

**Mark scheme for Support Worksheet – Option I,
Worksheet 2**

- 1 $Z = \rho c = 1.04 \times 10^3 \times 1560 = 1.62 \times 10^6 \text{ kg m}^{-2} \text{ s}^{-1}$ [1]
- 2 a Similar impedances: $Z_1 \approx Z_2$ and so $R = \left(\frac{Z_1 - Z_2}{Z_1 + Z_2} \right)^2 \approx 0$ [1]
- b Very different impedances: $Z_1 \gg Z_2$ and so $R = \left(\frac{Z_1 - Z_2}{Z_1 + Z_2} \right)^2 \approx \left(\frac{Z_1}{Z_1} \right)^2 \approx 1$ [1]
- 3 The density of the brain is fairly uniform and so the impedance throughout the brain is roughly the same so the ultrasound cannot distinguish any features. [1]
- 4 The wavelength is $\lambda = \frac{c}{f} = \frac{1560}{2.0 \times 10^6} = 7.8 \times 10^{-4} \text{ m}$ or about 0.8 mm; the ultrasound cannot distinguish anything below a wavelength and so this is the limit of resolution. [2]
- 5 A very thin laser beam can be focused on a tiny spot making very precise surgery possible/there is a quicker and less painful recovery time for the patient. [1]
- 6 a Exposure is the amount of positive charge per unit mass created as a result of ionisation. [1]
- b Absorbed dose is the energy deposited per unit mass. [1]
- c The quality factor is a numerical factor that is a measure of the damage done by different radiations of the same energy. [1]
- d The absorbed dose multiplied by the quality factor. [1]
- 7 Physical half-life is the time to reduce the activity of radioactive material by a factor of 2 by the process of radioactive decay; biological half-life is the time to reduce the activity of radioactive material by a factor of 2 by eliminating the material from the body of a patient by biological processes. [2]
- 8 $\frac{1}{T} = \frac{1}{2} + \frac{1}{12}$; hence $T = 1.7$ days [2]
- 9 Energy released in 1 second is $380 \times 10^6 \times 140 \times 10^3 \times 1.6 \times 10^{-19} = 8.51 \times 10^{-6} \text{ J}$; energy released in 6 hrs is $6 \times 3600 \times 8.51 \times 10^{-6} = 0.184 \text{ J}$; absorbed dose is then $\frac{0.184}{72} = 0.026 \text{ Gy}$; and the does equivalent is 0.026 Sv since the quality factor is 1. [4]