Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Electromagnetic spectrum

Time allowed: 1 hour 10 minutes

Subject code **0625**

Physics

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 70

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 70 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 **(a)** Remote controllers for television sets send a beam of electromagnetic radiation to the television.

Which region of the electromagnetic spectrum is used? Tick one box.

microwaves	☐
infra-red	☐
visible	☐
ultra-violet	☐
X-rays	☐

[1]

(b) Modern warfare often uses heat-seeking missiles.

Which region of the electromagnetic spectrum is used? Tick one box.

microwaves	☐
infra-red	☐
visible	☐
ultra-violet	☐
X-rays	☐

[1]

(c) Injured legs may be checked for possible fractures using electromagnetic radiation.

Which region of the electromagnetic spectrum is used? Tick one box.

microwaves	☐
infra-red	☐
visible	☐
ultra-violet	☐
X-rays	☐

[1]

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(d) Mobile phones communicate using electromagnetic radiation.

Which region of the electromagnetic spectrum is used? Tick one box.

microwaves	☐
infra-red	☐
visible	☐
ultra-violet	☐
X-rays	☐

[1]

[Total: 4]

Electromagnetic spectrum Click for more variations

1 **(a)** infra-red B1

(b) infra-red B1

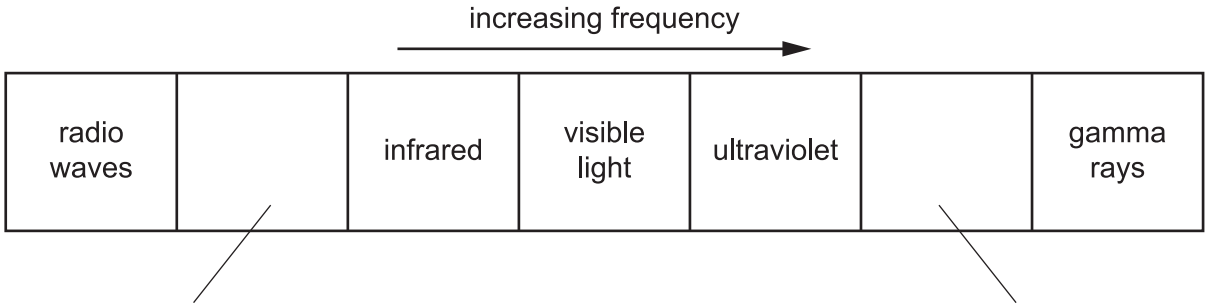
(c) X-rays B1

(d) microwaves B1

[Total: 4]

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2 Fig. 5.1 shows the main regions of the electromagnetic spectrum in order of increasing frequency.



....

Fig. 5.1

(a) Two of the regions are unlabelled.

Add the correct label to each of the unlabelled regions in Fig. 5.1. [2]

(b) State **one** use of infrared radiation and **one** use of ultraviolet radiation.

infrared radiation

.....

ultraviolet radiation

.....

[2]

(c) Describe possible harmful effects of excessive exposure to:

infrared radiation

.....

ultraviolet radiation

.....

[2]

[Total: 6]

Electromagnetic spectrum Click for more variations

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2(a)	microwaves (after radio waves)	**B1**
	X-rays (after ultraviolet)	**B1**
2(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**
2(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**

3 Fig. 7.1 shows some parts of the electromagnetic spectrum.

radio waves		infra-red waves	visible light	ultraviolet waves	X-rays	γ-rays

Fig. 7.1

(a) (i) In Fig. 7.1, one part of the electromagnetic spectrum is not labelled.

State the name of this part.

.....[1]

(ii) The speed of visible light waves in a vacuum is 3.0×10^8 m/s.

Suggest a value for the speed of infra-red waves in a vacuum.

speed = ... m/s [1]

(iii) Some parts of the electromagnetic spectrum have a wavelength shorter than that of visible light.

State one example.

.....[1]

(b) (i) X-rays and γ-rays are used in hospitals.

Describe one medical use for X-rays and one use for γ-rays.

X-rays .....

.....

γ-rays .....

.....
[2]

(ii) Explain why γ-rays are dangerous to living things.

.....

.....

