Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

Physics

Advanced Subsidiary
Unit 2: Physics at Work

Thursday 4 June 2015 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6PH02/01

You must have:
Ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 4 4 9 2 4 A 0 1 3 2

PEARSON

SECTION A

Answer ALL questions.

For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The current in a filament lamp is 250 mA.

How much charge flows through the lamp in 3 minutes?

- ☐ **A** 0.75 C
- ☒ **B** 45 C
- ☐ **C** 750 C
- ☐ **D** 45 000 C

3 minutes is 180s
0.25A
Q=It 0.25 x 180 = 45C

(Total for Question 1 = 1 mark)

2 A source of sound of constant frequency is moving towards an observer. Compared to the frequency of the source, the frequency of sound heard by the observer is

- ☐ **A** higher, because the speed of sound increases.
- ☐ **B** lower, because the air is compressed.
- ☒ **C** higher, because the wavelength of the sound decreases.
- ☐ **D** lower, because the amplitude increases.

(Total for Question 2 = 1 mark)

3 Radiation of frequency f and wavelength λ is emitted when an electron falls from energy level E_2 to energy level E_1.

$E_2 - E_1$ is equal to

- ☐ **A** $\frac{hc}{f}$
- ☒ **B** $\frac{hc}{\lambda}$
- ☐ **C** $\frac{hf}{c}$
- ☐ **D** $\frac{h\lambda}{c}$

E=hf
v=fλ
c=fλ
f= c/λ
so E_2-E= hc/λ

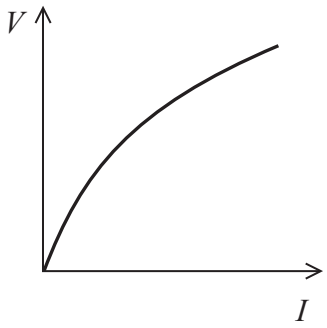
(Total for Question 3 = 1 mark)

4 Which of the following can be explained only by the wave nature of electromagnetic radiation?

- ☒ **A** atomic line spectra
- ☒ **B** electron diffraction
- ☒ **C** photoelectric effect
- ☒ **D** X-ray diffraction

(Total for Question 4 = 1 mark)

5 The graph shows how potential difference V varies with current I for a circuit component.



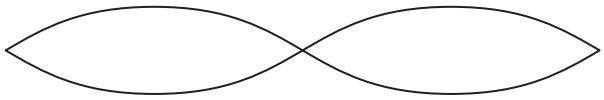
Which of the following could be the circuit component?

- ☒ **A** copper wire
- ☒ **B** filament lamp
- ☒ **C** fixed resistor
- ☒ **D** thermistor

(Total for Question 5 = 1 mark)

Questions 6 and 7 refer to the diagram below.

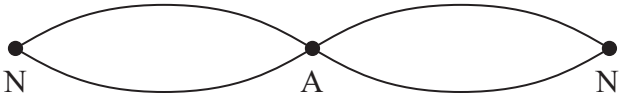
The diagram represents a stationary wave on a string.



6 Which diagram correctly shows the position of nodes N and/or antinodes A?

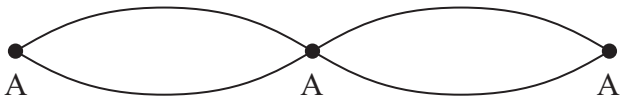
☒ **A**

☒ **B**



☒ **C**

☒ **D**



(Total for Question 6 = 1 mark)

7 The length of the string is 4 m.
What is the wavelength of the stationary wave?

its in second harmonic so L=λ
(for 1 harmonic L=1/2λ, if 3 L=3/2λ)

☒ **A** 1 m

☒ **B** 2 m

☒ **C** 4 m

☒ **D** 8 m

(Total for Question 7 = 1 mark)

8 Which of the following expresses the volt in SI base units?

- ☒ **A** $kg\ m^2\ s^{-2}\ C^{-1}$
- ☒ **B** $kg\ m^2\ s^{-3}\ C$
- ☒ **C** $kg\ m^2\ s\ A^{-1}$
- ☒ **D** $kg\ m^2\ s^{-3}\ A^{-1}$

V=W/Q one joule of energy per coulomb of charge

$\frac{km\ m^2}{A\ s^3}$

(Total for Question 8 = 1 mark)

9 A light illuminates a circular area of radius 30 cm. In a time of 20 s the total incident energy from the light is 70 J.

