

State Examination Commission – Physics Higher Level, 2010

Question 11

Read the following passage and answer the accompanying questions.

A person's exposure to radiation when using a mobile phone is measured in terms of the Specific Absorption Rate (SAR). This is a measure of the rate at which radio frequency energy is absorbed by a person's body during a phone call and is expressed in watts per kilogram. A radio frequency wave penetrates the body to a depth that depends on its frequency. At mobile phone frequencies the wave energy is absorbed by about one centimetre of body tissue. The energy absorbed is converted into heat and is carried away by the body. Any adverse health effects from radio frequency waves are due to heating. Current scientific evidence indicates that exposure to radiation from mobile phones is unlikely to induce cancer.

(Adapted from a Dept. of Communications, Energy and Natural Resources Press Release of 22 March 2007.)

- (a) Give two properties of radio waves. (7)
- (b) In a three-minute phone call, 10 g of head tissue absorbs 0.36 J of radio frequency energy. Calculate the SAR value. (7)
- (c) What happens to the radio frequency energy absorbed by the body? (7)
- (d) Why are radio frequency waves not very penetrating? (7)
- (e) A mobile phone converts the received radio frequency waves to sound waves. What are the audible frequency limits for sound waves? (7)
- (f) Give two safety precautions you should take when using a mobile phone. (7)
- (g) A mobile phone transmits at 1200 MHz from its antenna. Calculate the length of its antenna, which is one quarter of the wavelength that it transmits. (7)
- (h) Name an electromagnetic wave which may induce cancer. Justify your answer. (7)
- (speed of light = 3.0×10^8 m s⁻¹)

-
- (a) Give two properties of radio waves. (7)

They can be reflected and refracted and travel at speed of light in vacuum.

- (b) In a three-minute phone call, 10 g of head tissue absorbs 0.36 J of radio frequency energy. Calculate the SAR value. (7)

$$0.36 \text{ J absorbed by } 0.01 \text{ kg in } 3 \text{ min} \equiv 0.36 / (0.01 \times 180) \text{ J kg}^{-1} \text{ s}^{-1} \equiv 0.2 \text{ W kg}^{-1}$$

- (c) What happens to the radio frequency energy absorbed by the body? (7)

It warms the bodies tissues and is dissipated by the bodies circulatory system

- (d) Why are radio frequency waves not very penetrating? (7)

They are low energy electromagnetic waves

- (e) A mobile phone converts the received radio frequency waves to sound waves. What are the audible frequency limits for sound waves? (7)

Approximately 20 – 20,000 Hz

- (f) Give two safety precautions you should take when using a mobile phone. (7)

Use briefly. Communicate by text preferably. Use "hands-free" mic and headphones set.

- (g) A mobile phone transmits at 1200 MHz from its antenna. Calculate the length of its antenna, which is one quarter of the wavelength that it transmits. (7)

$$\lambda = c/f = 3.0 \times 10^8 / 1.2 \times 10^9 = 0.25 \text{ m} \Rightarrow \text{length} = 0.0625 \text{ m}$$

- (h) Name an electromagnetic wave which may induce cancer. Justify your answer. (7)

γ -rays: Highly penetrating and can ionize molecules (including dna) within cells