

Alternating Current MS

- M1.** (a) the square root of the mean of the squares of all the values of the voltage in one cycle **(1)**

or the equivalent dc/steady/constant voltage that produces the same heating effect/power **(1)**

1

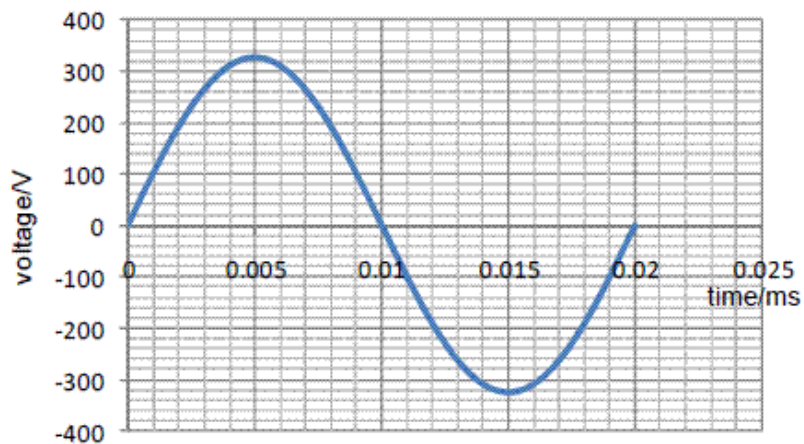
- (b) (i) peak voltage = $230 \times \sqrt{2}$ **(1)**
 peak voltage = 325 V (or 324 V) **(1)**

2

- (ii) average power = $230 \times 0.26 = 60$ W **(1)**

1

- (c)



shape and symmetrical with consistent values of x at $y = 0$ and consistent y_{\max} (must be at least one cycle) **(1)**

appropriate scale y-axis **(1)**

correct peak values (to within one 2 mm square) **(1)**

correct period (accept 0.02 or 20) **(1)**

4

[8]

- M2.** (a) (i) $T = 40$ (ms) **(1)**

$$f \left(= \frac{1}{T} \right) = 25 \text{ Hz} \text{ (1)}$$

(allow C.E. for value of T)

(ii) peak voltage ($= 3 \times 15$) = 45 (V) **(1)**

$$\text{rms voltage} = \frac{45}{\sqrt{2}} = 32 \text{ V (1)}$$

(31.8 V)

4

(b) (i) $I_{\text{rms}} = \frac{31.8}{540} = 59 \text{ mA (1)}$

(58.9 mA)

(use of 32 V gives 59.2 mA)

(allow C.E. for value of V_{rms} from (a))

(ii) $V_{\text{rms}} = 59 \times 10^{-3} \times 90 = 5.3(1) \text{ V (1)}$

(allow C.E. for value of I_{rms} from (i)) [or $V_2 = V_1 \frac{R_2}{R_1 + R_2}$]

2

(c) $V_{\text{peak}} = 5.31 \times \sqrt{2} = 7.5(1) \text{ (V) (1)}$

best choice: 5 V per division **(1)**

(allow C.E. for incorrect V_{rms} and for suitable reason)

reason: others would give too large or too small a trace **(1)**

3

[9]

M3. (a) ($V = IR$ gives) $V_{\text{rms}} = (5.3 \times 10^{-3} \times 2 \times 10^3) = 10.6 \text{ (V) (1)}$

$$V_0 = V_{\text{rms}} \sqrt{2} = 10.6\sqrt{2} = 15 \text{ V (1) (14.99 V)}$$

[or calculate I_0 (= 7.5 mA) and then V_0]

2

(b) (use of $T = \frac{1}{f}$ gives) $T = \frac{1}{500} = 2 \times 10^{-3} = 2.0 \text{ (ms) (1)}$

trace to show:

correct wave shape (sinusoidal) **(1)**

correct amplitude (3 divisions) **(1)**

correct period (8 divisions) **(1)**

4

[6]

- M4.** (a) (i) (use of $V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$ gives) $V_0 = 7.1\sqrt{2} = 10 \text{ V}$ **(1)**
 (ii) $T = 10 \text{ (ms)}$ **(1)**

(use of $f = \frac{1}{T}$ gives) $f = \frac{1}{10 \times 10^{-3}} = 100 \text{ Hz}$ **(1)**

3

- (b) control 1: time base **(1)** (or time period)

(use of $T = \frac{1}{f}$ gives) $T = \frac{1}{200} = 5 \times 10^{-3} \text{ (s)}$ **(1)**

setting = 2.5 ms (div⁻¹) **(1)**

control 2: voltage sensitivity or Y-plate setting (or Y-gain) **(1)**

setting = 20 V (div⁻¹) **(1)**

5

[8]

- M5.** (a) (i) use of 1.5 cycles **(1)**
 conversion to time eg time for 1.5 cycles = $10 \times 1.5 = 15\text{ms}$ **(1)**
 calculation of frequency eg frequency = $1 / 0.010 = 100 \pm 3\text{Hz}$ **(1)**
 (ii) peak voltage = 1.5×2 **(1)** = 3.0V **(1)**
 (iii) rms voltage = $3.0/\sqrt{2}$ **(1)** (ce from (a) (i))
 rms voltage = 2.12V **(1)**

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- (b) vertical line is formed **(1)**

of length equal to twice the peak voltage **(1)**

because trace no longer moves horizontally
 or spot moves **just** up and down **(1)**

max 2

[9]

