OCR
Oxford Cambridge and RSA

AS Level Physics A

H156/02 Depth in physics

Friday 18 May 2018 – Morning

Time allowed: 1 hour 30 minutes

You must have:
- the Data, Formulae and Relationships Booklet (sent with general stationery)

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

First name										
Last name										
Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*****).
- This document consists of **20** pages.

Answer **all** the questions.

1 Fig. 1 shows how the velocity v of a car varies with time t as the car approaches a road junction.

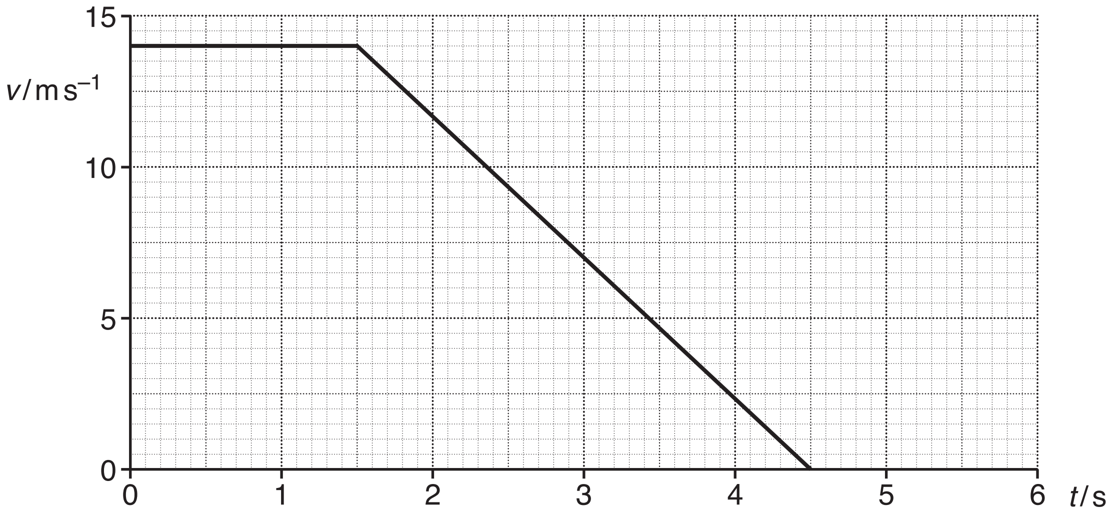

Fig. 1

(a) Explain what feature of the graph shows the deceleration of the car and that the deceleration is constant after 1.5 s.

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.... **[2]**

(b) The driver of the car applies the brakes at a distance of 20 m from the 'stop line' at the junction.

Calculate the distance s of the car relative to the stop line when the car comes to a stop.

s = ... m **[3]**

2* A student wishes to determine experimentally the efficiency of a small low-voltage DC motor. The motor is used to lift light loads.

Describe with the aid of a suitable diagram how an experiment to determine the efficiency of the electric motor can be safely conducted, and how the data can be analysed.

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.... **[6]**

3 A student is carrying out an experiment in the laboratory to determine the acceleration of free fall *g*. The student drops a small steel ball from rest and records the time *t* taken for the ball to fall through a vertical distance *h*.

The results for different vertical distances are shown in the table below.

h / m	t / s	t^2 / s^2
0.660	0.365	0.133
0.720	0.385	0.148
0.780	0.400	0.160
0.840	0.415	0.172
0.900	0.430	
0.960	0.445	0.198

(a) Describe and explain how the student could use standard laboratory equipment to make accurate measurements of *h* and *t*.

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.... **[4]**

(b) Complete the table for the missing value of t^2. **[1]**

(c) Fig. 3 shows the graph of t^2 (*y*-axis) against *h* (*x*-axis).

(i) Plot the missing data point and draw the straight line of best fit. **[2]**

(ii) Determine the gradient of the straight line of best fit.

