Physics Higher Level
Electricity and Electronics
Practice Unit Assessment

Time 45 minutes

Read Carefully

1 All questions should be attempted.

2 Enter the question number clearly beside the answer to each question.

3 Care should be taken to give an appropriate number of significant figures in the final answers to calculations.

4 The following data should be used when required.

| Speed of light in vacuum $c$ | $3.00 \times 10^8$ m s$^{-1}$ | Planck’s constant $h$ | $6.63 \times 10^{-34}$ J s |
| Magnitude of the charge on electron $e$ | $1.60 \times 10^{-19}$ C | Mass of electron $m_e$ | $9.11 \times 10^{-31}$ kg |
| Acceleration due to gravity $g$ | $9.8$ m s$^{-2}$ | Mass of proton $m_p$ | $1.67 \times 10^{-27}$ kg |

NOTE: This is a trial paper and contains questions of the type that will be encountered in the actual unit assessment. The threshold of attainment of the unit assessment (pass mark) is 18 marks.
1. A spark crosses the gap between the electrodes at the end of a spark plug. The voltage across the gap is 600 V. Calculate the electrical energy transferred by the spark if the spark transfers a charge of $1 \times 10^{-5} \text{ C}$.

2. A 22 $\Omega$ resistor is connected in series with a cell of e.m.f. 6 V and with an internal resistance of 2 $\Omega$.

   (a) (i) Find the current flowing through the ammeter.
   (ii) What will be the voltage across the terminals of the cell?
   (iii) What is the value of the lost volts in the circuit?

   (b) The 22 $\Omega$ resistor is replaced by a resistor with only 18 $\Omega$ resistance. State the effect this change will have on the value of the lost volts in the circuit. Explain your answer.

3. An oscilloscope is used to find the frequency of an a.c. power supply. The oscilloscope screen is divided into 1 cm squares and these are shown below. Each 1 cm square represents 2 ms.

   (a) Use the trace shown above to calculate the frequency of the power supply.

   (b) The root mean square (r.m.s.) output voltage from the power supply is 12 V. What is the peak output voltage from the power supply?
4. A circuit is set up which consists of a resistor and capacitor in series connected to a 9 V cell with negligible internal resistance. The capacitor has a capacitance of 2200 μF.

(a) The capacitor is initially uncharged. The switch, S, is closed and the capacitor allowed to charge. What will be the initial charging current recorded on the ammeter?

(b) The capacitor begins to charge. What will be the voltage across the capacitor at the instant the voltage across the resistor is 6 V?

(c) (i) Calculate the charge $Q$, on the capacitor when fully charged?
(ii) How much energy can the capacitor store when fully charged?

5. A capacitor is connected in series with a resistor as shown below.

The switch is closed so that the capacitor charges through resistor R.

(a) Sketch a graph of voltage against time for the charging capacitor.

(b) The value of the variable resistor is now decreased. State the effect this will have on the time it takes for the capacitor to charge.

6. An op-amp is set up as shown in the circuit diagram below.
The op-amp has two inputs, \( V_1 \) and \( V_2 \). The voltage applied to \( V_1 \) is 0·4 V and the voltage applied to \( V_2 \) is 0·5 V. Calculate the output from this op-amp.

7. An op-amp is set as shown below.

(a) In what mode is this op-amp operating?

(b) The output voltage from the op-amp is plotted against the input voltage to produce the graph shown below.

(i) Use the graph to find the gain of the op-amp.

(ii) If the input resistor has a value of 10 kΩ, find the value of the feedback resistor to provide the gain calculated in (b) (i).

(iii) Explain why the output voltage does not exceed 15 V.