Name:	**ANSWERS**	Date:	

P13 1 The Electromagnetic Spectrum

Worksheet Grade

Current ⇒ Target

Key Questions

- What are the parts of the electromagnetic spectrum (EMS)
- Range of wavelengths in the EMS that an eye can detect
- How energy is transferred by electromagnetic waves

Lesson Objective

To understand the spectrum of electromagnetic waves and how they transfer energy.

Route to Learning	Grade	Achieved
State that all EM waves travel at the same speed in a vacuum	4	
Identify the position of EM waves in the spectrum in order of wavelength and frequency.	5	
Describe the relationship between the energy being transferred by an EM wave and the frequency of the wave.	6	
Explain why the range of EM wavelengths detected by the human eye is limited.	7	
Use standard form in calculations of wavelength, frequency, and wave speed.	8	

What type of wave is Light and what does it transfer? **Grade 2-3**

Light is a transverse wave and it transfers energy

What can travel across a vacuum and does it have mass?

Light can travel across a vacuum and it does not have any mass

Complete the sentence **Grade 1-2**

Light is an **oscillating electric and magnetic field** transferring energy

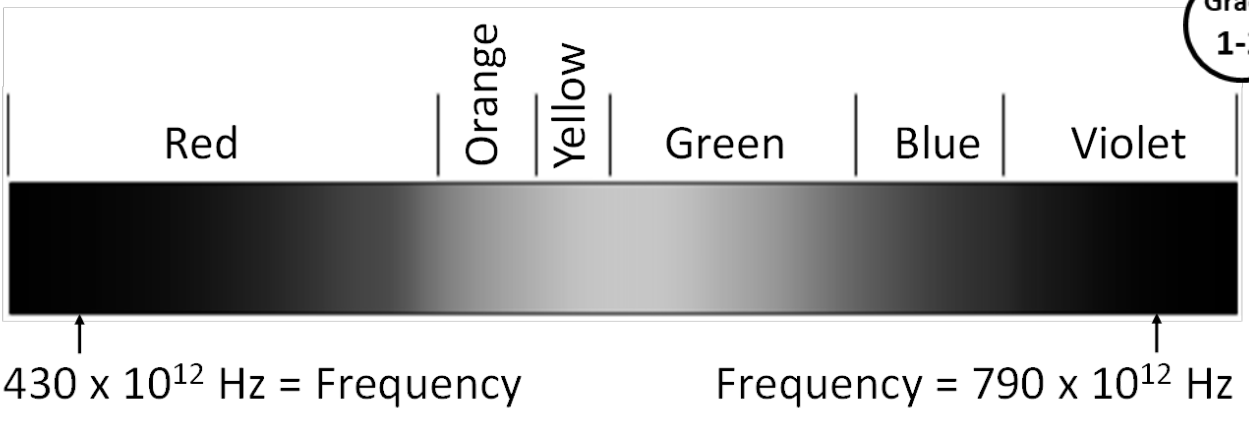
from **a source** (e.g. Sun, Light Bulb) **to an absorber** (e.g. Black blazer, Green Grass).

The combined oscillating **electric** and magnetic **field** is called **Electromagnetism.**.

What travels at the speed of light in a vacuum?

Light and all EMS waves travel at 300,000,000 m/s (3x108 m/s) in a vacuum **Grade 3-4**

