1	$[(W / g) a = W \sin \alpha - 0.02 W \cos \alpha]$	M1		For using Newton's second law
	$a = (\sin 14^\circ - 0.02 \cos 14^\circ) g$ $(= 2.225 \ldots)$	A1		
	$[v^2 = 8^2 + 2 \times 2.225 \ldots \times 50]$	M1		For using $v^2 = u^2 + 2as$
	Speed is 16.9 m s^{-1}	A1	[4]	
	Alternative Scheme			
1	WD against friction = $0.02 W \cos \alpha \times 50$	B1		
	PE loss = $W \times 50 \sin \alpha$	B1		
		M1		For using Gain in KE = Loss in PE – WD against friction
	Speed is 16.9 m s^{-1}	A1	[4]	
2 (i)		M1		PE loss = B's loss – A's gain
	Loss of PE = $2g \times 3.24 - 1.6 g (3.24 \times 0.8)$	A1		
	Loss is 23.328 J.	A1	[3]	AG
(ii)	$\frac{1}{2}(1.6 + 2) v^2 = 23.328$	B1		
	Speed is 3.6 m s^{-1}	B1	[2]	SR (max 1/2) for using Newton's second law and $v^2 = u^2 + 2as$ $2g - T = 2a$ and $T - 1.6g \times 0.8 = 1.6a$ $a = 2$ $v^2 = 2 \times 2 \times 3.24$ $v = 3.6$ B1
3		M1		For using DF = P / v
		M1		For using Newton's 2nd law for both speeds / accelerations
	$1000 P / 14 - R = 800 \times 1.4$ and $1000 P / 25 - R = 800 \times 0.33$	A1		
		M1		For solving for P
	P = 27.2	A1		
	R = 825	B1	[6]	Accept 825.5

4 (i)		M1		For integrating a (t) to obtain v (t)
	V (t) = 1.5 t + 0.006 t^2	A1		Constant of integration zero or absent
	[0.006 t^2 + 1.5 t - 90 = 0 ➔ t^2 + 250t – 15000 = 0] ➔ (t – 50) (t + 300) = 0]	DM1		For using v (t) = 90 and solving for t (dependent on integration)
	Leaves the ground when t = 50	A1	[4]	
(ii)		M1		For integrating v (t) and using limits 0 to candidate's answer for part (i)
	s = 0.75 t^2 + 0.002 t^3	A1ft		ft if there is a non-zero constant of integration C in part (i) s = 0.75 t^2 + 0.002 t^3 + C t
	Distance is 2125 m	A1ft	[3]	Accept 2120 or 2130 ft t from part (i) in 0.75 t^2 + 0.002 t^3
5 (i)	[T = 2 x 1.7 – 2 x 0.7] [for P 17 t – 5 t^2 = 0 and for Q 7 t = 5 t^2 = 0]	M1		T = 2 x time to max. height for P – 2 x time to max. height for Q or For using T = time for P to return to ground – time for Q to return to ground
	T = 2	A1	[2]	SR (max 1/2) for candidates who find difference in time to maximum height T = 1.7 – 0.7 = 1 B1
(ii)		M1		For using $h_P - h_Q = 5$ and s = u t – 5 t^2 for both P and Q
	$17(t + 2) – 5(t + 2)^2 – (7t – 5t^2) = 5$ or $17t – 5t^2 – 7(t - 2) + 5(t – 2)^2 = 5$			
		A1	ft	ft T from part (i)
	t = 0.9 or t = 2.9	A1		
		M1		For using v = u – 10 t for P and Q

	$v_P = 17 - 10(0.9 + 2)$, $v_Q = 7 - 10 \times 0.9$ → Magnitudes are 12 m s^{-1} & 2 m s^{-1}	A1	ft	ft using t_P and $t_P - T$ or using t_Q and $t_Q + T$
	The direction for both is vertically downwards	A1	[6]	
6 (i)		M1		For resolving the applied forces on the box in the *x*-direction or the *y*-direction.
	$100 \cos 30^\circ + 120 \cos 60^\circ - F \cos\alpha = 136$ ($F \cos \alpha = 10.6025 \ldots$) or $100 \sin 30^\circ - 120 \sin 60^\circ + F \sin \alpha = 0$ ($F \sin \alpha = 53.9230 \ldots$)	A1		
	$100 \sin 30^\circ - 120 \sin 60^\circ + F \sin \alpha = 0$ ($F \sin \alpha = 53.9230 \ldots$) or $100 \cos 30^\circ + 120 \cos 60^\circ - F \cos \alpha = 136$ ($F \cos \alpha = 10.6025 \ldots$)	B1		
		M1		for using $F^2 = (F \cos \alpha)^2 + (F \sin \alpha)$ or $\tan \alpha = F \sin \alpha \div F \cos \alpha$
	$F = 55.0$ or $\alpha = 78.9$	A1		
	$\alpha = 78.9$ or $F = 55.0$	B1	[6]	
(ii)	Magnitude is 136 N	B1		
	$R = 40$ g	B1		
	Coefficient is 0.34	B1	[3]	

7 (i)		M1		For applying Newton's 2nd law to A or to B
	$T - (2/7)\ 1.26\ g = 1.26\ a$ or $0.9\ g - T = 0.9\ a$	A1		
	$0.9g - T = 0.9\ a$ or $T - (2/7)\ 1.26\ g = 1.26\ a$ or $0.9\ g - (2/7)\ 1.26\ g = (0.9 + 1.26)\ a$	B1		
	Acceleration is $2.5\ m\ s^{-2}$	B1		AG
	Tension is 6.75 N	A1	[5]	
(ii)	$[v^2 = 2 \times (2.5) \times 0.45]$	M1		For using $v^2 = 2\ a\ h$
	Speed is $1.5\ m\ s^{-1}$	A1	[2]	
(iii)	$[-(2/7)\ 1.26\ g = 1.26\ a]$	M1		For applying Newton's 2nd law to A
	$a = -20/7$	A1		
	$[v^2 = 2.25 + 2\ (-20/7)\ (0.03)]$	M1		For using $v^2 = v_B^2 + 2\ a\ s$
	Speed is $1.44\ m\ s^{-1}$	A1	[4]	