OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



EXAM QUESTION PACK

P5.2 THE ELECTROMAGNETIC SPECTRUM

SCORE	PERCENTAGE
/101	%

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Gateway Physics A (9-1)

The electromagnetic spectrum

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **101**.
- The total number of marks may take into account some 'either/or' question choices.

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1(a) Ricco's school has an infrared sensor over the front entrance.
This operates the automatic door.

He does some tests to find out how the system works.

Look at his data.

Test	Details	Result
A	Ricco wears his school uniform and approaches the sensor	Door **opens** automatically
B	Ricco rolls some footballs towards the sensor	Door does **not** open
C	Ricco covers himself in aluminium foil and approaches the sensor	Door does **not** open

Explain why the door opens for test A.

---

[2]

(b)

(i) The door does not open for test B. Explain why.

---

[1]

(ii) The door does not open for test C. Explain why.

---

[1]

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2 Mobile phones are used by many people.

What type of wave is used by mobile phones?

Choose from the list.

gamma

microwave

ultrasound

ultraviolet

X-rays

[1]

3 Some waves in the electromagnetic spectrum are used for communication.

Look at the table. It shows how waves of different wavelengths are used.

Typical wavelength in metres	Uses
100 000	Signals for shipping
10 000	Navigation
1 000	Long wave radio
10	Short wave radio
1	FM radio
0.1	Mobile phone
0.01	Satellite communications
0.001	Radio astronomy

Complete the sentence.

Choose from:

longitudinal **sound** **transverse** **ultrasound**

Waves in the electromagnetic spectrum are all _____ waves.

[1]

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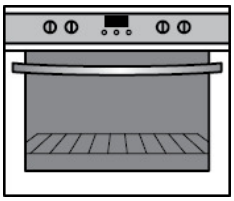
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4(a) Stefan experiments with different ovens in his kitchen.

He compares a microwave oven and an infrared oven for heating beakers of milk to 80 °C.

He heats the milk in glass beakers in both ovens.

Look at his results.

			Time to heat milk to 80 °C in minutes	
Beaker	Material	Colour	 Microwave oven	 Infrared oven
A	glass	white	2	25
B	glass	black	2	20
C	glass	transparent	2	22

Stefan makes sure his experiment is a fair test.

Suggest ways he can do this.

---[2]

(b) How do microwaves heat the milk?

---[1]

(c) The microwave oven takes the **same** time to heat the milk in the different beakers.

Explain why.

---[1]

(d) Look at the information in the table about the infrared oven.
Explain why the different coloured beakers take different times to heat up the milk.

---[2]

5(a) People worry about spending too much time in the sun.

This is due to the harmful effects of ultraviolet (UV) radiation.

Write about the problems caused by too much exposure to UV radiation.

---[3]

(b) Write about different ways people can protect themselves from UV radiation.

---[2]

6 TV satellites use short wavelength radio waves (microwaves) to receive and send signals.

Explain why these waves have to be used rather than long wavelength radio waves.

---[2]

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7 Ultrasound is used to 'look inside' a patient by scanning their body.

Write down **two** reasons why ultrasound scans may be used before operating on a patient.

---

[2]

8 This question is about using electromagnetic waves for communication.

Microwaves are used to communicate signals between Earth and satellites.
Sometimes when these signals are received they can be weak or of poor quality.

Suggest what engineers can do to the microwave dish on Earth to improve communication with a satellite.
Explain why the improvements work.

Suggestion 1 ---

Explanation ---

Suggestion 2 ---

Explanation ---

---

[4]

9 Steve has a combination microwave oven.
It can cook food using microwaves or infrared waves.

Microwaves and infrared waves cook food in different ways.

(i) What is **different** about the way microwaves and infrared waves heat food?

---

[2]

(ii) What is **similar** about the way microwaves and infrared waves heat food?

---

[2]

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10 Ultrasound is used on a patient.



Ultrasound is used to measure the speed of blood in her neck.

Explain **two** advantages of using ultrasound to do this.

---

[2]

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11 Low orbit satellites and geostationary satellites communicate with Earth.

