



Waves

FREE Online Physics GCSE Course

physicswithkate.com

Name _____ Date _____

TIME ALLOWED

70 minutes

TOTAL MARKS

37 COMBINED · 66 TRIPLE

YOU WILL NEED

a ruler, a pencil, a black or blue pen and a calculator

Instructions

- **Combined Science:** answer Questions 1–7 (about 40 minutes).
- **Physics (triple):** answer all twelve questions.
- Write in black or blue ink. Draw diagrams in pencil, with a ruler.
- In calculations, show clearly how you work out your answer.

Information

- The marks for each question are shown in brackets.
- Combined Science is out of 37 marks. Physics (triple) is out of 66 marks.
- You are reminded of the need for good English and clear presentation in your answers.

Your score

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Total	%
Out of	4	5	8	4	4	9	3	7	8	5	5	4	37 / 66	100
Your mark														

Marking your test

The full mark scheme is at the back of this booklet. Try every question first, then mark your answers in a different colour.

1 Question 1

4 marks

Water waves are transverse waves. Sound waves are longitudinal waves.

- (a) Explain the difference between a transverse wave and a longitudinal wave. You may include labelled diagrams in your answer.

(3)

- (b) Name **one** type of wave that can be either transverse or longitudinal.

(1)

Total for this question: 4 marks

2 Question 2

5 marks

Most young people can hear sounds in the frequency range 20 Hz to 20 000 Hz.

- (a) Which statement best describes *frequency*?

Tick (✓) **one** box.

A the maximum disturbance caused by a wave

☐

B the number of complete waves (vibrations) per second

☐

C the distance between one crest of a wave and the next one

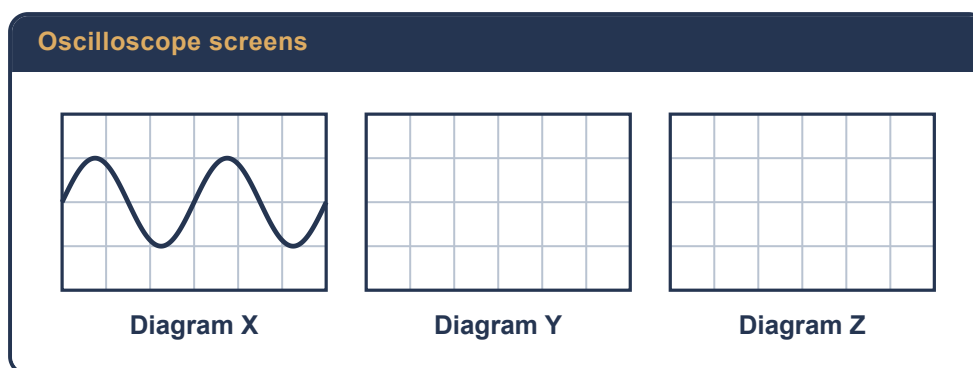
☐

D the distance travelled by a wave in 1 second

☐

(1)

(b) Diagram X shows a trace on an oscilloscope screen.



(i) On diagram Y, draw a trace which has a **higher frequency** than the trace in diagram X.

(ii) On diagram Z, draw a trace which has a **larger amplitude** than the trace in diagram X.

(2)

(c) Choose words from the box to complete the sentences.

higher louder lower quieter

(i) A musical note with a high frequency sounds than one with a low frequency.

(ii) A sound with a small amplitude sounds than one with a large amplitude.

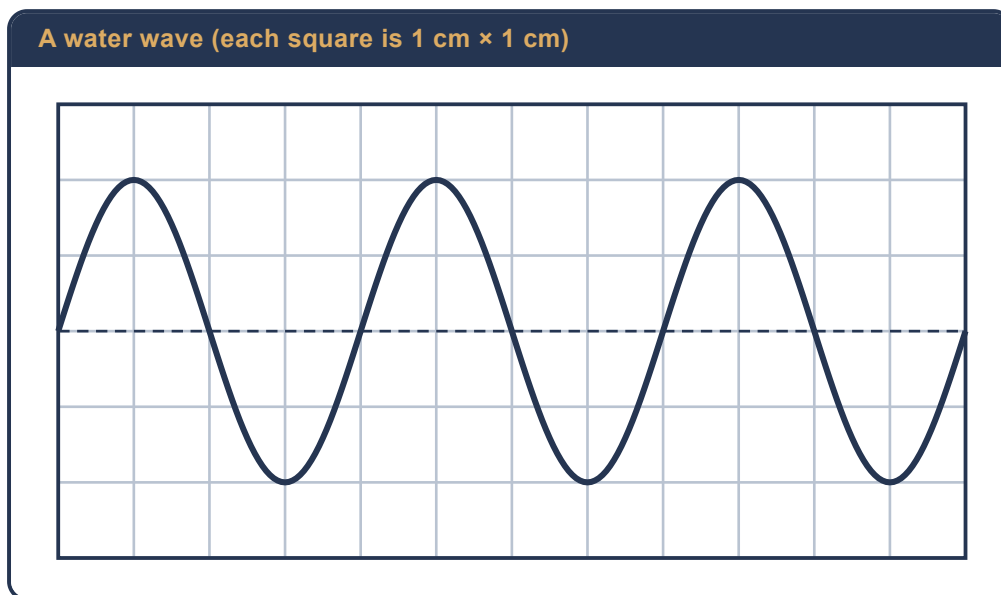
(2)

Total for this question: 5 marks

3 Question 3

8 marks

The diagram shows a water wave drawn on a grid of 1 cm squares.



