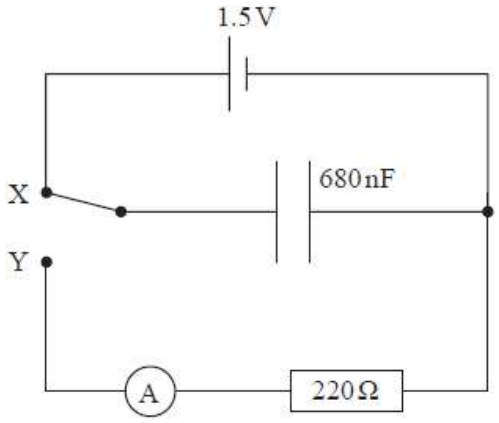
Capacitance - Questions by Topic

Q1.

A capacitor can be charged and discharged using the following circuit. It can be assumed that the ammeter has zero resistance.



(a) Initially the switch makes contact at X.
Calculate the charge stored by the capacitor when it is fully charged.

(2)

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Charge = ...

(b) The switch is moved to make contact at Y so that the fully charged capacitor is discharged through the 220 Ω resistor.

Calculate the charge remaining on the capacitor after it has been discharging for 1.0 ms and comment on your answer.

(4)

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Charge = ...

Comment

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(c) The capacitor is charged and discharged 500 times per second.

Calculate the average current through the ammeter.

(2)

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Average current = ...

(Total for question = 8 marks)

Q2.

The unit for capacitance is the farad.
The farad can also be written as

- ☒ **A** A s V^{-1}
- ☒ **B** A $s^{-1}V^{-1}$
- ☒ **C** A^{-1} $s^{-1}V$
- ☒ **D** A^{-1} s V

(Total for question = 1 mark)

Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A charged capacitor of capacitance 10 μF discharges through a resistor of resistance 10 kΩ.

After time *t*, 10% of the original charge remains on the capacitor.

Which of the following gives the value of *t* in seconds?

☐ **A** –100 × ln 0.90

☐ **B** –0.1 × ln 0.90

☐ **C** –100 × ln 0.10

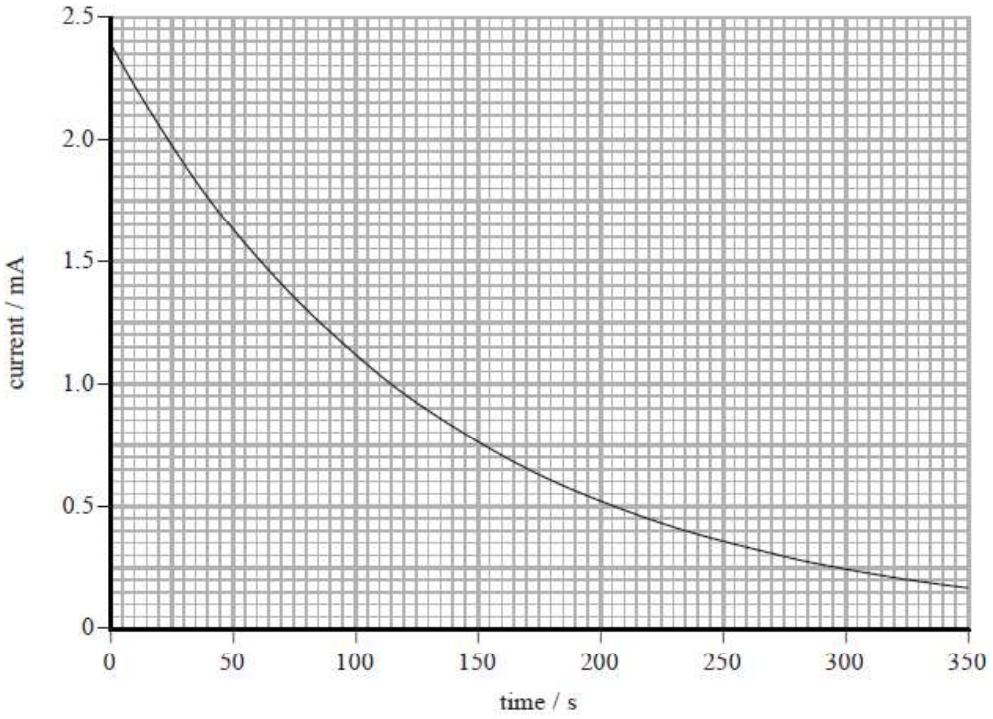
☐ **D** –0.1 × ln 0.10

(Total for question = 1 mark)

Q4.

A timer circuit includes a capacitor and a variable resistor in series.

