Question Number	Scheme	Marks
2(a)	$v=\dfrac{\mathrm{d}x}{\mathrm{d}t}=\dfrac{1}{(4x+3)}$	
	$\dfrac{\mathrm{d}t}{\mathrm{d}x}=4x+3$	
	$t=\int(4x+3)\mathrm{d}x,=\dfrac{1}{2}\times 4x^2+3x+c$	
	OR $\int_0^2 \mathrm{d}t=\int_0^X(4x+3)\mathrm{d}x,=\left[\dfrac{1}{2}\times 4x^2+3x\right]_0^X$	M1,dM1A1
	$c=0$	
	$t=2=\dfrac{1}{2}\times 4x^2+3x \quad 2x^2+3x-2=0$	dM1
	$x=\dfrac{1}{2}\ (x=-2)$	A1cso (5)
(b)	$a=v\dfrac{\mathrm{d}v}{\mathrm{d}x}$ $\quad alt:\quad a=\dfrac{d}{dx}\left(\dfrac{1}{2}v^2\right)$	M1
	$=\dfrac{1}{4x+3}\times\dfrac{-4}{(4x+3)^2}$	dM1A1
	$\lvert F\rvert=\dfrac{1}{2}\times\dfrac{4}{(2+3)^3}=\dfrac{2}{125}=0.016\,\mathrm{N}$	M1 A1cso (5)
		[10]

(a)	
M1	Rewrite as $\dfrac{dx}{dt}$ **and** separate variables to reach a form ready for integration
dM1	Attempt the integration (at least one power going up).
A1	Correct integration. Constant/limits not needed.
dM1	Use $t=2$ in their expression or substitute correct limits, and solve their 3 term quadratic to find x. If solving an incorrect quadratic, evidence of a correct method must be seen. Depends on the previous M mark.
A1cso	Obtain $x=\dfrac{1}{2}$ (and reject -2 if seen) from completely correct work. Constant of integration must have been seen, although we do not need to see evidence of evaluation.
(b)	
M1	Use $a=v\dfrac{\mathrm{d}v}{\mathrm{d}x}$
dM1	Differentiate the given expression for v and obtain an expression for a. We need to see a power of 2 (or a power of 3 if using $\dfrac{d}{dx}\left(\dfrac{1}{2}v^2\right)$). Depends on the previous M mark.
A1	Correct expression, any form.
M1	Use their acceleration in an equation of motion to obtain a value for F. Mass must be included and they must use their value of x. Independent, but must have found an expression for acceleration.
A1cso	Correct magnitude of F. Correct solution only. Can be fraction or decimal. Must be positive.

3 (a)	$\angle PBA=30°$	B1

Question Number	Scheme	Marks
	R$(\uparrow)$ $T\cos 30° + R\cos 60° = mg$	M1
	NL2 horizontally: $T\cos 60° + R\cos 30° = mr\omega^2$, $= ma\omega^2 \cos 30°$	M1A1,A1
	$T = \frac{m\sqrt{3}}{2}\left(2g - a\omega^2\right)$ o.e.	dM1A1 (7)
(b)	$R = 2mg - \frac{3m}{2}\left(2g - a\omega^2\right) = \frac{3ma\omega^2}{2} - mg$	M1A1
	Use $R \geq 0$	M1
	$\omega \geq \sqrt{\frac{2g}{3a}}$ *	A1cso (4)
		[11]

(a)

B1 Correct angle, seen explicitly, implied by a correct trig ratio, or used.

M1 Attempt a vertical equation with 3 forces, *T* and *R* resolved. Angles can be algebraic. Condone sin/cos confusion and use of the same angle for both forces.

M1 Equation of motion horizontally, two forces resolved and acceleration in either form. Attempt at radius not needed. Angles can be algebraic. Condone sin/cos confusion and use of the same angle for both forces.

A1 Correct LHS

A1 Correct acceleration with correct radius (which might be seen later in part (a)).

dM1 Eliminate *R* and solve to find expression for *T*. Depends on both previous M marks. Allow this mark even if they have not found an angle.

A1 Correct expression for *T* (any correct equivalent).

(b)

M1 Attempt to obtain an expression in *R*. Independent of the M marks in (a), but must have come from 2 equations in *T* and *R*.

A1 Correct unsimplified expression in R

M1 Use of the correct inequality for *R*

A1cso* Obtain given result from fully correct working.