(a) What is the wavelength of this water wave? cm (1)

(b) What is the amplitude of this water wave? cm (1)

(c) Twelve waves pass an observer in four seconds.

What is the frequency of the waves? Show clearly how you work out your answer and give the unit.

Frequency = (3)

- (d) Calculate the speed of the water wave, in metres per second.

Speed = _____ m/s
(3)

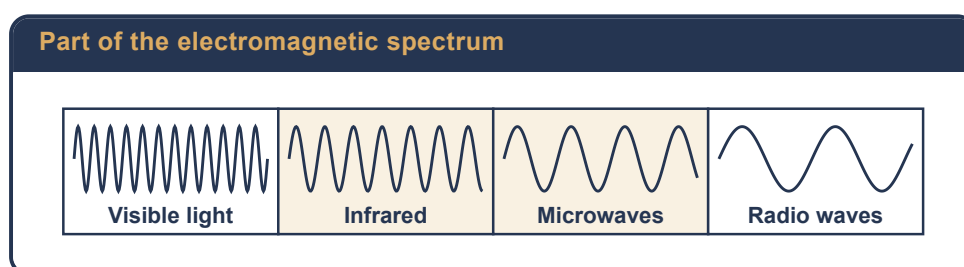
Total for this question: 8 marks

4 Question 4

4 marks

Infrared and microwaves are two types of electromagnetic radiation.

The diagram shows where they are in part of the electromagnetic spectrum.



- (a) Name **one** type of electromagnetic radiation which has more energy than infrared.

(1)

- (b) Use the correct answer from the box to complete each sentence. Each answer may be used once, more than once or not at all.

greater than less than the same as

The wavelength of infrared is _____ the wavelength of microwaves.

The frequency of microwaves is _____ the frequency of infrared.

The speed of microwaves in a vacuum is _____ the speed of infrared in a vacuum.

(3)

Total for this question: 4 marks

5 Question 5

4 marks

Different types of electromagnetic radiation are used for different jobs.

Choose words from the box to complete the table.

gamma rays light microwaves radio waves ultraviolet

Type of radiation	What the radiation is used for
	to send along optical fibres in an endoscope
	to give skin a tan (but can cause cancer in cells)
	to sterilise surgical instruments
	to send information to and from satellites

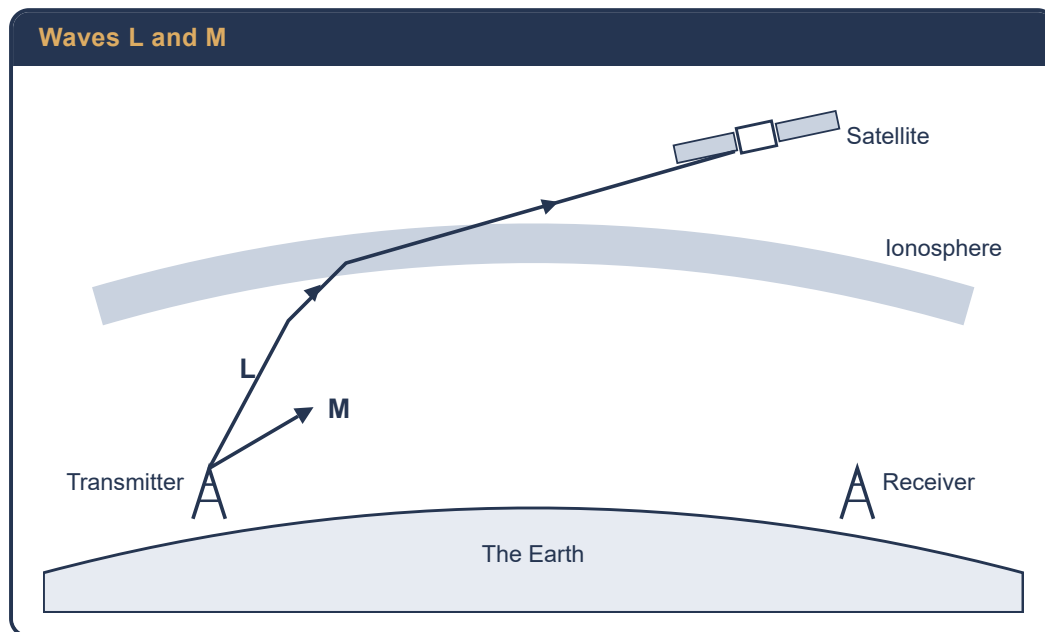
(4)

Total for this question: 4 marks

6 Question 6

9 marks

Different parts of the electromagnetic spectrum are useful for different methods of communication. The diagram shows a transmitter sending out two electromagnetic waves, **L** and **M**.



