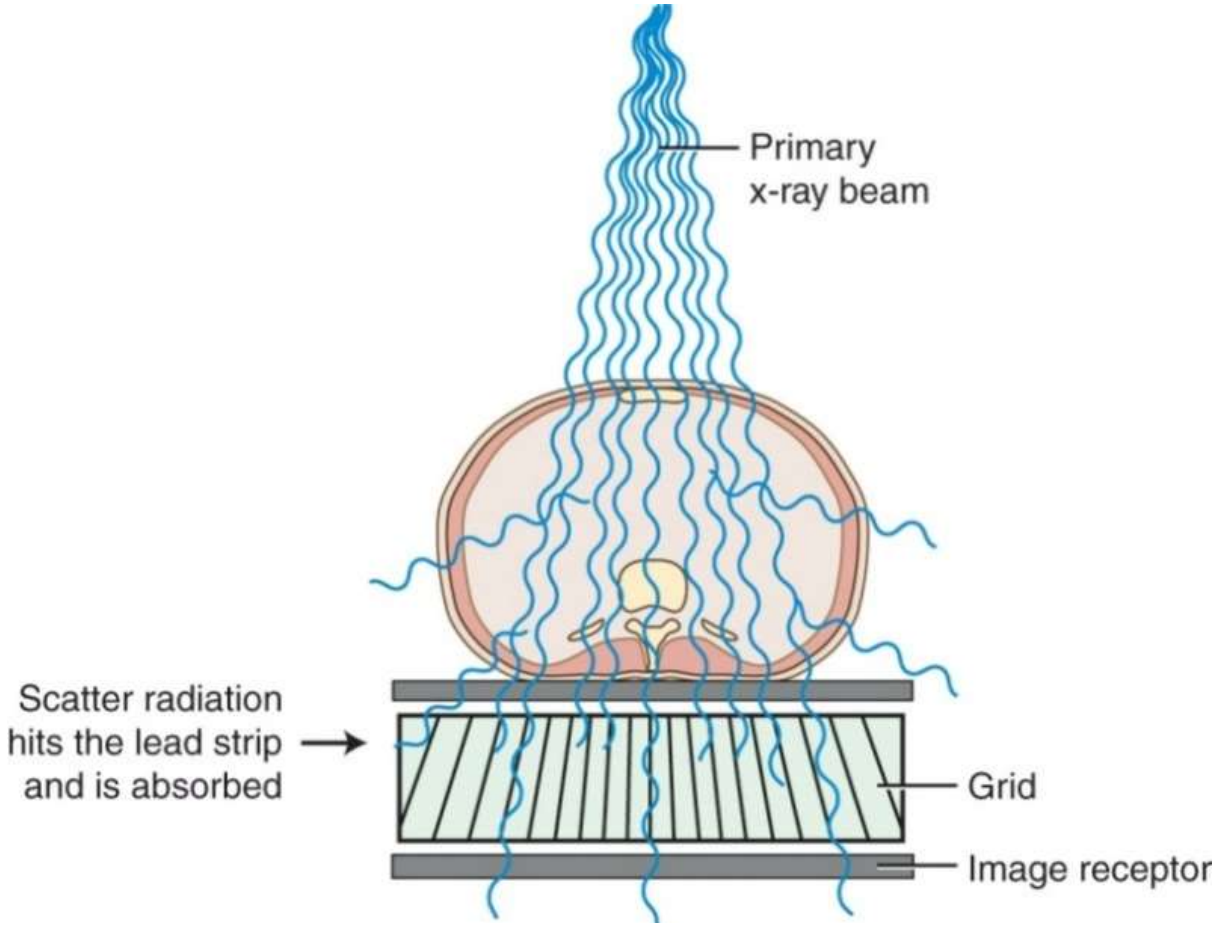
- Off centering – diverging portion striking body part will cause distortion





Grids

	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		X	
SID	X	X	Size
OID	X	X	Size
Grid			
Tube filtration			
Beam restriction			
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)		X	Shape



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Grids (Cont.)

