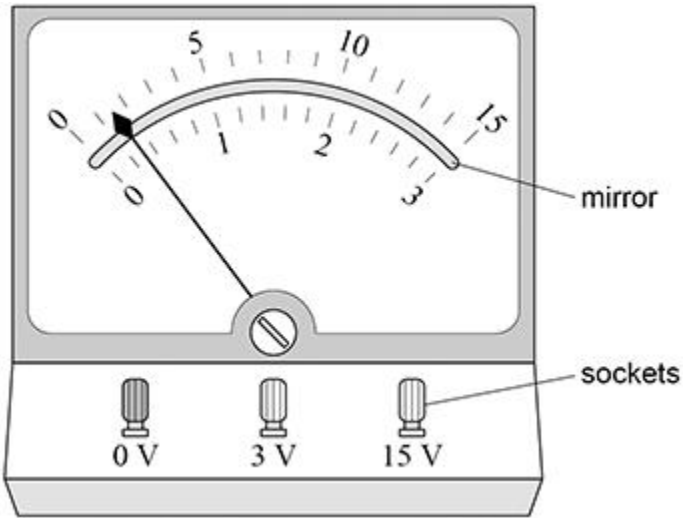
Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Q1.

An analogue voltmeter has a resistance that is much less than that of a modern digital voltmeter. Analogue meters can be damaged if the full-scale reading is exceeded.
Figure 1 shows a dual-range analogue voltmeter with a zero error.

Figure 1



(a) The voltmeter is set to the **more sensitive** range and then used in a circuit.

What is the potential difference (pd) between the terminals of the voltmeter when a full-scale reading is indicated?

Tick (✓) **one** box.

2.7 V ☐

3.3 V ☐

13.5 V ☐

16.5 V ☐

(1)

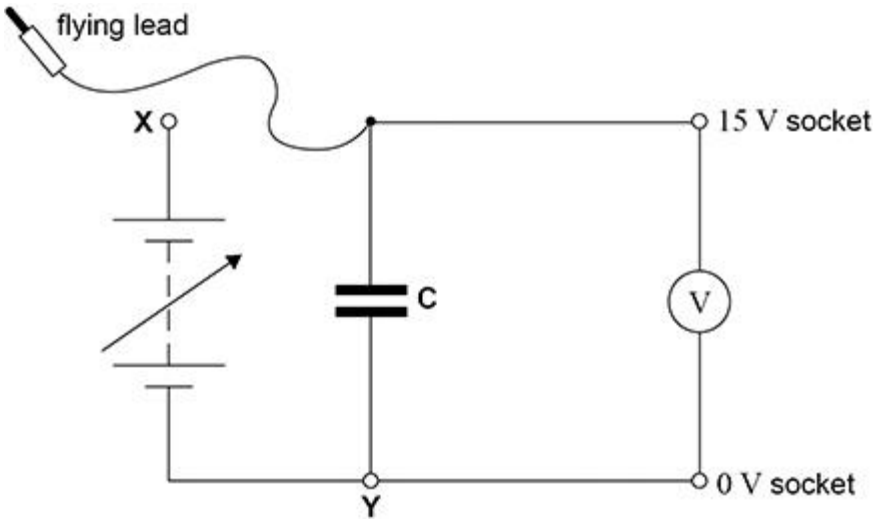
(b) Explain the use of the mirror when reading the meter.

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(2)

A student corrects the zero error on the meter and then assembles the circuit shown in **Figure 2**.
The capacitance of the capacitor **C** is not known.

Figure 2



The output pd of the power supply is set to zero.
The student connects the flying lead to socket **X** and adjusts the output pd until the voltmeter reading is full scale (15 V).
She disconnects the flying lead from socket **X** so that **C** discharges through the voltmeter.

She measures the time $T_{½}$ for the voltmeter reading V to fall from 10 V to 5 V.

She repeats this process several times.

Table 1 shows the student's results, **none** of which is anomalous.

Table 1

$T_{½}$ / s	12.00	11.94	12.06	12.04	12.16

(c) Determine the percentage uncertainty in $T_{½}$.

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percentage uncertainty = _____ %

(2)

(d) Show that the time constant for the discharge circuit is about 17 s.

(1)

(e) The student thinks that the time constant of the circuit in **Figure 2** is directly proportional to the range of the meter.
To test her theory, she repeats the experiment with the voltmeter set to the 3 V range.
She expects $T_{½}$ to be about 2.5 s.