(a) The graph shows how the current in the timer circuit varies with time when the capacitor discharges through the variable resistor. The resistance of the variable resistor is 8.2 kΩ.



(i) Show that the capacitance of the capacitor is about 0.02 F.

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(ii) Calculate the initial charge on the capacitor.

(3)

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Initial charge = ...

(iii) Calculate the energy initially stored in the capacitor.

(2)

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Energy = ...

(b) In another timer circuit the capacitance of the capacitor is 470 μF. The circuit switches off when the potential difference falls to 15% of its initial value. The variable resistor is adjusted so that the timer circuit switches off after 3.5 minutes.

Calculate the resistance of the variable resistor.

(3)

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Resistance = ...

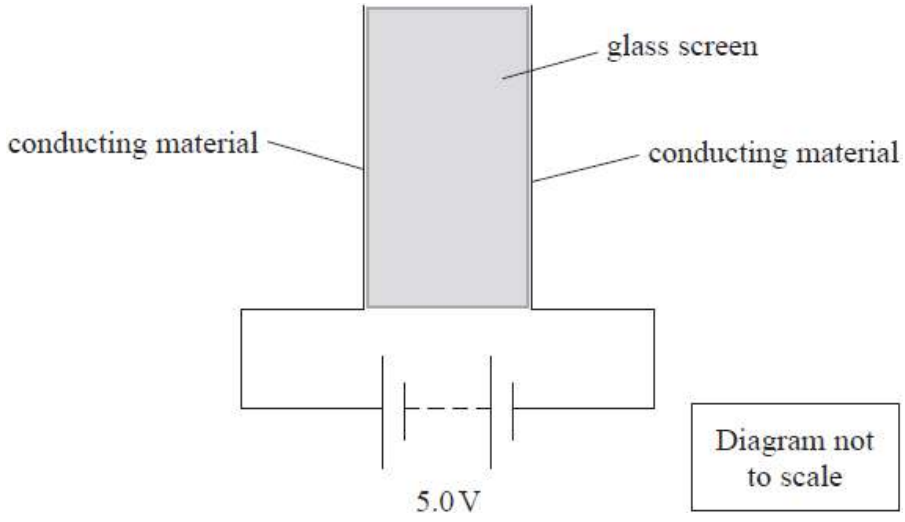
(Total for question = 11 marks)

Q5.

Most mobile phones have touch screens allowing a finger to select different functions.

A web site explains how this works with a simplified model.

The glass screen is coated on both sides with a conducting material, so that it forms a capacitor. A potential difference (p.d.) of 5.0 V is applied across the two sides.



(a) Add to the diagram to show the electric field between the two sides.

(3)

(b) The arrangement has a capacitance of 12 pF.

Calculate the energy stored on the capacitor.

(2)

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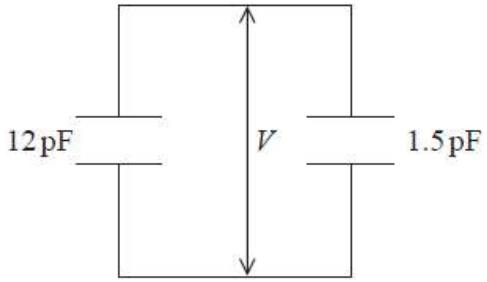
Energy stored = ...

In normal use, the capacitor is then disconnected from the power supply but the charge that gave a p.d. of 5.0 V is left on the capacitor. When the finger touches the screen, the effect is as if a "finger capacitor" of 1.5 pF has been connected to the original capacitor, forming the circuit shown.



Some charge flows from the charged capacitor to the finger capacitor, reducing the p.d. to the same value *V* across both capacitors.

Calculate *V*.

(3)

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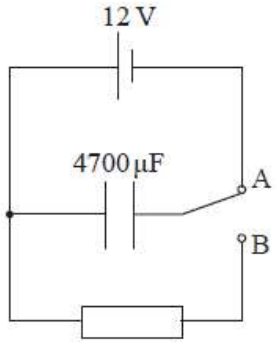
V = ...

(Total for question = 8 marks)

Q6.

Some lights are designed to dim gradually after being switched off. This can be done using a capacitor in a timer circuit.

The circuit diagram shows how a potential difference (p.d.) can be supplied across a resistor for a limited time.



*(a) When the switch is at position A, the capacitor charges.

(i) In terms of the movement of electrons, explain what happens to the capacitor as it becomes fully charged.

(2)

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(ii) Calculate the energy stored in the charged capacitor.

(2)

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Energy = ...

*(b) The switch is moved to position B and the capacitor discharges through the resistor.

(i) Describe what happens to the current through the resistor.

(2)

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(ii) For the circuit shown, the p.d. across the capacitor falls to 10% of the supply p.d. after 25 s.

