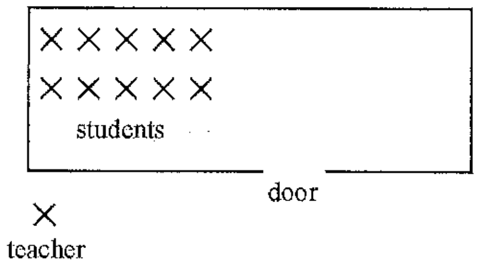
Question 14 71 %

A teacher stands in the corridor at a short distance from the open door of her classroom, as shown in the diagram below. She can hear her students, but cannot see them.



Diffraction is max when $\frac{\lambda}{W} \approx 1$

Which one of the following best explains why the teacher can hear her students?

A. The speed of sound is much greater than the speed of light.

B. The speed of sound is comparable with the speed of light.

C. Sound diffracts because the wavelength of sound is much smaller than the width of the door.

D. Sound diffracts because the wavelength of sound is comparable with the width of the door.

Question 15 86 %

Lee listens while a police car with a loud siren comes towards her, travels past her and then continues on away from her.

Compared with the sound she would hear from the siren if the police car were stationary, the sound has

A. a higher frequency as the car comes towards her and a lower frequency when the car moves away.

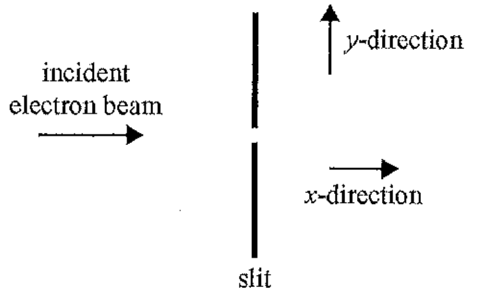
B. a lower frequency as the car comes towards her and a higher frequency when the car moves away.

C. a lower intensity as the car comes towards her and a greater intensity when the car moves away.

D. the same frequency at all times.

Question 16 66 %

A diffraction pattern is produced by a stream of electrons passing through a narrow slit, as shown in the diagram below.



$\Delta p \Delta x \geq \frac{h}{4\pi}$

$\Delta x \downarrow \rightarrow \Delta p \uparrow$, increased uncertainty in direction

This electron diffraction pattern can be used to illustrate Heisenberg's uncertainty principle.
This is because knowing the uncertainty in the

A. electron's speed is large leads to the uncertainty in its kinetic energy being small.
B. slit width is small leads to a large uncertainty in the electron's momentum in the y-direction.
C. electron's momentum in the y-direction is small leads to a large uncertainty in the slit's width.
D. electron's angle of approach to the slit leads to a large uncertainty in the electron's momentum in the y-direction.

Question 17 59%

Quantised energy levels within atoms can best be explained by

A. electrons behaving as individual particles with varying energies.
B. atoms having specific energy requirements that can only be satisfied by electrons.
C. electrons behaving as waves, with each energy level representing a diffraction pattern.
D. electrons behaving as waves, with only standing waves at particular wavelengths allowed.

Question 18

Two students, Rob and Jan, measure the current in the same circuit on separate occasions.
Rob obtains the following readings: 9.50 mA, 9.21 mA, 9.10 mA and 9.60 mA (average 9.35).
Jan obtains the following readings: 9.20 mA, 9.25 mA, 9.31 mA and 9.36 mA (average 9.28).
The true value of the current is known to be 9.35 mA.
Which one of the following best describes these two sets of measurements?

A. Rob's results are more accurate than Jan's results.
B. Both sets of results are equally accurate.
C. Rob's results are more precise than Jan's results.
D. Both sets of results are equally precise.

Question 14 (5 marks)

A light ray from a laser passes from a glucose solution (n = 1.44) into the air (n = 1.00), as shown in Figure 12.

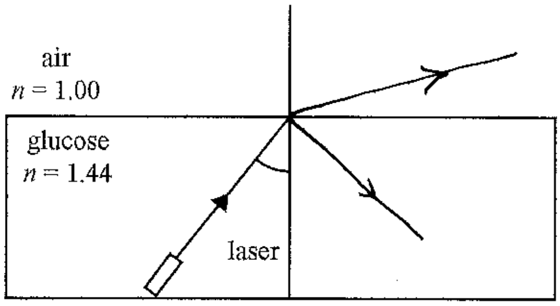


Figure 12

a. Calculate the critical angle (total internal reflection) from the glucose solution to the air. 81% 1 mark

$$\theta_c = \sin^{-1}\left(\frac{n_1}{n_2}\right) = \sin^{-1}\left(\frac{1}{1.44}\right)$$

44 °

b. The light ray strikes the surface at an angle of incidence to the normal of less than the critical angle calculated in **part a.** 9%

On Figure 12, sketch the ray or rays that should be observed. 2 marks

c. The angle to the normal is increased to a value greater than the critical angle. An observer at point X in Figure 13 says she cannot see the laser.

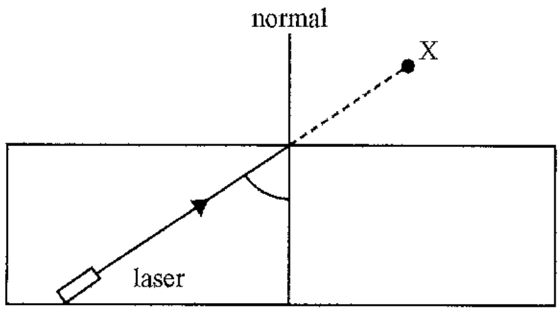


Figure 13

43 %

Explain why the observer says she cannot see the laser. 2 marks

Due to the total internal reflection the light ray is reflected back off the boundary into the glucose so observer cannot see it

Question 15 (7 marks)

A Physics teacher intends to demonstrate wave phenomena to her students. She takes her students to the school oval to listen to a 680 Hz sound.

The speed of sound in air is 340 m s^{-1}.

88 %

a. Calculate the wavelength of the sound. 1 mark

$\lambda = \frac{v}{f} = \frac{340}{680}$

$\boxed{0.5 \text{ m}}$

The teacher now sets up two loudspeakers placed 4 m apart with the sound in phase. Seven students are placed in a row 24 m from the loudspeakers, as shown in Figure 14. Each student is 1.5 m away from the next student.

