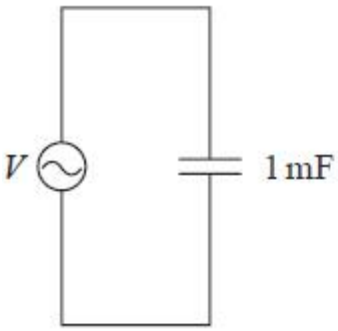
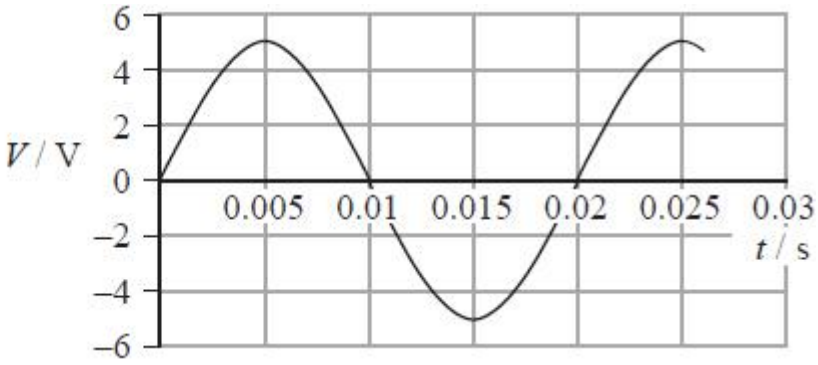
Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

The circuit shows a 1 mF capacitor connected to an a.c. supply. The graph shows how the potential difference *V* varies with time *t*.





A spreadsheet is used to model how the current *I* in the 1 mF capacitor varies with *t*. Six rows of the spreadsheet are shown below.

	A	B	C	D	E	F	G
	t / s	Δt / s	V / V	$Q_{initial}$ / C	Q_{final} / C	ΔQ / C	I / A
7	0.0050	0.0010	5.00	0.00476	0.00500	0.00024	0.24
8	0.0060	0.0010	4.76	0.00500	0.00476	–0.00024	–0.24
9	0.0070	0.0010	4.05	0.00476	0.00405	–0.00071	–0.71
10	0.0080	0.0010	2.94	0.00405	0.00294	–0.00111	–1.11
11	0.0090	0.0010	1.55	0.00294	0.00155	–0.00139	–1.39
12	0.0100	0.0010	0	0.00155	0.00000	–0.00155	–1.55

(i) Explain how cell E10 has been calculated.

(2)

.....

.....

.....

.....

(ii) State the formula used to calculate cell G11.

(1)

.....

.....

(iii) Calculate the maximum energy stored on the capacitor.

(2)

.....

.....

.....

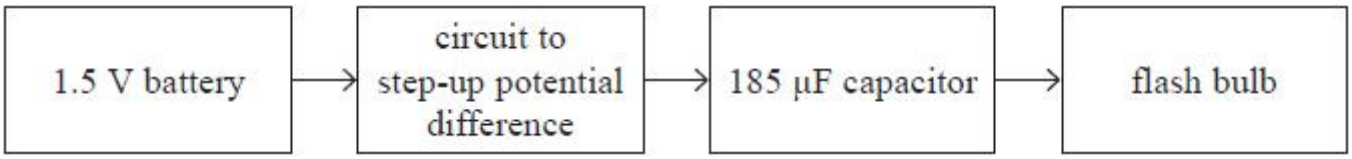
Maximum energy stored on the capacitor = ...

(Total for question = 5 marks)

Q2.

* Cameras usually have an inbuilt flash bulb that can be used to take photographs in poor light conditions. As a photograph is taken, the bulb should be able to produce a bright flash of light for up to 4 ms.

A capacitor can be used along with a battery as a power supply for the flash bulb. The flow diagram shows a possible arrangement.



Comment on the suitability of using this capacitor arrangement as a power supply rather than connecting the bulb directly to the battery.

A typical flash bulb has a resistance of 6 Ω.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

