

2006

Year 11 Half Yearly Examination

HSC Course

Physics

General Instructions

- Reading time – 5 minutes
 - Working time – 1 hour
 - Write using blue or black pen
 - Draw diagrams using pencil
 - Approved calculators may be used
 - Write your I.D.* on each answer sheet
- * Name or student number

Total marks

40

Section A

10 multiple choice worth 1 mark each

Section B

Short answer questions worth 30 marks

TIC: Mr Coombes

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Data and equations

Speed of light in a vacuum is $3 \times 10^8 \text{ m s}^{-1}$

Speed of sound in air is 340 m s^{-1}

Force of gravity on Earth is 9.8 N kg^{-1}

Average speed: $v_{av} = \frac{\Delta r}{\Delta t}$ (distance/time)

$$v_1/v_2 = \sin i / \sin r$$

$$v = f\lambda$$

$$T = \frac{1}{f}$$

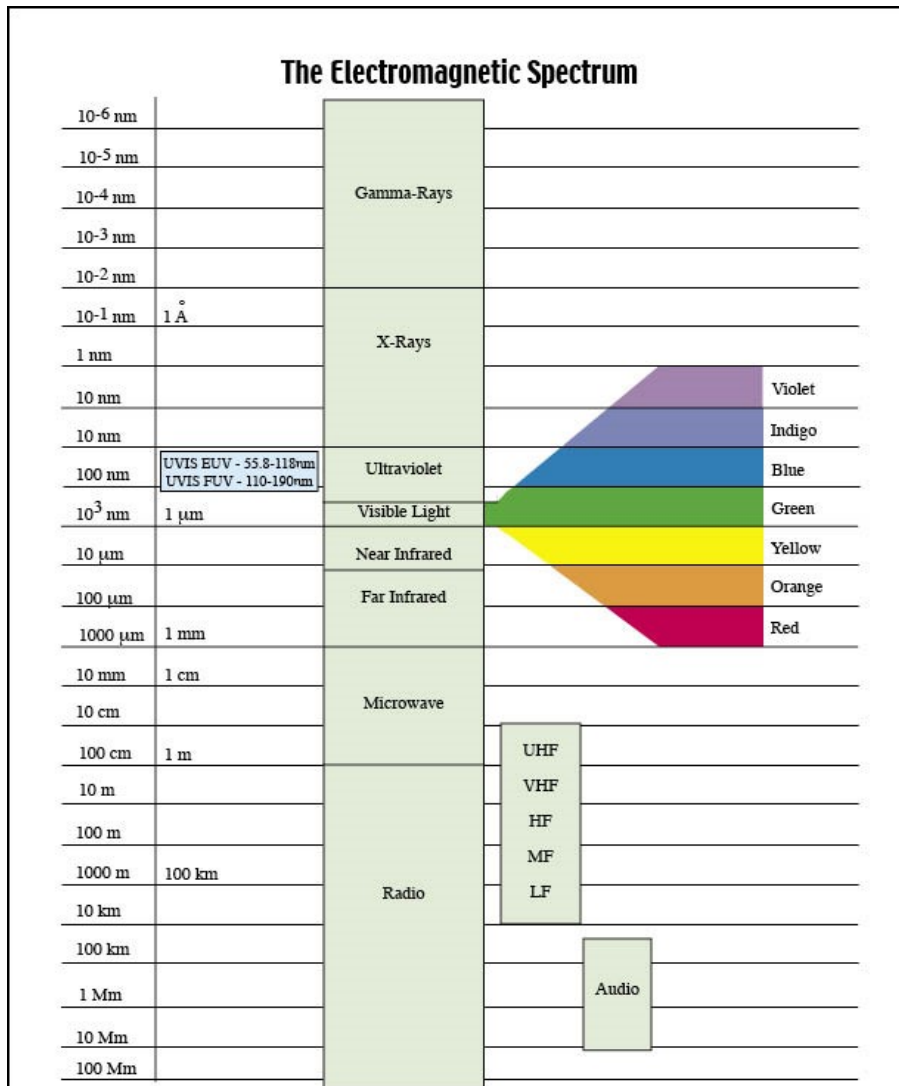
Paper begins on next page

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Section A

10 multiple choice questions worth one mark each
 Answer these on the multiple choice answer sheet provided

1. The following questions refer to this chart which shows information about the components of the electromagnetic spectrum.

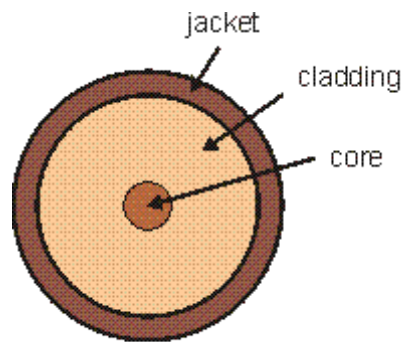


Which of the following statements is true?

- (A) Violet light has a wavelength of 10 nm
- (B) Microwaves have longer wavelengths than radio waves
- (C) Visible light has frequencies that are less than the frequencies of X-rays
- (D) Red light has a longer wavelength and higher frequency than blue light.