Student 4 is in the middle and is exactly the same distance from each loudspeaker.

When a single loudspeaker is sounding, all the students hear very close to the same intensity.

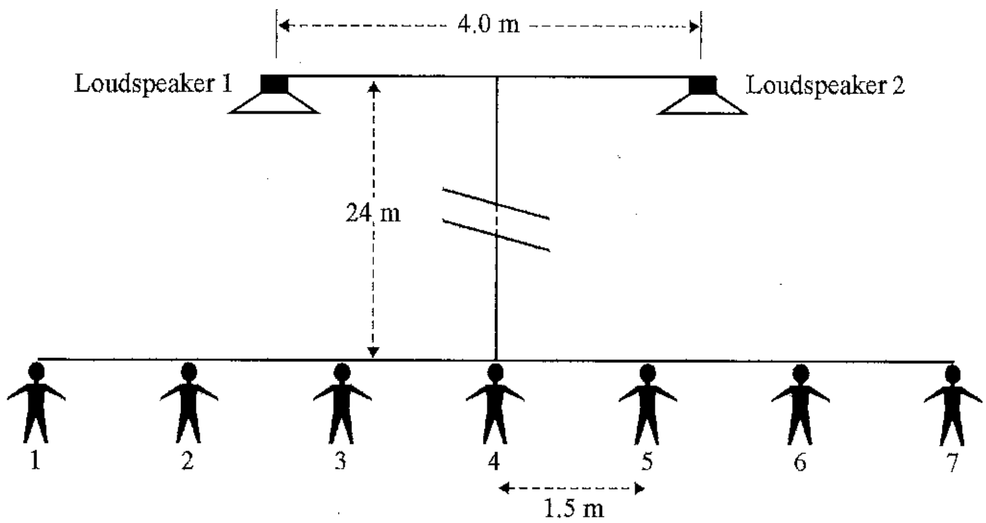


Figure 14

The teacher now connects both loudspeakers.

One student, Elli, predicts that now they will hear a similar sound of double the intensity.

Another student, Sam, disagrees. He says the intensity of the sound will depend on each student's relative distance from each speaker.

b. Evaluate Elli's and Sam's responses. 3 marks

22 %

Sam is correct

The addition of the second speaker will produce an interference pattern.

The intensity that a student hears will depend on the path difference between 2 loudspeakers

c. Will students 2 and 5 in Figure 14 hear similar or different sound intensities? If you predict that one of these students will hear a higher sound intensity, state which student and justify your prediction. Show your working. 3 marks

14 %

$\Delta x = \frac{\lambda L}{d} = \frac{0.5 \times 24}{4} = 3 \text{ m}$

Student 2 is 3 m from the centre, so there will be antinode and high intensity of sound.

Student 5 is 1.5 m away from the centre, so there will be a node - distructive interference and so low intensity

Question 16 (7 marks)

Standing waves are formed on a string of length 4.0 m that is fixed at both ends. The speed of the waves is 240 m s^{-1}.

62 %

a. Calculate the wavelength of the lowest frequency resonance. 2 marks

$\lambda = 2L = 2 \times 4$

8 m

57 %

b. Calculate the frequency of the second-lowest frequency resonance. 2 marks

Second harmonic – $\lambda = L = 4\,m$

$f = \frac{v}{\lambda} = \frac{240}{4}$

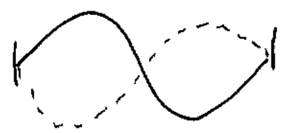
60 Hz

c. Explain the physics of how standing waves are formed on the string. Include a diagram in your response.

21 %

3 marks

Waves travelling in opposite directions and reflected at the end.
Superposition of the waves produce an interference pattern.



Question 17 (9 marks)

In an experiment, blue light of frequency 6.25×10^{14} Hz is shone onto the sodium cathode of a photocell. The apparatus is shown in Figure 15.

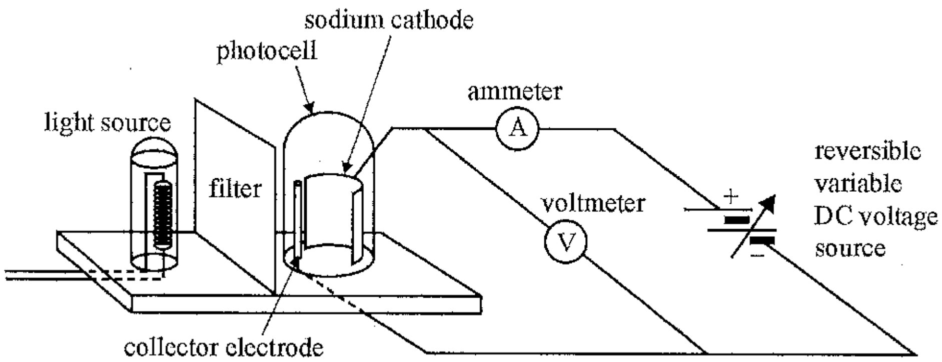


Figure 15

The graph of photoelectric current versus potential difference across the photocell is shown in Figure 16.

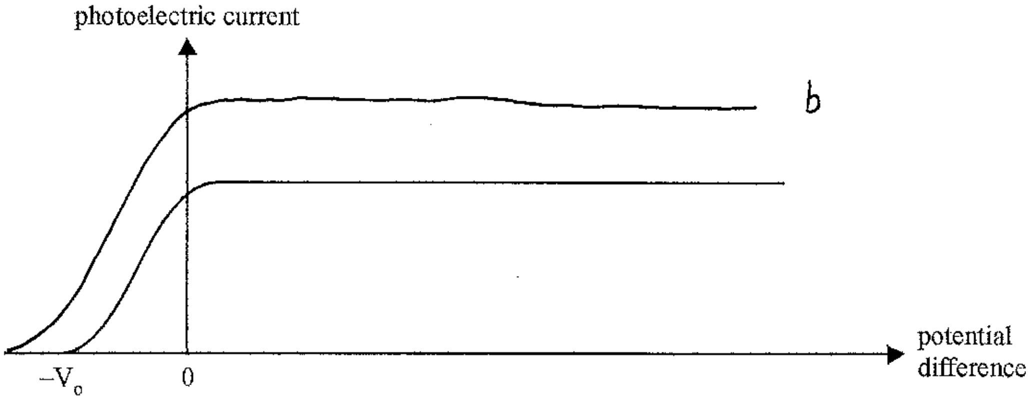


Figure 16

The threshold frequency for sodium is 5.50×10^{14} Hz.

