M1.(a) (i) Fluorescent screen A − converts X-ray (photon) to light (photons) / lower energy photon(s)

1

(ii) Photocathode − uses (energy of) each light photon to release an electron from surface of cathode

Do not allow converts light / photon into electron

1

(iii) Anodes − accelerate (released) electrons
focuses electron beams

Mention of negative anode disqualifies first mark awarded

Do not accept direct towards the screen as focussing

2

(iv) Fluorescent screen B − converts energy of electron(s) into (many) light (photons)

Do not allow converts electrons into light / photons

1

(b) Without Barium poor contrast between area to be investigated and surrounding tissue

This will get first mark

1

Barium meal proves high proton number / high density / high attenuation material at site to be investigated which provides much better contrast

This will gain the second mark

1

Barium meal proves high proton number / high density / high attenuation material at site to be investigated which provides much better contrast between area to be investigated and surrounding tissue

But this will get both marks

[7]

M2.(a) (i) Provide aperture through which X-rays may pass, stopping others ✓

Alternatives: provides collimation; produces narrow beam of X-rays; protects areas of the body not being scanned

1

(ii) Filters out (most) low energy photons (but allows high energy photons to pass through) ✓

Allow 'soft' or underpower' for low energy
Allow only high energy photons pass through

1

(b) $I / I_0 = 0.917$ ✓
$\ln (0.917) = -\mu \times 2.7 \times 10^{-3}$ ✓
$\mu = 32.1$ ✓
$\mu_m = \mu / 2700 = 0.012$ ✓
$m^2 kg^{-1}$ ✓

If 0.083 or 91.7 used, final 3 calc marks can be given
If 0.83 or 8.3 or 9.17 used, final 2 calc marks can be given
Unit mark is independent mark

5

[7]

M3. (a) for clear image need large difference in densities between part being investigated and parts around it **(1)**
when this is not natural, add material to part under investigation **(1)**
which has high density to provide good attenuation of X-rays **(1)**
barium meal use barium sulphate **(1)**

max 3

(b) μ (= $\rho\mu$m) = 2700 – 0.012 = 32.4 **(1)**

(use of $I = I_0 e^{-\mu x}$ gives) $1.2 \times 10^{-2} = 3.2 \times 10^{-2} \times e^{-32.4x}$ **(1)**

(allow C.E. for value of μ)

x = 0.03(0) m **(1)**

3

[6]

M4. (a) (i) converts X rays to visible photons **(1)**

(ii) converts photons to emission of electrons **(1)**

(iii) increases kinetic energy of electrons travelling from cathode to anode **(1)**
focuses rays of electrons to produce faithful image **(1)**

(iv) converts (increased) electron <u>energy</u> into light photons

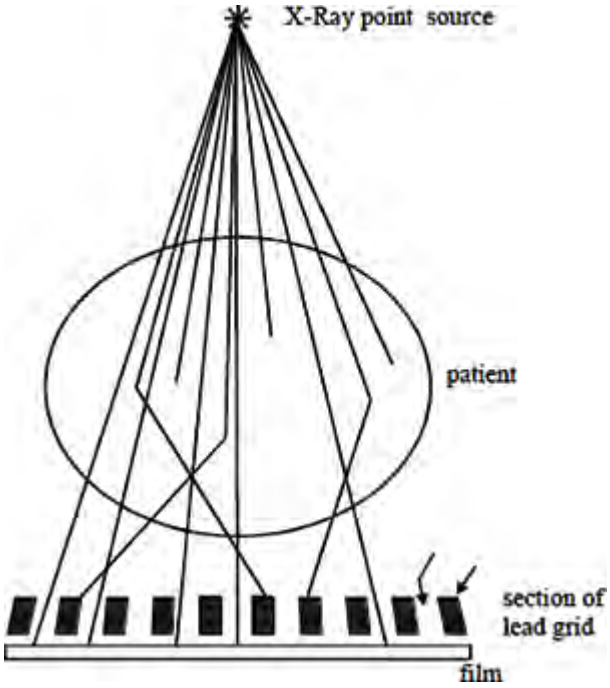
max 4

(b) dynamic process such as fluid flow **(1)**
cuts radiation dose whilst still providing good image
[or allows multiple or continuous use of X ray] **(1)**

2

[6]

M5.(a) (i) lead absorbs X-rays very well **(1)**



(ii) straight through tracks **(1)**
scattered tracks absorbed by lead **(1)**
some X-rays absorbed by patient **(1)**
clarity lost if scattered rays reach film, darkening image in random places **(1)**

lead grid allows through to film only those rays which are not scattered **(1)**
image intensity distribution represents accurately the body structure through which the radiation has passed **(1)**
grid moved systematically to prevent it forming image on film

(max 5)

(b) point source gives a sharp (shadow) image
[or point source produces no penumbra (grey fading at shadow edges) **(1)**

(1)

[6]

M6.(a) surface of body covered with an oil to improve transmission

from ultrasound transducer to body **(1)**

short ultrasound pulses sent into the body and echoes received

from surfaces detected by the transducer **(1)**

oscilloscope sweep time synchronised with the ultrasound pulse frequency **(1)**

(3)

(b) (i) thickness = $\frac{1}{2} v \Delta t$ **(1)** = $\frac{1}{2}$ × 1500 × 0.08 × 10^{-3} (m) **(1)**

= 0.06 m **(1)**

(ii) pulse duration = 0.3 × 0.02 = 0.006 m s **(1)**

(max 3)

(c) extra distance in tissue results in more signal absorption *

smaller fraction of signal reflected at second surface *

pulse more spread over time *

signal is diffracted *

* any two **(1) (1)**

(2)

[8]