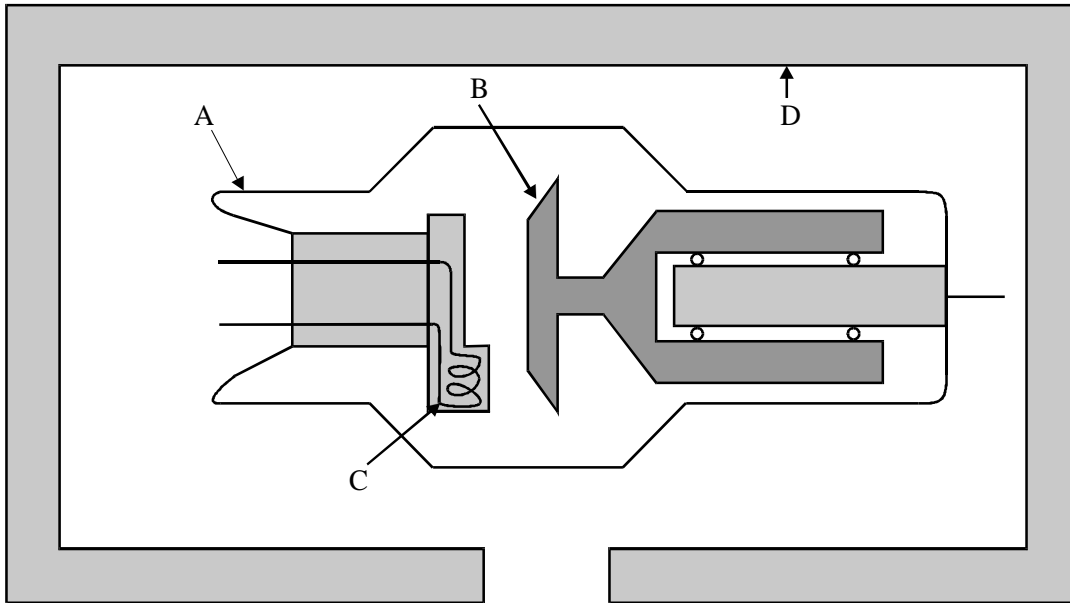


X-rays - Medical Physics Option

1. The simplified diagram shows a modern X-ray tube.



(a) For each of the labelled parts, state what it is and explain its purpose.

A name

purpose

.....

B name

purpose

.....

C name

purpose

.....

D name

purpose

.....

(8)

(b) On the diagram draw and label

(i) the direction of the electron beam,

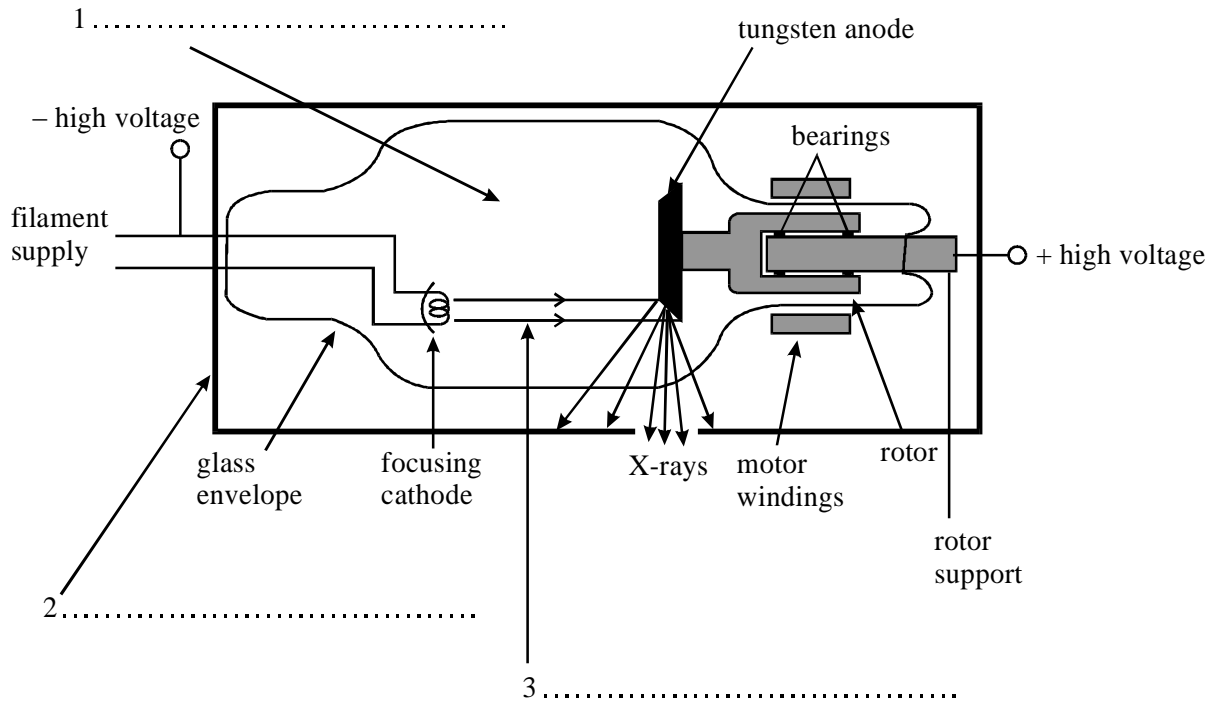
(ii) the direction of the useful X-ray beam.