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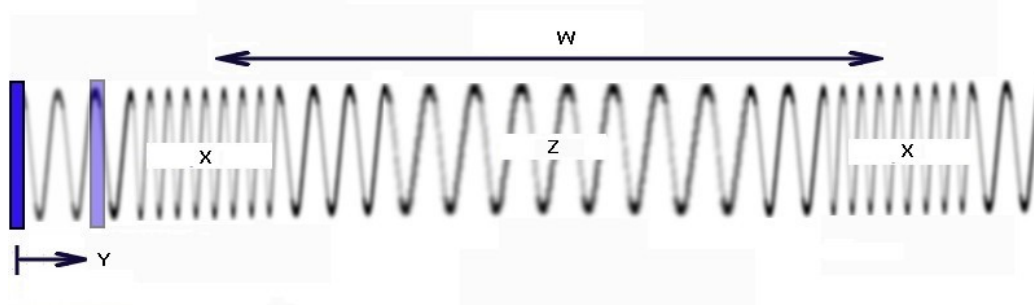
2. The following diagram shows a conventional optical fibre.



Conventional fibre

Which of the following statements is true about the cladding.

- (a) It is made of a material that reflects light so that the light stays within the core.
 - (b) It is the area of the fibre that carries most of the encoded light information.
 - (c) It has a refractive index greater than that of the core.
 - (d) It is made of a material that is less optically dense than the core.
3. The following diagram shows part of a wave travelling through a Slinky® spring.

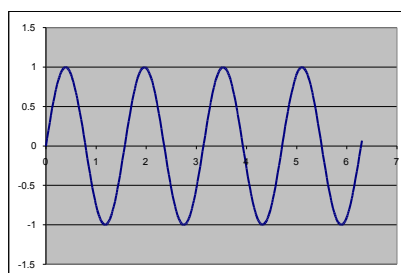


Identify the part labelled W.

- (a) amplitude
- (b) compression
- (c) rarefaction
- (d) wavelength

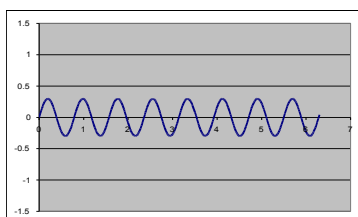
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4. Which of the following is not an example of a three-dimensional wave
- (A) Radio waves from NOVA FM's antenna
 - (B) Water ripples from an insect fallen onto the water surface
 - (C) Sound waves from a starting gun
 - (D) Light rays from candle
5. The following diagram represents a sound waves that was analysed using a cathode ray oscilloscope.

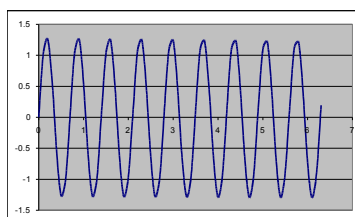


Compared to the sound represented by the graph above, which graph below represents a softer sound with a lower frequency?

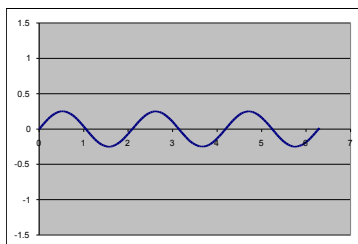
(A)



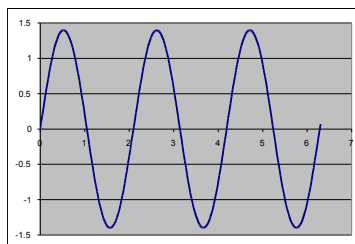
(B)



(C)



(D)



6. Which of the following statements best compares a sound wave and an electromagnetic wave?
- (A) Sound waves typically have higher frequencies than electromagnetic waves.
 - (B) Sound waves transmit matter outwards from the source whereas electromagnetic waves transmit only energy.
 - (C) The particles transmitting sound waves oscillate in a direction parallel to the energy propagation whereas vibrations of electromagnetic waves are perpendicular to the energy propagation direction.
 - (D) The frequency of the wave is determined by the source whereas the frequency of an electromagnetic wave is independent of the source.

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7. Two identical stars A and B are observed through a telescope. Star A is located at a distance of 100 light years and star B is located at a distance of 500 light years. Which of the following is true about the intensity of light coming from the two stars.
- (A) Star A will appear 5 times brighter than star B.
 - (B) Star B will appear to be 5 times brighter than star A
 - (C) Star B will appear to be 25 times brighter than star A
 - (D) Star A will appear to be 25 times brighter than star B.

8. A short pulse of sound was produced and a recording was made of the sound and an echo using a data logger with a microphone sensor connected to it. The following graph shows the data collected by the microphone placed next to the source of the sound.



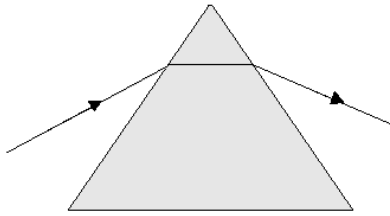
Which of the following statements about this process is correct?

