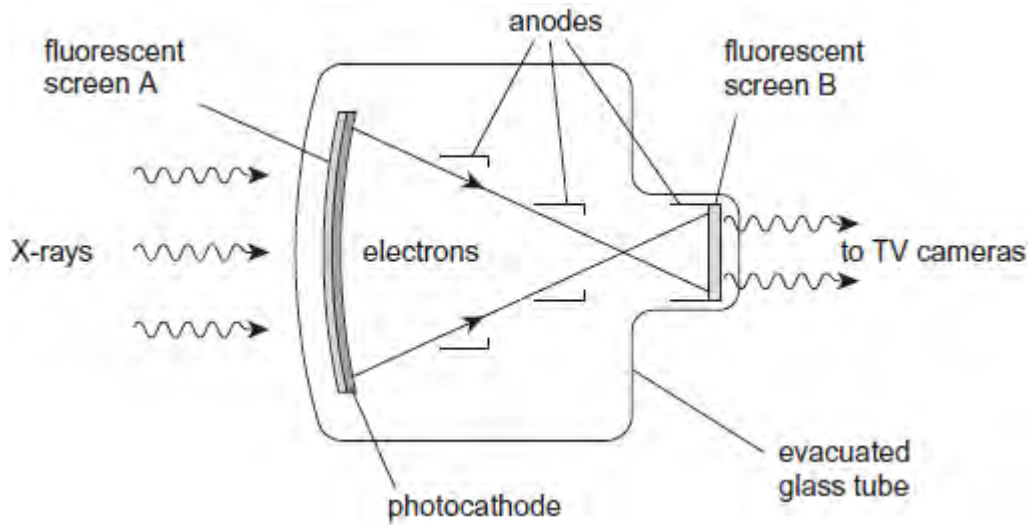


**Q1.(a)** The diagram below shows a fluoroscopic image intensifier.



State the purpose of each of the following components of the intensifier.

(i) fluorescent screen A,

.....  
 .....

(1)

(ii) photocathode,

.....  
 .....

(1)

(iii) anodes,

.....  
 .....  
 .....  
 .....

(2)

(iv) fluorescent screen B.

.....  
.....

(1)

(b) A patient is asked to swallow a suspension of barium sulfate before X-ray images are to be obtained. This is known as a barium meal technique. Explain why the patient needs to swallow the barium sulfate.

.....  
.....  
.....  
.....  
.....  
.....

(2)

(Total 7 marks)

**Q2.**A diagnostic X-ray tube produces a beam of X-rays. The beam passes through a diaphragm consisting of two pairs of lead sheets which can be moved at right angles to each other, and then through an aluminium filter.

(a) (i) State the use of the lead sheets.

.....  
.....

(1)

(ii) State the use of the aluminium filter.

.....  
.....

(1)

- (b) When a monochromatic beam of X-ray photons is passed through an aluminium sheet of thickness 2.7 mm, its intensity is reduced by 8.3%.

Calculate the mass attenuation coefficient of aluminium for these X-rays.

State an appropriate unit for your answer.

$$\text{density of aluminium} = 2700 \text{ kg m}^{-3}$$

mass attenuation coefficient ..... unit .....

(5)  
(Total 7 marks)

- Q3.** (a) When an X-ray image is obtained of certain organs, *image contrast enhancement* is necessary. Explain why image contrast enhancement is needed and describe how this might be achieved.

.....  
.....  
.....  
.....  
.....

(3)

- (b) A monochromatic X-ray beam of intensity  $3.2 \times 10^{-2} \text{ W m}^{-2}$  is incident on an aluminium sheet. Calculate the thickness of aluminium required to reduce the intensity of the X-ray beam to  $1.2 \times 10^{-2} \text{ W m}^{-2}$ .

$$\text{mass attenuation coefficient of aluminium, } \mu_m = 0.012 \text{ m}^2 \text{ kg}^{-1}$$

$$\text{density of aluminium, } \rho = 2700 \text{ kg m}^{-3}$$

.....

.....

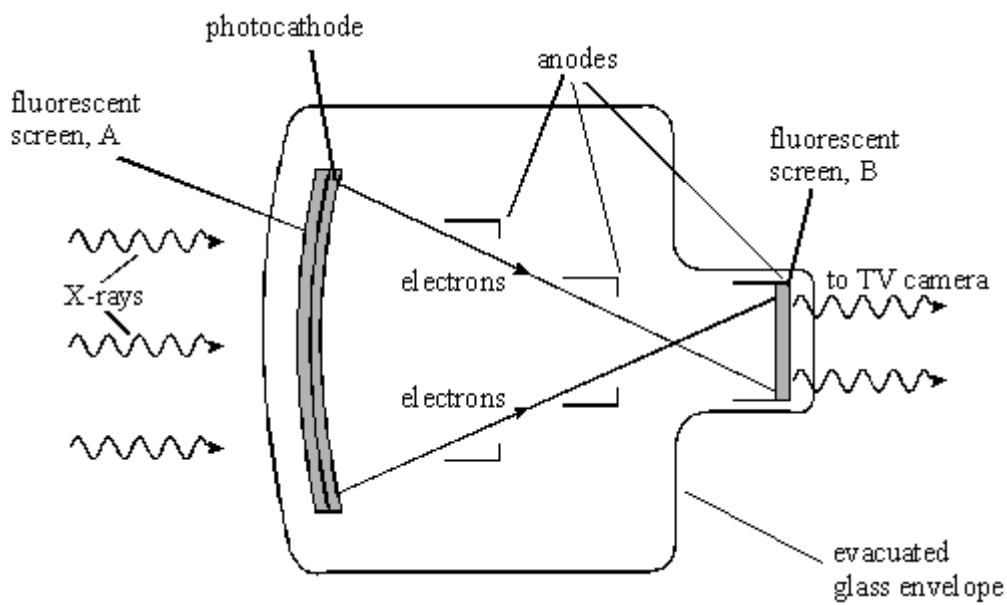
.....

