Name:__________________

Assignment due:

St Patrick's College, Silverstream

PHYSICS

Waves Homework Assignment 1

Level 3

90520 Demonstrate understanding of wave systems

Credits: Four

Answer **ALL** the questions in the spaces provided.

If you need more space for any answer, use the pages provided at the back of this booklet and clearly number the question.

For all numerical answers, full working should be shown and the answer should be rounded to the correct number of significant figures and given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences with all logic fully explained.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE ASSESSMENT.

For Assessor's use only

Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement With Excellence**
Identify or describe aspects of phenomena, concepts or principles. ☐	Give descriptions or explanations in terms of phenomena, concepts, principles and/or relationships. ☐	Give concise explanations that show clear understanding, in terms of phenomena, concepts, principles and/or relationships. ☐
Solve straightforward problems. ☐	Solve problems. ☐	Solve complex problems. ☐
Overall Level of Performance (all criteria within a column are met) ☐		

You may find the following formulae useful

$d \sin\theta = n\lambda$	$n\lambda = \frac{dx}{L}$	$f' = f \frac{v_w}{v_w \pm v_s}$
$v = f\lambda$	$f = \frac{1}{T}$	

NZIP 2008
QUESTION THREE

A laser producing orange light illuminates two narrow slits ruled close together. The resulting pattern of light and dark fringes is observed on a flat screen. The dark fringes are measured and are found to be 12.0 mm apart. The separation of the slits is 0.210 mm and the distance from slits to screen is 4.25 m.

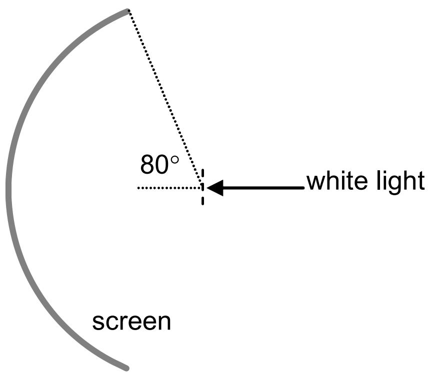
(a) Name the process that causes the dark fringes and explain clearly how they are formed.

(b) Show that the wavelength of the light being used is 5.93×10^{-7} m.

(c) The doubles slits are removed and replaced by a diffraction grating.

(i) Describe and explain what differences there are in the pattern observed on the screen.

(ii) The distance from the centre of the pattern produced from the diffraction grating to the first bright fringe is measured and found to be 0.82 m. The diffraction grating is still 4.25 m from the flat screen. Calculate the distance, d, between the slits in the diffraction grating.



(d) **White** light is shone through a diffraction grating on to a circular screen. Describe what is seen on the screen at **zero** diffraction angle.

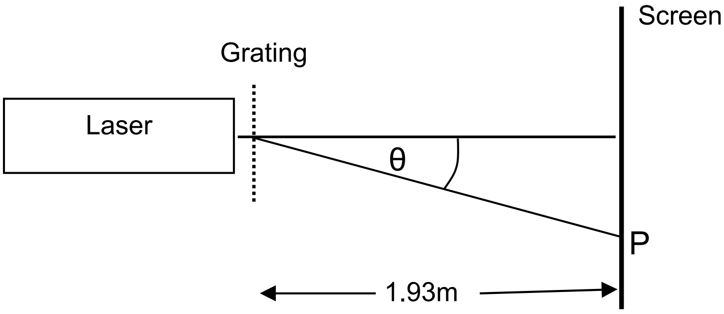
(e) The maximum angle through which the light can be diffracted and seen on the screen is 80°. Calculate how many **complete** spectra will be seen on the screen if white light is shone though a diffraction grating rated 245 lines / mm.

The wavelength of red light is 7.55×10^{-7} m
The wavelength of violet light is 4.12×10^{-7} m

Assessor's use only

NZIP 2005
QUESTION TWO: INTERFERENCE

Red light from a helium-neon laser shines on a diffraction grating of **5.0 x 10^5** lines per metre. A screen is kept **1.93m** away from the grating. The first order bright fringe is seen at point P on the screen.



(a) What is a diffraction grating?

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(b) State the type of interference seen at point P.

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(c) Explain, in terms of path difference, how the first order bright fringe is formed.