Look at the information about different waves.

Wave	Frequency in MHz	Wave information
A	more than 30 000	radio waves and microwaves can pass through the atmosphere but are absorbed by rain and dust
B	less than 30	radio waves with long wavelengths are reflected by the upper atmosphere
C	30 to 30 000	microwaves and some radio waves pass through the atmosphere

Which wave is best for communicating with

- low orbit satellites
- geostationary satellites?

Explain your answers.

---

[3]

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12 Low Earth Orbit (LEO) satellites and geostationary satellites communicate with the Earth.

Look at the information about different waves.

Wave	Frequency in kHz	Wavelength in m	Property
A	more than 30 000 000	less than 0.01	scattered
B	less than 30 000	more than 10	reflected by ionosphere
C	30 000 to 30 000 000	0.01 to 10	pass through the atmosphere

Which wave is best for communicating with

- LEO satellites
- geostationary satellites?

Explain your answers.

---

[2]

13 Sue investigates some uses of electromagnetic waves for communication.

Look at the table of her results.

Electromagnetic wave	Communication use
radio waves	TV remote controls
microwaves	TV signals
infrared	mobile phones
visible light	Morse code

Sue has mixed up some of the communication uses.

Match the correct communication use to each electromagnetic wave and suggest some of the advantages of wireless communication.

The quality of written communication will be assessed in your answer to this question.

[6]

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14(a) Exposure to ultraviolet radiation can be dangerous.

State two effects of ultraviolet radiation on people.

1 ----------

2 ----------

[2]

(b) Suggest **one** way that people can reduce exposure to ultraviolet radiation.

---------- [1]

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15(a) Look at the table showing information about the electromagnetic spectrum.

Radio	Micro-wave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays
3 MHz	30 GHz	3 THz		3000 THz	3 000 000 THz	300 000 000 THz
100 m	1 cm	100 μm				

The speed of all electromagnetic radiation is 3×10^8 m/s.

(i) Use data in the table to show that the speed of microwaves is 3×10^8 m/s.

[2]

(ii) Ultra-violet waves typically have a frequency of 3000 THz.

Calculate the wavelength of these ultra-violet waves in nm.

Answer = ---------- nm [3]

(b) Ultra-violet waves can damage human skin.

Describe the damage caused to human skin by ultra-violet waves.

---

[1]

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(c) Sun cream can be used to protect skin from ultra-violet waves. Sun creams have different sun protection factors (SPF).

Look at the information about a bottle of sun cream.

This sun cream has a SPF of 10. If used sensibly it can allow you up to 10 × longer in the Sun without increasing the risk from ultra-violet waves.

(i) A doctor says 'adults should not sunbathe for more than 20 minutes in the midday sunshine when **not** using sun cream'.

If an adult used sun cream with SPF 6, how long could they safely sunbathe for?

Answer = _____ minutes **[1]**

(ii) The doctor says that children should always use at least SPF 50 sun cream.

Suggest reasons why.

_____

_____

_____

_____ **[2]**

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(d) * Ultrasound and X-rays are used to scan patients in hospital.

Look at the information about these two different waves.

Name	Frequency	Wavelength	Type	Description
Ultrasound	$\geq$ 2 MHz	$\leq 1.6 \times 10^{-4}$ m	Longitudinal	Pressure sound wave
X-rays	$\geq 3 \times 10^{16}$ Hz	$\leq$ 10 nm	Transverse	Electromagnetic wave

Ultrasound and X-rays are used to scan different parts of the patient.

Explain how ultrasound and X-rays are used and evaluate the risks and benefits of using these two different waves to scan patients in hospital.

Use the information in the table in your answer.

---

[6]

16 Some electromagnetic waves are used to scan a person in hospital.

Which statement is true about a scan that uses **electromagnetic** waves?

A Micro-waves are used to scan skin.

B Ultrasound waves are used to scan an unborn baby.

C Ultra-violet is used to scan for cancer.

D X-rays are used to scan for broken bones.