a. What is the cut-off potential, V_0, when blue light of frequency 6.25×10^{14} Hz is shone onto the sodium cathode of the photocell referred to in Figures 15 and 16? 31% 2 marks

$W = hf_0$

$V = hf - hf_0 = h(f - f_0)$

$V = 4.14 \times 10^{-15} (6.25 - 5.5) \times 10^{14}$

0.31 V

b. On the graph of photoelectric current versus potential difference shown in Figure 16, sketch the curve expected if the light is changed to **ultraviolet** with a **higher intensity** than the original blue light. 40 %
2 marks

c. The results of photoelectric effect experiments in general provide strong evidence for the particle-like nature of light.

Outline **two** aspects of these results that provide the strong evidence that is not explained by the wave model of light, and explain why. 16 %
5 marks

1) Existence of a threshold frequency. According to wave model light of any frequency will produce a photocurrent as energy depends on amplitude. But if frequency is below the threshold there will be no current regardless of intensity.
2) Stopping voltage depends on frequency and independent of intensity. According to wave model higher intensity will require higher stopping voltage as more energy is delivered. But increase of intensity increases photocurrent but makes no effect on stopping voltage.
3) No time delay. According to wave theory for the dim light there will be delay in observing photocurrent as electrons will accumulate energy. But photocurrent starts immidiately or doesn't start at all.

Any 2 of those 3.

Question 18 (5 marks)

The energy-level diagram for sodium is shown in Figure 17. Part of the emission spectrum of sodium vapour includes a photon of energy 1.65 eV.

Assume that $c = 3.0 \times 10^8$ m s^{-1}.

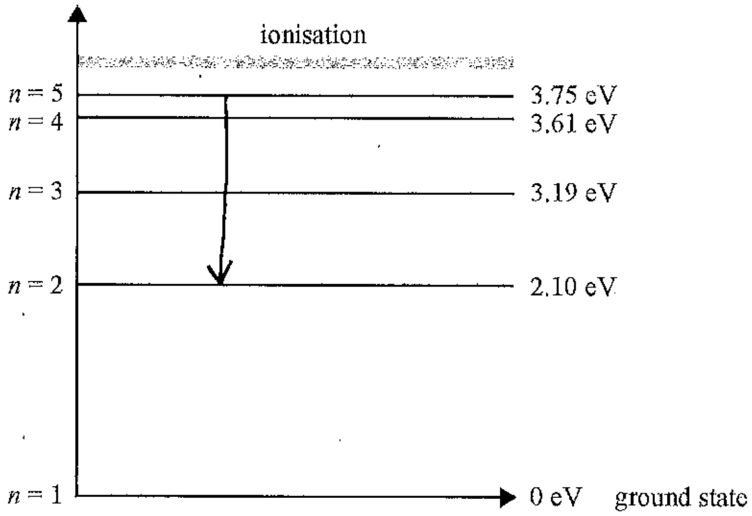


Figure 17

a. Draw an arrow on the energy-level diagram in Figure 17 to demonstrate the atomic energy level transition resulting in the emission of a 1.65 eV photon. 73 % 1 mark

b. What is the shortest possible wavelength of a photon that can be emitted when the atom decays from the $n = 5$ level to the ground state? 43 % 2 marks

$E = \frac{hc}{\lambda}$ $\lambda = \frac{hc}{E} = \frac{4.14 \times 10^{-15} \times 3 \times 10^{8}}{3.75}$

331 nm

c. A student reported observing a spectral line corresponding to 2.5 eV. 15 %

In terms of the quantised states of the atom, explain why this would be impossible. 2 marks

There is no difference between energy levels of 2.5 eV

So no such emission is possible and no photon of such energy observed

Question 19 (4 marks) 10 %

Roger and Mary are discussing diffraction.

Mary says electrons produce a diffraction pattern.

Roger says this is impossible as diffraction is a wave phenomenon and electrons are particles; diffraction can only be observed with waves, as with electromagnetic waves, such as light and X-rays.

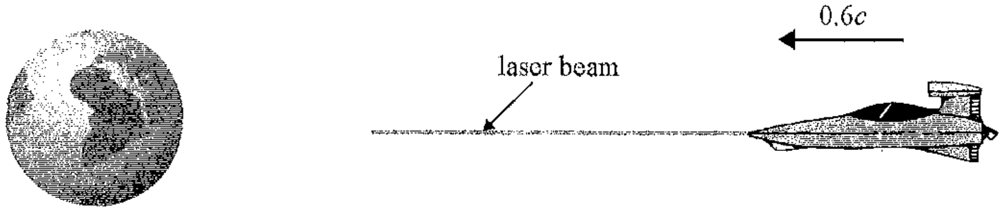
Evaluate Mary's and Roger's statements in light of the current understanding of light and matter. Describe **two** experiments that show the difference between Mary's and Roger's views.

Mary is correct, Roger incorrect.
Electrons have wave properties with deBroglie wavelength.
If electrons pass through the crystal they produce diffraction pattern same as X-Rays.
If electrons pass through a single or double ~~s~~ slit they produce interference pattern.

END OF QUESTION AND ANSWER BOOK

Question 11

An alien spaceship has entered our solar system and is heading directly towards Earth at a speed of $0.6c$, as shown in the diagram below. When it reaches a distance of 3.0×10^{11} m from Earth (in Earth's frame of reference), the aliens transmit a 'be there soon' signal via a laser beam.



How long will it take for the signal to reach Earth according to an observer on Earth?

A. 1.0 s

B. 1.7 s

C. 625 s

D. 1000 s

Question 12

A golf club strikes a stationary golf ball of mass 0.040 kg. The golf club is in contact with the ball for one millisecond. The ball moves off at 50 m s^{-1}.