- (A) The process which results in an echo being produced is called reflection and the object reflecting the sound was 170 m from the source.
 - (B) The process which results in an echo being produced is called reflection and the object reflecting the sound was 85 m from the source.
 - (C) The process which results in an echo being produced is called dispersion and the object producing the dispersion of the sound was 170 m from the source.
 - (D) The process which results in an echo being produced is called reflection and the object dispersion and the object producing the dispersion of the sound was 85 m from the source.
9. A guitar string was plucked and the resulting wave in the string had a wavelength of 20 cm and travelled at a speed of 100 m s^{-1} . What is the wavelength of the sound wave in air that was produced by the vibration of the string?
- (A) 20 cm
 - (B) 68 m
 - (C) 68 cm
 - (D) 100 m

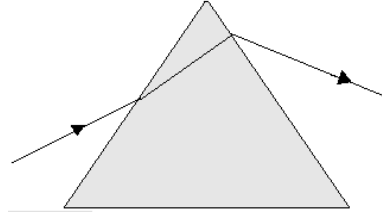
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10. Which of these diagrams correctly shows the path of light passing through a glass prism?

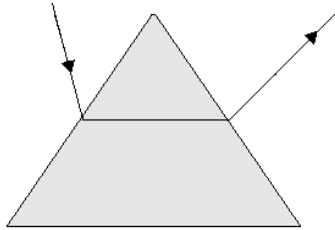
(A)



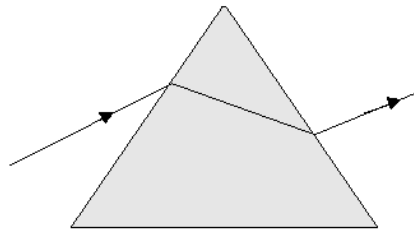
(B)



(C)



(D)



End of Section A

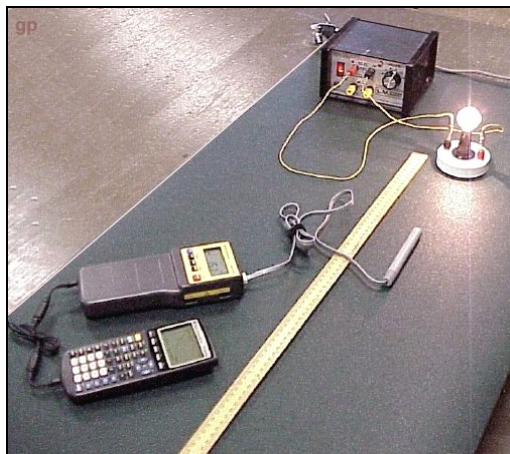
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Section B

This section is worth 30 marks.

Attempt all questions.

11. The apparatus shown in the photograph below was used to conduct a first-hand investigation of the properties and behaviour of light.