The radiation flux can be calculated from

r

Area= πr^2

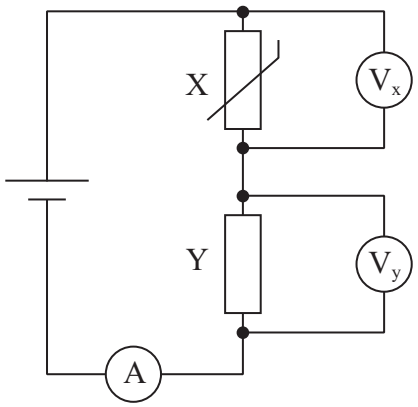
- ☒ **A** $\frac{70}{(\pi \times 0.30^2 \times 20)}$
- ☒ **B** $\frac{70}{(\pi \times 0.15^2 \times 20)}$
- ☒ **C** $\frac{70 \times \pi \times 0.30^2}{20}$
- ☒ **D** $\frac{70 \times 20}{(\pi \times 0.15^2)}$

energy per unit time

$\frac{70}{\pi \times 0.30^2 \times 20s}$

(Total for Question 9 = 1 mark)

10 The diagram shows a potential divider circuit that contains a negative temperature coefficient thermistor.



The temperature of the room containing the circuit increases.

Select the row of the table that correctly shows the changes in readings on the meters.

	V_x	V_y	A
☒ **A**	decrease	increase	decrease
☒ **B**	decrease	increase	increase
☒ **C**	increase	decrease	decrease
☒ **D**	increase	decrease	increase

(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

SECTION B

Answer ALL questions in the spaces provided.

11 When electromagnetic radiation is incident on a metal plate, electrons may be emitted.

(a) State what is meant by threshold frequency.

(1)

The minimum frequency photons incident on a surface that cause electrons to be liberated.

(b) Calculate the threshold frequency for a metal with a work function of 2.28 eV.

(3)

Convert eV into J where $1eV=1.6\times10^{-19}$ J

$= 2.28 \times 1.6\times10^{-19} = 3.65\times10^{-19}$

$E= hf$

$E/h=f$

$f= 3.65\times10^{-19} / 6.63\times10^{-34}$

$=5.50\times10^{14}$ Hz

Threshold frequency = ...

(Total for Question 11 = 4 marks)

12 An ultrasonic distance estimator can be used to measure the length of a room.

The estimator is held against one wall. It emits pulses of ultrasound and detects them when they return after reflection by the opposite wall.

(a) Explain why the ultrasound must be emitted in pulses.

(1)

so you cant distinguish which reflection comes from each emissio

(b) The shortest distance the estimator can measure is 40 cm.
Calculate the longest pulse duration that would allow this distance to be measured.

speed of ultrasound in air = 330 m s^{-1}

(3)

s=0.40m x 2 = 0.80m

v=330ms^{-1}

v=s/t

t= 0.80/330 = 2.4x10^{-3} s

Pulse duration = ...

(c) When the estimator is pointed at a sloping wall, as shown in the photograph, it is unable to measure this distance.

Suggest why the estimator is unable to measure the distance to the sloping wall.

(1)

The ultrasound is reflected back at an angle away from the sensor.

(Total for Question 12 = 5 marks)

13 (a) State what is meant by drift velocity when applied to a metal conductor.

(1)

The mean velocity of the charge carriers.

(b) Two conductors of the same material and length carry the same current. Conductor X has twice the cross-sectional area of conductor Y.

(i) By referring to an appropriate equation, compare the drift velocities for conductor X and conductor Y.

(2)

the velocity for X is half the velocity for Y.
I=nqvA where v is inversely proportional to A

*(ii) Explain the difference in resistance of conductor X and conductor Y in terms of the difference in drift velocity.

(3)

The resistance of Y is greater than the resistance of X. This means the electrons gain more KE between collisions. Therefore a greater pd is required for a given current.

(Total for Question 13 = 6 marks)

14 The instruction booklet for an electric garden shredder includes the following advice.

When using an extension cable, the following dimensions should be observed:

Cross-sectional area of conductor / mm^2	Maximum cable length / m
1.00	40
1.50	60
2.50	100

(a) Describe the relationship between area and length in the table.

(1)

The maximum length is directly proportional to the area.