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(d) The wavelength of the red light produced by the helium-neon laser is **5.20 x 10^{-7} m**. Calculate the **angle** θ, the first order fringe makes with the central line. The diffraction grating has **5.0 x 10^5** lines per metre.

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______________________________ Angle θ = ______________

Assessor's use only

(e) Calculate the **distance** between the central bright fringe and point P on the screen.

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____________________________ Distance = ____________________

(f) The diffraction grating in question (d) is replaced by one that has **2.5×10^5** lines per metre. Explain how the interference pattern formed by this grating would be different from the previous one. Justify your answer.

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(g) Explain what difference would have been noticed on the screen if the above diffraction grating was replaced with a **double slit**. Justify your answer.

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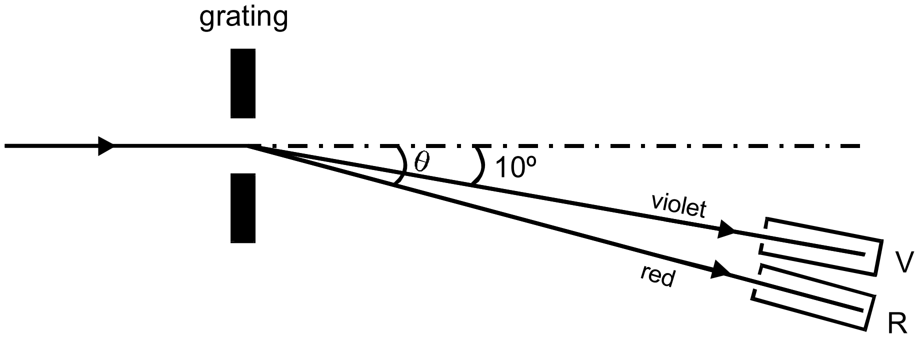
QUESTION TWO: VOYAGER SPACECRAFT

NASA launched the Voyager 1 interstellar mission in 1977. The twin Voyager 1 and 2 spacecraft opened new vistas in space by greatly expanding our knowledge of Jupiter and Saturn and beyond.

At more than thirteen billion kilometres from the sun, Voyager 1 is the most distant object from Earth built by humanity. Both craft are still sending back data.

An astronomer uses a diffraction grating with a line spacing of 2.510×10^{-6} m to observe first order diffraction. Two suitable detectors labelled V and R in the diagram below are located to receive the violet and red light respectively.

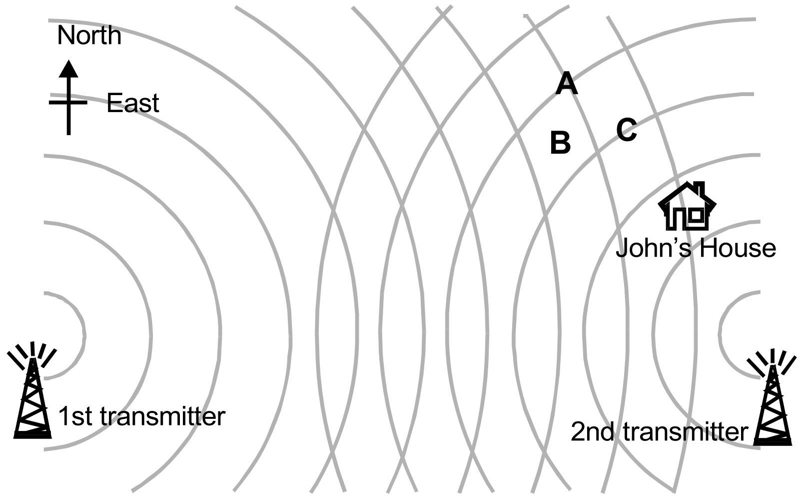


(e) What physical quantity is represented by θ in this diagram?

(f) Calculate the angle θ at which apparatus R must be placed to receive the red light of wavelength 6.45×10^{-7} m. Round your answer to the correct number of significant figures.

