Centre Number						Candidate Number				
Surname						Other Names				

Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature		Date	

For Teacher's Use	
Section	Mark
PSA	
Stage 1	
Section A	
Section B	
TOTAL (max 50)	

General Certificate of Education
Advanced Level Examination
June 2011

Physics (Specification A & B) PHY6T/Q11/test

Unit 6T A2 Investigative Skills Assignment (ISA) Q

For submission by 15 May 2011

For this paper you must have:	**Time allowed**
• your documentation from Stage 1 • a ruler with millimetre measurement • a calculator.	• 1 hour
Instructions:	**Information**
• 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 space provided. Do not write outside the box around each page or on blank pages. • Do all rough work in this book. Cross through any work you do not want to be marked.	• The marks for questions are shown in brackets. • The maximum mark for this paper and Stage 1 is 41.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes give the details below or on a separate page.

Yes ☐ No ☐

Teacher Declaration:
I confirm that the candidate's work was conducted under the conditions laid out by the specification. I have authenticated the candidate's work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate.

Signature of teacher ..... Date.....

Section A

Answer **all** questions in the spaces provided.
You should refer to your documentation from Stage 1 as necessary.

1 (a) State the control variable in your experiment.

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(1 mark)

1 (b) Calculate the percentage uncertainty in the smallest mean pd, V_{10}.

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(1 mark)

1 (c) Discuss **two** factors which determine the accuracy of the measurement of V_{10}.

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(4 marks)

1 (d) State **two** ways in which a data logger instead of a voltmeter and stopclock, would improve the accuracy in the measurement of V_{10}.

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(2 marks)

1 (e) For a capacitor of capacitance C discharging through a resistor of resistance R the potential difference across the capacitor is given by the equation

$$V = V_0\, e^{-t/RC}$$

where V is the pd across the capacitor at time, t, and V_0 is the pd across the capacitor at time $t = 0$

1 (e) (i) Use the above equation to show that $\ln\left(\frac{V_0}{V_{10}}\right) = \frac{10}{RC}$

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(1 mark)

1 (e) (ii) Explain how the capacitance of the capacitor can be determined from the graph in your experiment.

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(1 mark)

10

Turn over for the next question

Section B

2 The decay of a radioactive substance follows a similar pattern to the discharge of a capacitor through a resistor. It can be represented by the equation

$$A = A_0 e^{-\lambda t}$$

where A = the activity of the sample at time t
A_0 = the initial activity at time $t = 0$
λ = the decay constant

The half life, $T_{1/2}$ of the radioactive substance is given by

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

An experiment was performed to determine the half-life of a radioactive substance which was a beta emitter. The radioactive source was placed close to a detector. The total count for exactly 5 minutes was recorded. This was repeated at 20 minute intervals. The results are shown in the table below.

time, t / minutes	**total count, C, recorded in 5 minutes**	**count rate, R / counts minute^{-1}**	**corrected count rate, R_C / counts minute^{-1}**	**ln (R_C / minute^{-1})**
0	1016	203	183	5.21
20	892	178	158	5.06
40	774	155	135	4.90
60	665	133	113	4.73
80	608	122	102	4.62
100	546	109	89	4.49
120	495			
140	429			

2 (a) A correction has been made to the count rate, R, to give the corrected count rate, R_C. Explain why this correction has been made and deduce its value from the table.

