Question number	Answer	Notes	Marks
1 (a)	cell;	condone battery	1
(b)	(indicator) lamp;	allow (light) bulb, (filament) lamp	1
(c)	(fixed) resistor;	reject resistance	1
(d)	light dependent resistor / LDR;		1

Total for question 1 = 4 marks

Question number	Answer	Notes	Marks
3 (a)	D (2500 J); D is the only correct answer A is incorrect because this is the wasted output energy B is incorrect because this is the (useful – wasted) output energy C is incorrect because this is the useful output energy		1
(b)	any two from: MP1. there is a current in the coil / wire; MP2. coil / wire has resistance; MP3. electrical energy transferred to thermal energy;	 allow answer in terms of electron movement e.g. electrons move through coil allow electrons collide (with ions in the coil); condone electrical energy transferred to heat energy	2
(c) (i)	power = current × voltage;	allow in standard symbols and rearrangements e.g. P = I × V reject C, A for current reject W for power	1
(ii)	substitution OR rearrangement; evaluation to at least 3 s.f.; e.g. 2500 = I × 230 OR current = power / voltage (I =) 10.9 (A)	allow dimensionally correct substitution reject 10.8 (A) allow 10.86, 10.87, 10.869… (A)	2
(iii)	if current increases above 13A (for a sustained length of time); fuse (wire) melts / eq.; circuit is broken;	allow 'too large a current' condone 'fuse blows' allow current is cut off / eq.	3

Total for question 3 = 9 marks

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>4 (a)</td><td colspan="2"><table>
<tr><th>Statements</th><th>Tick</th></tr>
<tr><td>the light from the object passes through the image in a plane mirror</td><td></td></tr>
<tr><td>the light waves are longitudinal</td><td></td></tr>
<tr><td>the angle of incidence equals the angle of reflection</td><td>✓</td></tr>
<tr><td>the image in a plane mirror is virtual</td><td>✓</td></tr>
<tr><td>the incident ray is always at right angles to the reflected ray</td><td></td></tr>
</table>
1 mark for each correct tick;;
if more than two ticks, -1 for each additional tick to a minimum of zero</td><td>2</td></tr>
<tr><td>(b)</td><td>i = 45 (°);

r = 26 (°);</td><td>allow answers in range 43-47°
allow answers in range 24-28°</td><td>2</td></tr>
</table>

Question number	Answer	Notes	Marks
5 (a) (i)	voltage = current × resistance;	allow in standard symbols and rearrangements e.g. V = I × R reject C, A for current	1
(ii)	substitution; rearrangement; evaluation; unit; e.g. 4.80 = 0.42 × R (R =) 4.8 / 0.42 (R =) 11 ohms / Ω	 -1 if rounding error e.g. 11.42 allow 11.4, 11.43, 11.42857…	4
(b) (i)	charge = current × time;	allow in standard symbols and rearrangements e.g. Q = I × t reject C for current and charge	1
(ii)	dimensionally correct substitution; evaluation; e.g. (Q =) 0.42 × 45 (× 60) (Q =) 1100 (C)	can be scored even if time not converted to seconds allow 1130, 1134 (C) 18.9, 19 (C) gets 1 mark only	2
(iii)	time (to charge fully) increases; current reduces; (because) resistance of cable has increased;	 allow longer {wire / lead} has greater resistance	3

Total for question 5 = 11 marks

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>9 (a)</td><td>dimensionally correct substitution;
rearrangement;
evaluation of period in seconds;
period in minutes;

e.g.
$7.5 = \frac{2 \times \pi \times (780 + 6\,371)}{T}$
$(T =) \frac{2 \times \pi \times (780 + 6\,371)}{7.5}$
(T =) 5 991 (s)
(T =) 99.85 (mins)</td><td>no mark for equation as given

if R_E or height used instead of orbital radius then 3 marks max

allow range of 99-100 (mins)
10.89… , 88.9…gets 3 marks
653.45… , 5337… gets 2 marks</td><td>4</td></tr>
<tr><td>(b)</td><td>(number of revolutions = 24 × 60 / 99.8) = 14.42;</td><td>allow ECF from (a)
allow 14, 14.4</td><td>1</td></tr>
<tr><td>(c)</td><td><table><tr><th>Statements</th><th>Tick</th></tr><tr><td>the higher the speed, the lower the height of the satellite</td><td>✓</td></tr><tr><td>a greater period means that the satellite has a greater speed</td><td></td></tr><tr><td>satellites that orbit higher make more revolutions per day</td><td></td></tr><tr><td>lower height satellites have shorter periods</td><td>✓</td></tr><tr><td>satellites with a higher speed make fewer revolutions per day</td><td></td></tr><tr><td>the higher the number of revolutions per day, the shorter the period</td><td>✓</td></tr></table>
1 mark for each correct tick;;;
if more than three ticked, then -1 for each additional tick</td><td></td><td>3</td></tr>
</table>

Total for question 9 = 8 marks

Question number	Answer	Notes	Marks
11 (a)	A; A is the only correct answer B is incorrect because the amplitude of the alpha wave should be smaller than the amplitude of the delta wave C is incorrect because the frequency of the alpha wave should be higher than the amplitude of the delta wave D is incorrect because the amplitude of the alpha wave should be shorter than the amplitude of the delta wave and the frequency should be higher		1
(b)	B; B is the only correct answer A is incorrect because the motion arrows do not show vibrations C is incorrect because the motion arrows do not show vibrations D is incorrect because the motion arrows show vibrations, but in the wrong orientations compared to the direction of wave travel		1
(c)	any four from: MP1. rays A, B and C are refracted (at the boundary); MP2. A is un-deviated; MP3. C is more deviated than B; MP4. angles of incidence increase from A to B to C to D; MP5. ray D undergoes (total internal) reflection; MP6. ray D angle of incidence > critical angle;	 allow rays B and C refracted allow correct description of refraction e.g. 'rays B and C bend away from the normal' allow A does not change direction ignore A does not refract allow C bends more than B allow ray D undergoes TIR	4

Total for question 11 = 6 marks