

Question number	Answer	Notes	Marks
1(a)	any two from  MP1. (same) speed(in a vacuum); MP2. transverse waves; MP3. travel through vacuum/do not require a medium; MP4. em wave/spectrum; MP5. carry information ; MP6. transfer energy;	ignore  refraction reflection diffraction interference heat produced by Sun effects on body do not accept unqualified energy	(2)
(b)	infrared: skin burns;  ultraviolet: damage to surface cells; OR blindness;	ignore for IR skin cancer/ cell mutation /sunburn  accept causes (skin) cancer for UV sunburn for UV damage to eye for UV	(2)
(c)	red;		(1)

**Total for Question 1 = 5 marks**

Question number	Answer	Notes	Marks
2 (a)	A carbon;		(1)
(b)	A negatively charged electrons;		(1)
(c)	D steel;		(1)
(d)	C 2 N poles facing;		(1)

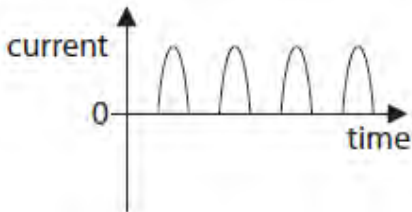
**Total for Question 2 = 4 marks**

Question number	Answer	Notes	Marks
3 (a)	C the Solar System;		(1)
(b)	small circle centred on Q;		(1)
(c)	correct shape;  correct orbit, star is clearly not at the centre of the orbit;	accept <ul style="list-style-type: none"> <li>• 'open' ellipse /eq</li> <li>• oval</li> <li>• hyperbola</li> </ul> it is not necessary that perihelion < orbital radius of S	(2)
(d) (i)	Any one comparison from: MP1. smaller {orbital path/ distance travelled} for close planets; MP2. larger speed for close planets;	Allow reverse arguments accept smaller orbital radius  ignore lack of gravity all refs to time	(1)
(ii)	C planet S makes more orbits than P;		(1)
(e) (i)	250 (million km);		(1)
(ii)	150 (million km);		(1)

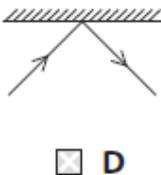
**Total for Question 3 = 8 marks**

Question number	Answer	Notes	Marks
4 (a) (i)	upward force label = lift/eq;  downward arrow drawn same size as up arrow; downward force arrow labelled as weight/eq;	allow upthrust (normal) reaction  judge by eye do not accept unqualified 'gravity' ignore horizontal forces/arrows	(3)
(ii)	any two from: MP1. speed remains (almost) constant /does not reduce (as much); MP2. (because) friction reduced/eq; MP3. (because of cushion of) air lifts the car;	allow KE for speed RA  allow for MP3 (because) the car does not touch the track Ignore idea that air pushes glider idea that speed increases unqualified 'travels further'	(2)
(b) (i)	(average) speed = $\frac{\text{distance}}{\text{time}}$ ;	accept standard abbreviations rearrangements	(1)
(ii)	substitution; evaluation; e.g. 8.3/0.314 26 (cm/s)	ignore the POT until evaluation  26.4 (cm/s)	(2)
(iii)	314 (ms) ;	Allow 0.314 s Accept answer in standard form, number and unit required Allow this mark if the working shows that time has been calculated by 8.3/26 (=0.319 or 0.32)	(1)

**Total for Question 4 = 9 marks**

Question number	Answer	Notes	Marks
5 (a) (i)	MP1. series circuit containing lamp and some form of power supply;  MP2. ammeter in series (with lamp/battery);  MP3. voltmeter in parallel across lamp;	correct symbols only condone cell for battery	(3)
(ii)	$V = I.R$ ;	accept in words rearrangements NOT the 'triangle'	(1)
(iii)	current reading from graph; calculation; unit; e.g. 1.5 (A) 4 $\Omega$ /ohms	do not accept V/A for $\Omega$	(3)
(iv)	correct shape; correct end position/size;		(2)
(b)	 D ;		(1)

**Total for Question 5 = 10 marks**

Question number	Answer	Notes	Marks
6 (a)			(1)
(b) (i)	normal drawn correctly;	judge by eye	(1)
(ii)	correct angle marked to their normal;	judge by eye	(1)
(iii)	correct angle chosen within $\pm 3^\circ$ ;	$27^\circ$ , no ECF from bi or bii	(1)
(vi)	$\frac{\sin i}{\sin r} = n$ ;	accept rearrangements	(1)
(v)	substitution; evaluation; e.g. $\frac{\sin 43}{\sin 27} = n$ 1.5	allow ECF from biii	(2)
(c) (i)	Total Internal Reflection;	accept TIR	(1)
(ii)	MP1. light reflects (inside (surface) of fibre);  MP2. with angle $i >$ critical angle;  MP3. (because) light travels slower in glass;	condone light hits/bounces off the fibre wall	(3)

