# Teacher Resource Bank

GCE Physics

Sample AS EMPA:

- Mark Schemes

## Sample AS EMPA Mark Scheme

### Section A Task 1

| Question 1 | | | |
|---|---|---|---|
| (a) | table 1: | three readings, all to 0.01 V, row 1 > row 2 > row 3 ✓ | **1** |
| (b) | table 2: | pd across $R_1$ = (table 1 row 1 – table 2 row 2)<br>pd across $R_2$ = (table 1 row 1 – table 1 row 3)<br>pd across $R_3$ = (table 1 row 3)<br>pd across $R_2 \approx$ pd across $R_3$<br>all 4 criteria met ✓✓ any 3 criteria met ✓ | **2** |
| (c) | explanation:<br><br><br>deduction: | resistances $R_1$, $R_2$ and $R_3$ are in series ✓<br>current in resistors is the same ✓<br>pd across a resistor $\propto$ resistance of the resistor ✓<br>$R_1$ is the smallest resistance ✓<br>$R_2 = R_3$ ✓ | **max 2**<br><br><br>**2** |
| (d) | table 3: | two readings to 0.01 V, row 1 > row 2 ✓ | **1** |
| (e) | table 4: | pd across $R_1$ = (table 1 row 1 – table 3 row 1)<br>pd across $R_2$ and $R_4$ = (table 3 row 1 – table 3 row 2)<br>pd across $R_3$ = (table 3 row 2)<br>pd across $R_1 \approx$ pd across $R_2$ and $R_4$<br>all 4 criteria met ✓✓ any 3 criteria met ✓ | **2** |
| (f) | explanation: | (from observation) pd across $R_1 \approx$ pd across $R_2$ and $R_4$ ✓<br>hence $R_1$ = **effective** resistance, $R_t$, of $R_2$ and $R_4$ ✓<br>$R_2$ and $R_4$ are in parallel; $\frac{1}{R_t} = \frac{1}{R_2} + \frac{1}{R_4}$ ✓<br>hence suggestion is correct ✓<br>[$R_2$ and $R_4$ are in parallel; $\frac{1}{R_t} = \frac{1}{R_2} + \frac{1}{R_4}$ ✓<br>if suggestion is correct, $R_1 \approx R_t$ ✓<br>and pd across $R_1 \approx$ pd across $R_2$ and $R_4$ ✓ hence suggestion is correct ✓] | **4** |
| | | **Total** | **14** |

**Section A Task 2**

| **Question 1** | | | |
|---|---|---|---|
| (a) & (b) | tabulation: | *V* /V *I* /mA ✓✓<br>insist on valid separator between quantity and unit; penalise if *V*/V is not in the left-hand column of the table (this should also be the case if separate tables are produced for (a) and (b)) | **2** |
| | results: | 8 sets of *V* and *I* with both sets positive, as in part (a) ✓<br>8 sets of *V* and *I* with both sets negative, as in part (b) ✓<br>V range $\geq$ 10 V ✓<br>for 5, 6 or 7 sets positive and 5, 6 or 7 sets negative, lose 1 mark | **3** |
| | significant figures: | all *V* to 0.01 V or all 0.001 V ✓<br>all *I* to 0.01 mA or all to 0.001 mA ✓ | **2** |
| | quality: | all points to ± 2 mm of suitable line, positive gradient (judge from graph, providing this is suitably-scaled) ✓ | **1** |
| (c) | axes: | marked *I*/mA (vertical) and *V*/V (horizontal) ✓✓<br>deduct ½ for each missing, rounding down; **1 max** if axes reversed | **2** |
| | scales: | points should cover at least half the grid horizontally ✓ **and** half the grid vertically ✓<br>(if necessary, a false origin should be used to meet these criteria; either or both marks may be lost for use of a difficult or non-linear scale or if the interval between the numerical values are marked on an axis with a frequency of > 5 cm) | **2** |
| | points: | 5 points plotted correctly in positive quadrant (check at least two) and 5 points plotted correctly in negative quadrant (check at least three) ✓✓✓<br>marks are deducted for points > 1 mm from correct position and if poorly marked | **3** |
| | line: | with 2 straight line (ruled) sections of positive gradients; smooth transition as gradients change ✓ | **1** |
| | | **Total** | **16** |

**Section B**

| **Question 1** | | |
|---|---|---|
| (a) or (b) | apply to **larger** of gradient triangles<br>*y*-step at least 8 cm and *x*-step at least 8 cm ✓<br>(if a poorly-scaled graph is drawn the hypotenuse of the gradient triangle should be extended to meet the 8 × 8 criteria)<br>correct transfer of *y*-step and *x*-step data between graph and calculation ✓<br>(mark is withheld if points used to determine either step > 1 mm from correct position on grid; if tabulated points are used these must lie on the line) | **2** |
| (c) | $\frac{G_1}{G_2}$ ,no unit, in range 1.56 to 1.72 or 1.6 ✓✓ [1.48 to 1.81 or 1.7 ✓]<br>no credit here if axes are reversed on graph | **2** |
| | **Total** | **4** |

| **Question 2** | | |
|---|---|---|
| | (idea that) Ohm's law obeyed where $I \propto V$ ✓<br>correct statement for negative *V*, e.g. always Ohmic ✓<br>correct statement for positive *V*, e.g. Ohmic up to V = 1.2 V ± 0.1 V ✓<br>(last two points may be earned for an appropriately annotated sketch) | **3** |
| | **Total** | **3** |

| **Question 3** | | |
|---|---|---|
| (a) (i) & (ii) | correct calculation of ($R_1 + R_3$) from $G_1^{-1}$, no order of magnitude errors;<br>correct calculation of ($R_1 + R_2 + R_3$) from $G_2^{-1}$, no order of magnitude errors ✓ | **1** |
| (b) (i)<br><br>(ii) | $R_2$ = difference (a) (ii) – (a) (i); allow order of magnitude error here ✓<br>$R_2$ in range 1620 Ω to 1980 Ω ✓<br>$R_1$ = difference (a) (ii) – 2 × (a) (i); allow order of magnitude error here ✓<br>$R_1$ in range 800 Ω to 1200 Ω ✓ | **4** |
| | **Total** | **5** |

| **Question 4** | | |
|---|---|---|
| (a) | percentage uncertainty in pd across $R_1$ = 3.13% ✓ [allow 3.125% or 3.1%]<br>percentage uncertainty in pd across $R_2$ = 1.72% ✓ [allow 1.717% or 1.7%] | **2** |
| (b) (i)<br><br><br>(ii) | percentage uncertainty in (pd across) $R_1$ result added to uncertainty in (pd across) $R_2$ result ✓<br>4.84% ✓ [allow 4.842% or 4.8%]<br>absolute uncertainty in $\frac{R_2}{R_1}$ = 1.82 × answer to (b)(i) ✓<br>absolute uncertainty in $\frac{R_2}{R_1}$ = 0.088, no unit ✓ [allow 0.09] | **4** |
| | **Total** | **6** |

| **Question 5** | | |
|---|---|---|
| (a) (i)<br><br>(ii) | when contact is at T, pd across X = E ✓<br>when contact is at L, pd across X = 0 ✓<br>when contact is at T, pd across X = E ✓<br>when contact is at L, pd across X > 0 ✓ | **4** |
| (b) (i)<br>(ii) | range of *I* and *V* data is greater ✓<br>interval between each set of *I* and *V* data is smaller ✓<br>greater **precision** can be achieved ✓ | **3** |
| | **Total** | **7** |
| | **Section B Total** | **25** |