The average force exerted by the club on the ball is closest to

A. 2.0 N

B. 1.0×10^3 N

C. 2.0×10^3 N

D. 1.0×10^6 N

Question 13

Which one of the following statements about the polarisation of waves is **true**?

A. Only electromagnetic waves can be polarised.

B. Both longitudinal and transverse waves can be polarised.

C. Longitudinal waves can be polarised but transverse waves cannot be polarised.

D. Transverse waves can be polarised but longitudinal waves cannot be polarised.

Question 14

Which one of the following best describes electromagnetic waves?

A. They all travel at the same speed in all mediums.

B. They all travel at the same speed in a vacuum.

C. They are not reflected by a surface.

D. They always travel in straight lines.

Question 15

Which of the following best gives the different regions of the electromagnetic spectrum in order from longest wavelength to shortest wavelength?

A. ultraviolet, visible light, infra-red, microwaves

B. microwaves, ultraviolet, visible light, infra-red

C. visible light, ultraviolet, infra-red, microwaves

D. microwaves, infra-red, visible light, ultraviolet

Question 16

When light of a specific frequency strikes a particular metal surface, photoelectrons are emitted.

If the light intensity is increased but the frequency of the light remains the same, which of the following is correct?

	Number of photoelectrons emitted	Maximum kinetic energy of the photoelectrons
A.	remains the same	remains the same
B.	remains the same	increases
C.	increases	remains the same
D.	increases	increases

Question 17

A metal surface has a work function of 2.0 eV.

The minimum energy of an incoming photon required to eject a photoelectron is

A. 3.2×10^{-19} J

B. 1.6×10^{-19} J

C. 8.0×10^{-20} J

D. 4.0×10^{-20} J

$E(J) = E(eV) \times 1.6 \times 10^{-19}$
$= 2 \times 1.6 \times 10^{-19}$

Question 18

A student measures a very small current in a circuit and obtains the result 0.000670 A.

The number of significant figures in the measurement 0.000670 A is

A. 2

B. 3

C. 5

D. 6

Question 19

An independent variable is best described as one that is

A. set by the researcher.

B. not relevant to the experiment.

C. fixed throughout the experiment.

D. not related to any other variables in the experiment.

Question 20

The main reason for repeating an experiment is to

A. reduce random error.

B. reduce systematic error.

C. allow for differences between researchers.

D. allow for variations in controlled variables.

END OF SECTION A
TURN OVER

Q11

c. The students now replace the two slits with a slit of width w, as shown in Figure 10.

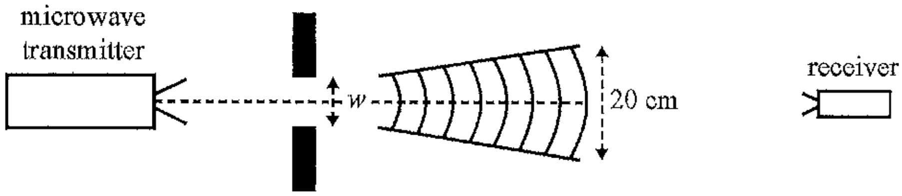


Figure 10

With the transmitter set to a wavelength of 3.0 cm, the students measure the width of the diffraction pattern to be 20 cm at a particular distance from the slit, as shown in Figure 10. They then switch to a 6.0 cm wavelength on the transmitter.

What effect will this have on the width of the pattern? Explain your answer. 2 marks

Pattern will spread out.

$\Delta x = \frac{\lambda L}{w}$ $\lambda \uparrow \rightarrow \Delta x \uparrow$

d. With the transmitter reset to a wavelength of 3.0 cm, the students place the receiver on a cart. With the cart stationary, the receiver measures the wavelength to be 3.0 cm exactly. The cart is now set moving away from the transmitter, as shown in Figure 11.

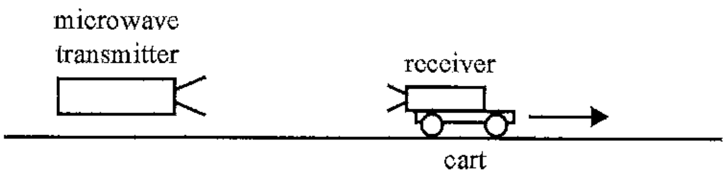


Figure 11

Will this movement increase, decrease or leave unchanged the wavelength as measured by the receiver on the cart? Explain your answer and name the physical principle involved. 2 marks

Wavelength will be measured as longer due to the Doppler effect.

Question 12 (3 marks)

Figure 12 shows the energy level diagram for the hydrogen atom.

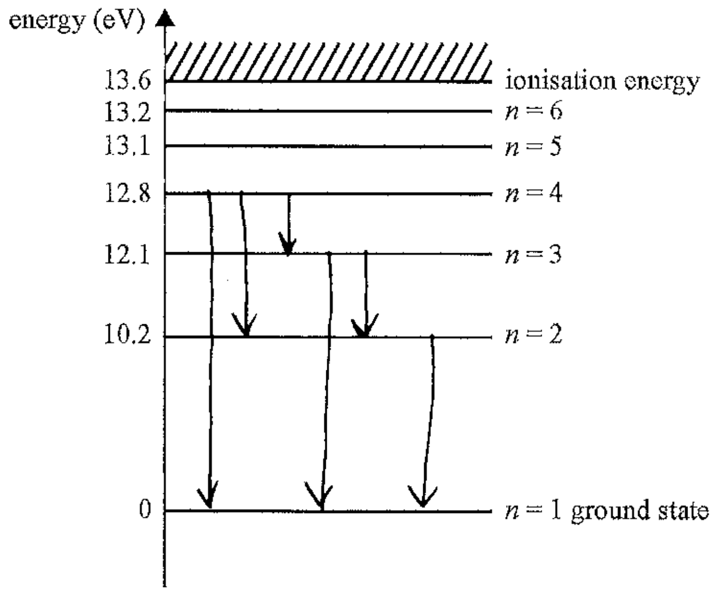


Figure 12

List the possible photon energies following emissions from the $n = 4$ state.

