

- 2.4 The speed of the light ray changes least in water [1 mark].
Water has the largest angle of refraction [1 mark], so has bent the light the least (so has slowed the light down the least) [1 mark].
- 2.5 The material of the container will also refract light [1 mark].
The thinner the walls of the container, the less this will affect the results [1 mark].

Page 77 — Radio Waves

Warm-up

True, True, False, True.

- 1 How to grade your answer:
Level 0: There is no relevant information. [No marks]
Level 1: A simple method of generating radio waves is described. [1 to 2 marks]
Level 2: A method of generating radio waves and how these waves generate an electrical signal in a distant TV aerial is described. [3 to 4 marks]
Here are some points your answer may include:
An alternating current flows in the circuit the transmitter is connected to.
Alternating currents are made up of oscillating charges/electrons.
As the electrons oscillate in the transmitter, they produce oscillating electric and magnetic fields/radio waves.
Radio waves are transmitted to and then absorbed by the distant TV aerial.
The energy carried by the waves is transferred to the electrons in the material of the receiver.
This causes electrons in the receiver aerial to oscillate.
This generates an alternating current/an electrical signal.
This alternating current has the same frequency as the original current used to generate the radio wave.
- 2 How to grade your answer:
Level 0: There is no relevant information. [No marks]
Level 1: There is a brief explanation of the differences between radio wave types used for broadcasting [1 to 2 marks]
Level 2: There is some explanation of the differences between radio wave types used for broadcasting, including their different ranges and how this affects which broadcast can be heard. [3 to 4 marks]
Level 3: There is a clear and detailed explanation of the differences between radio wave types used for broadcasting, including their different ranges and how this affects which broadcast can be heard. [5 to 6 marks]
Here are some points your answer may include:
FM radio is transmitted using very short wavelength radio waves.
These radio waves can only be received while the receiver is in direct sight of the transmitter.
This is because these wavelengths are easily absorbed by obstacles, e.g. buildings, and cannot diffract.
Therefore, the signal cannot be received in France.
Long-wave radio waves can be transmitted over long distances.
This is because long-wave radio waves diffract around the curved surface of the Earth.
Long-wave radio waves can also diffract around obstacles such as mountains.
Hence the signal can be received in France.

Page 78 — EM Waves and Their Uses

- 1.1 The microwaves are absorbed by water molecules in the potato [1 mark]. This transfers energy to the water molecules, causing the water in the potato to heat up [1 mark]. The water molecules transfer the energy they have absorbed to the rest of the molecules in the potato, cooking it [1 mark].
- 1.2 The glass plate does not absorb any microwaves [1 mark] as it does not contain any water molecules, and so it does not heat up [1 mark].
- 1.3 infrared [1 mark]
- 1.4 Satellites are located above the atmosphere [1 mark]. The atmosphere contains water molecules [1 mark]. The microwaves used in microwave ovens could not reach satellites as they would be absorbed by water molecules in the atmosphere [1 mark]. Different wavelengths which are not absorbed by the atmosphere must be used to communicate with satellites [1 mark].
- 2 It is dark so there is very little visible light for a normal camera to pick up [1 mark]. The person trying to hide is warmer than the surroundings and so emits more infrared radiation [1 mark]. This makes the person stand out from the surroundings if observed through infrared radiation [1 mark].

Page 79 — More Uses of EM Waves

Warm-up

UV Rays: A, C, D

Visible Light: B

X-rays: E, F

Gamma Rays: F

- 1.1 E.g. the patient is injected with a gamma-emitting source [1 mark]. Gamma radiation is detected outside of the body; which is used to follow the source's progress around the patient's body [1 mark].
- 1.2 E.g. they can pass out of the patient's body / they can be detected outside of the patient's body [1 mark].
- 1.3 X-rays are directed at the patient. The X-rays are absorbed by bones [1 mark], but transmitted by less dense body material, such as flesh [1 mark]. A screen behind the patient detects the X-rays and a negative image is formed with brighter areas where fewer X-rays are detected [1 mark].
- 1.4 E.g. wear lead aprons / stand behind lead screens / leave the room whilst treatment is taking place [1 mark].

Page 80 — Dangers of Electromagnetic Waves

- 1.1 X-rays and gamma rays transfer so much energy to living cells that they can knock off electrons (ionise atoms) [1 mark]. This can cause mutation of genes, leading to cancer [1 mark].
- 1.2 Any two from: sunburn / premature aging / blindness / (increased risk of) skin cancer [2 marks]
- 2.1 Compare risk of chest scan to risk of head scan,
 $10\,000 \div 2500 = 4$
Risk is 4 times greater, so dose is 4 times greater [1 mark].
Dose = $2 \times 4 = 8\text{ mSv}$ [1 mark]