2011 GCSE PHYSICS CHALLENGE PAPER

ONE HOUR PHYSICS COMPETITION PAPER

Friday 11th March

We hope teachers will set and mark the enclosed paper for their GCSE Physics students, or equivalent students in Scotland.

The solutions and marking scheme are contained herein.

It is intended that the paper should be taken on **Friday 11th March**. However, if this is not possible, any date during the period 9th to 15th March will be acceptable.

Scripts of the Gold Medallists, the entry form and the requests for certificates must be posted in sufficient time to arrive by first class post on **Wednesday 16th March 2011** at the Olympiad Office at the University of Oxford. Any scripts arriving after this date cannot be considered for an award.

After the scripts have been marked please send to the Oxford office:

- those scripts with marks of 38 and above (the scripts of the Gold Medal
- Certificate students) in order to be considered for the award of a book
- Prize (it is recommended that you keep a photocopy of the scripts)
- the entry form, which is on the following page
- the request form for certificates
- the completed teacher questionnaire

We will invite the five outstanding Gold Medallists, together with their teachers, to the Physics Challenge Presentation Ceremony at The Royal Society in London on **Thursday 28th April 2011**. Prizes and certificates will be despatched to all remaining medallists, who are not amongst those invited to the Presentation in May. Teachers are requested to complete the certificates according to the medal scheme specified on the last page, and present them to their students.

Oxford Office: Dr S. Owen
BPhO Office
Physics Challenge Competition
Department of Physics
Clarendon Laboratory
Parks Road,
University of Oxford
Oxford, OX1 3PU

Physics Challenge 2011 - Mark scheme

Please award marks as indicated below.

Equivalent valid reasoning should gain equal credit to the solutions presented here.

Error carried forward marks may be awarded where an incorrect answer is used as part of the data needed for a subsequent question, providing that the resulting answer is not plainly ridiculous.

If incorrect units are used more than once then **one** mark should be deducted from the total.

If an inappropriate number of significant figures are given more than once in final answers then **one** mark should be deducted from the total.

Section 1 – Multiple Choice Questions

1	2	3	4	5	6	7	8	9	10
A	B	C	D	C	C	D	B	D	A

Section 2 – Short Answer Questions

Marks for these two questions should be awarded for a clear explanation of the underlying Physical principals using correct scientific terminology. Answers that are incomplete, contain errors in Physics or use terminology incorrectly cannot be awarded full credit.

Award 0 marks: No valid attempt made to answer question
Award 1 mark: Valid point presented but other-wise incorrect or incomplete answer
Award 2 marks: Partially correct answer but major error or omission in reasoning
Award 3 marks: Mostly correct answer, only minor errors or omissions in reasoning
Award 4 marks: Completely correct answer, no errors, omissions of reasoning or incorrect use of terminology

Question 11. (4 max)

- Water / ethanol evaporates
- Only highest energy particles have enough energy to escape / evaporate
- Therefore average energy of remaining particles decreases
- Temperature depends on average energy of particles
- Therefore temperature of water / ethanol goes down (and you feel cold)

Question 12. (4 max)

- Temperature increases and so resistance of thermistor decreases (2)
- Therefore current in circuit increases
- Therefore voltage across resistor increases

(Give full marks for resistance of thermistor increases, current decreases, voltage decreases)

Section 3 – Longer Questions

Question 13

(a)(i)

- Volume = 0.2 x 0.2 x 0.2 = 0.008 m^3 → mass = 3.2kg [1]
- Weight = 32 N [1]

(a)(ii)

- Mass = 8kg → Weight = 80N [1]

(a)(iii)

- T = U - W [1]
- T = 80 – 32 = 48 N [1]

(b)

- Use of F = ma rearranged to give a = F/m [1]
- Giving a = 48 / 3.2 = 15 m/s^2 [1]

(c)

- Velocity and time axes labelled [1]
- Curve, with initial velocity = 0, reaching a steady terminal velocity [1]

(d)(i)

- Acceleration axes labelled with an initial value of 15 m/s^2 [1]
- Following a smooth curve to show acceleration becoming zero [1]

(d)(ii)

- Initial acceleration shown as greater [1]
- Labelled as 15.6 m/s^2 [1]
- Following a smooth curve to show acceleration becoming zero (any curve tending to zero is acceptable as long as it is similar to graph A) [1]

(d)(iii)

- Acceleration axes labelled with initial value of 15m/s^2 [1]
- Smooth curve to reach zero acceleration more quickly than graph A [1]

Question 14

(a)

- Correct circuit shown including ammeter and voltmeter (-1 for any error) [2]

(b)

- Repeat readings (or any other appropriate technique) [1]

(c)

- Appropriate scales used [1]
- Points plotted accurately [1]
- Best fit line – accept either straight line through first 6 points or through all 8 points. [1]

(d)

- Resistance increases as temperature increases [1]
- Points at $80^{o}C$ and $90^{o}C$ do not fit trend [1]

(e)

- Any suitable method to give $\alpha = 0.1\ \Omega\ /^{o}C$ [1]
- Any suitable method to give $R_o = 18\ \Omega$ (allow $\pm 0.5\ \Omega$) [1]

(f)

- Units $\Omega\ /^{o}C$ [1]

Question 15

(a)

- Volume ice = $0.2 \times 10^{-3}\ m^3$
- Mass ice = $920 \times 0.2 \times 10^{-3} = 0.184$ kg [1]
- Energy required to turn ice to water = $0.184 \times 334 \times 10^{3} = 61456$ J [1]
- Energy lost by water = $V \times 4200 \times 72 = 302400 \times V$ [1]
- Thus $V = 61456 / 302400 = 0.203$ litres = 0.203 kg (accept 0.2 kg) [1]

(b)

- Energy transferred to the surroundings [1]