L6th

A level Physics

Easter Vacation Work

Waves, Polarization, Interference & Diffraction

How much work should you be doing over the 4 weeks that you have off?

- 2 hours of file tidying – get them perfectly ordered
- 1 hour for each teacher of consolidating notes – are you missing any flashcards etc?
- *3 - 4 hours answering these questions*

What we are expecting to check when you return:

✔ These questions have been marked

✔ You have calculated your percentage and grade

✔ Written down the areas where you are still struggling. We will collate these and swiftly address these in clinic during the first few weeks of term.

Total: / 89 marks	**Grade (circle):**
Topics that you are still struggling with and why:	**A* = 75%**
	A = 70%
	B = 65 %

	C = 60 %

1. A source of light emits a train of waves lasting 0.04 μs. The light has a wavelength of 600 nm and the speed of light is 3×10^8 m s^{-1}. How many complete waves are sent out?

A 2.0×10^7

B 4.5×10^7

C 2.0×10^{10}

D 4.5×10^{13}

(Total 1 mark)

2. Which of the following statements about standing waves is true?

A particles between adjacent nodes all have the same amplitude.

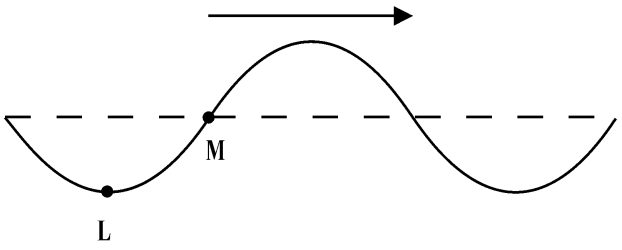
B particles undergo no disturbance at an antinode.

C particles immediately either side of a node are moving in opposite directions.

D particles between adjacent nodes are out of phase with each other.

(Total 1 mark)

3. The diagram shows a wave on a rope. The wave is travelling from left to right.



At the instant shown, point **L** is at a maximum displacement and point **M** has zero displacement. Which row in the table correctly describes the motion of points **L** and **M** during the next half cycle of the wave?

	Point L	**Point M**
A	rises	falls

B	rises	falls then rises
C	rises then falls	rises
D	rises then falls	falls then rises

(Total 1 mark)

4. Electromagnetic waves are produced by oscillating charges. Sound waves are produced by oscillating tuning forks. How are these waves similar?

A they are both longitudinal waves.

B they are both transverse waves.

C they both have the same frequency as their respective sources.

D they both require a medium to travel through.

(Total 1 mark)

5. Two points on a progressive wave differ in phase by $\frac{\pi}{4}$ radian. The distance between them is 0.50 m. The frequency of the oscillations is 10 Hz. The maximum speed of the wave is

A 2.50 m s^{-1}

B 5.00 m s^{-1}

C 12.5 m s^{-1}

D 40.0 m s^{-1}

(Total 1 mark)

6. An earthquake under the ocean floor may cause a tidal wave. It has been suggested that elephants may be able to give advance warning of the arrival of such a tidal wave by detecting the seismic p-waves produced by the earthquake.

(a) P-waves travel through the Earth's crust as longitudinal waves. Describe how longitudinal waves propagate.

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(2)

(b) Some p-waves have a frequency of 9.0 Hz and a wavelength of 0.8 km.

Calculate the speed of these waves.

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Wave speed = ...

(2)

(c) An elephant is 2500 km from the epicentre of an earthquake. A tidal wave would take about two hours to travel this distance. Determine whether it is possible for the elephant to detect the earthquake significantly earlier than the arrival of the tidal wave.

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(2)
(Total 6 marks)

7. (a) Explain what is meant by the term **transverse wave.** You may wish to illustrate your answer with the help of a simple diagram.

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(3)

(b) State two differences between a stationary wave and a progressive wave.

Difference 1 .....

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Difference 2 .....

