

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.6.2 ELECTROMAGNETIC WAVES (PACK 3)

SCORE

/204

PERCENTAGE

%

STEMUP

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Q1.

In the diagram below, a frog sits on a rock in a pond.

- (a) Complete the following sentences by drawing a ring around the correct line in the box.

- (i) The frog can see its image in the pond because the surface of the pond acts

like a

concave
convex
plane

 mirror.

(1)

- (ii) Draw a ring around each of **two** words from the box below to describe the image in the pond.

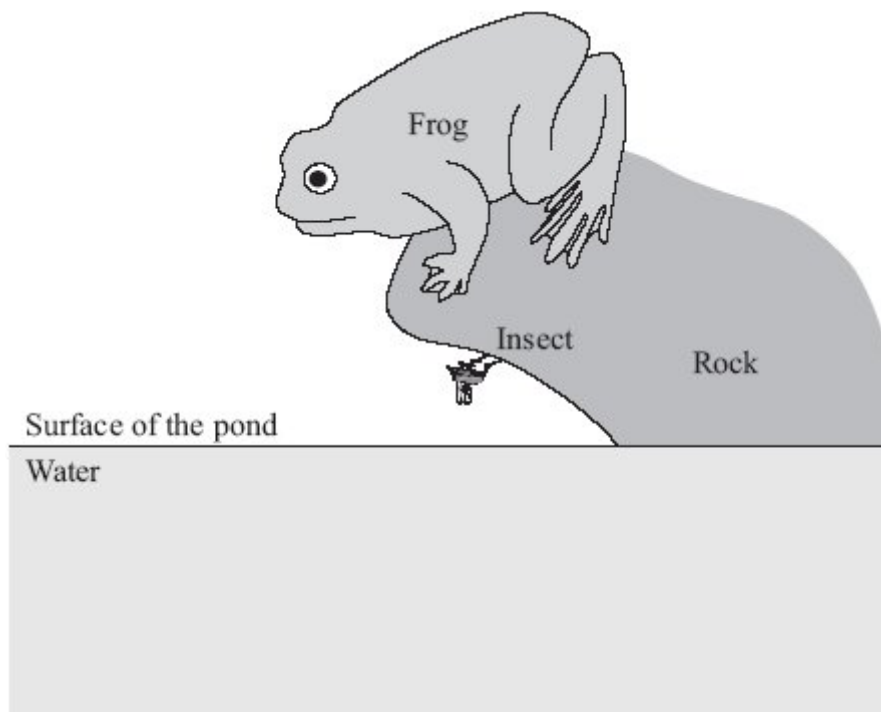
bigger	inverted	real	smaller	upright	virtual
---------------	-----------------	-------------	----------------	----------------	----------------

(2)

- (b) There is an insect underneath the rock.

Use a ruler to draw rays of light on the diagram to show how the frog uses reflection to see the insect.

Mark the direction of the rays.

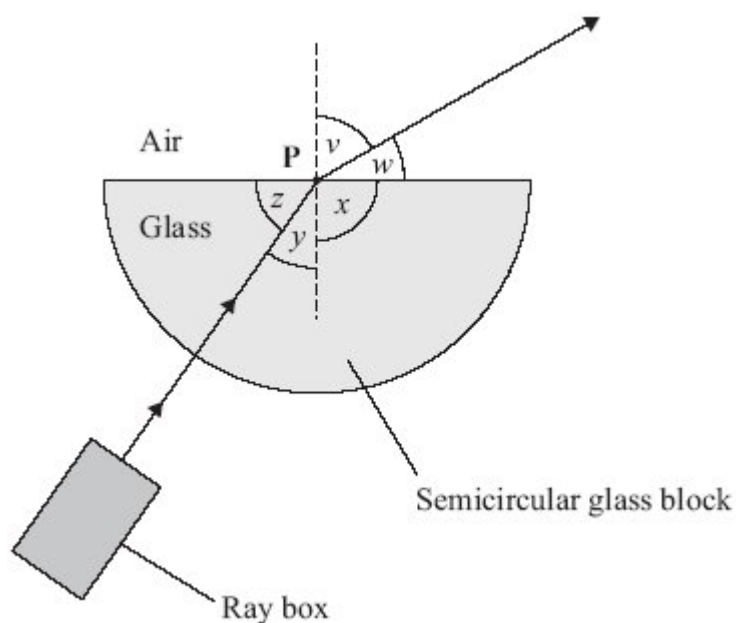


(3)

(Total 6 marks)

Q2.

A student uses a ray box and a semicircular glass block to investigate refraction.



- (a) What is the vertical dashed line called?

_____ (1)

- (b) Which angle, v , w , x , y or z , is the angle of refraction?

_____ (1)

- (c) Why has refraction taken place?

_____ (1)

- (d) In an investigation, a student always aims the light from the ray box at point **P**. She moves the ray box to give different values of angle v . She records angle y for each of these values. The table shows her results.

Angle v measured in degrees	Angle y measured in degrees
30	19
40	25
50	31
60	35
70	39

80	41
----	----

The student studies the data and comes to the following conclusion.

Angle y is directly proportional to angle v .

Her friend says that this conclusion is **not** correct.

- (i) Use data from the table to explain why the conclusion is **not** correct.

(2)

- (ii) Write a correct conclusion for the experiment.

(1)

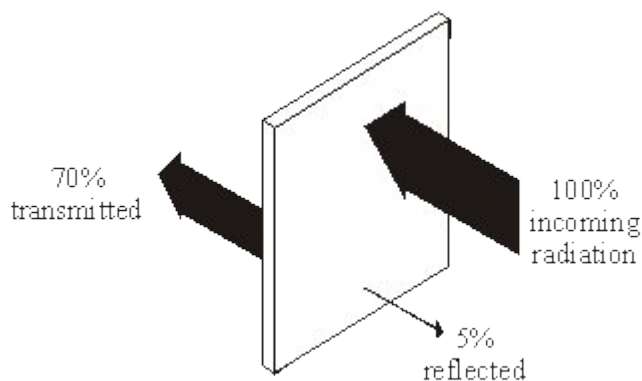
- (iii) Why is your conclusion only valid when angle v is between 30° and 80° ?

(1)

(Total 7 marks)

Q3.

- (a) Infra red radiation can be reflected, absorbed and transmitted by glass.



- (i) What percentage of infra red is absorbed by the glass?

(1)

- (ii) Complete the following sentence by drawing a ring around the correct word or phrase.

The absorbed infra red

increases
does not change
decreases

the temperature of the glass.

(1)

- (b) **Two** of the following statements are true. **One** of the statements is false.

Tick (✓) the boxes next to the **two** true statements.

All objects absorb infra red radiation.	☐
Black surfaces are poor emitters of infra red radiation.	☐
A hot object emits more infra red than a cooler object.	☐

(1)

- (c) The following statement is false.

Black surfaces are good reflectors of infra red radiation.

Change **one** word in this statement to make it true.

Write down your **new** statement.

(1)

(Total 4 marks)

Q4.

- (a) The wavelengths of four different types of electromagnetic wave, including visible light waves, are given in the table.

Type of wave	Wavelength
Visible light	0.0005 mm
A	1.1 km
B	100 mm
C	0.18 mm

Which of the waves, **A**, **B** or **C**, is an infra red wave?

(1)

- (b) A TV station broadcasts at 500 000 kHz. The waves travel through the air at 300 000 000 m/s.

Calculate the wavelength of the waves broadcast by this station.

Show clearly how you work out your answer.

Wavelength = _____ m

(2)

- (c) What happens when a metal aerial absorbs radio waves?

(2)

- (d) Stars emit all types of electromagnetic waves. Telescopes that monitor X-rays are mounted on satellites in space.

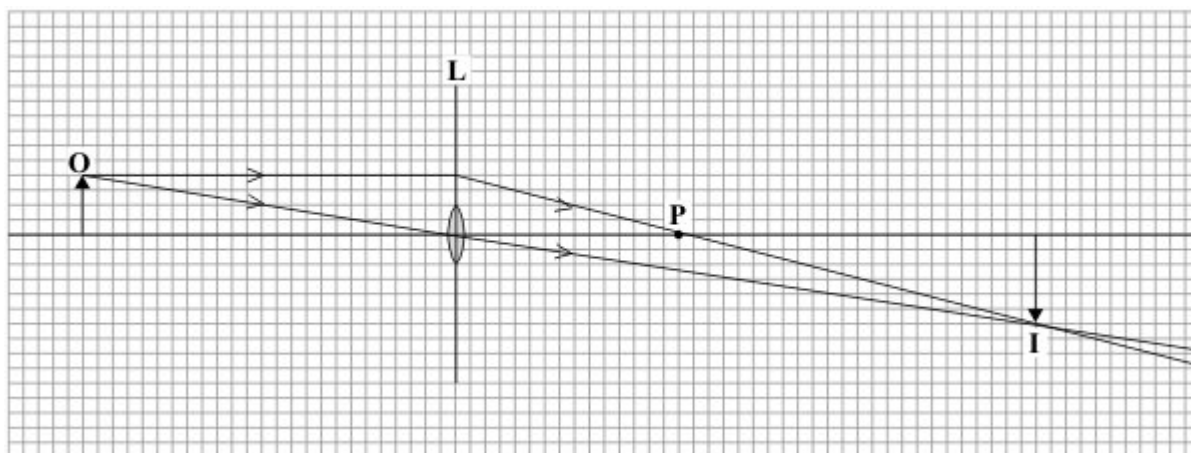
Why would an X-ray telescope based on Earth not be able to detect X-rays emitted from distant stars?

(1)

(Total 6 marks)

Q5.

The ray diagram shows the position and size of the image, **I**, of an object, **O**, formed by a lens, **L**.



- (a) What type of lens is shown in the ray diagram?

(1)

- (b) Name the point labelled **P**.

(1)

- (c) The ray diagram has been drawn to scale.

Use the equation to calculate the magnification.

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

Show clearly how you work out your answer.

Magnification = _____

(2)

- (d) How can you tell from this ray diagram that the image is a real image?

(1)

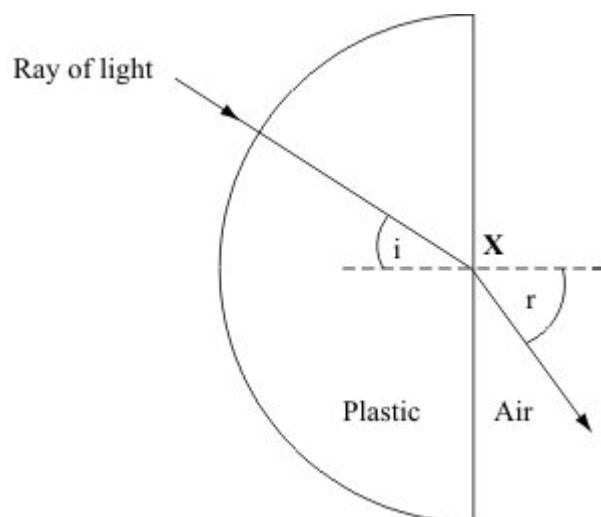
(Total 5 marks)

Q6.