gradient = ... $s^2\,m^{-1}$ **[1]**

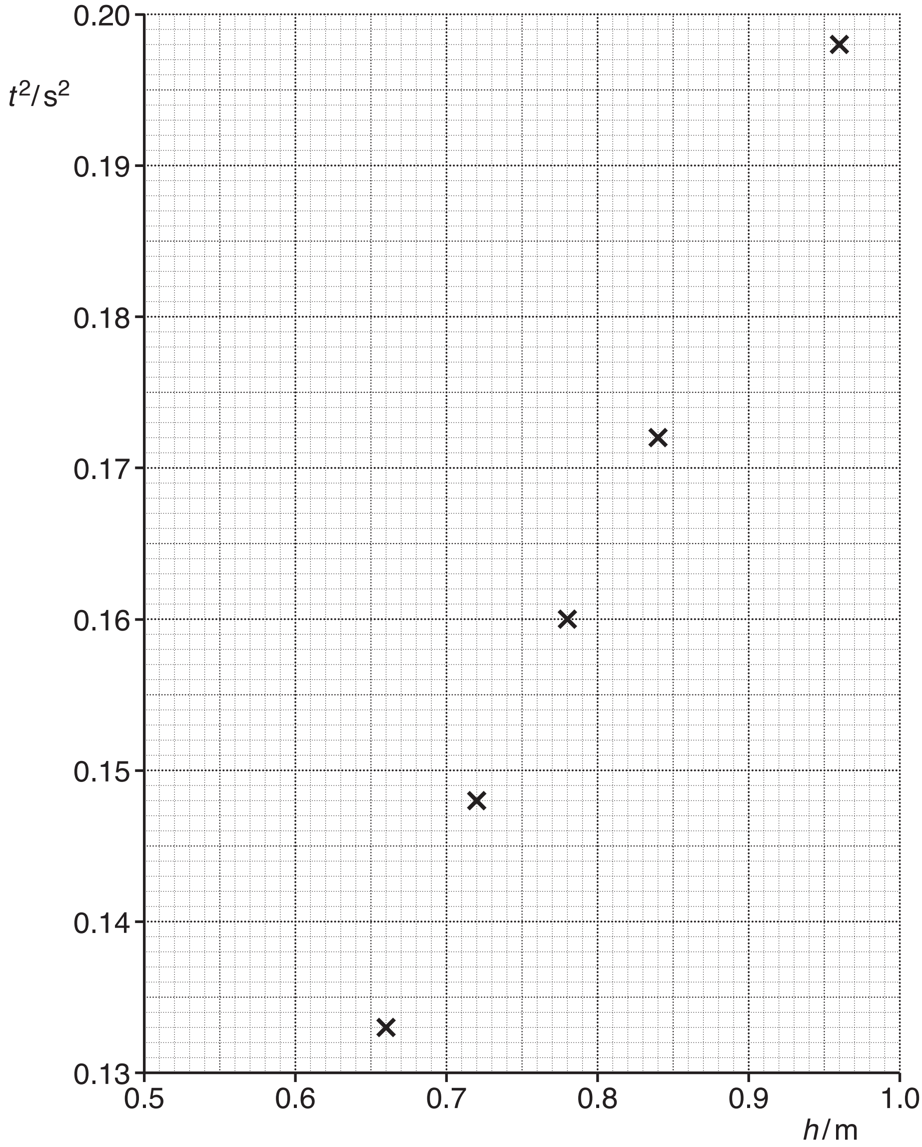

Fig. 3

(d) (i) Use the equations of motion for constant acceleration to show that the relationship between t and h is

$$t^2 = \left(\frac{2}{g}\right)h$$

where g is the acceleration of free fall.

[1]

(ii) Use your answer to **(c)(ii)** to determine the experimental value for g.

g = ... $m\,s^{-2}$ **[1]**

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4 An engineer is investigating the tension in a steel cable supporting a uniform wooden plank as shown in Fig. 4.

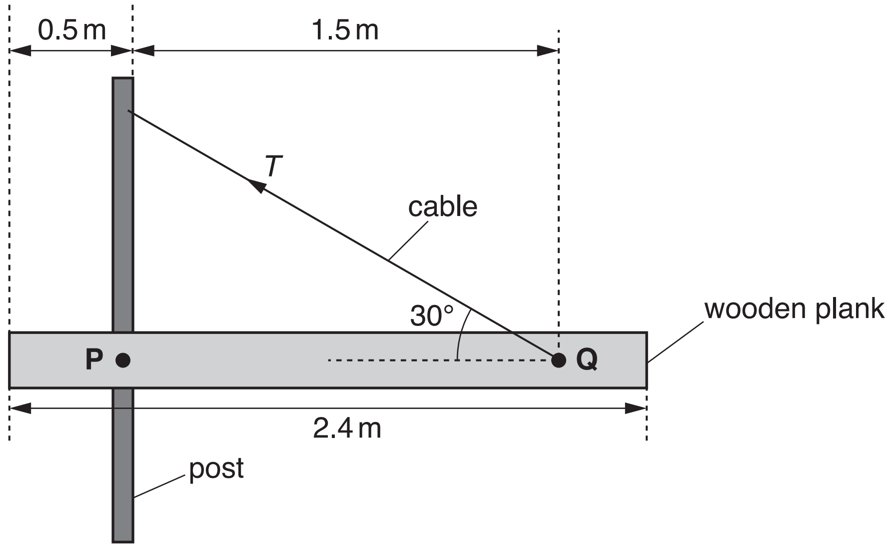

Fig. 4 (not to scale)

