

Question 22 (Answer: **D**)

- The electromagnetic spectrum runs from long-wavelength radio to short-wavelength gamma.
- Ultraviolet lies beyond violet and infrared lies beyond red, so ultraviolet has the shorter wavelength.
- Shorter wavelength means higher frequency, since c is the same for both.

Question 22 (Answer: **D**)

- In a vacuum *every* electromagnetic wave travels at the same speed, 3.0×10^8 m/s.
- So microwaves cannot travel faster than visible light.
- What differs is wavelength and frequency: X-rays have the shortest wavelength of the three and microwaves the longest.

5(a)(i)	all four correct = 2 marks; any two correct = 1 mark <table><tr><td>security marking</td><td></td><td>gamma rays</td></tr><tr><td>Bluetooth</td><td></td><td>ultraviolet</td></tr><tr><td>optical fibres</td><td></td><td>infrared</td></tr><tr><td>detection of cancer</td><td></td><td>radio waves</td></tr></table>	security marking		gamma rays	Bluetooth		ultraviolet	optical fibres		infrared	detection of cancer		radio waves
security marking		gamma rays											
Bluetooth		ultraviolet											
optical fibres		infrared											
detection of cancer		radio waves											
5(a)(ii)	any one from: • only require a short aerial / antenna • can pass through the atmosphere / ionosphere to satellites • can transmit large amounts of data at high speeds / high rate of data transmission												
5(b)	any two from: transverse: • oscillations / vibrations are at right angles to direction of propagation • medium not required / can travel through a vacuum (for e-m wave) • have crests / peaks and troughs longitudinal: • oscillations / vibrations are parallel to direction of propagation • medium is required • have rarefactions and compressions												
5(c)(i)	longitudinal												
5(c)(ii)	refraction any one from: • change in speed of the wave • change in density of the medium												
5(d)	<u>increase</u> in carbon dioxide / greenhouse gases (in the atmosphere) OR <u>increase</u> in methane / water vapour (in the atmosphere) any one from: prevents / reduces (re-emitted) radiation escaping (into space) OR radiation re-emitted / reflected back to surface (by atmosphere / greenhouse gases) OR (amount of) radiation absorbed is greater than (the amount of) radiation leaving the atmosphere												

Question 22 (Answer: **D**)

- A satellite that stays above the same point on Earth is in geostationary orbit.
- That lets a fixed dish stay pointed at it.
- The signals used are microwaves, which pass easily through the atmosphere.

Question 21 (Answer: **C**)

- Fake banknotes are detected by markings that glow under ultraviolet light.
- Ultraviolet causes fluorescence in certain inks.
- Radio and microwaves have far too long a wavelength, and X-rays are used for looking *through* objects.

Question 22 (Answer: **C**)

- $\lambda = v/f$, and radio waves travel at 3.0×10^8 m/s.
- $f = 200$ kHz = 2.0×10^5 Hz.
- $\lambda = 3.0 \times 10^8 / 2.0 \times 10^5 = 1.5 \times 10^3$ m.

Question 21 (Answer: **D**)

- $f = c/\lambda$, with $c = 3.0 \times 10^8$ m/s.
- The *longest* wavelength gives the *lowest* frequency: $3.0 \times 10^8 / 7.0 \times 10^{-7} = 4.3 \times 10^{14}$ Hz.
- The shortest gives the highest: $3.0 \times 10^8 / 4.0 \times 10^{-7} = 7.5 \times 10^{14}$ Hz.

6(a)	(wavelength =) 0.16m
	$v = f\lambda$ OR $(\lambda =) v/f$ OR $(\lambda =) 3 \times 10^8 / 1.9 \times 10^9$
6(b)	(microwaves) only need short aerials / antennas
	(microwaves) penetrate (some) walls
6(c)(i)	labelled diagram of digital (signal) with blocks of high (1) and low (0) AND labelled diagram of analogue with continuously variable signal
	digital (signal) consists of <u>two</u> values owtte
	analogue (signal) varies over a range (of values) owtte
6(c)(ii)	any two from: • faster (data) transmission rate OR data can be compressed • data / signal transmitted over long(er) distances (as signal can be regenerated) • noise easily removed (from signal / data) OR signal can be regenerated