Question			Expected Answers	Marks	
1	a	i	Work = force x distance ;moved in direction of force;		2
		ii	power = work/time;AW	1	
			power = force x distance/time = force x velocity	1	2
	b	i	k.e. = $\frac{1}{2}mv^2$;	1	
			= 0.5 x 120 x 25 = 1500 (J)	1	2
		ii	P = Fv or 200 = F x 5 ; F = 200/5 = 40 (N)		2
		iii	Fd = 1500 ; so d = 1500/40 = 37.5 (m) ecf from b(i) and (ii)		2
	c		Δp.e./second = mgvsin θ = 120 x 9.8 x 5 x 0.033 ; = 194 (W)	2	
			n.b. allow using 1/30 ans: 196 (W)		
			AW, e.g.: force downhill F = mgsin θ; extra power = Fv, etc.		
			P = 200 + 194 = 394 (W)	1	3
			Total		**13**
2	a		Celsius and kelvin scales have same increment/AW	1	
			temperature scales differ numerically by 273	1	
			at 500,000 273 is a negligible difference/AW *max 2*	1	2
	b	i	reference to V/T = constant / p/T = constant / pV/T = constant /= nR;	1	
			at absolute zero, p =0 / V = 0 / pV = 0	1	
			graphical solution/description acceptable		2
		ii	temperature is proportional to/a measure of (kinetic) energy of molecules/atoms *or relationship obviously implied*	1	
			at absolute zero, k.e. is zero/molecules stop moving	1	2
	c	i	p/T = constant /AW; $p/p_o = T_1/T_o$ = 400/300 giving p = 1.33 p_o		2
		ii	use of n = pV/RT / n $\propto$ p / N $\propto$ p / f = $(N_B/N_A) = n_B/n_A = p_o/p$	1	
			= ¾ or 0.75 ecf from c(i)	1	2
			Total		**10**
3	a		Force on unit charge (at that point);	1	
			further detail, e.g positive or stationary	1	2
	b	i	suitable recognisable pattern around (NOT just between) charges;	1	
			quality mark, i.e. symmetry, spacing, lines joined to charges, etc;	1	
			arrows towards B on some lines	1	3
		ii	use of $E = (1/4\pi\varepsilon_0) Q/r^2$; use of r = 4.0 x 10^{-10};	2	
			sum of two equal terms	1	
			E = 2 x 9 x 10^9 x 1.6 x 10^{-19}/(4.0 x $10^{-10})^2$ = 1.8 x 10^{10}	1	
			$N\,C^{-1}$ or $V\,m^{-1}$ or $C\,F^{-1}\,m^{-1}$	1	5
	c	i	equal and opposite forces or suitable E-field patterns drawn on each figure in correct directions	2	
		ii	(fig. 3.2) no motion as (electric) forces on charges are equal and opposite/AW	1	
			(fig. 3.3) the dipole rotates to/oscillates about the position in Fig.3.2 ;	1	
			because a couple is formed/no translational motion/no c. of m. motion/rotation clockwise	1	5
			Total		**15**