- (a) A student investigated the refraction of light as it passes out of a transparent plastic block.

She aimed a ray of light at point **X**. She marked the position of the ray as it passed through the transparent plastic block and into the air.

The angle i is the angle of incidence.



(i) What is the name of angle r ?

_____ (1)

(ii) What is the name of the dashed line?

_____ (1)

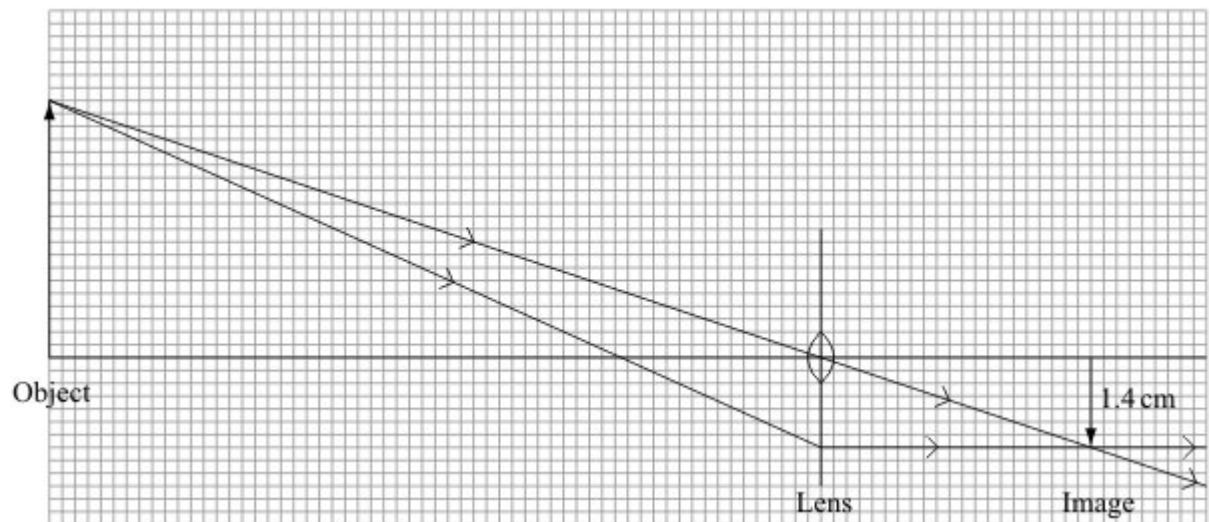
(b) A camera uses a lens to produce an image which falls on a light detector.



Name a light detecting device which may be used in a camera.

_____ (1)

(c) The diagram shows the position of an image formed in a camera.



(i) What type of lens is shown in the diagram?

_____ (1)

(ii) Use the equation in the box to calculate the magnification.

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

Show clearly how you work out your answer.

Magnification = _____

(2)

(d) Why does the image formed in a camera have to be a real image?

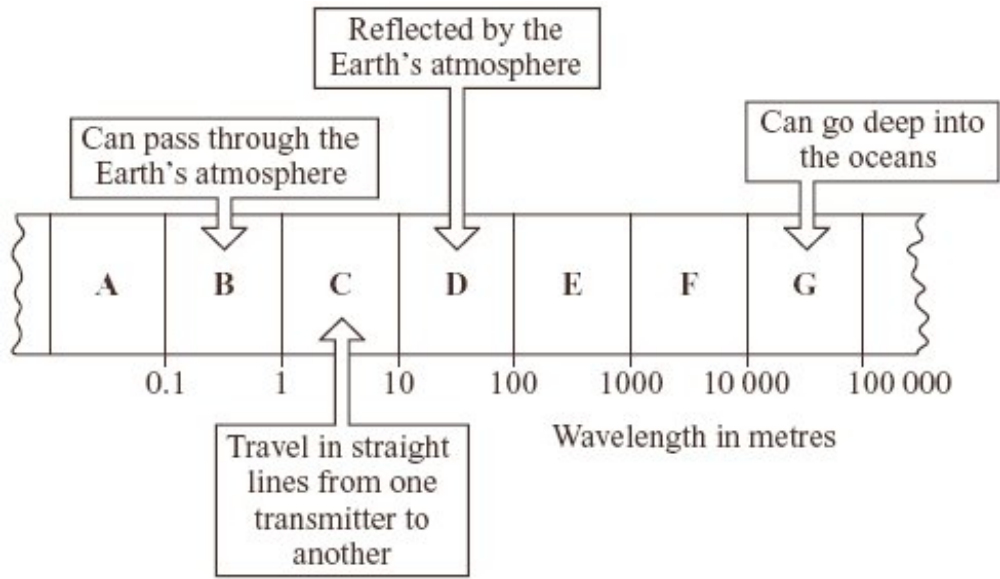
(1)

(Total 7 marks)

Q7.

The diagram shows a small part of the electromagnetic spectrum divided into seven sections.

The different properties of the waves in each section make them useful in different ways.



The waves in which section, **A**, **B**, **C**, **D**, **E**, **F** or **G**, are:

(a) used to send a signal to a satellite in space

(1)

(b) used to communicate with a submarine under the water

(1)

- (c) used by a radio station to broadcast programmes around the world

(1)

- (d) the waves with the shortest wavelength?

(1)

(Total 4 marks)

Q8.

- (a) Mobile phones send *digital* signals using electromagnetic waves.
- (i) Which **one** of the following types of electromagnetic wave is used to carry information between masts in a mobile phone network?

Draw a ring around your answer.

light	microwave	radio
-------	-----------	-------

(1)

- (b) Some people worry that using a mobile phone may be bad for their health.

Look at this information taken from a recent newspaper article.

- Scientists in Sweden found that the regular use of a mobile phone increases the risk of a cancerous growth between the ear and the brain.
- Some people who use mobile phones for a long time complain of headaches and tiredness. The same effect has not been noticed in laboratory tests.
- There is no reliable evidence to link using mobile phones with ill health.
- The waves from a mobile phone are not strong enough to cause long-term heat damage to cells in the body.

- (i) Complete the following sentence by drawing a ring around the word in the box that is correct.

The evidence from different scientists doing the same investigation is reliable if

all the scientists get

different
identical
random

results.

(1)

- (ii) What information in the article supports the idea that mobile phones are bad for your health?

(2)

- (iii) Some scientists say that using a mobile phone is totally safe.

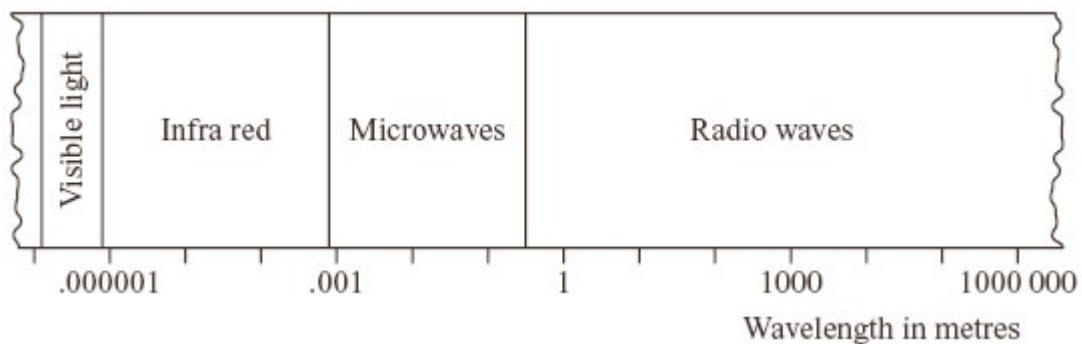
What information in the article supports this view?

(2)

(Total 6 marks)

Q9.

The diagram represents part of the electromagnetic spectrum.



- (i) Visible light travels through air at 300 000 000 m/s.

Why can we assume that radio waves travel through air at the same speed as light?

(1)

- (ii) A radio station broadcasts at a frequency of 200 kHz.

Calculate the wavelength of the waves broadcast by this radio station. Show clearly how you work out your answer.

Wavelength = _____ m

(2)

- (iii) Draw a vertical line on the diagram above to show the position of this radio wave in the electromagnetic spectrum.

Q10.

- (a) Satellites fitted with various telescopes orbit the Earth. These telescopes detect different types of electromagnetic radiation.

Why are telescopes that detect different types of electromagnetic waves used to observe the Universe?

(1)

- (b) In 2005 a space telescope detected a star that exploded 13 billion years ago. The light from the star shows the biggest *red-shift* ever measured.

- (i) What is *red-shift*?

(1)

- (ii) What does the measurement of its red-shift tell scientists about this star?

(1)

- (c) Red-shift provides evidence for the 'big bang' theory.

- (i) Describe the 'big bang' theory.

(2)

- (ii) Suggest what scientists should do if new evidence were found that did not support the 'big bang' theory.

(1)

(Total 6 marks)

Q11.

- (a) The new Tetra communications system to be used by the police transmits signals using microwaves of wavelength 75 cm.

Calculate the frequency of the microwaves used by the Tetra system. Show clearly how you work out your answer.

Frequency = _____ hertz

(2)

- (b) Read the following extract from a newspaper and then answer the questions that follow.

Residents of Stag Hill Court, a luxury block of flats, are shocked at the plans to site a mobile phone mast on the roof of the flats. They oppose the mast on health grounds, quoting research in Germany that has found a possible increase in cases of cancer around mobile phone masts.

A spokesperson for the telecoms company said, 'The residents should not worry. The research carried out by our own scientists has found no link between ill health and mobile phone masts'.

This has not reassured the residents, who argue that new independent research is urgently needed.

- (i) Explain why living near a mobile phone mast could cause ill health.

(3)

- (ii) Suggest **two** reasons why the residents have **not** been reassured by the research carried out by the telecoms company.

1. _____

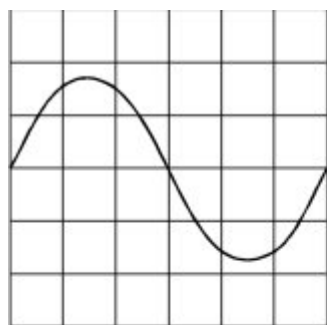
2. _____

(2)

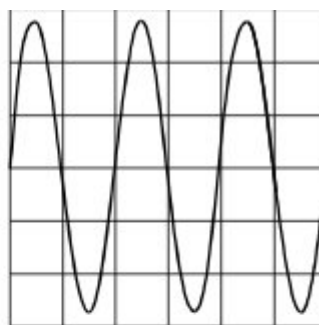
(Total 7 marks)

Q12.

