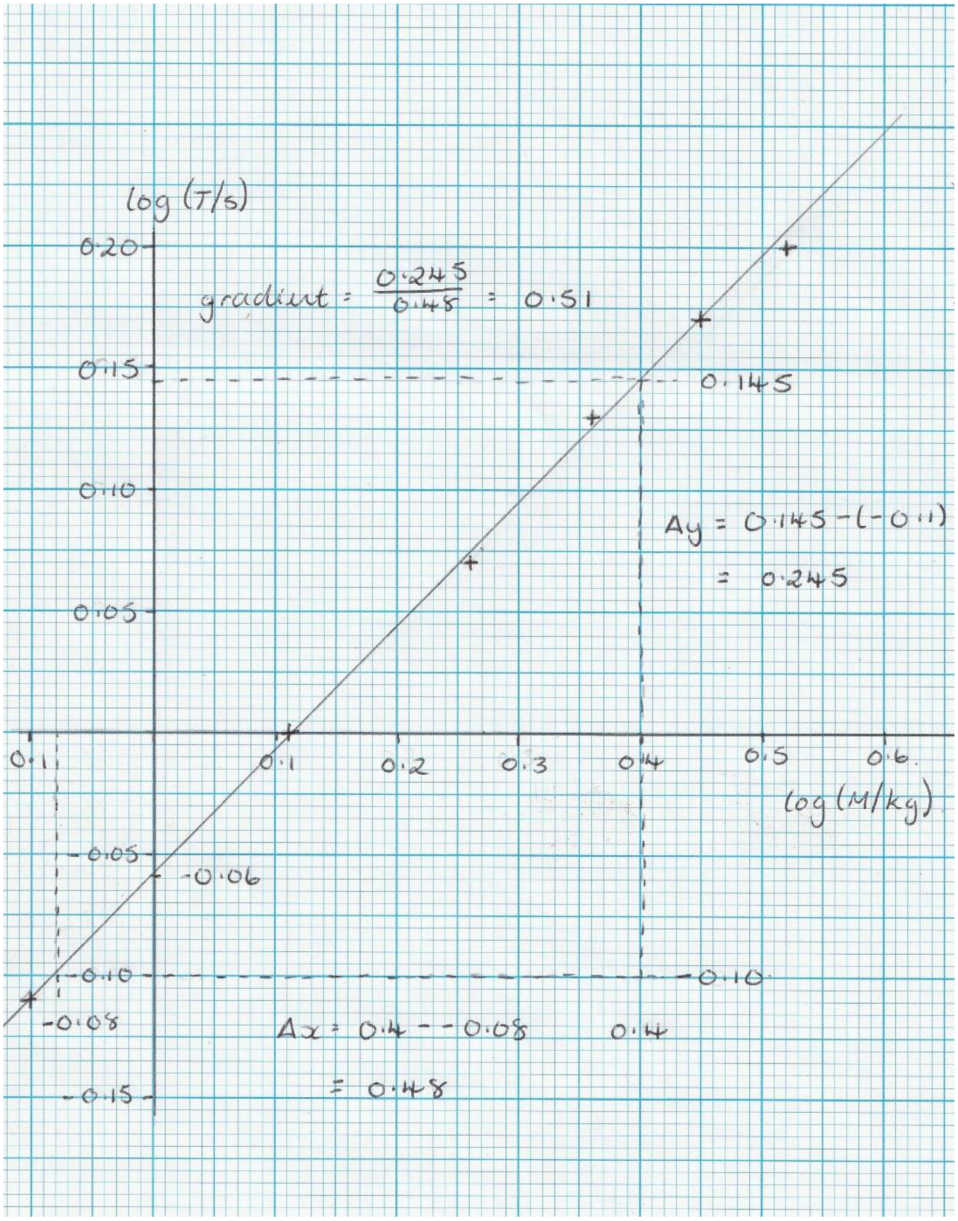
Question number	Answer		Mark
3(a)(i)	Place a (timing) marker on the bench [Accept labelled diagram] (Marker) directly below a point on the trolley when undisplaced	(1) (1)	**2**
3(a)(ii)	Max **TWO** from Time multiple oscillations **and** divide by the number of oscillations Repeat **and** calculate a mean Start timing after several oscillations have completed [Credit reference to stationary timing marker in (a)(i)]	 (1) (1) (1)	**2**
3(b)(i)	log T values correct and consistent to 2 d.p. [Accept 3 d.p] log M values correct and consistent to 2 d.p. [Accept 3 d.p] Axes labelled: y as log(T / s) and x as log(M / kg) Most appropriate scales for both axes Plots accurate to ± 1mm Best fit line with even spread of plots	(1) (1) (1) (1) (1) (1)	**6**
3 (b)(ii)	log T = log $(2\pi/\sqrt{k})$ + ½log M is in the form $y = c + mx$ with a gradient of 0.5 Correct calculation of gradient using large triangle shown Value of gradient 0.47 to 0.54 to 2 or 3 s.f., no unit Valid conclusion based on gradient calculation <u>Example of calculation</u> *gradient* = (0.145 – –0.10)/ (0.4 – –008) = 0.245 / 0.48 = 0.51 As the gradient is approximately 0.5 the prediction is valid	(1) (1) (1) (1) (1)	**5**

