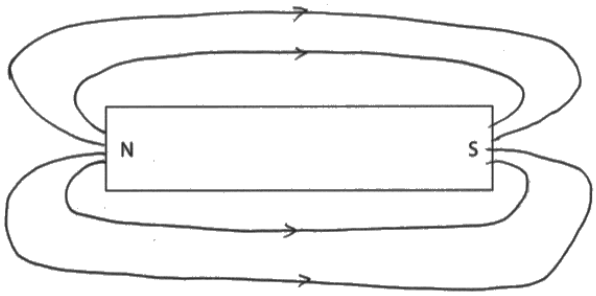
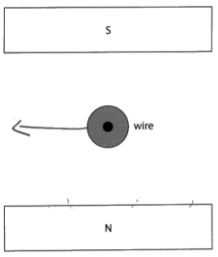
Question number	Answer	Notes	Marks
4 (a)	B (copper); A is incorrect because it is magnetic C is incorrect because it is magnetic D is incorrect because it is magnetic		1
(b)	field line connecting one pole to the other; at least two complete field lines, but none touching / crossing; all directions shown on field lines correct (N to S);  	allow small gap where field line joins magnet ignore field lines inside the magnet ignore field lines that start outside the pole region only one arrow required for the mark but contradictory directions negates the mark ignore arrow(s) inside the magnet	3
(c)	steel is magnetic / eq; (therefore) magnet stays magnetised (for a long period of time) /eq ;	 allow 'steel is a hard magnetic material' for both marks reject reference to charge	2

(d)	(i)	arrow drawn is horizontal; arrow drawn is to the left;  	ignore starting position of arrow judge by eye ignore field lines	2
	(ii)	Any two from: MP1 reference to weaker field MP2 moving magnets further apart MP3 use weaker magnets MP4 reference to lower current MP5 decreasing diameter of wire MP6 decrease voltage (of supply)	 increasing length of wire (in circuit)	2

Total for Question 4 = 10 marks

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>11 (a)</td><td>substitution into given formula;
evaluation of constant;

evaluation of constant for a second set of data;
conclusion consistent with candidate's evidence;
e.g. calculated value of constant doesn't change (much) so formula is justified
constant decreases so formula isn't justified

<table><tr><th>Distance from centre of Mars in km</th><th>Gravitational field strength in N/kg</th><th>Constant</th></tr><tr><td>4000</td><td>2.66</td><td>42560000</td></tr><tr><td>5000</td><td>1.70</td><td>42500000</td></tr><tr><td>6000</td><td>1.18</td><td>42480000</td></tr><tr><td>7000</td><td>0.87</td><td>42630000</td></tr><tr><td>8000</td><td>0.67</td><td>42880000</td></tr><tr><td>9000</td><td>0.53</td><td>42930000</td></tr></table></td><td>allow any consistent PoT

DOP</td><td>4</td></tr>
<tr><td>(b)</td><td>rearrangement of given formula;
substitution of constant and distance;

evaluation;

e.g.
gravitational field strength = constant / distance^2
gravitational field strength = 42 700 000 / 3410^2

gravitational field strength = 3.67 (N/kg)</td><td>allow ecf from (a)
allow mean constant
condone 3.7

allow range of 42 500 000 to 42 900 000 for constant
allow range of 3.65-3.69</td><td>3</td></tr>
</table>

Total for Question 11 = 7 marks