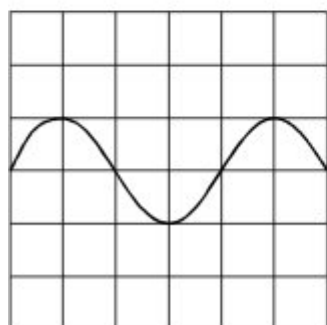
The diagram shows four oscilloscope wave traces. The controls of the oscilloscope were the same for each wave trace.



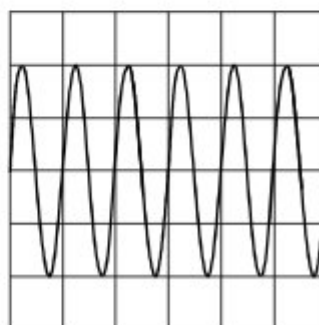
A



B



C



D

Which **one** of the waves traces, **A**, **B**, **C** or **D**, has:

(i) the largest amplitude," _____

(1)

(ii) the lowest frequency? _____

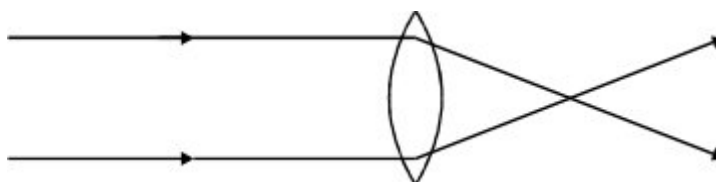
(1)

(Total 2 marks)

Q13.

(a) The diagram shows how parallel rays of light pass through a convex lens.

(i) Mark the position of the focus.



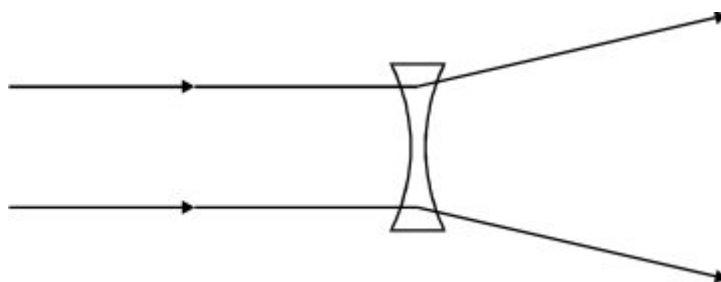
(1)

(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

(1)

(b) The diagram shows how parallel rays of light pass through a concave lens.

(i) Mark the position of the focus.



(1)

(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

(1)

(c) Complete these sentences by crossing out the **two** lines in each box that are wrong.

converging
diverging
parallel

In a camera, a _____ lens is used to produce an image of an

film
lens
screen

object on a _____.

larger than
smaller than
the same size as

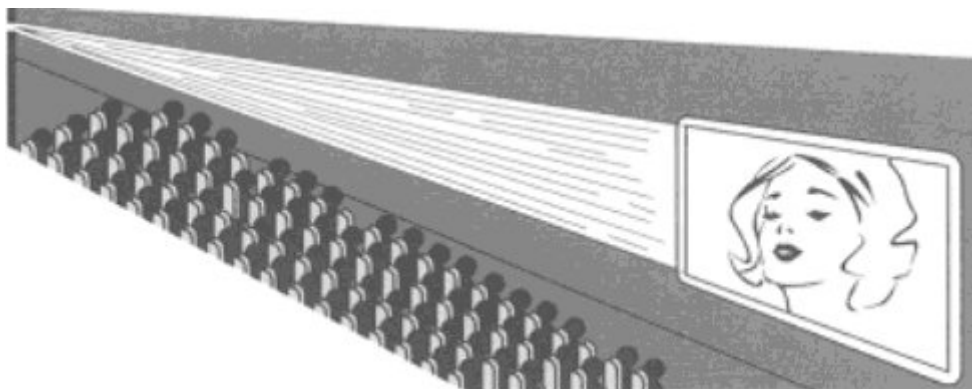
The image is _____ the object.

further from
nearer to
the same distance from

The image is _____ the lens, compared to the distance of the object from the lens.

(4)

(d) In a cinema projector, a convex lens is used to produce a *magnified, real* image.



(i) What does *magnified* mean?

(1)

(ii) What is a *real* image?

(1)

(e) You are in a dark room. You have a box containing some lenses. Only **one** of them is a converging lens.

Describe how, by just feeling the lenses, you can pick out the converging lens.

(2)

(Total 12 marks)

Q14.

The drawing shows someone ironing a shirt. The top of the ironing board is covered in a shiny silver-coloured material.



Explain why the shiny silver-coloured material helps to make ironing easier.

(Total 2 marks)

Q15.

(a) The diagram shows a lens used as a magnifying glass. The position of the eye is shown and the size and position of an object standing at point **O**.

(i) What type of lens is shown in the diagram?

(1)

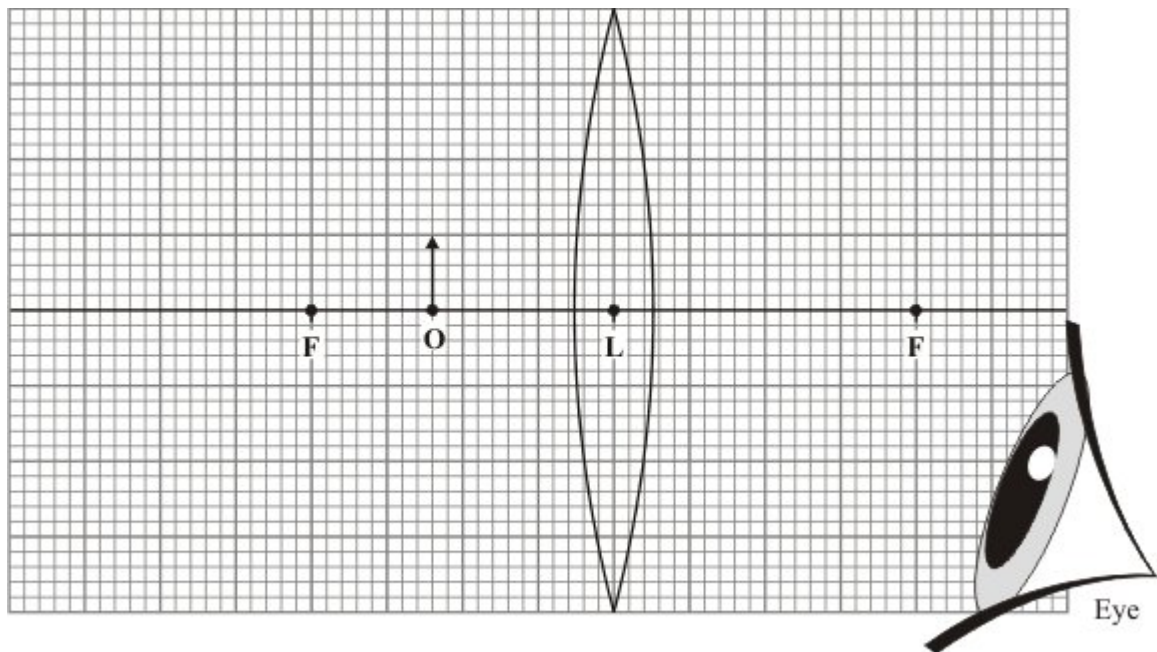
(ii) Two points are marked as **F**. What are these points?

(1)

(iii) What is the name of the straight line which goes through the point **F**, through the point **L** at the centre of the lens, and through the point **F** on the other side?

(1)

(iv) On the diagram, use a ruler to construct accurately the position of the image. You should show how you construct your ray diagram and how light appears to come from this image to enter the eye.



(5)

- (v) The image is *virtual*. What is a *virtual* image?

(1)

- (b) The lens shown in the diagram in part (a)(iv) can be used in a camera to produce a *real* image.

Explain why a *real* image must be produced in a camera and how the object and the lens are positioned to produce a *real* image which is **smaller** than the object.

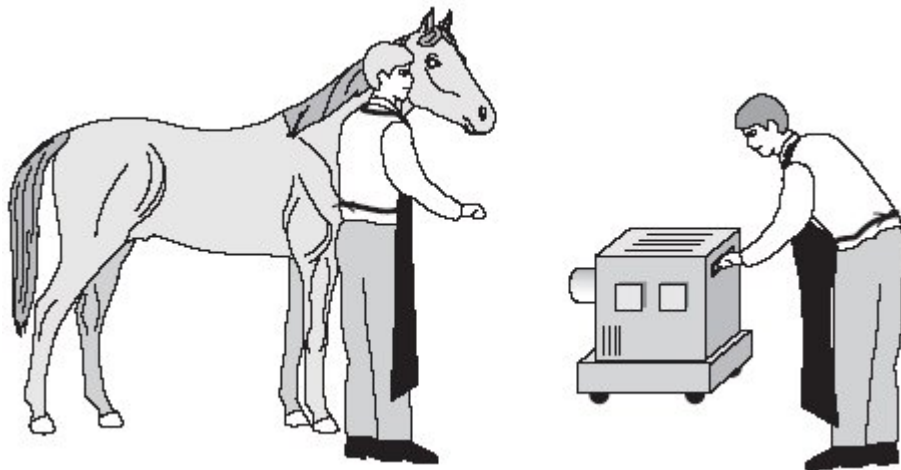
Do **not** draw a ray diagram as part of your answer.

(3)

(Total 12 marks)

Q16.

The picture shows a horse being prepared for an X-ray.



The person who will take the X-ray and the person holding the horse are wearing special aprons. These aprons have a lead lining.

Explain why the lead lining is important.

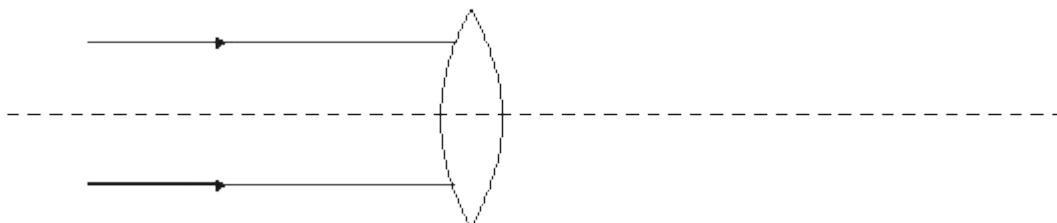
To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

(Total 3 marks)

Q17.

(a) The diagram shows two parallel rays of light, a lens and its axis.

(i) Complete the diagram to show what happens to the rays.



