| 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 2013

# Physics (Specification A & B) PHY3T/Q13/test

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

## For submission by 15 May 2013

| **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)** Suggest why the 330 Ω resistor was connected in series with the LED in Stage 1.

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*(1 mark)*

**1 (b) (i)** Use your graph to calculate the resistance of the LED when the current is 1.5 mA.

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*(2 marks)*

**1 (b) (ii)** Using the precision of your meters, calculate the percentage uncertainty in your answer to part 1(b)(i).

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*(2 marks)*

**1 (c)** Without further calculation, describe how the resistance of the LED changes with potential difference (pd) in the **forward** direction.

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*(2 marks)*

**1 (d) (i)** Draw the best fit straight line through the steepest part of your graph.

*(1 mark)*

**1 (d) (ii)** Extrapolate this line to give the intercept on the pd axis. Record this value as $V_{min}$.

$V_{min}$ = .....

*(1 mark)*

**1 (e)** State what your results indicate about the resistance of the LED when the pd is in the **reverse** direction.

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*(1 mark)*

**10**

## Section B

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

**2** In a similar experiment to the one you performed in Stage 1, a set of LEDs emitting light of different colours was used. The current-pd curve for each LED in the forward direction was plotted and $V_{min}$, the intercept on the pd axis, was recorded. The results are given in the table, together with the average wavelength, $\lambda$, and frequency, $f$, of the radiation from the LEDs.

| **colour** | **wavelength $\lambda$ / nm** | **frequency $f$ / $10^{14}$ Hz** | **minimum pd $V_{min}$ / V** |
|---|---|---|---|
| infrared | 940 | 3.19 | 0.92 |
| red | 665 | 4.51 | 1.54 |
| orange | 625 | 4.80 | 1.54 |
| yellow | 595 | 5.04 | 1.78 |
| green | 565 | | 1.87 |
| blue | 470 | | 2.37 |