.....[2]

[Total: 7]

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Electromagnetic spectrum Click for more variations

3(a)(i)	microwaves	**1**
3(a)(ii)	3.0×10^8 (m / s)	**1**
3(a)(iii)	ultraviolet or X-rays or gamma/γ-rays	**1**
3(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**
3(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**

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4 Fig. 9.1 represents the regions of the electromagnetic spectrum.

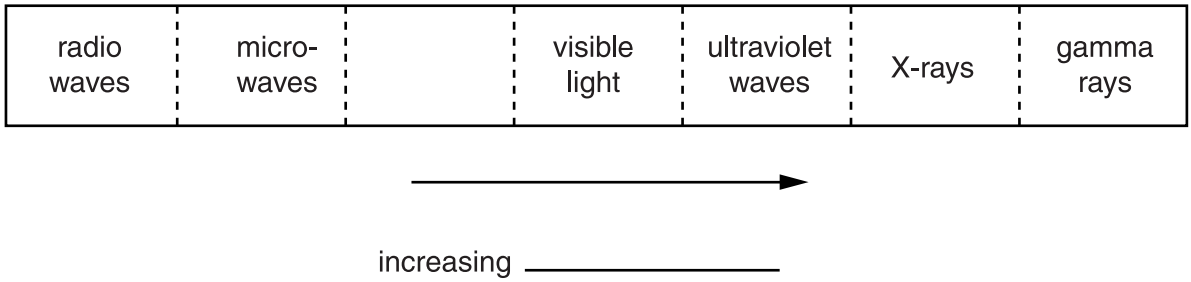


Fig. 9.1

(a) Complete Fig. 9.1:

(i) Add the label of the missing region. [1]

(ii) Complete the label under the arrow. [1]

(b) **(i)** State **two** uses of X-rays.

1. .....

2. .....

[2]

(ii) Describe **two** safety precautions taken by people using X-rays.

1. .....

2. .....

[2]

(iii) X-rays and light waves can both travel through a vacuum.

Identify the correct statement. Tick **one** box.

- ☐ X-rays travel at a slower speed than light waves.
- ☐ X-rays travel at the same speed as light waves.
- ☐ X-rays travel at a faster speed than light waves.

[1]

[Total: 7]

Electromagnetic spectrum Click for more variations

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4(a)(i)	infra-red	**B1**
4(a)(ii)	frequency	**B1**
4(b)(i)	any two different applications from: • (medical) imaging **OR** detecting fractures in bone **OR** specific example e.g. CT scan / imaging teeth at dentist • detecting faults in metal • security imaging e.g. airport security checks of bags • cancer treatment	**B2**
4(b)(ii)	any two from: • behind a screen **OR** lead apron • large distance from X-ray beam • monitoring of **OR** restricting exposure • low dosage **OR** limit exposure time • monitor frequency of x-ray sessions • other people not allowed in room when X-ray being taken • avoid when pregnant	**B2**
4(b)(iii)	same speed	**B1**
		Total: 7

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5 Fig. 7.1 shows a diagram of the main regions of the electromagnetic spectrum. Two labels are missing.

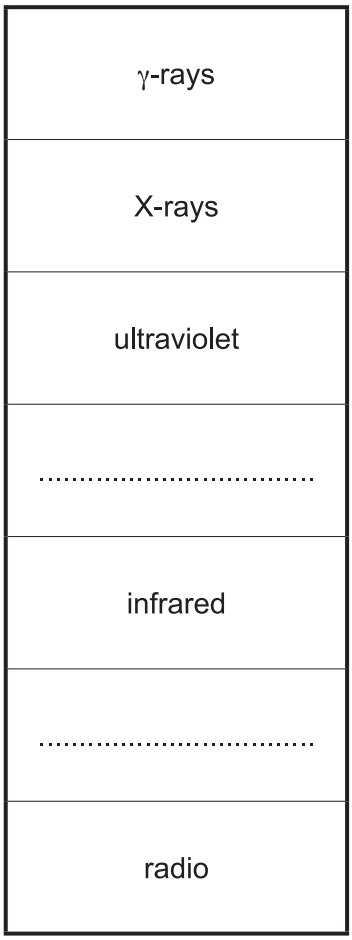


Fig. 7.1

(a) **(i)** Complete the labels on Fig. 7.1. [2]

(ii) State **two** properties that are the same for all waves in the electromagnetic spectrum.