(2)

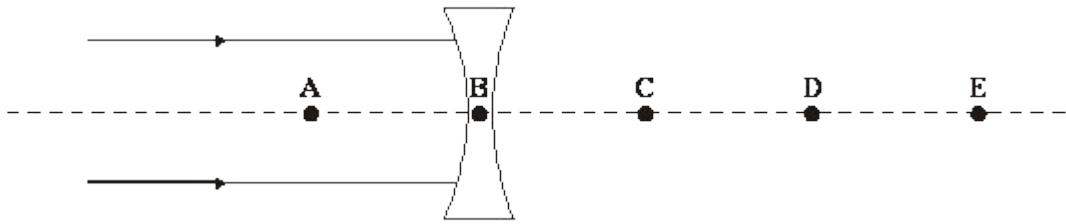
(ii) Name the point where the rays come together.

(1)

(iii) What word can be used to describe this type of lens?

(1)

- (b) The diagram shows two parallel rays of light, a lens and its axis.



- (i) Which point **A**, **B**, **C**, **D** or **E** shows the focal point for this diagram?

Point _____

(1)

- (ii) Explain your answer to part (b)(i).

(1)

- (iii) What word can be used to describe this type of lens?

(1)

- (c) Complete the following **three** sentences by crossing out the **two** lines in each box which are wrong

In a camera a converging lens is used to produce an image on a

film
lens
screen

The image is

larger than
smaller than
the same size as

the object.

Compared to the distance of the image from the lens, the object is

further away from
nearer to
the same distance from

the lens.

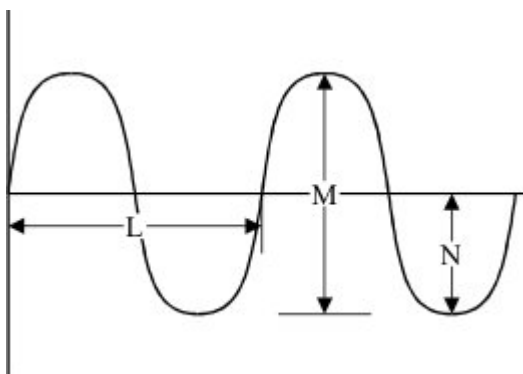
(3)

- (d) Explain the difference between a *real* image and a *virtual* image.

(3)
(Total 13 marks)

Q18.

- (a) The diagram shows a wave pattern.



Which letter, **L**, **M** or **N** shows:

- (i) the wavelength? _____
(ii) the amplitude? _____

(2)

- (b) Describe how you could show that visible light travels in straight lines. You may wish to draw a diagram to help explain your answer.

(2)
(Total 4 marks)

Q19.

All radio waves travel at 300 000 000 m/s in air.

- (i) Give the equation that links the frequency, speed and wavelength of a wave.

(1)

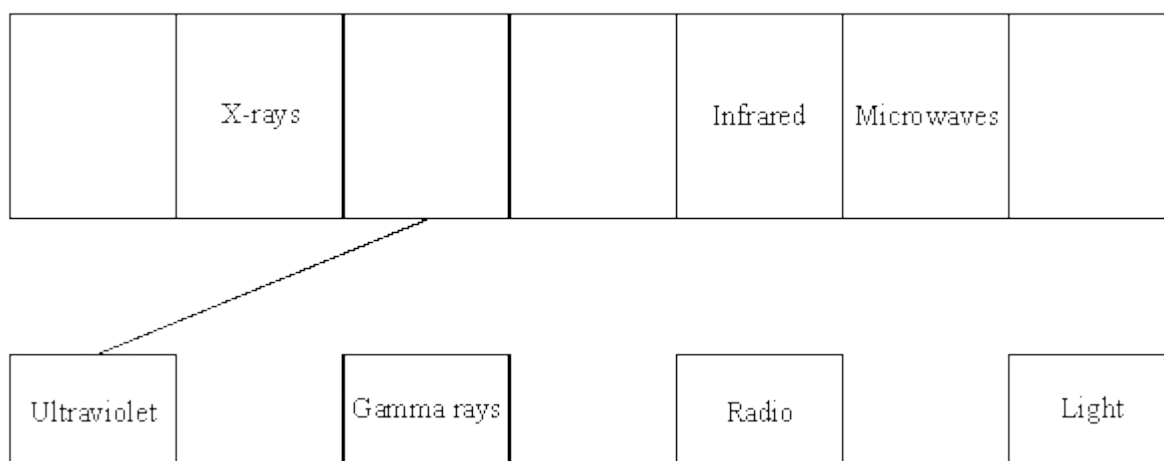
- (ii) Calculate the wavelength, in metres, of a radio wave which is broadcast at a frequency of 909 kHz. Show clearly how you work out your answer.

Wavelength = _____ metres

(2)
(Total 3 marks)

Q20.

- (a) The diagram represents the electromagnetic spectrum. Four of the waves have not been named. Draw lines to join each of the waves to its correct position in the electromagnetic spectrum. One has been done for you.



(2)

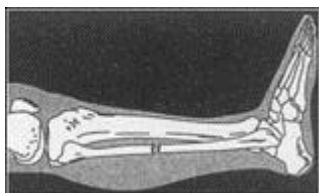
- (b) Complete the following sentence by choosing the correct answer and crossing out in the box the two lines which are wrong.

faster than
the same as
slower than

The speed of radio waves through a vacuum is _____ the speed of light through a vacuum.

(1)

- (c) The diagram shows an X-ray photograph of a broken leg.



Bones show up white on the photographic film. Explain why.

(2)

(Total 5 marks)

Q21.

- (a) A swimming pool has a wave making machine. The diagram shows the water wave pattern for 3 seconds.



- (i) How many water waves are shown in the diagram?

(1)

- (ii) What is the frequency of the water waves?

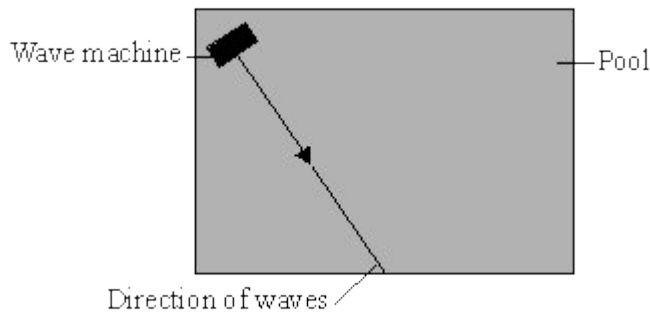
(1)

- (iii) Which **one** of the units below is used to measure frequency? Underline your answer.

hertz joule watt

(1)

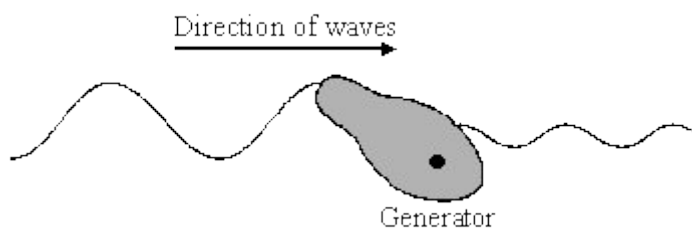
- (b) The diagram shows the direction of the waves across the pool. The waves reflect off the side of the pool.



Draw a line on the diagram to show the direction of the waves after they hit the side of the pool.

(1)

- (c) The swimming pool is used to test a model of an electricity generator. The waves make the floating generator move up and down. This energy is transferred to electricity.



- (i) In the following sentence, cross out the **two** lines that are wrong in the box.

The diagram shows that the amplitude of the waves

gets larger
stays the same
gets smaller

 as the waves pass the generator.

(1)

- (ii) What type of energy does the generator transfer to electricity?

(1)

- (iii) Energy from ocean waves could be used to generate electricity. Would this be a renewable or non-renewable energy resource?

(1)

(Total 7 marks)

Q22.

Microwaves are used to transmit signals to the satellite. The microwaves have a wavelength of 0.6 metres (m) and travel through space at a speed of 300 000 000 metres per second (m/s).

- (i) Write down the equation which links frequency, wavelength and wave speed.

(1)

- (ii) Calculate the frequency of the microwaves. Show clearly how you work out your answer and give the unit.

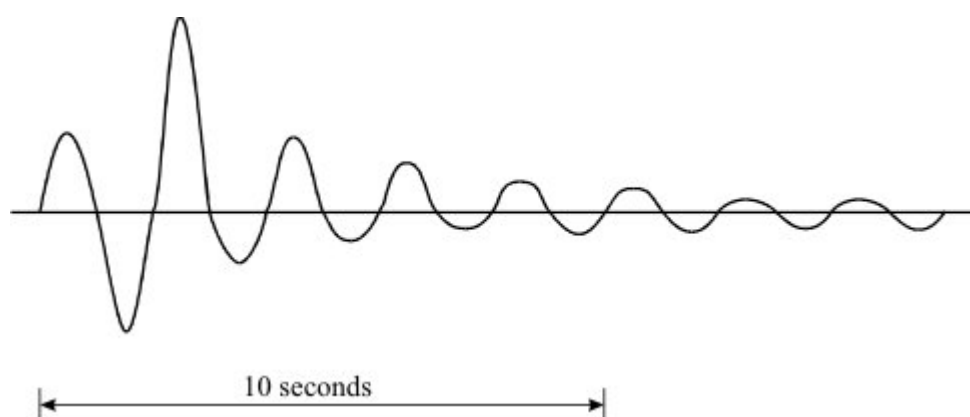
Frequency = _____

(3)

(Total 4 marks)

Q23.

The vibration caused by a P wave travelling at 7.6 km/s has been recorded on a seismic chart.



- (i) How many waves are produced in one second?

(1)

- (ii) Write down the equation which links frequency, wavelength and wave speed.

(1)

- (iii) Calculate the wavelength of the P wave. Show clearly how you work out your answer and give the unit.

Wavelength = _____

(2)

(Total 4 marks)

Q24.

After a person is injured a doctor will sometimes ask for a photograph to be taken of the patient's bone structure, e.g. in the case of a suspected broken arm.

- (i) Which type of electromagnetic radiation would be used to take the photograph?

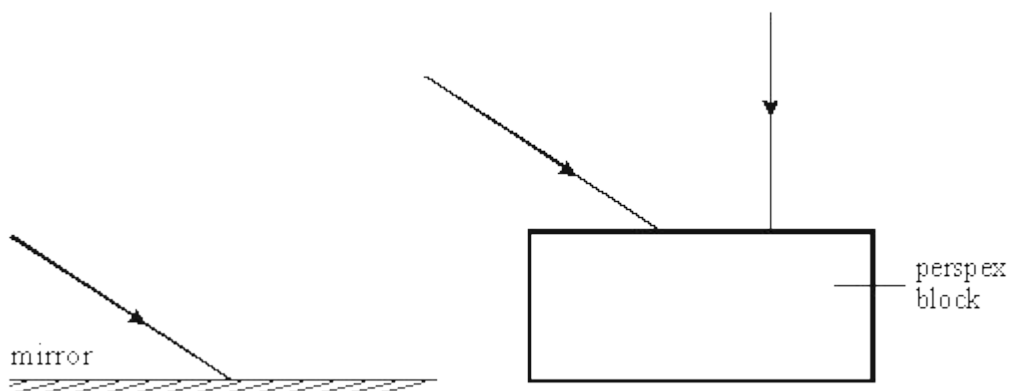
_____ (1)

- (ii) Describe the properties of this radiation which enable it to be used to photograph bone structure.