Question			Expected Answers		Marks
4	a	i	$C_p = 2C + C = 3C$		1
		ii	$1/C_s = 1/2C + 1/C$; $= 3/2C$ giving $C_s = 2C/3$		2
	b	i	V		1
		ii	$Q = C_pV$; $= 3CV$ ecf from a(i)		2
	c		$E = ½ C_sV^2$; $= {}^1/_3 CV^2$ ecf from a(ii)		2
	d	i	discharge circuit made through voltmeter/plates connected through voltmeter/AW	1	
			voltmeter behaves as a (large) resistor so plates will discharge;	1	
			rate of discharge depends on size of voltmeter's resistance/AW/ similar suitable comment *max 2*	1	2
		ii	capacitors in series/Fig.4.2 as capacitance is smaller;	1	
			rate of discharge depends on value of RC/time constant	1	2
			Total		**12**
5	a	i	An element can exist in more than one form, having a different number of neutrons/can have different mass but same proton number/AW		1
		ii	${}^4_2He$ / ${}^4_2\alpha$; (-) ${}^0_{-1}e$ / ${}^0_{-1}\beta$		2
		iii	${}^{238}_{92}U \rightarrow {}^{234}_{92}U + {}^4_2\alpha + {}^0_{-1}\beta + {}^0_{-1}\beta$	3	
			or ${}^{238}_{92}U \rightarrow {}^{234}_{90}X + {}^4_2\alpha$	1	
			${}^{234}_{90}X \rightarrow {}^{234}_{91}Y + {}^0_{-1}\beta$	1	
			${}^{234}_{91}Y \rightarrow {}^{234}_{92}U + {}^0_{-1}\beta$	1	
			or α followed by two β decays;	1	
			nucleon number =238 – 4 – 0 – 0 = 234;	1	
			proton number = 92 – 2 + 1 + 1 = 92	1	
			or answer in terms of A,p or n,p diagram		3
	b	i	N : the number of undecayed nuclei/nuclei of the original element (remaining)	1	
			N_o : the initial/original number of nuclei present	1	
			λ : the (decay) constant relating the activity to the number of undecayed nuclei/AW/the probability of a given nucleus decaying in the next second	1	3
		ii	$f = N/N_o = e^{-\lambda t}$; $= \exp(-0.693 \times 4.6 \times 10^9/7.1 \times 10^8)$;	2	
			$= \exp(-4.49) = 0.011$	1	
			or time = 6.48 half lives; so $f = 1/2^{6.48}$; = 0.011	3	3
			Total		**12**
6	a	i	Arrow through P towards centre of circle		1
		ii	Fleming's LHR (for conventional current/positive charge movement)		1
		iii	force of constant magnitude/on (moving) charge/ion caused by (perpendicular) B-field	1	
			direction perpendicular to path at all times/towards centre of circle	1	2
	b		larger semicircle/less curvature;	1	
			force same; quote Newton 2; mass larger so less acceleration *max 2*	2	3
	c	i	$F = BQv$; $= 0.60 \times 1.6 \times 10^{-19} \times 3.0 \times 10^5 = 2.9 \times 10^{-14}$ (N)		2
		ii	$F = mv^2/r$; $r = 4.0 \times 10^{-26} \times 9.0 \times 10^{10}/2.9 \times 10^{-14}$; = 0.125 (m)		3
			Total		**12**

Question		**Expected Answers**	**Marks**	
7	a	Resonance occurs at /close to the natural frequency of an oscillating object/system	1	
		caused by driving force (at this frequency)	1	
		when maximum amplitude of driven achieved/maximum energy transfer between driver and driven *max 2*	1	
		Examples:		
		(good) microwaves, watch (quartz), pendulum clock, open and closed pipes, electrical resonance/tuning, etc	1	
		(bad) Tacoma Narrows or Millennium bridge, wine glass fracture, vibration of building/earthquake, motor car wing mirror, rattles/steering wheel vibration at different speeds, etc	1	
		Practical significance of each choice given in a meaningful manner	2	
		Nature of driving force clearly stated for each example	2	
		maximum 7 marks		7
	b	Resonance over wider frequency range	1	
		energy stored/amplitude of resonance decreased	1	
		shift down of resonance frequency with increased damping	1	
		critically or overdamped system will not oscillate/no resonance	1	
		resonance oscillation die away quickly/ exponential decay of amplitude with damping etc. when driving force removed, etc	1	
		a correctly annotated amplitude v frequency diagram can score 3 marks		
		Suitable example of a real vibrating system *allow any sensible laboratory demonstration*	1	
		relating real system to features described *up to 2 marks*	2	
		maximum 5 marks		5
		Quality of Written Communication		4
		Total		**16**

Criteria for assessment of written communication

4 marks

- The candidate expresses ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically.
- Arguments are consistently relevant, based on sound knowledge of Physics, and are well structured.
- There are few, if any, errors in grammar, punctuation and spelling.

3 marks

- The candidate expresses moderately complex ideas clearly and reasonably fluently through well-linked sentences and paragraphs.
- Arguments are generally relevant being based on a good knowledge of physics, and are well structured.
- There are occasional errors in grammar, punctuation and spelling.

2 marks

- The candidate expresses straightforward ideas clearly and accurately, if not always fluently. Sentences and paragraphs are not always well connected.
- Arguments may sometimes stray from the point or be weakly presented.
- There are some errors in grammar, punctuation and spelling, but not to suggest a serious weakness in these areas.

1 mark

- The candidate expresses simple ideas clearly, but is imprecise and awkward in dealing with complex or subtle concepts.
- Arguments are of doubtful relevance or obscurely presented.
- Errors in grammar, punctuation and spelling and noticeable and intrusive, suggesting weaknesses in these areas.

0 marks

- Even simple ideas are not expressed clearly.
- Arguments are irrelevant or poorly stated.
- There are gross errors in grammar, punctuation and spelling.