3. Waves

3.3 Electromagnetic spectrum

Paper 3 and 4

Answer Key

Paper 3

Q1.

(c)(i)	radio waves **OR** microwaves **OR** infrared	**B1**
(c)(ii)	security marking **OR** detecting forged bank notes **OR** sterilising food / water	**B1**
(c)(iii)	(both have) same speed owtte	**B1**

Q2.

Question	Answer	Marks
(a)	microwaves (after radio waves)	**B1**
	X-rays (after ultraviolet)	**B1**
(b)	(use of infrared) any **one** from: electric grills, short range communications such as remote controllers for televisions, intruder alarms, thermal imaging, optical fibres, (heating) solar panels	**B1**
	(use of ultraviolet) any **one** from: security marking, detecting fake bank notes, sterilising water / food	**B1**
(c)	(infrared can cause) (skin) burns	**B1**
	(ultraviolet can cause) damage to (surface / skin) cells / eyes OR skin cancer OR can cause eye conditions e.g. cataracts	**B1**

Q3.

(b)	infrared (rays / waves) **OR** microwaves **OR** radio (waves)	**B1**
(c)(i)	any **one** from: • sterilising food / water • sterilising (medical) equipment • detection of cancer • treatment of cancer • space telescopes	**B1**
(c)(ii)	mutation (of cells / DNA) **OR** damage to cells / DNA	**B1**

Q4.

(d)(i)	gamma / γ (rays) on lhs	**B1**
	ultraviolet / uv (rays) between X rays and visible	**B1**
(d)(ii)	the same (speed)	**B1**
(e)(i)	infrared	**B1**
(e)(ii)	microwaves	**B1**

Q5.

Question	Answer	Marks
(a)(i)	(1st box) microwaves	**B1**
	(2nd box) infrared	**B1**
(a)(ii)	X-rays OR gamma rays	**B1**

(c)	microwaves	**B1**
	X-rays	**B1**

Q6.

(c)(i)	(The speed of visible light is) same (as) (the speed of X-rays.)	**B1**
	(The frequency of visible light is) lower OR smaller (than the frequency of X-rays)	**B1**
(c)(ii)	example of medical / security imaging or treatment of cancer	**B1**

Q7.

Question	Answer	Marks
(a)	any 6 correct colours from: red, orange, yellow, green, blue, indigo, violet	**M1**
	candidate's colours in correct order	**A1**
(b)(i)	refraction	**B1**
(b)(ii)	dispersion	**B1**
(c)	infrared (rays/waves) (are used in tv remote controllers)	**B1**
	gamma (rays/waves) (have the highest frequencies in em spectrum)	**B1**

Q8.

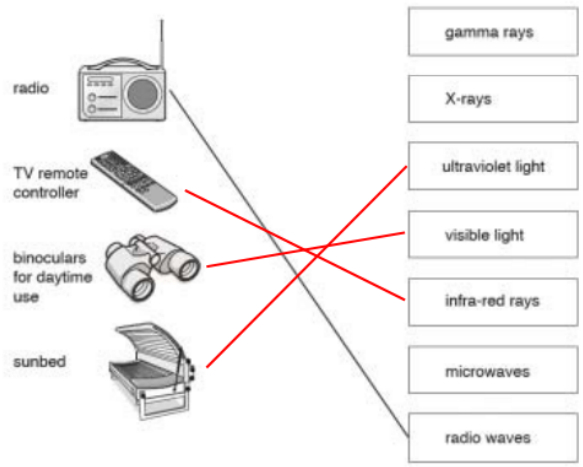
Question	Answer	Marks
(a)(i)	(1st box/next to visible) ultraviolet (rays)	**B1**
	(2nd box/next to gamma) X-rays	**B1**
(a)(ii)	detection and treatment of cancer OR imaging/gamma photography OR (space) telescopes OR sterilisation of food/medical equipment	**B1**
(a)(iii)	statement: (radiations arrive) at same time	**M1**
	reason: (because they have) same speed (in a vacuum)	**A1**

Q9.

Question	Answer	Marks
(a)(i)	top – visible light	**B1**
	bottom – microwaves	**B1**

Question	Answer	Marks
(a)(ii)	any **two** from: transverse wave travel at same speed do not need a medium	**B2**
(b)(i)	X-rays	**B1**
(b)(ii)	infrared	**B1**
(b)(iii)	microwaves	**B1**

Q10.

