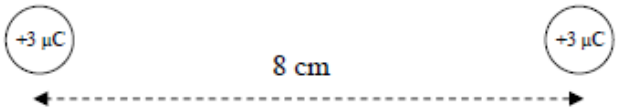
Physics
Leaving Certificate
Higher Level

Past Exam Questions on
Current and Charge

Q12 Part (c) Section B 2013

(*c*) Define the unit of charge, the coulomb. State Coulomb's law. (9)

Calculate the force of repulsion between two small spheres when they are held 8 cm apart in a vacuum. Each sphere has a positive charge of +3 μC. (9)



Copy the diagram above and show on it the electric field generated by the charges. Mark on your diagram a place where the electric field strength is zero. (10)

Q4 Section A 2012

4. The following is part of a student's report on an experiment to investigate the variation of the current I with potential difference V for a semiconductor diode.

"I set up the apparatus as shown in the circuit diagram. I measured the current flowing through the diode for different values of the potential difference. I recorded the following data."

V/V	0	0.50	0.59	0.65	0.68	0.70	0.72
I/mA	0	3.0	5.4	11.7	17.4	27.3	36.5

Draw a circuit diagram used by the student.

How did the student vary and measure the potential difference? (15)

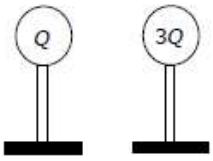
Using the data, draw a graph to show how the current varies with the potential difference for the semiconductor diode.
Does the resistance of the diode remain constant during the investigation? Justify your answer. (18)

The student continued the experiment with the connections to the semiconductor diode reversed.
What adjustments should be made to the circuit to obtain valid readings? (7)

Q9 Section B 2011

9. (*a*) State Coulomb's law. (6)

Two identical spherical conductors on insulated stands are placed a certain distance apart. One conductor is given a charge Q while the other conductor is given a charge $3Q$ and they experience a force of repulsion F. The two conductors are then touched off each other and returned to their original positions. What is the new force, in terms of F, between the spherical conductors? (18)



(*b*) Draw a labelled diagram of an electroscope.

Why should the frame of an electroscope be earthed?

Describe how to charge an electroscope by induction. (15)

(*c*) How does a full-body metal-foil suit protect an operator when working on high voltage power lines?

Describe an experiment to investigate the principle by which the operator is protected. (17)

Q12 Part (c) Section B 2011

(*c*) List the factors that affect the heat produced in a current-carrying conductor. (7)

An electric cable consists of a single strand of insulated copper wire. The wire is of uniform cross-sectional area and is designed to carry a current of 20 A. To preserve the insulation, the maximum rate at which heat may be produced in the wire is 2.7 W per metre length.

Calculate

(i) the maximum resistance per metre of the wire

(ii) the minimum diameter of the wire. (21)

(resistivity of copper = $1.7 \times 10^{-8}\ \Omega\,\text{m}$)

Q12 Part (d) Section B 2010

(*d*) Define electric field strength and give its unit of measurement. (9)

The diagram shows a negative charge of 2 μC, positioned 25 cm away from a positive charge of 5 μC.

Copy the diagram into your answerbook and show on it the direction of the electric field at point P.

Calculate the electric field strength at P. (15)

Under what circumstances will point discharge occur? (4)

(permittivity of free space = 8.9×10^{-12} F m^{-1})

Q5 Part (g) Section B 2008

(*g*) What are the charge carriers when an electric current
(i) passes through a semiconductor; (ii) passes through an electrolyte? (7)

Q5 Part (h) Section B 2007

(*h*) State the principle on which the definition of the ampere is based. (7)

Q8 Section B 2007

8. Define electric field strength and give its unit of measurement. (9)

Describe how an electric field pattern may be demonstrated in the laboratory. (12)

The dome of a Van de Graff generator is charged. The dome has a diameter of 30 cm and its charge is 4 C. A 5 μC point charge is placed 7 cm from the surface of the dome.