_____ (2)
(Total 3 marks)

Q25.

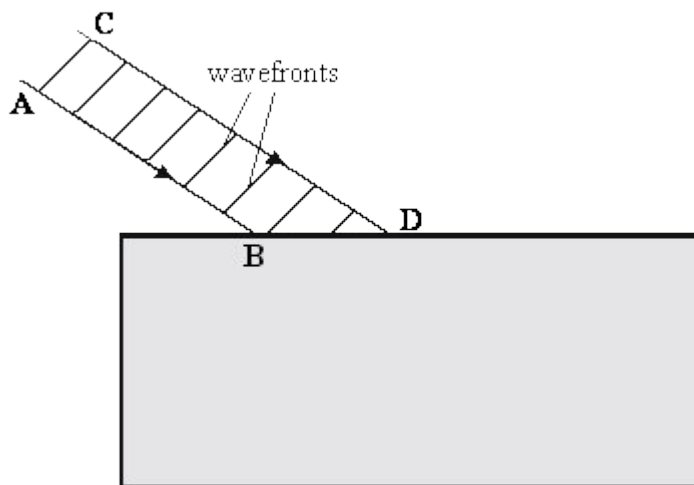
- (a) The diagrams below show rays of light striking a mirror and a perspex block.



Complete the paths of the three rays of light on the diagrams to show the rays leaving the mirror and the perspex block.

(4)

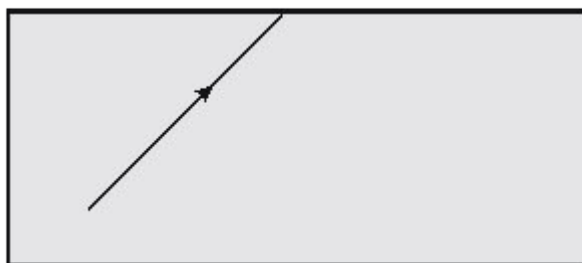
- (b) The diagram below shows a beam of light striking a perspex block.



- (i) Continue the paths of the rays AB and CD inside the perspex block.
- (ii) Draw the wavefronts of the beam of light in the perspex.
- (iii) Explain why the beam behaves in the way you have shown.

(7)

- (c) The diagram below shows a ray of light striking a perspex-air surface from inside the perspex. The critical angle is 45° .



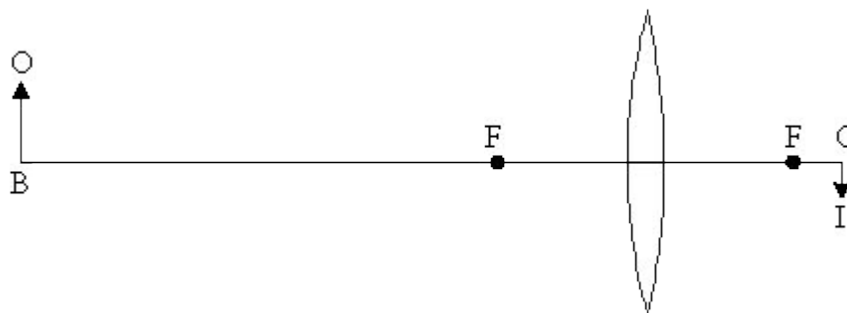
Draw the path of the ray after it reaches the perspex-air boundary.

(2)

(Total 13 marks)

Q26.

The diagram shows the image IC formed by a lens, of an object OB a long way from it. The points F mark the focal points of the lens.



- (a) Describe, either by writing below or drawing on the diagram, how the size and position of the image changes:

- (i) when the object OB is moved towards the focal point F.

- (ii) when the object OB is moved past F to a point nearer the lens than the focal point.

(4)

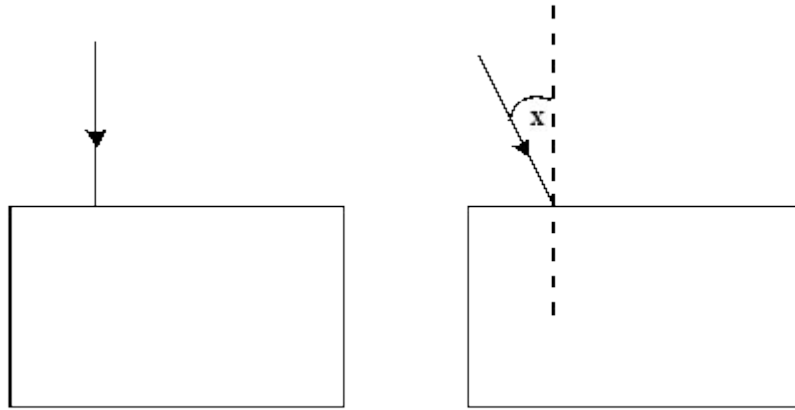
- (b) Explain how a converging lens in a camera is used to produce sharp images on the film when the object is a long distance away from the camera, and when it is close to the camera.

(3)

(Total 7 marks)

Q27.

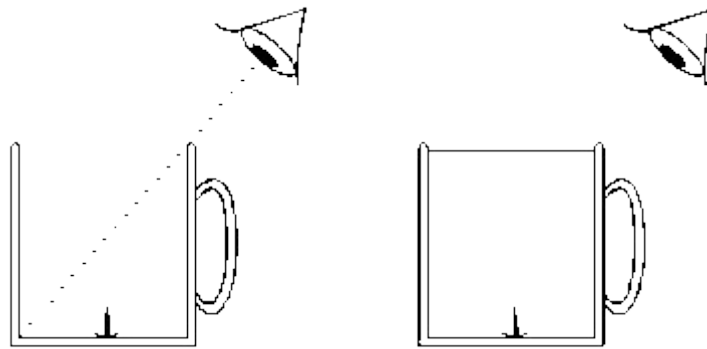
- (a) The diagrams show rays of light. Each ray strikes a surface of a glass block.



- (i) On the diagram draw the path of each ray through the glass block and out into the air again.
- (ii) Label another angle on the diagram which is equal to the angle marked **X**. Label this angle **Y**.

(4)

- (b) The diagrams show two beakers. Both beakers have a drawing pin inside as shown.



The first beaker is empty. The eye cannot see the drawing pin.
The second beaker is full of water and the eye can see the drawing pin.

Explain how the eye is able to see the drawing pin in the second beaker. You may add to the diagram if it helps your answer.

(3)

(Total 7 marks)

Q28.

Lenses are used in many optical devices.

Complete the table below about the images formed by some optical devices.

OPTICAL	NATURE OF	SIZE OF	POSITION OF
---------	-----------	---------	-------------

DEVICE	IMAGE	IMAGE	IMAGE
Eye	real		
Projector		Magnified	
camera			Closer to lens than the object

(Total 6 marks)

Q29.

Radio waves, ultra-violet, visible light and X-rays are all types of electromagnetic radiation.

- (a) Choose wavelengths from the list below to complete the table.

$3 \times 10^{-8} \text{ m}$ $1 \times 10^{-11} \text{ m}$ $5 \times 10^{-7} \text{ m}$ 1500 m

TYPE OF RADIATION	WAVELENGTH (m)
Radio waves	
Ultra-violet	
Visible light	
X-rays	

(4)

- (b) Microwaves are another type of electromagnetic radiation.

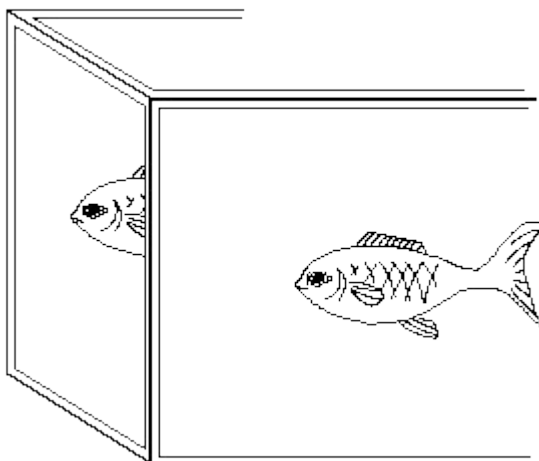
Calculate the frequency of microwaves of wavelength 3 cm.
(The velocity of electromagnetic waves is $3 \times 10^8 \text{ m/s}$.)

(4)

(Total 8 marks)

Q30.

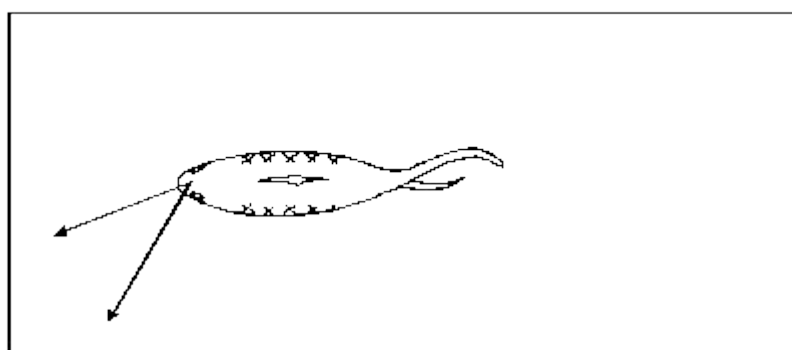
An aquarium contains only one fish. But if you look at the corner of the aquarium, there seem to be two fish.



The diagram below shows the top of the aquarium.

Two light waves have been drawn from the fish.

- (a) Complete the diagram to show how the light waves reach the eye.



(2)

- (b) Complete each sentence by using the correct words from the box.

colour	diffraction	longitudinal	reflection
refraction	speed	transverse	

When the light waves pass from glass into the air they change _____

This causes a change in direction called _____

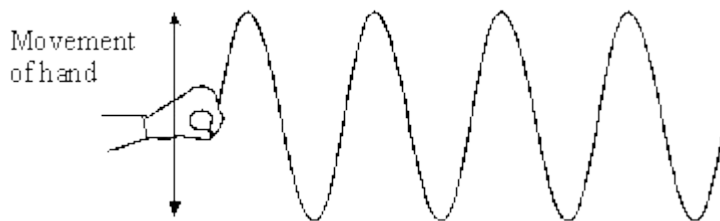
Light waves are _____ waves.

(3)

(Total 5 marks)

Q31.

The diagram shows a wave travelling along a rope.



