

X-RAYS

1. (a) Minimizing energy lost due to collisions; (1mk)
 (b) Hard Soft
 1. Highly penetrative /Energy Low penetrative /Energy
 2. Short wavelength Long wavelength
 3. High frequency Low frequency
 4. Produced at high voltage produced at low voltage
 Any one x 3 = (3mks)

2. Lead. 1
 Lead shields will stop the travel of X-rays. 1
 X rays are dangerous/ hazardous. 1

3. (a) Rays originating from target. 1
 Rays directed out of window. 1
 (b) Cathode 1
 (c) >10,000V (10kV) 1
 (d) Electrons are boiled/ given off 1
 Attracted/ accelerated towards anode 1
 (e) Anode becomes warm/ hot 1
 due to energy absorbed from electrons. 1
 (f) Electrons would bump into / ionise/ excite gas molecules 1
 Fewer electrons would reach the anode
 Or
 The electrons have not enough energy to make X-rays 1
 (g) Lead. 1
 Lead shields will stop the travel of X-rays. 1
 X rays are dangerous/ hazardous. 1
TOTAL / 13

4. Appropriate voltage:
 kilovolt range [Not keV] (1) 1
 Anode rotated:
 so heat spread out/not just one point (1) 1
 Tube evacuated:
 So no collisions/obstruction/scattering of electrons with air molecules
 OR by atoms/particles OR equivalent (1) 1
 Appropriate material:
 Lead (1) 1

[4]

5. (i) thermionic emission; 1
 (ii) A description to include three from:
 1. heat in filament (releases electrons);
 2. reference to 50 kV supply;
 3. KE (due to electric field);

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|-------|---|---|
| | 4. wave energy/energy of X-rays/heat; | 3 |
| (iii) | (50 kV) power supply;
[Reject heater filament] | 1 |