Calculate the resistance of the resistor in the circuit.

(3)

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Resistance = ...

(Total for question = 9 marks)

Q7.

Two capacitors of capacitance 1000 μF and 10 μF are charged so that they store the same amount of energy. The potential difference (p.d.) across the 1000 μF capacitor is V_1 and the p.d. across the 10 μF capacitor is V_2.

The value of $\left(\frac{V_1}{V_2}\right)^2$ is

☐ **A** 1×10^{-4}

☐ **B** 1×10^{-2}

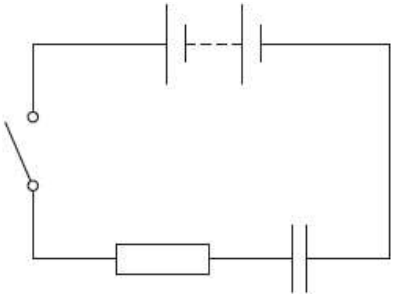
☐ **C** 1×10^{2}

☐ **D** 1×10^{4}

(Total for question = 1 mark)

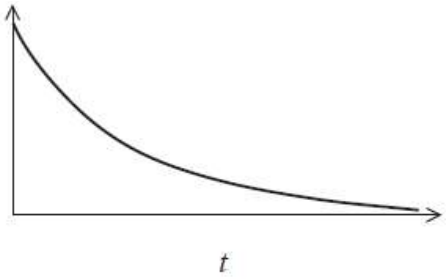
Q8.

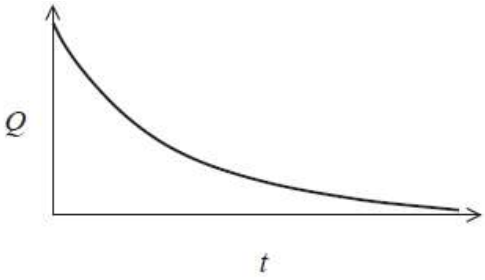
The following circuit is used to charge a capacitor.



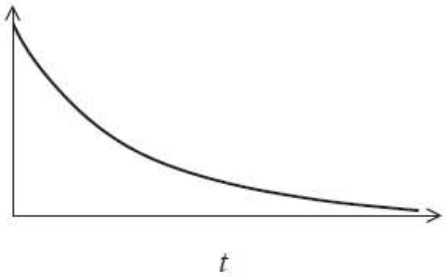
Which of the following pairs of graphs shows the variation of the current *I* in the resistor with time *t* and the variation of charge *Q* stored on the capacitor with *t*?

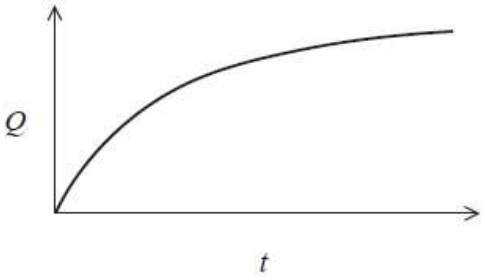
☐ **A**



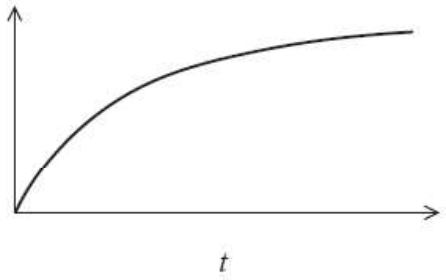


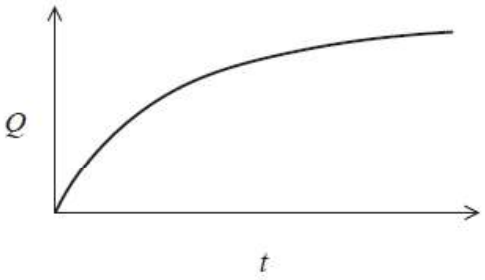
☐ **B**



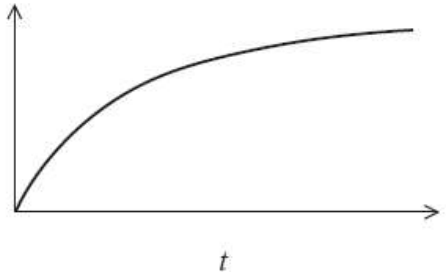


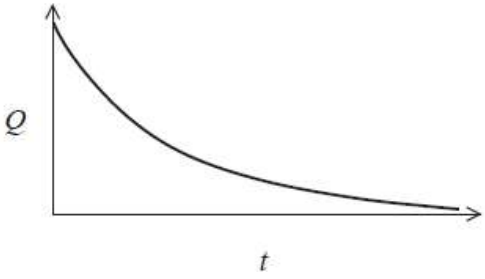
☐ **C**





☐ **D**



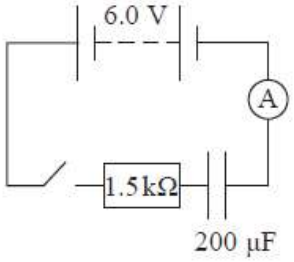


(Total for question = 1 mark)

Q9.