(a) Wave **L** is used to send a signal to a satellite.

(i) Which part of the electromagnetic spectrum does wave **L** belong to?

_____ (1)

(ii) What name is given to the process that happens as wave **L** passes into the ionosphere?

_____ (1)

(b) Explain what this process is and what causes it.

_____ (2)

(c) Wave **M** is **reflected** by the ionosphere.

(i) On the diagram, draw the path of wave **M** until it reaches the receiver.

(2)

- (ii) On the diagram, draw a line to show the normal where wave **M** meets the ionosphere. Label the line **N**. (1)

- (d) Give **two** properties of all electromagnetic waves.

1
2

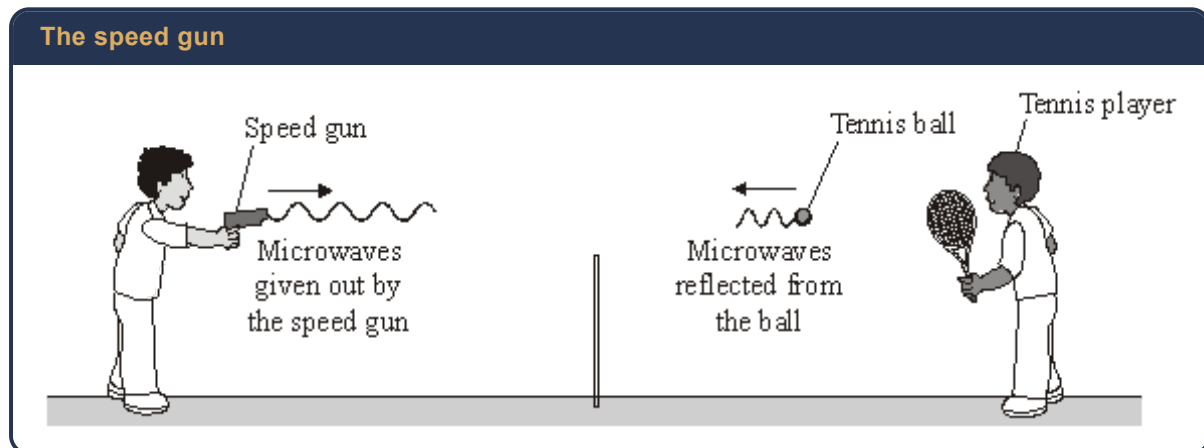
(2)

Total for this question: 9 marks

7 Question 7

3 marks

The picture shows a tennis coach using a speed gun to measure how fast a player serves the ball.



- (a) The microwaves sent out by the speed gun have a frequency of 24 GHz and travel through the air at 3×10^8 m/s.

Calculate the wavelength of the microwaves. Show clearly how you work out your answer.

.....
.....
.....

Wavelength = m
(2)

- (b) Some of the microwaves sent out by the speed gun are absorbed by the ball. What effect will the absorbed microwaves have on the ball?

(1)

Total for this question: 3 marks

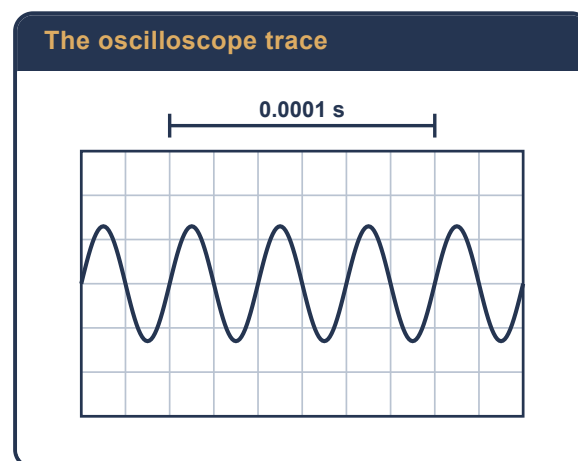
8 Question 8

Physics (triple) only

7 marks

Physics (triple) only. Combined Science students: skip this question.

A high-frequency signal generator is connected to a loudspeaker. A microphone connected to an oscilloscope detects the sound from the loudspeaker. The diagram shows the trace on the oscilloscope.



- (a) (i) How many waves are produced by the loudspeaker in 0.0001 seconds?