Complete the labelling **Grade 1-2**



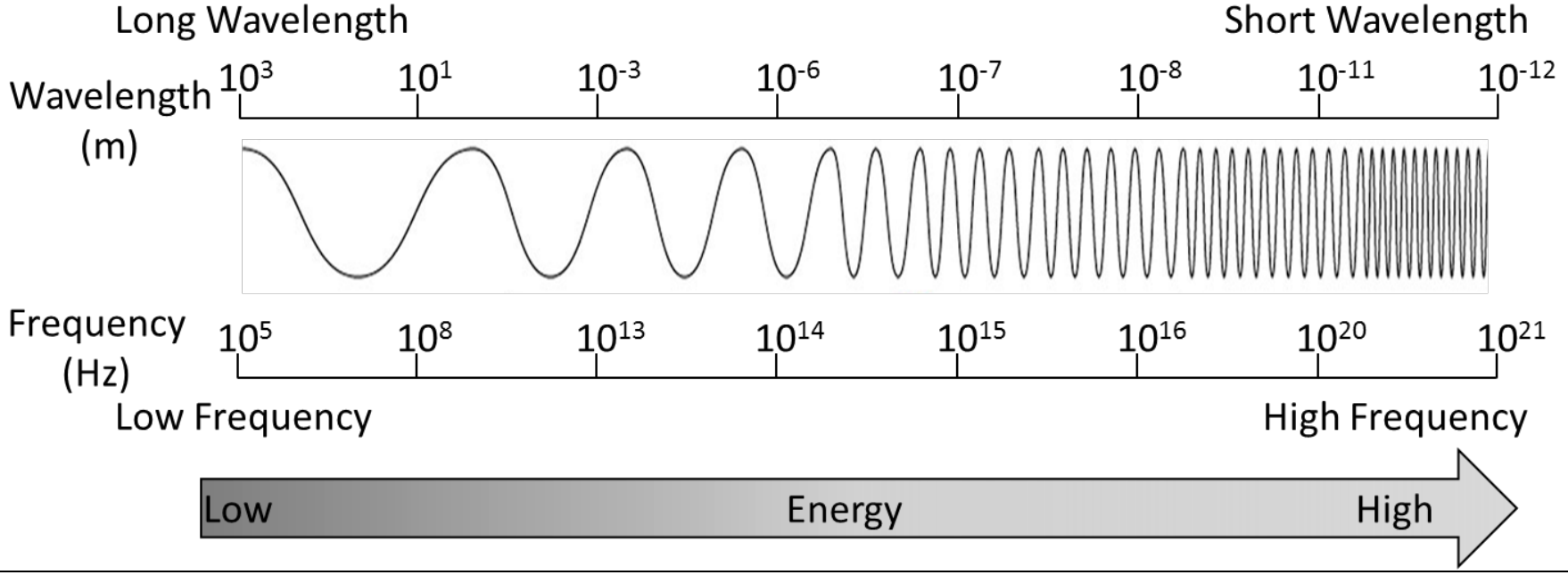
Complete the missing information for the Electromagnetic Spectrum (EMS)

EM Banding	Radio Waves	Micro Waves	Infrared (IR)	Visible Light	Ultraviolet (UV)	X-rays	Gama Waves
Usage Example	TV's Radio's, MRI Scan	WiFi, Radar, Mobiles, Cooking	Remotes, Night-Vision	Eyes, Light-bulb	Suntan-bed	Bag-Check, Medical	Nuclear, Space
Wavelength Size Example	**Football Field**	**Tennis Ball**	**Blood Cells**	**Bacteria**	**Virus**	**Atom**	**Atom Nucleus**

Grade 1-2

Grade 4-5

Grade 3-4



Extension: Describe how night vision works

All objects are warm to some amount. Heat is transmitted as an infrared radiation wave.

The night vision device can detect infrared radiation and converts it into visible light on a screen

Grade 4-5

Describe the relationship between the energy transferred by an EM wave and the frequency of the wave
As the frequency of the wave increases the amount of energy it transfers also increases

Grade 5-6

Describe how the eye sees movement and colour
Movement is detected by Rod cells (which also work in low light). Colour is detected by Cone cells
Both cell types chemically transmit their reactions to the brain

Grade 4-5

Explain why the range of EM wavelengths detected by the human eye is limited.
Intensity of sunlight at the earth's surface is highest in the visible range of the EMS. Evolution of
light detecting cells developed in response to the high energy levels available from the visible range of
the EMS. Other cells detecting the other frequencies in the EMS didn't develop due to the low
levels of energy availability.

