Oxford Cambridge and RSA

AS Level Physics B

H157/02 Physics in depth

Question Set 4

1 This question is about the structure and properties of metals.

(a) **Fig. 1.1** shows one layer of the crystal structure of copper metal. The copper atoms are all spherical.

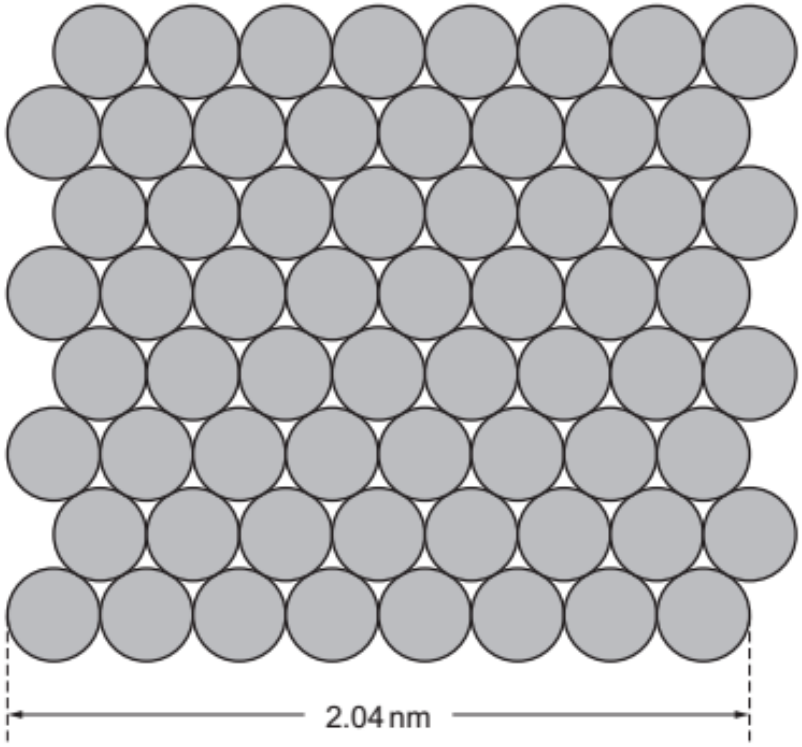


Fig. 1.1

The length of the bottom row of copper atoms was measured directly with a Scanning Tunneling Microscope.

(i) Use data from **Fig. 1.1** to show that the volume V of a copper atom is about 9×10^{-30} m^3. **[3]**

(ii) The mean molar mass of copper is 63.5g.
1 mole of copper = N_A atoms, where $N_A = 6.02 \times 10^{23}$ atoms mol^{-1}.

Calculate the mean mass m of a single copper atom.

m = ... kg **[2]**

(iii)

Density ρ is defined as the mass per unit volume of a material: $\rho = \frac{m}{V}$

Use the answers to **(i)** and **(ii)** to calculate the mean density of a copper atom.

mean density of a copper atom = ... kg m^{-3} **[1]**

(iv) The density of copper in the data book is 892 0kg m^{-3}.
Suggest and explain one reason for the difference between the value obtained in **(iii)** and the measured density of copper. **[2]**

(b)* One particular copper alloy consists of 95% copper and 5% zinc. The table compares the masses and sizes of the two atoms.

$\frac{\text{mass of zinc atom}}{\text{mass of copper atom}}$	$\frac{\text{diameter of zinc atom}}{\text{diameter of copper atom}}$
1.03	1.04

The structure of the alloy crystal is shown in **Fig. 1.2**.

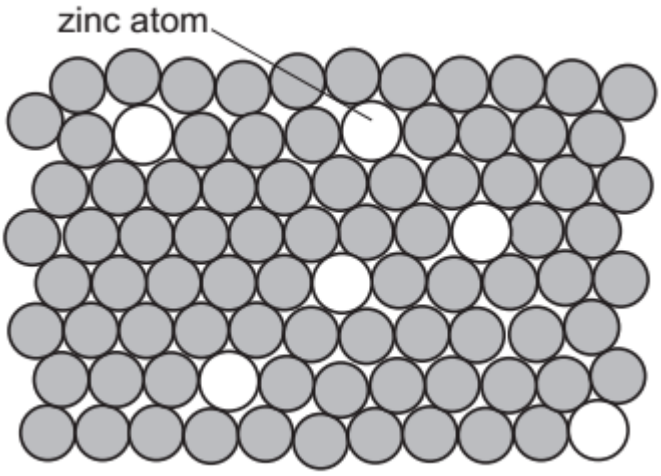


Fig. 1.2

This alloy is used to make coins.
Use the information from the table and **Fig. 1.2** to suggest and explain differences between the physical properties of copper and this alloy and suggest and explain how these differences make the alloy more suitable than copper for making coins. **[6]**

[Question total: 14]

2 Lizzie has bought a new lens for her camera. It is marked with the focal length 50mm (**Fig. 2.1**).
She wants to measure its focal length as accurately as possible to see if this value is correct.

