Q1.

Hertz did an experiment to determine the speed of radio waves.

Describe this experiment.

In your answer you should:

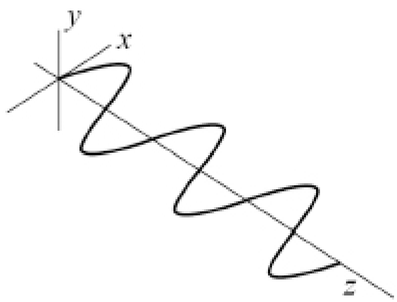
- include a labelled diagram
- state the measurements that were taken
- describe how the data were used to determine the speed of radio waves.

(Total 5 marks)

Q2.

An electromagnetic wave is propagating through space.

The figure below shows the variation of the magnetic flux density of the wave with distance. The magnetic field is in the xz plane.
The y-axis is at right-angles to the xz plane.



(a) Draw and label on the figure above:

- the corresponding electric field
- the direction of propagation of the wave.

(1)

(b) Which scientist proposed the electromagnetic wave model of light?

Tick ✓ **one** box.

Hertz	☐
Huygens	☐
Maxwell	☐
Young	☐

(1)

(c) Another theory of the nature of light was proposed by Isaac Newton.

Describe how Newton's theory was used to explain the refraction of light as it moves from air into glass.

(3)

(d) Describe a demonstration using visible light that can be performed in a school laboratory to show that Newton's theory is not correct.

(3)

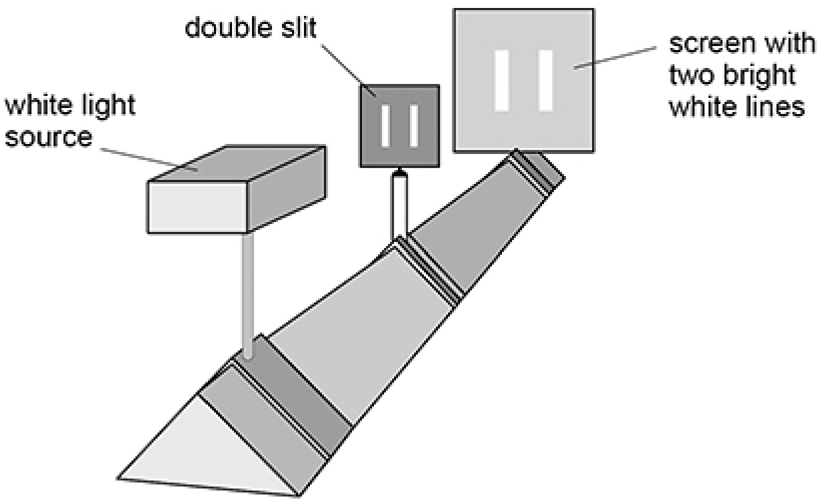
(Total 8 marks)

Q3.

In the 17th century, Isaac Newton proposed a theory to explain some of the properties of light. An alternative theory of light was proposed by Christiaan Huygens at about the same time.

A student uses the arrangement in **Figure 1** to investigate the two theories.

Figure 1



(a) The student observes two bright white lines on the screen.

Explain how this observation supports Newton's theory of light.

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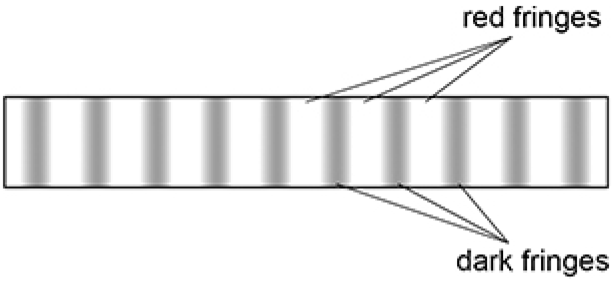
(2)

(b) The student makes alterations to the apparatus in **Figure 1**.
Figure 2 shows the red and dark fringes that the student now observes on the screen.

Figure 2



Identify the alterations made by the student and explain how the observations in **Figure 2** support Huygens' theory of light.

