Physics Challenge 2012 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 A – Multiple Choice Questions

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

Section B – Short Answer Questions

Marks for these two questions should be awarded for a clear explanation of the underlying physical principles 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

11. Dispersion

- White light is made up of many different colours
- The light refracts towards the normal when it enters the prism and away from the normal as it leaves
- The amount of refraction depends on the speed of the light in the glass
- Each colour has a different wavelength and travels at a different speed in the glass and therefore refracts by a different amount
- Red light has a longer wavelength and slows down the least and so is refracted the least
- Whilst blue light has a shorter wavelength and is slowed down more and so it refracts more
- Different colours change direction by different amounts and so white light is split up into the various colours

12. Transformer

- Electromagnetic induction occurs due to a changing magnetic field
- A changing magnetic field in the secondary coil induces a voltage across the secondary coil
- This changing magnetic field in the secondary coil is created by a changing magnetic field in the iron core or there is a changing field linking the secondary coil.
- A changing magnetic field in the iron core is produced by a changing current in the primary coil
- Therefore a.c. is required

Section C – Short Answer Questions

13. Bouncing Ball

a) Use of CoE: $mgh = 0.5mv^2$ or suvat [1]
gives $v = \sqrt{(10/0.5)} = 4.47$ m/s [1]

b) $v = 4.47 \times 0.9 = 4.0$ m/s [1]
use of CoE or suvat [1]
gives height = 0.81 m [1]

c) Showing height reducing [1]
Appropriate shape – exponential curve [1]
Not touching x-axis [1]

d) Ball has less velocity after each bounce [1]
and so ball achieves less height on each bounce [1]
and so takes less time to rise/fall [1]

14. Planetary Motion

a) Use of speed = distance / time and distance = $2\pi r$ [1]
Correct translation of units to give v = 29700 m/s [1]

b) Use of $k = T^2/R^3$ attempted [1]
to give 3.00×10^{-19} [1]
with units s^2/m^3 [1]
Note: correct values in other units acceptable e.g.
$k = 4.03 \times 10^{-20}$ $days^2/km^3$

c) Use of calculated value of k or use of ratios attempted [1]
to give T = 691 days (5.97×10^7 seconds) [1]
T used with R to give v = 24000 m/s [1]

d) East to West because Mars is travelling more slowly and appears to fall behind the motion of Earth, therefore its position in the sky appears further to the West each night (or words to that effect).
Note – mark awarded for correct answer **and** explanation. [1]

15. Potential Divider

a) Use of R_{Total} = 20 kΩ and V=IR [1]
to show that I = 12/20 k = 0.6 mA [1]

b) Use of V=IR or any equivalent method [1]
to **clearly show** V = 6.0 V [1]

c) 12 V - 5.5 V = 6.5 V [1]
therefore I_A = 6.5/10 k = 0.65 mA [1]

d) I_B = 5.5/10 k = 0.55 mA [1]

e) Current through voltmeter = 0.65 mA – 0.55 mA = 0.1 mA [1]
Therefore R_v = 5.5 V/0.1 mA = 55 kΩ [1]

f) Use of V_A=10 V and R_A=200 Ω giving I=50 mA [1]
so current through R_B is 30 mA and p.d = 2 V [1]
thus R = 67 Ω [1]