12.8, 12.1, 10.2, 2.6, 1.9, 0.7 eV

Question 13 (7 marks)

Electrons are accelerated through a potential difference of 4000 V and then pass through a metallic crystal. The resulting diffraction pattern is observed.

a. Calculate the de Broglie wavelength of these electrons. 3 marks

$qV = \frac{mv^2}{2}$ $v = \sqrt{\frac{2qV}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 4000}{9.1 \times 10^{-31}}}$

$v = 3.7 \times 10^7 \, ms^{-1}$

$\lambda = \frac{h}{p}$ $\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 3.7 \times 10^7}$

$\lambda = 2 \times 10^{-11} \, m$

2×10^{-2} nm

b. A student, Jane, says that X-rays of a suitable wavelength could produce the same diffraction pattern.

Calculate the energy of the X-ray beam required to give a similarly spaced diffraction pattern to the electrons. Show your working. 2 marks

$E = \frac{hc}{\lambda} = \frac{4.14 \times 10^{-15} \times 3 \times 10^8}{2 \times 10^{-11}}$

6.5×10^4 eV

c. Explain how electrons and X-rays can exhibit similar diffraction patterns. 2 marks

Diffraction depends on wave length.
Same wavelength of electrons and X-rays equal, so diffraction pattern is the same.

Question 16 (6 marks)

Students are investigating the photoelectric effect.

The apparatus used by the students is shown in Figure 13. A light source shines light through a filter that only allows one frequency of light to pass through. This monochromatic light shines onto a metal plate and photoelectrons are emitted. Different filters allow different frequencies to strike the metal plate. For each frequency, the maximum kinetic energy of the emitted photoelectrons is measured by using a stopping voltage.

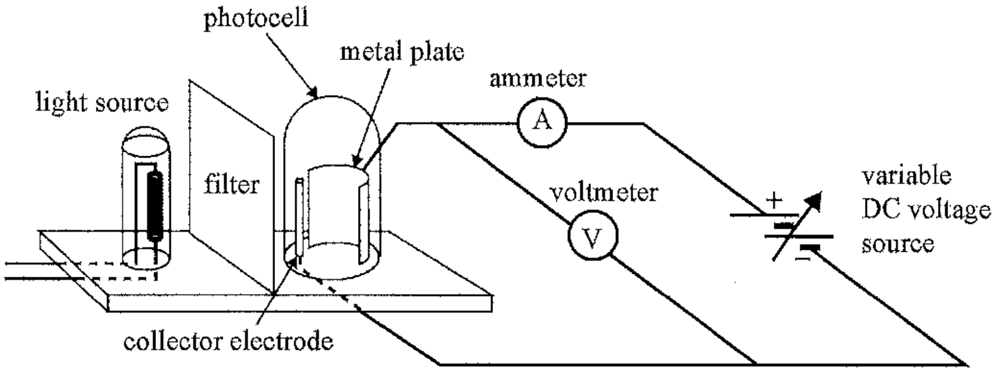


Figure 13

The graph of the data the students collected for the maximum kinetic energy of emitted photoelectrons versus frequency is shown in Figure 14. A line of best fit has been drawn.

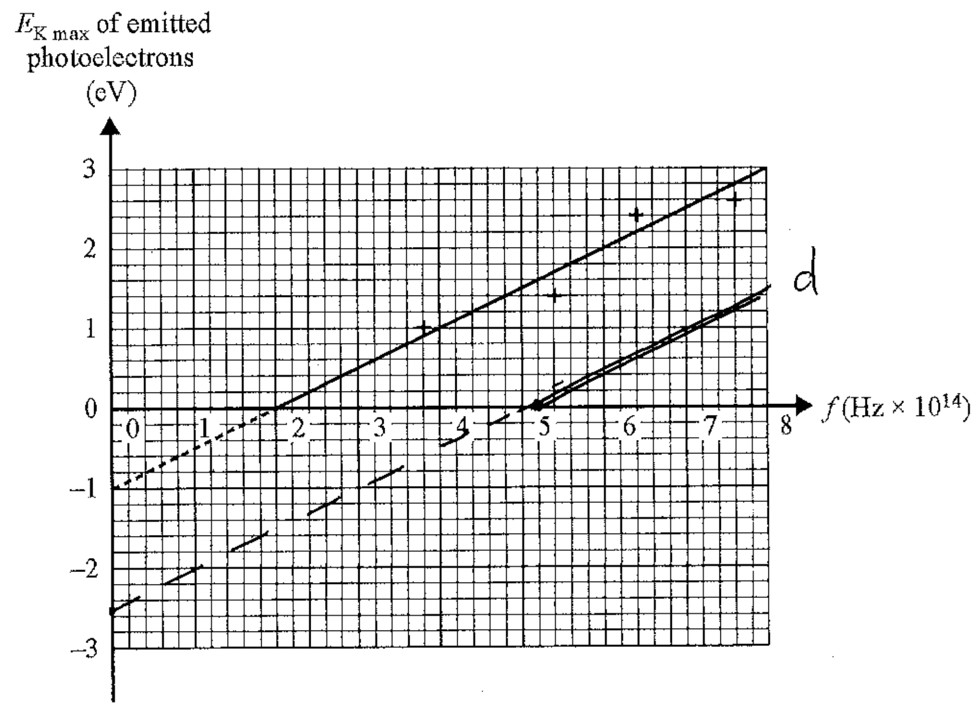


Figure 14

a. Determine the value of Planck's constant, h, that the students would have obtained from this graph. 2 marks

Gradient $h = \frac{3}{6 \times 10^{14}}$

5×10^{-15} eV s

b. Determine the value of the minimum frequency, or cut-off frequency, f_0, that the students would have obtained from this graph. 1 mark

2×10^{14} Hz

c. Determine the value of the work function of the metal in the plate that the students would have obtained from this graph. 1 mark

1 eV

d. The students replace the photocell with one that has a different metal plate with a work function of 2.5 eV.

On Figure 14, draw in the graph they would now expect. 2 marks

Question 17 (6 marks)

The results of photoelectric effect experiments provide evidence for the particle-like nature of light.

Outline **one** aspect of the results that would provide this evidence. Your response should explain:

- why a wave model of light cannot satisfactorily explain this aspect of the results
- how the photon theory does explain this aspect of the results.