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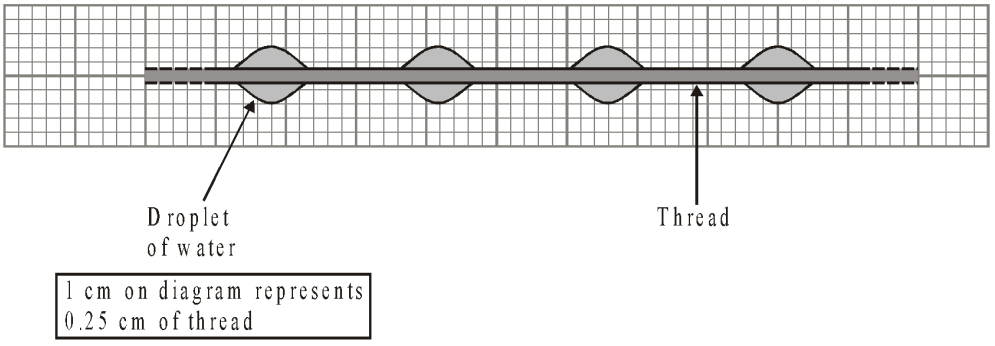
(2)

(c) Spiders are almost completely dependent on vibrations transmitted through their webs for receiving information about the location of their prey. The threads of the web are under tension. When the threads are disturbed by trapped prey, progressive transverse waves are transmitted along the sections of thread and stationary waves are formed.

Early in the morning droplets of moisture are seen evenly spaced along the thread when prey has been trapped.



(i) Explain why droplets form only at these points.

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(1)

(ii) The speed of a progressive transverse wave sent by trapped prey along a thread is 9.8 cm s^{-1}. Use the diagram to help you determine the frequency of the stationary wave.

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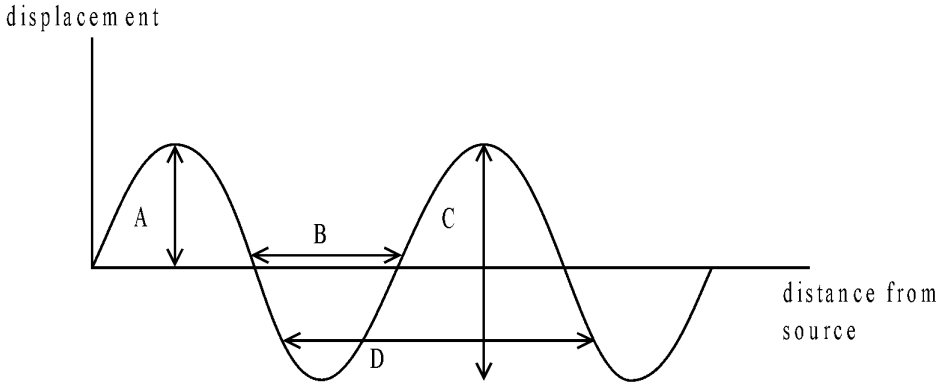
Frequency = ...

(4)

(Total 10 marks)

8. A loudspeaker emits a sound wave of wavelength 0.66 m. The diagram shows how displacement varies with distance from the loudspeaker at one instant of time.



(a) Which letter indicates the wavelength of the sound wave?

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(1)

(b) Sound travels at 330 m s^{-1} in air. Calculate the period of the wave.

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Period = ...

(3)

(Total 4 marks)

9. (a) Explain with the aid of a diagram why transverse waves can be plane polarised but longitudinal waves cannot be plane polarised.

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(3)

(b) (i) A filament lamp is observed directly and then through a sheet of Polaroid. Describe and explain the effect of the sheet of Polaroid on the intensity of the light seen.

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(2)

(ii) The sheet of Polaroid is now rotated in a plane perpendicular to the direction of travel of the light. What effect, if any, will this have on the intensity of the light seen?

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(1)

(Total 6 marks)

10. (a) Explain with the aid of diagrams why transverse waves can be polarised but longitudinal

ones cannot be polarised.

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(3)

(b) Describe with the aid of a diagram how you could demonstrate that light can be polarised.

