Question Number	Answer	Acceptable answers	Mark
1(a)(i)	B it decreases		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(a)(ii)	C it does not change		**(1)**

Question Number	Answer	Acceptable answers	Mark
1 (b)(i)	horizontal arrow (judge by eye), pointing to the right **anywhere** on the diagram 		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(b)(ii)	substitution: (1) 130 000 × 75 evaluation: (1) 9 750 000 (kgm/s) (Ns)	give full marks for correct answer, no working Ignore minus sign 9.75×10^6 (kgm/s) (Ns)	**(2)**

Question Number	Answer	Acceptable answers	Mark
1 (b)(iii)	9 750 000 kgm/s	same value as answer to (b)(ii) Ignore minus sign	**(1)**

Question Number	Answer	Acceptable answers	Mark
1(c)(i)	An explanation linking two of the following: • force is smaller/less (1) • momentum changes more slowly (1) • lower deceleration (1) • use of the formula (1)	 pressure is smaller/less slower deceleration force is proportional to rate of change of momentum/F= (mv – mu)/t	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(c)(ii)	Any two from: (for loaded aircraft) • has more mass (1) • has more momentum (1) • has more k.e. (1) • higher velocity • brakes need to do more work (1)	accept reverse argument for empty aircraft heavier/more passengers/more cargo higher speed/moving faster	**(2)** **expert**

Total marks for question 4 = 10 marks

Question Number	Answer	Acceptable answers	Mark
2(a)(i)	substitution (1) work done = 84 x 0.25 evaluation (1) 21(J)	Full marks for correct answer even if no working is evident	**(2)**

Question Number	Answer	Acceptable answers	Mark
2(a)(ii)	21 J	Ecf from (a)(i)	**(1)**

Question Number	Answer	Acceptable answers	Mark
2(a)(iii)	substitution (1) KE = ½ x 27 x $(2.3)^2$ evaluation (1) = 71.4 (which is approx 71)	V=2.29 gains two marks Reverse argument which shows that V = $\sqrt{}$5.3 gains two marks	**(2)**

Question Number	Answer	Acceptable answers	Mark
2 (a)(iv)	B		**(1)**

Question Number		Indicative Content	Mark
QWC	***2(b)**	An explanation linking some of the following points • kinetic energy varies during swing • kinetic energy maximum at bottom of swing • kinetic energy minimum at top of swing • gravitational potential energy(gpe) varies during swing • gpe maximum at top of swing • gpe minimum at bottom of swing • (continuous) interchange of KE and gpe • total amount of energy is constant during one swing • over a number of swings max KE and max PE decreases • energy is dissipated/'lost' to surroundings • because of air resistance / friction • amplitude/size of swings decrease (as energy 'lost' to surroundings) ignore references to momentum	**(6)**
Level	**Mark**	**Descriptor**	
	0	No rewardable content	
1	**1 - 2**	• a limited explanation which states some facts e.g. (max) Kinetic energy decreases over time. KE will transfer to GPE. **or** KE increases and decreases over one swing. The height which the swing reaches gets less over time. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple explanation with links between facts; either over one period of oscillation or over several periods of oscillations. Kinetic energy decreases as he gets higher and the GPE increases. There is a continuous interchange of KE and gpe as he swings. **or** KE is gradually transferred to heat so swing rises to a slightly lower height each time. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed explanation with links between facts over one period of oscillation **and** over several periods of oscillations e.g. kinetic energy is at a maximum at bottom of swing There is a continuous interchange of KE and gpe. KE (and gpe) reduce over a number of swings as energy is dissipated to the surroundings due to friction. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Question number	Ans	Mark
3(a)	D	(1)

Question number	Answer	Mark
3(b)	C	(1)

Question number	Answer	Additional guidance	Mark
3(c)(i)	An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark): • frictional forces increase as more trucks are added (1) Plus **one** from: • hence, in order to keep constant speed, the student must increase the force she applies to **Z** (1) • when **Y** and **Z** separate, the frictional forces (to the left) are more than magnetic attraction between **Y** and **Z** (1)		(2)

Question number	Answer	Mark
3(c)(ii)	An answer that combines the following points to provide a plan: • use of a Newton meter used horizontally (1) • record largest force observed (1) • repeat readings several times under same conditions (1)	**(3)**

Question number	Answer	Mark
3(c)(iii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): • the applied force must be resolved horizontally to determine the force that separates the engine from the trucks • and since the (size of) the resolved force is always less than the (size of) the actual force then a larger force (applied at an angle) is needed to separate the trucks from the engine	**(2)**