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LIGHT AND EM WAVES

SECTION A: TYPICAL EXAM QUESTIONS

QUESTION 1 – 8 minutes

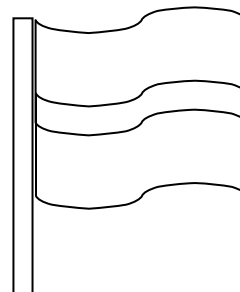
- 1.1 Crystal Chandeliers are beautiful decorations as they dispersed light into the colours of the visible spectrum. Explain this statement. (3)
- 1.2 Consider the following continuous spectrum:

Colour	Violet	Indigo	Blue	Green	Yellow	Orange	Red
Wavelength (nm)	400		500		600		700

Calculate the wavelength, in nm, of light which has a frequency of $6,5 \times 10^{14}$ Hz and identify which colour it should represent. (4)

QUESTION 2 – 7 minutes (taken from Gauteng P1 Prelim 2009)

- 2.1 A checkered flag has yellow and red blocks printed on it. It is used in a school play to indicate when the audience may laugh and when they have to keep quiet. Rose, a grade 12 Physical Science learner notes that the flag changes colour when the stage lights change colour.



- 2.1.1 What will the colour of the yellow blocks and the red blocks respectively be, when a magenta light is shone on the flag? (2)
- 2.1.2 Explain the observation in 8.1.1 using the colour subtraction theory. (4)
- 2.1.3 What colour light has to shine on the flag for the red blocks to appear red and the yellow blocks to appear yellow? (1)

QUESTION 3 – 5 minutes

A ray of white light is passed through a green filter and then shone onto a piece of white paper with blue writing on it.

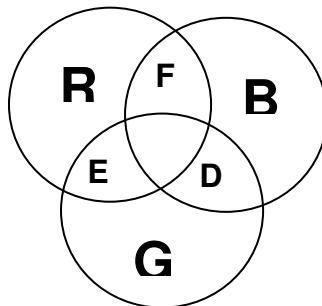
- 3.1 What colour will the white paper appear under this light? Explain your answer. (2)
- 3.2 What colour will the writing appear under this light? Explain your answer. (2)

[4]

QUESTION 4 – 5 minutes

(Taken from the DoE Feb/March P1 2009)

- 4.1 The diagram below shows the three primary colours of light. Each of D, E and F in the diagram below is obtained by adding a pair of primary colours. This is the basis of how technology may use colour to produce desired colour effects as is done in the television.



D is where blue(B) and green(G) overlap, E is where green and red(R) overlap and F is where blue and red overlap.

- 4.1.1 Which three colours are represented by the letters D, E AND F respectively? (3)

- 4.1.2 Why are the colours red, blue and green referred to as primary colours? (2)
[5]

SECTION B: SOLUTIONS AND HINTS
Question 1

- 1.1 Each colour of the rainbow has a unique frequency / wavelength ✓
As light enters glass block it undergoes refraction (bends) ✓ away from the normal
Different wavelengths bend to a different degree and thus spread out. ✓ (3)
Too many are confusing diffraction with refraction.
- 1.2 $c = f\lambda$ ✓ $3,0 \times 10^8 = 6,5 \times 10^{14} \lambda$ ✓ subs
 $\lambda = 4,62 \times 10^{-7} = 461,5 \text{ nm}$ ✓ Therefore BLUE ✓ (4)
Answer definitely closer to blue therefore blueish/indigo not valid Only 7 colours

Question 2

- 2.1.1 The yellow blocks appear red and the red blocks appear red as well (2)
- 2.1.2
- The magenta light is made up of red and blue light
 - The yellow blocks will reflect red and green and absorb blue, since only red light is provided and not green light, the yellow will appear red.
 - The red blocks only reflect red light and absorbs blue and green. Thus it will appear red. ✓ (3)
- 2.1.3 White light (1)

Question 3

- 3.1 White paper will appear green ✓
 Green filter cuts out all but green, white reflects all colours ✓ (2)
Many went on about the filter but forgot the paper is also involved!!!
- 3.2 Blue writing will appear black ✓
 Green filter cuts out all but green but blue can only reflect blue therefore it reflects nothing which we perceive as black ✓ (lack of colour) (2)