Question	Answer	Marks
(a)		B1
		B1
		B1
(b)(i)	infrared **OR** microwaves **OR** radio waves	B1
(b)(ii)	speed	B1

Q11.

Question	Answer	Marks
(a)(i)	ultraviolet (waves / radiation)	B1
(a)(ii)	wavelength	B1
(a)(iii)	(visible light and radio waves) / (they have) the same (speed)	B1
(b)(i)	**Any 2 from:** Checking bags or people or packages For hidden objects shadow / image on screen / monitor	B2
(b)(ii)	Transmission (of X-rays) through less dense materials owtte OR absorption (of X-rays) by dense materials	B2

Q12.

Question	Answer	Marks
(a)	orange yellow green blue indigo	B2
(b)(i)	detecting an intruder to infra-red	B1
	communicating by satellite to microwaves	B1
	detecting broken bones to X-rays	B1
(b)(ii)	frequency	B1

Q13.

Question	Answer	Marks
(a)(i)	X-rays between gamma rays and ultraviolet	1
	microwaves between infra-red and radio	1
(a)(ii)	ring drawn around radio on Fig.9.1	1
(b)	any **two** from: lead/metal apron (use long) tongs limit (time of) exposure point source away (from you) owtte	2

Q14.

Question	Answer	Marks
(a)(i)	microwaves	1
(a)(ii)	3.0×10^8 (m / s)	1
(a)(iii)	ultraviolet or X-rays or gamma/γ-rays	1
(b)(i)	X-rays any one from: detecting broken bones/damaged teeth or detecting/treating cancer	1
	gamma: any one from: detecting/treating cancer or sterilising (hospital) equipment/food	1
(b)(ii)	any **two** from: ionising radiations/high frequency/high energy (e-m radiation) (may) damage or mutate cells/DNA (may) cause radiation burns	2

Paper 4

Q15.

Question	Answer	Marks
(a)	use of electromagnetic radiation: Bluetooth headset; thermal imaging; photography of people's faces; sterilising medical equipment region of electromagnetic spectrum: gamma rays; radio waves; infrared; visible light all correct 2 marks 1 or 2 correct 1 mark	B2
(b)	3.0×10^8 m / s	B1
(c)(i)	0.12 m	A3
	(mid-point of frequency range identified as) 2.44 (GHz)	C1
	$v = f\lambda$ **OR** (λ =) v / f **OR** (λ =) $3.0 \times 10^8 / 2.44 \times 10^9$ **OR** (λ =) 1.2×10^N	C1
(c)(ii)	(radio waves / signal) lose energy / get weaker / lose (signal) strength (passing through walls) owtte	B1

Q16.

Question	Answer	Marks
(a)	(wavelength =) 0.16 m	A2
	$v = f\lambda$ **OR** (λ =) v / f **OR** (λ =) $3 \times 10^8 / 1.9 \times 10^9$	C1
(b)	(microwaves) only need short aerials / antennas	B1
	(microwaves) penetrate (some) walls	B1

Question	Answer	Marks
(c)(i)	labelled diagram of digital (signal) with blocks of high (1) and low (0) **AND** labelled diagram of analogue with continuously variable signal	B1
	digital (signal) consists of <u>two</u> values owtte	B1
	analogue (signal) varies over a range (of values) owtte	B1
(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	B2

Q17.

Question	Answer	Marks
(a)(i)	(J) ultraviolet (radiation) (K) infrared (radiation) (L) radio (waves)	
	two correct	**C1**
	all three correct	**A1**
(a)(ii)	L **or** radio (waves)	**B1**
(b)	(c =) 3.0×10^8 (m / s) seen	**C1**
	(f =) v / λ in any form **or** $3.0 \times 10^8 / 1.2 \times 10^{-9}$	**C1**
	2.5×10^{17} Hz	**A1**
(c)(i)	stated medical use (e.g. treating cancer / X-ray shadowgraph / sterilising equipment)	**B1**
	statement of what happens to the X-rays (e.g. absorbed by tumour / bones / bacteria)	**B1**
	stated consequence (e.g. tumour killed **or** image / picture / shadow / photograph produced)	**B1**
(c)(ii)	can cause burns / (cell) mutation / cell damage / tumours / cancer / damages DNA etc.	**B1**