OCR
Oxford Cambridge and RSA

AS Level Physics B

H157/02 Physics in depth

Question Set 1

1 In a computer chip, the connections between the chip terminals and the semiconductor are thin gold wires.

Fig. 1 shows one gold wire and the section of silicon to which it is connected. The p.d.s V_1 and V_2 across the gold wire and the silicon section result in the current I shown.

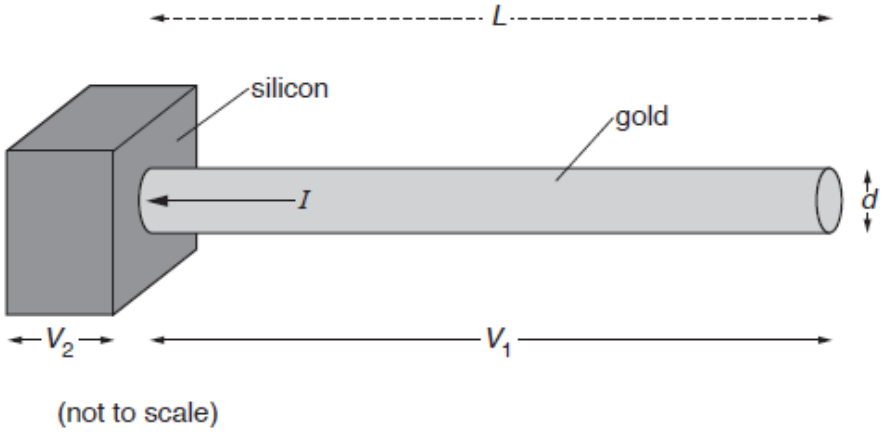

Fig. 1

(a) The gold wire has length $L = 3.2 \times 10^{-3}$ m and diameter $d = 2.0 \times 10^{-5}$ m. It carries a current $I = 4.5 \times 10^{-5}$ A.

Calculate the p.d. V_1 across the length L of wire.

resistivity of gold, $\rho = 2.3 \times 10^{-8}\ \Omega$ m

V_1 =..... V **[3]**

(b) The conductance of the silicon section, in the direction of current, is 1.7 mS.

Calculate the p.d. V_2 across the silicon section.

V_2 =..... V **[2]**

[Question total: 5]

2 **Fig. 2** shows a simple model of the structure of a metal.

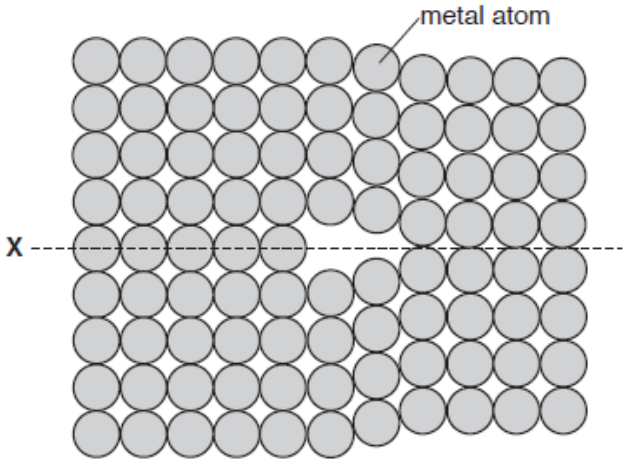

Fig. 2

(a) **(i)** Identify the structure marked **X.** **[1]**

(a) **(ii)** Explain how structure **X** makes the metal ductile.
You may wish to draw on **Fig. 2** to help your explanation. **[2]**

(b) A pure metal is alloyed by adding a small proportion of atoms of a different metal while themetal is molten. The alloy is often much stiffer and harder than the pure metal of **Fig. 2**.

Explain why alloying can produce these changes. **[2]**

[Question total: 5]

3 A book is held 25cm from an eye. This is the smallest distance from an object for which a normal eye can form a clear image.
Light is refracted by the cornea and the lens together, and a clear image is formed on the sensitive retina, 2.1cm behind the lens.
The ray diagram for this arrangement is shown in **Fig. 3**.

