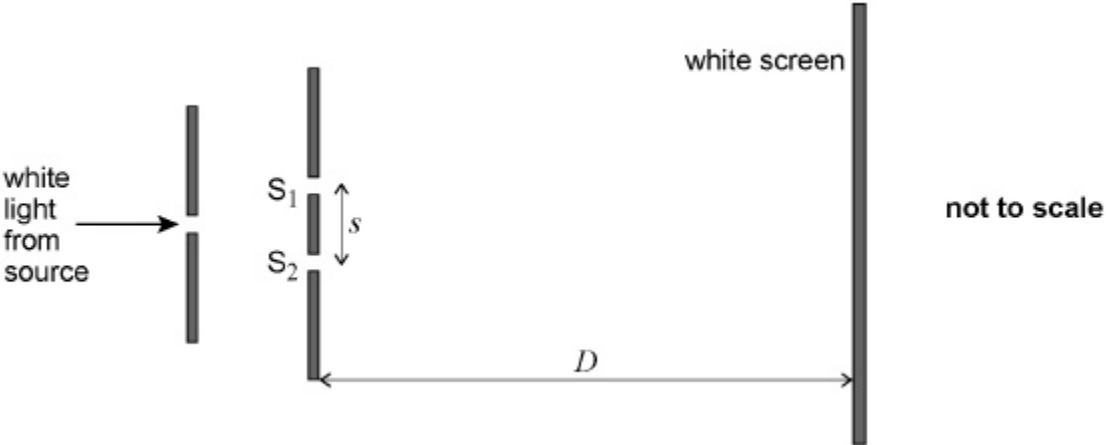


1

The figure below shows a diagram of apparatus used to demonstrate the formation of interference fringes using a white light source in a darkened room. Light from the source passes through a single slit and then through two narrow slits  $S_1$  and  $S_2$ .



(a) Describe the interference pattern that is seen on the white screen.

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(2)

- (b) A filter transmits only green light of wavelength  $\lambda$  and red light of wavelength  $1.2\lambda$ . This filter is placed between the light source and the single slit.

Describe the interference pattern now seen on the white screen.

Use a calculation to support your answer.

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(4)

- (c) A student decides to use the apparatus shown in the figure to determine the wavelength of red light using a filter that transmits only red light.

The student suggests the following changes:

- decrease slit separation  $s$
- decrease  $D$ , the distance between the slits and the screen.

The student decides to make each change independently.

Discuss the effects each independent change has on the interference pattern, and whether this change is likely to reduce uncertainty in the determination of the wavelength.

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(6)  
(Total 12 marks)

2

The table shows results of an experiment to investigate how the de Broglie wavelength  $\lambda$  of an electron varies with its velocity  $v$ .

$v / 10^7 \text{ m s}^{-1}$	$\lambda / 10^{-11} \text{ m}$
1.5	4.9
2.5	2.9
3.5	2.1

- (a) Show that the data in the table are consistent with the relationship  $\lambda \propto \frac{1}{\nu}$

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(2)

- (b) Calculate a value for the Planck constant suggested by the data in the table.

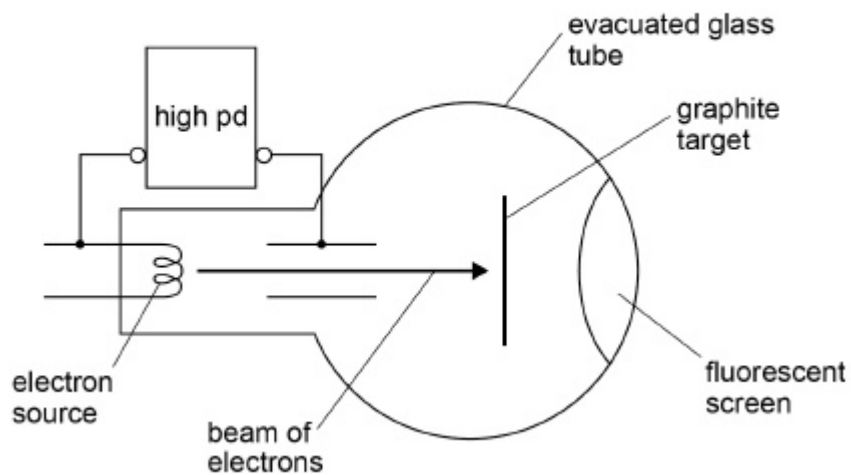
Planck constant = \_\_\_\_\_ J s

(2)

- (c) **Figure 1** shows the side view of an electron diffraction tube used to demonstrate the wave properties of an electron.