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(3)
(Total 6 marks)

11. Explain what is meant by the term **polarisation** when referring to light.

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(2)

Sugar is produced from plants such as sugar cane. The stems are crushed and the juice extracted. The concentration of sugar in the juice is used to value the crop.

The concentration can be determined using polarised light.

Explain how to measure the angle of rotation of polarised light when it passes through a sugar solution.

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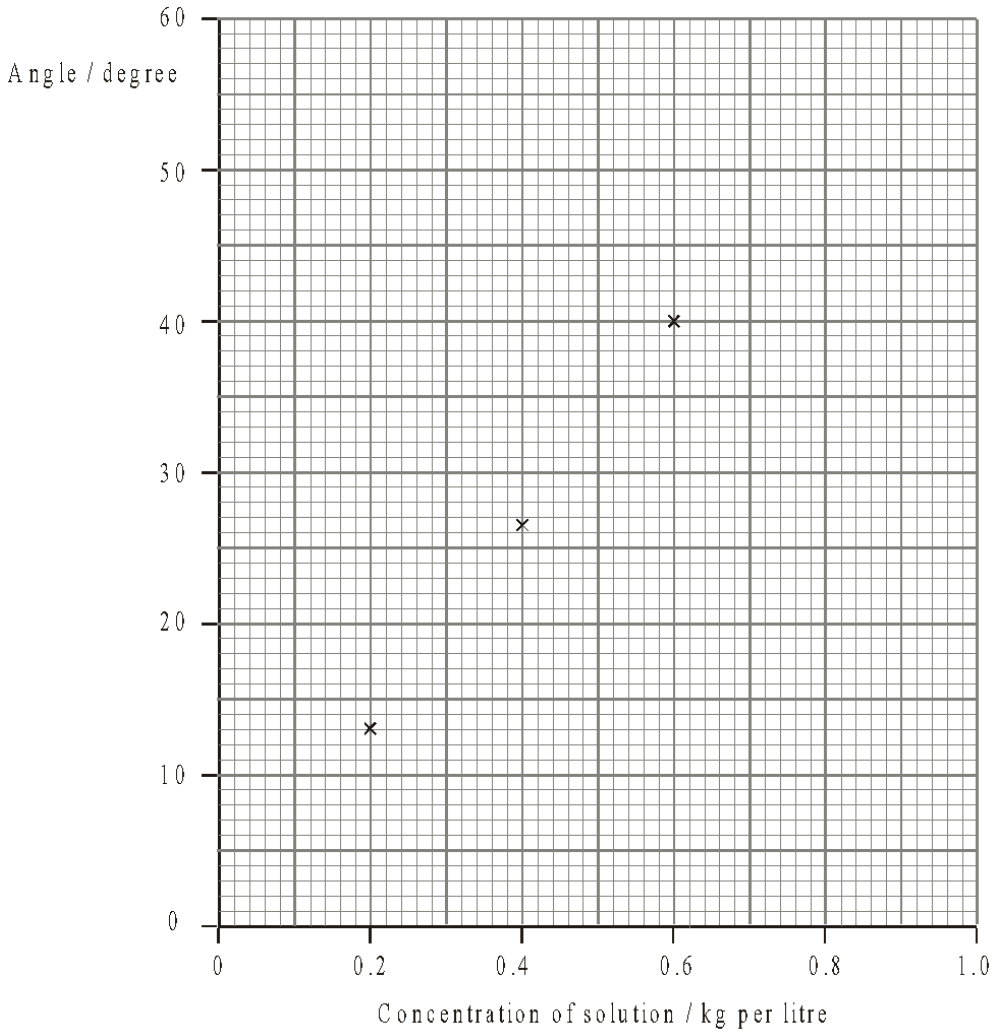
(4)

A student has carried out this experiment and obtains three results. He has plotted them on the graph below. He takes three more results and tabulates them.

Angle of rotation/degrees	Concentration of solution/ kg per litre
17	0.25
33	0.50
50	0.75

Add these results to the graph.