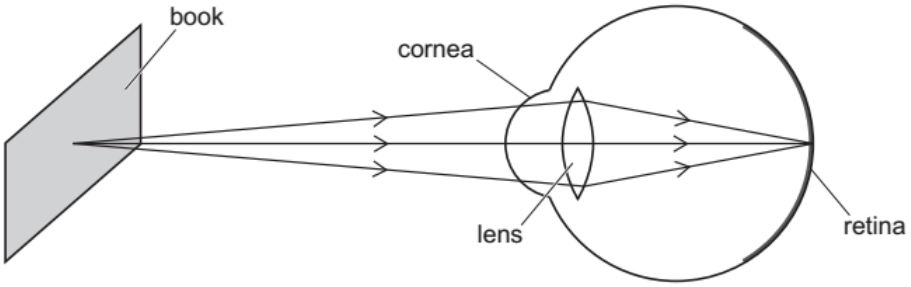

Fig. 3

(a) Calculate the power *P* of the combination of the cornea and the lens.

P =…….. D **[2]**

(b) The sensitive cells at the centre of the retina are separated by 2.5μm.
Calculate the distance *d* on the book that would correspond to this separation in the image on the retina.

d = …….m **[2]**

(c) A long-sighted person cannot focus on an object 25cm from the eye.
Carol is long-sighted and the closest object that forms a sharp image on her retina is 1.5m from the eye.

Explain why Carol has difficulty reading small print in a book when she is not using her glasses **[2]**

[Question total: 6]

4 A modern digital television has a screen measuring 1280 pixels by 720 pixels (**Fig. 4**).

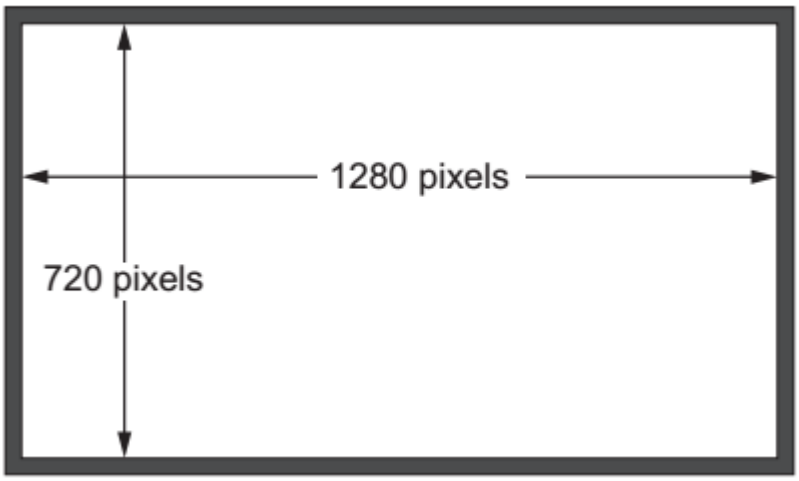

Fig. 4

(a) Each pixel is encoded by 3 bytes, one for each of the colours red, green and blue. A new image is displayed on the screen 30 times each second.

Calculate the number of gigabytes needed to encode a high-definition video lasting for one hour. You can assume that every pixel must be encoded every time a new image appears on the screen.

number =…….. GB **[2]**

(b) When this one-hour high-definition video is downloaded, it takes up 13GB on the digital storage. This value is much smaller than the value calculated in **(a)**.

Suggest and explain **one** reason for this. **[2]**

[Question total: 4]

5 **Fig. 5** shows a lift designed for a very tall building.
It consists of a 'cage' that can hold up to eight passengers. The total mass of the cage and passengers must not exceed 1200kg. The cage is supported by a steel cable of cross-sectional area $2.8 \times 10^{-3}\,m^2$ and density $7800kg\ m^{-3}$.