Grade 6-7

Write the numbers in standard form		Write the numbers in the normal format	
120,000,000	**$120x10^{6}$ or$1.2x10^{8}$**	$8x10^{-6}$	**0.000,008**
0.000,000,456	**$45.6x10^{-8}$ or $456x10^{-9}$**	$4x10^{3}$	**4,000**
936000000000000	**$936x10^{12}$ or $9.36x10^{14}$**	$4.67x10^{-8}$	**0.000,000,046,7**
0.0000000029	**$2.9x10^{-9}$ or $29x10^{-10}$**	$92.6x10^{12}$	**92,600,000,000,000**
469200000000000000.0	**$469.2x10^{15}$**	$0.74x10^{-6}$	**0.000,000,74**

Grade 4-5

Calculate the missing value and write the answers in standard form		$v = f \times \lambda$
Wave Speed m/s	**Frequency Hz**	**Wavelength m**
$170x10^{3}$	$170x10^{6}$	$1x10^{-3}$
$420x10^{3}$	$75x10^{8}$	$56x10^{-6}$
$8.4x10^{-1}$ or $840x10^{-3}$	$0.04x10^{8}$	$2.1x10^{-7}$
$3x10^{8}$	**$769.2x10^{12}$**	$390x10^{-9}$
$3x10^{8}$	**$428.6x10^{12}$**	$7000x10^{-10}$
$270x10^{6}$	$456x10^{15}$	**$5.9x10^{-10}$**
$0.45x10^{10}$	$86.5x10^{14}$	**$520.2x10^{-9}$**

Grade 6-7

Extension:	
A green laser is fired through water at a frequency of $560x10^{12}$ Hz and wavelength of $401x10^{-9}$ m. What's the speed of light in water?	**$560x10^{12}$ x $401x10^{-9}$ = $224.56x10^{6}$ m/s**
Light from a distant star shines red ($450x10^{12}$Hz) and blue ($650x10^{12}$Hz). What's the difference in wavelength between the two colours?	**$3x10^{8} \div 450x10^{12}$ = $666.7x10^{-9}$ m** **$3x10^{8} \div 650x10^{12}$ = $461.5x10^{-9}$ m** **$666.7x10^{-9}$ - $461.5x10^{-9}$ = $205.2x10^{-9}$ m**

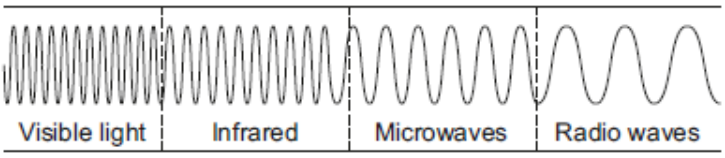
Grade 7-8

Grade 7-8

What is the wavelength?	
 Frequency is 2.45×10^9Hz	 Frequency is 5×10^9Hz
Show your calculations **$3 \times 10^8 \div 2.45 \times 10^9 = 0.122$ m** **Wavelength = 0.12m**	Show your calculations **$3 \times 10^8 \div 5 \times 10^9 = 0.06$ m** **Wavelength = 0.06m**

Exam Questions:

Infrared and microwaves are two types of electromagnetic radiation. The diagram below shows the positions of the two types of radiation within part of the electromagnetic spectrum.



(a) Name **one** type of electromagnetic radiation which has more energy than infrared.

any one from: (visible) light, UV / ultra violet, X-ray, gamma / γ-ray

(1)

(b) Use the correct answer from the box to complete each sentence. Each answer may be used once, more than once or not at all.

greater than	**less than**	**the same as**

The wavelength of infrared is **less than** the wavelength of microwaves.

The frequency of microwaves is **less than** the frequency of infrared.

The speed of microwaves in a vacuum is **the same as** the speed of infrared in a vacuum.

(3)

(c) Some of the properties of infrared and microwaves are the same.

State **two** of these properties.

any two from: same speed, travel at the speed of light (in a vacuum), transverse (*accept a full description of a transverse wave)*, transfer energy (from one place to another), can be reflected, can be refracted, can be diffracted, can be absorbed / transmitted, can travel through a vacuum/space, can be polarised

travels in straight lines is insufficient

(2)