1. .....

2. .....

[2]

(b) State which region of the electromagnetic spectrum is used in each situation.

(i) detecting objects without opening baggage at a security check

..... [1]

(ii) television remote control

..... [1]

(iii) satellite television transmissions

..... [1]

[Total: 7]

Electromagnetic spectrum Click for more variations

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5(a)(i)	top – visible light	B1
	bottom – microwaves	B1

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

6 **(a)** Both radio waves and γ-rays (gamma) are radiations in the electromagnetic spectrum. Fig. 7.1 shows the main regions of the electromagnetic spectrum. Most regions are labelled.

radio waves	microwave radiation	infrared radiation	visible light	....	....	γ-rays

Fig. 7.1

(i) On Fig. 7.1, write the names of the radiations in the other **two** parts of the electromagnetic spectrum. [2]

(ii) State **one** use of γ-rays.

..... [1]

(iii) A star emits radio waves and γ-rays at the same time. They all travel across the vacuum of space to the Earth's atmosphere.

State whether the radio waves or the γ-rays, if either, arrive first at the Earth's atmosphere. Give a reason for your answer.

statement .....

reason ..... [2]

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(b) Fig. 7.2 shows pulses of a signal from a star.

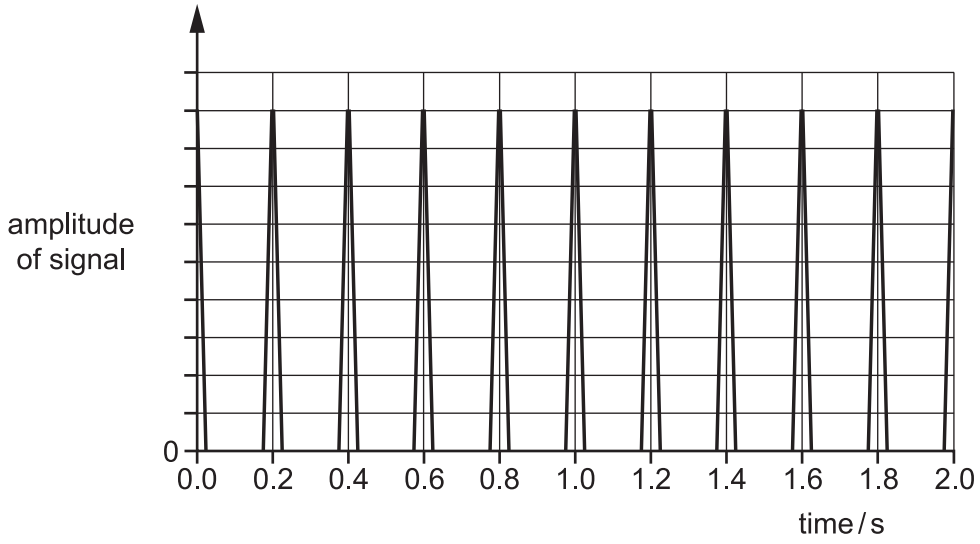


Fig. 7.2

(i) Use the graph in Fig. 7.2 to determine the time between pulses.

time between pulses = ... s [2]

(ii) Determine the frequency of the pulses in Fig. 7.2.

frequency = ... Hz [2]

[Total: 9]

Properties of waves Click for more variations

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6(a)(i)	(1st box/next to visible) ultraviolet (rays)	**B1**
	(2nd box/next to gamma) X-rays	**B1**
6(a)(ii)	detection and treatment of cancer OR imaging/gamma photography OR (space) telescopes OR sterilisation of food/medical equipment	**B1**
6(a)(iii)	statement: (radiations arrive) at same time	**M1**
	reason: (because they have) same speed (in a vacuum)	**A1**
6(b)(i)	use of peaks to find time interval	**C1**
	0.2 (s)	**A1**
6(b)(ii)	frequency = number of pulses per s	**C1**
	5 (Hz)	**A1**

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7 Some of the components of the electromagnetic spectrum, in order of decreasing wavelength, are shown.

radio waves **microwaves** **visible light** **ultraviolet radiation** **gamma rays**

(a) **(i)** State the speed at which all electromagnetic waves travel in a vacuum.

