Q1. Electrons and protons in two beams are travelling at the same speed. The beams are diffracted by objects of the same size.

Which correctly compares the de Broglie wavelength λ_e of the electrons with the de Broglie wavelength λ_p of the protons and the width of the diffraction patterns that are produced by these beams?

	comparison of de Broglie wavelength	diffraction pattern	
A	$\lambda_e > \lambda_p$	electron beam width > proton beam width	⬭
B	$\lambda_e < \lambda_p$	electron beam width > proton beam width	⬭
C	$\lambda_e > \lambda_p$	electron beam width < proton beam width	⬭
D	$\lambda_e < \lambda_p$	electron beam width < proton beam width	⬭

(Total 1 mark)

Q2. The intensity of a monochromatic light source is increased. Which of the following is correct?

	Energy of an emitted photon	**Number of photons emitted per second**	
A	increases	increases	⬭
B	increases	unchanged	⬭
C	unchanged	increases	⬭
D	unchanged	unchanged	⬭

(Total 1 mark)

Q3. A diffraction pattern is formed by passing monochromatic light through a single slit. If the width of the single slit is reduced, which of the following is true?

	Width of central maximum	Intensity of central maximum	
A	unchanged	decreases	⬭
B	increases	increases	⬭
C	increases	decreases	⬭
D	decreases	decreases	⬭

(Total 1 mark)

Q4. When comparing X-rays with UV radiation, which statement is correct?

A X-rays have a lower frequency. ⬭

B X-rays travel faster in a vacuum. ⬭

C X-rays do not show diffraction and interference effects. ⬭

D Using the same element, photoelectrons emitted using X-rays have the greater maximum kinetic energy. ⬭

(Total 1 mark)

Q5. Monochromatic radiation from a source of light (source A) is shone on to a metallic surface and electrons are emitted from the surface. When a second source (source B) is used no electrons are emitted from the metallic surface. Which property of the radiation from source A must be greater than that from source B?

A amplitude ⬭

B frequency ⬭

C intensity ⬭

D wavelength ⬭

(Total 1 mark)

Q6. An electron has a kinetic energy E and a de Broglie wavelength λ. The kinetic energy is increased to $4E$. What is the new de Broglie wavelength?

A $\frac{\lambda}{4}$ ⬭

B $\frac{\lambda}{2}$ ⬭

C λ ⬭

D 4λ ⬭

(Total 1 mark)

Q7. In a photoelectric experiment, light is incident on the metal surface of a photocell. Increasing the intensity of the illumination at the surface leads to an increase in the

A work function ⬭

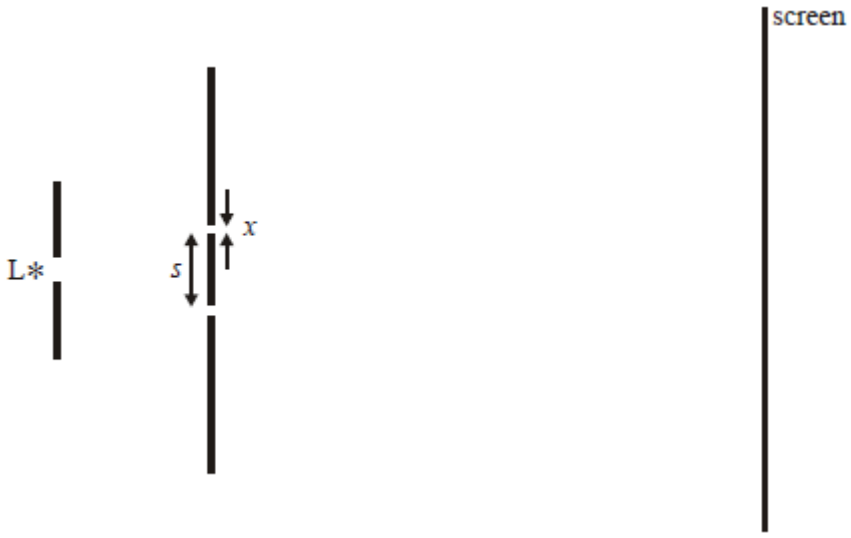
B minimum frequency at which electrons are emitted ⬭

C current through the photocell ⬭

D speed of the electrons ⬭

(Total 1 mark)

Q8.



