AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2011

Physics   PHA3/B3/XPM1
(Specifications A and B)

Unit 3   **Investigative and Practical Skills in AS Physics**
Route X Externally Marked Practical Assignment (EMPA)

Section A   Part 1

For this paper you must have:
- a calculator
- a pencil
- a ruler.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for Section A Part 1 is 16.

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

Section A Part 1

Follow the instructions given below.

Answer **all** the questions in the spaces provided.

No description of the experiment is required.

1 You are to identify the diameter of a wire and the material from which it is made.

1 (a) Wire is manufactured in certain diameters under a system known as the *English Standard Wire Gauge*, each diameter of wire being identified by a particular SWG number.
Table 1 shows the diameter of wires with certain SWG numbers.

Table 1

SWG number	16	20	22	24	28	30
diameter / mm	1.626	0.914	0.711	0.559	0.376	0.315

1 (a) (i) You are provided with about 20 cm of loose wire.
Use the micrometer screw gauge to determine d, the diameter of this wire.

....

....

$d =$ ....

1 (a) (ii) Identify the SWG number of the wire you have been given.

SWG number = ...
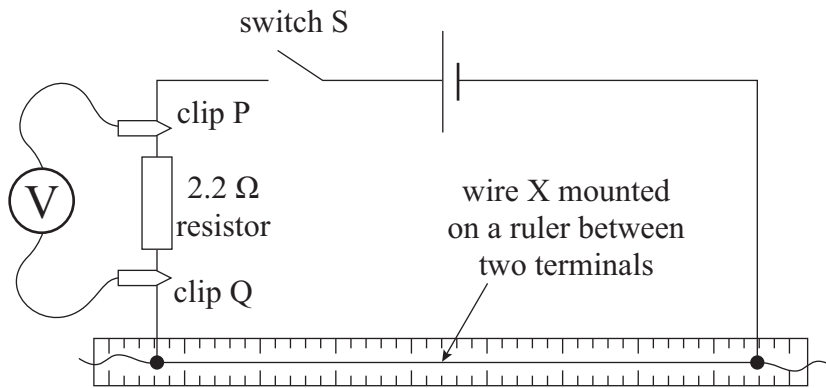
(2 marks)

Question 1 continues on the next page

Turn over ▶

1 **(b)** You are provided with a circuit that includes a wire X, mounted on a ruler between two terminals. The wire is connected in series with a $2.2\,\Omega$ resistor, a power supply and a switch S. Connect the voltmeter in parallel with the resistor by attaching the clips P and Q to the exposed legs of the resistor, as shown in **Figure 1**.
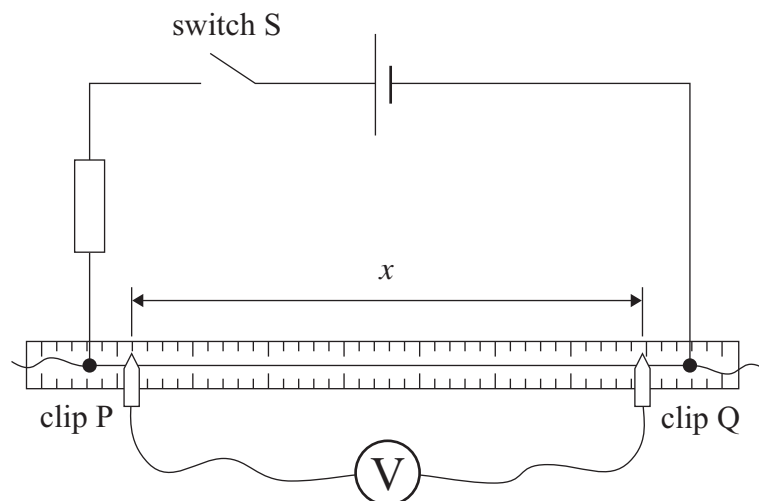
Figure 1

1 **(b)** **(i)** Close switch S, then read and record the voltmeter reading, V_1.

V_1 = ...

Open switch S and disconnect the clips from the resistor, then reattach P and Q at points along the wire X close to each of the round terminals, as shown in **Figure 2**.

Figure 2

1 **(b)** **(ii)** Close switch S, then read and record the new voltmeter reading, V_2.

V_2 = ...

Open switch S before moving on to the next part of the question.

1 **(b)** **(iii)** Use the ruler readings to determine the length, x, of wire between the clips P and Q.

....

$x = $ ....

1 **(b)** **(iv)** The resistance of the wire between P and Q is given by $2.2 \times \dfrac{V_2}{V_1}$.

Calculate the resistance of the wire between P and Q.

....

resistance of the wire between P and Q = ...

(2 marks)

1 **(c)** The uncertainty in V_1 and in V_2 is $\pm 10\,\text{mV}$.

1 **(c)** **(i)** Calculate the percentage uncertainty in V_1.

....

....

percentage uncertainty in $V_1 = $ ....

