

PHYSICS



EXAM QUESTION PACK

M5 GEOMETRY AND TRIGONOMETRY

SCORE

/16

PERCENTAGE

%

STEMUP

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Gateway Physics A (9-1)

Maths 5: Geometry and trigonometry

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 **16**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 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]

- 2 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 $\times$ Wavelength

Calculate the frequency of the wave.

- A 3 MHz
- B 30 MHz
- C 300 MHz
- D 3000 MHz

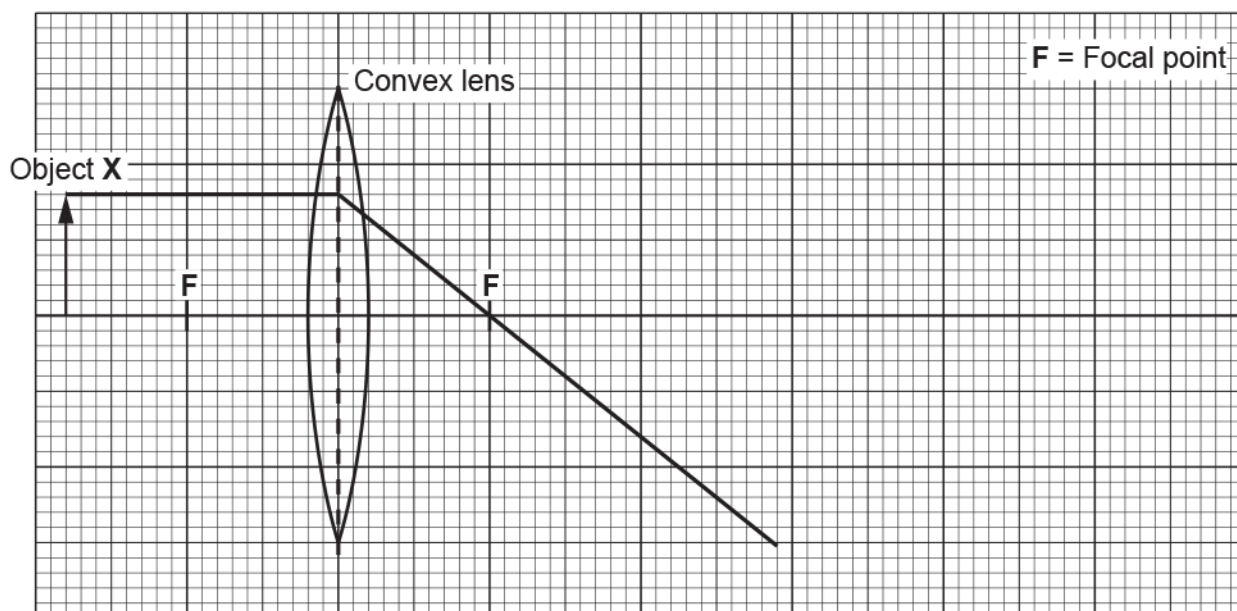
Your answer

[1]

- 3 A projector is used to create a larger image of an object.

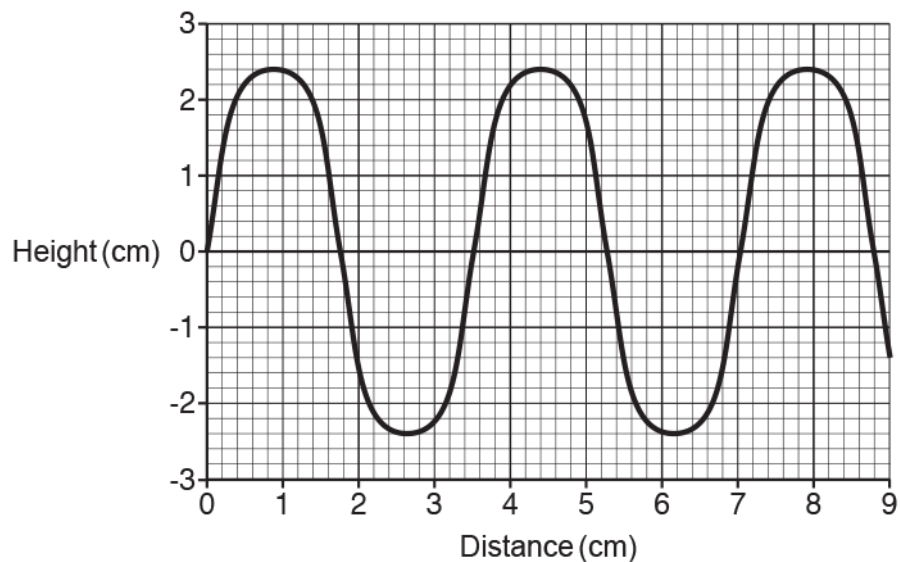
The diagram shows one light ray as it passes through the convex lens.

Draw **one** more ray on the diagram to show where the image is formed. Label the image Y.



[2]

4 Look at the diagram of a water wave.



(i) What is the **wavelength** of this wave?

Answer = ... cm [1]

(ii) What is the **amplitude** of this wave?

Answer = ... cm [1]

(iii) The wavelength of the wave is changed to 25 cm. Two waves are produced each second.

Use the equation: Wave speed = Frequency $\times$ Wavelength

Calculate the speed of the wave.

Answer = ... m/s [2]

5 A student uses a ruler to determine the volume of a cube, **A**. The length of one side of the cube is 0.100 m.

(i) Calculate the volume of cube **A**.

Volume of cube **A** = ... m³ [2]

(ii) Cube **B** has the same volume as cube **A**.