Grid Ratios	Grid Conversion Factor (CGF)
No **grid**	1
5:1	2
6:1	3
8:1	4
12:1	5
16:1	6

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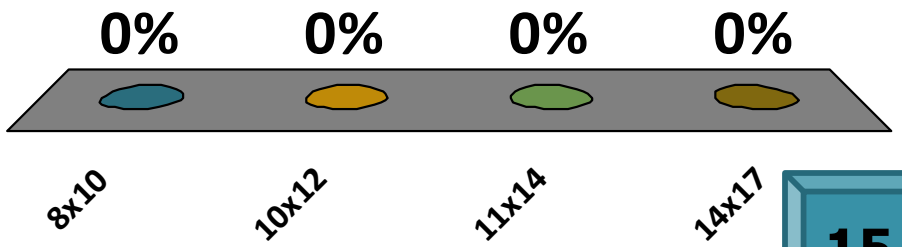
Beam Restriction

	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		X	
SID	X	X	Size
OID	X	X	Size
Grid	X		
Tube filtration			
Beam restriction			
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)		X	Shape

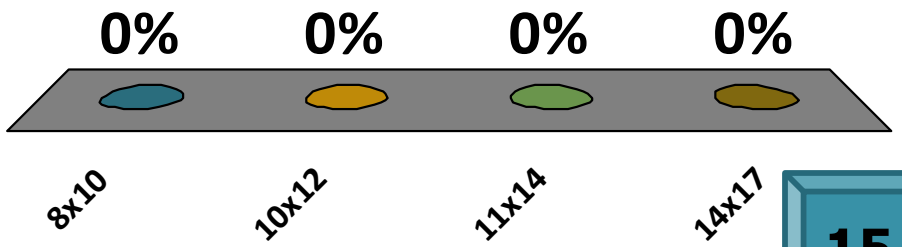
Which of the following field sizes would result in the **least** receptor exposure?

A. 8x10
B. 10x12
C. 11x14
D. 14x17



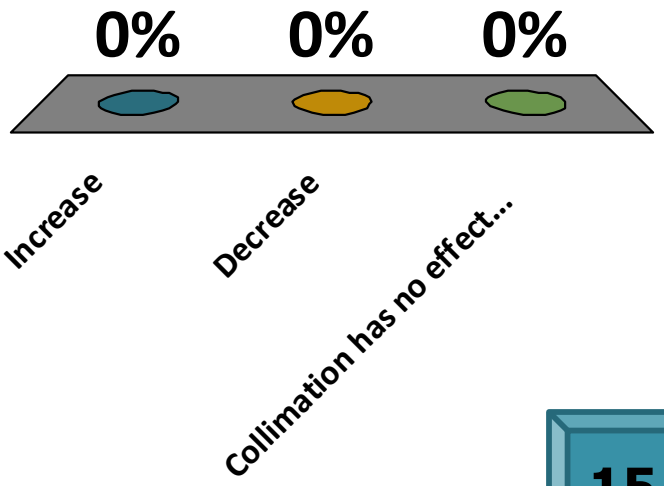
Which of the following field sizes would result in the **highest** patient dose?

A. 8x10
B. 10x12
C. 11x14
D. 14x17



How will **increasing** collimation effect radiographic contrast?

A. Increase
B. Decrease
C. Collimation has no effect on contrast



Beam Restriction Summary

- Larger field size (decreasing collimation)
  - Increases the amount of tissue irradiated,
    - More / less scatter produced?
    - Increase / decrease receptor exposure?
    - Increase / decrease patient dose?
    - Higher / Less radiographic contrast?

Beam Restriction Technique Adjustment

- Does a technologist need to do anything to accommodate for the loss of receptor exposure when increasing collimation?