1 **(c)** **(ii)** Calculate the percentage uncertainty in V_2.

....

....

percentage uncertainty in $V_2 = $ ....

(2 marks)

1 **(d)** The percentage uncertainty in the resistance of the $2.2\,\Omega$ resistor is 5%.

Calculate the percentage uncertainty in the resistance of the wire between P and Q.

....

....

percentage uncertainty in resistance of wire between P and Q = ...

(1 mark)

Question 1 continues on the next page

Turn over ▶

1 (e) X is a wire of the same material and diameter as that you used in part (a).
The material from which X has been made can be identified by measuring its
resistance per unit length, ie the resistance of 1 metre of the wire.
Use your answers to part (a) and part (b) and the information contained in **Table 2** to
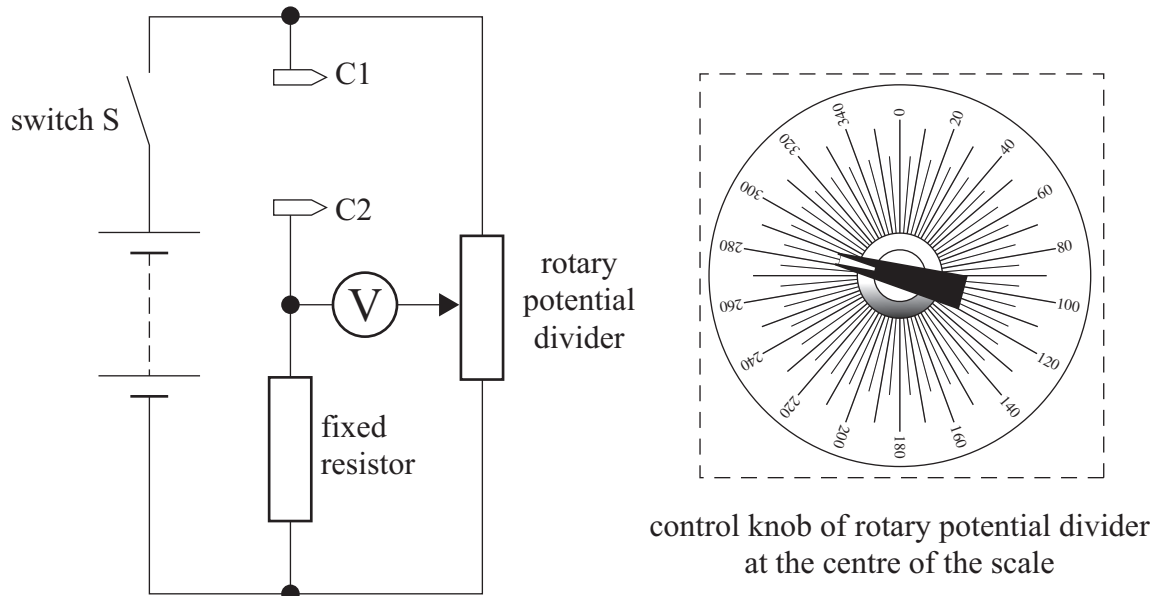determine the material from which X has been made.

Table 2

SWG number	resistance per metre of wire / Ω m^{-1}				
	tinned copper	*manganin*	*constantan*	*chromel*	*nichrome*
16	0.00831	0.200	0.234	0.337	0.517
20	0.0263	0.633	0.747	1.07	1.64
22	0.0434	1.05	1.23	1.76	2.70
24	0.0703	1.69	2.00	2.85	4.37
28	0.155	3.74	4.41	6.30	9.66
30	0.221	5.33	6.29	8.98	13.8

....

....

....

material from which X has been made = ...

(2 marks)

9

2   You are to determine the resistance of an unknown resistor using the circuit shown in
Figure 3.

Figure 3

control knob of rotary potential divider
at the centre of the scale

You are provided with six resistors of known resistance.
Connect the 1 kΩ resistor between clips C1 and C2 and close switch S.
Rotate the control knob of the rotary potential divider **fully** anti-clockwise. Check that the
voltmeter shows a negative reading.
Slowly rotate the control knob in a clockwise direction until the voltmeter reading just starts
to change.

2   **(a)**   **(i)**   Read and record the position, θ_0 of the control knob against the scale.

$\theta_0 =$ ....

Question 2 continues on the next page

2 **(a)** **(ii)** Rotate the control knob further in a clockwise direction until the voltmeter reading becomes zero.
Read and record in **Table 3** below, the new position, θ, of the control knob against the scale.

2 **(a)** **(iii)** Remove the $1\,k\Omega$ resistor from clips C1 and C2 then repeat the procedure in part (a)(ii) to read values of θ when each of the remaining resistors of known resistance R are connected, in turn, between clips C1 and C2.
Record the values of θ for each of these resistors in **Table 3** then complete the right-hand column to show the corresponding values of $(\theta - \theta_0)$.
When you have completed these readings remove the resistor from C1 and C2 and open switch S.