3 (b)(iii)	Correct value of y-intercept read from graph shown	(1)	
	Calculation using antilog to determine $2\pi/\sqrt{k}$ shown	(1)	
	Value of k in range 50 to 54 to 2 or 3 s.f. with unit of kg s^{-2}	(1)	
	[Accept N m^{-1}]		
	Example of calculation		
	$c = -0.06 = \log (2\pi/\sqrt{k})$		
	$(2\pi/\sqrt{k}) = 10^{-0.06} = 0.87$		
	$k = (2\pi/0.87)^2 = 52$ kg s^{-2}		
	Or		
	Correct value of y-intercept using coordinates from point on best fit line with gradient shown [e.c.f. (b)(ii)]	(1)	
	Calculation using antilog to determine $2\pi\sqrt{k}$ shown	(1)	
	Value of k in range 50 to 54 to 2 or 3 s.f. with unit of kg s^{-2}	(1)	
	[Accept N m^{-1}]		
	Example of calculation		
	From best fit line, $y = 0.095$, $x = 0.3$		
	$c = y - mx = 0.095 - (0.51 \times 0.3) = 0.095 - 0.153 = -0.058$		
	$(2\pi/\sqrt{k}) = 10^{-0.058} = 0.875$		
	$k = (2\pi/0.875)^2 = 52$ kg s^{-2}		
	Or		
	Correct antilog of coordinates from point on best fit line shown	(1)	
	Use of $T = 2\pi\sqrt{(M/k)}$ shown	(1)	
	Value of k in range 50 to 54 to 2 or 3 s.f. with unit of kg s^{-2}	(1)	**3**
	[Accept N m^{-1}]		
	Example of calculation		
	From best fit line, $y = 0.095$, $x = 0.3$		
	$T = 10^{0.095} = 1.24$, $M = 10^{0.3} = 2.00$		
	$k = 4\pi^2 M / T^2 = 4\pi^2 \times 2 / 1.24^2 = 79 / 1.54 = 51$ kg s^{-2}		
		Total mark for Question 3 = 18	

***M* / kg**	***T* / s**	**log (*M*/kg)**	**log (*T*/s)**
0.800	0.78	–0.10	–0.11
1.300	1.01	0.11	0.00
1.800	1.18	0.26	0.07
2.300	1.34	0.36	0.13
2.800	1.49	0.45	0.17
3.300	1.60	0.52	0.20



Examples of completed tables and graph

***M* / kg**	***T* / s**	**ln (*M*/kg)**	**ln (*T*/s)**
0.800	0.78	–0.22	–0.25
1.300	1.01	0.26	0.01
1.800	1.18	0.59	0.17
2.300	1.34	0.83	0.29
2.800	1.49	1.03	0.40
3.300	1.60	1.19	0.47