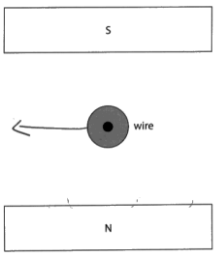
<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>1 (a)</td><td>3 correct ticks;;;
2 correct ticks;;
1 correct tick;
<table><tr><th>Statement</th><th>Correct</th></tr><tr><td>all electromagnetic waves are longitudinal</td><td></td></tr><tr><td>all electromagnetic waves travel at the same speed in free space</td><td>✓</td></tr><tr><td>radio waves have the longest wavelength in the electromagnetic spectrum</td><td>✓</td></tr><tr><td>x-rays have the highest frequency in the electromagnetic spectrum</td><td></td></tr><tr><td>all electromagnetic waves transfer energy</td><td>✓</td></tr><tr><td>all electromagnetic waves can cause cancer</td><td></td></tr></table></td><td>-1 for each additional tick if more than three ticks shown</td><td>3</td></tr>
<tr><td>(b) (i)</td><td>microwaves:
one valid use;
• communication /eq
• heating food /eq
one valid harmful effect;
• internal heating (of body tissue) / eq</td><td>allow other valid uses e.g. radar, locating rain clouds etc.
reject "cancer"
apply "list principle"</td><td>2</td></tr>
<tr><td>(ii)</td><td>gamma rays:
one valid use;
• sterilising {food / medical equipment}
• kill microbes or bacteria;
• treating cancer / radiotherapy;
• medical tracing
one valid harmful effect;
• ionisation / mutation of cells /eq
• risk of cancer</td><td>allow other valid uses e.g. gamma photography, identifying cancer etc.
condone damages or kills cells or tissues</td><td>2</td></tr>
</table>

Total for Question 1 = 7 marks

Question number	Answer	Notes	Marks
2 (a)	C (the Moon); A is incorrect because comets orbit stars B is incorrect because Mars orbits the Sun D is incorrect because the Sun orbits in the Milky Way galaxy		1
(b)	D (gravitational); A is incorrect because there is no air in space; B is incorrect because the ISS is not charged; C is incorrect because friction would act in the opposite direction to motion, not towards Earth		1
(c) (i)	substitution into given formula ($v= 2\pi r/T$); conversion of minutes to seconds; evaluation; e.g. orbital speed = $2 \times \pi \times 6.8\times10^3$ / 93(×60) 93 minutes = 93 × 60 (= 5580 seconds) (orbital speed =) 7.7 (km/s)	mark independently -1 for POT errors if km/s changed to m/s unnecessarily allow 7.656... 459.4, 15.31, 27565, 7.6 scores 2 marks	3
(ii)	successful conversion of orbital period and a day into the same unit; evaluation of ratio to 15.48... to at least 3 sf; e.g. 1 day = 24 × 60 = 1440 minutes 1440/93 =15.5	e.g. 1 day = 24 hours = 1440 mins = 86400 seconds, 1 orbit = 0.0645 days=1.55 hours=5580 seconds, allow use of number of orbits = distance travelled in 24 hours ÷ circumference of orbit	2

Total for question 2 = 7 marks

(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

Question number	Answer	Notes	Marks
9 (a) (i)	recall of (unbalanced) force = mass × acceleration; substitution and rearrangement; evaluation to 2 s.f. or more; e.g. F = m × a a = 41000 / 830 a = 49 (m/s^2)	allow symbols can be implied from valid substitution of data allow 49.39...	3
(ii)	substitution into $v^2 = u^2 + 2as$; rearrangement; evaluation; e.g. $26^2 = 72^2 + 2\times(-50)\times s$ (distance =) 5184-676 / 100 (distance =) 45 (m)	allow ecf from (i) expect answers in range 45-46 (m) reject 72-26 = 46 (wrong physics) accept 46 if unqualified	3
(b)	kinetic energy (store) of car decreases; thermal energy (store) of brake(s) increases; energy transferred mechanically;	kinetic energy/ KE of car transforms to {heat/thermal} energy of brakes due to work done by {friction / brakes} NB only award from either the answer column or notes column, not from a mix of the two.	3
(c)	any two from: MP1. idea that insulating materials are poor conductors; MP2. layers trap air; MP3. air itself is a poor conductor/(good) insulator MP4. (energy transfer due to / rate of) conduction reduces; MP5. idea increased thickness reduces (rate of) conduction	 condone idea of stopping conduction	2

Total for Question 9 = 11 marks

Question number	Answer	Notes	Marks
10 (a) (i)	pressure difference = height × density × *g*;	allow in words or standard symbols e.g. p = h × ρ × *g* condone d for density	1
(ii)	substitution; evaluation of pressure difference in kPa; evaluation of total pressure by adding 100 (kPa); e.g. (pressure difference =) 35 × 1000 × 10 (pressure difference =) 350 (kPa) (pressure = 350 + 100 =) 450 (kPa)	allow 343 (kPa) for use of g=9.8 N/kg ECF candidate's water pressure allow 443 (kPa) for use of g=9.8(1) N/kg allow 450 000 Pa with clear intent from candidate i.e. removal of 'k' from unit on answer line. -1 for POT error but not if due to physics error such as missing *g*, substitution of 100 (kPa) for g 350 kPa gets 2 marks 350 100 kPa gets 2 marks unqualified 350 000 (kPa) gets 1 mark	3
(b) (i)	pressure = force ÷ area;	allow in words or standard symbols e.g. p = F / A	1
(ii)	substitution; rearrangement; evaluation; corresponding unit of area; e.g. 260 000 = 430 / area (area =) 430 / 260 000 (area =) 0.0017 m^2	condone pressure in Pa or kPa accept standard form i.e. 1.7×10^{-3} (m^2) allow 0.0016538... m^2 etc allow 17, 16.5... (cm^2) etc allow 1.65... m^2 scores 3 allow 1.65...cm^2 scores 2	4
(c)	pressure (at bottom) is greater than before / eq; wider base /eq;	allow stronger material/eq ignore taller	2

Total for Question 10 = 11 marks