Generator Output and Technique

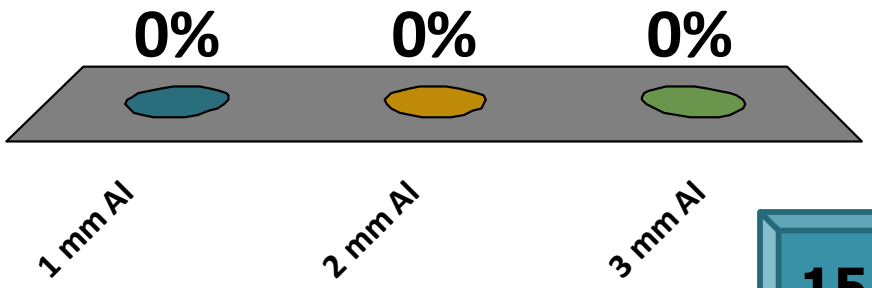
#13 - How do technical factors need to be adjusted if using a high frequency unit in comparison to a single phase unit?

Tube Filtration

	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		X	
SID	X	X	Size
OID	X	X	Size
Grid	X		
Tube filtration			
Beam restriction	X		
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)		X	Shape

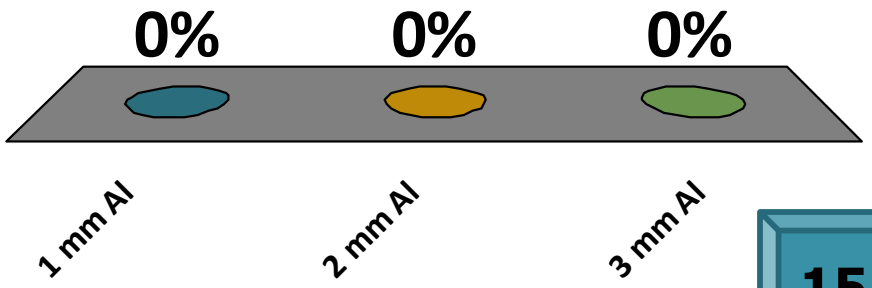
Which of the following filtration amounts would result in the **least** receptor exposure?

A. 1 mm Al
B. 2 mm Al
C. 3 mm Al



Which of the following filtration amounts would result in a **longer** scale of contrast?

A. 1 mm Al
B. 2 mm Al
C. 3 mm Al



Compensating Filters

#15 - How do technical factors need to be adjusted if using a compensating filter? How does this affect patient dose?

Patient Factors

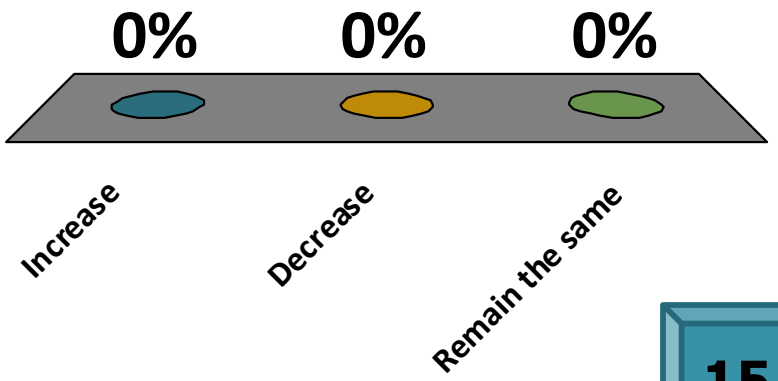
	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		X	
SID	X	X	Size
OID	X	X	Size
Grid	X		
Tube filtration	X		
Beam restriction	X		
Motion			
Patient factors (size, pathology)			
Angle (tube, part, receptor)		X	Shape

Body Habitus

#16 - Explain how technical factors need to be adjusted for hypersthenic and asthenic patients.

