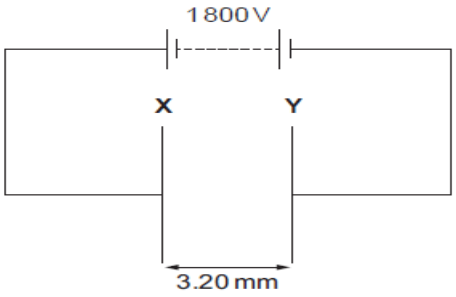
Physics

Question	Maximum Mark	Mark Awarded
#1	10	
#2	13	
#3	15	
#4	12	
#5	15	
Total	65	

#1

A scientist investigating electric fields places two parallel plates **X** and **Y** a distance 3.20 mm apart and connects them to a high voltage supply as shown. There is a vacuum between the plates.



(a) **Sketch the electric field pattern** between the plates indicating clearly the direction of the field. [1]

(b) Electrons are accelerated from plate **Y** to plate **X**. Calculate:

(i) the force on an electron; [2]

(ii) the gain in kinetic energy of an electron as it travels from **Y** to **X**; [2]

(iii) the time it takes for an electron to travel from **Y** to **X**. Assume the electron starts from rest at plate **Y**. [3]

(c) The separation between the plates is now halved but the pd is unchanged. The scientist believes that the gain in kinetic energy of an electron travelling (from rest) from **Y** to **X** will be unchanged. Verify this claim. [2]

Question taken from Eduqas examination paper 842102, June 2017

#2

Question taken from Eduqas examination paper 842102, November 2020

#3

3. *(a)* Two parallel plate capacitors, X and Y, have equal plate areas. The capacitance of X is greater than the capacitance of Y. Suggest two possible reasons for the difference. [2]

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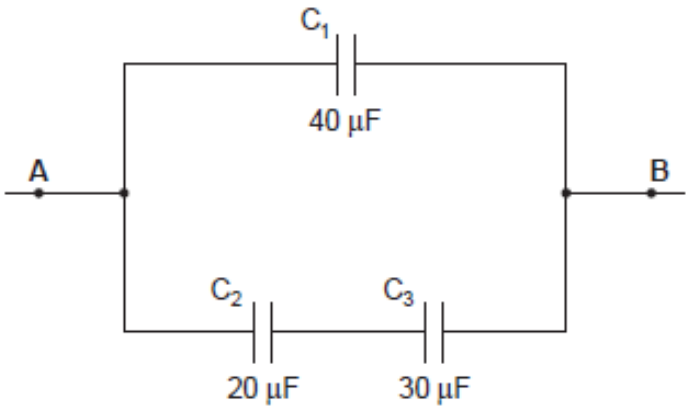
(b) The diagram shows an arrangement of 3 capacitors.



(i) Calculate the total capacitance of this combination of capacitors. [3]

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(ii) Explain why:

pd across C_2 = 1.5 × pd across C_3. [2]

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(iii) Hence, calculate the pd across C_3 given that 100 V is applied between A and B. [1]

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(iv) Explain which of the three capacitors stores the greatest charge, and calculate the size of this charge. [2]

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(c) A 1.6 mF capacitor is charged from a 300 V d.c supply. Engineers wish to use the energy stored in this capacitor to heat a small coil embedded in a thermally insulated block of aluminium of mass 0.10 kg. It is required that the heating process be at least 80% efficient. Experiments show that when the capacitor is discharged through the coil, the temperature of the block increases by 0.60 K.

Determine whether this method of heating meets the efficiency specified.
[Specific heat capacity of aluminium, $c = 910\,J\,kg^{-1}\,K^{-1}$]. [5]

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Question taken from Eduqas examination paper 842102, June 2019

#4

6. *(a)* Define the *capacitance* of a capacitor. [1]

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(b) Two capacitors, initially uncharged, are arranged in series as shown. When a battery is connected across A and B, the charge on plate P is found to be +75 nC.

(i) Write down the charges on each of the plates Q, R and S. Give a reason for your answer to the charge on plate S. [3]

Charge on Q: .....

Charge on R: .....

Charge on S: .....

Reason:

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(ii) Calculate the pd across A and B. [2]

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(iii) A Physics student makes the following comment:

For capacitors in series, a capacitor of higher capacitance stores more energy than a capacitor of smaller capacitance.