(1)

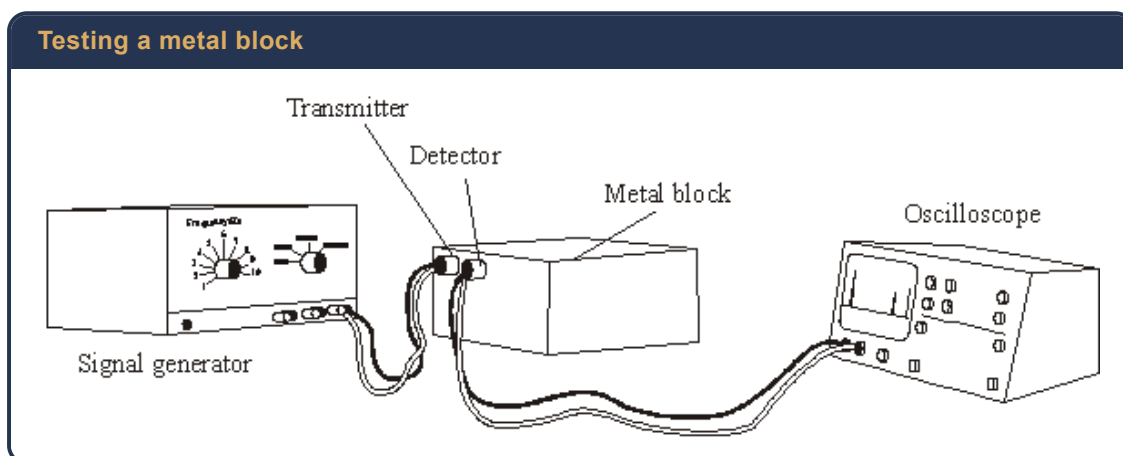
- (ii) How many waves are produced by the loudspeaker every second? Assume the signal to the loudspeaker does not change.

(1)

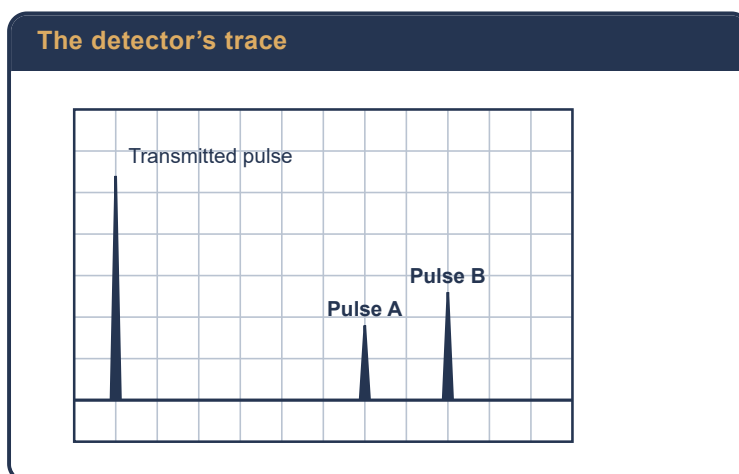
- (iii) A person with normal hearing cannot hear the sound produced by the loudspeaker. Explain why.

(2)

- (b) The diagram shows an ultrasound transmitter and detector fixed to the front of a metal block. The block has a crack inside it.



The diagram below shows the oscilloscope connected to the detector.



- (i) Explain why pulse **A** and pulse **B** happen.

(2)

- (ii) The metal block is 120 mm from front to back. What is the distance from the front of the block to the crack?

Distance = _____ mm
(1)

Total for this question: 7 marks

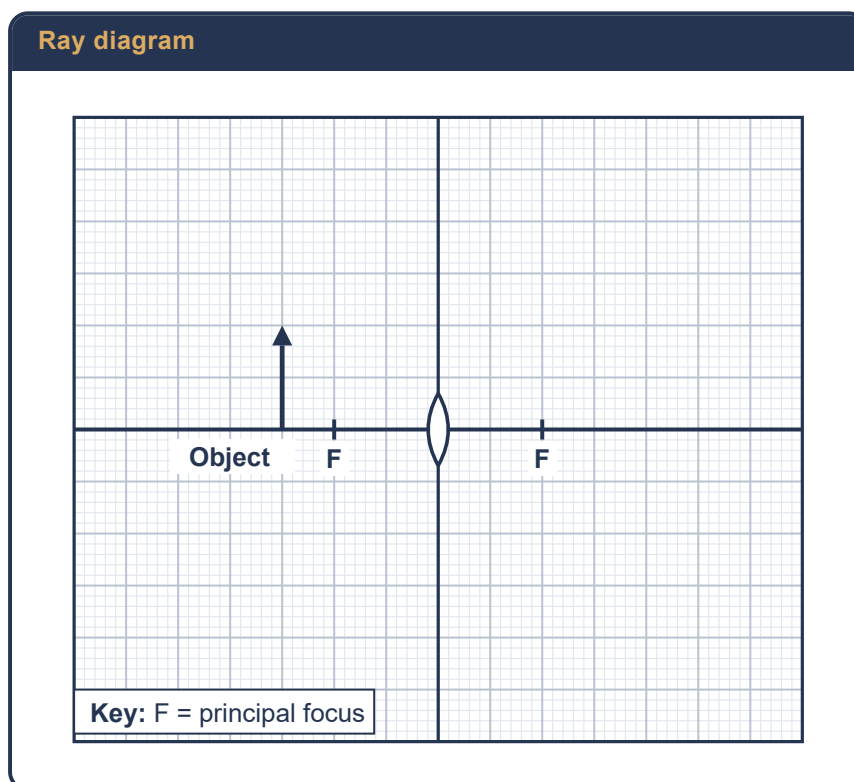
9 Question 9

Physics (triple) only

8 marks

Physics (triple) only. Combined Science students: skip this question.

