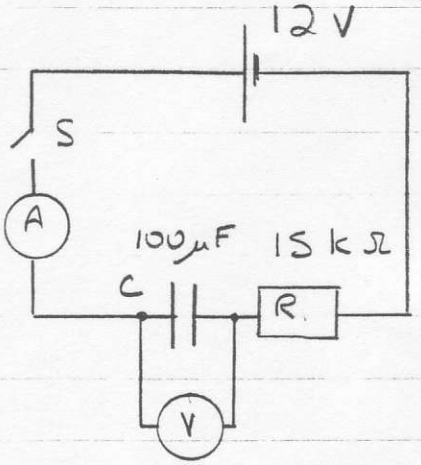
# Capacitors - Topic Test

A level Physics

1. Explain fully the meaning, with definitions, of...
   (a) Capacitance (3)
   (b) Time constant (3)

[6]

2. In the circuit shown → switch S is closed, with C uncharged. What are ...

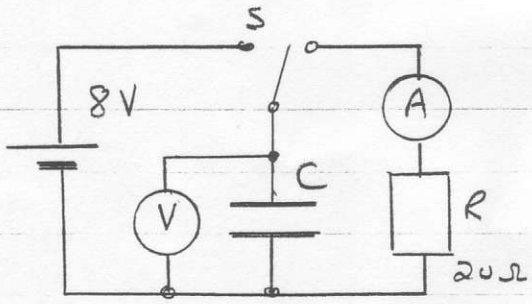



   (a) initial and final current values? (3)
   (b) initial and final voltmeter readings? (2)
   (c) What is the time constant of the circuit? (2)

   Sketch graphs to show how...
   (d) current changes with time (4)
   (e) voltage across C changes with time (4)
   (f) what does the area under the I/t curve show? (1)

[16]

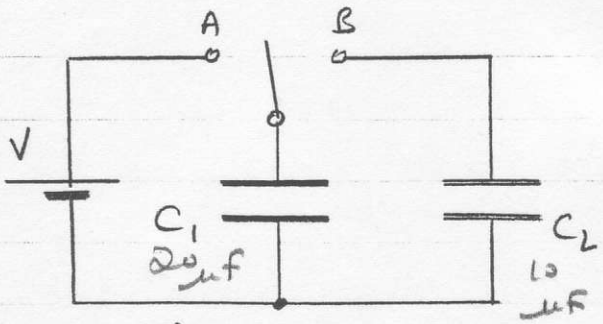
3. The reed switch S operates at 250 Hz. The ammeter shows a current of 120 mA is flowing through it.




   (a) What is the value of C? (3)
   (b) The student doubles the resistance, and notices the current falls. Explain why this happens. (2)

[5]

4. The switch is moved to A.
   (a) Calculate the charge and energy stored in C1 (4)
   The switch is moved to B.
   (b) Calculate the charge and energy stored in $C_1$ and $C_2$ together. (3)
   (c) Explain the difference in energy values. (2)




[9]

5. How can you combine "1μF, 10V" capacitors, to give you a 1μF capacitance, that can withstand 20V? (2)

TLN 3-98. ×13

# Capacitors – ANSWERS — A-level Physics

Farad – what else?

1 (a) Capacitance – charge (C) stored per volt ① $C = Q/V$ ① coulombs / volt /3

(b) Time constant = $C \times R$ ① — Farad (sec) — ohm. $t_{1/2} = 0.69CR$ ① /3 [6]

2. (a) $I$ initial = $V/R$ ① $= 12/15000 = 8 \times 10^{-4}$ A ① $I$ final = 0 ① !! (3)

(b) $V$ initial = 0 V ① $V$ final = 12 V !! (2)

(c) Time constant = $CR$ ① $= 100 \times 10^{-6} \times 15 \times 10^{3} = 1.5$ s ① (2)

So $t_{1/2}$ = time for {current / voltage} to halve

$= 0.69CR = 1.04$ s

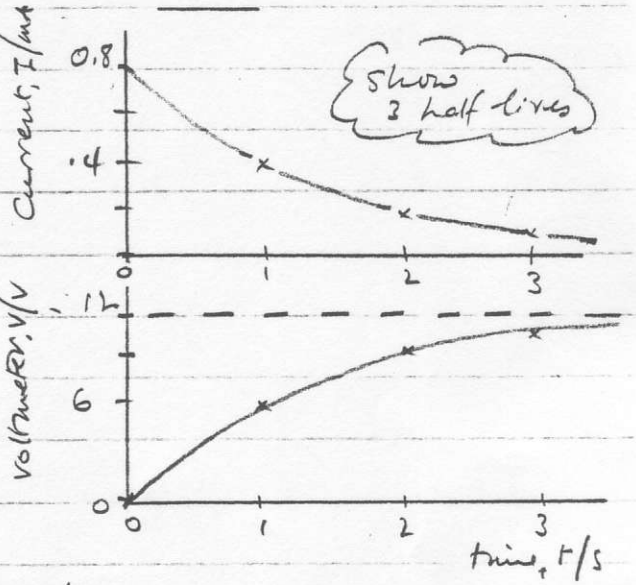
(d) Current: $I$ falls exponentially. (4)

(e) Voltage: rises towards 12 V (4)

marking axes – labelled + scales ① each

curve – (2)

(f) Area under $I/t$ = charge stored [16]




3. (a) Charge /sec $Q = I \times 1 = CVf = 120$ mA ①

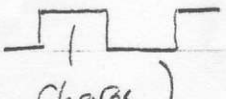
So $C = 0.12/8 \times 250 = 60 \times 10^{-6}$ f $= 60$ μF ① (3)

(b) Time constant $CR = 60 \times 10^{-6} \times 20 = 1.2$ ms

at 250 Hz time for discharging in ½ of 1/250 s.

which = 2 ms. C just has time to discharge fully before being recharged. If you double R, T.C. will double, and C will not fully discharge (2) [5]

(It's not following Ohm's Law $I = V/R$ !)




4. (a) Switch at A $Q = CV = 20 \times 10^{-6} \times 8 = 1.6 \times 10^{-4}$ C

energy $E = \frac{1}{2}CV^2 = \frac{1}{2} \times 20 \times 10^{-6} \times 8^2 = 6.4 \times 10^{-4}$ J

(b) Switch to B total charge stays constant ①

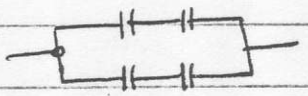
$C_{total} = 30$ μF ① $E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C} = 4.3 \times 10^{-4}$ Joules 2/3 of 8

(you don't really need to calculate new p.d. ... but if you did it would be $V_{new} = Q/C_{new} = \frac{1.6 \times 10^{-4}}{30 \times 10^{-6}} = 5.3$ V

(c) Energy lost as heat in wires as charge moves / current flows. (2) [9]

5.  $= 0.5$ μF max 20V

10.56



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So ... $= 1$ μF max 20V (2)

Total /38