Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

(a) Describe the links between galaxies, black holes and quasars.

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(2)

(b) At a distance of 5.81×10^8 light year, Markarian-231 is the closest known quasar to the Earth. The red shift z of Markarian-231 is 0.0415

Use these data to estimate an age, in seconds, of the Universe.

age = _____ s

(4)

(c) A typical quasar is believed to be approximately the size of the solar system, with a power output similar to that of a thousand galaxies.

Estimate, with reference to the inverse-square law, how much further the most distant visible quasar is likely to be compared to the most distant visible galaxy.

(3)
(Total 9 marks)

Q2.

Evidence to support the Big Bang theory comes from cosmological microwave background radiation and the relative abundance of hydrogen and helium in the Universe.

(a) Explain what is meant by cosmological microwave background radiation and how its existence supports the Big Bang theory.

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_____

(3)

(b) Explain how the relative abundance of hydrogen and helium supports the Big Bang theory.

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(3)

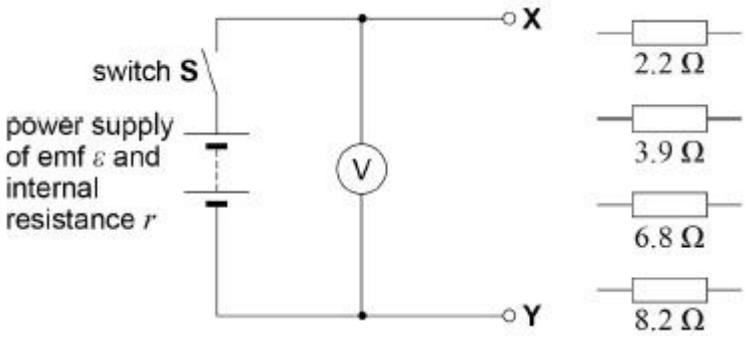
(Total 6 marks)

Q3.

This question is about an experiment to determine the internal resistance of a power supply.

A student is given the circuit and the four resistors of known resistance shown in **Figure 1**.

Figure 1



The student can change the external resistance R of the circuit between terminals **X** and **Y**. This is done by connecting different combinations of **two** resistors in series or in parallel between **X** and **Y**. This method can produce **12 different values** for R.

(a) Calculate the largest value of R that the student can obtain using **two** resistors.

largest value of R = _____ Ω

(1)

(b) Calculate the smallest value of R that the student can obtain using **two** resistors.

smallest value of R = _____ Ω

(2)

(c) With switch **S** closed (in the on position) and no resistors connected between **X** and **Y** the voltmeter reading V is 1.62 V.

The student concludes that this voltmeter reading equals the emf ε of the power supply.

State why the student's conclusion that ε = 1.62 V was correct.

_____

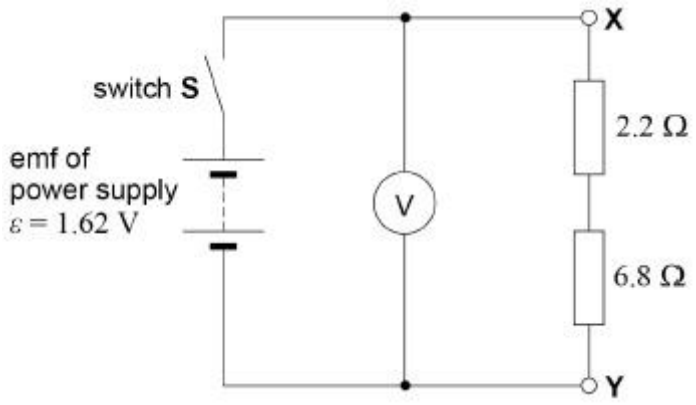
_____

_____

(1)

(d) **Figure 2** shows one particular combination and arrangement of two resistors that the student could use.

Figure 2



When **S** is closed the voltmeter reading V is 1.14 V.

Explain why V is less than 1.62 V when **S** is closed.

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_____

(1)

(e) It can be shown that

$$\varepsilon - V = r \times \frac{V}{R}$$

where r is the internal resistance of the power supply.

Determine (ε – V) and $\frac{V}{R}$ for this circuit using the data given in part (d).

($\varepsilon - V$) = _____ V

$\frac{V}{R}$ = _____ V Ω^{-1}

(1)

(f) The student obtains values of V for five further different values of R.

These data were used to produce the graph of ($\varepsilon - V$) against $\frac{V}{R}$ in **Figure 3**.

Plot the point you determined in part (e) on **Figure 3** and add a suitable best-fit line.