A student investigated how the image formed by a converging lens depends on where the object is. The diagram shows one position of the object.



- (a) Use a ruler to complete a ray diagram to show how the image of the object is formed.

(4)

- (b) Describe the nature of this image compared with the object.

(2)

- (c) Use the equation to calculate the magnification produced by the lens in your diagram.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Magnification = _____
(2)

Total for this question: 8 marks

10 Question 10

Physics (triple) only

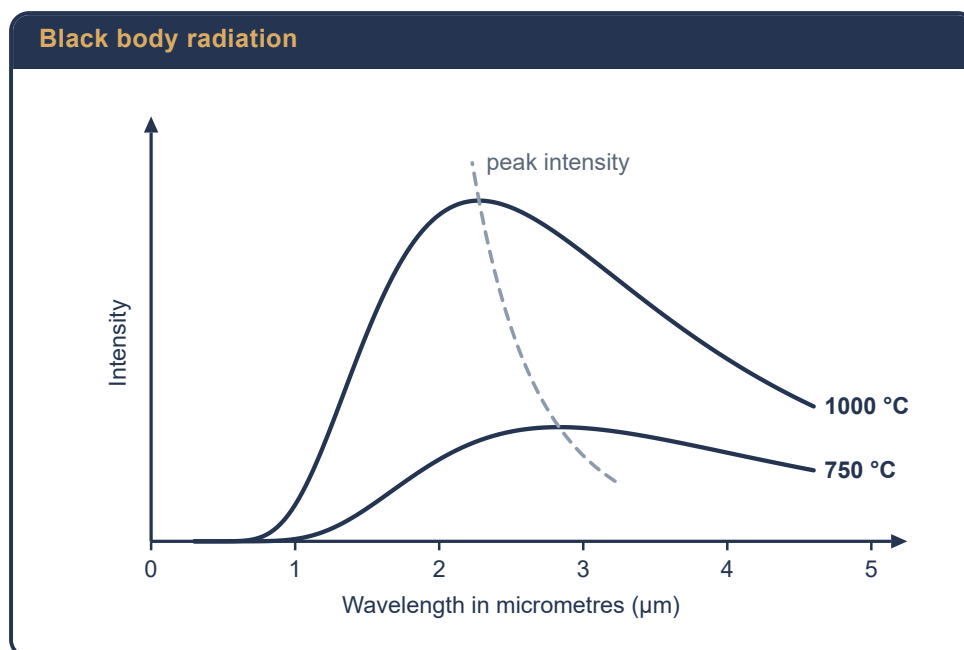
5 marks

Physics (triple) only. Combined Science students: skip this question.

- (a) A body radiates energy at the same rate as it absorbs energy. What happens to its temperature?
Explain your answer.

(2)

- (b) The graph shows the intensity of the radiation given out by a black body, at each wavelength, at two different temperatures.



Describe **two** ways in which the radiation from the black body changes when its temperature increases.

- 1
- 2

(2)

- (c) A black body that is much hotter than $3000\text{ }^{\circ}\text{C}$ can look blue. Suggest why.

(1)

Total for this question: 5 marks

11 Question 11

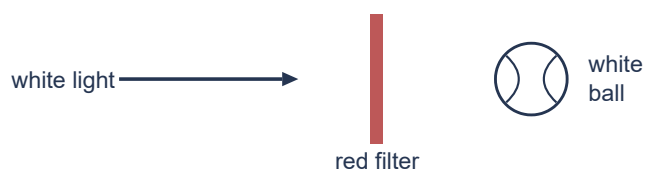
Physics (triple) only

5 marks

Physics (triple) only. Combined Science students: skip this question.

Peter has a white tennis ball and a green tennis ball. He shines white light through a red filter onto each ball.

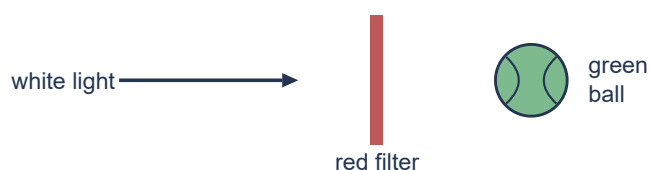
(a) (i) Experiment 1



The white ball looks red. Explain why.

