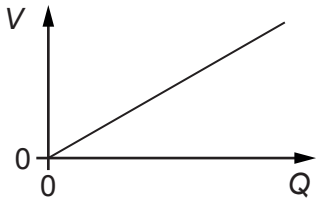
7 The graph below shows the variation of potential difference V with charge Q for a capacitor.



Which row is correct for the gradient of the graph and the area under the graph?

	Gradient of graph	Area under the graph
A	capacitance^{-1}	work done
B	capacitance^{-1}	permittivity
C	capacitance	power
D	capacitance	energy

Your answer ☐ **[1]**

8 A capacitor discharges through a resistor. At time $t = 0$, the charge stored by the capacitor is 600 μC. The capacitor loses 5.0 % of its charge every second.

What is the charge **left** on the capacitor at time $t = 4.0$ s?

A 111 μC

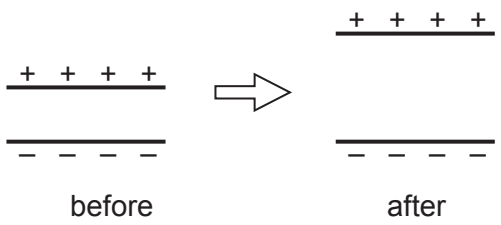
B 120 μC

C 480 μC

D 489 μC

Your answer ☐ **[1]**

9 Two isolated parallel capacitor plates have an equal and opposite charge.
The separation between the plates is doubled.
The charge on each plate remains the same but the potential difference between the plates doubles.



Which statement is correct?

A The capacitance of the capacitor doubles.

B The energy stored by the capacitor is halved.

C The permittivity of free space doubles.

D The electric field strength between the plates remains the same.

Your answer ☐ **[1]**

[1]

21 **(a)** A capacitor of capacitance 7.2 pF consists of two parallel metal plates separated by an insulator of thickness 1.2 mm. The area of overlap between the plates is $4.0 \times 10^{-4}\,m^2$. Calculate the permittivity of the insulator between the capacitor plates.

permittivity = ... $F\,m^{-1}$ **[2]**

(b) Fig. 21 shows a circuit.

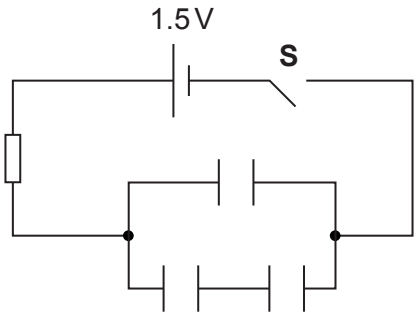


Fig. 21

The capacitance of each capacitor is 1000 μF. The resistance of the resistor is 10 kΩ. The cell has e.m.f. 1.5 V and negligible internal resistance.

(i) Calculate the total capacitance *C* in the circuit.

C = ... μF **[2]**

(ii) The switch **S** is closed at time $t = 0$. There is zero potential difference across the capacitors at $t = 0$.
Calculate the potential difference V across the resistor at time $t = 12\,\text{s}$.

$V =$ ..... V **[2]**

3 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.