By considering this combination of capacitors, investigate whether or not the student is correct. [2]

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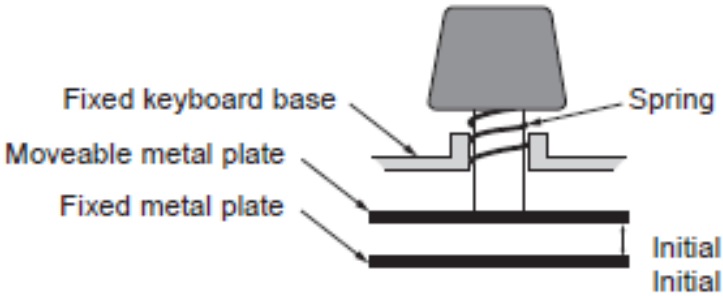
(c) Some computer keyboards work on the principle of varying capacitance. When a key is pressed, a spring is compressed and the separation of two parallel metal plates is decreased. The computer responds if the increase in capacitance of the plates is 0.20 pF or more.
The diagram shows how a single key is constructed.



Initial separation of plates = 5.2×10^{-3} m
Initial capacitance = 0.27 pF
Plate area = 1.6×10^{-4} m^2

The designers of a keyboard require that the increase in capacitance of 0.20 pF occurs when a force of 0.20 N is exerted on a key. Different springs are available, of spring constant 90 N m^{-1}, 120 N m^{-1} and 150 N m^{-1}. Determine which (if any) of these springs would be suitable in meeting the designer's requirements. The capacitor is filled with air. [4]

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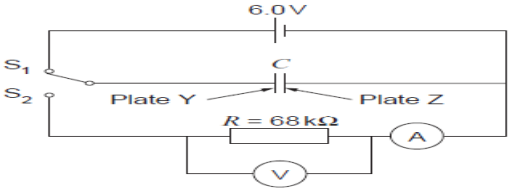
Question taken from Eduqas examination paper 842102, June 2018

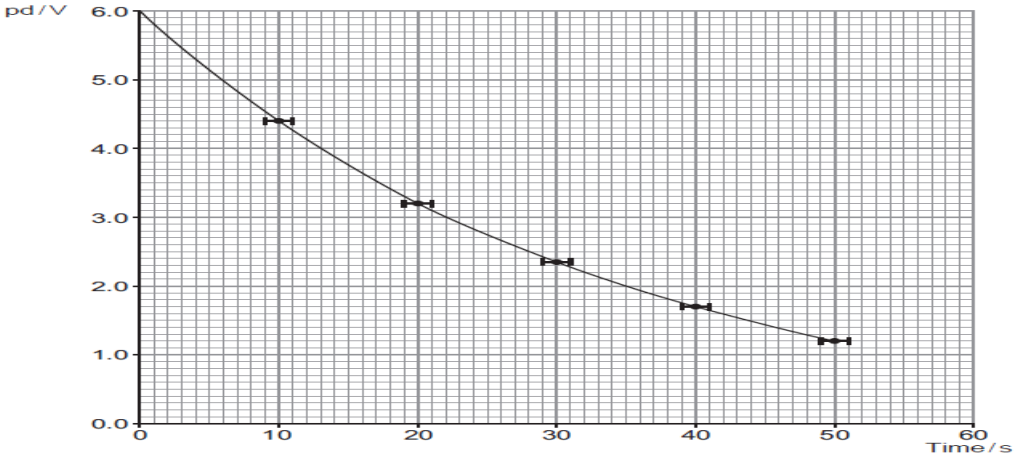
#5

Katie uses the following circuit to investigate the discharging of a capacitor of unknown value C.



(a) The plates of the capacitor are labelled Y and Z. When the switch is moved to S_1, explain how each plate becomes charged in terms of the movement of charges in the circuit. [2]

(b) The switch is now moved to S_2 and the capacitor is allowed to discharge through the resistor. Katie takes readings of pd every 10 s for a period of 50 s and plots her results on the following grid.



(i) The initial current in the circuit was 88 μA. Show that this is consistent with the value $R = 68\ \text{k}\Omega$. [1]

(ii) Katie took **single** readings of pd. She used a voltmeter with a resolution of 0.01 V. Explain why it was not appropriate to include error bars when plotting pd. [2]

(iii) She uses a stopwatch of resolution 1 second. State how this is represented on the graph. [1]

(iv) Show that the time constant of the circuit is approximately 30 s. [2]

(v) The resistor manufacturer states that the resistors are accurate to ± 3% of their given values. Use this information to calculate C along with its **absolute** uncertainty. [Take the absolute uncertainty in the time constant as being the same as the absolute uncertainty in the readings of time.] [4]

(vi) Determine a value for pd at a time $t = 55$ s and state whether this is consistent with the trend shown by the graph. [3]

Question taken from Eduqas examination paper 842102, June 2017