**2 (a)** Use $\lambda f = c$, where $c = 3.00 \times 10^8\ m\ s^{-1}$ to complete the table.

*(1 mark)*

**2 (b)** Complete the graph by plotting the missing two points and drawing a straight line of best fit.

*(2 marks)*

**2 (c) (i)** Determine the gradient of the graph.

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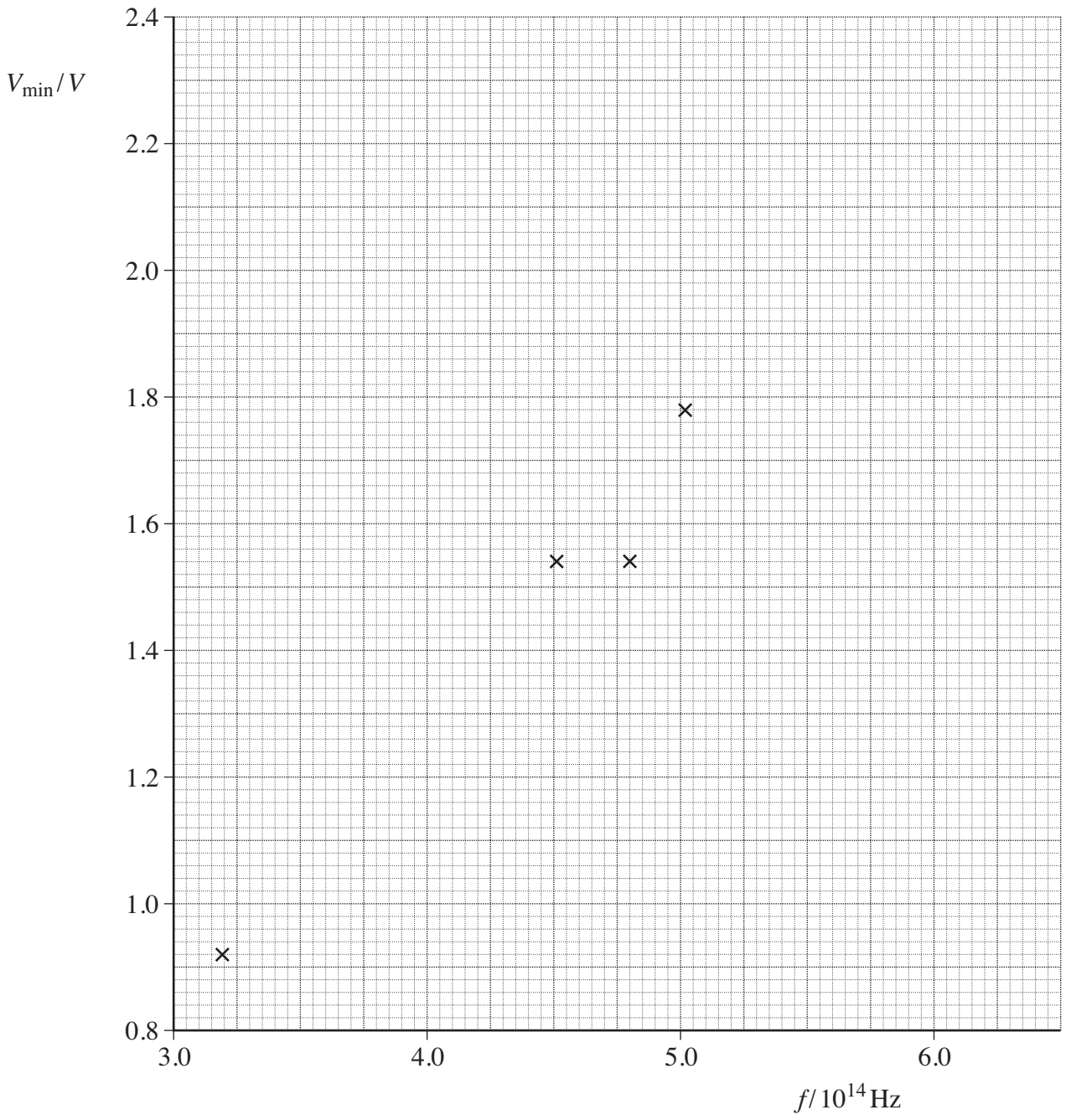
*(3 marks)*

**Graph of minimum pd against frequency**



**2 (c) (ii)** Discuss the reliability of your value for the gradient.

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*(2 marks)*

**2 (d)** Theory predicts that the energy lost by the electron in passing through the LED is the energy of the emitted photon. Hence

$$eV_{\text{min}} = hf,$$

where $h$ is the Planck constant and $e = 1.60 \times 10^{-19}$ C.

**2 (d) (i)** Find a value for $h$ by using the general equation of a straight line, $y = mx + c$, and your answer to part (c)(i).

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*(3 marks)*

**2 (d) (ii)** The accepted value for $h = 6.63 \times 10^{-34}$ J s. Calculate the percentage difference between the value calculated in part (d)(i) and the accepted value.

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*(1 mark)*

**2 (d) (iii)** The precision of the voltmeter was ± 0.01 V. Calculate the percentage uncertainty this produces in the value of $V_{min}$ for the infrared radiation.

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*(1 mark)*

**2 (d) (iv)** A student assumes that the percentage difference calculated in part (d)(ii) is due only to the uncertainty in $V_{min}$, as determined in part (d)(iii), and the uncertainty in the frequency. Using this assumption calculate the uncertainty in the value of the infrared frequency quoted in the table.

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*(3 marks)*

**2 (d) (v)** The student's assumption about the uncertainty in part (d)(iv) is not justified. Suggest **two** other sources of experimental error in the experiment which could have contributed to the discrepancy calculated in part (d)(ii).

Source of error 1 .....

.....

Source of error 2 .....

.....

*(2 marks)*

**18**

**3** A set of LEDs is used to provide a colour display. Red, green and blue LEDs produce the full range of required colours. When all LEDs emit the same light intensity white light is observed.

Describe how you would investigate whether or not the intensity of the light emitted from each LED in the set is the same when operated at the same current. Assume that you are provided with a light sensor which responds equally to light of all wavelengths, together with any other laboratory equipment that you might need.

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*(5 marks)*

**5**

**END OF QUESTIONS**