In a double slit system used to produce interference fringes, the separation of the slits is *s* and the width of each slit is *x*. L is a source of monochromatic light. Which one of the following changes would **decrease** the separation of the fringes seen on the screen?

A moving the screen closer to the double slits

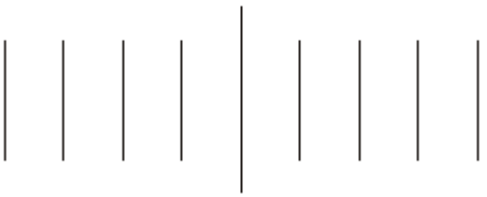
B decreasing the width, *x*, of each slit, but keeping *s* constant

C decreasing the separation, *s*, of the slits

D exchanging L for a monochromatic source of longer wavelength

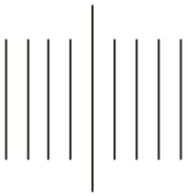
(Total 1 mark)

Q9.

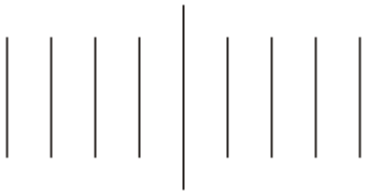


The diagram above shows the first four diffraction orders each side of the zero order when a beam of monochromatic light is incident normally on a diffraction grating of slit separation d. All the angles of diffraction are small. Which one of the patterns, **A** to **D**, drawn on the same scale, is obtained when the grating is exchanged for one with a slit separation $\frac{d}{2}$?

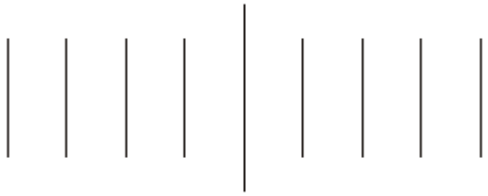
A



B



C



D

(Total 1 mark)

Q10. Light of wavelength λ is incident normally on a diffraction grating for which adjacent lines are a distance 3λ apart. What is the angle between the second order maximum and the straight-through position?

A 9.6°

B 20°

C 42°

D There is no second order maximum.

(Total 1 mark)

Q11. Light of wavelength λ is incident normally on a diffraction grating of slit separation 4λ. What is the angle between the second order maximum and third order maximum?

A 14.5°

B 18.6°

C 48.6°

D 71.4°

(Total 1 mark)

Q12. A narrow beam of monochromatic light falls on a diffraction grating at normal incidence. The second order diffracted beam makes an angle of 45° with the grating. What is the highest order visible with this grating at this wavelength?

A 2

B 3

C 4

D 5

(Total 1 mark)

Q13. Monochromatic light of wavelength 590 nm is incident normally on a plane diffraction grating having 4×10^5 lines m^{-1}. An interference pattern is produced. What is the highest order visible in this interference pattern?

A 2

B 3

C 4

D 5

(Total 1 mark)

Q14. Using a diffraction grating with monochromatic light of wavelength 500 nm incident normally, a student found the 2nd order diffracted maxima in a direction at 30° to the central bright fringe. What is the number of lines per metre on the grating?

A 2×10^4

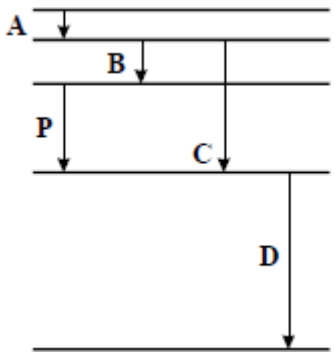
B 2×10^5

C 4×10^5

D 5×10^5

(Total 1 mark)

Q15. The diagram **drawn to scale** shows some of the energy levels of an atom. Transition **P** results in the emission of a photon of wavelength 4×10^{-7} m.



