| 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 Subsidiary Examination
June 2011

# Physics (Specification A & B) PHY3T/P11/test

## Unit 3T AS Investigative Skills Assignment (ISA) P

## For submission by 15 May 2011

| **For this paper you must have:** | **Time allowed** |
|---|---|
| • your documentation from Stage 1<br>• a ruler with millimetre measurement<br>• a calculator. | • 1 hour |
| **Instructions:** | **Information** |
| • Use black ink or black ball-point pen.<br>• Fill in the boxes at the top of this page.<br>• Answer **all** questions.<br>• You must answer the questions in the space provided. Do not write outside the box around each page or on blank pages.<br>• 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.<br>• 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)** Tick the box next to the statement which best describes the relationship between $s$ and $h$ as shown by your graph.

(A) $s$ is proportional to $h$ ☐

(B) $s$ increases linearly with $h$ ☐

(C) $s$ is not related to $h$ ☐

(D) $s$ has a non-linear relationship with $h$ ☐

*(1 mark)*

**1 (b) (i)** State the uncertainty in your measurement of $h$.

.....

**1 (b) (ii)** Use data from your table to estimate the uncertainty in your largest mean value of $s$.

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**1 (b) (iii)** State and explain your estimate for the uncertainty in your measurement of the diameter, $d$, of the table tennis ball.

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*(4 marks)*

**1 (c)** The loss in gravitational potential energy, $\Delta E_P$, of a body falling near to the Earth's surface is given by

$$\Delta E_P = mgx$$

where $mg$ is the weight of the ball and $x$ is the vertical distance through which its centre of mass falls.

**1 (c) (i)** In your experiment $x = h - d$. Calculate $x$ for your smallest value of $h$.

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.....

**1 (c) (ii)** Using your answers to parts **(b)(i)** and **(b)(iii)**, estimate the uncertainty in your value for $x$.

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**1 (c) (iii)** Calculate $\Delta E_P$ for your smallest value of $h$.

$mg = 0.026 \pm 0.001$ N.

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**1 (c) (iv)** Determine the percentage uncertainty in $\Delta E_P$.

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*(6 marks)*

11

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## Section B

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

**2** A toy manufacturer needs a material to absorb some of the kinetic energy of a hollow rigid ball of diameter 10 cm when it collides with a flat surface. One suitability test for such a material is a variation of the experiment carried out in Stage 1. The ball is dropped onto a sample of the material which is placed on a flat horizontal surface and the height of the first bounce is recorded.

**2 (a)** The ball was first dropped from a height $h = 1.620\,\text{m}$ directly onto the flat surface without a sample of the material in place.

The mass of the ball was 0.125 kg and the height, $s_0$, of its first bounce was 1.149 m.

The kinetic energy, $\Delta E_0$, lost during the collision is given by the equation

$$\Delta E_0 = mg\,(h - s_0)$$

$g = 9.81\,\text{N kg}^{-1}$

Show that $\Delta E_0 = 0.578\,\text{J}$.

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*(1 mark)*

**Question 2 continues on the next page**

**2 (b)** The test was carried out on different sample thicknesses, $t$, of the material and the following data were recorded.

| **sample thickness $t$ / mm** | **height of rebound $s$ / m** | **energy absorbed $E$ / J** |
|---|---|---|
| 0.50 | 0.824 | 0.401 |
| 1.00 | 0.679 | 0.579 |
| 1.50 | 0.515 | 0.781 |
| 2.00 | 0.371 | 0.958 |
| 2.50 | 0.222 | |
| 3.00 | 0.121 | |
| 3.50 | 0.100* | |
| 4.00 | 0.100* | 1.292 |

*Note: The ball did not bounce. The diameter of the ball is 0.100 m, so this is the height to the top of the ball.

The energy, $E$, absorbed by the material is given by

$$E = mg\,(h–s) – \Delta E_0$$

The drop height, $h$, was 1.620 m and the weight, $mg$, was 1.23 N; both were unchanged throughout the tests.