The plank is 2.4 m long and has a mass of 50 kg. It is pivoted at point **P** to a vertical post. The cable is fixed to the plank at point **Q** and to the vertical post as shown in Fig. 4. The cable is at an angle of 30° to the plank. The plank is in equilibrium and resting in a horizontal position.

(a) Show that the tension T in the cable is about 460 N.

[4]

(b) The original length of the steel cable is 1.73 m and it has a cross-sectional area of 11.0 mm^2.
The Young modulus of steel is 210 GPa.
Calculate the extension *x* of the cable shown in Fig. 4.

x = ... m **[3]**

Question 5 begins on page 10

5 **(a)** State *Newton's second law of motion*.

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.... **[1]**

(b) Fig. 5.1 shows a tennis ball before and after bouncing on the ground.

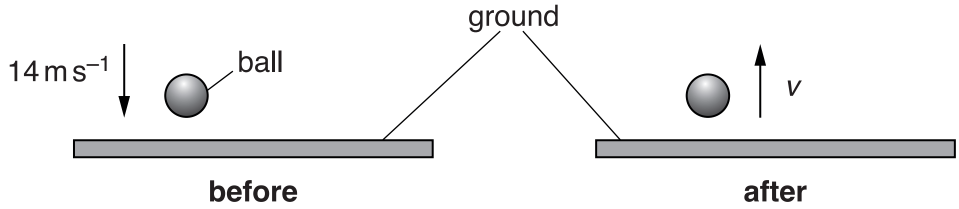

Fig. 5.1

The mass of the tennis ball is 0.062 kg. The tennis ball is slightly warmer after its collision with the ground.

(i) The tennis ball hits the ground at a speed of $14\,m\,s^{-1}$.
Calculate the momentum p of the tennis ball as it hits the ground.

p = ... Ns **[1]**

The force acting on the ball during collision with the ground is F.
Fig. 5.2 shows a graph of force F acting on the tennis ball against time t.

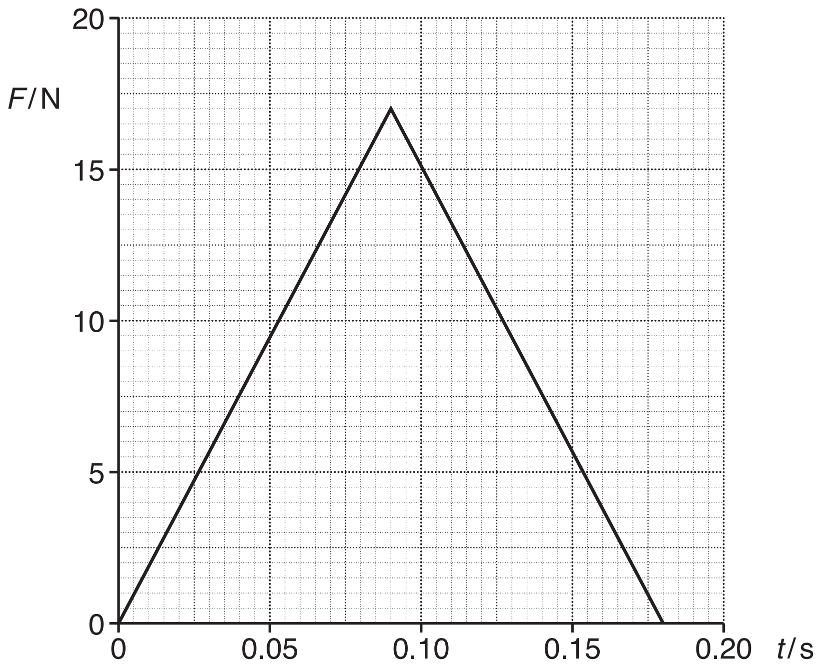

Fig. 5.2

The tennis ball is in contact with the ground for 0.18 s.

(ii) Determine the speed v of the tennis ball as it leaves the ground.

v = ... $m\,s^{-1}$ **[3]**

(iii) State what is meant by an elastic collision and explain how your answer to **(ii)** shows that this collision is **not** elastic.

