1 Two waves, of wavelength λ, from a single source diverge and then meet again. Which of the following situations would cause constructive interference?

☒ **A** a path difference of $\frac{\lambda}{2}$

☒ **B** a path difference of λ

☒ **C** a phase difference of $\frac{\pi}{2}$

☒ **D** a phase difference of π

(Total for Question 1 = 1 mark)

9 An ultrasound pulse-echo technique is used to produce an image by reflection from many boundaries.

If the transmitted pulse is too long, the image produced is of poor quality.

This could be because the

☒ **A** energy of the pulse is too high.

☒ **B** frequency of the ultrasound is too high.

☒ **C** time between consecutive transmitted pulses is too short.

☒ **D** wavelength of the ultrasound is too long.

(Total for Question 9 = 1 mark)

2 Light from a discharge tube is viewed through a diffraction grating. An emission line spectrum is observed.

Which of the following explains how electrons in the discharge tube produce the emission line spectrum?

☒ **A** Excited electrons move to higher energy levels and absorb photons.

☒ **B** Excited electrons move to higher energy levels and emit photons.

☒ **C** Excited electrons move to lower energy levels and absorb photons.

☒ **D** Excited electrons move to lower energy levels and emit photons.

(Total for Question 2 = 1 mark)

4 Which of the following has the largest de Broglie wavelength?

☒ **A** an electron travelling at $3.0 \times 10^5\,m\,s^{-1}$

☒ **B** an electron travelling at $4.0 \times 10^5\,m\,s^{-1}$

☒ **C** a neutron travelling at $3.0 \times 10^5\,m\,s^{-1}$

☒ **D** a neutron travelling at $4.0 \times 10^5\,m\,s^{-1}$

(Total for Question 4 = 1 mark)

5 Ultrasound has a number of different uses in medicine.

Which of the following is the main reason why ultrasound is not used to perform scans of the chest and lungs?

☐ **A** The air in the lungs causes most of the ultrasound to be reflected back.

☐ **B** The duration of the pulses of ultrasound limits the amount of detail that can be seen.

☐ **C** The wavelength of the ultrasound is too long.

☐ **D** Ultrasound can damage the lungs.

(Total for Question 5 = 1 mark)

8 Which of the following statements about waves is correct?

☐ **A** Both longitudinal and transverse waves can be polarised.

☐ **B** Neither longitudinal nor transverse waves can be polarised.

☐ **C** Only longitudinal waves can be polarised.

☐ **D** Only transverse waves can be polarised.

(Total for Question 8 = 1 mark)

3 An electron has a de Broglie wavelength of 3.5×10^{-10} m.

Which of the following expressions gives the velocity of the electron in $m\,s^{-1}$?

☐ **A** $\dfrac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 3.5 \times 10^{-10}}$

☐ **B** $\dfrac{6.63 \times 10^{-34}}{3.5 \times 10^{-10}}$

☐ **C** $\dfrac{9.11 \times 10^{-31} \times 3.5 \times 10^{-10}}{6.63 \times 10^{-34}}$

☐ **D** $\dfrac{3.5 \times 10^{-10}}{6.63 \times 10^{-34}}$

(Total for Question 3 = 1 mark)

10 The evidence for the wave nature of electrons came from experiments involving

☐ **A** diffraction.

☐ **B** polarisation.

☐ **C** reflection.

☐ **D** refraction.

(Total for Question 10 = 1 mark)

16 After an atom of hydrogen has been exposed to suitable electromagnetic radiation, the atom can emit visible light. The emitted light contains a small number of different wavelengths of visible light.

*(a) Explain the process that results in the emission of different wavelengths of visible light. Your answer should include reference to energy levels in atoms.

(6)

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(b) It is also possible to make the atoms in a sample of air emit visible light.

14 A student used a diffraction grating to investigate the properties of light.

(a) Light is a transverse wave.

State what is meant by a transverse wave.

(1)

.....

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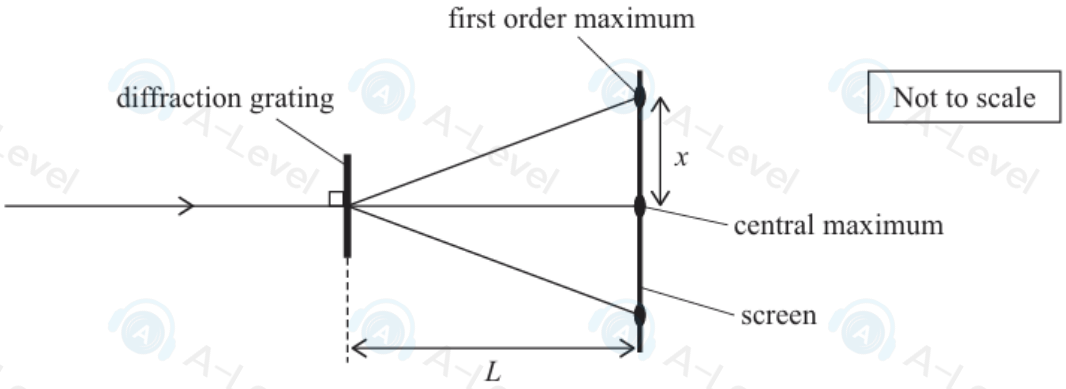
(b) The student directed monochromatic light of wavelength λ onto the diffraction grating. A series of maxima was produced on a screen a distance L from the diffraction grating, as shown.



The distance between the central maximum and the first order maximum was x.

