11 Modelling oscillations
Answers to practice questions

Question	Answer	Marks
1	B	1
2 a i	$F = -1.0$ N $a = -4.0$ m s^{-2}	1 1
2 a ii	$F = -0.5$ N $a = -2.0$ m s^{-2}	1 1
2 b	$T = 2\pi\sqrt{\frac{0.25}{10}}$ = 1.0 s (2 s.f.)	1 1
3 a	$T = 0.011$ s	1
3 b	$a = (-)4\pi^2 \times 90^2 \times 0.06$ $= (-)1.9 \times 10^4$ m s^{-2}	1 1
4 a	0.001 40 m	1
4 b	$2\pi f = 1650$ $f = 262.6$ Hz	1 1
5	Sand will just leave contact with the plate when the downward acceleration is 9.8 m s^{-2}. $A = 4\pi^2 f^2 A$ $A = \frac{9.8}{4\pi^2 \times 15^2}$ = 1.1 mm This will occur at highest point of the oscillation.	1 1 1 1
6 a	Substitution into $f = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ Evaluation of $k = 45.5$ N m^{-1}	1 1
6 b	Curve starts at amplitude 2 mm for frequency = 0.1 Hz rises to maximum of 8.0 mm at 2.4 Hz falls after this value, becoming lower than 2 mm at highest frequency values, graph a smooth curve resembling figure 7, section 11.4. The amount of damping is not discussed so the peak can be sharp or broad.	1 1 1 1
7	See figure 2, section 11.4. (1 mark for each curve).	2
8 a	$k = \frac{4\pi^2 m}{T^2}$ = 79 000 N m^{-1}	1 1
8 b	$x = \frac{F}{k} = \frac{500 \times 10}{79000}$ = 0.06 m	1 1
8 c	$E = \frac{1}{2} \times 79\,000 \times 0.1^2$ = 400 J	1 1
8 d	maximum magnitude of velocity = $2\pi fA$ = 1 m s^{-1} (1 s.f.)	1 1
9 a	$k = 2.8 \times 10^4$ N m^{-1}	1
9 b	$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ = 3.4 Hz	1 1

9 c	Any three of the following, for 1 mark each: • bumps/road vibrate spring at natural frequency (and resonance occurs) • (at resonance) the frame/rider experience large amplitude oscillations • damping removes energy from the system • by converting kinetic energy into heat • reducing amplitude of oscillations	3
9 d	Use amplitude A to calculate maximum kinetic energy from $E = \frac{1}{2}kA^2$ = 2.1 J or 2.3 J depending on k value. Graph of correct shape and time period.	1 1