17. Oscillations

17.3 Damped and forced oscillations, resonance

Paper 4

Marking Scheme

Q1.

(a)	oscillation (of object) at maximum amplitude	**B1**
	when driving frequency = natural frequency (of system)	**B1**
(b)(i)	light damping	**B1**
(b)(ii)	oscillations (of ball) lose energy	**B1**
	(due to) resistive forces (acting on ball)	**B1**
(c)	curve showing a maximum amplitude at a single non-zero frequency	**B1**
	single maximum amplitude shown at 4.0 Hz	**B1**

Q2.

(c)	sketch: line starting at (0, 0.036) and not reaching $x = \pm 0.036$ m at any other time	**B1**
	smooth curve, with no sudden changes in gradient, showing continuously decreasing magnitude of x from maximum displacement at $t = 0$ to final displacement of zero where the gradient is also zero	**B1**
	displacement reaches final value of zero between $t = 0.75$ s and $t = 3.0$ s at the latest	**B1**

Q3.

(a)	oscillations (of object) at maximum amplitude	**B1**
	when driving frequency equals natural frequency (of object)	**B1**

Q4.

(c)(i)	loss of (total) energy (of system)	**B1**
	due to resistive forces	**B1**

Q5.

(c)(i)	resonance	**B1**
(c)(ii)	oscillator supplies energy (continuously)	**B1**
	energy of trolley constant so energy must be dissipated **or** without loss of energy the amplitude would continuously increase	**B1**

Q6.

(c)	smooth wave starting at 3.0 cm when $t = 0$	**B1**
	positions of peaks and troughs show same period (or slightly longer)	**B1**
	each peak and trough at lower amplitude than the previous one	**B1**

Q7.

(c)	wave starting with a peak at (0,6)	**B1**
	wave with same period (or slightly greater)	**B1**
	peak height decreasing successively	**B1**

Q8.

(a)(i)	loss of energy	**B1**
(a)(ii)	amplitude (of oscillations) decreases (with time)	**B1**
(c)(i)	(one) smooth curve, not touching the *f*-axis, with two concave sides meeting at a peak in between them	**B1**
	(one) peak at 1.0ω	**B1**
(c)(ii)	• lower peak/(whole) line is lower • flatter peak/peak is less sharp • peak at (slightly) lower angular frequency/peak moves to left *any two points, one mark each*	**B2**

Q9.

(b)(i)	**1.** amplitude decreases gradually so light damping **or** oscillations continue so light damping	**B1**
	2. loss of energy	**B1**
	due to friction in wheels **or** due to friction between wheels and surface (during slipping) **or** due to air resistance (on trolley)	**B1**

Q10.

(b)(i)	e.g. viscosity of liquid/friction within the liquid/viscous drag/friction between walls of tube and liquid	**B1**

Q11.

(c)(i)	Any one from: • viscosity of liquid • friction within the liquid • viscous drag • friction/resistance between walls of tube and liquid	**B1**