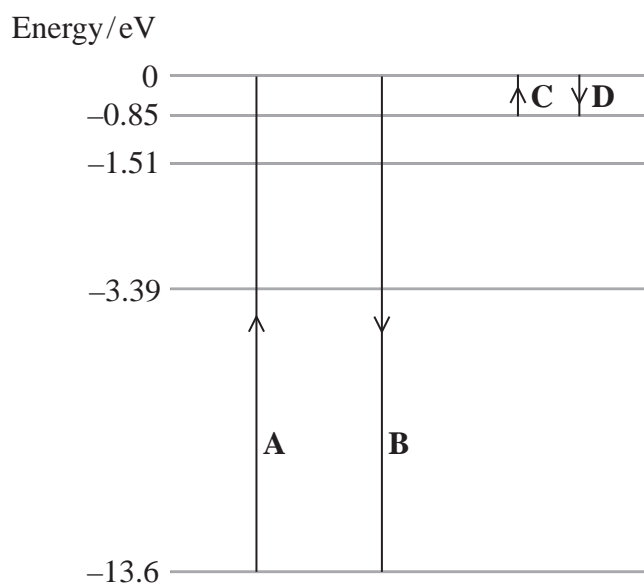1  A brick of mass 5.0 kg falls through water with an acceleration of 0.90 m s$^{-2}$.

   Which of the following can be used to calculate the resistive force acting on the brick?

   ☒  **A**  $5.0 \times (0.90 - 9.81)$

   ☒  **B**  $5.0 \times (0.90 + 9.81)$

   ☒  **C**  $5.0 \times 0.90$

   ☒  **D**  $5.0 \times 9.81$

                                              **(Total for Question = 1 mark)**


2  The diagram shows some of the energy levels for a hydrogen atom.

   Energy/eV



   Which arrowed line, A, B, C or D, shows the transition of an electron that corresponds to
   the absorption of light with the shortest wavelength?

   ☒  **A**

   ☒  **B**

   ☒  **C**

   ☒  **D**

                                              **(Total for Question = 1 mark)**

**3** A beam of electrons spreads out into several distinct beams after passing through a crystalline material.

This demonstrates that

☒ **A** electrons behave as particles.

☒ **B** electrons behave as waves.

☒ **C** electrons exist in energy levels.

☒ **D** electrons have negative charge.

**(Total for Question = 1 mark)**

**4**  Which variables are linked in the de Broglie equation?

⊠ **A**  frequency and wavelength of a photon

⊠ **B**  wavelength and momentum of a moving electron

⊠ **C**  energy and frequency of a photon

⊠ **D**  work function and threshold frequency of a metal

**(Total for Question = 1 mark)**

**5**  The de Broglie wavelength for neutrons used to study crystal structure is 1.2 nm.
mass of a neutron $= 1.67 \times 10^{-27}$ kg

The speed of these neutrons would be

⊠ **A**  $3.0 \times 10^{6}$ m s$^{-1}$

⊠ **B**  $3.3 \times 10^{2}$ m s$^{-1}$

⊠ **C**  $3.0 \times 10^{-3}$ m s$^{-1}$

⊠ **D**  $3.3 \times 10^{-7}$ m s$^{-1}$

**(Total for Question = 1 mark)**

**6**  A wave is diffracted as it passes through an opening in a barrier.  The amount of
diffraction that the wave undergoes depends on both the

⊠       **A**  amplitude and frequency of the incident wave.

⊠       **B**  wavelength and amplitude of the incident wave.

⊠       **C**  wavelength of the incident wave and the size of the opening.

⊠       **D**  amplitude of the incident wave and the size of the opening.

**(Total for Question = 1 mark)**

**7** The effect of diffraction is more noticeable, in everyday life, with sound than with light. This is because

☒ **A** sound has a much longer wavelength than light.

☒ **B** sound is a longitudinal wave, light is a transverse wave.

☒ **C** sound is a mechanical wave, light is an electromagnetic wave.

☒ **D** sound travels more slowly in air than light does.

**(Total for Question    1 mark)**

**8** In the 1930s, experiments were performed where beams of X-rays or beams of high energy electrons were directed through a crystal as shown in the diagram.
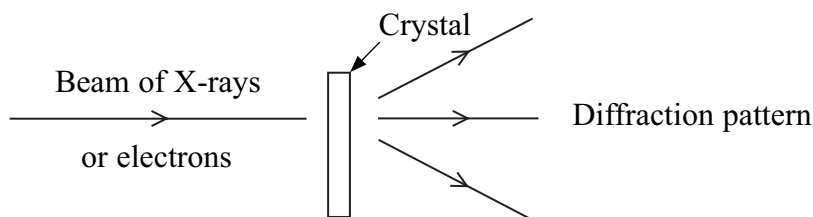


Which of the following statements about the experiments is correct?