The mass of cube **B** is ten times greater than the mass of cube **A**.

Compare the density of cube **B** with cube **A**.

Use the equation for density to help your explanation.

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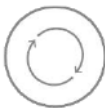
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END OF QUESTION PAPER

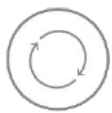
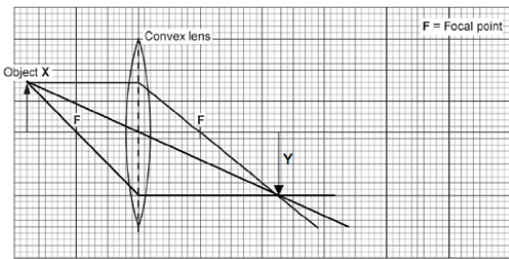
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1		i	(Wave speed =) frequency x wavelength ✓ 30 × 10 ⁹ × 0.01 or 30 × 10 ⁹ × 1 × 10 ⁻² ✓	2 (AO1.1) (AO3.2b)	ALLOW correct symbol equation eg (v =) f × λ ALLOW equation in any form ALLOW any frequency and corresponding wavelength from the table substituted into this equation IGNORE units for this marking point only ALLOW 30 000 000 000 × 0.01 or 30 000 000 000 × 1 × 10⁻² ALLOW reverse arguments using speed and wavelength or speed and frequency <u>Examiner's Comments</u>  This question assessed AO1 and AO3 and required candidates to recall and use the equation: <i>wave speed = frequency x wavelength</i> as well as convert 30 GHz into Hertz and 1 cm into metres. Most candidates struggled with the meaning of the prefixes and converting the units. Because many of these candidates did not write down the equation or their workings they could not be credited for any of the compensatory marks available in the mark scheme. A number of candidates used data from the table for radio or infra-red waves. Although they could not gain full marks they were credited with 1 mark for correct use of the equation.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (nm) award 3 marks (Wavelength =) velocity $\div$ frequency ✓ $\frac{3 \times 10^8}{3000 \times 10^{12}}$ or 1×10^{-7} ✓ = 100 (nm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW (λ =) $v \div f$ IGNORE $v = f \times \lambda$ and $f = v / \lambda$ or words ALLOW 3×10^8 divided by any frequency from the table IGNORE units for this marking point only <u>Examiner's Comments</u> This question required candidates to convert the prefix Tera into a power of ten, recall and rearrange the equation: <i>wave speed = frequency $\times$ wavelength</i> to calculate the wavelength of ultra-violet, and then convert their answer into nanometres. Only the higher ability candidates gained full credit. The majority of candidates did not score any marks. Those candidates, who did gain credit, were credited with a one mark for correctly rearranged equation or for the correct application of the equation (i.e. 3×10^8 divided by any frequency from the table).  OCR support Candidates would benefit from greater familiarity with the standard metric prefixes (WS1.4d). The Mathematical Skills Handbook provides additional support on the use of prefixes and powers of ten for orders of magnitude: http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	5	

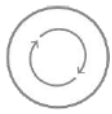
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
2			A ✓	1 (AO 2.2)	Examiner's Comments This was the most challenging question in Section A. The most common response was distractor D, where candidates multiplied the numbers together rather than dividing wave speed by wavelength.  AfL For these type of questions candidates should be encouraged to insert the numbers into the equation. When they do this they will see that the equation needs to be rearranged. Alternatively, candidates could rearrange the equation so that the unknown quantity is on the left-hand side of the equal sign.
			Total	1	
3			Either ray (centre ray or focal ray) drawn as indicated below ✓  Image upside down AND in the correct place ✓	2 (AO2 × 2.2)	ALLOW just one ray drawn If no rays drawn (or incorrect) but image is inverted, slightly larger and roughly in the correct place then award this mark IGNORE position of Y (if arrow is in the correct place) ALLOW tolerance of +/- 2 squares for image position
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4		i	3.5 (cm) ✓	1 (AO 1.1)	ALLOW 3.4 to 3.6 Examiner's Comments One in five candidates answered this question correctly. Some candidate confused wavelength with the amplitude. Another common response was 9 cm.
		ii	2.4 (cm) ✓	1 (AO 1.1)	Examiner's Comments Many candidates read the vertical axis incorrectly and gave values that were around 2.4 cm but not that specific value (for example 2.5 cm).  Misconception A common incorrect answer was 4.8 cm, where candidates confused the peak to peak value with amplitude. Other candidates confused amplitude with the wavelength.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 (m/s) award 2 marks 2×25 OR 2×0.25 ✓ 0.5 (m/s) ✓	2 (AO 2 x 2.1)	ALLOW 50 <u>Examiner's Comments</u> Most candidates were credited with one mark for multiplying 2 by 25 to give an answer of 50. Fewer candidates appreciated that this was 50 cm/s while the unit on the answer line was m/s.  AfL Encourage candidates to check the unit used on the answer line. This additional information can help them to understand the question and the equations they should use.
			Total	4	
5		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = $0.001 / 1 \times 10^{-3} \text{ (m}^3\text{)}$ award 2 marks $0.1 \times 0.1 \times 0.1$ ✓ $= 0.001 / 1 \times 10^{-3} \text{ (m}^3\text{)}$ ✓	2 (AO2x2.2)	
		ii	Density = mass/volume / density is proportional to mass ✓ (Cube B has 10 x mass of cube A, so) density of cube B is 10 x density of cube A ✓	2 (AO1.2) (AO2.2)	ALLOW density is 10 times larger ALLOW numerical values used to show density of cube B is 10 x density of cube A
			Total	4	