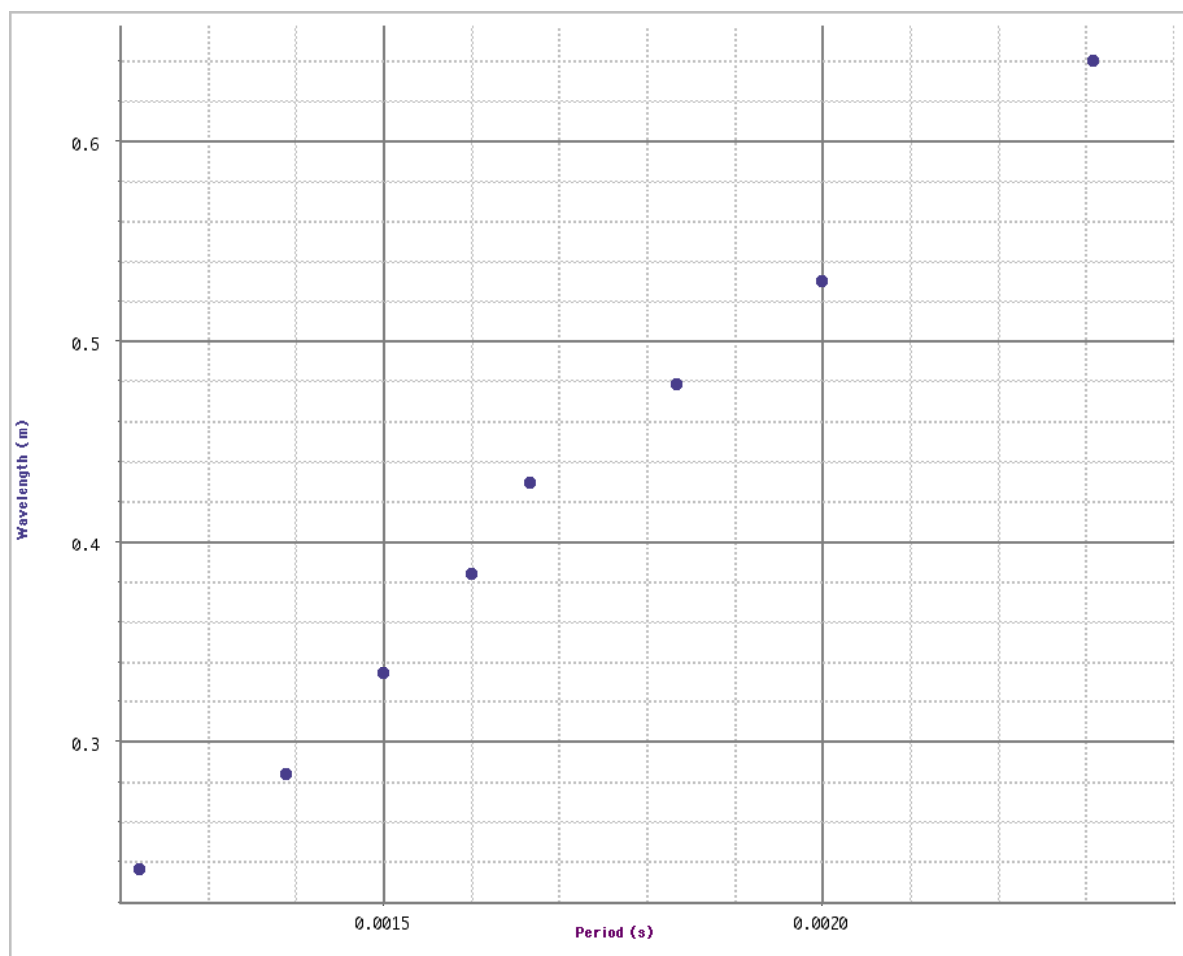


Distance (cm)	10	12	14	16	18	20	22	24
Intensity (W/m^2)	84	59	44	33	30	20	17	14

- (a) Analyse the data by drawing an appropriate graph to show that the intensity of the light is inversely proportional to the square of the distance from the source. **(3 M)**
- (b) Identify the feature of the graph that allows you to make this conclusion **(1 M)**
12. Using communications technologies to clarify your answer, describe how one application of physics has affected society. **(3 M)**
13. Astronomers are able to recognise that certain stars in our galaxy are almost identical to each other in composition and in the amount of light that they produce.
- Describe the scientific principle that enables astronomers to compare the relative distances of such stars from the Earth. **(2 M)**

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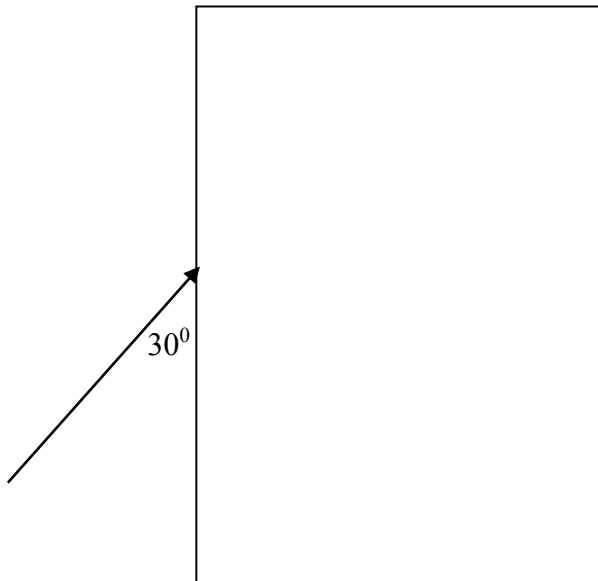
14. This graph shows data collected during the investigation of waves.



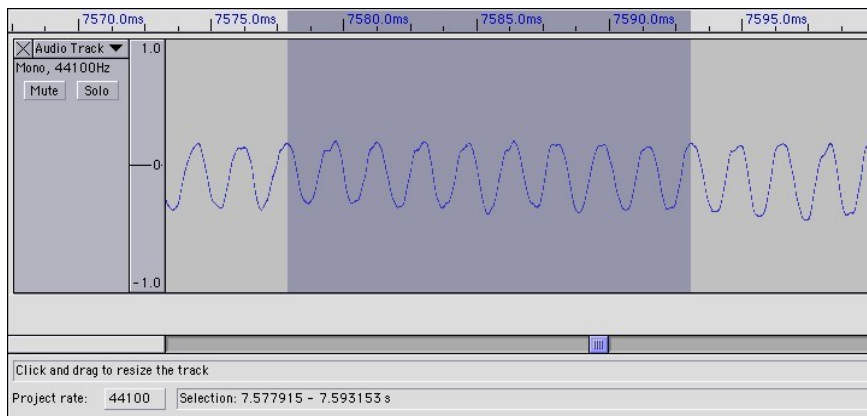
- (a) Describe the relationship between the variables shown on this graph. **(1 M)**
- (b) Calculate the gradient of this graph, including the units and hence deduce what the gradient represents. **(3 M)**

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15. The diagram below shows the path of a ray of light entering a rectangular glass prism. The refractive index of the glass prism is 1.5.



- (a) Calculate the angle of refraction for the light entering the prism. **(2 M)**
- (b) Calculate the speed of light passing through the prism. **(2 M)**
16. The following is a pressure / time graph representation produced by the Audacity program.
- The horizontal axis units are milliseconds.

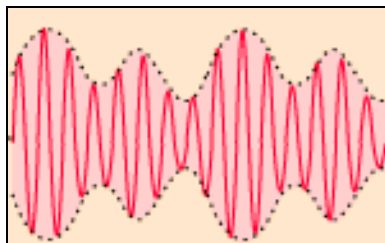


- Calculate the frequency of the sound wave represented by this graph. **(2 M)**

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17. Outline two procedures that must be adhered to in order to ensure the validity of a scientific investigation. **(2 M)**

18. The following diagram shows a modulated radio wave.



- (a) Identify the type of modulation represented by this graph. **(1 M)**
(b) One Sydney radio station broadcasts information using a carrier frequency of 92.9 MHz. Calculate the wavelength of these radio waves. **(2 M)**
19. An investigation was carried out to investigate the behaviour of light passing from air into glass.