**Total for Question 6 = 11 marks**

Question number	Answer				Notes	Marks																
7 (a)	<div><div><div>description</div><div>type of radiation</div></div><div><div>electromagnetic waves</div><div>particles with a negative charge</div><div>particles with a positive charge</div></div><div><div>alpha</div><div>beta</div><div>gamma</div><div>neutron</div></div></div> <div>positive charge to alpha; negative charge to beta; electromagnetic waves to gamma;</div>				One mark for each correct line Minus one mark for two lines from any one box on the left	(3)																
(b) (i)	in this order only: gamma, beta, alpha;					(1)																
(ii)	any two from: can damage cells; can cause mutation; can cause cancer;				allow kill cells/tissues radiation burns radiation poisoning change genes	(2)																
(c)	<table><tr><td></td><td>0.1 cm paper</td><td>0.5 cm aluminium</td><td>0.5 cm lead</td></tr><tr><td>alpha radiation</td><td>stopped</td><td>stopped</td><td>stopped</td></tr><tr><td>beta radiation</td><td>goes through</td><td>stopped</td><td>stopped</td></tr><tr><td>gamma radiation</td><td>goes through</td><td>goes through</td><td>goes through</td></tr></table> Each row correct for 1 mark;;;					0.1 cm paper	0.5 cm aluminium	0.5 cm lead	alpha radiation	stopped	stopped	stopped	beta radiation	goes through	stopped	stopped	gamma radiation	goes through	goes through	goes through		(3)
	0.1 cm paper	0.5 cm aluminium	0.5 cm lead																			
alpha radiation	stopped	stopped	stopped																			
beta radiation	goes through	stopped	stopped																			
gamma radiation	goes through	goes through	goes through																			
(d)	any suitable device e.g. (thin window) GM tube; cloud chamber; spark chamber; semiconductor detector;				accept spelling mistakes Geiger counter NB do not accept repeat of stem (film badge or photographic film)	(1)																

Total for Question 7 = 10 marks

Question number	Answer	Notes	Marks
8 (a)	any two from: MP1. reverse the magnet (N into coil);  MP2. reverse the connections at the ammeter;  MP3. move the magnet out of coil;	ignore all references to • speed of movement • numbers of turns on the coil CARE that candidate does not conflate MP2 and 3 to negate their answer allow for MP2 invert the coil	(2)
(b) (i)	Y= magnet; Z = coil (of wire);		(2)
(ii)	(±)1.6 (V);		(1)
(iii)	reading of time for 1 cycle ; evaluation; e.g. 0.04s 25 (Hz)	no mark for eqn as it is given time can be assumed if $f = 1/0.04$ seen allow for 1 mark 50, 12.5 (Hz)	(2)
(vi)	C higher higher ;		(1)
(v)	any one from stronger magnet; more turns on the coil;	ignore bigger magnet condone more coils	(1)
(c) (i)	rearrangement of eqn; substitution; evaluation; e.g. work done (energy output) = power x time (=) $3.1 \times 290$ 900 (W)	Accept 899 (W)	(3)
(ii)	$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$	accept standard abbreviations rearrangements with factor of X 100	(1)
(iii)	substitution; rearrangement of eqn; evaluation; e.g. input energy = $\frac{\text{output energy}}{\text{efficiency}}$  = $\frac{899 \text{ (W)}}{0.72}$ = 1200 (J)	ECF from ci   allow 900 for 899  1245, 1250, 1300 (J)	(3)

Total for Question 8 = 16 marks

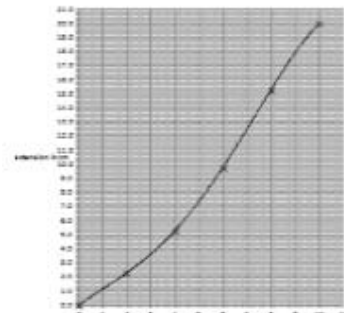
Question number	Answer	Notes	Marks
9 (a) (i)	work done = force $\times$ distance moved;	accept standard abbreviations rearrangements	(1)
(ii)	Substitution into correct equation; evaluation; e.g. $= 23 \times 0.34$ 7.8 (J)	allow a POT error for -1  7.82	(2)
(b)	determination of time for 1 movement/eq; substitution; evaluation;  e.g. 15 times in 60 s = 4 s $= \frac{7.8}{4}$ 2.0 (W)	ecf from (aii)  allow: calculation of total work done /60 allow 1 mark for correct use of 15  1.955, 2 (W)  allow 1 mark only for 7.82/60 or 782/60	(3)

