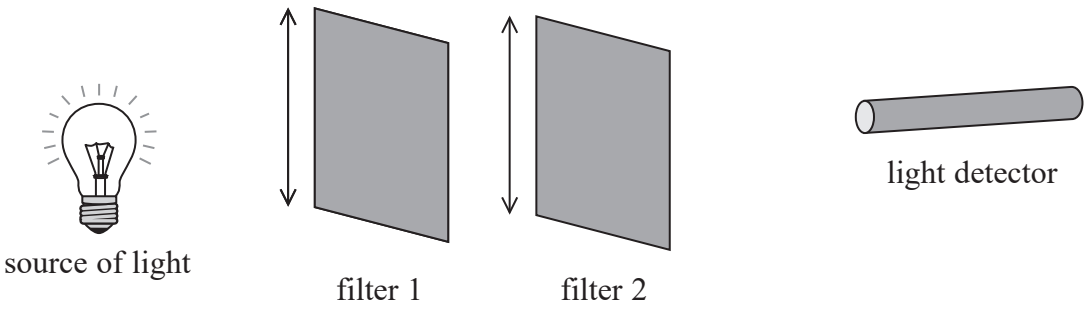
***15** The diagram shows apparatus used to investigate polarising filters.



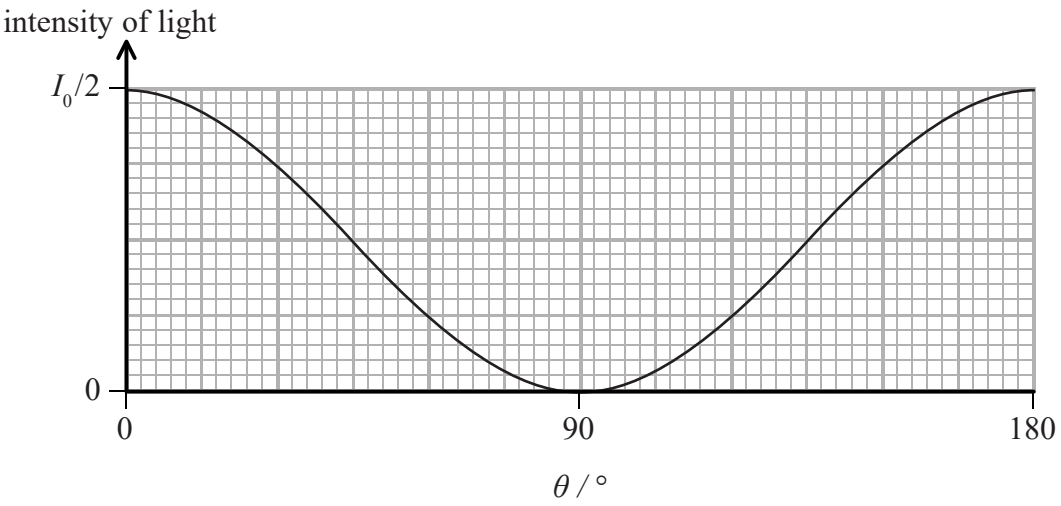
The arrows show the orientation of the plane of polarisation of the filters.

Light is incident on filter 1 and the intensity of the light is measured, using the light detector, when the filters are in the positions shown.

Filter 2 is then rotated and the intensity of light is measured for different angles of rotation θ.

The intensity of light measured with no filters present is I_0.

The results are shown on the graph.



Explain the effect of the filters on the intensity of light and why the intensity varies as shown.

(6)

(Total for Question 15 = 6 marks)

3 In the 19th century experiments with magnetic and electric field deflections were used to determine the charge to mass ratio of electrons.
Later experiments showed the diffraction of electrons as they passed through thin metal foils.
Deduce what these experiments tell us about electrons.

(3)

(Total for Question 3 = 3 marks)

17 A coulombmeter is used to measure charge.

In a laboratory demonstration of the photoelectric effect, a sheet of zinc was placed on top of a coulombmeter and the zinc was given a negative charge.

*(a) The following observations were made:

- under normal lighting conditions the charge remained constant
- when the zinc was illuminated with ultraviolet light, the magnitude of the charge on the zinc decreased as time passed
- when a larger sheet of zinc was used the charge on the zinc decreased more rapidly.