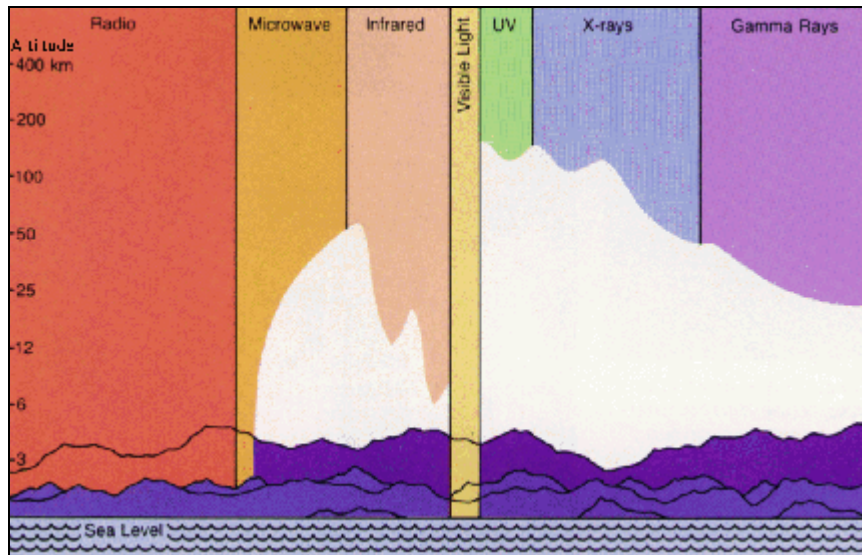
The following table shows data relating to the refraction of light at a plane boundary between air and glass.

Incident angle (i)	Angle of Refraction (r)
0.000	0.000
20.000	13.064
30.000	19.099
40.000	24.553
60.000	33.080
70.000	35.894
80.000	37.617
90.000	38.197

- (a) Use the information in this table to reliably determine the refractive index of the glass. **(2 M)**
(b) Propose a graph that could be drawn using this data which would provide evidence to support Snell's Law. (Do not draw the graph). **(1 M)**
20. Outline one application of concave reflectors. **(1 M)**

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21. Scientists have hypothesised that black holes can be identified by the X-rays produced when charged particles spiral into them. An astronomer proposed that a distant object, Cygnus-X, was a possible candidate for a black hole and set out to test his hypothesis by constructing a very sensitive ground-based X-ray telescope. The following diagram shows the ability of different types of electromagnetic radiation to penetrate the atmosphere.



- (a) With reference to the diagram, explain why the astronomer was unsuccessful in his attempt to show that Cygnus X could be a black hole. (1 M)
- (b) Propose a method that could be used by the scientist to test the hypothesis (1 M)

[end of paper]

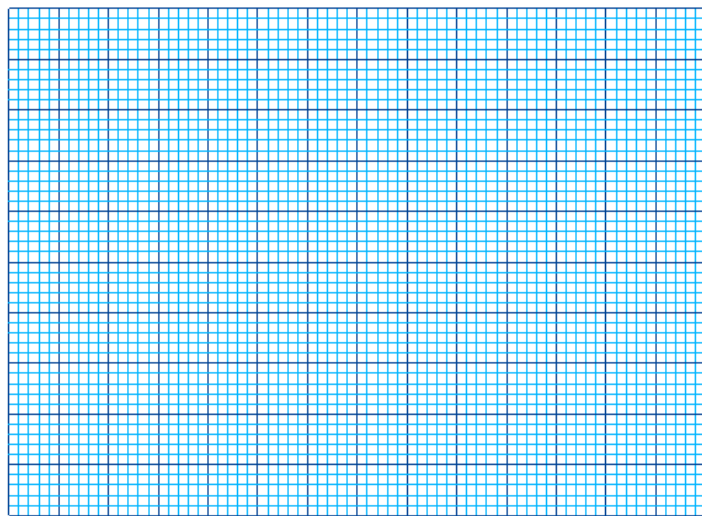
Write your answers in the spaces provided.

11.

(a)

3 M

Distance (cm)	10	12	14	16	18	20	22	24
Intensity (W/m^2)	84	59	44	33	30	20	17	14



(b)

1 M

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12.

3 M

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13. 2 M
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14. (a) 1 M
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(b) 3 M
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15 (a) 2 M
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(b) 2 M
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16. 2 M
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17. 2 M
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18. (a) 1 M
(b) 2 M
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19. (a) 2 M
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(b) 1 M
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20. 1 M
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21. (a)
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1 M

(b)
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1 M

End of Exam

Half-yearly Exam Marking Criteria

Multiple Choice Answers

2006: C, D, D, B, C, C, D, B, C, A

11. (a)

Criteria	Marks
Graph of intensity vs $1/d^2$ drawn neatly, INCLUDING quantities labelled on axes AND a suitable scale	3
Graph of intensity vs $1/d^2$ drawn but quantities OR scale omitted/unsuitable	2
Graph of intensity vs distance drawn with quantities labelled on axes and scales shown on both axes	1

11. (b)

Criteria	Marks
Identifies that the graph is linear (must have drawn the correct graph to get this mark)	1

12.

Criteria	Marks
Uses at least one ONE example of a communication technologies to describe TWO effects that the application of physics has had on society. The effects must be relevant, significant and related to the chosen technology.	3
Uses at least one ONE example of a communication technologies to describe ONE significant effect that this application of physics has had on society. The effect must be relevant, significant and related to the chosen technology.	2
One technology is identified and one effect less well described OR poorly identifies the technology and outlines one effect that the technology has produced.	1

13.