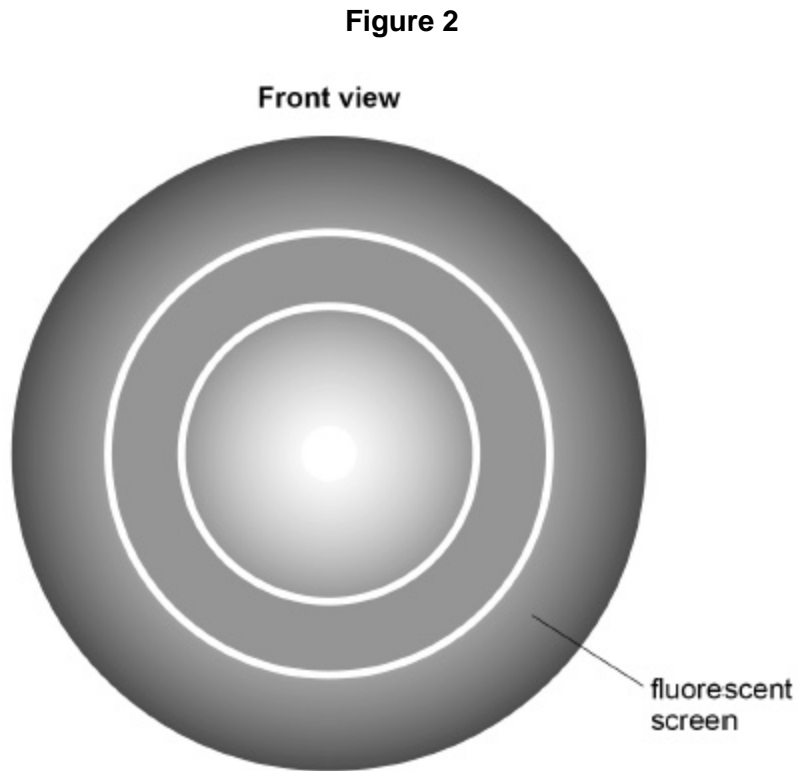
**Figure 1**

Side view



An electron beam is incident on a thin graphite target that behaves like the slits in a diffraction grating experiment. After passing through the graphite target the electrons strike a fluorescent screen.

**Figure 2** shows the appearance of the fluorescent screen when the electrons are incident on it.



Explain how the pattern produced on the screen supports the idea that the electron beam is behaving as a wave rather than as a stream of particles.

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**(3)**

(d) Explain how the emission of light from the fluorescent screen shows that the electrons incident on it are behaving as particles.

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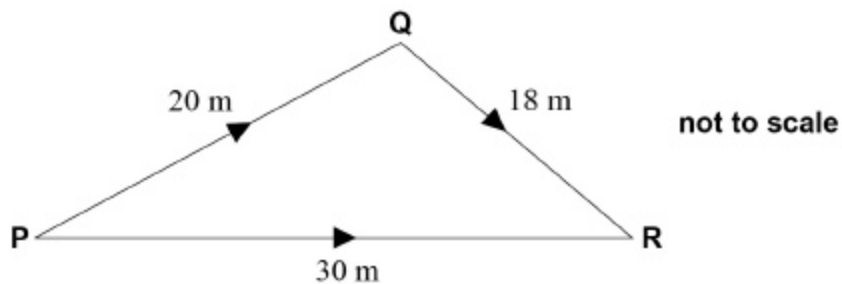
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(3)  
(Total 10 marks)

3

In the diagram, **P** is the source of a wave of frequency 50 Hz



The wave travels to **R** by two routes, **P** → **Q** → **R** and **P** → **R**. The speed of the wave is 30 m s<sup>-1</sup>

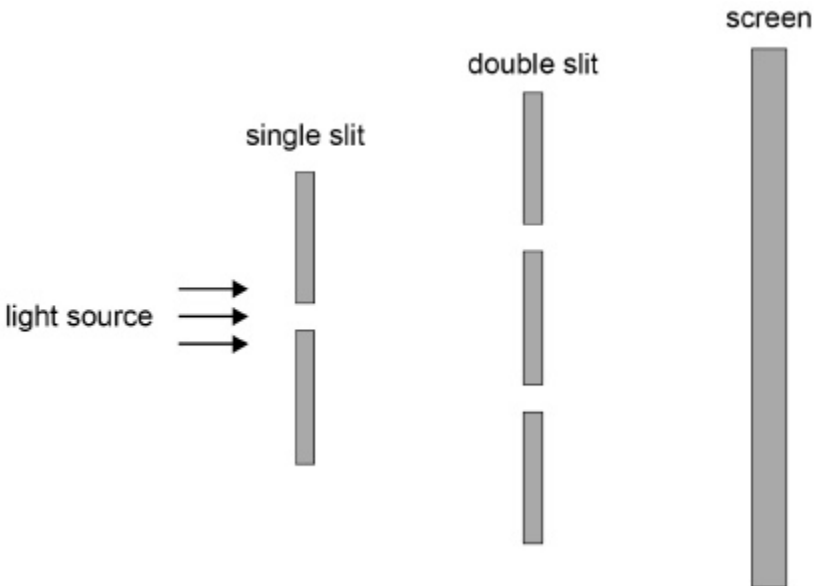
What is the path difference between the two waves at **R** in terms of the wavelength  $\lambda$  of the waves?

- A  $4.8\lambda$
- B  $8.0\lambda$
- C  $13.3\lambda$
- D  $20.0\lambda$

(Total 1 mark)

4

Light from a point source passes through a single slit and is then incident on a double-slit arrangement. An interference pattern is observed on the screen.



What will increase the fringe spacing?

- A increasing the separation of the single slit and the double slit
- B increasing the width of the single slit
- C decreasing the distance between the double slits and the screen
- D decreasing the separation of the double slits

(Total 1 mark)