Existence of threshold frequency.
According to wave model energy of light depends on intensity (amplitude) so light of all frequencies will produce photocurrent.
Experiment shows that Light with frequency above threshold produce photocurrent. Particle model predicts that energy of photons proportional to their frequency so only light with high enough frequency will release electrons.

Question 18 (3 marks)

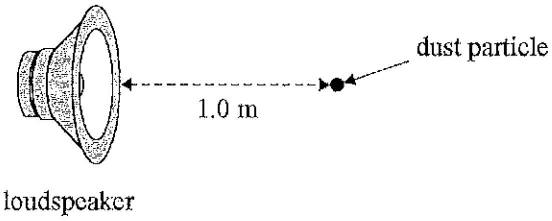
Explain how the diffraction pattern produced by a stream of electrons passing through a narrow slit can illustrate Heisenberg's uncertainty principle.

$\Delta x \Delta p \geq \frac{h}{4\pi}$ When electron pass through the slit ~~its~~ uncertainty in its position decreases, so uncertainty of the momentum and so direction of the momentum increases, so electrons paths spread out.

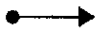
END OF QUESTION AND ANSWER BOOK

Question 10 59 %

A loudspeaker is producing a sound wave of constant frequency. Consider a tiny dust particle 1.0 m in front of the loudspeaker.



Which one of the following diagrams best describes the motion of the dust particle?

A.  **B.**  **C.**  **D.** 

Sound is longitudinal wave.

Question 11 88 %

Alex hears the siren from a stationary fire engine.

Compared with the sound Alex hears from the stationary fire engine, the sound Alex will hear as the fire engine approaches him will have increased

A. speed.

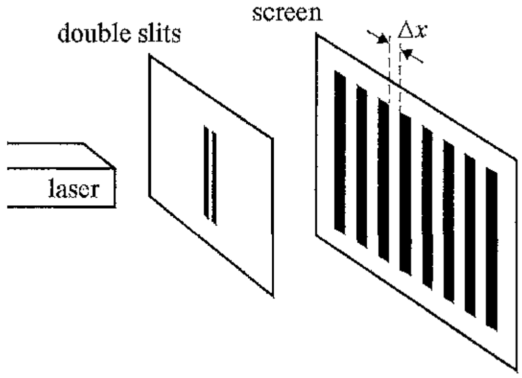
B. period.

C. amplitude.

D. frequency.

Question 12 55%

A teacher sets up an apparatus to demonstrate Young's double-slit experiment. A pattern of bright and dark bands is observed on the screen, as shown below.



Which one of the following actions will increase the distance, Δx, between the adjacent dark bands in this interference pattern?

A. Decrease the distance between the slits and the screen.

B. Decrease the wavelength of the light.

C. Decrease the slit separation.

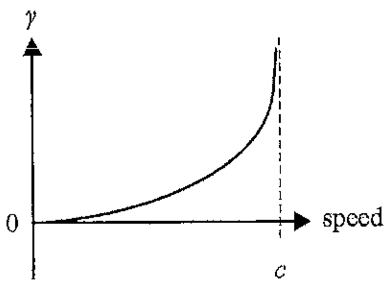
D. Decrease the slit width.

$\Delta x = \frac{\lambda L}{d}$ $d \downarrow \rightarrow \Delta x \uparrow$

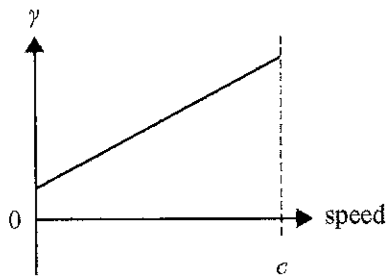
Question 13

Which one of the following diagrams best represents the graph of γ (the Lorentz factor) versus speed for an electron that is accelerated from rest to near the speed of light, c?

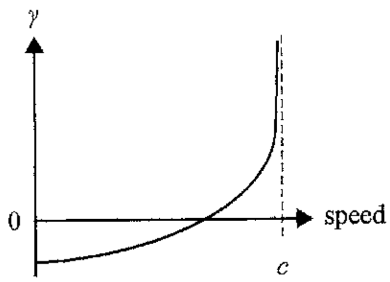
A.



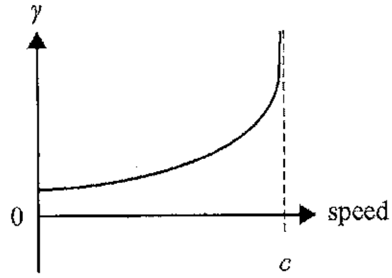
B.



C.



D.



Question 14

Which one of the following statements about the kinetic energy, E_k, of a proton travelling at relativistic speed is the most accurate?

A. The difference between the proton's relativistic E_k and its classical E_k cannot be determined.

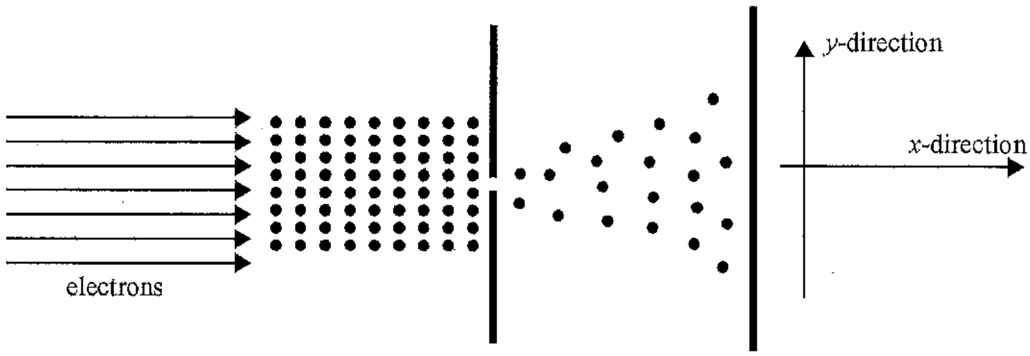
B. The proton's relativistic E_k is greater than its classical E_k.

C. The proton's relativistic E_k is the same as its classical E_k.

D. The proton's relativistic E_k is less than its classical E_k.

Question 15 49%

When a beam of particles, such as electrons, passes through a narrow slit, diffraction effects can occur, as shown in the diagram below.