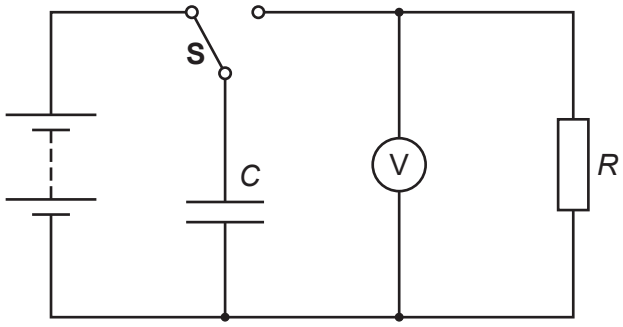


Fig. 3.1

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]**

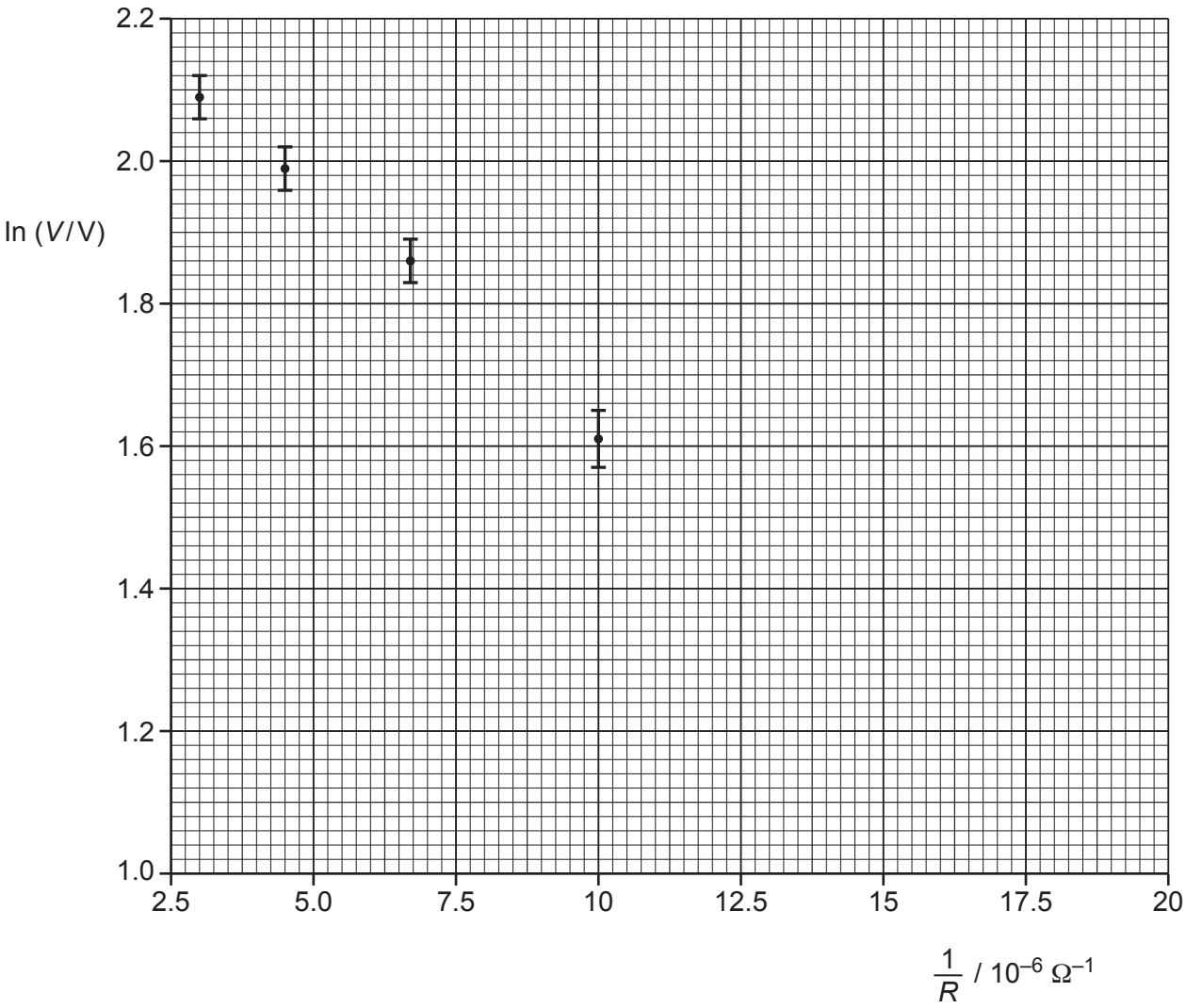


Fig. 3.2

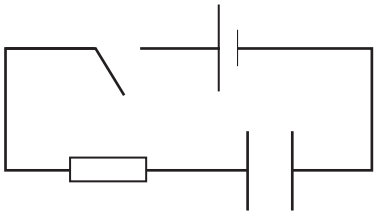
(iii) Use the graph to determine a value for *C*. Include the absolute uncertainty and an appropriate unit in your answer.

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]**

9 A capacitor is charged through a resistor.



The cell has e.m.f. 1.50 V and negligible internal resistance.
The capacitor is initially uncharged. The time constant of the circuit is 100 s.
The switch is closed at time $t = 0$.

What is the potential difference across the capacitor at time $t = 200$ s?

A 0.20 V

B 0.55 V

C 0.95 V

D 1.30 V

Your answer ☐ **[1]**

22 A student wishes to determine the permittivity ε of paper using a capacitor made in the laboratory.

The capacitor consists of two large parallel aluminium plates separated by a very thin sheet of paper.

The capacitor is initially charged to a potential difference V_0 using a battery. The capacitor is then discharged through a fixed resistor of resistance 1.0 MΩ.

The potential difference V across the capacitor after a time t is recorded by a data-logger. The student uses the data to draw the ln$V$ against t graph shown in Fig. 22.

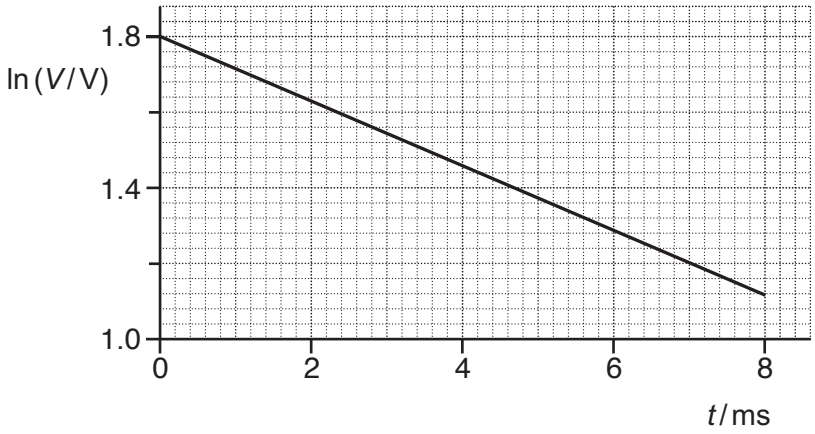


Fig. 22

(a) Show that the magnitude of the gradient of the line shown in Fig. 22 is equal to

$$\frac{1}{CR}$$

where C is the capacitance of the capacitor and R is the resistance of the resistor.

[2]

(b)* Use Fig. 22 to determine the capacitance C of the capacitor. Describe how the student can then use this value of C to determine a value for ε.
In your description, mention any additional measurements required on the capacitor.

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