3)



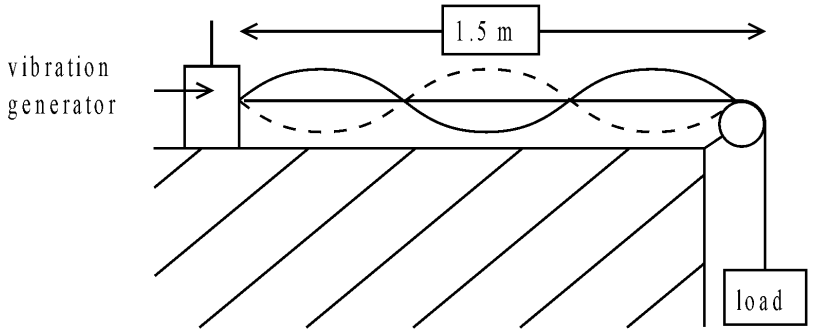
Use your graph to determine the concentration of an unknown sample which gives a rotation of 38°.

Concentration: ..... kg per litre

(1)

(Total 10 marks)

12. The following apparatus is set up. When the frequency of the vibrator is 60 Hz, the standing wave shown in the diagram is produced.



(a) What is the wavelength of this standing wave?

Wavelength = ...

(1)

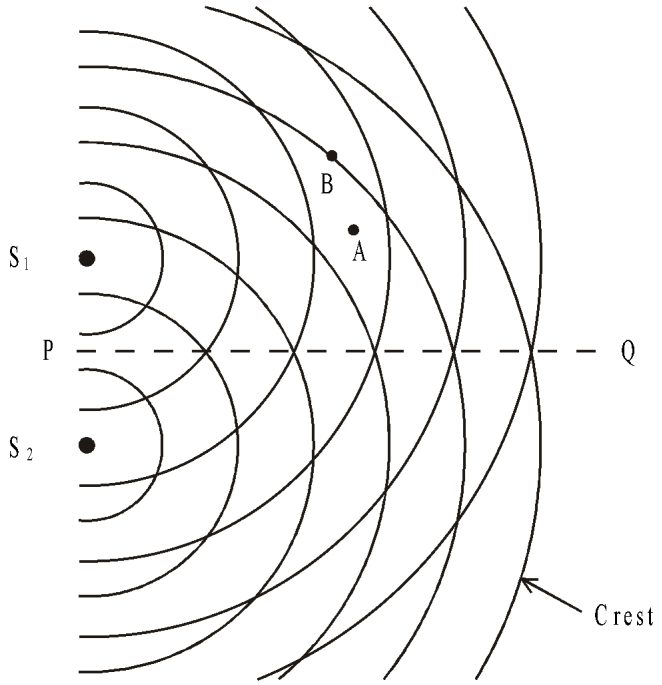
(b) The frequency of the vibrator is altered until the standing wave has two more nodes. Calculate the new frequency.

Frequency = ...

(2)

(Total 3 marks)

13. Two point sources, S_1 and S_2, emit waves of equal amplitude and frequency. The diagram, which is full size, shows the positions of successive crests of each wave at one particular instant of time.



(a) (i) How can you tell from the diagram that the speed of the waves is the same everywhere?

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(1)

(ii) The frequency of the waves is 40 Hz. Use information from the diagram to determine their speed.

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Speed = ...

(3)

(b) On the diagram, draw a line joining points where the waves from S_1 have travelled one wavelength further than the waves from S_2. Label this line X.

(1)

(c) The waves from the two sources superpose.

(i) Describe and explain the result of this superposition along line PQ.

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(3)

(ii) Tick the appropriate boxes in the table to show what is observed at the points marked A and B in the diagram.

Point	What is observed		
	Constructive interference	**Destructive interference**	**Neither**
A			
B			

(2)
(Total 10 marks)

14. (a) State three conditions which must be satisfied if two waves are to produce an observable interference pattern.

1 .....

2 .....

3 .....

(3)

(b) (i) Describe an experiment using microwaves to produce and detect a two slit

interference pattern. You may find it useful to draw a diagram.