.....

.....

(3)  
(Total 6 marks)

**Q4.** The diagram shows a fluoroscopic image intensifier.



- (a) State the purpose of:
- (i) the fluorescent screen, A,

.....

.....

- (ii) the photocathode,

.....

.....

(iii) the anodes,

.....  
.....

(iv) the fluorescent screen, B.

.....  
.....

(4)

(b) Give **one** example of a medical application for which an image intensifier might be used. Explain why the use of an image intensifier is required.

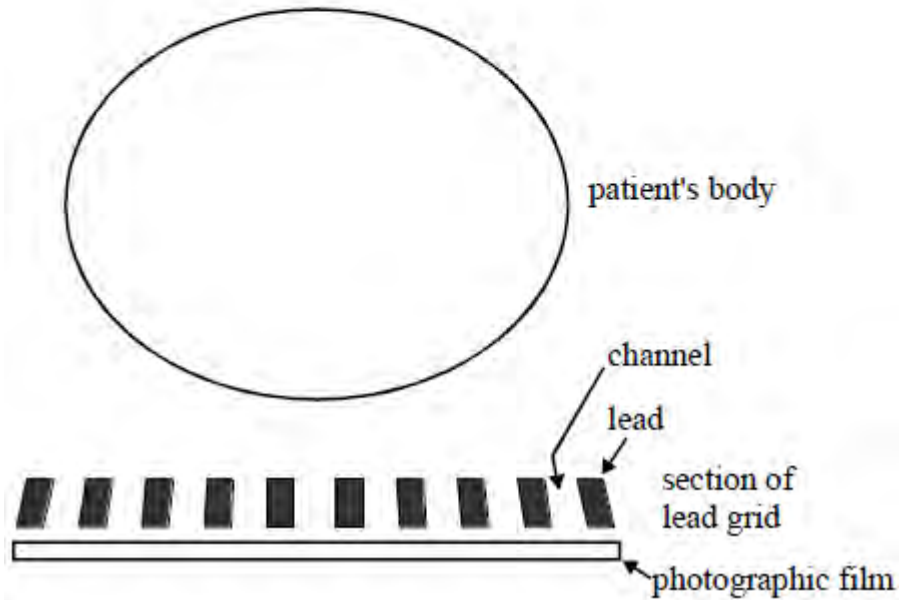
.....  
.....  
.....  
.....  
.....

(2)

(Total 6 marks)

**Q5.**When using an X-ray source to produce an image of part of a patient a lead grid is sometimes placed between the patient and the photographic film, as shown in the diagram. The channels in the grid diverge from the X-ray source.

\* X-Ray source



(a) (i) Why is the grid made of lead? .....

.....

(ii) By drawing the paths of about 10 rays from the X-ray source to illustrate your answer, explain how the use of the grid improves the clarity of the X-ray image.

.....

.....

.....

.....

(5)

(b) Explain why it is important to use a *point source* of X-rays for imaging purposes.

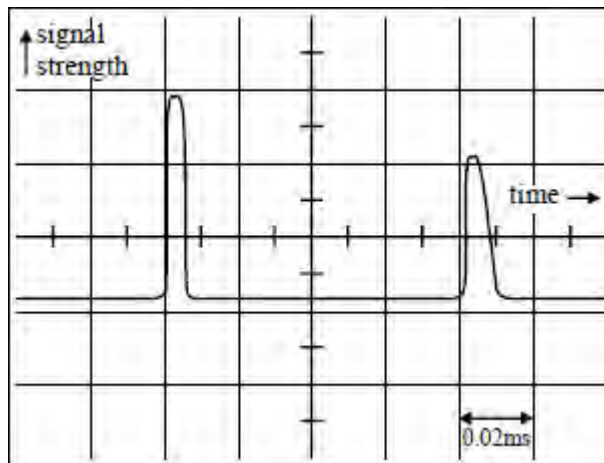
.....

.....

.....

.....

**Q6.**An ultrasound transducer is used to obtain an A-scan of an internal organ. The A-scan pulses shown on the diagram were identified as coming from the front and rear surfaces of the organ.



- (a) Describe the practical process, including details of the use of the transducer and the adjustment of the oscilloscope, required to produce this A-scan.

.....  
.....  
.....  
.....  
.....

(3)

- (b) From the A-scan, estimate
- (i) the thickness of the organ if the speed of ultrasound in the tissue is  $1500 \text{ m s}^{-1}$  (the horizontal scale is  $0.02 \text{ ms/cm}$ ),

.....  
.....

.....

(ii) the duration of the first ultrasound pulse.

.....

**(3)**

(c) Give **two** reasons why the height of the second pulse is smaller than that of the first pulse.

.....  
.....  
.....  
.....

**(2)**

**(Total 8 marks)**