5.

a. **List the characteristics which make a material suitable for use as a phantom. Provide examples of materials commonly used in clinical practice.**

b. **With the aid of a diagram, outline the design principles and characteristics of a practical thimble ionisation chamber used with MV photon beams.**

c. **Briefly describe the procedure for absolute calibration of a clinical 6MV photon beam. Identify how the dose per monitor unit is determined for the reference conditions described. Include in your answer a description of equipment and diagram of setup.**

a) Phantoms are used to estimated dose distribution in patients treated with radiation.
Majority of the human body is made out of water. Hence water phantoms or water equivalent phantoms are used.
Anthropomorphic phantoms which match attenuation and scatter properties of human tissues, but also mimic external and internal contours of patients are also used.
This is too long and not directed at the Q. You could spread these explanations into what goes below and get many more marks. The presentation of your knowledge has to be directed. It is not just a matter of putting as many facts about phantoms on the page as possible and then leaving it up to me to decide if you pass – because I will say 'no'! Why? because regurgitation of AmuchAP from a text book, passes the textbook. As an examiner I want to see understanding and how your knowledge has been built.
Characteristics which would make a material suitable as a phantom include:

- Should closely approximate the radiation absorption and scattering properties of tissue, and since the scattering tissues of the soft tissues very closely reflect the scattering properties of water, phantom materials should be "water-equivalent"
- Universally available& cheap
- Reproducible radiation properties
- Should not damage radiation measuring devices or be damaged by radiation
- Cheap

~~Phantoms~~ MATERIALS (RTQ!) in clinical use:

- Water
- Lucite
- Polystyrene
- Anthropomorphic phantoms (this is not a material!)
- Solid water

b) When an x-ray beam passes through air, it causes electrons to be produced by photoelectric effect, Compton effect and pair production.
These electrons produce ionization (electrons don't produce ionisation, Ionisation is the process of liberating electrons to produce ions). If you have an electric field applied across 2 plates, this would cause positive charges to move to the negative plate and negative charges to move to the positive plate. This produces a current and it can be measured.
The thimble chamber is a condensed ionization chamber using the above concept. A potential difference (usually afew hundred volts) is maintained between the central cathode and cap. Radiation falls on the chamber, causes ionization, an ionization current will flow, and this is measure.
(would include cross section diagram of thimble chamber)

A thimble chamber will give an accurate measurement, provided

- walls made of material with same atomic number as air (why??)
- the wall has a thickness greater than the range of secondary electrons produced in the material (why??)

Hence for MV photons, the chamber wall needs to be of **appropriate thickness** (this term requires some discussion. You wouldn't be suggesting using an INAPPROPRIATE thickness would you? This is called a *motherhood statement*. It is right but it is non-specific and does not portray that you have any real understanding of the concept, in fact it is a statement that does not permit you to be wrong – hence it can't permit you to be right either. If you said "The chamber wall thickness for MV photons needs to be more than 1.5cm to maintain electronic equilibrium, I would have a better chance of giving you a mark depending on whether the actual thickness is 1.0, 1.4, 1.5, 1.9 or

2.1cm. But then you also would run the risk of a failure!) to maintain electronic equilibrium. (In addition this is a repetition and therefore a waste of time.)

c) Water phantom (usually 40 x 40cm cube) is setup at source to surface depth (SSD) 100cm
A waterproofed ion chamber (thimble chamber) would be placed in the water phantom at central axis
Temperature, pressure and humidity measured for calibration of ion chamber
Dose delivered to water phantom with ion chamber at various depths (typical depths are 10cm and 20cm)
(would include PDD curve showing reading at 10 and 20cm)
Field size of 10 x 10cm usually used.
A set number of monitor units used (Eg 200MU) and dose measured by the ion chamber in the water phantom is collected. Dose delivered per monitor unit can then be calculated.