A student was investigating the charge and discharge of a capacitor.

He set up the following circuit.



(a) Calculate the time constant for the circuit.

(2)

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Time constant = ...

(b) The student wanted to plot a current-time graph as the capacitor charged, but found that the current changed too rapidly for him to take readings.

Instead, he modelled the experiment using a spreadsheet. The switch was closed at time $t = 0$ s. V is the potential difference across the capacitor.

	A	B	C	D	E
1	t/s	I/mA	ΔQ/μC	Q/μC	V/V
3	0.0	4.00	400	400	2.00
4	0.1	2.67	267	667	3.33
5	0.2	1.78	178	844	4.22
6	0.3	1.19	119	963	4.81
7	0.4	0.79	79	1042	5.21
8	0.5	0.53	53	1095	5.47
9	0.6	0.35	35	1130	5.65
10	0.7	0.23	23	1153	5.77
11	0.8	0.16	16	1169	5.84
12	0.9	0.10	10	1179	5.90
13	1.0	0.07	7	1186	5.93

Explain how the value in cell B5 is calculated.

(2)

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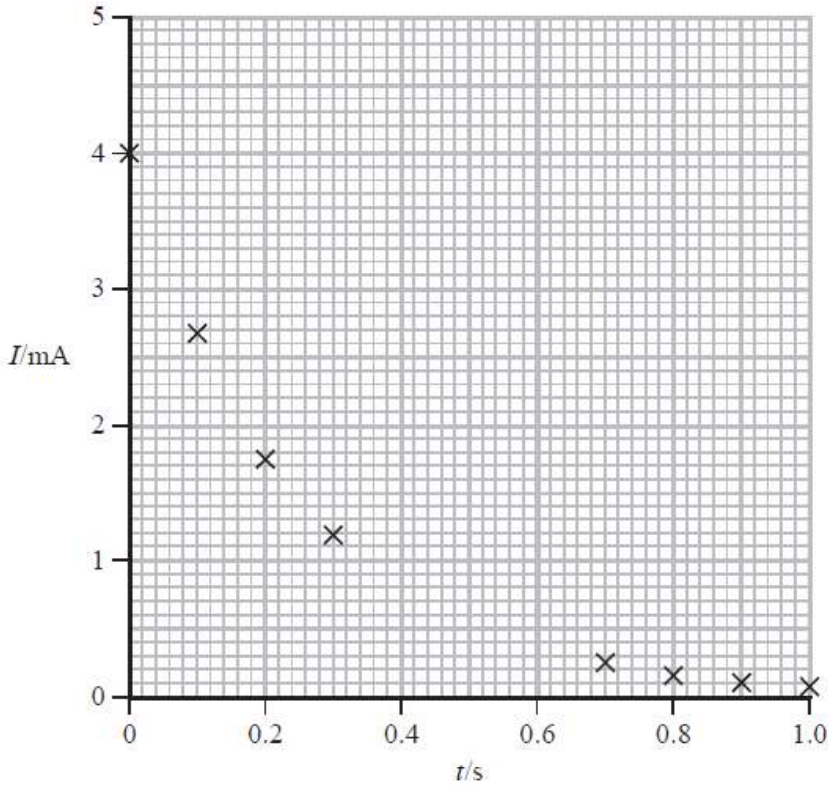
(c) Some of the data from the spreadsheet has been plotted on a graph of current *I* against time *t*.



(i) Plot the missing points and draw a line of best fit.

(2)

(ii) Use the graph to determine a second value for the time constant.

(2)

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Time constant = ...

(iii) Suggest how the student might change his spreadsheet to give a more accurate model of the charging of the capacitor.

(1)

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*(d) An alternative method of determining the time constant is to use a straight line graph.

State and explain the variables that the student should plot and how he should determine the time constant from this graph.

(3)

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(Total for question 12 marks)

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Q10.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

A potential difference V is applied across two identical capacitors of capacitance C connected in series.

Which of the following expressions is the total energy stored on the capacitors?

☐ **A** $\frac{1}{4}CV^2$

☐ **B** $\frac{1}{2}CV^2$

☐ **C** CV^2

☐ **D** $2CV^2$

(Total for question = 1 mark)