Capacitance

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Capacitance
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **88 minutes**

Score: **/73**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** e.g. 'storage of charge' / storage of energy
blocking of direct current
producing of electrical oscillations
smoothing
(any two, 1 mark each) B2 [2]

(b) (i) capacitance of parallel combination = 60 μF C1
total capacitance = 20 μF A1 [2]

(ii) p.d. across parallel combination = ½ × p.d. across single capacitor C1
maximum is 9V A1 [2]

(c) *either* energy = ½CV^2 *or* energy = ½QV and $Q = CV$ C1
energy = ½ × 4700 × 10^{-6} × ($18^2 - 12^2$) C
= 0.42 J A1 [3]

2 **(a** charge / potential ……(*ratio must be clear*) ..... **B1** [1

(b) potential (at surface of sphere) = $Q / 4\pi\varepsilon_0 R$ M1
$C = Q / V = 4\pi\varepsilon_0 R$ ..... A0 [1]

(c) (i) $C = 4\pi \times 8.85 \times 10^{-12} \times 0.63$ C1
$= 7.0 \times 10^{-11}$ A1
farad / F ..... B1 [3]

(ii) energy = ½CV^2 .....C1
$0.25 \times ½C \times (1.2 \times 10^6)^2 = ½CV^2$ C1
$V = 6.0 \times 10^5$ V ..... A1 [3]
(*use of 0.75 rather than 0.25, allow max 2 marks*)

[Total: 8]

3 **(a (i)** ratio of charge (on body) and its potential — B1 [1]
(do not allow reference to plates of a capacitor)

(ii) (potential at surface of sphere =) $V = Q / 4\pi\varepsilon_0 r$ — M1
$C = Q / V = 4\pi\varepsilon_0 r$ — A0 [1]

(b) (i) $C = 4 \times \pi \times 8.85 \times 10^{-12} \times 0.36$
$= 4.0 \times 10^{-11}$ F *(allow 1 s.f.)* — A1 [1]

(ii) $Q = CV$
$= 4.0 \times 10^{-11} \times 7.0 \times 10^{5}$
$= 2.8 \times 10^{-5}$ C — A1 [1]

(c) plastic is an insulator / not a conductor / has no free electrons — B1
charges do not move (on an insulator) — B1
either so no single value for the potential
or charge cannot be considered to be at centre — B1 [3]

(d) *either* energy = $\frac{1}{2}CV^2$ *or* energy = $\frac{1}{2}QV$ and $C = Q/V$ — C1
energy = $\frac{1}{2} \times 4 \times 10^{-11} \times \{(7.0 \times 10^{5})^2 - (2.5 \times 10^{5})^2)\}$
$= 8.6$ J — A [3]

4 **(a** at $t = 1.0$ s, $V = 2.5$ V — C1
energy = $\frac{1}{2}CV^2$ — C1
$0.13 = \frac{1}{2} \times C \times (8.0^2 - 2.5^2)$ — M
$C = 4500\ \mu$F — A [3]

(b) use of two capacitors in series in all branches of combination — M1
connected into correct parallel arrangement — A1 [2]

5 **(a)** e.g. separate charges, store energy, smoothing circuit. etc. ..... B1 [1]
(*allow 'stores charge'*)

(b) **(i)** charge = current × time ..... B1 [1]

(ii) area is 21.2 cm^2 (*allow ±0.5 cm^2*) C2
(*allow 1 mark if outside ±0.5 cm^2 but within ±1.0 cm^2*)
1.0 cm^2 represents (0.125 × 10^{-3} × 1.25 =) 156 μC C1
charge = 3300 μC ..... A1 [4]

(iii) capacitance = Q/V C1
= (3300 × 10^{-6}) / 15
= 220 μF ..... A1 [2]

(c) *either* energy = ½CV^2 or energy = ½QV and $C = Q/V$ C1
½ × C × 15^2 = 2 × ½ × C × V^2 ..... C1
V = 10.6 V ..... A1 [3]

6 **(a)** **(i)** peak voltage = 6√2 C1
peak voltage = 8.48 V A1 [2]

(ii) zero because *either* no current in circuit (and $V = IR$)
or all p.d. across diode B1 [1]

(b) waveform: half-wave rectification B1
peak height at about 4.25 cm B1
half-period spacing of 2.0 cm B1 [3]
(allow ±¼ square for height and half-period)

(c) **(i)** *capacitor shown in parallel with resistor* B1 [1]

(ii) *either* energy = ½CV^2 or = ½QV and $Q = CV$ C1
= ½ x 180 x 10^{-6} x $(6\sqrt{2})^2$ C1
= 6.48 x 10^{-3} J A1 [3]

(iii) *either* fraction = 0.43^2 or final energy = 1.2 mJ C1
fraction = 0.18 A1 [2]

7 **(a)** Q/V, with symbols explained [do not allow in terms of units] **B1** **[**1]

(b) **(** on a capacitor, there is charge separation/there are + and - charges **M1**
either to separate charges, work must be done
or energy released when charges 'come together' **A1** **[2]**

(ii) either energy = ½CV^2 or energy = ½QV and $C = Q/V$ **C1**
change = ½ × 1200 × 10^{-6} (50^2 - 15^2) **C1**
change = 1.4 J (1.37) **A1** **[3]**
[allow 2 marks for ½C(ΔV)^2, giving energy = 0.74 J)

8 **(a)** two capacitors in series
or any circuit such that V = 25 V across any C ..... B 1
in parallel with second series pair or any correct combination ..... BI [2]

(b) two capacitors in series in parallel with a single capacitor
or other correct combination ..... B2 [2]
{leads not shown, then - 1 overall)

9 **(a)** single diode.....M1
in series with R *OR* in series with a.c. supply ..... A1 [2]

(b) **(i)1** 5.4 V (allow ± 0.1 V)..... A1

(i)2 $V = iR$
I = 5.4/1.5 x 10^3 ..... C1
= 3.6 x 10^{-3} A A1

(i)3 time = 0.027 s ..... A1 [4]

(ii) $Q = it$
= 3.6 x 10^{-3} x 0.027 ..... C1
= 9.72 x 10^{-5} C A1

(ii) $C = \Delta Q/\Delta V$ (allow C – Q/V for this mark) C1
= (9.72 x 10^{-5})/1.2
= 8.1 x 10^{-5} F ..... A1 [4]

(c) line: reasonable shape with less ripple..... B1 [1]