

Physics Challenge 2014 Mark-scheme

Preamble:

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 mark each]

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

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.

Markers are encouraged to be generous and award credit where possible.

- Award 0 marks: No valid attempt made to answer question
- Award 1 mark: Single valid point presented but other-wise incorrect or incomplete
- Award 2 marks: Partially correct answer but major error(s) or omission(s) in reasoning
- Award 3 marks: Mostly correct answer, only minor error(s) or omission(s) in reasoning
- Award 4 marks: Essentially correct answer, no errors or omissions of reasoning but answer is not clear on first reading or uses terminology incorrectly
- Award 5 marks: Completely correct answer, no errors, omissions of reasoning or incorrect use of terminology, clear on first reading

Any valid explanation should be awarded credit. Example solutions might include:

11. Block on a slope [5 marks]
- Friction force depends on normal force
 - As angle increases, normal force decreases
 - Therefore friction force decreases
 - Component of weight causes block to slide down slope
 - As angle increases, a greater component of the weight acts down the slope
 - When force down slope exceeds friction force, block slides
12. Parallel Circuit [5 marks]
- Brightness of X decreases
 - When switch closed current through resistor increases
 - Therefore, potential difference across resistor increases
 - Potential difference across X decreases
 - Therefore current through X decreases
- Or
- Resistance of the X Y pair halves
 - But (because of fixed R in series) the resistance of the circuit is not halved
 - So the current in the circuit does not double
 - So current through the X Y pair does not double
 - X Y in parallel so take equal current
 - So the current through X must be less than before

Section 3 – Longer Answers

13. Sprinter

- a) Use of area under graph = displacement [1]
Correct use Area = $9v + \frac{1}{2} 2v = 100$ [1]
to give $v = 10$ m/s [1]
(accept reverse argument using $v = 10$ m/s to show displacement = 100m)
- b) Acceleration = $10/2 = 5$ m/s² [1]
 $F = 70 \times 5 = 350$ N [1]
- c) Area: $100 = (\frac{1}{2} \times 10 \times t) + (10.99 - t) \times 10$ [1]
Any correct calculation or partial calculation [1]
To give $t = 9.9 / 5 = 1.98$ s [1]
Allow equal credit for alternative solutions
- d) Acceleration = $10 / 1.98 = 5.05$ m/s² [1]
Giving resultant force = $5.05 \times 70 = 353.5$ N [1]
Extra force = $353.5 - 350.0 = 3.5$ N [1]
- e) Use of $u^2 = 3.5 / 0.7$ [1]
Giving $u = 2.25$ m/s [1]
- f) After a short time, sprinter is running faster than 2.25 m/s [1]
and so the following wind is no longer a following wind [1]
Accept any other reasonable answer, be generous.
However, answers must relate to the approximation of the effect of following wind and not to other unrelated factors.

14. Fibre Optics

- a) Use of $\sin(C) = 1.6 / 1.7$ [1]
Giving $C = 70.3^\circ$ [1]
- b) Use of any correct geometry [1]
and correct use of $d = 0.6 \text{ mm}$ [1]
to give path difference of 64 m [2]
Speed in fibre = $3 \times 10^8 / 1.7 = 1.76 \times 10^8 \text{ m/s}$ [1]
Therefore time difference = $64 / 1.76 \times 10^8 = 3.6 \times 10^{-7} \text{ s}$ [1]
- c) Time period of signal = $2 \times 3.6 \times 10^{-7} \text{ s}$ [1]
Use of $f = 1 / T$ [1]
Giving frequency = 1.4 MHz [1]
($T = 0.4 \mu\text{s}$ giving $f = 2.5 \text{ MHz}$ scores 2 marks)
- d) (i) No effect [1]
Path difference remains the same [1]
(ii) Decreases maximum frequency [1]
Critical angle decreases, path difference increases [1]