M6. (i) 10.0 (V) **(1)**

1

(ii) $V_{\text{rms}} = 10.0/\sqrt{2} = 7.1$ (V) **(1)**

1

(iii) time period = $3 \times 2 = 6$ (ms) **(1)**

1

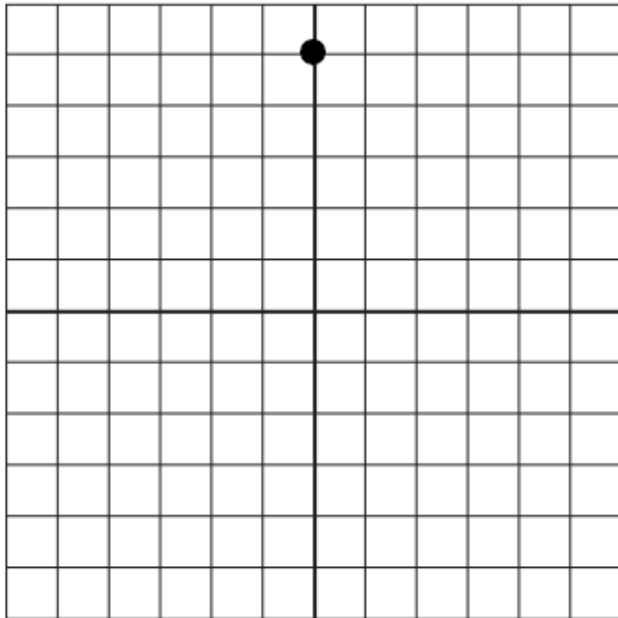
(iv) frequency = $1/0.006$ or $1/6$ **(1)**

frequency = 167 **(1)** (Hz)

2

[5]

M7. (a)



1

- (b) (i) the **voltage reverse/changes** direction/sign ✓
 this makes **the spot** move up and down **or** correct
 explanation of lack of horizontal movement ✓ 2
- (ii) length of line = 8 divisions
 peak to peak = $8 \times 0.5 = 4.0 \text{ V}$ ✓✓ 2
- (iii) (peak = 2.0 V)
 rms = $2.0/\sqrt{2} = 1.4 \text{ V}$ ✓ 2

[7]

M8. (a) $V_0 = \sqrt{2} V_{\text{rms}} = \sqrt{2} \times 4.2 \text{ V}$ (1) (5.94 V)
 $V_{\text{p-p}} (= 2 \times V_0) = 2 \times 5.94 = 11.8 \text{ V}$ (1) 2

(b) (i) voltage sensitivity = $11.8/5.9 = 2.0 \text{ V div}^{-1}$ (1)
 (ii) $T (= 1/f = 1/2500) = 4.0 \times 10^{-4} \text{ s}$ (1)
 time base = $4.0 \times 10^{-4}/8 = 5.0 \times 10^{-5} \text{ s div}^{-1}$ (1) 3

(c) (i) spot at $(1.75/0.5) = 3.5 \text{ div}$ (1)
 (ii) (use of sum of emf = sum of pd)
 $1.75 = I (3.5 + 10)$ (1)
 $I = 0.13 \text{ A}$ (1)
 (iii) $V (= RI = 10 \times 0.13) = 1.3 \text{ V}$ (1)
 [or $V = \epsilon - Ir = 1.75 - 0.13 \times 3.5 = 1.3 \text{ V}$]
 spot at $(1.3/0.5) = 2.6 \text{ div}$ (1) (accept 2.5 to 2.75 div) 5

[10]

- M9. (a) The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.**

The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria.

High Level (Good to excellent): 5 or 6 marks

The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question.

The candidate states that the power supply is connected to the input of the oscilloscope. The time base is switched off and the y gain adjusted until a complete vertical line is seen on the screen. The length of the line is measured and this is converted to peak to peak voltage using the calibration. The peak voltage is divided by root two to get the rms voltage and this is compared with the stated value. The time base is now switched on and adjusted until a minimum of one cycle is seen on the screen. The length of one cycle is measured and this is converted to time using the time base setting. Frequency is the reciprocal of this time.

Intermediate Level (Modest to adequate): 3 or 4 marks

The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate.

The candidate states that the power supply is connected to the input of the oscilloscope. The y gain adjusted. The length of the line/height of peak is measured. The peak voltage is divided by root two to get the rms voltage. The time base is now switched on and adjusted until a minimum of one cycle is seen on the screen. The length of one cycle is measured and this is converted to time using the time base setting.

Low Level (Poor to limited): 1 or 2 marks

The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate.

The candidate states that the power supply is connected to the input of the oscilloscope. The length of the line/height of peak is measured. The time base is now switched on and adjusted until a minimum of one cycle is seen on the screen. The length of one cycle is measured and this is converted to time.

The explanation expected in a competent answer should include a coherent selection of the following points concerning the physical principles involved and their consequences in this case.

- power supply connected to oscilloscope input
- time base initially switched off
- y gain adjusted to get as long a line as possible
- length of line used to find peak to peak voltage
- rms voltage found
- time base switched on and adjusted to get several cycles on the screen
- use the time base setting to find period
- use period to find frequency
- compare vales with stated values

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(b) (i) (use of $P = IV$)

$$I = 24/12 = 2.0 \text{ (A)} \checkmark$$

1

(ii) peak current = $\sqrt{2} \times 2.0 = 2.8 \text{ (A)} \checkmark$

1

(iii) peak power = $\sqrt{2} \times 12 \times \sqrt{2} \times 2.0 \checkmark = 48 \text{ (W)} \checkmark$

2

[10]