Explain:

- what the student should do, before connecting capacitor **C** to the 0 V and 3 V sockets, to avoid exceeding the full-scale reading on the voltmeter
- how she should develop her procedure to get an accurate result for the time constant
- how she should use her result to check whether her theory is correct.

_____

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(4)

The student wants to find the resistance of the voltmeter when it is set to the 15 V range.
She replaces **C** with an 820 μF capacitor and charges it to 15 V.
She discharges the capacitor through the voltmeter, starting a stopwatch when V is 14 V.
She records the stopwatch reading T at other values of V as the capacitor discharges.

Table 2 shows her results.

Table 2

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V / V	14	11	8	6	4	3	2
t / s	0.0	3.1	7.2	11.0	16.2	19.9	25.2

(f) Suggest **two** reasons why the student selected the values of V shown in **Table 2**. Explain each of your answers.

1 _____

_____

_____

_____

_____

_____

2 _____

_____

_____

_____

_____

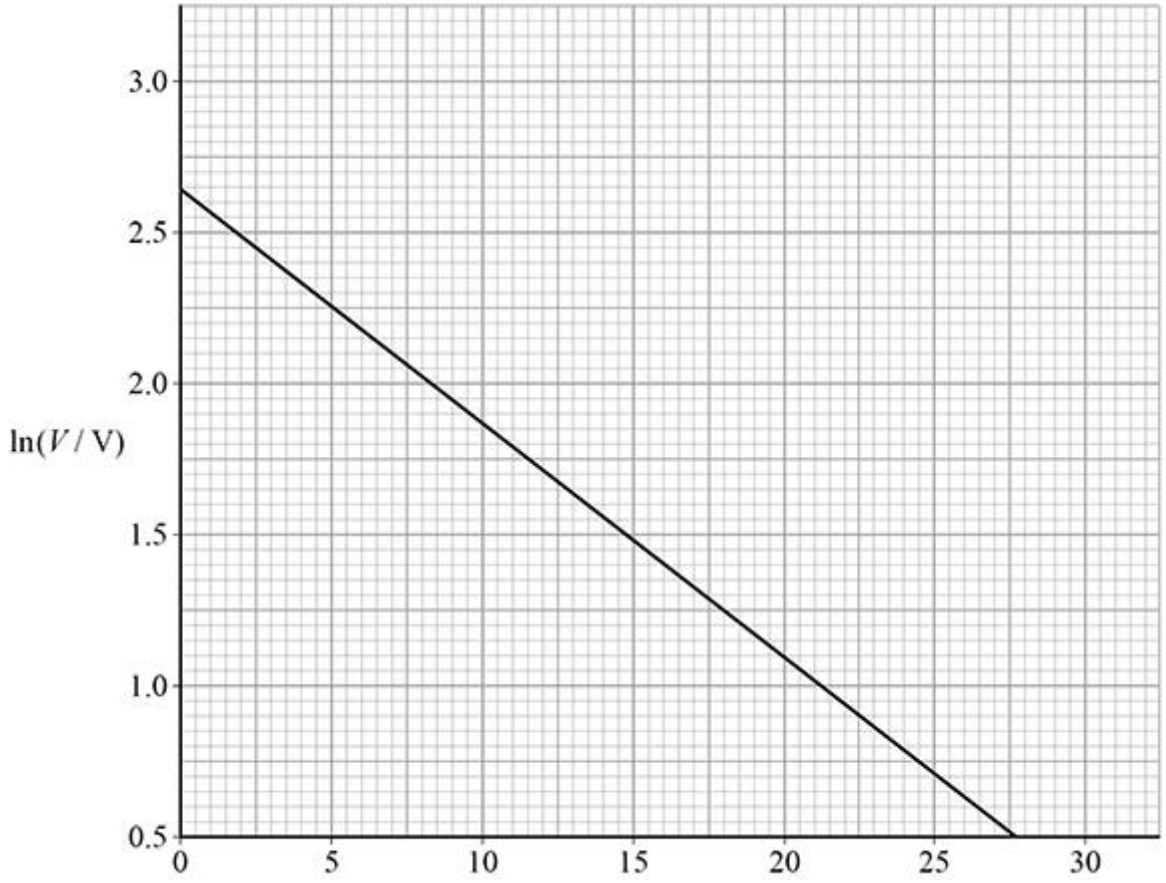
_____

(4)

Figure 3 shows a graph of the experimental data.

Figure 3

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(g) Show, using **Figure 3**, that the resistance of the voltmeter is about 16 kΩ.

(3)

(h) Determine the current in the voltmeter at t = 10 s.

current = _____ A

(2)

(Total 19 marks)

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