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.... **[2]**

6 Fig. 6.1 shows the I–V characteristics for two electrical components **X** and **Y**.

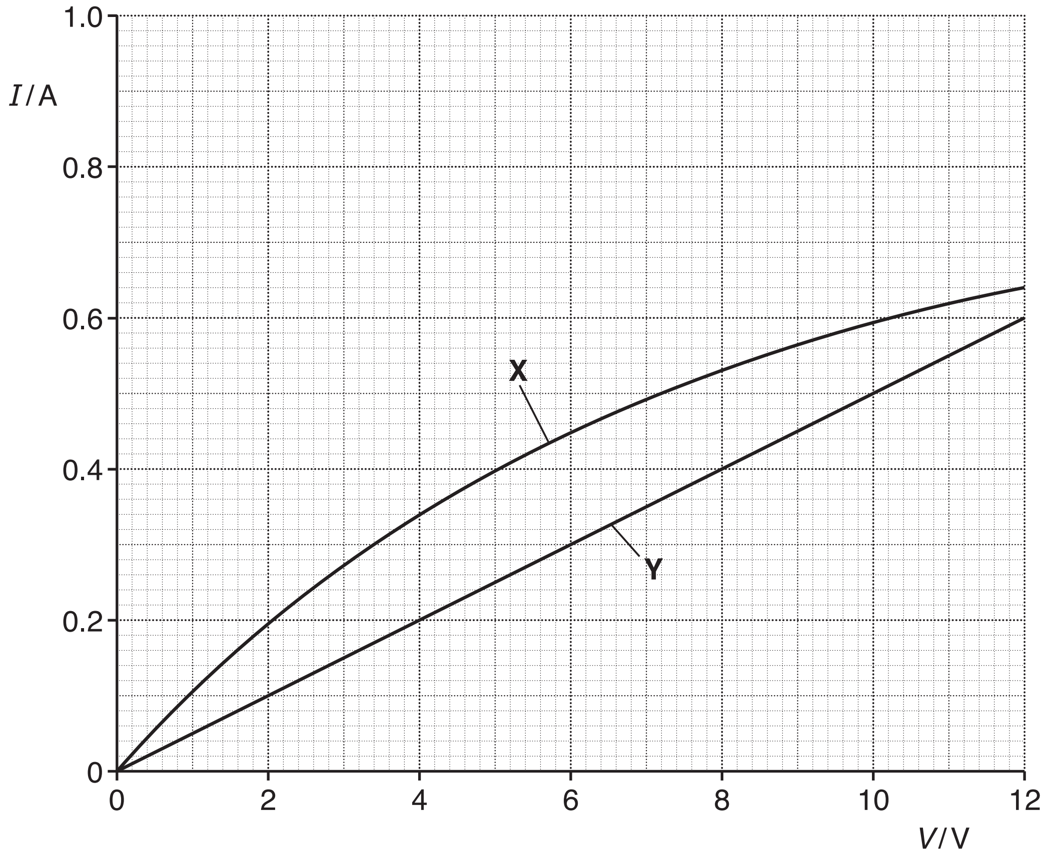

Fig. 6.1

(a) Suggest the two components **X** and **Y** that were used.

Name of component **X** ....

Name of component **Y** .... **[1]**

(b) Fig. 6.2 shows components **X** and **Y** connected in parallel to a battery of e.m.f. 9.6 V and internal resistance *r*.

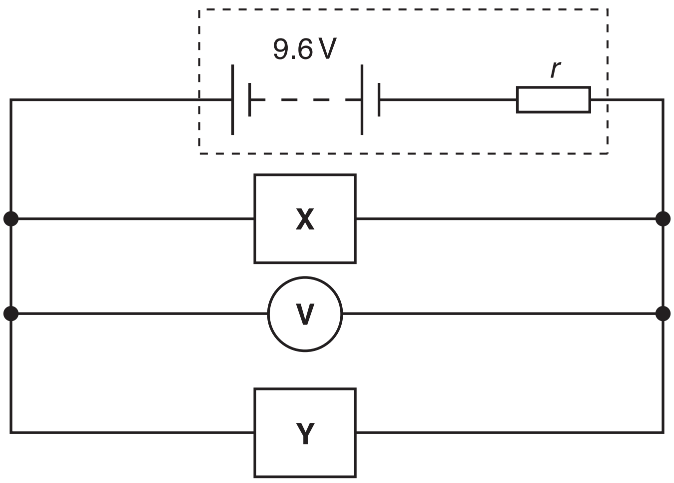

Fig. 6.2

The voltmeter reading is 7.2 V. Determine r.

r = ... Ω **[3]**

(c) A cable consists of 17 tightly packed copper wires, see Fig. 6.3.

