



ANSWER BOOK

Alternating currents

Magnetic fields · Year 13

AQA 3.7.5.5 · CIE 21.1.1, 21.1.2, 21.1.3, 21.1.4 · OCR A 4.4.1(b)(ii)

18 questions · 49 marks

NAVY EDITION

SECTION A · Warm-up

- A1** The value of the steady direct current (1); that would dissipate the same average power in a given resistor as the alternating current (1). [2]
- A2** $V_{\text{rms}} = V_{\text{peak}}/\sqrt{2} = 10/\sqrt{2}$ (1) [2]
 $V_{\text{rms}} = 7.07 \text{ V}$ (1)
- A3** Peak-to-peak value = $2 \times 15 = 30 \text{ V}$ (1). [1]
- A4** $T = 1/f = 1/50 = 0.020 \text{ s}$ (1) [2]
 $\omega = 2\pi f = 2\pi \times 50 = 314 \text{ rad s}^{-1}$ (1)
- A5** $T = 4.0 \times 5.0 \text{ ms} = 20 \text{ ms}$ (1) [2]
 $f = 1/T = 1/0.020 = 50 \text{ Hz}$ (1)

SECTION B · Standard

- B1** $V_{\text{peak}} = \sqrt{2} \times V_{\text{rms}} = \sqrt{2} \times 230$ (1) [2]
 $V_{\text{peak}} = 325.3 \text{ V}$ (1)
- B2** $I_{\text{rms}} = I_{\text{peak}}/\sqrt{2} = 4.0/\sqrt{2}$ (1) [2]
 $I_{\text{rms}} = 2.83 \text{ A}$ (1)
- B3** $I_{\text{rms}} = V_{\text{rms}}/R = 12/6.0 = 2.0 \text{ A}$ (1) [4]
Mean power = $V_{\text{rms}}I_{\text{rms}} = 12 \times 2.0 = 24 \text{ W}$ (1)
Peak power = $V_{\text{peak}}I_{\text{peak}} = 48 \text{ W}$ (1)
Peak power is twice the mean power (1).
- B4** $V_{\text{rms}} = V_{\text{peak}}/\sqrt{2} = 4.0/\sqrt{2}$ (1) [2]
 $V_{\text{rms}} = 2.83 \text{ V}$ (1)
- B5** Peak voltage = 325 V (1) [3]
 $\omega = 100\pi \text{ rad s}^{-1}$, so $f = \omega/2\pi = 50 \text{ Hz}$ (1)
 $V_{\text{rms}} = 325/\sqrt{2} = 230 \text{ V}$ (1)
- B6** $I_{\text{rms}} = 2.6/\sqrt{2} = 1.84 \text{ A}$ (1) [3]
 $P = I_{\text{rms}}^2 R = 1.84^2 \times 15$ (1)
 $P = 51 \text{ W}$ (1)

- B7** Peak-to-peak voltage = $6.4 \times 0.50 = 3.2 \text{ V}$ (1) [3]
 $V_{\text{peak}} = 3.2/2 = 1.6 \text{ V}$ (1)
 $V_{\text{rms}} = 1.6/\sqrt{2} = 1.13 \text{ V}$ (1)

SECTION C · Stretch

- C1** $T = 4.0 \times 5.0 \text{ ms} = 20 \text{ ms}$ (1) [4]
 $f = 1/T = 50 \text{ Hz}$ (1)
 $V_{\text{peak}} = 3.0 \times 2.0 = 6.0 \text{ V}$ (1)
 $V_{\text{rms}} = 6.0/\sqrt{2} = 4.24 \text{ V}$ (1)
- C2** Mean power = $V_{\text{rms}}^2/R = 230^2/100$ (1) [3]
 $P = 529 \text{ W}$ (1)
 The rms value is defined as the DC value giving the same average power in a resistor, so 230 V DC gives the same power (1).
- C3** The rms value is the steady (DC) equivalent for power dissipation (1); it [3]
 represents the effective heating or working value of the supply over a cycle (1); so AC and DC can be compared directly and average power calculated simply as $P = V_{\text{rms}}I_{\text{rms}}$ (1).
- C4** $P = V_{\text{rms}}^2/R$: for 2.0Ω , $P = 12^2/2.0 = 72 \text{ W}$ (1) [4]
 For 3.0Ω , $P = 12^2/3.0 = 48 \text{ W}$, below 60 W (1)
 Current check for the 2.0Ω element: $I_{\text{rms}} = 12/2.0 = 6.0 \text{ A}$, within the 7.0 A limit (1)
 Only the 2.0Ω element meets the 60 W requirement, so choose it (1)
- C5** dc: $P = V^2/R = 12^2/6.0 = 24 \text{ W}$ (1) [4]
 ac: $V_{\text{rms}} = 12/\sqrt{2} = 8.5 \text{ V}$ (1)
 $P = V_{\text{rms}}^2/R = 8.5^2/6.0 = 12 \text{ W}$ (1)
 The dc supply makes the lamp brighter, with twice the power, because the ac supply spends most of each cycle below its peak (1)
- C6** The power dissipated is proportional to v^2 , which is positive in both half-cycles [3]
 (1); the power is a maximum whenever the voltage reaches +peak or -peak, which happens twice per cycle (1); so the heating peaks at $2 \times 50 = 100$ times per second (1).