..... [1]

(ii) State which of the components of the electromagnetic spectrum shown has the lowest frequency.

..... [1]

(iii) Two components of the electromagnetic spectrum are not listed above.

State the names of these components.

1. .....

2. .....
[2]

(b) One application of microwaves is in microwave ovens, which cook food very quickly.

Fig. 7.1 shows the inside of the glass door of a microwave oven, covered with a metal mesh.

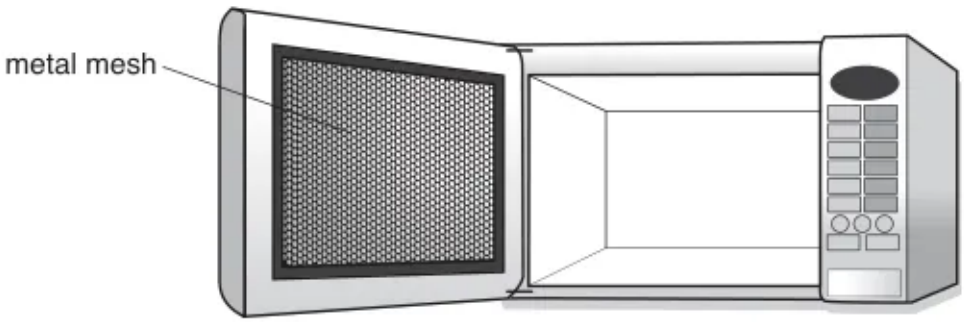


Fig. 7.1

The metal mesh prevents the microwaves from escaping by reflecting them back into the oven.

(i) Suggest **one** reason why it is sensible to prevent microwaves from escaping.

.....

..... [1]

(ii) State **one** further application of microwaves, other than in microwave ovens.

..... [1]

[Total: 6]

Electromagnetic spectrum Click for more variations

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7(a)(i)	3.0×10^8 m/s	**B1**
7(a)(ii)	radio (waves)	**B1**
7(a)(iii)	infra-red (radiation) X-rays **or** Röntgen rays	**B1** **B1**
7(b)(i)	less energy wasted **or** danger (to people nearby)/harmful	**B1**
7(b)(ii)	satellite communication / television **or** mobile / cell telephones **or** other sensible use (e.g. radar)	**B1**
	Total	**6**

8 **(a)** State **two** uses for infrared radiation.

1. .....

.....

2. .....

.....

[2]

(b) X-rays are used in hospitals to help treat patients.

Suggest and explain **three** precautions for the safe use of X-rays.

1. .....

.....

2. .....

.....

3. .....

.....

[3]

(c) **(i)** State the speed in a vacuum of

1. microwaves ..... [1]

2. X-rays ..... [1]

(ii) State a possible frequency for an ultrasound wave.

..... [1]

[Total: 8]

Alpha, beta and gamma radiation Click for more variations

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8(a)	any **two** from: remote controls (infrared) sensors / alarms specific electrical appliances thermal imaging	**B2**
8(b)	Any **three** from • shielding of operator behind screen / lead apron / out of room AND to absorb radiation • shielding of other parts of patient with lead / shielding of other parts of patient AND to absorb radiation • distance from source AND reduces intensity / amount of radiation / exposure • limit time of exposure / not too frequent / max number of X-rays per year AND to limit dose • limit strength / intensity of X-ray beam AND to limit dose	**B3**
8(c)(i)	**1** 3×10^8 m / s	**B1**
	2 3×10^8 m / s	**B1**
8(c)(ii)	> 20 000 Hz	**B1**

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9 Fig. 7.1 shows some uses of electromagnetic radiation and different regions of the electromagnetic spectrum.