Your answer ☐ **[1]**

17 Which row **A**, **B**, **C** or **D**, is true for electromagnetic waves?

	Transmission	Type	Movement in space
A	Transmit energy from absorber to source	Longitudinal	Travel through space at different velocities
B	Transmit energy from absorber to source	Transverse	Travel through space at different velocities
C	Transmit energy from source to absorber	Longitudinal	Travel through space where all have the same velocity
D	Transmit energy from source to absorber	Transverse	Travel through space where all have the same velocity

Your answer ☐ **[1]**

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18 A radio wave has a wavelength of 100 m. It has a speed of 3×10^8 m/s.

Use the equation: Wave speed = Frequency × Wavelength

Calculate the frequency of the wave.

A 3 MHz

B 30 MHz

C 300 MHz

D 3000 MHz

Your answer ☐ [1]

19 An electromagnetic wave transfers energy.

Which row in the table is correct?

	Electromagnetic wave	Energy transfer
A	Infra-red	From a heating element of a toaster to the bread inside
B	Radio	From a radio to a transmitter
C	Gamma rays	From a high voltage supply to heating water in food
D	X-rays	From bones in the body to an X-ray machine

Your answer ☐ [1]

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20 Look at the diagram of the electromagnetic spectrum.

Radio	Microwave	Infra-red	Visible light	Ultra-violet	X-rays	Gamma-rays

(i) Name a wave that has a longer wavelength than red light.

---

[1]

(ii) Name a wave that has a higher frequency than violet light.

---

[1]

(iii) State two **uses** of gamma-rays.

1. ---

2. ---

[2]

21 Which waves can damage cells and cause cancer?

A Radio, X-rays and infra-red.

B Sound, gamma-rays and microwaves.

C Sound, visible light and ultraviolet.

D Ultraviolet, gamma-rays and X-rays.

Your answer ☐ [1]

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22 All bodies emit electromagnetic radiation.

Body **R** is at a higher temperature than body **S**.

Which statement is correct?

A **R** emits radiation with a mean higher frequency.

B **R** emits radiation with a mean longer wavelength.

C **S** emits radiation with a higher intensity.

D **S** emits radiation with a mean shorter wavelength.

Your answer ☐ [1]

23(a) Energy is transferred at high voltages in the national grid.

This house is near to a transmission line.



Explain why radio waves may be produced by the transmission line.

---

[2]

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(b) Explain why it is more efficient to transfer energy at high voltages.

---

[2]

(c) The transmission line has a power loss of 6.156 kW.

Its resistance is 15.39 Ω.

Calculate the current in the transmission line.

Current = ... A **[5]**

24 *The Earth contains a crust, mantle and core as shown in **Fig. 22.1**.

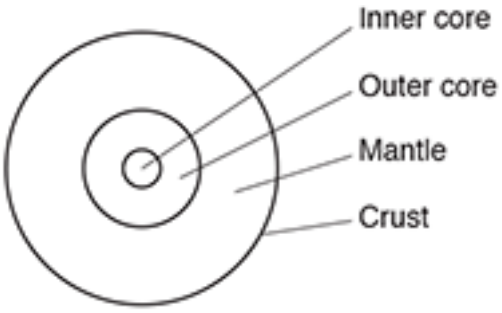


Fig. 22.1

Table 22.1 gives some data about seismic waves and the Earth.

	Density (g / cm^3)	P wave speed (km / s)	S wave speed (km / s)
Top of crust	2.2	5.55	3.25
Top of mantle	3.4	7.97	4.55

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Top of outer core	9.9	8.10	-
Bottom of outer core	12.2	10.30	-

Table 22.1

Describe what information the data in **Table 22.1** gives about the structure of the Earth.

In your answer you should explain any trends in the data in **Table 22.1**.

[6]

25 Ultrasound wave pulses are used by vets to scan inner tissues inside animals.

The ultrasound pulses partially reflect from different layers of tissue. These reflected wave pulses (echoes) are collected by the detector as shown in **Fig. 24.2**.

