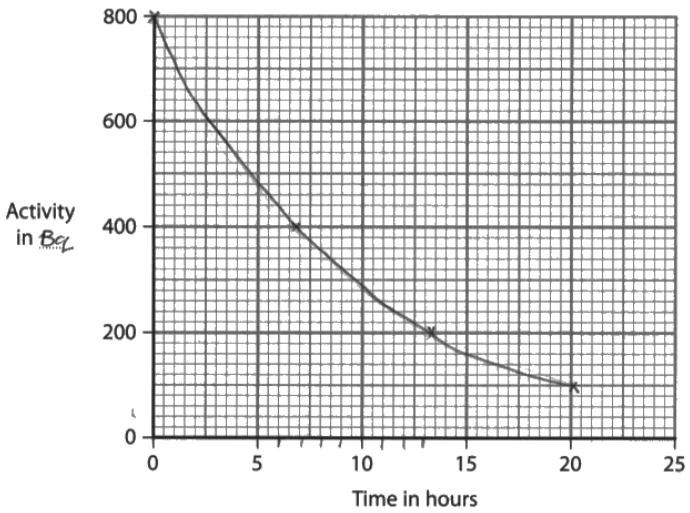
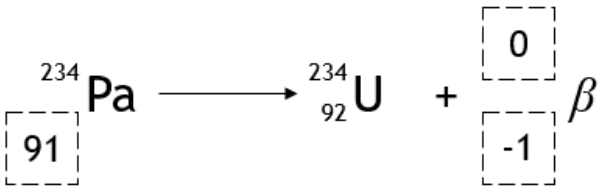
Question number	Answer	Notes	Marks
2 (a)	C (the Moon); A is incorrect because comets orbit stars B is incorrect because Mars orbits the Sun D is incorrect because the Sun orbits in the Milky Way galaxy		1
(b)	D (gravitational); A is incorrect because there is no air in space; B is incorrect because the 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

Question number	Answer	Notes	Marks
3 (a) (i)	GPE = mass × *g* × height;	allow standard symbols and rearrangements e.g. h = GPE / m×*g* ignore 'gravity' for *g*	1
(ii)	substitution; rearrangement; evaluation; e.g. 3.2 = 0.40 × 10 × h h = 3.2 / 0.40 × 10 (h =) 0.80 (m)	in either order -1 for POT error due to not converting g to kg but not if due to physics error such as missing *g* accept use of *g* = 9.8(1) accept 1sf answer i.e. 0.8 (m) 0.815 or 0.816 or 0.82 if g used is 9.8(1) and then rounded	3
(iii)	3.2 (J);	this answer only	1
(b)	downward arrow labelled "weight"/"W"/"mg"; vertically downward arrow drawn equal in length to lifting force arrow;	ignore starting position of arrow ignore 'gravity/g/gravitational field strength' allow 'gravitational force' reject if both gravity force and weight force shown mark independently by eye reject any other labelled arrows for second mark	2
(c) (i)	recall of efficiency formula; substitution; evaluation; e.g. efficiency = $\frac{\text{useful energy output}}{\text{total energy output}}$ efficiency = 3.2 / 11.0 (×100%) efficiency = 0.29 or 29%	may be implied from substitution allow 0.29, 0.2909…, 29%, 29.09…% 29 without % is PoT 2 marks	3
(ii)	idea that energy must be conserved; demonstration that 7.8 + 3.2 = 11(.0);	comparison in words e.g total = useful + wasted /eq allow 11(.0) - 3.2 = 7.8	2

Question number	Answer	Notes	Marks
6 (a)	resistor, battery, voltmeter, ammeter all present in a complete circuit	all four symbols drawn correctly condone use of cell or dc power supply symbol for battery	4
	variable resistor connected in series with resistor;	symbol drawn correctly	
	ammeter in series with resistor;	condone incorrect yet identifiable ammeter symbol	
	voltmeter in parallel with 60 ohm resistor;	condone incorrect yet identifiable voltmeter symbol accept higher level answers involving potential divider circuits	
(b)	any four from: MP1. measure voltage and current; MP2. idea of varying voltage (across resistor); MP3. take repeat readings and average (at each voltage); MP4. switch off circuit in between readings; MP5. other reasonable safety measure relating to equipment heating up	 e.g. by altering the resistance of the variable resistor e.g. not using full range of voltages so current doesn't get too high ignore references to graph	4
(c) (i)	line passes through origin; line is straight throughout; line passes/would pass through the point (12,0.20);	 by eye	3
(ii)	any three from: MP1. line will be same shape / straight line through origin / both components are resistors; MP2. line (for 120Ω resistor) will have a lower gradient; MP3. line (for 120Ω resistor) will have half the gradient; MP4. (because) larger resistance will result in a lower current in the circuit;	 allow (still) directly proportional also award MP2 allow relevant justification by V=IR all three marks can be awarded from a correct new line on the graph.	3

Total for Question 6 = 14 marks

Question number	Answer	Notes	Marks
7 (a) (i)	becquerel(s);	allow kilobecquerels, Bq, kBq, curie, Ci allow recognisable spelling allow mixed case letters	1
(ii)			3
	evidence that sketch starts at (0,800)	accept plotted point	
	evidence sketch passes through (6.7,400)	accept plotted point	
	smooth curve decreases with decreasing steepness 		
(iii)	both numbers for beta correct; atomic number of protactinium = 91; e.g. 		2

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