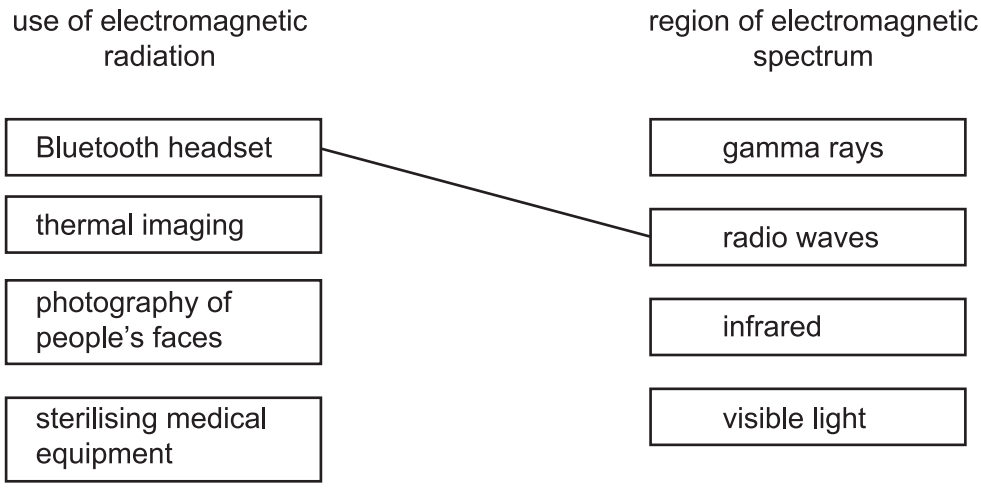


Fig. 7.1

(a) Draw a line from each use to the correct region of the spectrum. Each region of the spectrum is used once. One line has been completed for you. [2]

(b) State the speed of electromagnetic waves in a vacuum.

speed = ... [1]

(c) A Bluetooth headset can be used to listen to music on a mobile (cell) phone without the need for wires to connect the headset to the phone.

(i) The headset uses frequencies in the range 2.40–2.48 GHz.

Calculate the wavelength of the radio waves when the frequency is in the middle of the frequency range.

wavelength = ... [3]

(ii) Suggest why a Bluetooth headset only works well over short distances.

.....

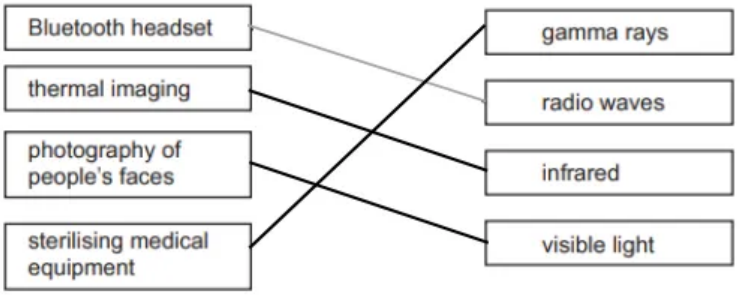
..... [1]

[Total: 7]

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Properties of waves Click for more variations

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9(a)	use of electromagnetic radiation / region of electromagnetic spectrum  all correct 2 marks 1 or 2 correct 1 mark	**B2**
9(b)	3.0×10^8 m / s	**B1**
9(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
9(c)(ii)	(radio waves / signal) lose energy / get weaker / lose (signal) strength (passing through walls) owtte	**B1**

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10 A mobile phone (cell phone) network uses microwaves of frequency 1.9×10^9 Hz to transmit and receive signals.

The speed of microwaves in air is 3.0×10^8 m/s.

(a) Calculate the wavelength of these microwaves in air.

wavelength = ... [2]

(b) State **two** reasons why microwaves are used for mobile phone (cell phone) signals.

1 .....

.....

2 .....

.....

[2]

(c) All mobile phone (cell phone) networks use digital signals to communicate with the phone.

(i) Describe, with the aid of a diagram, how a digital signal differs from an analogue signal.

.....

.....

.....

..... [3]

(ii) State **two** advantages of using digital signals rather than analogue signals.

1 .....

.....

2 .....

.....

[2]

[Total: 9]

Electromagnetic spectrum Click for more variations

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10(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
10(b)	(microwaves) only need short aerials / antennas	**B1**
	(microwaves) penetrate (some) walls	**B1**

10(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**
10(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**

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