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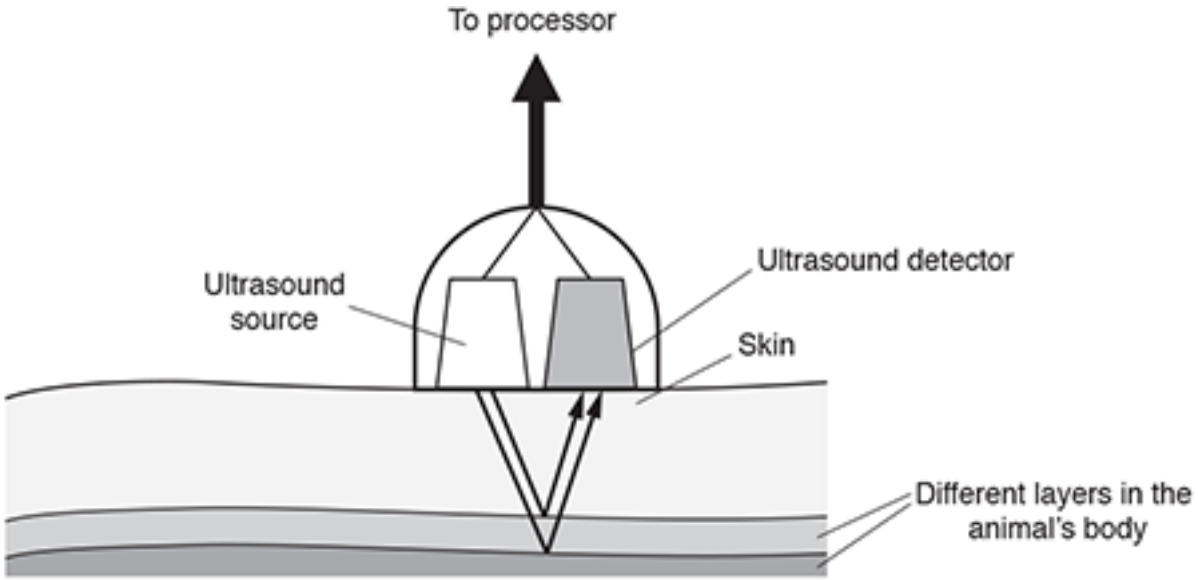


Fig. 24.2

In a scan using ultrasound pulses, three layers of tissue are detected, with each layer having a different thickness.

Describe and explain how the results from the detector can show:

- that there are three layers
- that each layer has a different thickness.

[3]

26 What type of wave is light?

A A longitudinal electromagnetic wave

B A longitudinal P wave

C A transverse S wave

D A transverse electromagnetic wave

Your answer [ ] [1]

27 Which statement is **true** for electromagnetic waves?

A High frequency electromagnetic waves have a long wavelength.

B High frequency electromagnetic waves have no wavelength.

C Low frequency electromagnetic waves have a long wavelength.

D Low frequency electromagnetic waves have a short wavelength.

Your answer [ ] [1]

28 Which row in the table is correct?

	Electromagnetic wave	Use
A	Radio	Killing bacteria
B	Microwaves	Mobile phones
C	X-rays	Optical fibres
D	Gamma rays	Tanning beds

Your answer [ ] [1]

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29 An electromagnetic wave transfers energy.

Which row in the table is correct?

	Electromagnetic wave	Energy transfer
A	Infra-red	From a heating element of a toaster to the bread inside
B	Radio	From a radio to a transmitter
C	Gamma rays	From a high voltage supply to heating water in food
D	X-rays	From bones in the body to an X-ray machine

Your answer ☐ [1]

30(a) A student looks at two identical metal spoons, **A** and **B**.

Spoon **A** was placed in hot water at 70 °C.

Spoon **B** is at 20 °C.

Which spoon emits the most radiation?

Tick (✓) **one** box.

Spoon **A** ☐

Spoon **B** ☐

Explain your answer.

---

[1]

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(b) Explain why both spoons look identical to the student, even though they are at different temperatures.

---

[1]

31(a) This question is about X-rays and visible light.

State one **similarity** and one **difference** between X-rays and visible light.