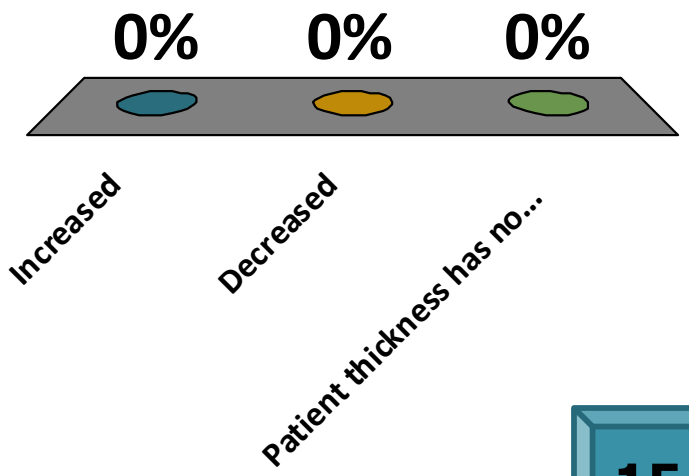
Increased patient thickness will cause receptor exposure to:

A. Increase
B. Decrease
C. Remain the same



Increased patient thickness will lead to _____ scatter production.

A. Increased
B. Decreased
C. Patient thickness has no effect on scatter production

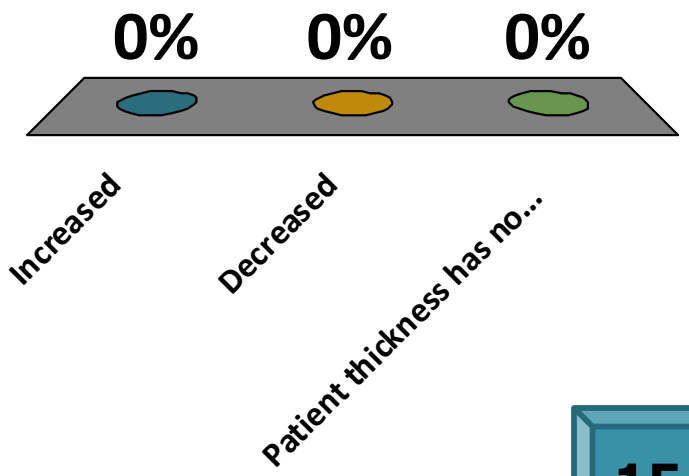


Increased patient thickness will lead to _____ radiographic contrast.

A. Increased

B. Decreased

C. Patient thickness has no effect on contrast

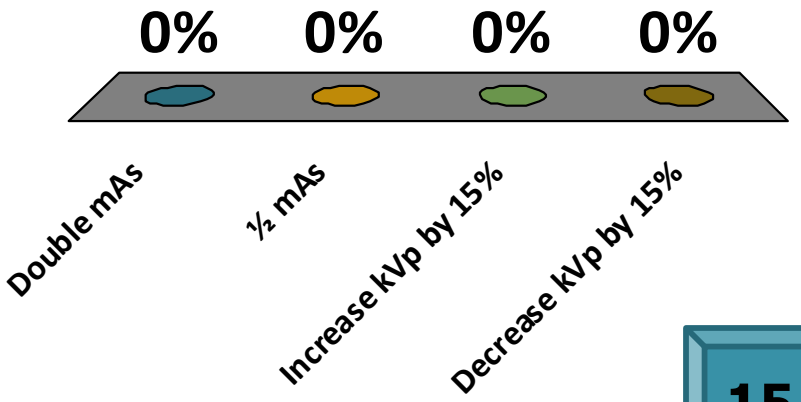


Motion

	Receptor Exposure	Spatial Resolution	Distortion
Focal Spot Size		X	
SID	X	X	Size
OID	X	X	Size
Grid	X		
Tube filtration	X		
Beam restriction	X		
Motion			
Patient factors (size, pathology)	X	X	Size
Angle (tube, part, receptor)		X	Shape

Radiation Protection Review

#19 - Identify four ways a radiographer can reduce patient dose.

Using CR instead of DR requires the radiographer to:

A. Double mAs
B. ½ mAs
C. Increase kVp by 15%
D. Decrease kVp by 15%