Physics Challenge 2016

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	E	D	A	B	B	C	B

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, is confused 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, but are not limited to:

11. Walking on Ice [5 marks]

- To start walking (moving) from rest or to maintain motion reduced by a resistance it is necessary to accelerate.
- For an object to accelerate a resultant force is required. (Newton's Second Law)
- To provide the necessary resultant force we push our foot backwards across the ground.
- The motion of our foot across the ground is resisted by a force of friction applied in the opposite direction to the motion of our foot. (Newton's Third Law)
- The friction force acting on our foot provides the necessary resultant force to enable us to accelerate in the forward direction.

12. Properties of a Thermistor [5 marks]

- The thermistor is a resistor and as the voltage increases the current increases.
- The current through the thermistor causes (ohmic) heating and so the resistance of the thermistor decreases. Therefore the current rises more due to both the increase in voltage and the decrease in resistance.
- At some point electrical energy is being transferred to thermal energy at a greater rate than the thermal energy is radiated away and the thermistor cannot maintain a thermal equilibrium – the temperature continues to rise.
- Increasing temperature reinforces the reduction in resistance and the subsequent increase in current and thermal runaway occurs.

Section 3 – Longer Answers

Question 13

(a)	Correct calculation of volume = 1.3×10^{-3} m^3	[1]
	Used with density equation to give mass = 10.05 kg	[1]
(b)	Weight or Force = 100 N	[1]
	Stress = 80 kPa	[1]
(c)	Reverse of (a) and (b) to give Weight = 503 kN	[1]
	and Length = 5000 m	[1]
(d)	(stated) NO effect	[1]
	because Area in Weight term and so cancels (owtte)	[1]
(e)	To support mass, Force = 34,000 N	[1]
	To provide acceleration, Resultant Force = 8500 N	[1]
	Maximum force = 42,500 N	[1]
(f)	Maximum Stress = 100 MPa	
	Therefore maximum Weight supported = 126 kN	[1]
	So maximum weight of cable = 83,500 N	[1]
	Giving a maximum length of 830 m	[1]

Question 14

(a)	Calculation of wave speed (s=d/t) to give 0.22 ms^{-1}, 0.27 ms^{-1} and 0.33 ms^{-1}	[1]
	Calculation of √g from c/√d to give 3.17, 3.22 and 3.19 $m^{½}$ s^{-1}	[1]
	Appreciation that ratio is roughly constant validates relationship	[1]
	Calculation of g from ratio gives values of 10.1, 10.4 and 10.2 ms^{-2}	[1]
	Full credit for reverse argument i.e. use g and d to calculate speeds and compare	
	Full credit for a graphical solution to show relationship	
(b)	Use of d=0.9m with equation to give c = 3 ms^{-1}	[2]
(c)(i)	Arrow perpendicular to wave heading towards beach	[1]
	Wave at a shallower angle to the beach	[1]
(c)(ii)	Speed in region B = 2.45 ms^{-1}	[1]
	Appreciation that angle to normal is also 30°, could be on diagram	[1]
	Use of equation to give angle to shore of 24°	[1]
(d)	Use of c=f λ and f=1/T to give a wavelength of 30 m	[2]
(e)	At least four or five waves progressing towards beach	[1]
	Curving / changing direction to become parallel to shore	[1]
	and getting closer together	[1]