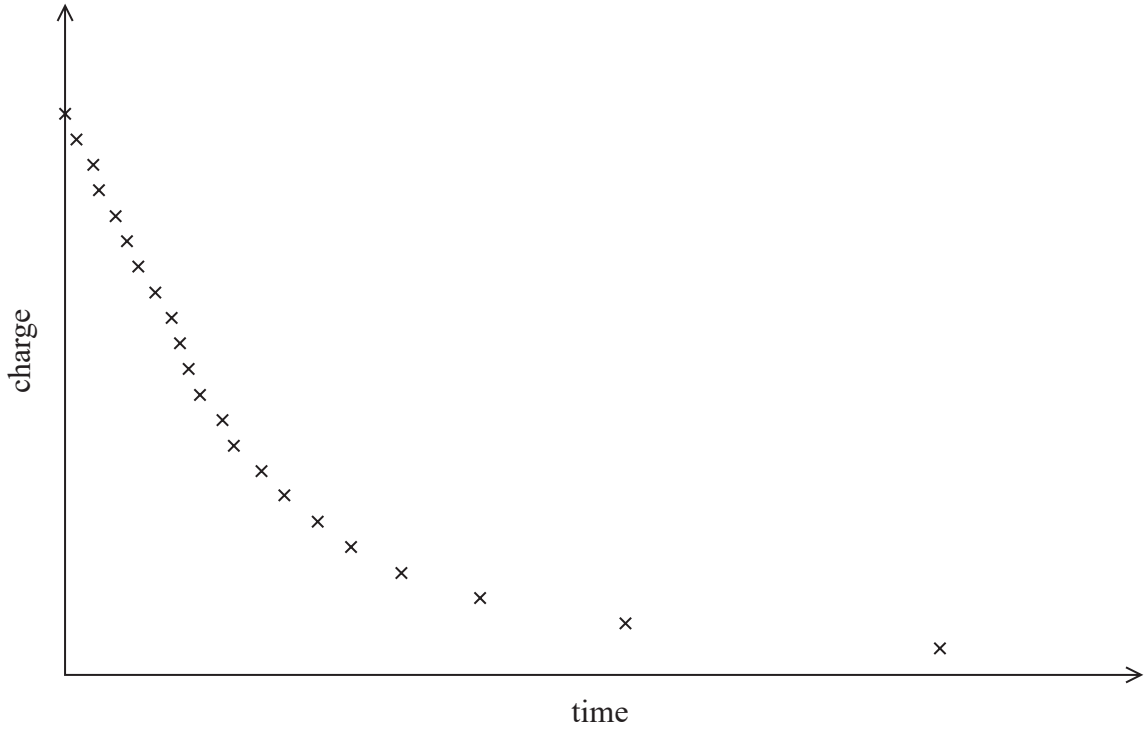
In each case the initial charge on the zinc was the same.

Explain these observations.

(6)

(b) For one sheet of zinc, the charge at different times was measured.

The following graph was obtained.

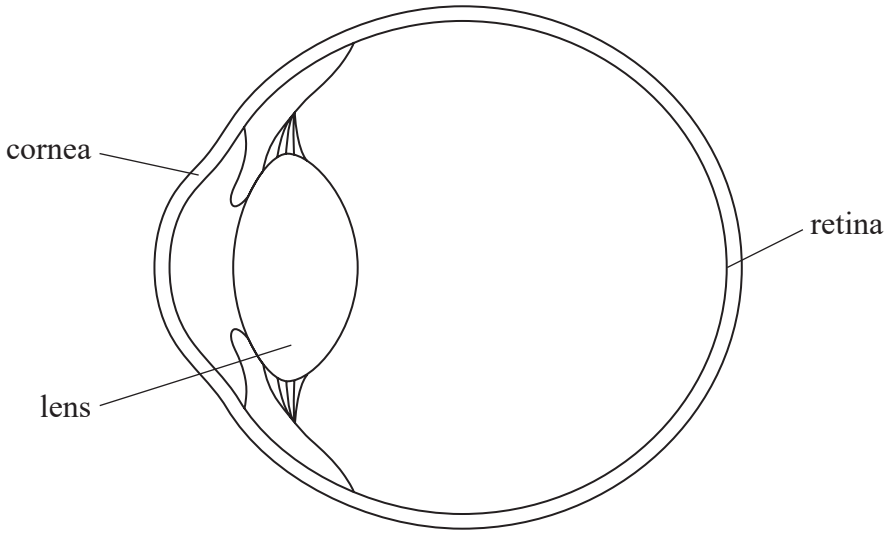


A student suggests that this is an exponential decay curve.
Explain how this suggestion could be tested.

(3)

(Total for Question 17 = 9 marks)

18 Light entering a normal eye is refracted by both the cornea and the lens before a focused image is formed on the retina.



(a) It is suggested that the cornea provides 80% of the focusing power of the eye.

Determine whether this is correct.

focal length of cornea = 2.23 cm

focal length of lens for near object = 5.27 cm

(4)

(b) Light from a point object forms a focused image on the retina.

The cornea and lens may be treated as a single lens of focal length 1.6 cm that is 2.4 cm from the retina.

(i) Calculate the distance from the point object to this single lens when a focused image is formed on the retina.

(2)

Distance = ...

(ii) A ray of light strikes the front of the cornea at an angle to the normal in air of 15°.

Calculate the angle of the ray to the normal in the cornea.

speed of light in air = $3.00 \times 10^8\ m\,s^{-1}$

speed of light in cornea = $2.18 \times 10^8\ m\,s^{-1}$

(3)

Angle to normal in cornea = ...

(c) People swimming under water often wear goggles. The goggles enable them to see objects under water clearly whereas without goggles objects appear blurred.

Explain why wearing goggles has this effect.

speed of light in water = $2.25 \times 10^8\ \text{m s}^{-1}$

(3)

(Total for Question 18 = 12 marks)