Criteria	Marks
Describes the effect of distance on light intensity consistent with the inverse square law	2
Identifies the inverse square law for light (by name only)	1

14. (a)

Criteria	Marks
Indicates that the wavelength is proportional to the period	1

14. (b)

Criteria	Marks
Calculates the gradient of the graph and shows the units as $m s^{-1}$ and hence deduces that the gradient represents the wave's velocity (ans. 210 to $280 m s^{-1}$)	3
Calculates the gradient of the graph and identifies either the units OR the quantity represented (velocity)	2
Uses the correct formula/process to determine the gradient (but does not necessarily get the correct answer)	1

15. (a)

Criteria	Marks
Calculates the answer (35°)	2
Writes the appropriate formula ($n = \sin(i)/\sin(r)$)	1

15. (b)

Criteria	Marks
Calculates the answer, including units ($2 \times 10^8 m s^{-1}$)	2
Gives the correct formula $n = c/v$ or has the correct numerical answer without the units.	1

16.

Criteria	Marks
Substitutes correct quantities into the formula $f = 1/T$ Answer is 600 Hz	2
Determines the period for 9 vibrations OR writes the formula $f = 1/T$ for use in the answer	1

17.

Criteria	Marks
Outlines two appropriate procedures such as ensuring that the measuring equipment is chosen and checked to ensure that it measures what is intended and that all variables affecting the result have been identified and taken into account in the investigation plan.	2
Outlines one appropriate procedure	1

18. (a)

Criteria	Marks
Identifies the modulation as amplitude modulation	1

18. (b)

Criteria	Marks
Calculates the answer from $\lambda = v/f = (3 \times 10^8) / (92.9 \times 10^6) = 3.3 m$	2
Appropriate formula stated in answer ($v = f\lambda$)	1

19. (a)

Criteria	Marks
Determines the refractive index by averaging results from ALL available data substituted into $n = \sin(i)/\sin(r)$ to obtain the answer 1.57 (or 1.6)	
Calculates the refractive index from fewer than all the data pairs OR for concept of averaging demonstrated	

19. (b)

Criteria	Marks
Proposes that $\sin(i)$ be graphed against $\sin(r)$	1

20.

Criteria	Marks
Outlines a use of concave reflectors!	1

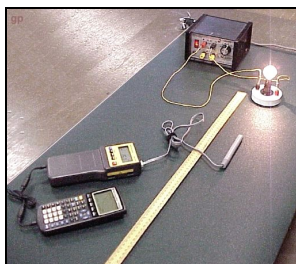
21. (a)

Criteria	Marks
Relates the inability to detect x-rays from Cygnus-X to the fact that X-rays cannot penetrate the thickness of the Earth's atmosphere to reach the surface from space (because they are absorbed)	1

21. (b)

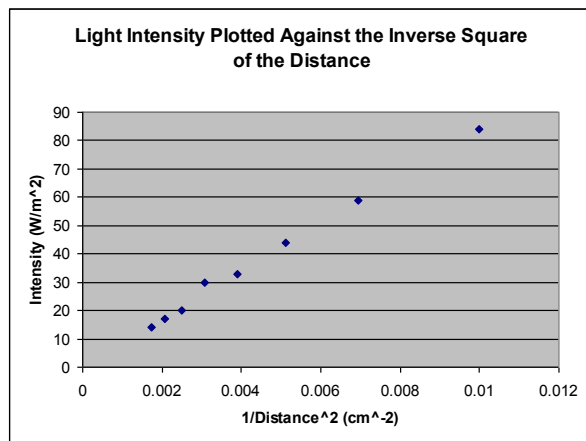
Criteria	Marks
Proposes that the X-ray telescope be put in orbit so that the atmosphere was not a factor.	1

11. The apparatus shown in the photograph below was used to conduct a first-hand investigation of the properties and behaviour of light.



Distance (cm)	10	12	14	16	18	20	22	24
Intensity (W/m ²)	84	59	44	33	30	20	17	14

- (a) Analyse the data by drawing an appropriate graph to show that the intensity of the light is inversely proportional to the square of the distance from the source. (3 M)



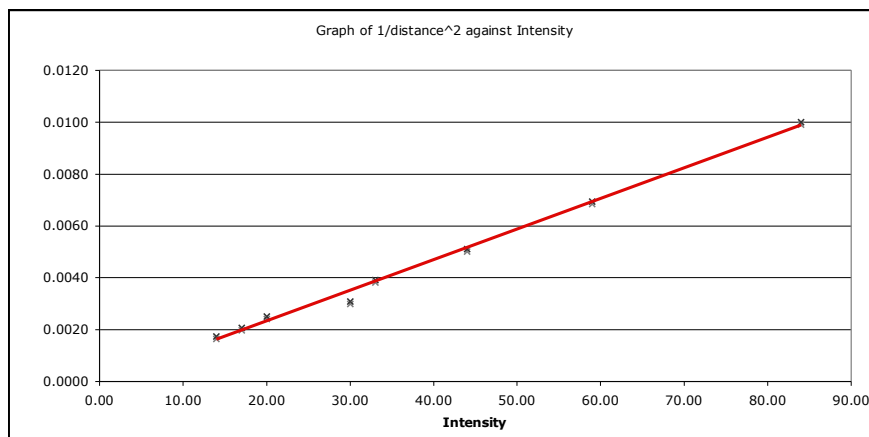
Include line of best fit on graph.

