

## 2.1 Electromagnetism

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 12 marks

KEY WORDS flux • potential

### Objective

Use electrostatic potentials, fields and Gauss's law; Analyse circuits, magnetism and induction; Apply Maxwell equations and electromagnetic wave relationships. Original public practice; not an ETS paper.

### 1 Key knowledge and worked examples

Electric field is the negative gradient of potential . A value and a spatial change are different quantities.

Use Gauss's law with symmetry. A known total flux alone does not give the field at every surface point.

Kirchhoff's laws track charge and energy in circuits. Induced emf follows changing magnetic flux with the Lenz-law sign.

Maxwell equations link electric and magnetic fields. In vacuum a wave has  $E/B=c$  and carries energy.

#### ■ Worked method

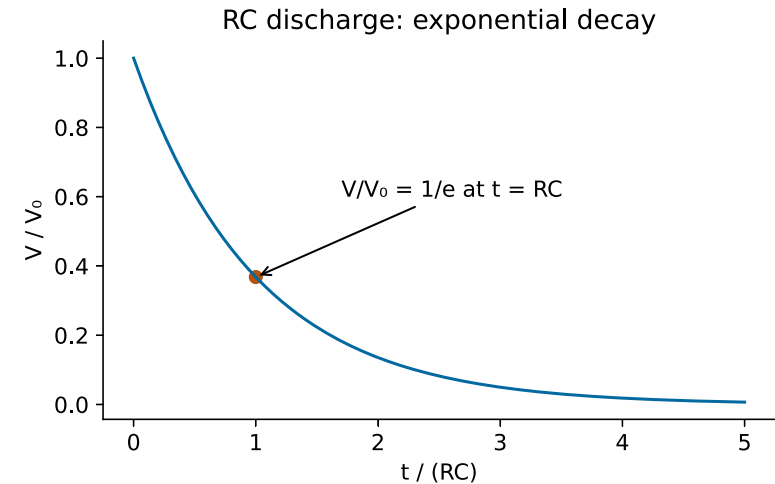
A spherical shell has radius  $R$  and uniform charge  $Q$ . Choose zero potential at infinity. Spherical symmetry lets Gauss's law determine the field outside.

$$4\pi r^2 E = Q/\epsilon_0, \quad E = Q/(4\pi\epsilon_0 r^2) \quad (r > R).$$

Inside, enclosed charge is zero and symmetry gives  $E = 0$ . Continuity gives

$$V(r) = \begin{cases} Q/(4\pi\epsilon_0 R) & r \leq R, \\ Q/(4\pi\epsilon_0 r) & r > R. \end{cases}$$

The potential is nonzero and constant inside. A zero gradient, rather than a zero value, gives a zero field. The radial field jumps at the charged surface.



### 2 Practice

2.1 Choose one answer. An RC time constant has units of:

[1]

- A seconds
- B volts
- C amperes

2.2 Choose one answer. For an ideal electrostatic conductor in equilibrium, its internal electric field is:

[1]

- A zero
- B always positive
- C infinite

2.3 For  $R=1000$  ohms and  $C=0.002$  farads,  $RC=$ \_\_\_\_\_ seconds. Show your relation and units.

[2]

[2]

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