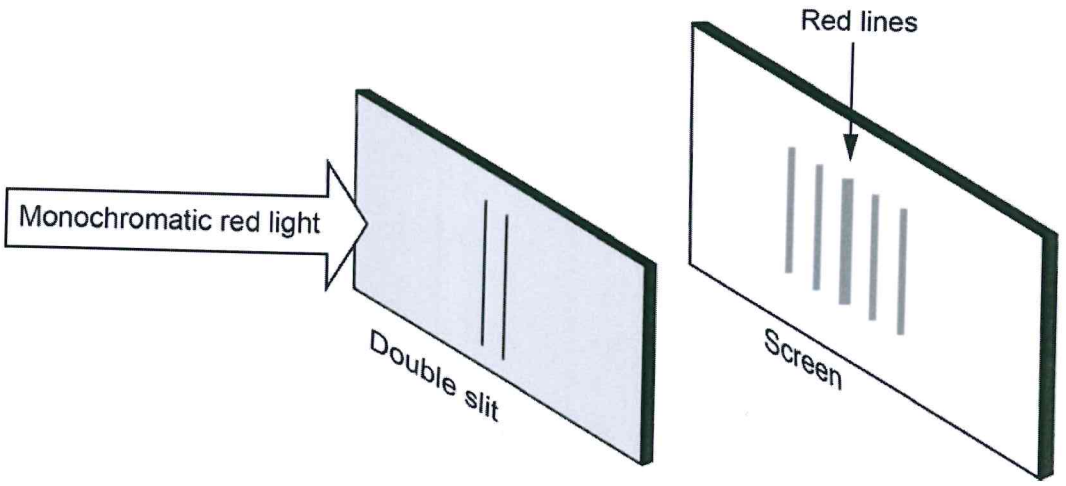
Solution 1

(3 marks)

The pattern observed when monochromatic light passes through a piece of cardboard with twin slits close together is often considered evidence for the wave theory of light. A diagram of an experiment set up in a classroom is provided below.



Explain how the pattern of red lines is formed on the screen and why this is considered to be evidence for the wave theory of light.

Description	Marks
diffraction spreads the light sideways	1
Interference: dark where destructive, light where constructive	1
only wave theory explains interference pattern formed	1
	Total 3

Solution 2

(15 marks)

(a) Explain why a series of dark and light fringes may be observed at the detector of an interferometer. (3 marks)

Description	Marks
Light recombining after travelling different paths will interfere	1
Dark fringes occur where there is destructive interference	1
Light fringes occur where there is constructive interference	1
Total	3

(b) In an interferometer the distance from the half-silvered mirror to Mirror 1 is 1.5 m. The distance from the half-silvered mirror to Mirror 2 is 1.85 m. The light used in the interferometer has a wavelength of 694 nm. Calculate the difference in path length between the light beams arriving at the detector in terms of number of wavelengths. You should express your answer to 1 significant figure. (2 marks)

Description	Marks
Path difference = (1.85 × 2)-(1.5×2) = 0.7 m	1
$0.7/694\times10^{-9} = 1\times10^{6}$ wavelengths (to 1 sig fig)	1
Total	2

(c) Two stars, separated by an angle of 0.5°, are both emitting radio waves with a frequency of 1×10^6 Hz. Can they be seen as separate sources by a telescope with a diameter of 76 m? You should show the calculations you have used to justify your answer. (4 marks)

Description	Marks
$\lambda = c/f = 3\times10^8/1\times10^6 = 300$ m	1–2
$R = 57.3 \times 300/76 = 226°$	1
No they would not be distinguishable	1
Total	**4**

Note: If answer calculates D or λ from R = 0.5° and correct conclusion drawn, allow full marks.

(d) Determine the resolution of two telescopes, 5 km apart receiving radio waves with a wavelength of 1.71 m. (2 marks)

Description	Marks
$R = 57.3\times1.71/5\times10^3$	1
R = 0.0196° (must show degree sign)	1
Total	**2**

(e) Give 3 reasons why radio waves are used to explore very distant regions of the universe instead of visible light by comparing the characteristics of the two regions of the electromagnetic spectrum. (4 marks)

Description	Marks
Comparison of visible and radio characteristics eg. energy, wavelength	1
Any three valid points, such as: • Visible light covers only a very narrow band of the em spectrum, radio waves cover a much wider range of wavelengths • Radio waves due to their much larger wavelengths (up to km in length) can diffract around objects • Even very low energy processes can produce radio waves so more information is available • Enables detection of more distant or more ancient objects, as radiation from distant sources has red shifted toward the radio wave region	1–3
Total	**4**