$$\Delta E_0 = 0.578\,\text{J}.$$

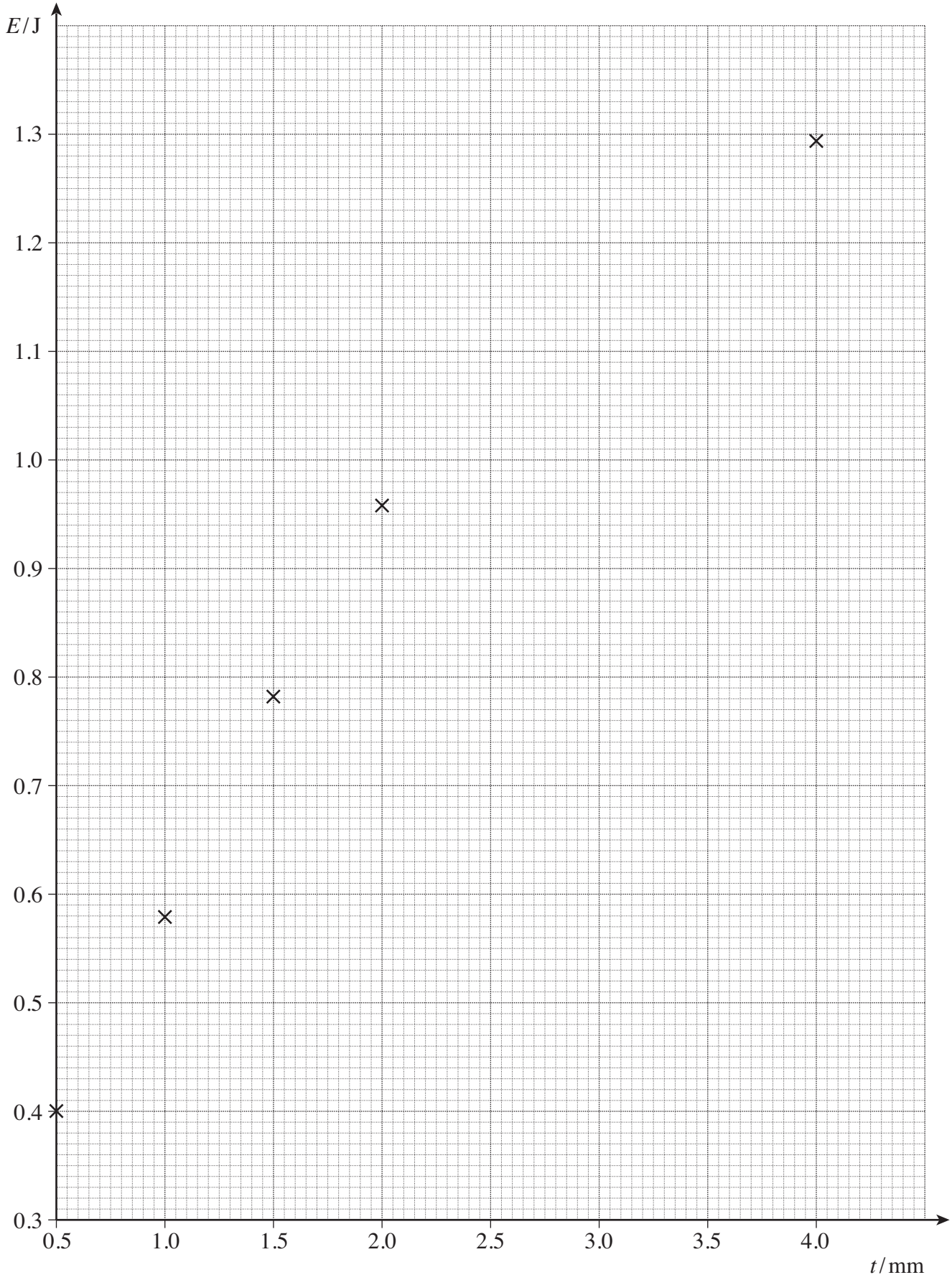
Complete the table by filling in the missing values of $E$.

*(1 mark)*

**2 (c)** Complete the graph on **page 7** by plotting the missing three points and drawing a line of best fit.

*(2 marks)*

**Graph of energy absorbed against material thickness**




**Question 2 continues on the next page**

**2 (d) (i)** Determine the gradient of the initial portion of the graph of $E$ against $t$.

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**2 (d) (ii)** State the unit of the quantity represented by the gradient you found in part **(d)(i)**.

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*(4 marks)*

**2 (e) (i)** Use the graph on **page 7** to determine the minimum thickness of material needed to absorb all of the kinetic energy of the ball during the collision.

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**2 (e) (ii)** Use the graph on **page 7** to determine the thickness of material needed to absorb 70% of the kinetic energy of the ball during the collision.

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*(3 marks)*

**2 (f) (i)** The thickness, $t$, of each sample tested was measured using a micrometer with a precision of ± 0.01 mm.
Calculate the percentage uncertainty in the measurement for the sample of thickness 1.50 mm.

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**2 (f) (ii)** The height, $s$, of the rebound was measured electronically with a precision of ± 1 mm.
For the test when $t$ = 1.50 mm, which is the more accurate: the measurement of $t$, or the measurement of $s$?
Explain your reasoning.

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*(3 marks)*

**14**

**3** The temperature of the 10 cm diameter ball referred to in Question 2 may affect the height to which it bounces. Describe an experiment, based on your experiment in Stage 1, which would enable you to investigate whether or not temperature does affect the height of the bounce. You should consider safety issues and the reduction of random errors in this experiment.

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*(5 marks)*

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**END OF QUESTIONS**

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