(a) On the diagram:

- (i) show the wavelength and label it **W**;
- (ii) show the amplitude and label it **A**.

(2)

(b) The wavelength of the wave is 0.1 m. Its frequency is 2 Hz.

Calculate the speed of the wave. Show clearly how you work out your answer and give the unit.

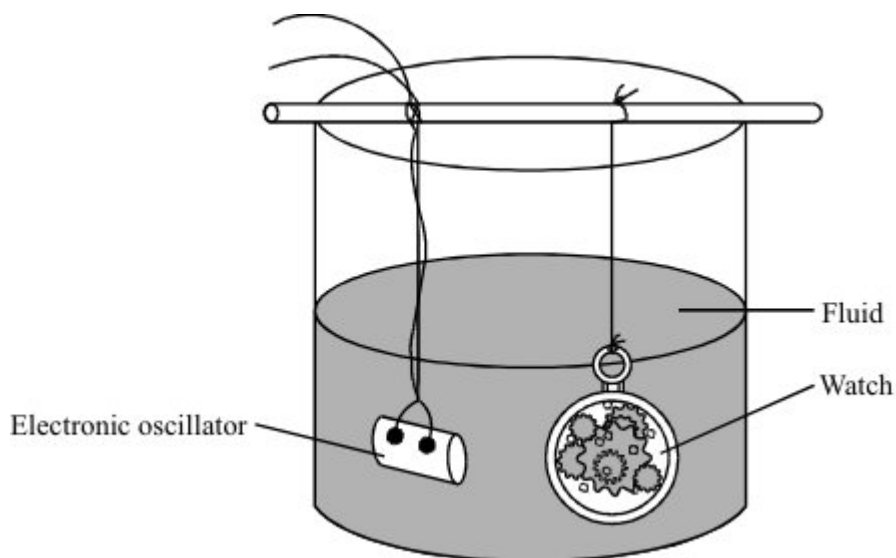
Speed of wave _____

(3)

(Total 5 marks)

Q32.

The diagram shows how ultrasonic waves can be used to clean a watch.

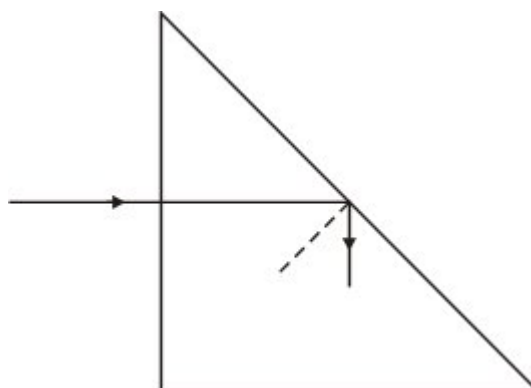


Suggest how this method cleans the watch.

Q33.

Glass prisms are used in many optical devices.

- (a) The diagram shows what happens to a ray of light as it travels through a glass prism.



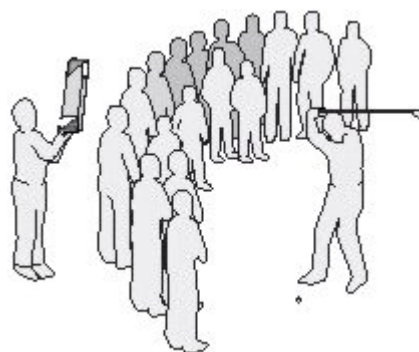
To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

Use the words in the box to help you to explain why the ray behaves in this way.

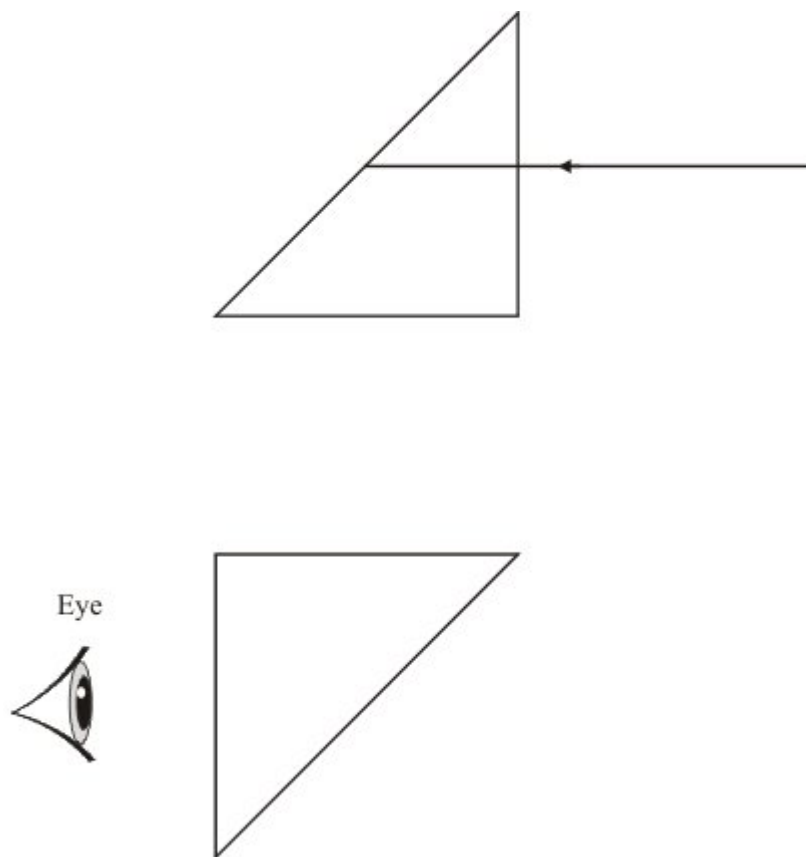
angle	critical	normal
-------	----------	--------

(3)

- (b) Periscopes can be used to look over the heads of other people.



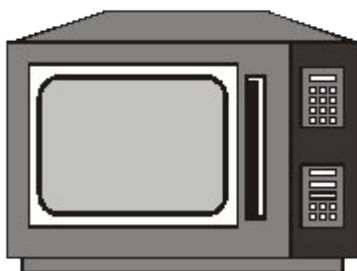
A periscope contains two glass prisms.
Complete the diagram to show the ray of light reaching the person's eye.



(3)
(Total 6 marks)

Q34.

Microwave ovens can be used to heat many types of food.



- (i) Describe, in as much detail as you can, how microwaves heat food.

(2)

- (ii) Microwaves have a frequency of 10 000 million Hz. Their wavelength is 0.03 m.

Calculate the speed of microwaves.

Show clearly how you work out your answer.

Speed of microwaves _____ m/s

(2)

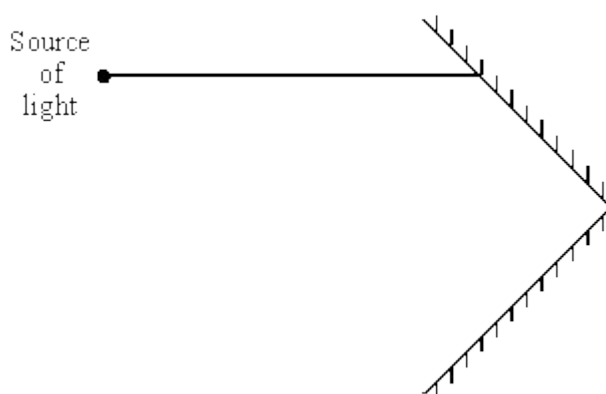
(Total 4 marks)

Q35.

- (a) The diagram shows two mirrors at right angles to each other. A ray of light shines onto one mirror as shown.

Carefully draw the path of the ray which is reflected from both mirrors.

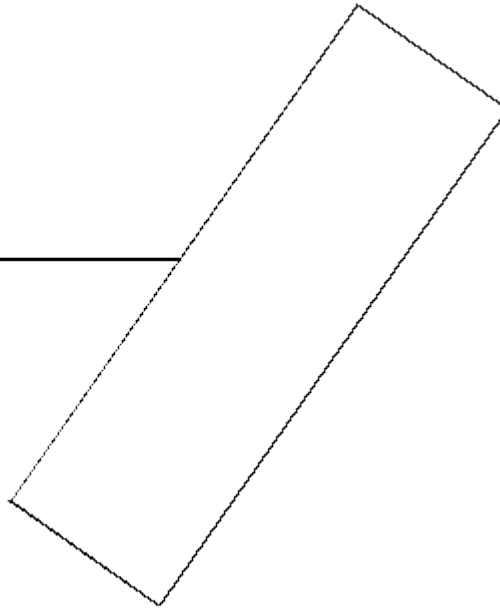
Draw an arrow on the ray to show the direction of the light.



(3)

- (b) Light can also be made to change direction as it passes into and out from a block of glass. Complete the ray diagram below.

Source
of
light



(2)
(Total 5 marks)

Mark schemes

Q1.

- (a) (i) plane

accept any unambiguous indication

1

- (ii) inverted

1

virtual

accept any unambiguous indication

1

- (b) reflection takes place at the surface of the pond and angle of incidence = angle of reflection

as judged by eye

1

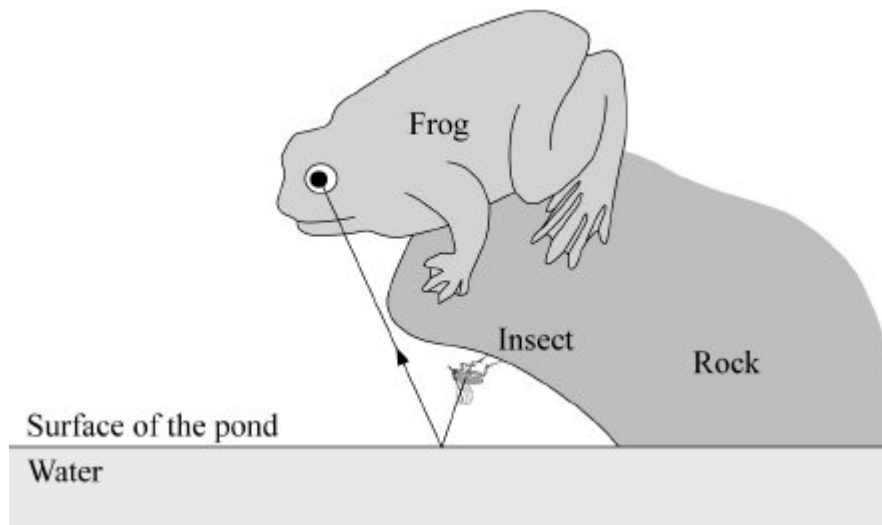
reflected ray is a straight line to frog's eye through the air

1

correct direction arrow **either** from insect **or** to frog's eye

only one arrow essential but

*do **not** accept if either arrow contradicted example of a fully correct response*



1

[6]

Q2.