(2)

(ii) Experiment 2

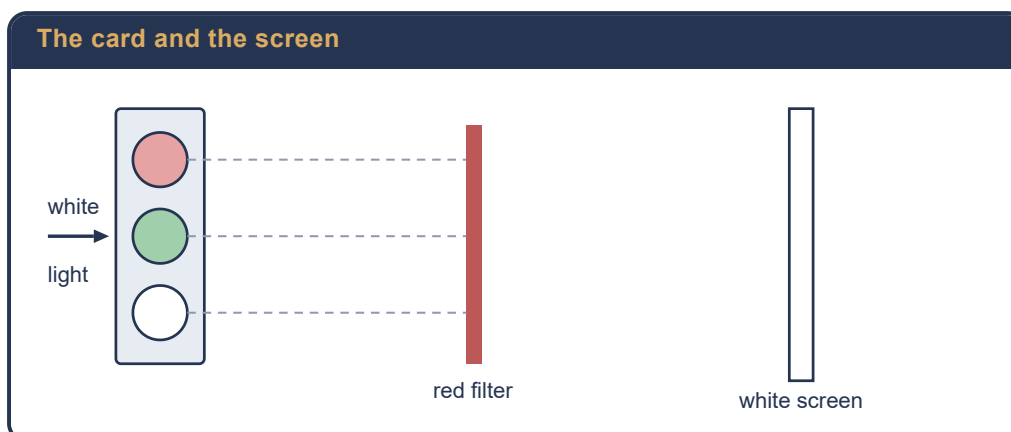


What colour does the green ball look?

Explain your answer.

(2)

- (b) Peter cuts three holes in a piece of card. He covers two of the holes with coloured filters. He puts a red filter between the card and a white screen, and shines white light at the card.



What does Peter see on the screen?

(1)

Total for this question: 5 marks

12 Question 12

Physics (triple) only

4 marks

Physics (triple) only. Combined Science students: skip this question.

Earthquakes produce seismic waves.

- (a) Which row of the table is correct for P-waves and S-waves?

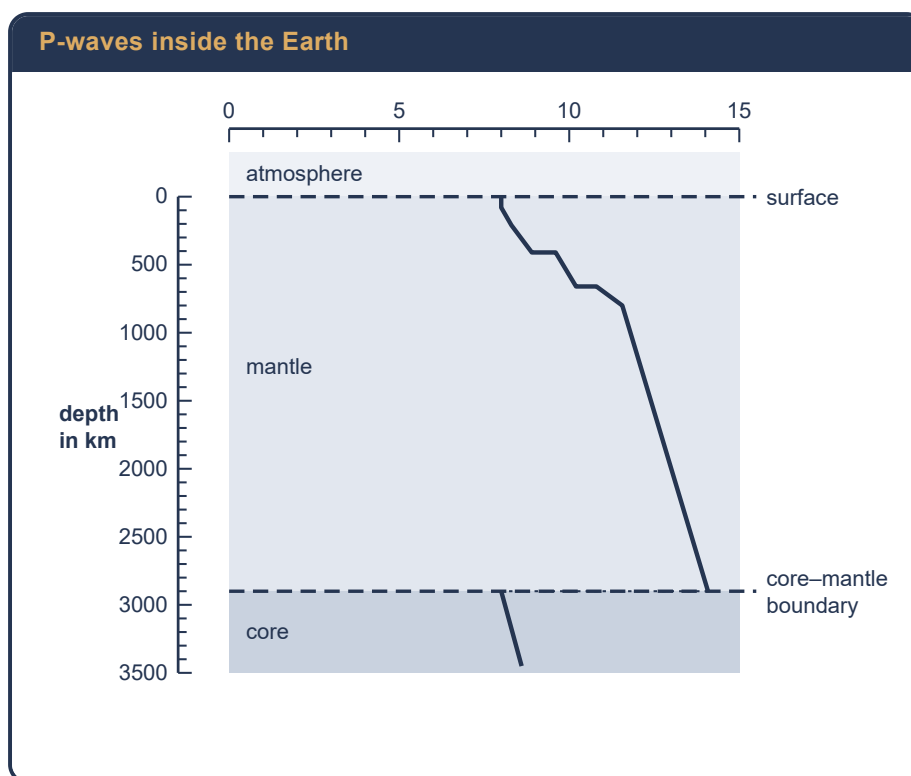
	P-waves are	S-waves are
A	longitudinal	transverse
B	transverse	longitudinal
C	longitudinal	longitudinal
D	transverse	transverse

Tick (✓) **one** box.

A ☐
B ☐
C ☐
D ☐

(1)

- (b) The chart shows how the speed of P-waves changes with depth below the Earth's surface.



- (i) State what happens to a P-wave when it crosses from the mantle into the core.

(1)

- (ii) Describe how the speed of a P-wave changes between a depth of 1000 km and 2500 km.

(2)

Total for this question: 4 marks

END OF TEST

Now mark your answers using the mark scheme that follows.