(b) The cable for the shredder contains two conductors in series, the live wire and the neutral wire. A cable of length 40 m has a total conductor length of 80 m.

(i) Show that the resistance of a copper conductor of length 80 m and cross-sectional area 1.00 mm^2 is about 1.3 Ω.

resistivity of copper = 1.68×10^{-8} Ω m

(2)

$\rho l/A = R$

$R = 1.68 \times 10 \Omega m \times 80m / 1.0 \times 10\ m$

$= 1.34 \Omega$

(ii) When in use the current for the shredder is 11 A.
Calculate the rate of energy dissipation by the 40 m, 1.00 mm^2 cable when it is used with the shredder.

(2)

$p=I^2R$

$11^2 \times 1.34$ 162W

Rate of energy dissipation = ...

(iii) Calculate the total potential difference across the conductors in the 40 m cable when it is used with the shredder.

(2)

$V=IR$

$V= 11 \times 1.34 = 14.7V$

Potential difference = ...

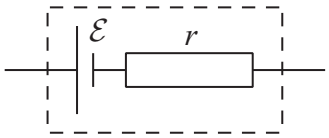
(c) Suggest why the advice in the instruction booklet is included.

(2)

To prevent the user using a resistance too high, meaning more power available

(Total for Question 14 = 9 marks)

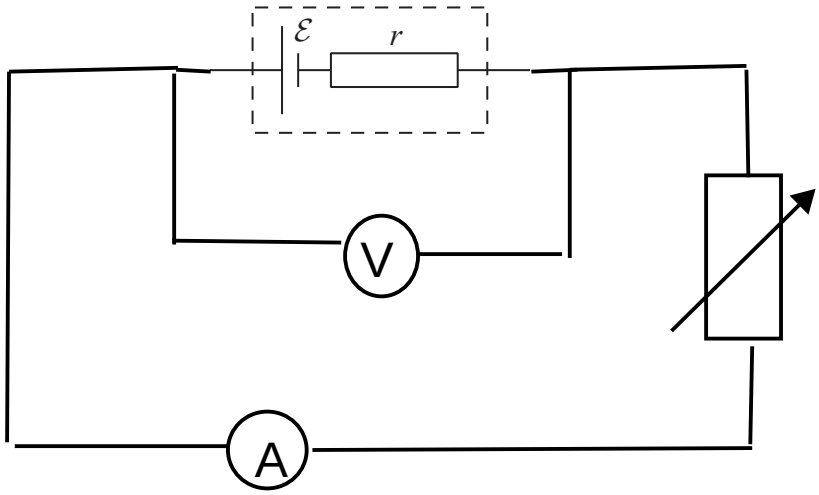
15 A cell may be represented as an e.m.f. $\mathcal{E}$ in series with an internal resistance r.



A student used the relationship $V = \mathcal{E} - Ir$ and a graphical method to determine $\mathcal{E}$ and r. She connected a cell in a circuit and took a series of measurements of the current I in the cell and the potential difference V across the terminals of the cell.