[A common error in this question was to use FRACTIONS to try and make a suitable scale for the 1/distance² axis. Students who did this marked a scale so equal distances on the horizontal axis went as follows:

1/10², 1/12², 1/14² etc

It must be noted that the difference between successive pairs of these fractions is not the same amount – and so representing them as equal distances on the axis is misleading. It is best NEVER to use fractions on a graph scale – always convert numbers to be graphed to a decimal quantity before working out a suitable scale.

Distance (cm)	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
Intensity (W/m ²)	84.00	59.00	44.00	33.00	30.00	20.00	17.00	14.00
1/Distance ² (cm ⁻²)	0.0100	0.0069	0.0051	0.0039	0.0031	0.0025	0.0021	0.0017
1/Distance ² (m ⁻²)	100.00	69.44	51.02	39.06	30.86	25.00	20.66	17.36



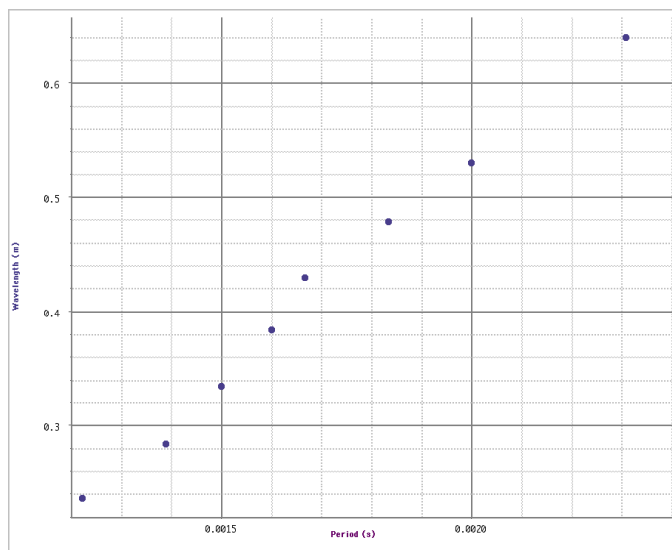
- (b) Identify the feature of the graph that allows you to make this conclusion (1 M)
 The line of best fit is linear.

12. Using communications technologies to clarify your answer, describe how one application of physics has affected society. **(3 M)**
13. Astronomers are able to recognise that certain stars in our galaxy are almost identical to each other in composition and in the amount of light that they produce.

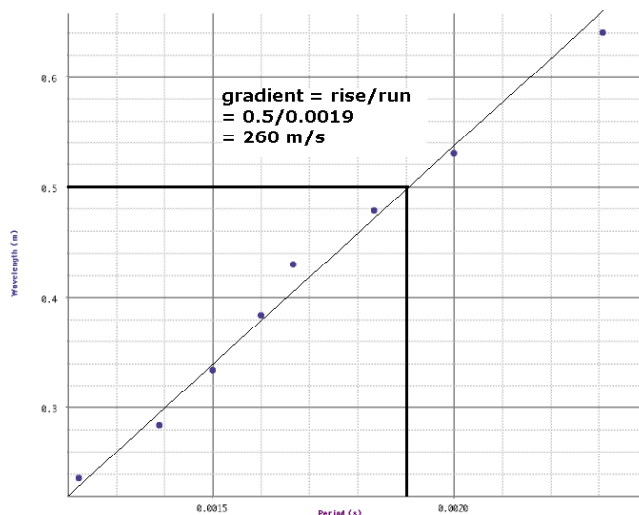
Describe the scientific principle that enables astronomers to compare the relative distances of such stars from the Earth. **(2 M)**

The principle used is that the intensity of the light at a particular distance from a source is inversely proportional to the distance from the source.

14. This graph shows data collected during the investigation of waves.



- (a) Describe the relationship between the variables shown on this graph. **(1 M)**
 The wavelength is proportional to the period.
- (b) Calculate the gradient of this graph, including the units and hence deduce what the gradient represents. **(3 M)**

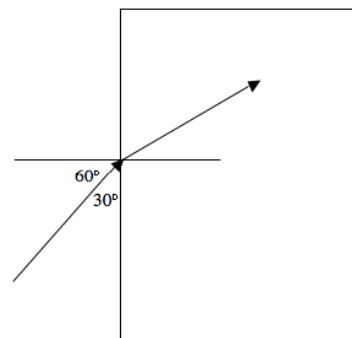


Gradient = 0.5/0.019 = 260 m/s (variations in the range 210 to 280 m s⁻¹ accepted)

The gradient represents the wave's velocity (it has units of metres/second)

- 15.

15. The diagram below shows the path of a ray of light entering a rectangular glass prism. The refractive index of the glass prism is 1.5.