(2)

(Total 10 marks)

X-rays - Medical Physics Option

2. (a) The diagram shows a rotating-anode X-ray tube. Complete the labelling of the **three** numbered arrows in the diagram.



(3)

- (b) Explain why the anode

- (i) is rotated,

.....

- (ii) has a bevelled edge.

.....

(3)

- (c) Define for a material,

- (i) the linear attenuation coefficient, μ ,

.....

X-rays - Medical Physics Option

- (ii) the half-value thickness.

.....

.....

.....

(2)

- (d) A monochromatic X-ray beam of intensity 6.0 W m^{-2} is incident on an aluminium sheet of thickness 2.0 mm . For these X-rays, the half-value thickness of aluminium is 3.2 mm . Calculate the intensity of the transmitted beam.

.....

.....

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.....

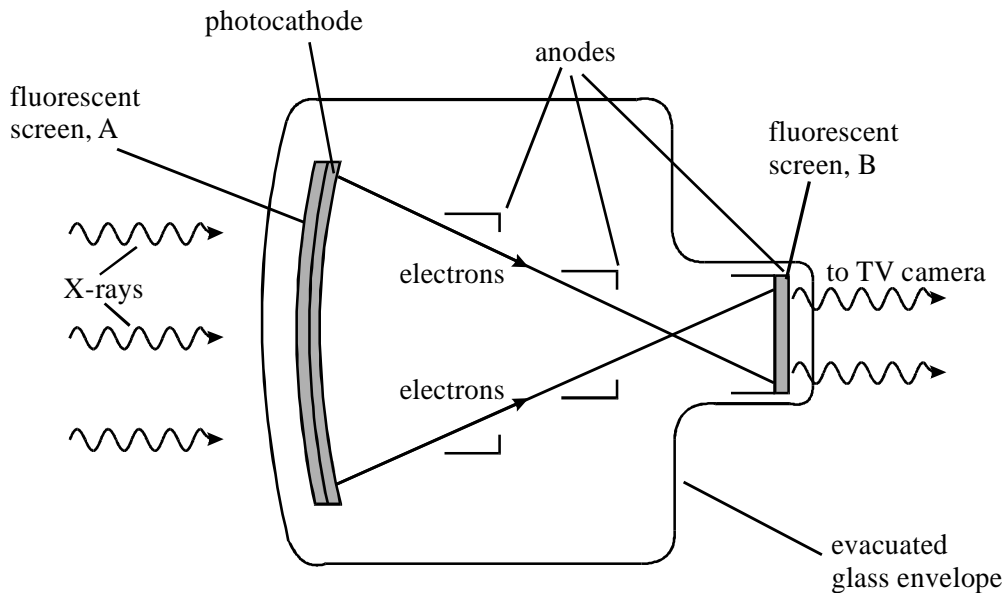
.....

.....

(3)

(Total 11 marks)

3. The diagram shows a fluoroscopic image intensifier.



- (a) State the purpose of:

- (i) the fluorescent screen, A,

.....

.....

X-rays - Medical Physics Option

(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)

4. Diagnostic X-rays are produced using a rotating anode X-ray tube.

(a) (i) State **two** methods which can be used to increase the intensity of the X-ray beam produced by the tube.

method 1

method 2

(ii) For each method of increasing intensity, state the effect on the maximum X-ray photon energy.

method 1

method 2

(3)

X-rays - Medical Physics Option

- (b) Before taking an X-ray photograph, the X-ray beam emerging from the tube is passed through an aluminium filter. State and explain the reason for filtering the X-rays.

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

(3)
(Total 6 marks)

5. (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 $1.2 \times 10^{-2} \text{ W m}^{-2}$.

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

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

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

(3)
(Total 6 marks)

X-rays - Medical Physics Option

6. In the course of diagnosis and treatment of a child's broken arm, several images of the arm are required. Similarly, to check the progress of a woman's pregnancy, several images of the foetus are required. **In each case**, state which imaging technique would probably be used and give **two** reasons for the choice.

