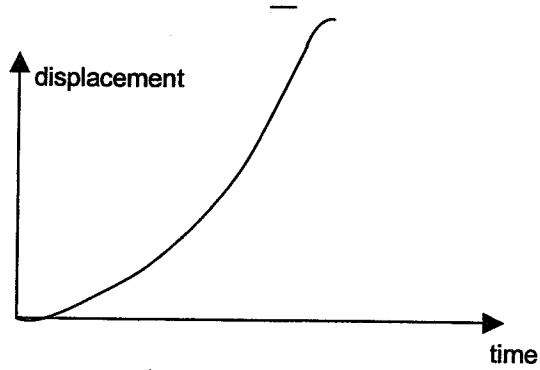


Abbreviations, annotations and conventions used in the Mark Scheme	/	= alternative and acceptable answers for the same marking point
	;	= separates marking points
	NOT	= answers which are not worthy of credit
	()	= words which are not essential to gain credit
	<u> </u>	= (underlining) key words which must be used to gain credit
	ecf	= error carried forward
AW	= alternative wording	
ora	= or reverse argument	

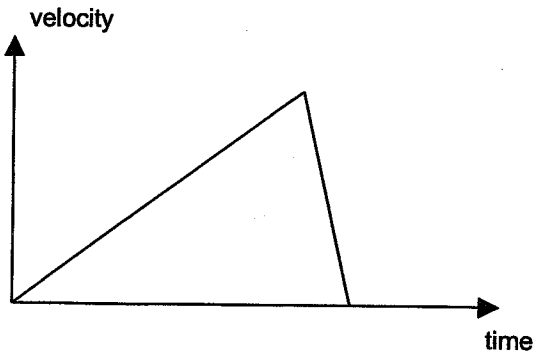
1 (a) Points which can be credited

- (i) upward curve
- zero gradient at the start
- short time to stop



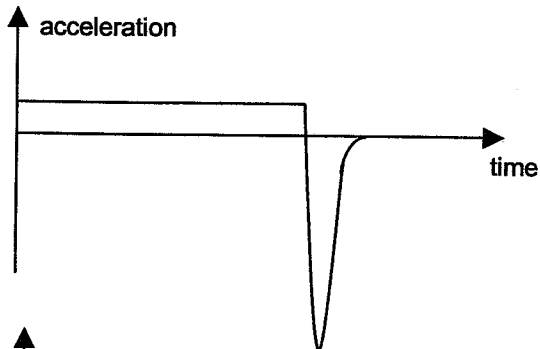
1
1
1 3

- (ii) straight line
- sudden stop
- which is not instantaneous



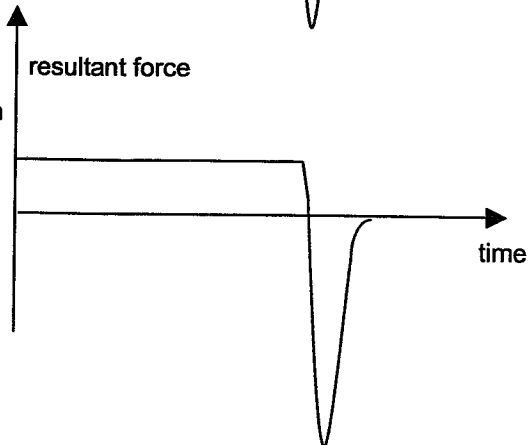
1
1
1 3

- (iii) constant zero slope
- does not start at origin
- high negative peak
- final acceleration zero



1
1
1
1 4

- (iv) identical shape to acceleration graph
- final force zero



1
1 2 9

12 marks available
9 required for maximum mark

(b)(i)	object starts with gravitational p.e.	1		
	converted into k.e. (as it falls)	1		
	maximum k.e. as it hits ground	1		
	on stopping converted into elastic p.e. (for an instant)	1		
	becomes internal energy / heat of fragments (and floor)	1		
	and sound	1	4	
	6 marking points; only 4 required			
(ii)	momentum of falling object (increases as it falls)	1		
	total momentum starts at zero	1		
	momentum finishes at zero	1		
	Earth gains momentum up as body falls	1		
	Earth's velocity is very small (due to its large mass)	1	4	8
	5 marking points; only 4 required			
(c)	ball is elastic but cup is brittle	1		
	distortion of cup is small	1		
	so acceleration of cup is very large	1		
	<u>requiring a large force</u>	1		
	distance of distortion for ball is much greater	1	4	4
	OR in terms of $F\delta t$ or $F\delta x$			
	5 marking points; only 4 required			

