5(a)(i)	straight line through the origin shows that *a* is proportional to *x*
	negative gradient shows that *a* is always in the opposite direction to *x*
5(a)(ii)	$a_0 = \omega^2 x_0$
	$\omega = 2\pi / T$
	$T = 2\pi \sqrt{(x_0 / a_0)}$ $= 2\pi \sqrt{(1.2 / 13)}$ $= 1.9$ s
5(b)(i)	loss of energy of oscillations
	due to <u>resistive</u> force(s)
5(b)(ii)	line starting from $x = \pm 1.2$ cm at $t = 0$
	line starting from non-zero value of *x* from $t = 0$ to $t = 2T$ that is entirely either above or below the *t*-axis
	curve from $t = 0$ starting from non-zero *x* value, with both magnitude of *x* value and magnitude of gradient continuously decreasing

4(a)	<u>number</u> of oscillations per unit time
4(b)(i)	kinetic energy (of object) reaches maximum / minimum / zero twice in a cycle
4(b)(ii)	$\omega = 2\pi / T$ $= 2\pi / 0.80$ **or** $a_0 = \omega^2 x_0$ $\omega = \sqrt{(1.0 / 0.016)}$
	$\omega = 7.9$ rad s^{-1}
4(b)(iii)	*Any three points from:* • oscillations are simple harmonic • <u>amplitude</u> = 0.016 m • maximum speed = 0.13 m s^{-1} • total energy of oscillations = 7.0×10^{-4} J • mass of object = 0.087 kg • maximum momentum = 0.011 kg m s^{-1} **or** 0.011 N s
4(b)(iv)	*Any two points from:* • kinetic energy is a maximum at zero displacement **or** kinetic energy is zero at maximum displacement • potential energy is zero at zero displacement **or** potential energy is a maximum at maximum displacement • kinetic energy is maximum when the potential energy is zero **or** potential energy is a maximum when the kinetic energy is zero
	kinetic energy + potential energy is constant

5(a)	(motion in which) acceleration is (directly) proportional to displacement
	(motion in which) acceleration is (always) in the opposite <u>direction</u> to displacement **or** acceleration is (always) directed towards a fixed point
5(b)(i)	period $= 2\pi / 16$ $= 0.39$ s
5(b)(ii)	$v_0 = \omega x_0$ **or** $v_0 = \omega\sqrt{\left(x_0^{\,2} - 0^2\right)}$
	$x_0 = 0.56 / 16$ $= 0.035$ m
5(b)(iii)	$v = \pm 16\ \surd(0.0352 - x^2)$
5(b)(iv)	closed loop surrounding the origin
	loop crosses $v = 0$ at maximum values of x at $x = \pm$ 3.5 cm
	loop crosses $x = 0$ at maximum values of v at $v = \pm$ 0.56 m s^{-1}

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5(a)(i)	amplitude = 0.60 m
5(a)(ii)	oscillations are simple harmonic
5(b)	*Any three points from:* • mean / equilibrium position is at $h = 1.4$ m • total energy of oscillations = 9.0 J • angular frequency of oscillations = 1.2 rad s^{-1} **or** period of oscillations = 5.1 s **or** frequency of oscillation = 0.19 Hz • maximum speed of block = 0.73 m s^{-1} • mass of block = 33 kg
5(c)	U-shaped curve resting on h axis (with minimum at $E_P = 0$)
	curve from $h = 0.8$ m to $h = 2.0$ m, with minimum E_P shown at $h = 1.4$ m
	both end-points of curve shown at $E_P = 9.0$ J

4(a)	(motion in which) acceleration is (directly) proportional to displacement
	(motion in which) acceleration is (always) in the opposite direction to displacement **or** acceleration is (always) directed towards a fixed point
4(b)(i)	t_1 **and** t_5 **or** t_3 **and** t_7
4(b)(ii)	$f = 1 / T$
	period = 2.2 / 1.25 f = 1.25 / 2.2 = 0.57 Hz
4(c)	$v_0 = \omega x_0$ **and** $\omega = 2\pi f$
	$0.080 = 2\pi \times 0.57 \times x_0$
	$x_0 = 0.022$ m

4(a)	$\omega = 2\pi / T$
	$= 2\pi / (0.15 \times 10^{-6}) = 4.2 \times 10^{7}$ rad s^{-1}
4(b)	$a_0 = \omega^2 x_0$
	$= (4.2 \times 10^{7})^2 \times 40 \times 10^{-6}$ $= 7.1 \times 10^{10}$ m s^{-2}
4(c)	$E = ½ m\omega^2 x_0^2$
	$= ½ \times 2.4 \times 10^{-4} \times (4.2 \times 10^{7})^2 \times (40 \times 10^{-6})^2$
	= 340 J
4(d)(i)	apply alternating p.d. (to / across crystal)
	applying p.d. to / across crystal causes it to distort
4(d)(ii)	$Z = \rho c$ $Z_m = 1100 \times 1600$ (= 1.76×10^6) $Z_b = 1900 \times 4100$ (= 7.79×10^6)
	intensity reflection co-efficient= $[(7.79 - 1.76) / (7.79 + 1.76)]^2$ = 0.40 or 40%
	percentage transmitted = 60%