

SPH4U UNIVERSITY PHYSICS

THE WAVE NATURE OF LIGHT

Introduction
(P.434-437)

Light & Interference

*A hummingbird is one of the most colourful animals in nature and if you have ever seen one, their colours almost seem to change. This is because their feathers have specialized cells, or platelets, on the top layer that act as prisms. These prisms split white light into the many different colours. This phenomena is known as **iridescence**.*



December 1, 2012

4U4 - Introduction

1

Light & Interference

An iridescent object appears to change colour as your angle of view of the object changes. Many other insects and animals have iridescent features, such as the wings of dragonflies, the shells of beetles, and the eyes of many nocturnal animals. For example, the eerie glow of a cat's eyes occurs because of iridescence due to structures that improve the cat's night vision.




December 1, 2012

4U4 - Introduction

2

Light & Interference


Iridescence is not only found in insects and animals – you can observe it in everyday situations. Think about the soap bubbles created when washing dishes or blowing soap bubbles. The iridescent properties of the bubbles, like the brilliant colours of the hummingbird feathers, are a result of the light reflecting from the bubble's surface. Different surfaces, viewing angles, and thicknesses result in different colours.



December 1, 2012 4U4 - Introduction 3

Light & Interference

NOTE!
The colour of an object is not a part of the object, but rather depends on which wavelengths of light that object reflects and absorbs. For example, a green grape is not made up of the colour green, but rather reflects a wavelength of light that appears green to the observer, and all other visible wavelengths of light are absorbed. The wave properties of light affect how we see colours, shapes, and textures.




December 1, 2012 4U4 - Introduction 4

Overall Expectations

By the end of this unit, students will:

1. analyse technologies that use the wave nature of light, and assess their impact on society and the environment;
2. investigate, in qualitative and quantitative terms, the properties of waves and light, and solve related problems;
3. demonstrate an understanding of the properties of waves and light in relation to diffraction, refraction, interference, and polarization.


December 1, 2012 4U4 - Introduction 5

 **Big Ideas**

Concepts that students should retain long after this course are:

- ▶ Light has properties that are similar to the properties of mechanical waves.
- ▶ The behaviour of light as a wave can be described mathematically.
- ▶ Technologies that use the principles of the wave nature of light can have societal and environmental implications.

December 1, 2012 4U4 - Introduction 6

 **Getting Started: Useful Concepts & Skills**


CONCEPTS REVIEW

1. Describe the direction in which a ray of light bends as it travels:

- (a) from air into diamond.
- (b) from water into air.
- (c) normal to the interface of two media.

(a) towards the normal
(b) away from the normal
(c) no bending occurs

December 1, 2012 4U4 - Introduction 7

 **Getting Started: Useful Concepts & Skills**

CONCEPTS REVIEW

2. Theories and experiments are two very different methods used in scientific research.

- (a) Explain the difference between the two.

(a) Theory
– set of principles that explain and predict a phenomena
Experiment
– methodical trial and error procedure carried out with the goal of verifying, falsifying, or establishing the validity of a hypothesis

December 1, 2012 4U4 - Introduction 8

Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

2. Theories and experiments are two very different methods used in scientific research.
 (b) Discuss why both are useful in researching the wave nature of light.

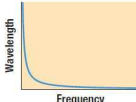
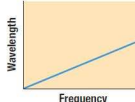
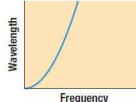
(b) answers will vary

December 1, 2012 4U4 - Introduction 9

Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

3. Which graph shows the relationship between the wavelength and frequency for sound waves that travel at a constant speed?

(a)  (b)  (c) 

(b) since $v = f\lambda$

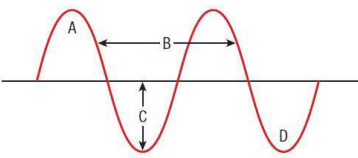
December 1, 2012 4U4 - Introduction 10

Getting Started: Useful Concepts & Skills


CONCEPTS REVIEW

4. Identify the parts of the wave labelled.

A crest
 B wavelength
 C amplitude
 D trough



December 1, 2012 4U4 - Introduction 11


 Getting Started: Useful Concepts & Skills

SKILLS REVIEW

5. A swimming pool pump generates 10 water waves every 15 s.
(a) Determine the frequency of the waves.

(a) $f = 0.67 \text{ Hz}$

December 1, 2012 4U4 - Introduction 12


 Getting Started: Useful Concepts & Skills

SKILLS REVIEW

5. A swimming pool pump generates 10 water waves every 15 s.
(b) If the wave crests are separated by 2.0 m, determine the speed of the waves.

(b) $v = 1.3 \text{ m/s}$

December 1, 2012 4U4 - Introduction 13

 Getting Started: Useful Concepts & Skills

SKILLS REVIEW

5. A swimming pool pump generates 10 water waves every 15 s.
(c) Predict what will happen as two wave crests interfere near the middle of the pool.

(c) larger wave – constructive interference

December 1, 2012 4U4 - Introduction 14

Getting Started: Useful Concepts & Skills

SKILLS REVIEW

6. Green light has a frequency of 5.70×10^{14} Hz. Use the universal wave equation to calculate the wavelength, in nanometres, of green light. The speed of light in a vacuum is 3.00×10^8 m/s.

$\lambda = 526 \text{ nm}$

December 1, 2012 4U4 - Introduction 15

Getting Started: Useful Concepts & Skills

SKILLS REVIEW

7. The vibrating end of the standing wave shown makes 25 complete vibrations in one minute. Calculate:

(a) the frequency of the waves.

$f = 0.42 \text{ Hz}$

December 1, 2012 4U4 - Introduction 16

Getting Started: Useful Concepts & Skills

SKILLS REVIEW

7. The vibrating end of the standing wave shown makes 25 complete vibrations in one minute. Calculate:

(b) the wavelength of the waves.

$\lambda = 3.0 \text{ m}$

December 1, 2012 4U4 - Introduction 17

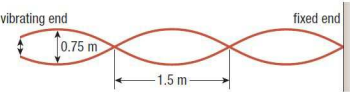
Getting Started: Useful Concepts & Skills

SKILLS REVIEW

7. The vibrating end of the standing wave shown makes 25 complete vibrations in one minute. Calculate:

(c) the speed of the waves.

(c) $v = 1.3 \text{ m/s}$



December 1, 2012 4U4 - Introduction 18