NZIP 2004

QUESTION THREE: RADIO RECEPTION

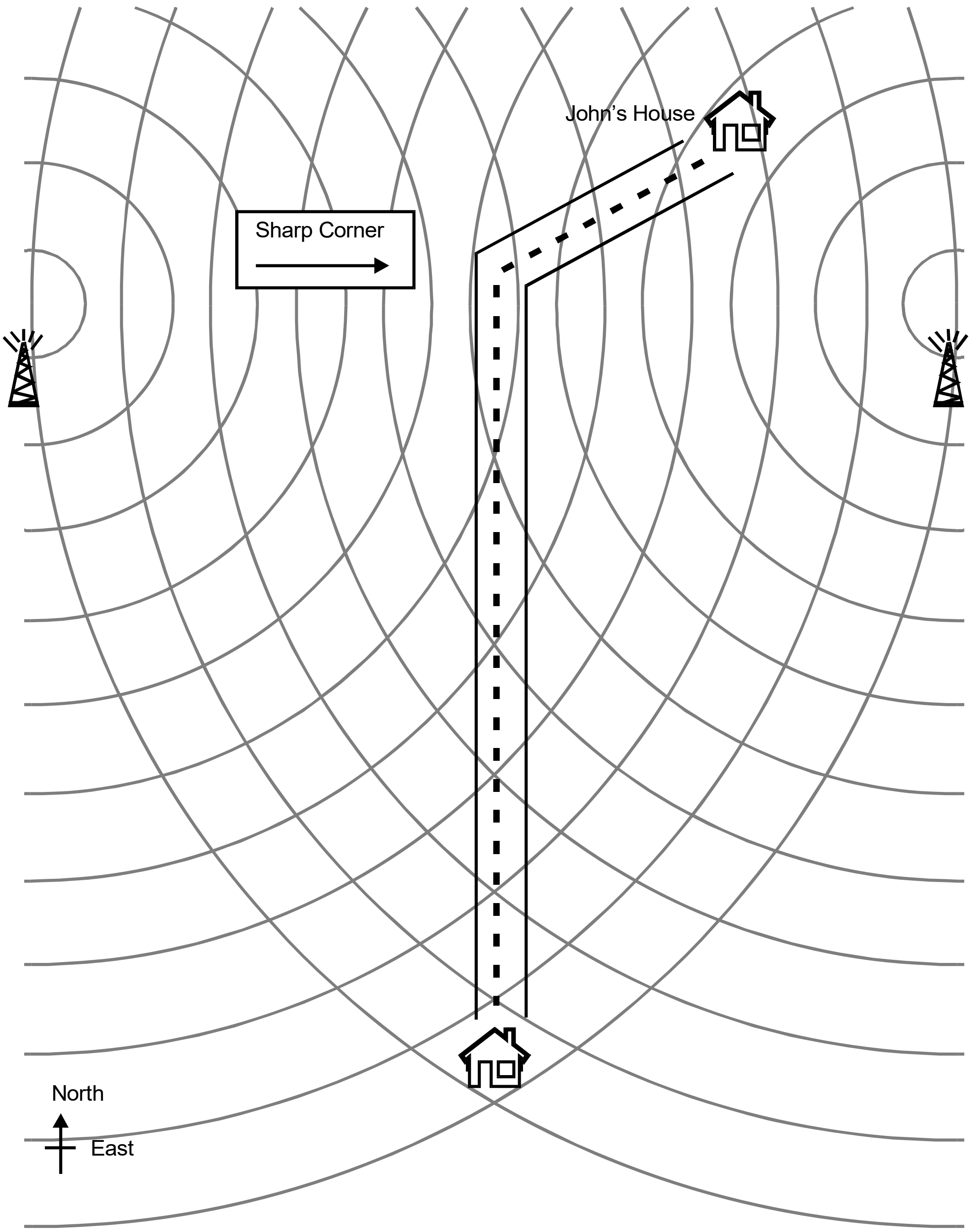


John lives a long way from the nearest radio transmitter so his radio reception is poor. When a second transmitter is placed nearer his house he is astonished to find his signal gets even weaker.

(a) Use the diagram to explain why John's radio got quieter when the second transmitter started broadcasting.

(b) To which of the places, A, B or C or any combination of these, could John go to hear his favourite radio programme clearly? Explain your answer.

John drives to visit his friend Jimmy. He has his radio turned on in the car.



(c) Describe the changes in volume that John would notice during his journey.

Jimmy's house is 40km South of the transmitters. The transmitters are 10km apart. John's radio is tuned to a station with a wavelength of 200m. (1503 kHz)

Note: the diagram on the previous page is not drawn to scale.