2(a)	a transformer	1	1
(b)	the turns ratio	1	
	9/230 OR 0.039 OR 1:25 OR 1:26	1	2
	If a factor of 1.41 appears, 1:36 allow full credit		
(c)	marking points allowed - 3 required for full marks	3	3
	diode in connection from secondary to battery		
	diode connected the correct way round		
	light bulb connected in possible circuit		
	light bulb connected across transformer secondary – (it will then go out when the transformer is not in use)		
(d)	secondary coil is removed from (alternating) field of primary	1	
	so no induced e.m.f. (diode prevents bulb lighting from the battery)	1	2 8

3(a)	Q charge on capacitor (at time t)	Q_0 initial charge (on capacitor)	1
	C capacitance	R resistance	1
	N number of undecayed atoms (at time t)	N_0 initial number of undecayed atoms	1
	λ decay constant	t time	1 4
(b)(i)	unit of C = coulomb per volt = ampere second per volt OR as $A s V^{-1}$		1
	unit of R = volt per ampere OR as $V A^{-1}$		1
	deduction required		1
	e.g. unit of CR = $A s V^{-1} \times V A^{-1} = s$ therefore since t has the unit s t/CR has no unit		
(ii)	s^{-1}		1 4
(c) (i)	$\frac{Q}{Q_0} = e^{-\frac{5CR}{CR}}$		1
	$= e^{-5} = 0.0067$ (4)		1
(ii)	$\frac{1/2 Q}{Q_0} = e^{-\frac{t}{100 \times 10^{-6} \times 200 \times 10^3}}$		1
	$\frac{1}{2} = e^{-\frac{t}{20}}$		1
	$\ln 0.5 = -\frac{t}{20} = -0.693$		
	$t = 13.86 = 13.9s$		1 5
(d) (i)	time constant = $1/\lambda$		1
(ii)	$\lambda t_{1/2} = 0.693$		1
	time constant = $1/\lambda = 850/0.693 = 1230 s$		1
(iii)	same as for capacitors, namely 0.0067(4)		1 4 17

4(a)	Gravitational field	1	
	as force acting on unit mass	1	
	Electric field	1	
	Strong nuclear force	1	
	as force acting on unit (positive) charge	1	
	Magnetic field	1	
	as force acting on unit current in a wire of unit length	1	
	Allow as force acting on unit charge travelling with unit velocity	1	6
	Notes: deduct 1/3 if done in terms of units		
	deduct 2/3 if done with equations for which the symbols are not explained		
(b)	Gravitational field - only one kind of mass so force is always in the direction of the field	1	
	Electrical field - two kinds of charge	1	
	Strong nuclear force	1	
	so force is either in the direction of the field (with positive charge) or in the opposite direction to the field (with negative charge)	1	
	Magnetic field – direction of wire controls direction of force	1	
	maximum force when wire is at right angles to field	1	
	direction of force given by (Fleming's) left hand rule	1	
	Distance over which forces act / inverse square law	1	
	force given by $B I l \sin \theta$ where θ is angle between field and current	1	5
	Maximum 5 awarded for 5 of these 8 points		
(c)	protons in the nucleus have a positive charge	1	
	they are very close (10^{-15} m) so <u>repel each other strongly</u>		
	(because of their charge)	1	
	since the nucleus does not explode there must be an (even larger) force holding it together	1	
	magnetic and/or gravitational forces are (far) too small	1	
	so there must be another force, provided by some other (nuclear) field	1	3 14
	Maximum 3 awarded for 3 of these 5 points		