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(3)

(ii) The dimensions of a microwave experiment are such that the equation $\lambda = xs/D$ is not valid. Explain how you would find a value for the wavelength of the microwaves from your experiment.

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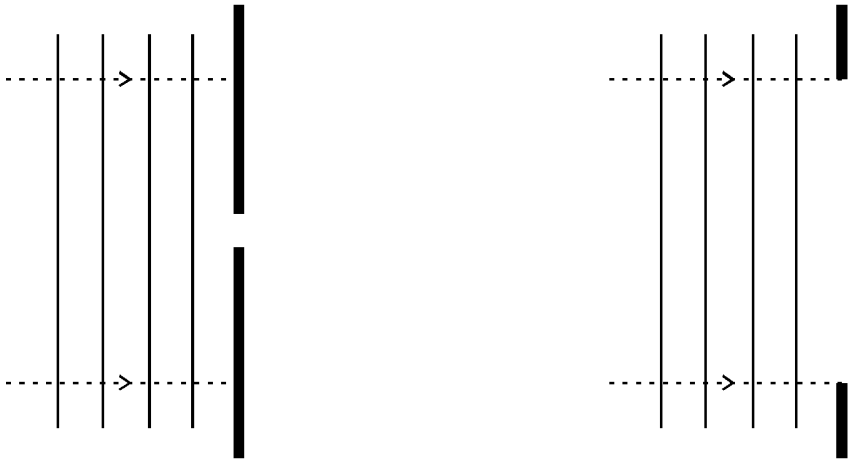
(3)
(Total 9 marks)

15. Each of the diagrams below shows a series of wavefronts, one wavelength apart, approaching a gap between two barriers in a ripple tank.



What is a wavefront?

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(1)

Add further wavefronts to each diagram to show what happens as the waves pass through each gap.

(3)

The station BBC Radio 4 broadcasts both on the Long Wave band at 198 kHz and on VHF at approximately 94 MHz. In mountainous parts of the country, reception is better on Long Wave than on VHF. Suggest why.

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(2)
(Total 6 marks)

16. *Read the following passage and answer the questions which follow.*

Diffraction

Light bends when it passes around an edge or through a slit. This effect is called diffraction. The angle through which the light bends is proportional to the wavelength of the light. Red light bends about 50% more than blue light.

The pattern of light and dark created when light passes through two slits shows that light has wave properties. The light waves that go through the slits spread out, overlap and add together to produce the pattern. In fact, the spacing between two adjacent dark bands in the pattern is inversely proportional to the slit separation.

Adapted from the website of the Exploratorium San Francisco

Use diagrams to explain how two waves overlap to produce a dark band.

(2)

Use the information in the passage to calculate an approximate wavelength for red light. Assume that the wavelength of blue light equals 460 nm.

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(2)

Blue light is shone through two slits separated by 0.10mm and adjacent dark bands in the pattern are 8.0 mm apart.

How far apart will the dark bands be if the slit separation is doubled?

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(1)

The website also states that the diffraction pattern produced when sunlight passes through a feather consists of bands of light with coloured edges. Explain how this pattern occurs.

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(3)
(Total 8 marks)

17. Until the early 20th century, the wave theory of light was successful at explaining different properties of light such as reflection, refraction and diffraction. With the discovery of the photoelectric effect, scientists had a problem. The wave theory of light assumes that the energy of the wave is spread over the whole wavefront. Using the wave theory, scientists calculated that, if light of very low intensity is shone onto the metal, it should take a very long time for an electron to gain sufficient energy to break free from a metal. It was discovered that, providing the light was above a certain frequency, electrons could escape from a metal surface instantly. The new model that was introduced treated light as being made of particles called photons.

(a) What is meant by diffraction?

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(2)

(b) How did considering light as photons enable scientists to explain why electrons could be emitted instantly from a metal surface?

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(2)

(c) Explain why this effect only happens when the light is above a certain frequency.

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(2)
(Total 6 marks)