This phenomenon can be described by Heisenberg's uncertainty principle because, when electrons pass through the slit, the uncertainty in their

A. y-position does not affect the uncertainty in their y-momentum.

B. y-momentum affects the uncertainty in their x-momentum.

C. x-position affects the uncertainty in their x-momentum.

D. y-position affects the uncertainty in their y-momentum.

Question 16 84%

Polarisation is a property of

A. all types of waves.

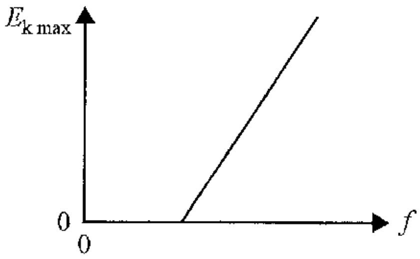
B. only sound waves.

C. only transverse waves.

D. only longitudinal waves.

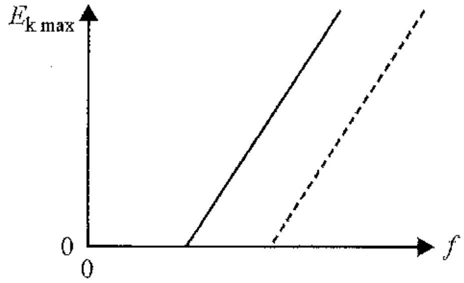
Question 17 70%

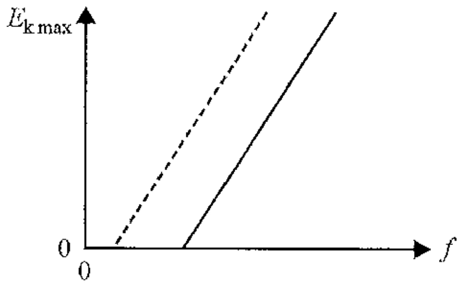
The results of a photoelectric experiment are displayed in the graph below. The graph shows the maximum kinetic energy ($E_{k\ max}$) of photoelectrons versus the frequency (f) of light falling on the metal surface.

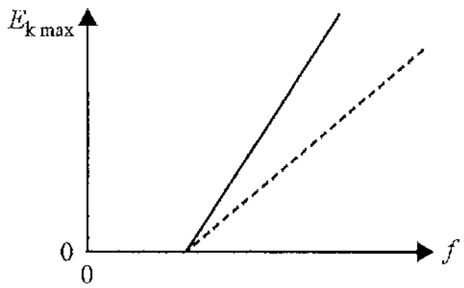


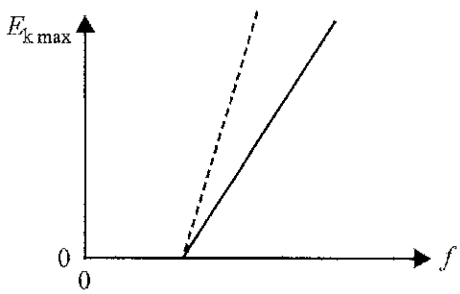
A second experiment is conducted with the original metal surface being replaced by one with a larger work function. The original data is shown with a solid line and the results of the second experiment are shown with a dashed line.

Which one of the following graphs shows the results from the second experiment?

A.


B.


C.


D.


Question 18

The experimental uncertainty in a measurement of any particular quantity is **best** described as

A. a quantitative estimate of the doubt associated with the measurement.

B. the degree of confidence a scientist has in their experimental technique.

C. the difference between the measurement and the true value of the quantity.

D. the result of one measurement; repeated measurements can eliminate uncertainty.

Question 12 (5 marks)

Optical fibres are constructed using transparent materials with different refractive indices.

Figure 14 shows one type of optical fibre that has a cylindrical core and surrounding cladding. Laser light of wavelength 565 nm is shone from air into the optical fibre.

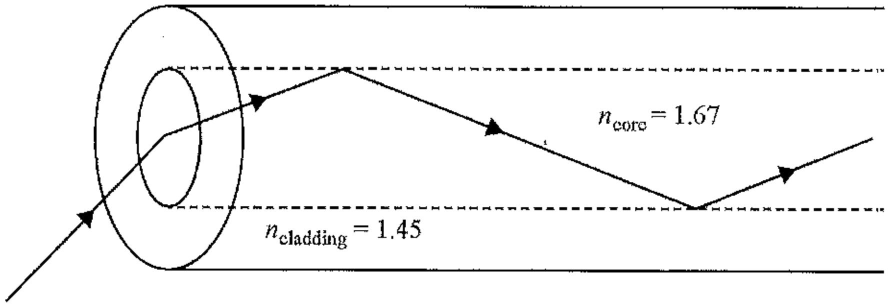


Figure 14

72 %

a. Calculate the frequency of the laser light before it enters the optical fibre. 1 mark

$f = \frac{v}{\lambda} = \frac{3 \times 10^{8}}{565 \times 10^{-9}}$

5.3×10^{14} Hz

71 %

b. Calculate the critical angle for the laser light at the cladding–core boundary. Show your working. 2 marks

$\theta_c = \sin^{-1}\left(\frac{1.45}{1.67}\right)$

60.3 °

35%

c. Calculate the speed of the laser light once it enters the core of the optical fibre. Give your answer correct to three significant figures. Show your working. 2 marks

$n = \frac{c}{v}$ $nv = c$ $n_{air} V_{air} = n_c V_c$

$1 \times (3 \times 10^8) = 1.67 V_c$

$V_c = 1.8 \times 10^8$

3 s.f. $V = 1.80 \times 10^8$

1.80×10^8 m s^{-1}

Question 13 (7 marks)

Physics students studying interference set up a double-slit experiment using a 610 nm laser, as shown in Figure 15.

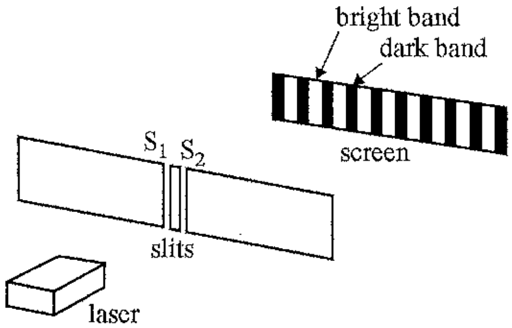


Figure 15

The light power output of the laser is 5.03×10^{-3} J s^{-1}.