In your answer you should:

- identify alterations made to the apparatus in **Figure 1**
- outline the key features of Huygens' theory
- explain how the result of this experiment supports Huygens' theory.

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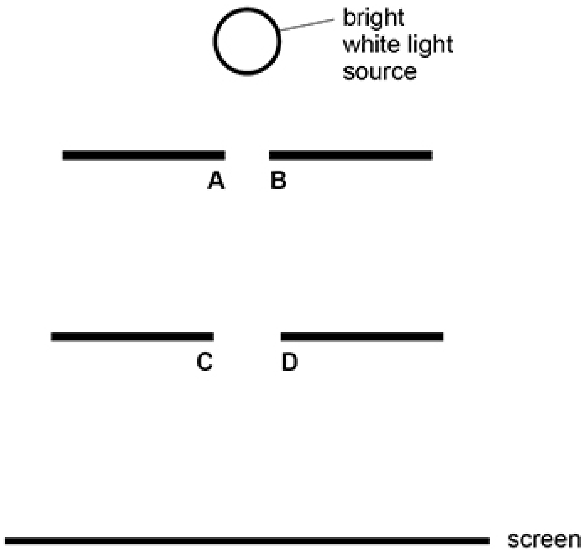
(6)

(c) Shortly before the work of Newton and Huygens, Francesco Grimaldi carried out an experiment into the behaviour of light. **Figure 3** shows Grimaldi's arrangement.

Figure 3



A bright white light source is used to illuminate a small circular aperture, **AB**.
The light from this aperture illuminates a second, slightly larger circular aperture, **CD**.

The light passing through both apertures arrives at a screen.

Newton's theory and Huygens' theory make different predictions about the appearance of the light on the screen.

Discuss these differences in appearance.

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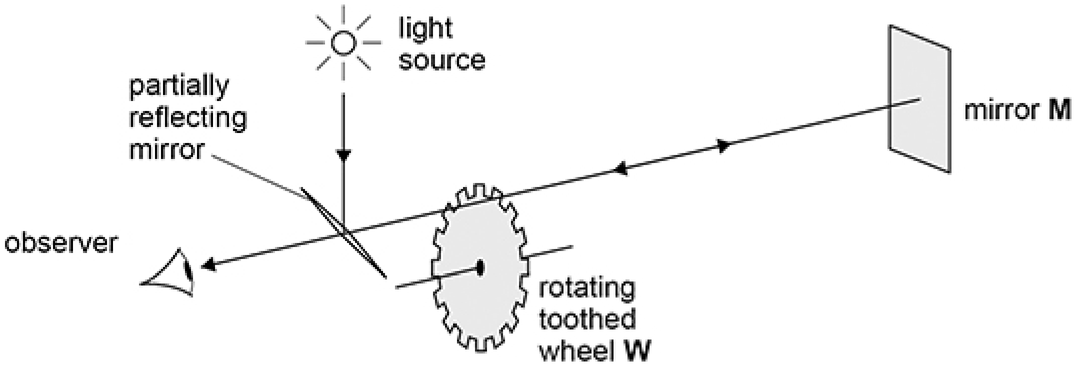
(3)

(Total 11 marks)

Q4.

The figure below shows the arrangement used by Fizeau to determine the speed of light.



The toothed wheel **W** is rotated and the reflected light from a distant mirror **M** is observed.

The speed of light is calculated from the equation

$$c = 4dnf_0$$

where d is the distance from **W** to **M** and
n is the number of teeth on the rotating wheel **W**.

(a) State what f_0 represents in the equation.

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(2)

(b) The experiment is attempted using a rotating wheel with 720 teeth that can be rotated at up to 620 revolutions per minute.
The distance between **W** and **M** is 8.5 km.

Deduce whether the speed of light can be determined with this particular arrangement.

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(2)

(c) The determination of the speed of light took on extra significance when Maxwell derived the wave-speed equation

$$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$$

State how ε_0 and μ_0 are related to the types of field in the wave.

ε_0 ___

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μ_0 ___

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(2)
(Total 6 marks)