(i) Calculate the number of lines per mm on the diffraction grating.

$\lambda = 650\,\text{nm}$
$L = 1.30\,\text{m}$
$x = 0.22\,\text{m}$

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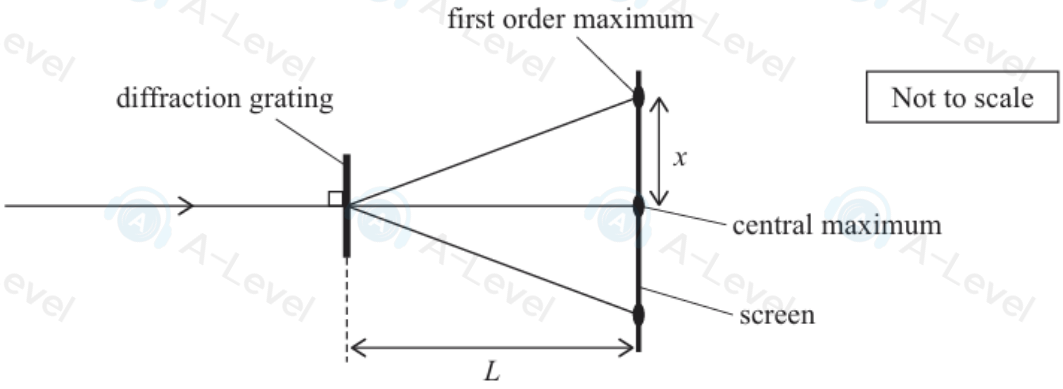

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(ii) Explain how a first order maximum is produced on the screen.

(3)

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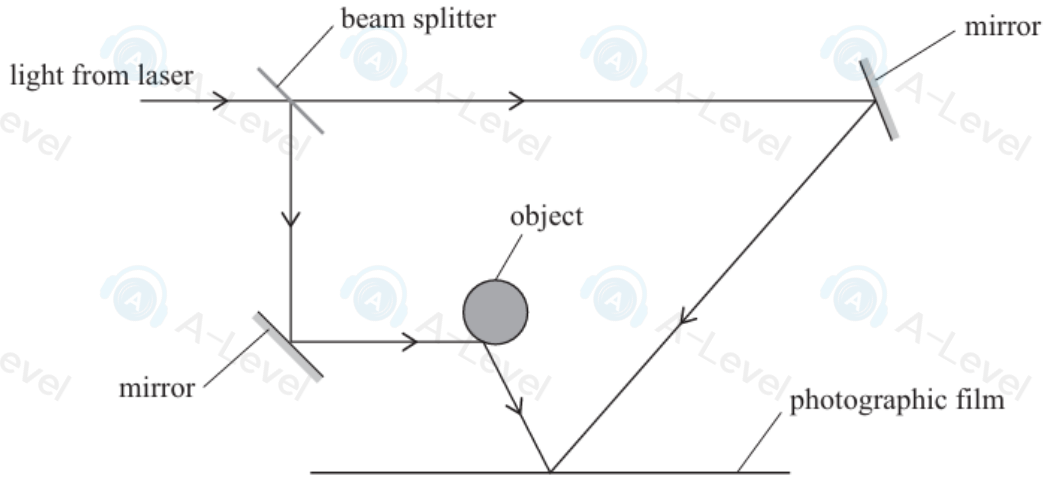
13 A hologram is an interference pattern that can produce a three-dimensional image.

To form a hologram, a beam of light from a laser is split by a beam splitter. The light then takes two different paths to a photographic film, as shown.



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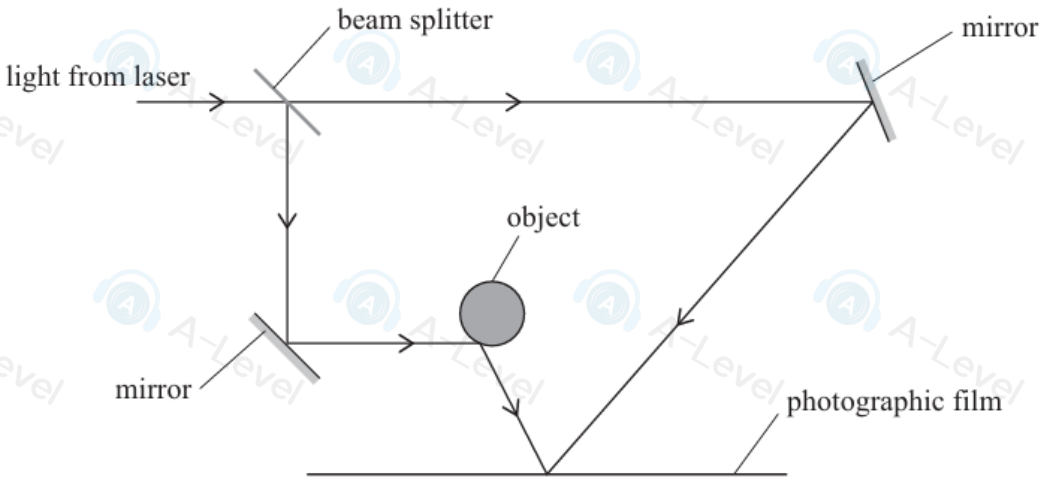

(a) Light is a transverse wave.

State what is meant by a transverse wave.

(1)

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(b) Light arrives at the photographic film from the two paths.

Explain how this could cause constructive interference.

(3)

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