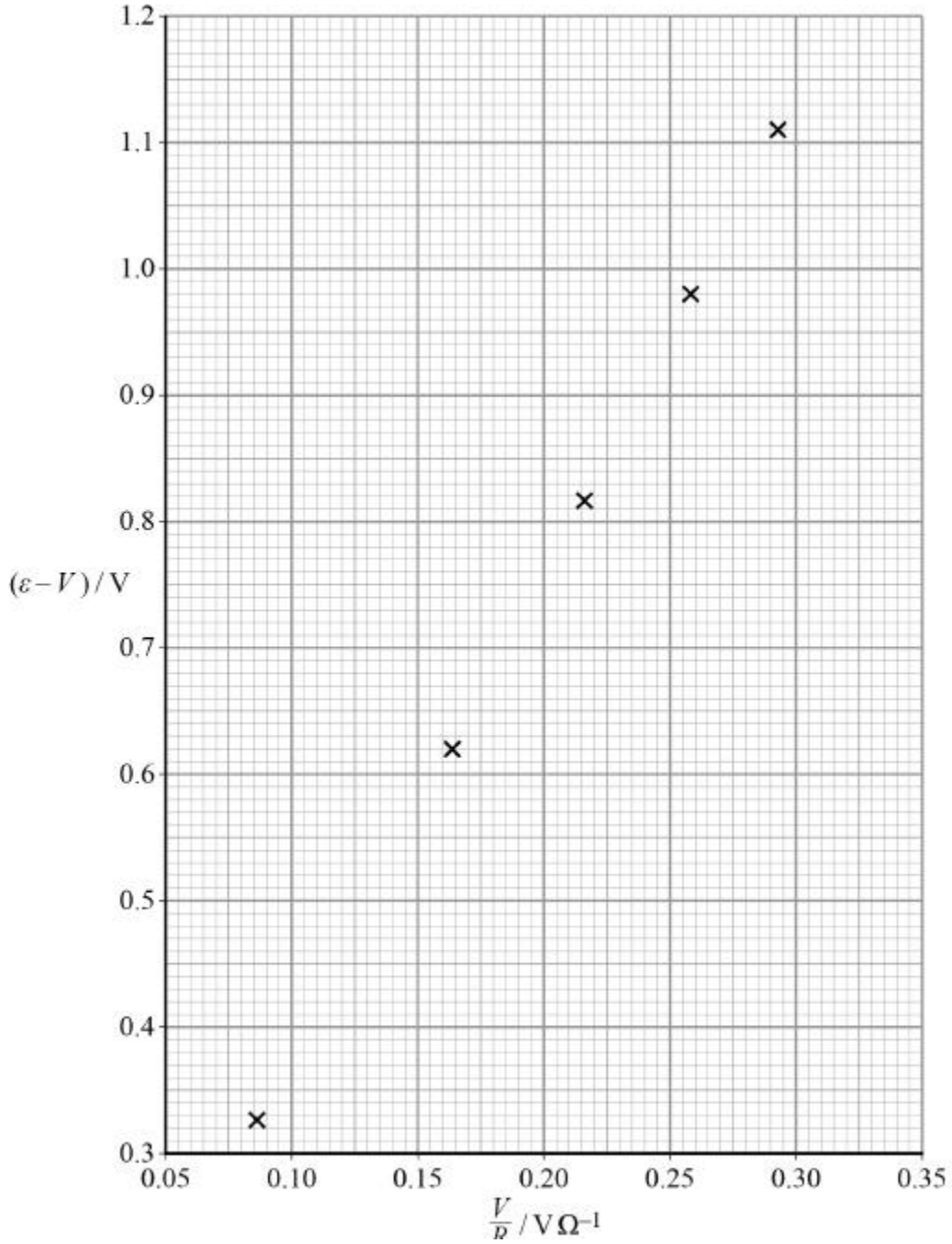
(1)

(g) Use **Figure 3** to determine r.

r = _____ Ω

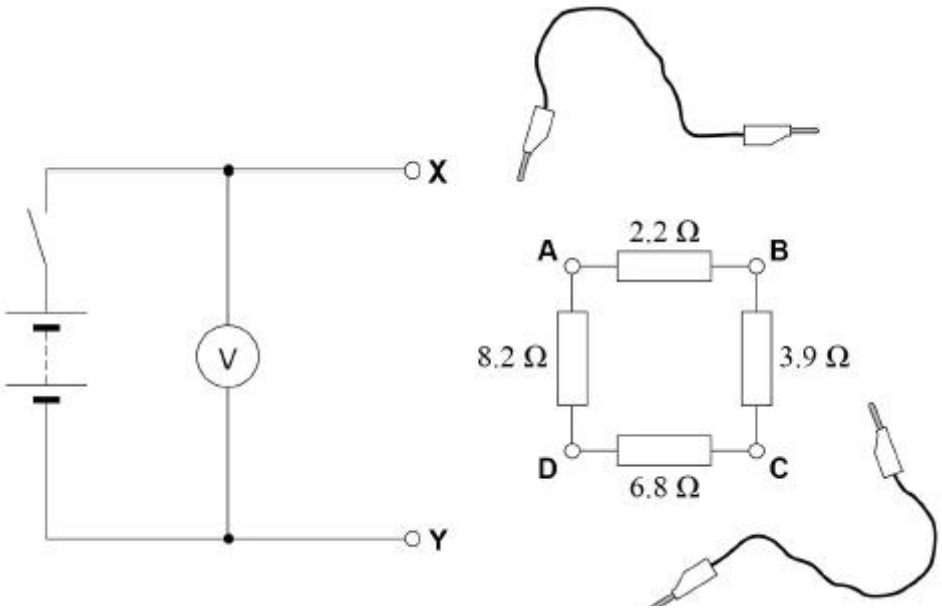
(2)

Figure 3



(h) **Figure 4** shows a different method for varying the resistance R described in part (a).

Figure 4



The four resistors are connected in a loop with sockets **A**, **B**, **C** and **D** at each junction. Two leads are used to connect the resistor loop to **X** and **Y**.

Discuss whether this method is an improvement over the method described in part (a). In your answer, you should refer to the number of different values that can be obtained for R.

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(2)

(Total 11 marks)