Broken arm:

technique used

reason 1

.....

reason 2

.....

Foetus:

technique used

reason 1

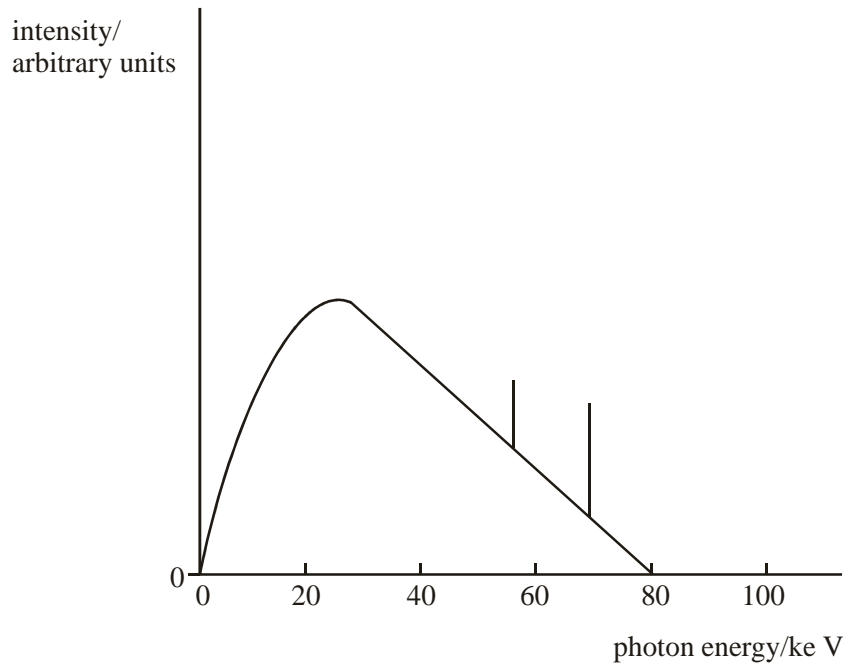
.....

reason 2

.....

(Total 4 marks)

7.



- (a) An X-ray tube operates with a pd across the tube of 80 kV. The figure above shows the X-ray spectrum emitted. Explain why the spectrum has spikes at specific photon energies.

.....

.....

.....

.....

(2)

- (b) The pd across the tube is increased to 90 kV. Sketch on the figure above the X-ray spectrum produced at this new pd.

(3)

- (c) At the working pd of 80 kV, the anode current was 120 mA. The X-ray tube has an efficiency of 0.70 %. Calculate the rate of production of heat at the anode.

.....

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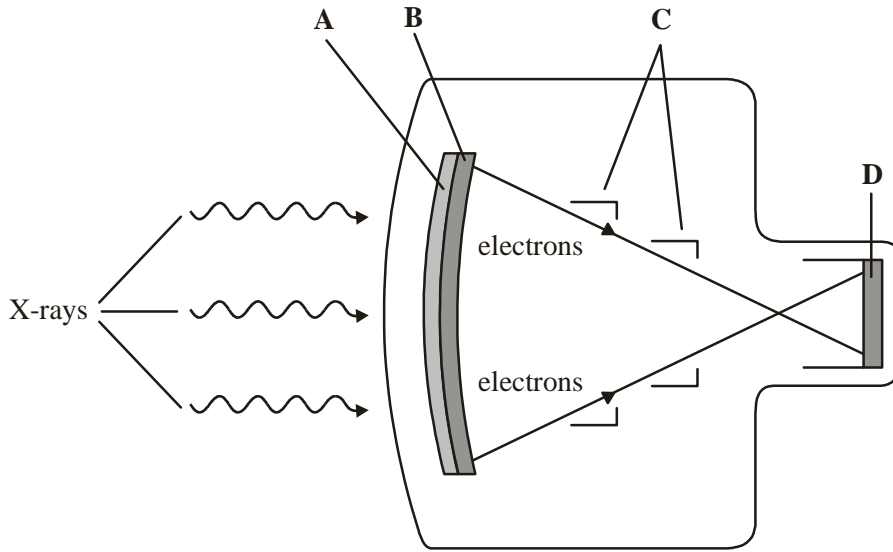
.....

(3)

(Total 8 marks)

X-rays - Medical Physics Option

8. The figure below shows the design of an X-ray image intensifier.



The main components are labelled **A** to **D**. Name each component and state its purpose in the process of image intensification.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

A.....
.....
.....

B.....
.....
.....

C.....
.....
.....

D.....
.....
.....

(Total 8 marks)