A Level Physics A

H556/03 Unified physics

Question Set 3

1 A student is investigating how the discharge of a capacitor through a resistor depends on the resistance of the resistor.
The equipment is set up as shown in Fig. 3.1.

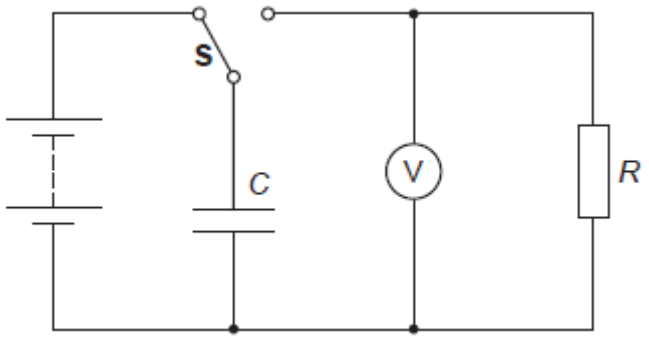

Fig. 3.1

The student charges the capacitor of capacitance C and then discharges it through a resistor of resistance R using switch **S**. After a time t = 15.0 s the student records the potential difference V across the capacitor. The student repeats this procedure for different values of R.

It is suggested that V and R are related by the equation

$$V = V_0 e^{-\frac{t}{CR}}$$

where V_0 is the initial potential difference across the capacitor and t is the time over which the capacitor has discharged.

(a)
The student decides to plot a graph of ln (V/V) on the y-axis against $\frac{1}{R}$ on the x-axis to obtain a straight line graph. Show that the magnitude of the gradient is equal to $\frac{15}{C}$. **[2]**

(b) Values of R and V at t = 15.0 s are given in the table below.

R/kΩ	V/V	$\left(\frac{1}{R}\right)$/10^{-6} Ω^{-1}	ln (V/V)
56	3.0 ± 0.2	18	
68	3.7 ± 0.2	15	1.31 ± 0.06
100	5.0 ± 0.2	10	1.61 ± 0.04
150	6.4 ± 0.2	6.7	1.86 ± 0.03
220	7.3 ± 0.2	4.5	1.99 ± 0.03
330	8.1 ± 0.2	3.0	2.09 ± 0.03

(i) Complete the missing value of ln (V/V) and its absolute uncertainty in the table above. **[1]**

(ii) Use the data to complete the graph of Fig. 3.2. Four of the six points have been plotted for you. **[2]**

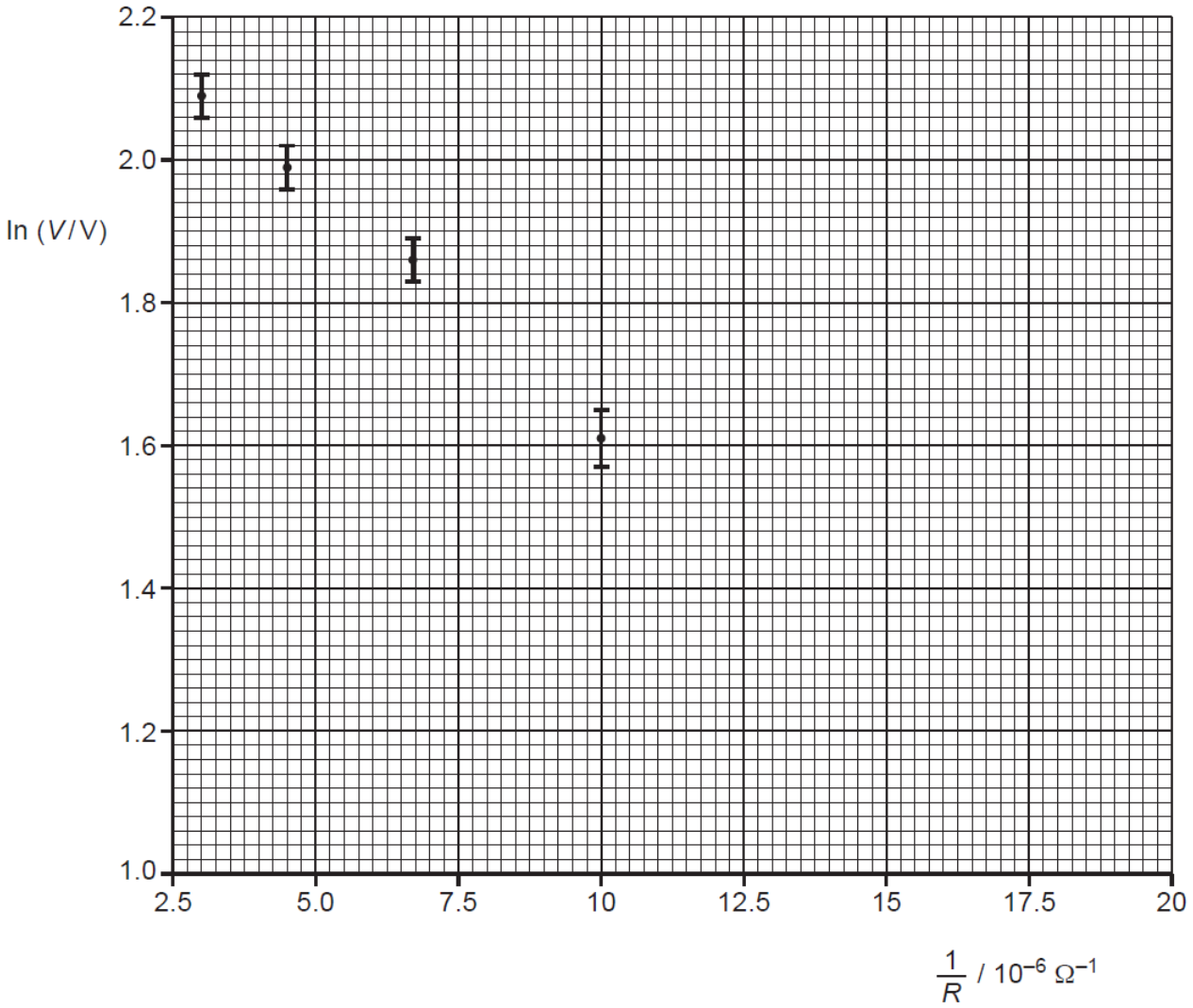

Fig. 3.2

(iii) Use the graph to determine a value for C. Include the absolute uncertainty and an appropriate unit in your answer.

C = ... ± ..... unit..... **[4]**

(c) Determine the value of R, in kΩ, for which the capacitor discharges to 10% of its original potential difference in 15.0 s. Show your working.

R = ...kΩ **[2]**

Total Marks for Question Set 3: 11