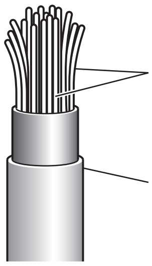

Fig. 6.3 (not to scale)

The student measures the diameter d of one of the copper wires as 0.12 ± 0.01 mm.

(i) Explain how the student should measure precisely the diameter of the wire.

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.... **[2]**

The student measures the resistance R of the whole **cable** as 1.86 ± 0.02 Ω.
The length L of the cable is 21.0 ± 0.1 m.

(ii) Determine the resistivity ρ of copper.

ρ = ... Ω m **[3]**

(iii) Determine the percentage uncertainty in ρ.

percentage uncertainty = ... % **[2]**

7 (a)* In an experiment to investigate microwaves, a microwave detector **D** is placed between a microwave transmitter **T** and a flat metal sheet.

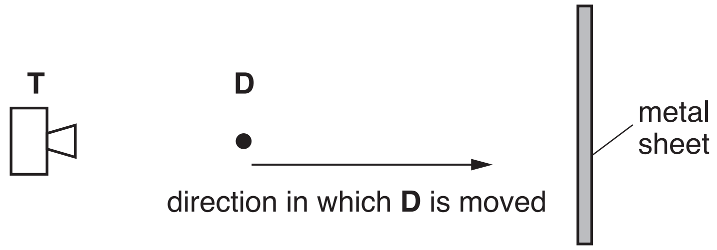

Fig. 7.1

The detected signal at **D** shows regions of maximum and minimum intensity as **D** is moved towards the metal sheet as shown in Fig. 7.1. The distance between **adjacent** regions of maximum and minimum intensities is 72 mm.

Explain the presence of the regions of maximum and minimum intensity **and** determine the frequency of the microwaves.
The speed of microwaves in air is $3.0 \times 10^8\,\mathrm{m\,s^{-1}}$. **[6]**

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(b) In another experiment using microwaves, a metal grille **G** consisting of a series of long metal rods is placed between the transmitter **T** and the detector **D** as shown in Fig. 7.2.

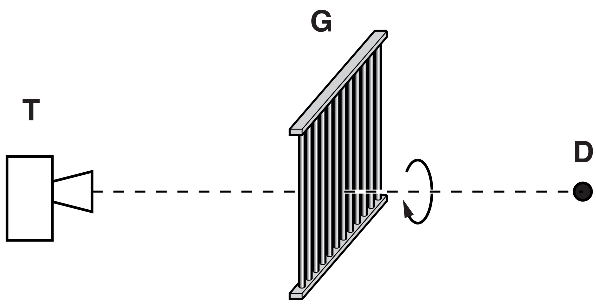

Fig. 7.2

The grille is slowly rotated through 180° about the line joining **T** and **D**. The detected signal at **D** varies from zero to maximum and back to zero again.

Explain why the detected signal behaves in this way.

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.... **[2]**

8 A student investigates the path of a light ray through ethanol. Fig. 8.1 shows ethanol in a rectangular glass container. Light of wavelength 5.2×10^{-7} m is incident on the container as shown.