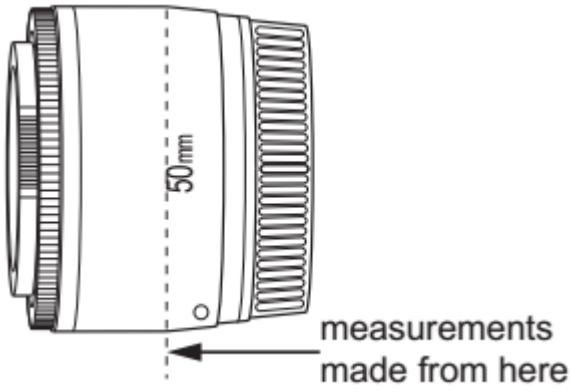


Fig. 2.1

(a) The lens is made up of several different parts fixed inside a plastic case, and Lizzie cannot tell exactly where the centre of the lens is. She decides to make measurements from the top of the '5' as shown.

Lizzie realises that measuring from this point may introduce a systematic error in her data. Explain the term *systematic error* and state how it will affect values of the object distance *u* and the image distance *v* that she obtains. **[3]**

(b) Lizzie uses the arrangement in **Fig. 2.2** to measure object (*u*) and image (*v*) distances.
As an object, she marks a black letter **X** on a thin sheet of paper.
The image is formed on a sheet of white card.

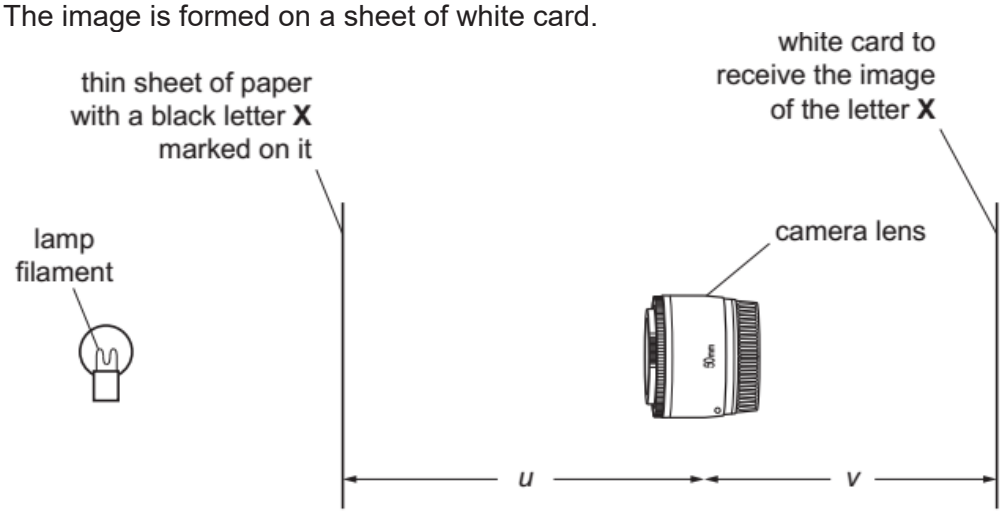


Fig. 2.2

Lizzie finds that a clear image can be seen on the white card over a range of values of *v*. She records this for four repeats at each chosen image position.
Here are her results for *u* = –37cm.

smallest *v*/cm	34	35	34	36
largest *v*/cm	41	41	40	42

Use these data to find the best estimate of *v* and Δ*v* for *u* = –37cm.
Explain your working.