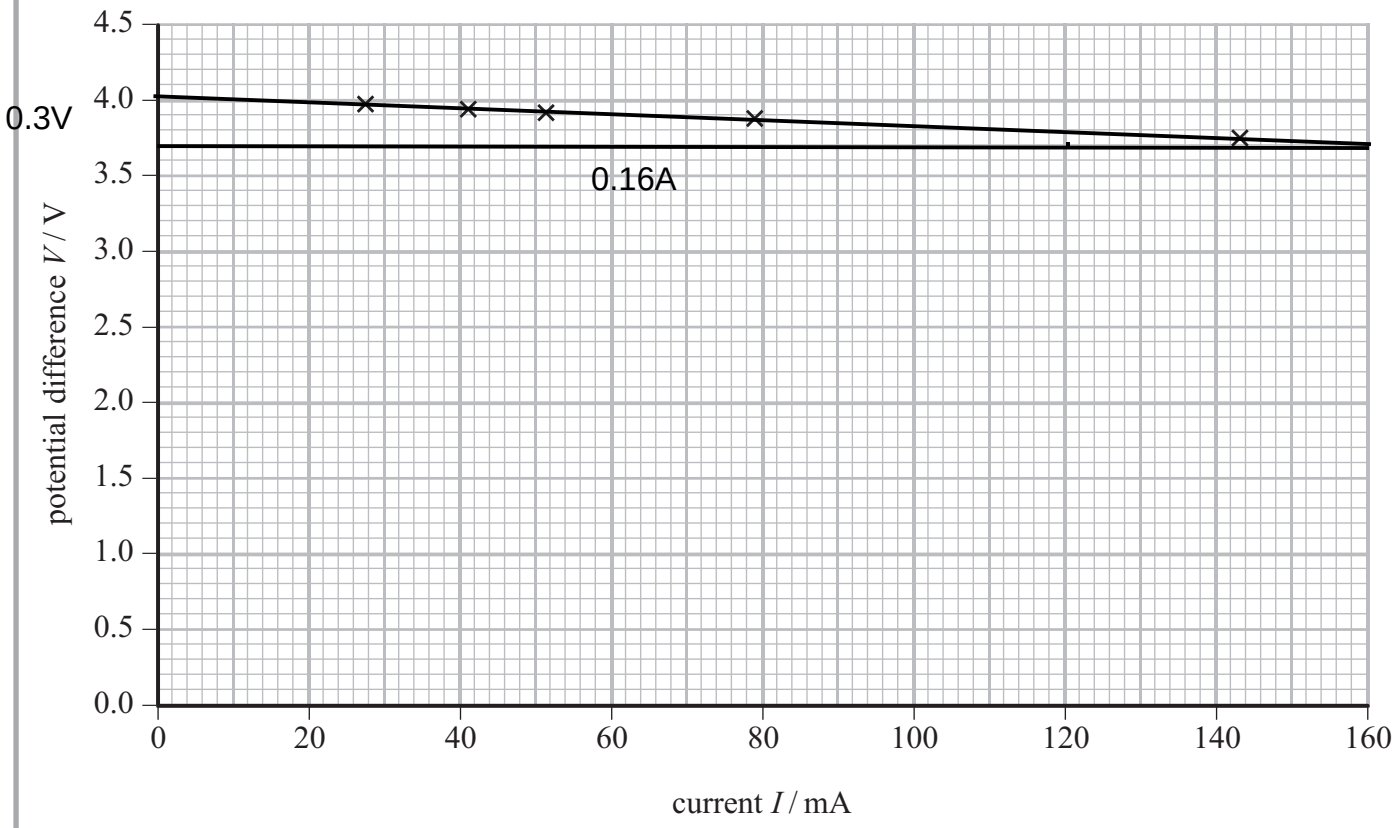
(a) Complete a circuit diagram of a circuit she could have used.

(2)



(b) The student's measurements are shown in the table and plotted on the graph.

I / mA	V / V
27.5	3.97
41.0	3.94
51.6	3.90
78.6	3.88
143.0	3.75



Determine values for $\mathcal{E}$ and r from the graph and show how you obtained your answers.

(4)

y intercept is ε which is about 4.0V
gradient is the r value which is 0.3/0.16 = -1.9Ω

$\mathcal{E}$ = ...

r = ...

(c) Explain how the graph could be constructed to obtain better values for $\mathcal{E}$ and r.

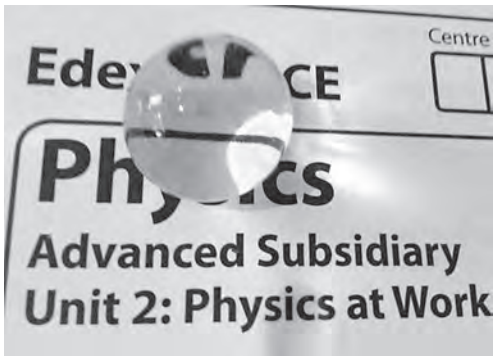
(2)

the y axis from 3.0 to 3.75V as this will allow plots to be made more accurately, and the y intercept and gradient will be able to be calculated to more sf.

(Total for Question 15 = 8 marks)

16 Flower arrangers sometimes use gel balls instead of water to fill vases.

The photograph below shows some writing seen through one of these gel balls. The writing is distorted because the gel ball refracts light.