31 %

a. Calculate the number of photons leaving the laser each second. Show your working. 3 marks

$$E_{ph} = \frac{hc}{\lambda} = \frac{6.63\times10^{-34} \times 3\times10^{8}}{610\times10^{-9}} = 3.26\times10^{-19}\ \text{J}$$

$$n = \frac{5.03\times10^{-3}}{3.26\times10^{-19}}$$

$\boxed{1.54\times10^{16}}$

A section of the interference pattern observed by the students is shown in Figure 16. There is a bright band at point C, the centre point of the pattern.

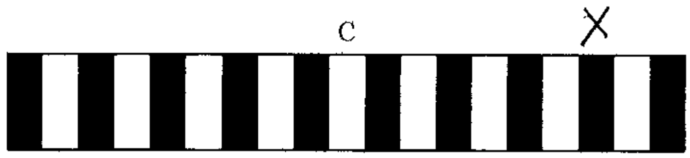


Figure 16

32 %

b. Explain why point C is in a bright band rather than in a dark band. 2 marks

Path difference = 0.

Constructive interference.

c. Another point on the pattern to the right of point C is further from S_1 than S_2 by a distance of 2.14×10^{-6} m.

45%

Mark this point on Figure 16 by writing an X above the point. You must use a calculation to justify your answer. 2 marks

$\frac{Pd}{\lambda} = \frac{2.14\times10^{-6}}{6.1\times10^{-7}} = 3.5$ – fourth dark

With 6.0×10^{14} Hz light, the ammeter always shows zero. Sai wants to repeat the experiment for this frequency with a much brighter light source and wants to expose the metal to the light for much longer. Kym says photoelectrons will never be ejected with this frequency of light.

78%

a. **i.** Who is correct – Sai or Kym? Write the name in the box provided below. 1 mark

Kym

ii. What explanation might Sai give to support her opinion that by waiting longer and using a brighter light source, photoelectrons could be ejected from the metal with light of a frequency of 6.0×10^{14} Hz? 17% 2 marks

As brightness ↑, energy of light ↑, so electrons can accumulate more energy and be ejected.

43%

b. Use the graph to calculate Planck's constant. Show your working. 2 marks

$h = \text{Gradient} = \frac{3.3-0.2}{6\times10^{14}}$

5.2×10^{-15} eV s

40%

c. Determine the work function of the metal from the graph. Give your reasoning. 2 marks

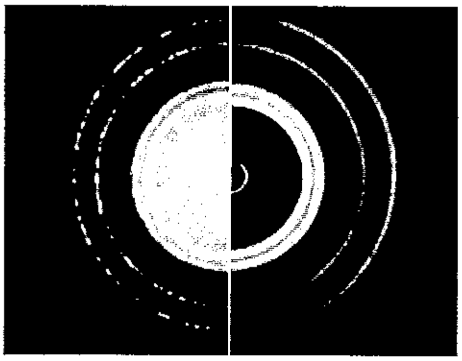
V(y)-intercept on the graph

3.5 eV 3.0 – 4.0 was accepted

Question 18 (5 marks)

The diffraction patterns for X-rays and electrons through thin polycrystalline aluminium foil have been combined in the diagram in Figure 18, which shows an electron diffraction pattern on the left and an X-ray diffraction pattern on the right. The images are to the same scale.

The X-rays have a photon energy of 8000 eV.



electrons X-rays

Figure 18

43%

a. Calculate the wavelength of the electrons in nanometres. Show your working. 2 marks

$\lambda = \frac{hc}{E} = \frac{4.14\times10^{-15}\times3\times10^{8}}{8000} = 1.55\times10^{-10}$ m

0.155 nm

28%

b. Calculate the kinetic energy of the electrons in joules. Show your working. 3 marks

$\lambda = \frac{h}{mv}$ $v = \frac{h}{m\lambda} = \frac{6.63\times10^{-34}}{9.1\times10^{-31}\times1.55\times10^{-10}} = 4.7\times10^{6}$

$E_k = \frac{mv^2}{2} = \frac{9.1\times10^{-31}\times(4.7\times10^{6})^2}{2}$

1.0×10^{-17} J

or

$E_k = \frac{p^2}{2m}$

$E_{ph} = pc$ $p = \frac{E_{ph}}{c} = \frac{8000\times1.6\times10^{-19}}{3\times10^{8}} = 4.27\times10^{-24}$

$E_k = \frac{(4.27\times10^{-24})^2}{2\times9.1\times10^{-31}} = 1.0\times10^{-17}$

Question 19 (4 marks)

Figure 19 shows the spectrum of light emitted from a hydrogen vapour lamp.

The spectral line, indicated by the arrow on Figure 19, is in the visible region of the spectrum.

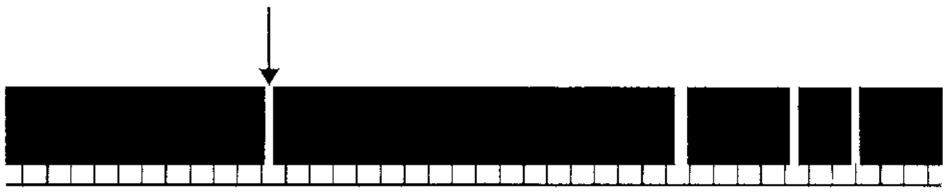


Figure 19

a. The following list gives the four visible colours that are emitted by the hydrogen atom. 64%

Circle the colour that corresponds to the spectral line indicated by the arrow on Figure 19. 1 mark

violet blue-violet blue-green red

b. Explain why the visible spectrum of light emitted from a hydrogen vapour lamp gives **discrete** spectral lines, as shown in Figure 19. 11% 3 marks

Electrons in atom have discrete energy levels.
Electrons can move between those levels by emiting/absorbing discrete amounts of energy equal to difference between levels.
As electrons can release only discrete amounts of energy, only discrete spectral lines will be observed.