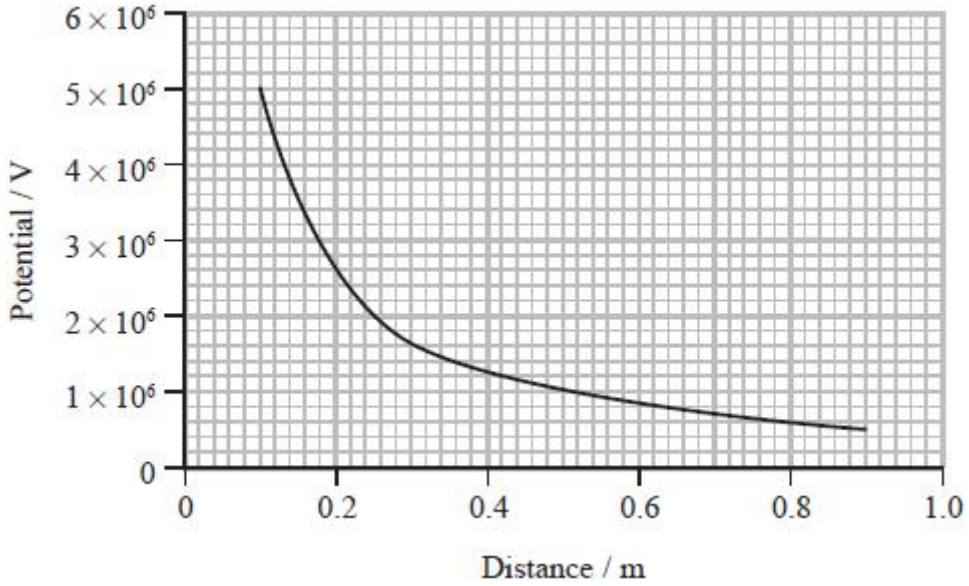
.....

.....

(Total for question = 6 marks)

Q3.

The graph shows how potential varies with distance from the centre of a charged sphere.



Air molecules will be ionised if the electric field strength exceeds 3×10^6 V m^{-1}.

Deduce whether air molecules will be ionised at a distance of 30 cm from the centre of this sphere.

(4)

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q4.

The photograph shows a statue of Buddha in Sri Lanka, which is protected by a lightning conductor.

© Valery Shanin/123RF

Give a reason why the lightning conductor should be taller than the statue.

(1)

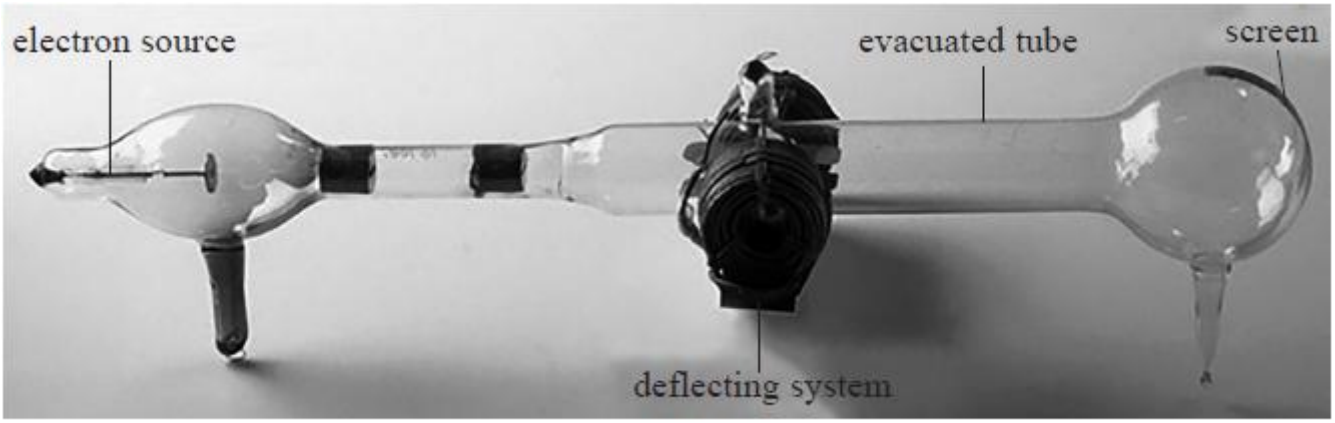
.....

.....

(Total for question = 1 mark)

Q5.

At the end of the 19th century, J.J. Thompson used electric and magnetic fields to deflect beams of charged particles. A photograph of his apparatus is shown.



© Science Museum London

Electrons were accelerated through a potential difference to produce a beam of high-energy electrons. The beam was then deflected in perpendicular directions by the magnetic and electric fields. The final position of the beam on the screen was determined by the charge and mass of the electrons.

In a modern version of Thompson's experiment, a uniform electric field of electric field strength *E* is applied so that the electric and magnetic forces on the electrons are equal and in opposite directions.

(i) Show that for electrons to be undeflected their velocity must be given by

$$v = \frac{E}{B}$$

where *B* is the magnetic flux density of the magnetic field.

(2)

.....

.....

.....

.....

(ii) The beam is produced by accelerating electrons through a potential difference of 250 V.

The electric field strength is $1.4 \times 10^{4}\,\text{V m}^{-1}$. The magnetic flux density is $1.5 \times 10^{-3}\,\text{T}$.

Calculate the value of the specific charge e/m for the electron using this data.

(3)

.....

.....

.....

.....

.....

e/m = ...

(Total for question = 5 marks)