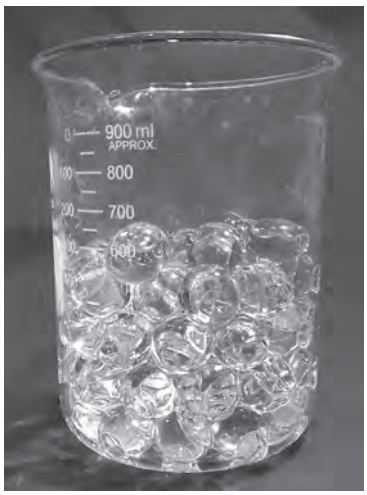


(a) Explain what is meant by refraction.

(2)

Change in direction of range due to a change in medium.

(b) The photographs below show a beaker containing gel balls. When water is added to the beaker, the gel balls below the water surface are no longer visible.



Explain how this shows that the gel has the same refractive index as water.

(2)

There is no change in direction of the light (no refraction) so the light must have the same wave speed in both the water and the gel.

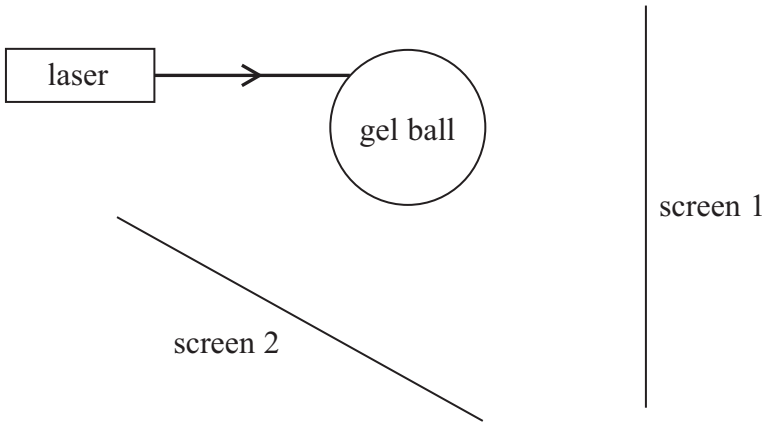
(c) A student decides to use a gel ball to model the formation of a rainbow by raindrops. He wants to see if total internal reflection occurs.

Explain what is meant by total internal reflection.

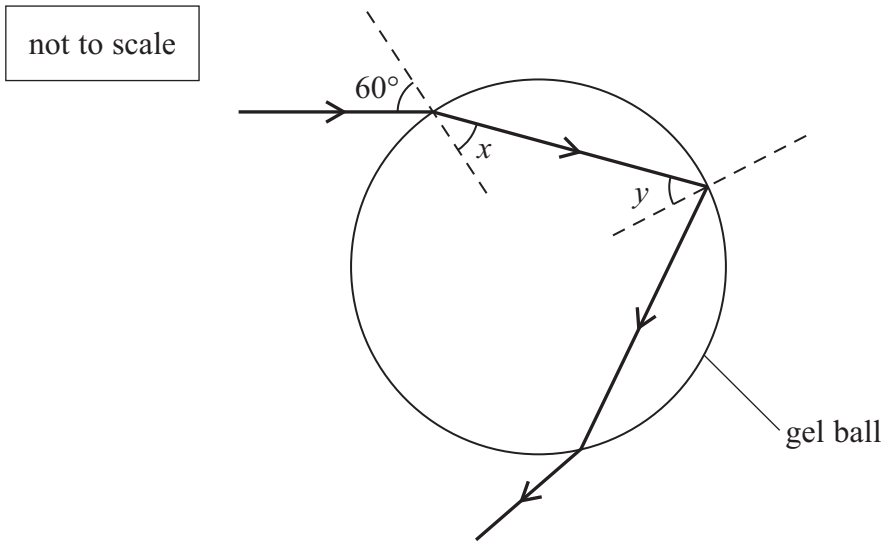
(2)

The angle of incidence is greater than the critical angle, and all of the light is refracted.

(d) The student shines a narrow laser beam at a gel ball using the arrangement shown.



When the angle of incidence of the laser beam with the gel ball is 60°, light from the laser illuminates screen 2 following the path shown.



(i) Show that the angle x is about 40°.

refractive index of gel = 1.33

(2)

$\mu = \sin i / \sin r$

$\sin x = \sin 60 / 1.33$

$x = 40.6$

(ii) Show that the critical angle for light striking the boundary of gel with air is about 50°.

(2)

$\mu = 1/\sin c$

$c = 49$

(iii) Angle x has the same value as angle y.
Explain whether light from the laser will be observed on screen 1.