Which one of the transitions **A**, **B**, **C**, or **D** could result in the emission of a photon of wavelength 8×10^{-7} m?

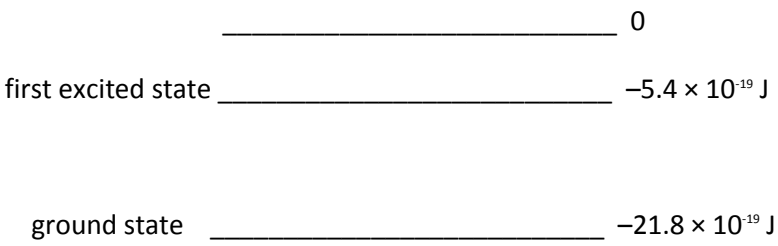
(Total 1 mark)

Q16. For which of the following relationships is the quantity *y* related to the quantity *x* by the relationship $x \propto \frac{1}{y}$?

	x	*y*
A	energy stored in a spring	extension of the spring
B	gravitational field strength	distance from a point mass
C	de Broglie wavelength of an electron	momentum of the electron
D	period of a mass-spring system	spring constant (stiffness) of the spring

(Total 1 mark)

Q17. The diagram shows some of the energy levels for a hydrogen atom.



A free electron of kinetic energy 20.0×10^{-19} J collides with a hydrogen atom in its ground state. The hydrogen atom is excited from its ground state to the first excited state. The kinetic energy of the free electron after the collision is

A 1.8×10^{-19} J

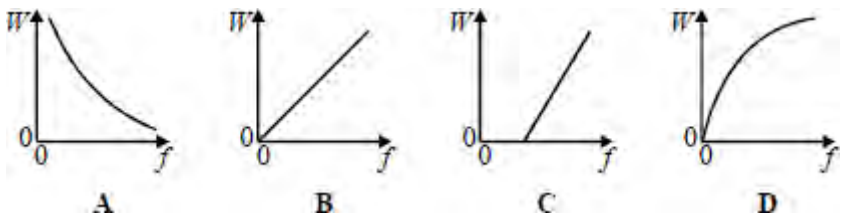
B 3.6×10^{-19} J

C 5.4×10^{-19} J

D 16.4×10^{-19} J

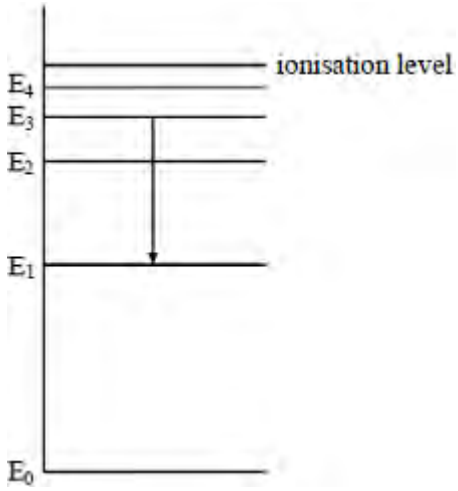
(Total 1 mark)

Q18. Which one of the graphs best represents the relationship between the energy W of a photon and the frequency f of the radiation?



(Total 1 mark)

Q19. The diagram shows some energy levels of an atom.



The transition E_3 to E_1 corresponds to the emission of visible light.

A transition corresponding to the emission of infrared radiation could be

A E_1 to E_0

B E_4 to E_1

C E_1 to E_2

D E_3 to E_2

(Total 1 mark)

Q20. An electron initially at rest is accelerated through a potential difference. It is then brought to rest in a collision, and all of its kinetic energy is converted into a single photon of electromagnetic radiation. Which one of the following quantities is **not** required to find a value for the wavelength of the photon?

A The mass of the electron

B The charge on the electron

C The velocity of electromagnetic waves

D The value of the potential difference

(Total 1 mark)