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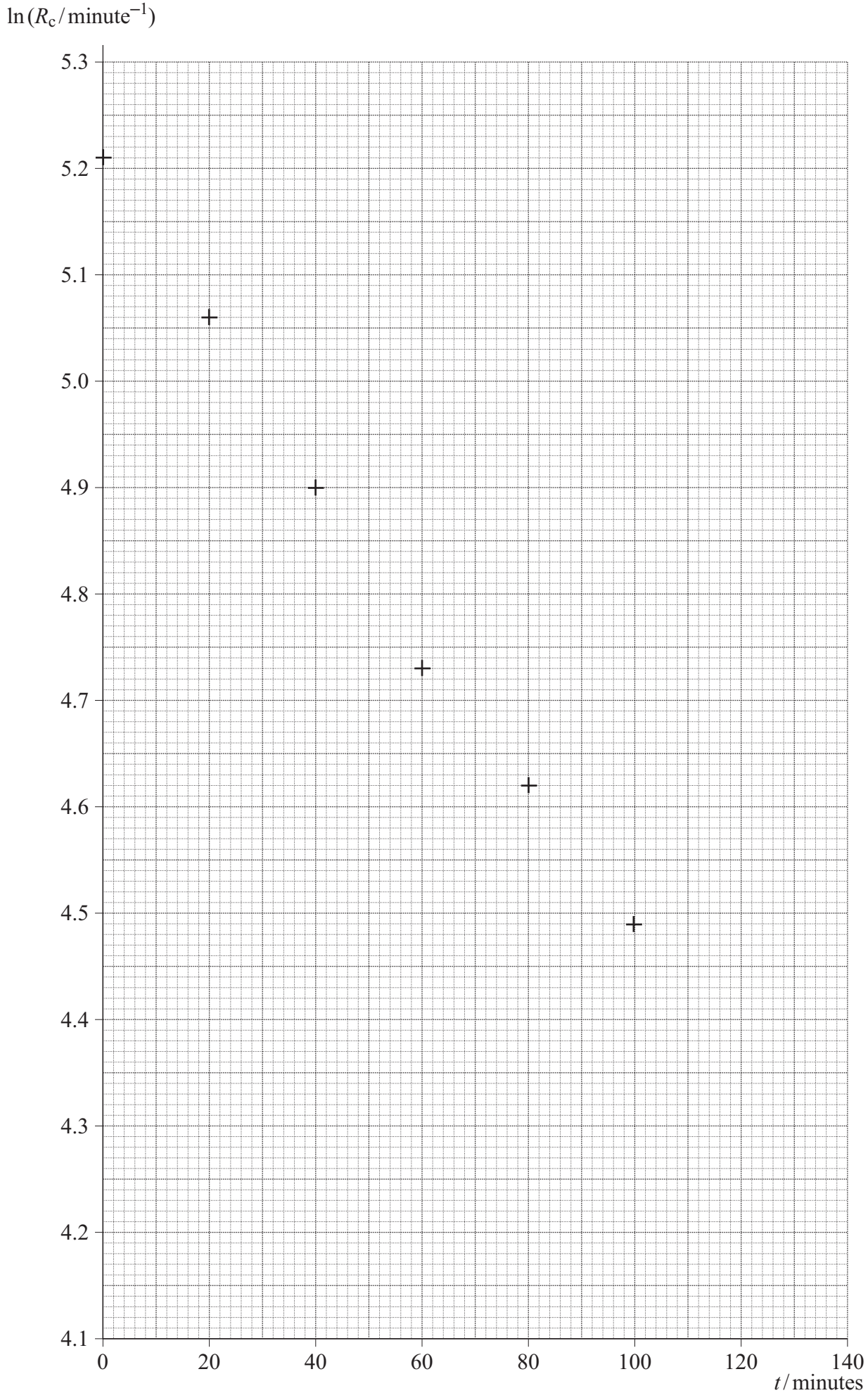
(2 marks)



Question 2 continues on the next page

2 (b) Complete the table on **page 4** by entering values for the count rate, R, the corrected count rate, R_C and $\ln(R_C / \text{minute}^{-1})$, corresponding to times 120 minutes and 140 minutes respectively.

(2 marks)

2 (c) Complete the graph on **page 5** by plotting the remaining two points. Draw an appropriate straight line through the plotted points.

(2 marks)

2 (d) Determine the gradient G of your graph.

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(3 marks)

2 (e) Use your graph to determine the half-life in minutes of the radioactive substance used in this experiment.

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half-life, $T_{1/2}$ ..... minutes

(2 marks)

11

3 (a) Due to the nature of a radioactive decay there will be an uncertainty in the total count recorded. What type of error is this called?

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(1 mark)

3 (b) (i) It can be shown that the error in the total count C, is given by

$$\text{uncertainty in total count } C = \pm \sqrt{C}$$

Using data from the table on page 4, calculate the uncertainty **in the smallest total count, *C***.

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(1 mark)

3 (b) (ii) Hence calculate the percentage uncertainty in the **smallest total count, *C***.

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(1 mark)

3 (b) (iii) Another student performed the same experiment with identical equipment but took total counts over a 1 minute period rather than a 5-minute period. The total count, C, at 140 minutes was equal to 84 counts. Estimate the percentage uncertainty in this total count, and hence explain the advantage of using a larger time.

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(2 marks)

5

Turn over ▶

4 (a) (i) If the detector had been moved further away from the source in this experiment, discuss how this would have affected the results and accuracy.

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(3 marks)

4 (a) (ii) If a graph of $\ln(R_C / \text{minute}^{-1})$ against time were drawn for these results, state what features of the graph would be similar and what features would be different to the graph on **page 5**.

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(3 marks)

4 (b) State **two** essential safety precautions when handling radioactive sources in experimental work.

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(1 mark)

END OF QUESTIONS

7