- (a) the normal

1

- (b) v

1

- (c) any **one** from:

- light has moved from glass to air / from air to glass
accept light has changed medium
 - speed of light has changed
beware of contradictions for this marking point eg light has moved from glass to air and slowed down gets zero
 - angle of incidence is less than the critical angle
or (angle) $i < \text{(angle) } c$ or (angle) y is less than the critical angle
 - change in density (of medium)
eg glass is more (optically) dense than air
- 1
- (d) (i) ratio of v to y does not give the same answer (in every case)
- or** value of v doubles value of y does not double
- 1
- or** increments for v are the same but increments for y are not the same
allow for 1 mark a calculation but no conclusion
eg $30 \rightarrow 60$ $19 \rightarrow 35$ (38)
- 1
- (ii) as (angle) v increases, angle y increases
accept as the angle of incidence increases, the angle of refraction increases
or there is a (strong) positive(non-linear) relationship between the variables
or ratio of sines is constant
*do **not** accept angle y is not directly proportional to angle v*
- 1
- (iii) no evidence outside this range
OWTTE
- or** when angle y is greater than the critical angle total internal reflection occurs
- 1

[7]

Q3.

- (a) (i) 25 (%)
*do **not** accept $\frac{1}{4}$*
- 1
- (ii) increases
- 1
- (b) tick (✓) in top and bottom box
both required
- 1
- (c) SHINY surfaces are good reflectors of infra-red radiation

accept white for shiny

or black surfaces are POOR reflectors of infra-red radiation

accept bad for poor

accept insertion of 'not' before 'good' in statement

or black surfaces are good EMITTERS of infra-red radiation

or black surfaces are good ABSORBERS of infra red radiation

1

[4]

Q4.

(a) C or 0.18 mm

1

(b) 0.6 m

allow 1 mark for correct transformation and substitution

allow 1 mark for changing frequency to Hz

answer 600 gains 1 mark

2

(c) creates an alternating current

accept 'ac' for alternating current

accept alternating voltage

1

with the same frequency as the radio wave

accept signal for radio wave

or it gets hotter

1

(d) X-rays cannot penetrate the atmosphere

accept atmosphere stops X-rays

*do **not** accept atmosphere in the way*

or X-rays are absorbed (by the atmosphere)

before reaching Earth

ignore explanations

1

[6]

Q5.

(a) converging

or convex

1

(b) (principal) focus

or focal point

1

- (c) **either** (×)1.5 **or** (×)1½ **or** 150%
unambiguous evidence of appropriate measurements for 1 mark only eg 4 and 6 or 8 and 12 or 0.8 and 1.2 2
- (d) real rays cross to form it / formed at the intersection of real rays
accept 'image on the opposite side of the lens to the object'
accept 'can be put onto a screen' 1

[5]

Q6.

- (a) (i) (angle of) refraction
*take care **not** to credit 'angle of reflection'* 1
- (ii) normal
*do **not** credit 'horizontal'* 1
- (b) **either**
 (photographic) film
or CCD(s) (charge-coupled device(s)) / CMOS(s) (sensor(s)) / (active) pixel sensor(s)
accept 'LDR(s)' / 'light dependent resistor(s)'
***not** lux meter*
*do **not** accept light sensor(s)* 1
- (c) (i) converging
***or** 'convex'* 1
- (ii) **either**
 (0).35
or (0).4(1...)
*do **not** give any credit for an answer greater than 1*
or
7 ÷ 20 for 1 mark
or
clear evidence that appropriate measuring / counting, has been made for 1 mark 2
- (d) otherwise it will have no effect on the light detector
or otherwise no (real) light will fall on the light detector
***or** 'a virtual / imaginary image will have no effect on the light detector'*
allow error carried forwards for 'light detector'

allow so it can be formed on the film

1

[7]

Q7.

(a) B

1

(b) G

1

(c) D

1

(d) A

1

[4]

Q8.

(a) (i) microwave

1

(b) (i) identical

1

(ii) • increased risk of cancerous growth (between ear and brain)

1

• complaints of headaches and tiredness

1

(iii) any **two** from:

• tests in a laboratory did not give effects of tiredness or headaches

• waves not strong enough to cause long term heat damage to cells

• evidence to link mobile phones and ill health is not reliable

2

[6]

Q9.

(i) all electromagnetic waves travel at the same speed through a vacuum, (so assume same speed in air)

accept 'all parts of spectrum' for electromagnetic waves

1

(ii) 1500 (m)

allow 1 mark for correct transformation and substitution

allow 1 mark for using 200 000 Hz

answers 1 500 000 = 1 mark

2

(iii) line drawn at correct position

anywhere between 1000 and next section (10 000)

accept their value for (a)(ii) drawn in
the correct position

1

[4]

Q10.

- (a) stars / galaxies / sources emit all / different types of electromagnetic waves / radiation

accept two or more named electromagnetic waves
accept answers in terms of frequencies / wavelengths

1

- (b) (i) wavelength (of light) increases
accept frequency decreases

or

light moves to red end of spectrum

accept redder but do **not** accept red alone

1

- (ii) it is the star (detected) furthest from the Earth

accept galaxy for stars

or

it is moving away the fastest

ignore reference to universe expanding

1

- (c) (i) all matter compressed to / starts at / comes from a single point

do **not** accept increasing gravitational pull

accept everything / the universe for all matter

1

(massive) explosion sends matter outwards

accept explosion causes universe to expand

ignore explosion creates the universe or further reference to star / Earth formation

1

- (ii) check validity / reliability of the evidence

or

change the theory to match the new evidence

accept comparison of new and old evidence

1

[6]

Q11.

- (a) 400 000 000

or

correct equivalent

allow **1** mark for correct transformation **and** substitution (of 75)

answer 4 000 000 gains **1** mark only

2

(b) (i)

any mention of alpha, beta, gamma waves scores 0 marks

emit / uses / transmit / receive microwaves
accept radiation for microwaves throughout
ignore radio waves

1

some microwave / energy absorbed by / enters the body
ecf for their given electromagnetic wave
*do **not** accept goes through the body*

1

raises temperature of (body) cells / tissue / water
accept reference to water molecules vibrating faster
accept it could cause mutation / harm / kill cells
*do **not** accept answers in terms of ionisation*
ignore references to cancer

1

(ii) any **two** from:

- research (may be) biased
or may have been misled in the past
accept not independent
or may be lying
- some research suggests a link
- long-term effect not proven / studied
accept not studied for long enough
- residents may not have seen the research

2

[7]

Q12.

(i) B

1

(ii) A

1

[2]

Q13.

(a) (i) point where the rays cross
do not credit if ambiguous

1

(ii) converging (lens)
*do **not** accept convex*

1

- (b) (i) point where the rays appear to diverge from
this should appear to be within 10mm in front of the back of the arrows on the approximate centre line
need not be accurately constructed using a ruler 1
- (ii) diverging (lens)
*do **not** accept concave* 1
- (c) converging 1
- film 1
- smaller than
- nearer to
accept any clear indication of the response e.g. ticking, ringing, writing in after a mistake 1
- (d) (i) (image) bigger than object enlarge
accept just 'made bigger' 1
- (ii) it / real image can be put on a screen **or** real image on the opposite side of the lens to the object
accept 'not an imaginary or virtual image'
assume 'it' refers to a real image
*do **not** credit 'it can be seen'* 1
- (e) **either** (the converging lens is) thick in the middle thin(ner) at the edge 1
- thickest in the middle gains 2 marks* 1
- or** (both) sides bend outwards (1) in the middle (1)
convex gains 2 marks
suitable diagrams gains 2 marks
- or** one side bends in the middle (1) more than the other side bends inwards (in the middle) (1) 1

[12]

Q14.

silver is a (good) reflector of heat
 (radiation) **or**
 silver reflects the heat (radiation)
fact
heat = infra red
ignore references to light

accept shiny for silver
 good radiator negates the mark
 ignore references to good conductor
 do **not** accept bounce back

1

less heat is lost through the board **or** more heat is retained by the shirt

explanation
 accept both sides of shirt heated
 reflects heat back up gets **1** mark only
 ignore mention of friction

1

[2]

Q15.

(a) (i) converging / convex / biconvex

1

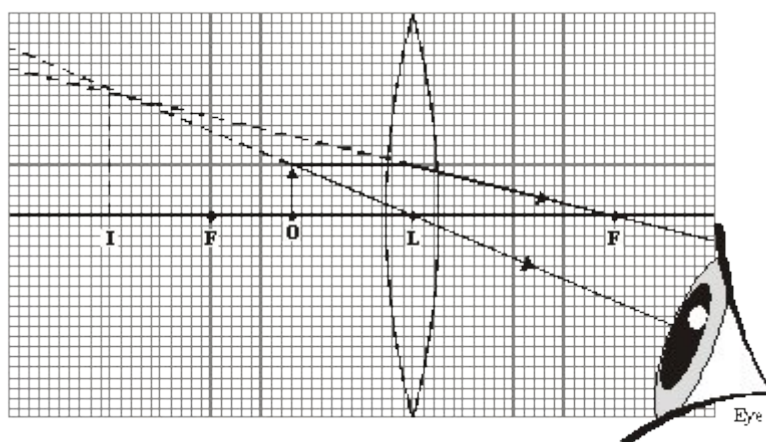
(ii) focal (points) **or** foci
 accept focuses **or** focus (point)

1

(iii) (principal) axis

1

(iv)



all lines drawn with a ruler for full marks

no ruler, penalise **1** mark from first four

last mark can still be awarded

double refraction drawn could get **4** out of 5 marks

ray that continues from the top of the object through L
 to the eye

1

horizontal ray from the top of the object, refracted by the lens
 and continued through F on the r.h.s. to the eye

1

- back projections of these rays (shown as dotted lines)* 1
- image 25 mm high at 61 mm left of L*
(tolerance 1 mm $\pm$ vertically, 2 mm $\pm$ horizontally) 1
- at least one arrow shown on real ray and towards the eye*
*but do **not** credit if contradicted by other arrow(s)* 1
- (v) formed where imaginary rays intersect / cross **or** not formed by real rays
accept (virtual image) is imaginary
accept cannot be put on screen
*do **not** credit just '... is not real'* 1
- (b) (the image) needs to fall on film / sensors / LDRs / CCDs
accept just 'charged couples'
*do **not** credit '... solar cells'*
*do **not** accept virtual image cannot be stored* 1
- either** to cause a (chemical) reaction **or** to be digitalised
for credit response must be appropriate to camera type 1
- object (should be) on the far side of F / the focus (from the lens)
or ... *more than the focal length (away from the lens)*
allow 'beyond the focus'
- or** object should be more than twice the distance / 2F (from the lens) (2 marks)
or ... *more than twice the focal length (away from the lens)*
(2 marks) 1

[12]

Q16.