Calculate:

(i) the electric field strength at a point 7 cm from the dome

(ii) the electrostatic force exerted on the 5 μC point charge. (15)

All the charge resides on the surface of a Van de Graff generator's dome. Explain why.
Describe an experiment to demonstrate that total charge resides on the outside of a conductor.
Give an application of this effect. (20)

(permittivity of free space = 8.9×10^{-12} F m^{-1})

Q5 Part (f) Section B 2006

(f) An RCD is rated 30 mA. Explain the significance of this current. (7)

Q5 Part (g) Section B 2006

(g) Why is Coulomb's law an example of the inverse square law? (7)

Q9 Section B 2006

9. What is an electric current? Define the ampere, the SI unit of current. (12)

Describe an experiment to demonstrate the principle on which the definition of the ampere is based. (15)

Sketch a graph to show the relationship between current and time for
(i) alternating current;
(ii) direct current. (9)

The peak voltage of the mains electricity is 325 V. Calculate the rms voltage of the mains? (6)

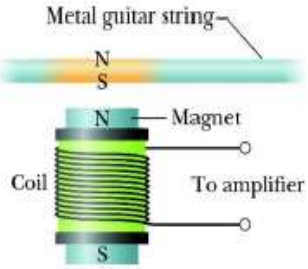
What is the resistance of the filament of a light bulb, rated 40 W, when it is connected to the mains? (9)

Explain why the resistance of the bulb is different when it is **not** connected to the mains. (5)

Q11 Section B 2006

11. Read the following passage and answer the accompanying questions.

The growth of rock music in the 1960s was accompanied by a switch from acoustic guitars to electric guitars. The operation of each of these guitars is radically different.



The frequency of oscillation of the strings in both guitars can be adjusted by changing their tension. In the acoustic guitar the sound depends on the resonance produced in the hollow body of the instrument by the vibrations of the string. The electric guitar is a solid instrument and resonance does not occur.

Small bar magnets are placed under the steel strings of an electric guitar, as shown. Each magnet is placed inside a coil and it magnetises the steel guitar string immediately above it. When the string vibrates the magnetic flux cutting the coil changes, an emf is induced causing a varying current to flow in the coil. The signal is amplified and sent to a set of speakers.

Jimi Hendrix refined the electric guitar as an electronic instrument. He showed that further control over the music could be achieved by having coils of different turns.

(Adapted from Europhysics News (2001) Vol. 32 No. 4)

(a) How does resonance occur in an acoustic guitar? (7)

(b) What is the relationship between frequency and tension for a stretched string? (7)

(c) A stretched string of length 80 cm has a fundamental frequency of vibration of 400 Hz. What is the speed of the sound wave in the stretched string? (7)

(d) Why must the strings in the electric guitar be made of steel? (7)

(e) Define magnetic flux. (7)

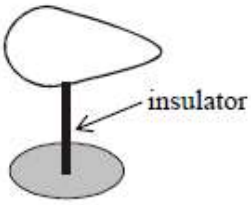
(f) Why does the current produced in a coil of the electric guitar vary? (7)

(g) What is the effect on the sound produced when the number of turns in a coil is increased? (7)

(h) A coil has 5000 turns. What is the emf induced in the coil when the magnetic flux cutting the coil changes by 8×10^{-4} Wb in 0.1 s? (7)

Q5 Part (g) Section B 2005

(g) A pear-shaped conductor is placed on an insulated stand is shown. Copy the diagram and show how the charge is distributed over the conductor when it is positively charged. (7)



Q10 Section B 2005

10. Define electric field strength.

State Coulomb's law of force between electric charges. (12)

Why is Coulomb's law an example of an inverse square law? (6)

Give two differences between the gravitational force and the electrostatic force between two electrons. (6)

Describe an experiment to show an electric field pattern. (12)

Calculate the electric field strength at the point B, which is 10 mm from an electron.

What is the direction of the electric field strength at B?

A charge of 5 μC is placed at B. Calculate the electrostatic force exerted on this charge. (20)

(permittivity of free space = 8.9×10^{-12} F m^{-1}; charge on the electron = 1.6×10^{-19} C)