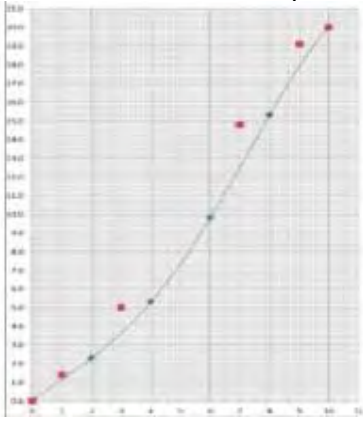
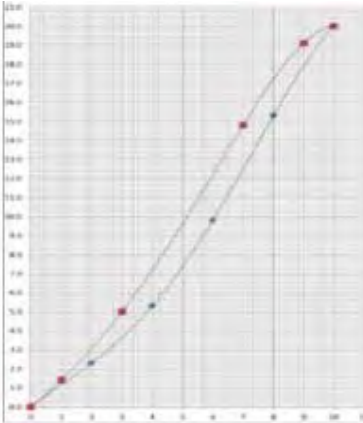
**Total for Question 9 = 6 marks**



Question number	Answer	Notes	Marks
10 (a) (i)	Any three of MP1. idea of (continuous) random movement; MP2. collisions / impact/eq with (inside) fabric/walls; MP3. idea that force is produced (by bombarding molecules); MP4. idea of pressure as force on an area;	ignore moves freely  allow momentum or NIII argument	(3)
(ii)	any four from:  MP1. pressure inside stays constant;  MP2. pressure difference across the balloon fabric; MP3. (resultant) force acting down on the fabric; MP4. balloon fabric becomes concave / moves downwards; MP5. (free end of) pointer moves up;	allow  for MP1, pressure increases slightly, for MP2 volume of air in can decreases,  for MP5 end of pointer on the fabric moves down	(4)
(iii)	accept any two sensible suggestions e.g. longer stick/lever; narrower (diameter of) can; more stretchy material; less taut material;		(2)
(b) (i)	either it/the reading would decrease;  OR (right end of) pointer goes down;  OR left end of pointer goes up;		(1)
(ii)	more pressure inside the can ;  plus any one from: particles inside can now move faster / have more KE; (hence) particles hit the balloon fabric more frequently;  (hence) particles hit the fabric harder;	allow if seen in (i)  look for idea of time implied more often allow momentum idea	(2)

**Total for Question 10 = 12 marks**

Question number	Answer	Notes	Marks
11 (a) (i)	MP1. means of securing one end of elastic band; MP2. ruler; MP3. weights;		(3)
(ii)	extension linked to dependent force linked to independent temperature linked to control  <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>variable</p> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">extension</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">force</div> <div style="border: 1px solid black; padding: 2px;">temperature</div> </div> <div style="text-align: center;"> <p>type of variable</p> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">control</div> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;">dependent</div> <div style="border: 1px solid black; padding: 2px;">independent</div> </div> </div> <p>all three correct;; any one correct;</p>		(2)
(iii)	any two from: determine length without weights; determine length with 12 N; subtraction to get extension;	allow find difference in lengths	(2)
11 (b)(i)	any two suggestions from: - MP1. unloading and loading at same intervals; MP2. filling in the (large) gap in the unloading data; MP3. more readings (where curve is most pronounced); MP4. increase the range of loads;	ignore repeat and average  allow 'go up in ones'	(2)
(ii)	best fit curve;  		(1)

11 (b)(iii)	<p>4 points plotted correctly;; -1 for each incorrect point</p> 		(2)
(vi)	<p>best fit curve;</p> 		(1)
(v)	<p>a discussion to include any three points:</p> <p>MP1. does not obey Hooke's law; MP2. because graph is not linear throughout; MP3. Hooke's law requires extension directly proportional to force; MP4. it does show elastic behavior; MP5. because it returns to its original length; MP6. data points quoted to support other MP;</p>	<p>MP1 should only be awarded if there is an attempt at an explanation</p>	(3)

**Total for Question 11 = 16 marks**

Question number	Answer	Notes	Marks
12 (a) (i)	any three from: MP1. air becomes hot; MP2. air expands; MP3. air becomes less dense; MP4. air rises;	NOTE cannot award MP4 unless MP2 or MP3 has been given  reject for 1 mark( ie MAX mark = 2) air particles expand OR air particles become less dense	(3)
(ii)	clear inward arrow above the heat absorbing materials; clear up arrow inside the tower;		(2)
(iii)	convection (current);		(1)
(b) (i)	thermal (energy);  kinetic (energy);	allow heat or solar or light	(2)
(ii)	(hot) air turns turbines; turbines turn the generator/magnets inside a coil;		(2)
(c) (i)	during the day there is direct heating from the sun/eq;	allow RA	(1)
(ii)	any sensible suggestion e.g. so that convection continues beyond daylight hours; to act as heat source for night time;		(1)
(iii)	any sensible suggestion e.g. water tanks (to provide hot water at night); crops;	Allow photovoltaic cells solar panel (dull) black objects / blocks painted black	(1)

**Total for Question 12 = 13 marks**