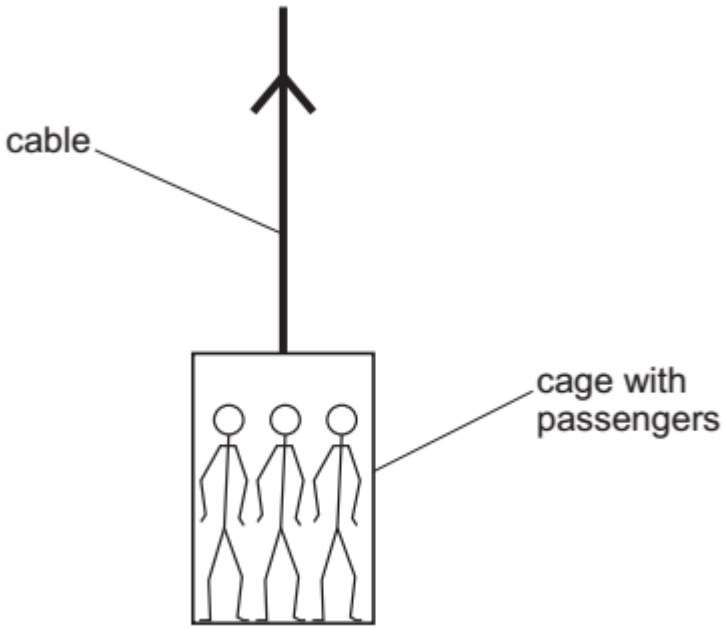

Fig. 5

(a) The lift cable is 420m long when completely unwound.
Calculate the tensile stress at the **top** of the cable, when it is completely unwound and supporting a fully-loaded cage.
$g = 9.8\ m\ s^{-2}$

$$\text{density } \rho = \frac{\text{mass}}{\text{volume}}$$

stress = …….. Pa **[3]**

(b) Explain why it is incorrect to use the value of the stress calculated in **(a)** and the equation $E = \frac{\text{stress}}{\text{strain}}$ to calculate the extension of the cable.

[2]

[Question total: 5]

6 **Fig. 6** is the stress-strain graph for a sample of steel which was extended until it fractured.

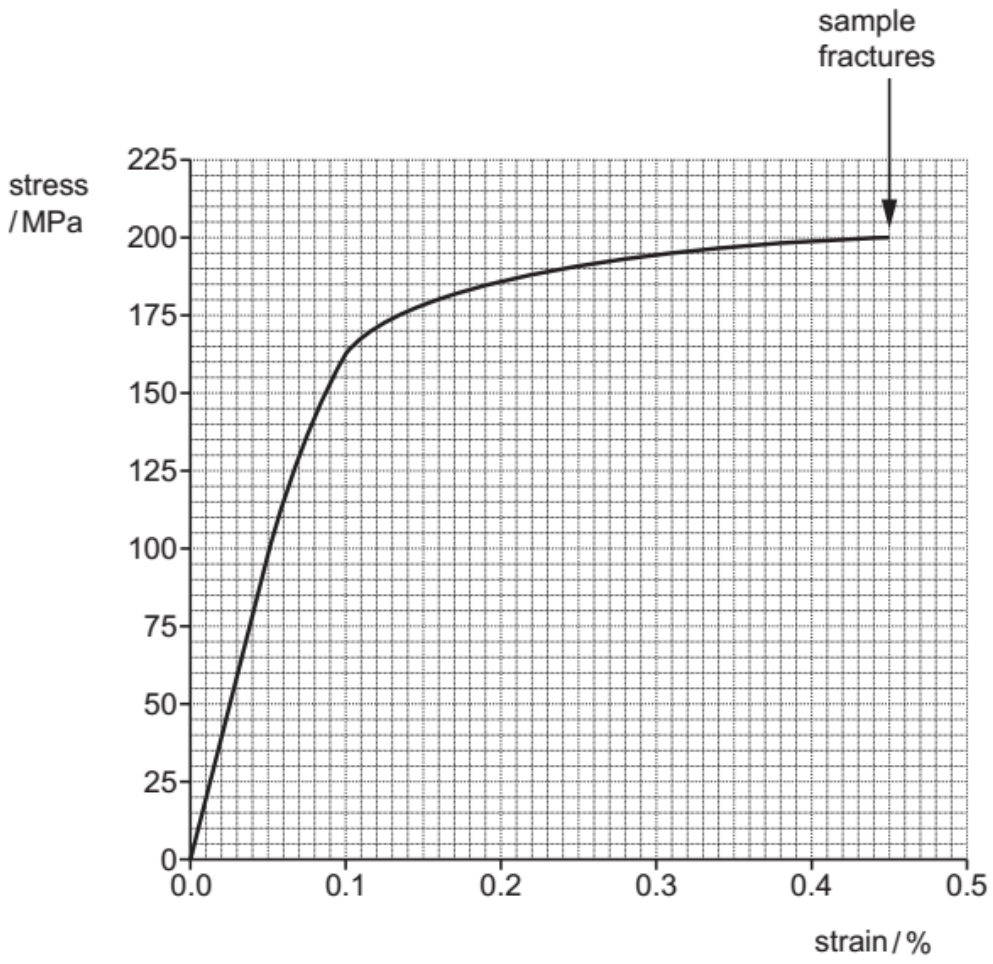

Fig. 6

The sample used to obtain these results was a cylindrical rod of length 31.0cm and diameter 13.0 mm.