Quality of written communication

- award for a sensible sequence of **two** points* 1
- X-rays do not go through lead
accept lead protects them from the X-rays
accept not exposed to X-rays 1
- lead stops / reduces risk of X-rays harming / damaging / killing (persons) cells
accept X-rays (may) cause cancer
accept organs for cell
*do **not** accept references to electric shock*
*do **not** accept stops bones of people showing on X-ray*
answers involving the horse wearing an apron are incorrect
references to gamma rays are incorrect 1

[3]

Q17.

- (a) (i) rays continued to meet on the right hand side of the lens and beyond
must be straight lines from the right hand side of the lens
ignore details through the lens
allow if no arrows 1
- meet exactly on the axis
negate mark if contradictory arrow(s) added
do not need to go beyond the focus for this mark 1
- (ii) (principal) focus
or focal (point) 1
- (iii) converging
or convex 1
- (b) (i) **A** 1
- (ii) rays seem to come from this point
or words to this effect
or shows this on the diagram 1
- (iii) diverging
or concave 1
- (c) film
accept any unambiguous method of showing the correct response 1
- smaller than 1
- further away from 1
- (d) any **three** from:
- real image can be put on a screen
allow film
 - virtual image cannot be put on a screen / film
 - virtual image is imaginary
 - real image is formed where (real) rays cross / converge
allow real image has light travelling through it
 - virtual image is where virtual / imaginary rays (seem to) come from

or virtual image is where rays seem to come from

- virtual image formed where virtual rays intersect / cross

3

[13]

Q18.

- (a) (i) L

1

- (ii) N

1

- (b) the answer should be in the form:

not inside the eye

either for **both** marks an arrangement which could demonstrate visibly light travels in straight lines

full credit should be given for answer presented as a diagram

and

an explanation of how it shows the straightness

or for one mark

named device which uses principle of light travelling in straight lines to work

examples

light (from a street lamp) strikes an object producing a shadow

laser light travelling through (fine) dust shows a straight beam

three pieces of card with central holes need to be lined up to be able to see through the third hole from the first

ray box type experiment using mirrors/prisms, etc

beams on paper or in smoke

torch beams through smoke

example devices:–

–pinhole camera (qualification may get second mark)

–periscope

–optical fibre

*–reflection 'in a **mirror***

2

[4]

Q19.

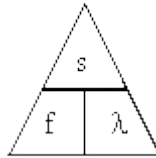
- (i) speed = frequency × wavelength

accept the equation rearranged

*accept v **or** $s = f \times \lambda$*

do not allow w for wavelength

do not accept



unless subsequent calculation correct

1

(ii) 330 (m)

allow 1 mark for

$$\lambda = \frac{300\,000\,000}{909\,000}$$

or $300\,000\,000 = 909\,000 \times \lambda$

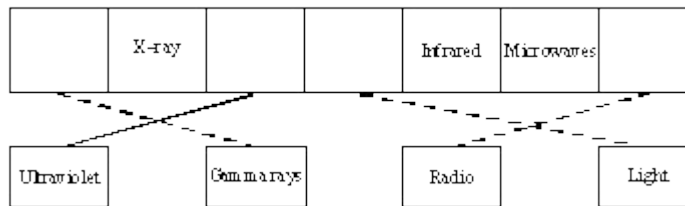
or answer of 330000(m) or 330033(m)

2

[3]

Q20.

(a) all **three** correct



one only correct, 1 mark only

allow names in boxes

*there should be only **one** line from **or** to each box*

2

(b) the same as

1

(c) any **two** from:

- bones absorb X-rays
- so film not exposed
- X-rays pass through flesh or skin or
- body or tissue (to expose film)

allow X-rays cannot pass through bones

2

[5]

Q21.

(a) (i) 3

1

(ii) 1

accept a definition of frequency ignore units

1

(iii) hertz

1

(b) straight line in correct direction

judge by eye (from 'a' of waves to 's' of across) ignore arrow

accept equal angles shown on waves

1

(c) (i) gets smaller

1

(ii) kinetic

accept movement

1

(iii) renewable

1

[7]

Q22.

(i) wave speed = frequency $\times$ wavelength

accept correct transformation

accept $v = f \times \lambda$

accept s for speed

accept $m/s = Hz \times m$

accept  if subsequent use of  is correct

1

(ii) 500 000 000

*credit for 1 mark correct transformation in words **or** numbers
or correct substitution*

2

Hertz

3 marks for 500 000k Hz **or 500 MHz**

*numerical answer **and** unit must be consistent for full credit*

1

[4]

Q23.

(i) 0.5

1

(ii) wave speed = frequency $\times$ wavelength

accept $v = f \times \lambda$

accept s for v

accept $m/s = Hz \times m$

accept



providing subsequent method correct

1

(iii) 15.2 km

*both numerical answer and unit are required for both marks
numerical answer and unit must be consistent
allow 1 mark for 15.2 with incorrect or no unit
allow 2 marks for an answer of 1.52 km if the answer to
(b)(i) was given as 5
r 1 mark for correct transformation
or 1 mark for correct use of speed = distance/time
unit on its own gains no credit*

2

[4]

Q24.

(i) X-rays or gamma rays
for 1 mark

1

(ii) passes through flesh;
stopped by bone/absorbed
for 1 mark each

2

[3]

Q25.

(a) Reflection correct
Normal incidence correct in and out
Correct refraction in
Parallel ray out
each for 1 mark

4

(b) (i) Each ray correctly refracted in
 $1 + 1 = 2$

7

(ii) Wavefronts perp sides
Wavefronts closer
(Cannot score wavefront marks if refracted rays clearly wrong)

(iii) Speed reduces
Starting at B
Then D
each for 1 mark

(c) TIR correct

gets 2 marks

Else rough reflection

gets 1 mark

2

[13]

Q26.

- (a) (i) Image distance increases
Image size increases
Remains inverted
Remains real

for 1 mark each

2

- (ii) Image distance decreases
Image size decreases
Becomes upright
Becomes virtual

for 1 mark each

2

- (b) Move lens with respect to film
Closer for distant objects
Further for near objects

for 1 mark each

3

[7]

Q27.

- (a) (i) Ignore arrows on rays
perpendicular rays goes straight in and out
other ray refracts towards normal (not along)
emerges parallel incident ray (by sight) if refraction correct (ignore reflections)

for 1 mark each

3

- (ii) emergent angle marked Y if emerges parallel to right of normal
for 1 mark

1

- (b) straight ray to water surface refracts/bends
straight to eye/towards surface on right image correctly shown
or states the same mark prose only of diagram incomplete

any 3 for 1 mark each

3

[7]

Q28.

Eye – Diminished/smaller than object
Nearer the lens than object or on the retina

for 1 mark each

2

Projector – real
Further from lens than object
for 1 mark each

2

Camera – real
Smaller (than object)
for 1 mark each

2

[6]

Q29.

- (a) radio – 1500
ultra violet 3×10^{-8}
visible – 5×10^{-7}
X-rays – 1×10^{-11}

4

- (b) $1 \times 10^{10}\text{Hz}$ 10^{10}HzOK
for 4 marks

else 1×10^{10}
for 3 marks

else $3 \times 10^8/0.03$
for 2 marks

else $v = \text{frequency} \times \text{wavelength}$ or $3 \times 10^8 = 0.03f$
any answer with unit Hz scores 1, 2 or 3
for 1 mark

4

[8]

Q30.

- (a) one mark for each ray correctly drawn straight to glass then bent towards pupil
accept both rays hitting any part of eye
judge straightness by eye
*accept dotted **or** dashed lines*
ignore any arrows
N.B. the rays must reach the eye

2

- (b) speed

1

refraction

1

transverse

1

[5]

Q31.

- (a) any two successive peaks labelled **W**

*accept any 2 points on same part of adjacent waves
correct by eye*

1

half 'height' of wave labelled **A**

correct by eye

N.B. at least one of the answers must be labelled

1

- (b) 0.2

correct answer with no working = 2

allow 1 mark for $s = f \times w$ or correct working i.e., 2×0.1

N.B. correct answer from incorrectly recalled relationship = 0

2

m/s (unit)

*independent mark do **not** allow mps or mHz*

1

[5]

Q32.

(ultrasonic) waves **or** vibrations **or** oscillations in fluid

*N.B. must mention fluid **or** liquid*

***or** water*

1

idea of shaking dirt particles off watch

allow cavitation / implosion of small bubbles

1

[2]

Q33.

- (a) Quality of written communication:

Correct use of 2 of the words, angle, critical, normal and reflection

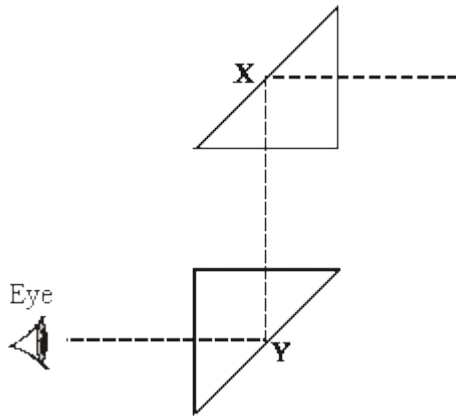
1

any **two** from

- light is reflected / bounces off
- if angle between ray and normal angle of incidence
- is greater than critical angle
- idea that no refraction bending if ray at 90°

2

- (b)



1 mark for reflection at **X** if ray would reach the lower prism
 1 mark for subsequent reflection at **Y**
 1 mark for subsequent ray emerging from prism in direction of front of eye
 accept dotted **or** dashed lines
 ignore any arrows

3

[6]

Q34.

- (i) absorbed by water / water heated

1

hot water heats (rest of) food / idea of particle vibration

1

- (ii) 300 000 000 / 3×10^8

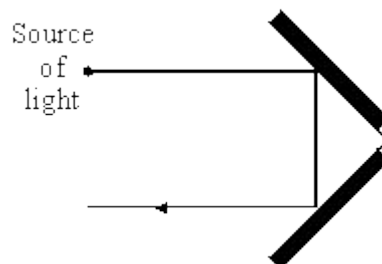
correct answer with no working = 2
 allow 1 mark for $s = f \times w$ **or** correct working i.e., $10000 (000000) \times 0.03$
 N.B. correct answer from incorrectly recalled relationship / substitution = 0

2

[4]

Q35.

- (a) first reflection vertically down to the fourth hatch line or just to the left of it reaching mirror (must come from incident ray given)



1

second reflection back parallel to incident ray must be linked to first part of ray

1

appropriate arrow on a part of the ray (may be given if lines wrong)

(must come from source of light)

maximum of one mark to be lost for poor diagrams not using a ruler for straight lines

first time you come across wavy line, it is penalised

1

(b) ray in block bent downwards, not beyond the normal

do not credit if exactly on normal

1

emergent ray parallel to incident ray

do not credit a continuation of the line straight through the block these are independent

1

[5]