MARK SCHEME

Waves · Topic Test

[1] in the Mark column means one mark for that line.

accept / allow notes (gold) are other answers that also score.

reject / do not accept notes (red) are answers that do not.

1 Question 1 — mark scheme

4 marks

PART	ANSWER	MARK
(a)	the oscillations / vibrations (that cause the wave) <i>"a movement causes the wave" is insufficient</i>	1
	for a transverse wave are perpendicular to the direction of energy transfer <i>answers in terms of the direction of wave travel (not energy transfer) for both waves: 1 mark for these two points</i>	1
	and for a longitudinal wave are parallel to the direction of energy transfer <i>the marks may be scored by two correctly labelled diagrams</i> <i>two labelled diagrams showing the general shape of each wave gain 1 mark if no other mark has been awarded</i>	1
(b)	seismic / earthquake waves <i>accept waves on a spring / slinky</i> <i>do not accept shock waves</i>	1

Total: 4 marks

2 Question 2 — mark scheme

5 marks

PART	ANSWER	MARK
(a)	the number of complete waves (vibrations) per second	1
(b)(i)	Y: more waves across the screen than X	1
(b)(ii)	Z: taller waves (peaks higher, troughs lower) than X	1

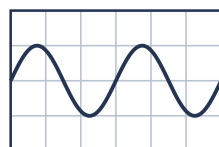


Diagram X

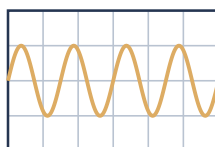


Diagram Y

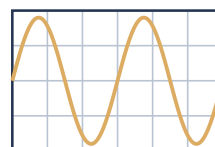


Diagram Z

(c)(i) higher

1

(c)(ii) quieter

1

Total: 5 marks

3 Question 3 — mark scheme

8 marks

PART	ANSWER	MARK
(a)	4 (cm) allow 3.9 to 4.1	1
(b)	2 (cm) do not accept 4 cm: that is crest to trough	1
(c)	frequency = $12 \div 4$ allow 1 mark for frequency = number of waves $\div$ time	1
	= 3 correct answer with no working = 2 marks	1
	Hz accept waves per second or cycles per second	1
(d)	wave speed = frequency $\times$ wavelength allow error carried forward from (a) and (c)	1
	wavelength = 4 cm = 0.04 m	1
	speed = $3 \times 0.04 = 0.12$ (m/s) 0.12 m/s scores 3 marks allow 12 cm/s for 2 marks	1

Total: 8 marks

4 Question 4 — mark scheme

4 marks

PART	ANSWER	MARK
(a)	any one from: (visible) light, ultraviolet, X-rays, gamma rays	1
(b)	less than	1
	less than	1
	the same as	1

Total: 4 marks

5 Question 5 — mark scheme

4 marks

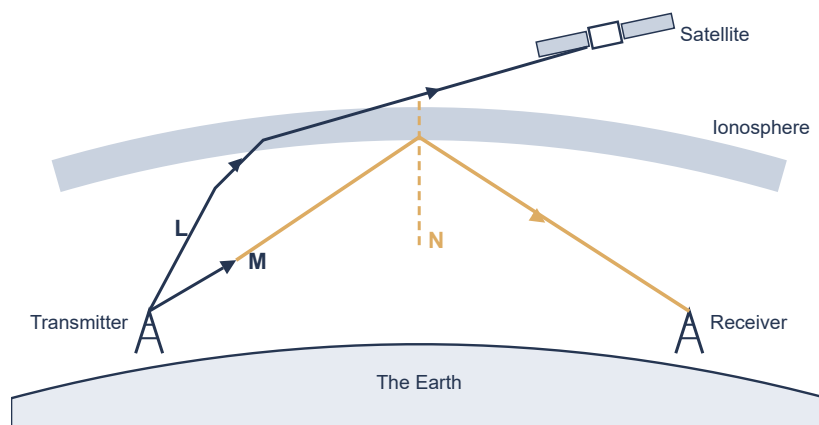
PART	ANSWER	MARK
	endoscope: light	1
	skin tan: ultraviolet	1
	sterilise instruments: gamma rays	1
	satellites: microwaves	1

Total: 4 marks

6 Question 6 — mark scheme

9 marks

PART	ANSWER	MARK
(a)(i)	microwaves	1
(a)(ii)	refraction	1
(b)	the wave changes direction as it passes from one medium into another	1
	because the wave's speed changes <i>accept: because it changes speed</i>	1
(c)(i)	M drawn as a straight line from the transmitter to the ionosphere <i>if more than two rays are shown, 1 mark maximum</i> <i>ignore arrows</i>	1
	correctly reflected, as a straight line reaching the receiver	1
(c)(ii)	normal drawn at the point where their M meets the ionosphere, labelled N	1



(d) any **two** from:

2

- they are transverse
- they all travel at the same speed in a vacuum (or air)
- they can travel through a vacuum
- they transfer energy
- they can be reflected / refracted / absorbed / transmitted

| accept the speed of light or 3×10^8 m/s

| "travel at the same speed through a vacuum" scores 2 marks

| "travel in straight lines" is insufficient

Total: 9 marks

7

Question 7 — mark scheme

3 marks

PART	ANSWER	MARK
(a)	$\lambda = v \div f = 3 \times 10^8 \div 24 \times 10^9$ allow 1 mark for the correct rearrangement and substitution	1
	= 0.0125 (m) accept 1.25×10^{-2} m	1
(b)	it makes the ball hot(ter) accept: the water in the ball gets hotter do not accept "cooks it"	1

Total: 3 marks

8

Question 8 — mark scheme

Physics (triple) only

7 marks

PART	ANSWER	MARK
(a)(i)	3	1
(a)(ii)	30 000 allow 10 000 × their (a)(i), correctly calculated	1
(a)(iii)	any two from: • the frequency is above 20 000 Hz • the upper limit of human hearing is 20 000 Hz • it is ultrasound accept: the frequency is 30 000 Hz ignore references to the lower limit	2

(b)(i) the ultrasound is (partially) reflected

1

| accept echo

| "bounces" is insufficient

at the crack to produce **A** and at the back of the block to produce **B**

1

| both A and B needed for this mark

(b)(ii) 90 (mm)

1

| A is 6 squares from the transmitted pulse, B is 8 squares: $6 \div 8 \times 120$

| accept 88 to 92 (mm)

Total: 7 marks

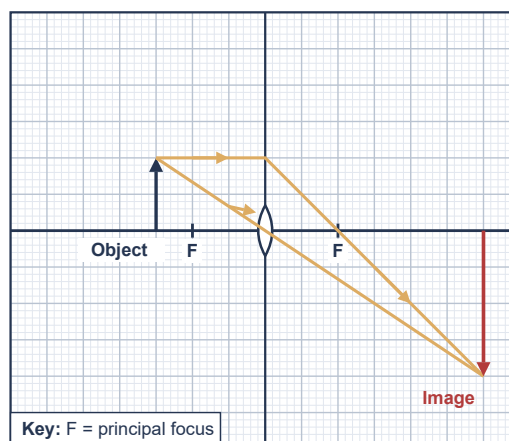
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Question 9 — mark scheme

Physics (triple) only

8 marks

PART	ANSWER	MARK
(a)	any two rays from the top of the object, 1 mark each: <ul style="list-style-type: none"> through the centre of the lens, undeviated parallel to the axis, then through F on the right through F on the left, then parallel to the axis deduct 1 from these two marks if a ruler has not been used but the intention is clear if more than two rays are drawn, all must be correct for 2 marks rays drawn as dashed lines do not score	2
	image drawn as a vertical line from the axis to where the rays cross the image need not have an arrowhead, but if it has, it must point down	1
	ray direction shown only one correct arrow is needed, but there must be no contradiction	1



Waves · Topic Test

(b)	any two from: inverted, magnified, real accept upside down; bigger; not virtual one correct feature gains 1 mark an incorrect feature cancels a correct one ignore the position	2
(c)	magnification = $4 \div 2$ (squares) allow their image height $\div$ object height	1
	= 2 allow error carried forward from their diagram no unit: magnification is a ratio	1

Total: 8 marks

10 Question 10 — mark scheme

Physics (triple) only

5 marks

PART	ANSWER	MARK
(a)	the temperature stays the same accept: it is in thermal equilibrium	1
	because there is no net energy transfer (energy in = energy out)	1
(b)	the intensity increases (at every wavelength)	1
	the peak intensity is at a shorter wavelength accept: the peak moves to the left	1
(c)	its peak wavelength is shorter still, at the blue end of the visible spectrum accept: it gives out more blue light than red light	1

Total: 5 marks

11 Question 11 — mark scheme

Physics (triple) only

5 marks

PART	ANSWER	MARK
(a)(i)	only red light passes through the filter accept: the other colours are absorbed by the filter "red light passes through" on its own is insufficient this mark may be awarded in (a)(i) or (a)(ii), as long as there is no contradiction	1
	the ball reflects the red light accept: white objects reflect all colours	1
(a)(ii)	black	1

Waves · Topic Test

the green ball absorbs the red light / does not reflect red light

1

accept: no green light reaches the ball

(b) two red spots

1

accept: red, black, red

“two spots” or “red spots” is insufficient

do not accept “only red light”

Total: 5 marks

12 Question 12 — mark scheme

Physics (triple) only

4 marks

PART	ANSWER	MARK
(a)	A	1
(b)(i)	its speed decreases suddenly accept: it refracts / changes direction	1
(b)(ii)	the speed increases (as the depth increases)	1
	steadily / linearly, or from about 11.8 km/s to 13.6 km/s, or by about 1.8 km/s allow 11.6 to 12.0 and 13.4 to 13.8 km/s	1

Total: 4 marks

END OF MARK SCHEME