v = ... ± ..... cm **[2]**

(c) (iii) Show that the lens equation for a converging lens of power *P* should result in a **[2]**

straight-line graph with gradient 1 and *y*-axis intercept *P* if

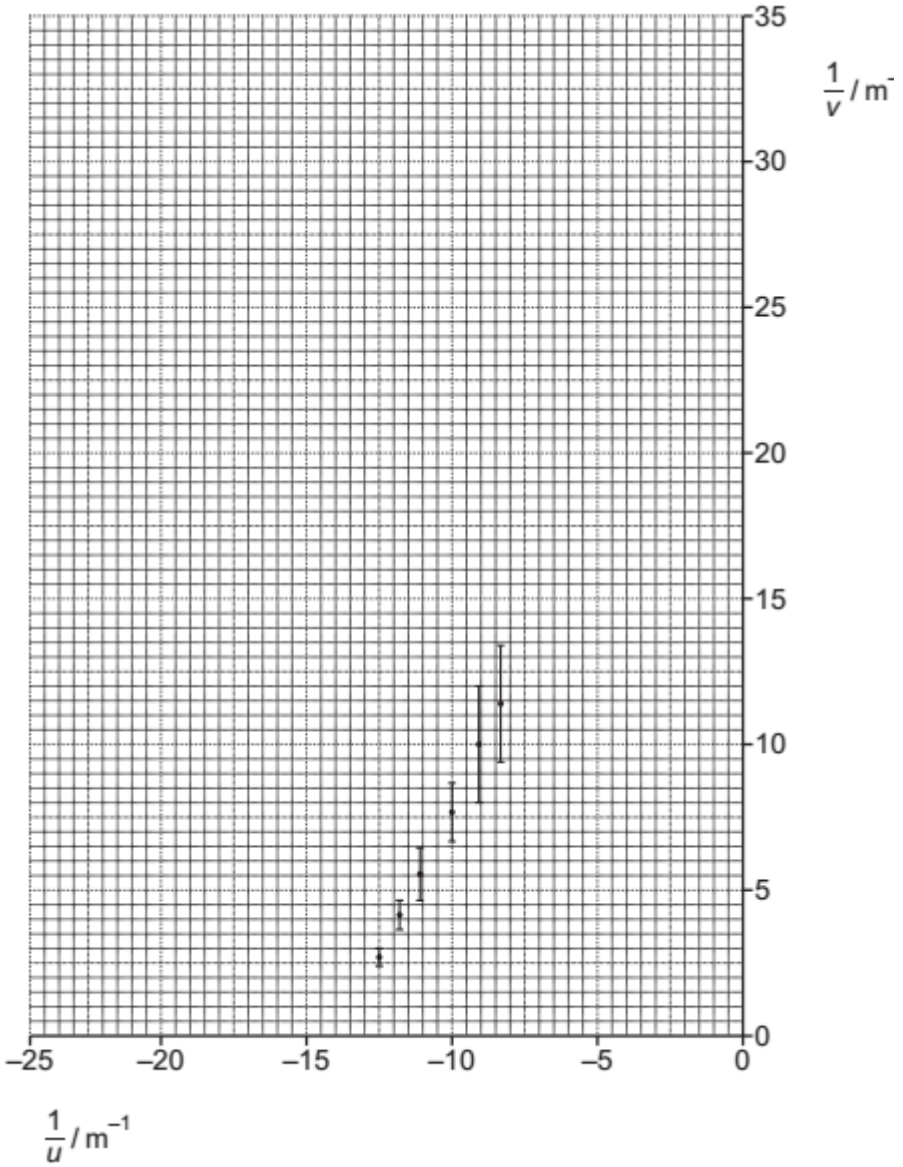
$\frac{1}{v}$ is plotted on the *y*-axis for a range of values of $\frac{1}{u}$ on the *x*-axis.

(d) In her experiment, Lizzie obtains the following set of values of *v* and Δv for each chosen value of *u*.

Complete the last two columns and plot the missing data on the graph following.

u/m	v/m	Δv/m	$\frac{1}{u}$/m^{-1}	$\frac{1}{v}$/m^{-1}	$\Delta\left(\frac{1}{v}\right)$/m^{-1}
–0.080	0.37	0.04	–12.5	2.70	0.3
–0.085	0.24	0.03	–11.8	4.17	0.5
–0.090	0.18	0.03	–11.1	5.55	0.9
–0.10	0.13	0.02	–10.0	7.69	1
–0.11	0.10	0.02	–9.09	10.0	2
–0.12	0.088	0.01	–8.33	11.4	2
–0.14	0.072	0.008	–7.14		
–0.16	0.063	0.007	–6.25		

[3]



(**e)*** Use the graph to find the maximum and minimum values of the gradient and the *y*-axis intercept and to evaluate the findings of the experiment. There is lined answer space for your evaluation on the following page. **[6]**

[Question total: 16]

Total Marks for Question Set 4: 30

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