- (a) Calculate the angle of refraction for the light entering the prism. (2 M)

$$n = \frac{\sin(i)}{\sin(r)}$$

$$1.5 = \frac{\sin(60)}{\sin(r)}$$

$$r = 35^\circ \text{ (rounded from } 35.26^\circ\text{)}$$

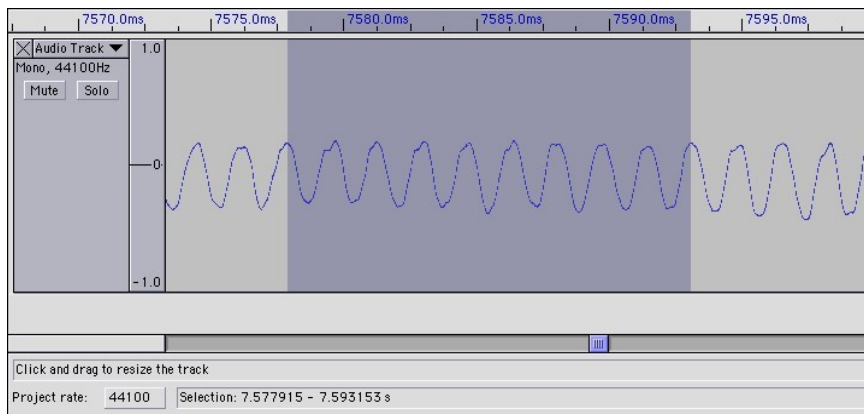
- (b) Calculate the speed of light passing through the prism. (2 M)

$$n = c/v$$

$$v = c/n = 3 \times 10^8 / 1.5 = 2 \times 10^8 \text{ m s}^{-1}$$

16. The following is a pressure / time graph representation produced by the Audacity program.

The horizontal axis units are milliseconds.



- Calculate the frequency of the sound wave represented by this graph. (2 M)

$$\text{Frequency } f = 1/T$$

There are 9 cycles in the selected region.

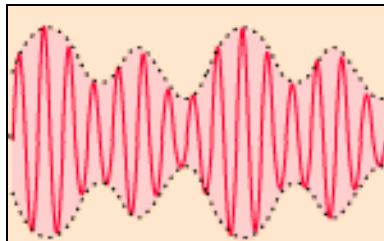
$$\text{Period } T = (7593 - 7578)/9 \text{ ms} = 15/9 \text{ ms} = 1.670 \times 10^{-3} \text{ s}$$

$$\text{Frequency} = 1/(1.67 \times 10^{-3} \text{ s}) = 600 \text{ Hz (rounded)}$$

17. Outline two procedures that must be adhered to in order to ensure the validity of a scientific investigation. (2 M)

Ensure that the measuring equipment is chosen and checked to ensure that it measures what is intended and that all variables affecting the result have been identified and taken into account in the investigation plan.

18. The following diagram shows a modulated radio wave.



(a) Identify the type of modulation represented by this graph. (1 M)

Amplitude modulation

(b) One Sydney radio station broadcasts information using a carrier frequency of 92.9 MHz. Calculate the wavelength of these radio waves. (2 M)

$V = f\lambda$

$\lambda = v/f = (3 \times 10^8) / (92.9 \times 10^6) = 3.3 \text{ m}$

19. An investigation was carried out to investigate the behaviour of light passing from air into glass.

The following table shows data relating to the refraction of light at a plane boundary between air and glass.

(a) Use the information in this table to reliably determine the refractive index of the glass. (2 M)

Incident angle (i)	Angle of Refraction (r)	Refractive Index
0	0	
20	13.064	1.513100377
30	19.099	1.528110791
40	24.553	1.54689236
60	33.08	1.586680682
70	35.894	1.602784605
80	37.617	1.613433283
90	38.197	1.617161977
	Av R.I.	1.572594868

Answer must show average based on ALL data provided.

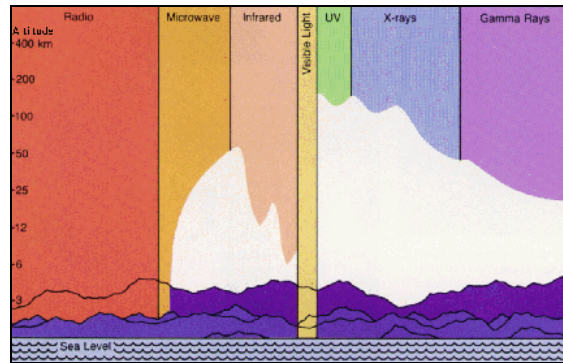
(b) Propose a graph that could be drawn using this data, which would provide evidence to support Snell's Law. (Do not draw the graph). (1 M)

A graph of sin(i) against sin(r) would need to be plotted

20. Outline one application of concave reflectors. (1 M)

Answers could include: Satellite dishes, radio telescopes, optical reflecting telescopes, makeup mirrors, car headlight reflectors, torch reflectors

21. Scientists have hypothesised that black holes can be identified by the X-rays produced when charged particles spiral into them. An astronomer proposed that a distant object, Cygnus-X, was a possible candidate for a black hole and set out to test his hypothesis by constructing a very sensitive ground-based X-ray telescope. The following diagram shows the ability of different types of electromagnetic radiation to penetrate the atmosphere.



- (a) With reference to the diagram, explain why the astronomer was unsuccessful in his attempt to show that Cygnus X could be a black hole. (1 M)
- X-rays from Cygnus-X to the fact that X-rays cannot penetrate the thickness of the Earth's atmosphere to reach the surface from space. They are absorbed before they reach the Earth's surface and therefore cannot be detected by an Earth-based telescope.**
- (b) Propose a method that could be used by the scientist to test the hypothesis (1 M)
- The X-ray telescope could be put in orbit so that the atmosphere did not affect the telescope's detection of the X-rays.**