

### Answers to the Example Questions for Introduction to Image Acquisition Methods

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1. a) 5.6 – b) 1/500 second, aperture 5.6 – c) scenes with large variation in depth (distance of objects from camera), since depth of focus is greater for small aperture (large aperture number) – d) e.g. using a sensor with higher sensitivity

a) Aperture has to be increased to 5.6.

b) Fast moving objects are better imaged by shorter exposure time, i.e. with 1/500 second and aperture 5.6

c) Scenes with large variations in depth should better be imaged with smaller apertures, thus longer exposure times.

d) Increasing the sensitivity of the sensor (if possible) allows short exposure times and small apertures.

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2. One of these light sources could have a continuous spectrum, the other could have a spectrum of only two lines. For example, a blue and a yellow line could be mixed to give white light. In this illumination, a red and a green object appear both as yellow, while they are easily distinguished under the continuous-spectrum illumination. – *Other configurations are possible.*

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3. a) spatial resolution on detector side: classical photography, radioastronomy, and numerous others

spatial resolution on illumination side: dual photography, STEM

b) For instance, 3D reconstruction can be achieved (active triangulation using structured illumination), or a full optical transfer function between the source and detector position can be measured (extension of dual photography)

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4. Ultrasound: Here, oscillating voltage at a suitable frequency is sent to the piezoelectric elements to generate ultrasound; in detection, they are used as sensors.

STM: Piezoelectric elements are used to adjust the position of the scanning needle. At the same time, the control information is used to generate the scanned image.

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5. (b) is correct. Gradients are vectorial quantities, thus simultaneous  $x$  and  $y$  gradients superpose to one in direction of the vector  $v = (1, 1, 0)^T$ . The RF pulse therefore excites all hydrogen nuclei in some plane perpendicular to  $v$ , i.e. a plane spanned by direction vectors  $(1, -1, 0)^T$  and  $(0, 0, 1)^T$  ( $z$  direction). The  $z$  gradient during readout restricts the readout frequency to one plane perpendicular to the  $z$  direction. Both planes intersect in a line parallel to the  $x$ - $y$  plane. – Shorter answers are possible, particularly since it is not required to specify exactly the direction of the line within the plane.

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6.

A: false

B: false

C: true (in first generation scanners, most scattered rays are just lost; in later generations they can hit the wrong detector, thus contributing to noise)

D: false

E: true

F: false (the dominant limiting factor for PET resolution is the medium free path length of the positrons between emission and annihilation, which is in the range of millimetres to centimetres)

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