(2)

angle in gel < critical angle

no internal reflection so some light will reach the screen

(Total for Question 16 = 12 marks)

17 (a) State what is meant by the principle of superposition of waves.

(2)

When two waves interfere, the resulting displacement is the sum of the individual displacements.

(b) Electromagnetic waves involve oscillating electric fields.

A student made the following notes about the polarisation of electromagnetic waves. The notes contain a number of errors.

Electromagnetic waves are transverse, with oscillations ~~parallel~~ perpendicular *to the direction of ~~motion~~.* energy transfer

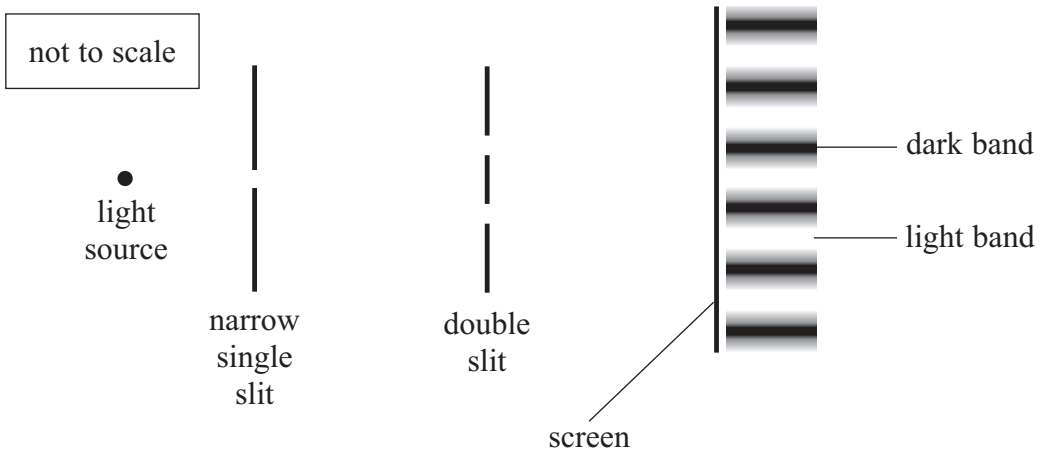
When they pass through a polarising filter all the components of the oscillations perpendicular to the filter's plane of polarisation are ~~rotated.~~ absorbed

The oscillations of the polarised wave are all in the same ~~plane~~ direction *which is perpendicular to the direction of energy transfer.*

Copy the passage, correcting the errors.

(4)

(c) The arrangement in the diagram demonstrates the effect of superposition. When a monochromatic light source is used, a series of dark and light bands is formed on the screen.

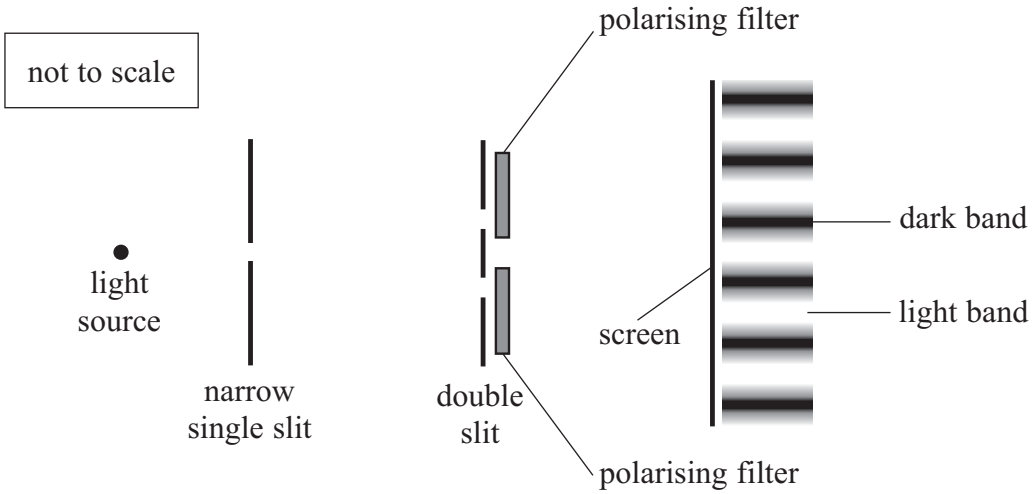


*(i) Explain how the dark and light bands are formed by light reaching the screen from the two slits of the double slit.