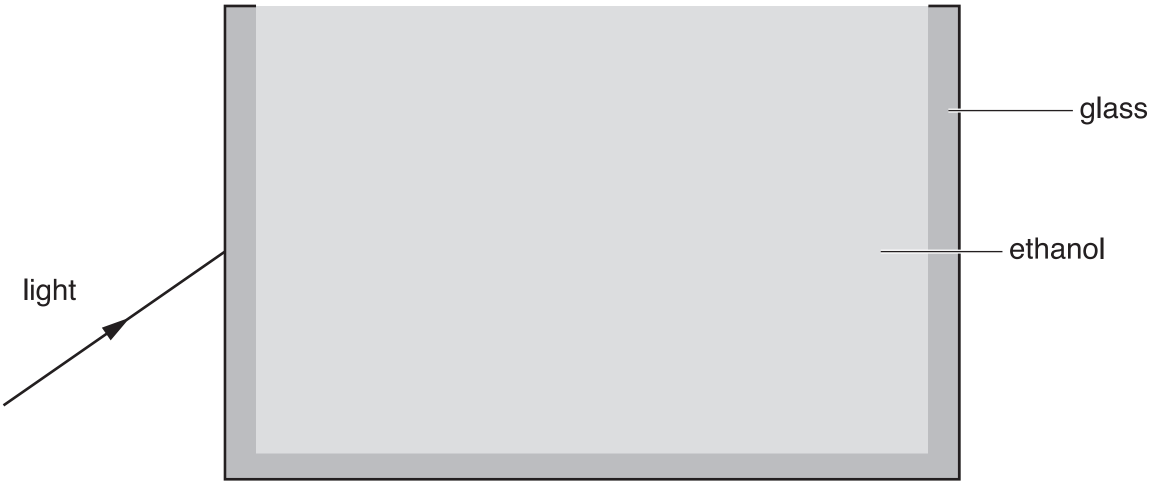

Fig. 8.1 (not to scale)

(a) The table below shows the refractive indices *n* and speeds of light *v* in various transparent media.

medium	***n***	v / m s^{-1}
air	1.00	3.00×10^8
ethanol		2.20×10^8
glass	1.52	
vacuum	1.00	3.00×10^8

(i) Complete the table by calculating the missing values of *n* and *v*. **[2]**

(ii) Determine the wavelength λ of the light in glass.

λ = ... m **[1]**

(b) Fig. 8.2 shows an enlarged version of a section of the left hand side of the glass container.

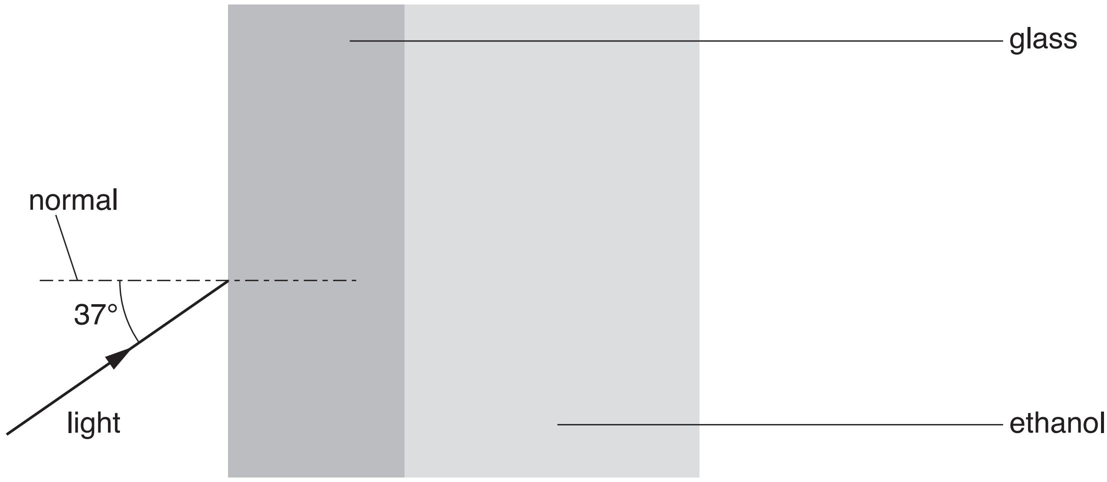

Fig. 8.2 (not to scale)

(i) The light is incident on the glass at an angle of 37°.
Determine the angle of refraction θ in the glass.

θ = ...° **[2]**

(ii) Without any further calculation, sketch the ray of light as it passes through the glass into the ethanol. **[1]**

9 Einstein derived the following equation to explain the photoelectric effect:

$$hf = \phi + KE_{max}$$

(a) Define the following terms from the equation

(i) *hf*

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.... **[1]**

(ii) ϕ

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.... **[1]**

(b) Electromagnetic radiation of frequency 1.2×10^{15} Hz is incident on the surface of a negatively charged aluminium plate. The work function of aluminium is 4.1 eV.

(i) Show that the maximum speed of the electrons emitted from the surface of the aluminium is $5.5 \times 10^{5}\,\text{m}\,\text{s}^{-1}$.

[4]

(ii) State and explain what change, if any, occurs to the maximum speed of the emitted electrons when the intensity of the electromagnetic radiation is increased.

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.... **[2]**

(c) Moving electrons have wave-like properties.
Calculate the de Broglie wavelength λ for electrons travelling at $5.5 \times 10^5\,m\,s^{-1}$.

λ = ... m **[2]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).