Similarity ---

Difference ---

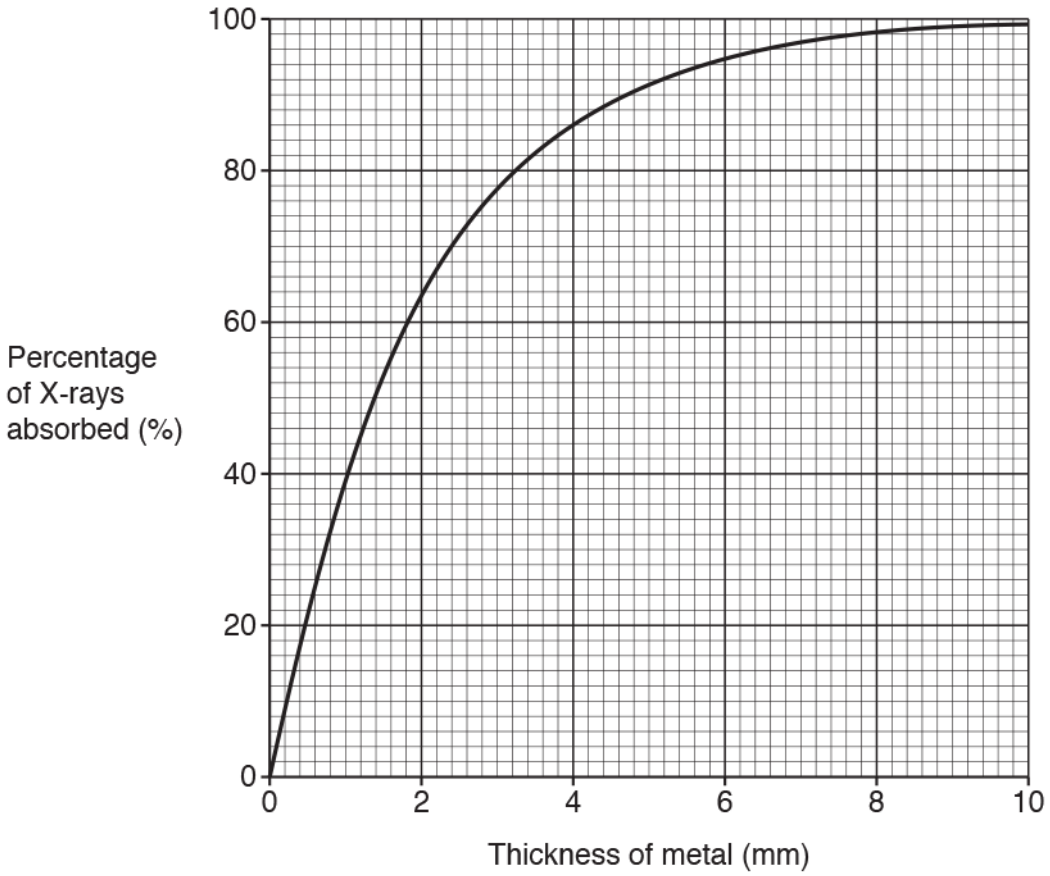
[2]

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(b) This graph shows how the absorption of X-rays changes with the thickness of metal.



(i) What percentage of X-rays is absorbed by 4 mm of metal?

Percentage of X-rays absorbed = ... % **[1]**

(ii) Calculate the percentage of X-rays passing **through** 4 mm of metal.

Use your answer to **(i)** to help you.

Percentage of X-rays = ... % **[2]**

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32 Which row in the table describes all electromagnetic waves?

	Type of wave	Speed of wave in space
A	Longitudinal	Changes with wavelength.
B	Longitudinal	Stays the same.
C	Transverse	Changes with wavelength.
D	Transverse	Stays the same.

Your answer [1]

33 Electromagnetic waves can be ordered by frequency.

Which answer shows the waves in order of **increasing** frequency?

Low frequency → **High** frequency

A	Infra-red	Visible light	X-rays
B	Visible light	Infra-red	X-rays
C	Visible light	X-rays	Infra-red
D	X-rays	Visible light	Infra-red

Your answer [1]

END OF QUESTION PAPER

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