☒        **A** They show that the X-rays are behaving like particles.

☒        **B** They show that the electrons have a wavelength similar to the size of the atoms.

☒        **C** They show that electrons are charged.

☒        **D** They show that electrons can have all of the properties of electromagnetic radiation.

**(Total for Question    1 mark)**

**9** The four diagrams show waves of different wavelengths approaching slits of different widths.
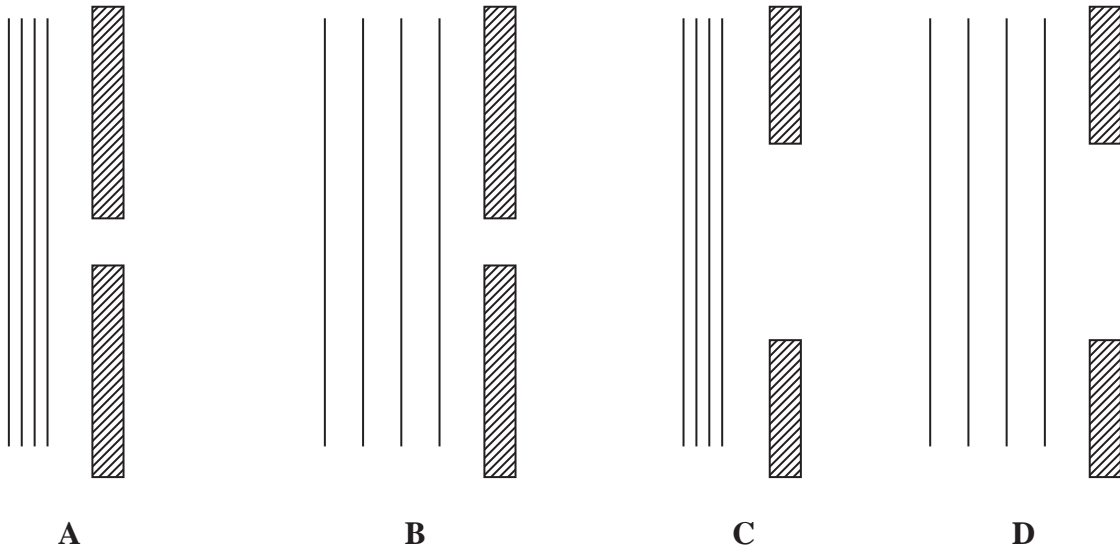


A          B          C          D

In which diagram will the diffraction be the greatest?

☒   **A**

☒   **B**

☒   **C**

☒   **D**

**(Total for Question = 1 mark)**

**10** Light from a lamp passes through two polarising filters, P1 and P2, before reaching a detector. The filters initially have their planes of polarisation parallel.

The intensity of light at the detector will be greatest if

☒ **A**  P1 is rotated by 45° and P2 is rotated by 315° in the same direction.

☒ **B**  P1 is rotated by 90° and P2 is rotated by 270° in the same direction.

☒ **C**  P1 is rotated by 45° and P2 is rotated by 270° in the same direction.

☒ **D**  P1 is rotated by 90° and P2 is rotated by 315° in the same direction.

**(Total for Question = 1 mark)**

**11**   A beam of electrons is directed towards a section of crystalline material.



electron beam

sheet of
crystalline
material
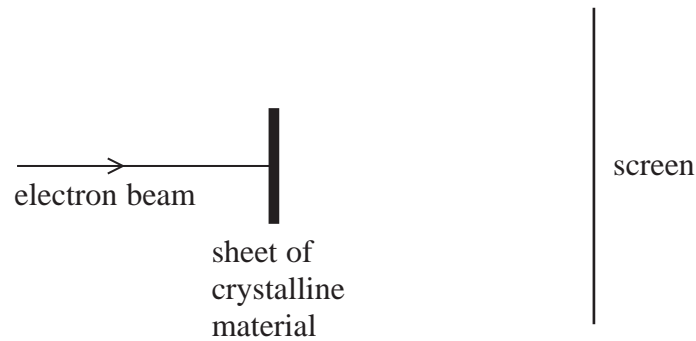
screen

The following pattern is produced by the electrons on the screen.
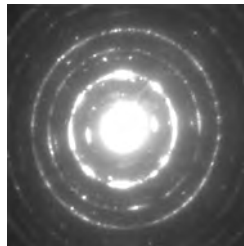


This pattern demonstrates

⊠  **A**  diffraction.

⊠  **B**  polarisation.

⊠  **C**  reflection.

⊠  **D**  refraction.

**(Total for Question = 1 mark)**

**12** Which one of the following quantities would the de Broglie equation be used to
calculate?

⊠    **A** The momentum of a moving particle.

⊠    **B** The value of the Planck constant.

⊠    **C** The wavelength of a moving electron.

⊠    **D** The wavelength of a photon of light.

**(Total for Question 10 = 1 mark)**