Question 4

- 4.1 D: cyan ✓
 E: yellow ✓
 F: magenta ✓ (3)
- 4.2 All other colours can be obtained by mixing of these three colours ✓✓ (2)

SECTION D: HOMEWORK**Question 1 – 2 minutes**

A certain electromagnetic wave has a photon energy of $1,89 \times 10^{-24}$ J. What kind of electromagnetic wave is this? (2)

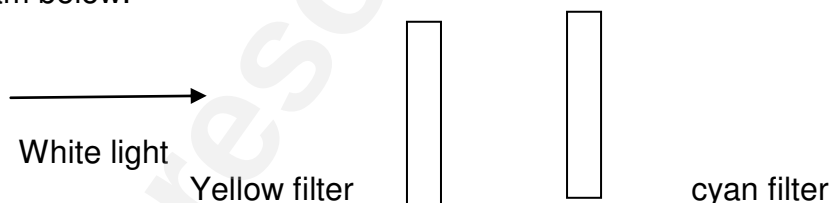
Question 2 – 13 minutes

An electromagnetic wave of frequency 405 MHz is travelling through space.

- 2.1 What is the wavelength of the wave? (3)
 2.2 What type of electromagnetic radiation is this? (2)
 2.3 How much energy does each photon have? (4)

Question 3 – 10 minutes

White light passes through a yellow filter, which is in turn followed by a cyan filter as shown in the diagram below.



- 3.1 Identify the colour that emerges from the cyan filter. (1)
- 3.2 Explain your answer to question 3.1 (4)
- 3.3 The cyan filter is now replaced with a magenta filter. What colour will emerge from the magenta filter? (1)
 [6]

SECTION E: SOLUTIONS TO SESSION 8 HOMEWORK

$$\begin{aligned}
 1. \quad v &= f \times \lambda \checkmark \\
 2. \quad v &= \text{m} \cdot \text{s}^{-1} \checkmark \quad f = \text{Hz} \checkmark \quad \lambda = \text{m} \checkmark \\
 3.1. \quad v &= f \times \lambda \checkmark \\
 &= 5 \times 0,05 \checkmark \\
 &= 0,25 \text{ m} \cdot \text{s}^{-1} \checkmark
 \end{aligned}$$

$$3.2. \quad T = 1/f \checkmark = 1/5 \checkmark = 0,2 \text{ s} \checkmark$$

$$\begin{aligned}
 3.3. \quad \text{distance} &= \text{speed} \times \text{time} \checkmark \\
 &= 0,25 \times 4 \checkmark \\
 &= 1 \text{ m} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 4.1. \quad v &= f \times \lambda \quad \checkmark \quad f = 1/T \checkmark = 1/0,2 \checkmark = 5 \text{ Hz} \checkmark \\
 \lambda &= v/f \\
 &= 1,2/5 = 0,24 \text{ m} \checkmark
 \end{aligned}$$

4.2. the period would half ($T = 1/f$) $\checkmark$

4.3. the wavelength would also half $\checkmark$

5. temperature of the gas $\checkmark$ – sound moves faster through hot air than cold air $\checkmark$
 Density $\checkmark$ – the higher the density, the slower the speed of sound through the gas $\checkmark$

1. hydrogen $\checkmark$ – the fastest $\checkmark$
 air
 carbon dioxide $\checkmark$ – slowest $\checkmark$

hydrogen is the least dense and sound moves faster through low density gases than high density gases like carbon dioxide.

2. Sound moves faster in hot air because a temperature increase increases the speed of the air particles and that makes air move fast, hence increasing the speed of sound through it.

6.1 Light travels faster than sound and therefore the smoke is seen before the explosion is heard. $\checkmark$

$$\begin{aligned}
 6.2 \quad \text{Distance} &= \text{speed} \times \text{time} \checkmark \\
 &= 340 \times 5 \checkmark \\
 &= 1700 \text{ m} \checkmark
 \end{aligned}$$