Table 3

$R\,/\,k\Omega$	$\theta\,/\,^\circ$	$(\theta - \theta_0)\,/\,^\circ$
1.0		
2.7		
5.6		
15.0		
27.0		
39.0		

(2 marks)

2 **(b)** Plot, on the grid on **page 9**, a graph with $(\theta - \theta_0)\,/\,^\circ$ on the vertical axis and $R\,/\,k\Omega$ on the horizontal axis.

(3 marks)

2 **(c)** You are provided with another resistor, U, of unknown resistance R_U.
Connect U between clips C1 and C2 and close switch S.

2 **(c)** **(i)** Adjust the position of the control knob until the voltmeter reading becomes zero then read and record the position, θ_U, of the control knob against the scale.
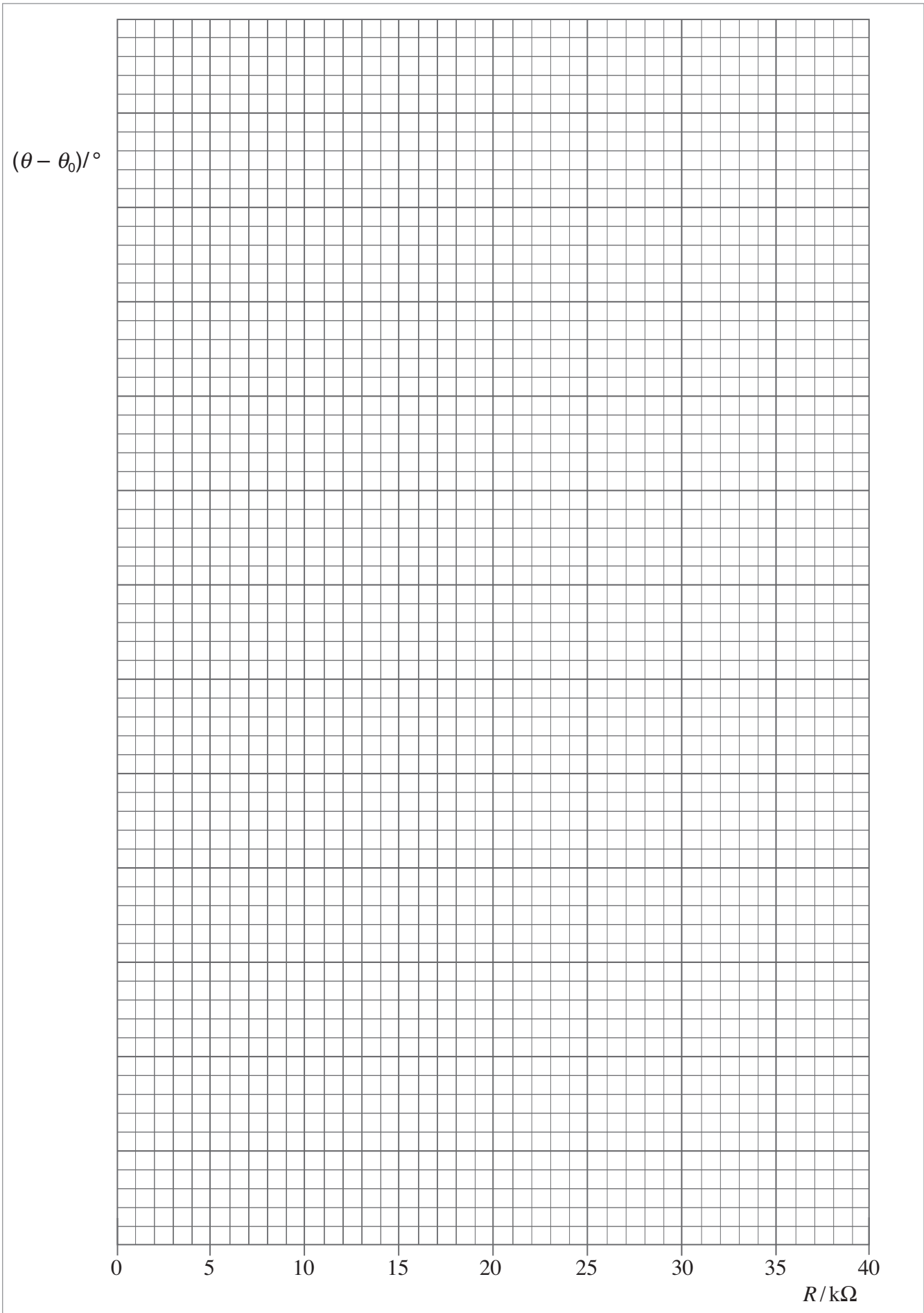
$\theta_U = $ ....

2 **(c)** **(ii)** Showing your working clearly, use your graph to determine R_U.

$R_U = $ ....

(2 marks)

END OF SECTION A PART 1

$(\theta - \theta_0)/°$

$R/\,\mathrm{k\Omega}$

0   5   10   15   20   25   30   35   40

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