Question	Scheme	Marks	AOs
9(a)(i)	Weight = mass × g $\Rightarrow m = \dfrac{30\,000}{g} = 3000$ But mass is in thousands of kg, so $m = 3$	M1	3.3
(ii)	$\dfrac{\mathrm{d}x}{\mathrm{d}t} = 40\cos t + 20\sin t,\ \dfrac{\mathrm{d}^2x}{\mathrm{d}t^2} = -40\sin t + 20\cos t$	M1	1.1b
	$3(-40\sin t + 20\cos t) + 4(40\cos t + 20\sin t)$ $+ 40\sin t - 20\cos t = \ldots$	M1	1.1b
	= 200 cos t so PI is $x = 40 \sin t - 20 \cos$	A1*	2.1
	or		
	Let $x = a\cos t + b\sin t$ $\dfrac{\mathrm{d}x}{\mathrm{d}t} = -a\sin t + b\cos t,\ \dfrac{\mathrm{d}^2x}{\mathrm{d}t^2} = -a\cos t - b\sin t$	M1	1.1b
	$4b - 2a = 200,\ -2b - 4a = 0 \Rightarrow a = \ldots, b = \ldots$	M1	2.1
	$x = 40\sin t - 20\cos t$	A1*	1.1b
(iii)	$3\lambda^2 + 4\lambda + 1 = 0 \Rightarrow \lambda = -1, -\dfrac{1}{3}$	M1	1.1b
	$x = A\mathrm{e}^{-t} + B\mathrm{e}^{-\frac{1}{3}t}$	A1	1.1b
	$x = PI + CF$	M1	1.1b
	$x = A\mathrm{e}^{-t} + B\mathrm{e}^{-\frac{1}{3}t} + 40\sin t - 20\cos t$	A1	1.1b
		(8)	
(b)	$t = 0, x = 0 \Rightarrow A + B = 20$	M1	3.4
	$x = 0, \dfrac{\mathrm{d}x}{\mathrm{d}t} = -Ae^{-t} - \dfrac{1}{3}Be^{-\frac{1}{3}t} + 40\cos t + 20\sin t = 0$ $\Rightarrow A + \dfrac{1}{3}B = 40$	M1	3.4
	$x = 50\mathrm{e}^{-t} - 30\mathrm{e}^{-\frac{1}{3}t} + 40\sin t - 20\cos t$	A1	1.1b
	$t = 9 \Rightarrow x = 33\mathrm{m}$	A1	3.4
		(4)	
			(12 marks)

Question 9 notes:

(a)(i)

M1: Correct explanation that in the model, $m = 3$

(ii)

M1: Differentiates the given PI twice

M1: Substitutes into the given differential equation

A1*: Reaches $200\cos t$ and makes a conclusion

or

M1: Uses the correct form for the PI and differentiates twice

M1: Substitutes into the given differential equation and attempts to solve

A1*: Correct PI

(iii)

M1: Uses the model to form and solve the auxiliary equation

A1: Correct complementary function

M1: Uses the correct notation for the general solution by combining PI and CF

A1: Correct General Solution for the model

(b)

M1: Uses the initial conditions of the model, $t = 0$ at $x = 0$, to form an equation in A and B

M1: Uses $\frac{\mathrm{d}x}{\mathrm{d}t} = 0$ at $x = 0$ in the model to form an equation in A and B

A1: Correct PS

A1: Obtains 33m using the assumptions made in the model