Use these data, together with the graph, to make the following calculations. Show your working clearly in each case.

(a) Calculate the length of the rod just before fracture. Express your answer to 3 significant figures.

length = …….. cm **[2]**

(b) Calculate the force *F* that was required to produce a strain of 0.1%.

F = …… N **[3]**

(c) Calculate the Young modulus *E* for small strains.

E = …… Pa **[3]**

[Question total: 8]

7 The graph of **Fig. 7** shows the current in each of two different components **A** and **B** when potential differences from 0 to 7.0 V are applied across them.

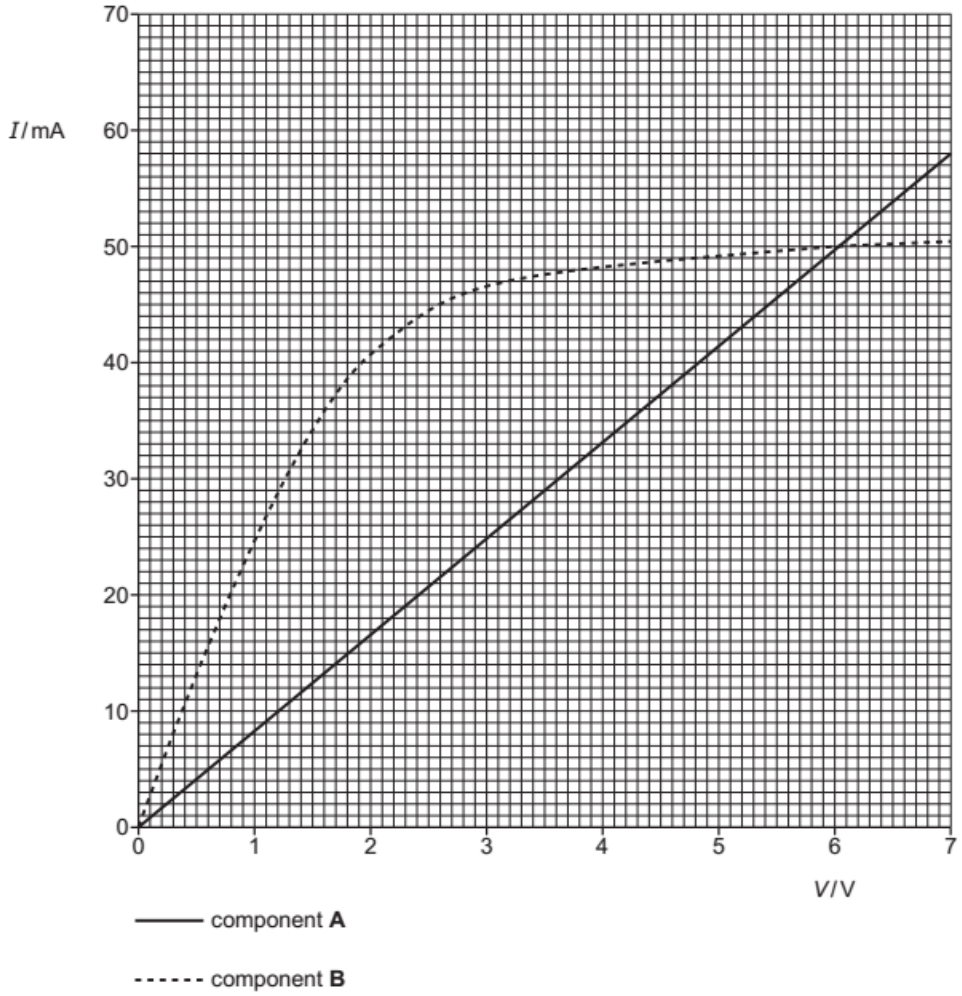

Fig. 7

(a) The two components are connected, in parallel, between the terminals of a battery of e.m.f. 3.0 V with negligible internal resistance.

Calculate the conductance of the parallel combination of **A** and **B** in this case. Show your working clearly.

conductance = ……S **[3]**

(b) **A** and **B** are now connected in series to a battery of e.m.f. 6.0 V with negligible internal resistance.

Explain why the graph of **Fig. 7** shows that the current through **A** and **B** must be about 36 mA. **[2]**

[Question total: 5]

Total Marks for Question Set 1: 38