$L = 4.00 \times 10^4$ m
$d = 1.00 \times 10^4$ m
$\lambda = 2.00 \times 10^2$ m.

(d) Show that the **first** place East of Jimmy's house where the signal is **strong** for this station is 800m away.

(e) A signal is broadcast at a frequency of 89.2 MHz. Calculate the distance to the **first** place East of Jimmy's house where it would **not** be heard.
(Use $c = 3.00 \times 10^8$ ms^{-1})

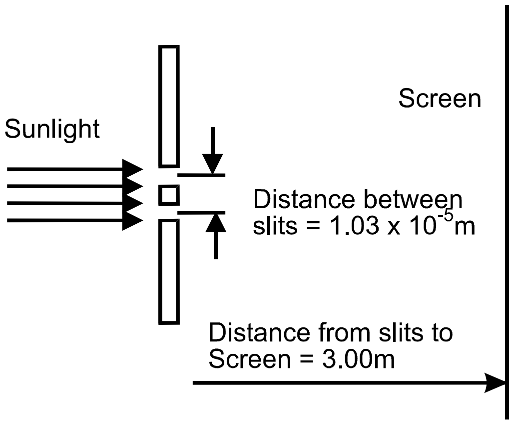
(f) How far East would Jimmy and John need to go to get another strong signal on **both** of the stations they like: $f_1 = 90.0$ MHz and $f_2 = 99.0$ MHz

NZIP 2003 these older questions are before NCEA

QUESTION 8: LIGHT AND WAVES (16 marks)

ANSWER THESE QUESTIONS ON REFILL AND ATTACH TO THE ASSIGNMENT

Austin decides to investigate the behaviour of light and attempts to replicate Young's Double Slit experiment. He sets up the following apparatus using sunlight to shine through a double slit screen.



(a) The sunlight does not produce a clear interference pattern on the screen. Explain this. (1 mark)

(b) He replaces the sunlight source with a hand held laser, (λ = 731 x10^{-9}m), which produces a clear pattern on the screen. Sketch the pattern he is likely to observe. (1 mark)

(c) Calculate the angle between the central antinodal line and the third bright fringe. (2 marks)

(d) He then replaces the double slit screen with a diffraction grating with 4000 slits per cm. Make a sketch of this new pattern to show how it differs from that in question b. (2 marks)

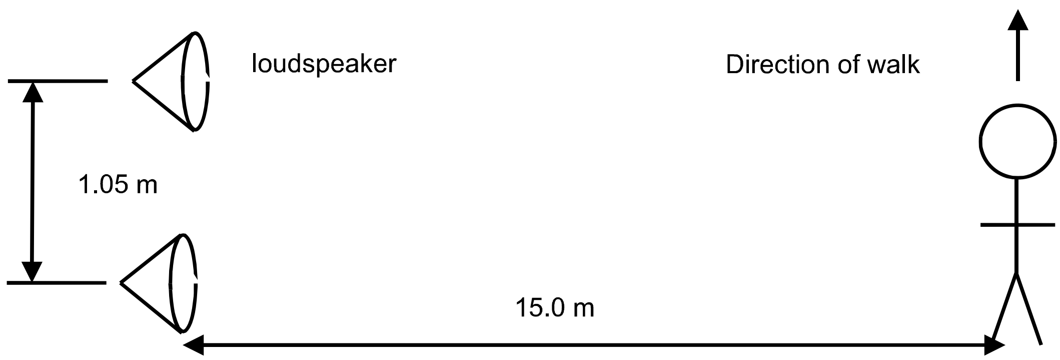
(e) State two essential features of a diffraction grating. (2 marks)

(f) Calculate the distance between each slit on the diffraction grating. (1 mark)

(g) Explain what would happen to the pattern if he shone a monochromatic light source of wavelength 455 nm through the diffraction grating. (2 marks)

(h) Explain how these experiments provide evidence for a wave model of light. (2 marks)

Young's double slit experiment can be replicated using two speakers attached to a signal generator, which can produce sound waves of variable wavelength and frequency. Austin is 15.0 m away, and walking across in front of the speakers, when he notices loud and quiet zones. Use as the speed of sound v_s= 335 ms^{-1}.



(i) If the speakers are placed 1.05 m apart, what frequency of sound should be used to create a 3.00m gap between loud zones? (3 marks)

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