

Name of the Student: _____

Max. Marks : 17 Marks

Time : 17 Minutes

Mark Schemes

Q1.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|-----------------|--|---|------|
| (a) | <ul style="list-style-type: none"> As graphene is only 1 atom thick so the CSA/thickness is far smaller than for a sample of steel Or most applications need a thickness greater than one atom Or if more than one layer of graphene is used it will be weaker or the bonds between the layers will not be strong Or Graphene is difficult to manufacture because it has only one atomic layer (1) Although graphene has a greater breaking stress it will break at a lower force (1) | MP1: accept graphene can only be 1 atom thick but steel can be any thickness (MP1, treat references to cost/energy as neutral) | 2 |

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|-----------------|--|---|------|
| (b) | <ul style="list-style-type: none"> Use of depth of graphite = $100 \times$ diameter of 1 carbon atom (1) Use of cross-sectional area = depth \times (0.5×10^{-3} m) (1) Use of $\rho = \frac{RA}{l}$ (1) $\rho = 3.6 \times 10^{-5} \Omega \text{ m}$ Or $36 \mu\Omega \text{ m}$ | <u>Example of calculation</u> Depth of graphite = $100 \times 1.4 \times 10^{-10} \text{ m} = 1.4 \times 10^{-8} \text{ m}$ CSA = $1.4 \times 10^{-8} \text{ m} \times 0.50 \times 10^{-3} \text{ m} = 7.0 \times 10^{-12} \text{ m}^2$ $\rho = \frac{1.029 \times 10^6 \Omega \times 7.0 \times 10^{-12} \text{ m}^2}{0.200 \text{ m}} = 3.6 \times 10^{-5} \Omega \text{ m}$ | 4 |

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|-----------------|---|--|------|
| (c) | <p>Max 3</p> <ul style="list-style-type: none"> • Silicon will only release a (photo) electron for a limited range of frequencies/wavelengths (1) • Silicon releases only one (photo) <u>electron</u> per incident photon (1) • Greater current (for the same illumination) in graphene (1) • Graphene (cells are) more efficient Or graphene cells could be smaller / cheaper / thinner | MP1: accept single frequency for limited range | 3 |

Q2.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|-----------------|---|---|------|
| (i) | <ul style="list-style-type: none"> • Use of γ-sensitivity value (1) • $V_0 = 4.0 \text{ V}$ (1) | <p><u>Example of calculation:</u> $V_0 = 2 \times 2.0 \text{ V} = 4.0 \text{ V}$</p> | 2 |
| (ii) | <ul style="list-style-type: none"> • Use of $I = \frac{V}{R}$ (1) • Use of $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$ (1) Or use of $V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$ (1) • $I_{\text{rms}} = 0.019 \text{ A}$ ECF from(i) (1) | <p><u>Example of calculation</u> $I_0 = \frac{4.0 \text{ V}}{150 \Omega} = 0.0267 \text{ A}$ $I_{\text{rms}} = \frac{0.0267 \text{ A}}{\sqrt{2}} = 0.0189 \text{ A}$</p> | 3 |
| (iii) | <ul style="list-style-type: none"> • Use of $R = R_1 + R_2$ (1) • Use of $P = I^2 R$ (or other valid power equation) (1) • $P = 0.096 \text{ W}$ ECF from(i) and (ii) (1) | <p><u>Example of calculation:</u> $R = 150 \Omega + 120 \Omega = 270 \Omega$ $P = I^2 R$ $= (0.019 \text{ A})^2$ $\times 270 \Omega = 0.0964 \text{ W}$</p> | 3 |