(3)

When in phase constructive superposition occurs. This causes light bands. When out of phase destructive superposition occurs. This causes dark bands.

(ii) Polarising filters are placed behind the slits as shown. When the planes of polarisation are parallel, the pattern of light and dark bands is still seen.



If one polarising filter is rotated through 90° there are no dark bands and the screen is illuminated evenly.

Explain why there are no dark bands when one filter has a plane of polarisation at 90° to that of the other filter.

(3)

Oscillations of light from the 2 filters are perpendicular to each other, so the waves do not interfere, so zero amplitude is impossible.

(Total for Question 17 = 12 marks)

18 When food is cooked in a microwave oven, microwave radiation is absorbed by water molecules, increasing the internal energy of the food.

(a) A student heats water in a microwave oven for 1 minute to determine the efficiency of the oven at transferring energy to the water. The current in the microwave oven is 5.0 A and the potential difference is 230 V. The increase in internal energy of the water is 29 000 J.

Calculate the efficiency of the microwave oven at heating the water.

(4)

W=VIt

230 x 5 x 60 = 69,000J

Efficiency = useful energy/total energy x 100

29,000/69,000 (x 100) = 0.42 or 42%

Efficiency = ...

(b) The photograph shows a microwave leakage detector.

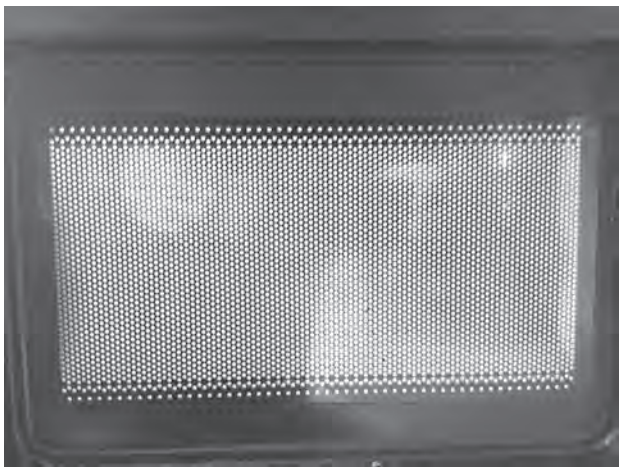
The detector is held next to the microwave oven to see if any microwave radiation is leaking to the surroundings.

Suggest why microwave radiation leaking to the surroundings could be dangerous to people.

(2)

The human body contains water, similar to most food. This means the cells may gain internal energy due to the increase in temperature.

(c) The internal walls of the microwave oven are solid metal. The photograph shows the door of a microwave oven.



The door consists of two sheets of glass with a layer of metal between. The layer of metal has many small holes in it, so that food inside the microwave oven may be seen while it is being heated without exposing the user to dangerous levels of microwave radiation. It has been suggested that, due to diffraction effects, light can pass through the holes but microwaves cannot.

(i) Explain what is meant by diffraction.

(2)

After passing through a small gap/slit the waves spread out.

(ii) Calculate the wavelength of the microwave radiation used in the oven.

microwave frequency = 2.5 GHz.

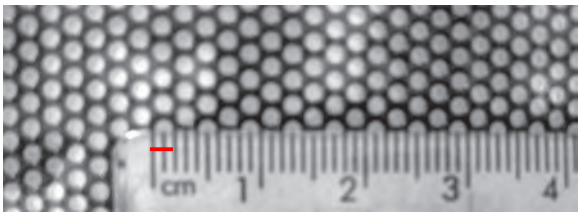
(2)

c=fλ where c is the speed of light

$\lambda = 3.0 \times 10^{8} / 2.5 \times 10^{9} = 1.12\text{m}$

Wavelength = ...

(iii) The photograph shows a section of the microwave oven door. Use the photograph to determine the diameter of the holes.



(1)

2mm

Diameter = ...

*(iv) Discuss the suggestion that, due to diffraction effects, light can pass through the holes but microwaves cannot.

(3)

Diffraction is greatest when λ=gap size.
Diameter of holes is greater than light λ, and diameter of holes is less than microwaves λ. So no diffraction takes place

(Total for Question 18 = 14 marks)

TOTAL FOR SECTION B = 70 MARKS

TOTAL FOR PAPER = 80 MARKS