Markscheme: Q4-6 P161

Question	Answer	Mark	Comment
4 (a)	the resultant force steadily decreases during the first 4 s	1	**(a)** is an exercise in interpreting the velocity-time graph. The gradient decreases over the first 4 s, indicating a decreasing acceleration. Beyond 4 s, the constant velocity shows that there is no acceleration.
	it is zero for the all times beyond 4 s	1	
(b)	maximum kinetic energy	1	When the car has its maximum kinetic energy it has reached its constant speed, which you read from the graph. Take care when doing this: it is **not** 15 m s^{-1}.
	$= \frac{1}{2} m v^2 = \frac{1}{2} \times 1.4 \times 10^3 \times 16^2 = 1.8 \times 10^5$ J	1	
(c)	when at a constant speed, power $P = F v$	1	For this part of the question, the car is travelling at a higher constant speed. Power is equal to the work done per second, which is (force) × (distance moved per second), or $F \times v$.
	gives $2.0 \times 10^4 = F \times 30$ ∴ driving force $F = 670$ N	1	
5 (a) (i)	use of $\Delta E_P = m g \Delta h$ gives	1	Part **(ii)** requires particular care, because you cannot use (E_K gained) = (E_P lost). You may only become aware of this when you first read through part **(b)**. The skydiver encounters significant air resistance and therefore some of the E_P lost becomes thermal energy.
	$\Delta E_P = 70 \times 9.81 \times 150 = 1.03 \times 10^5$ J	1	
(ii)	use of $E_K = \frac{1}{2} m v^2$ gives	1	
	$E_K = \frac{1}{2} \times 70 \times 45^2 = 7.09 \times 10^4$ J	1	
(b) (i)	work done against air resistance $= (1.03 \times 10^5) - (7.09 \times 10^4) = 3.21 \times 10^4$ J	1	The 'missing' energy must be equal to the work done.
(ii)	use of work done $= F s$ gives $3.21 \times 10^4 = F \times 150$	1	The resistive force will increase as the speed of the skydiver increases. This result is an average value.
	∴ average resistive force = 210 N (to 2 significant figures)	1	
6 (a)	use of $P = F v$ gives $1.8 \times 10^4 = F \times 10$ and F = 1800 N	1	You are asked to show that this value is 1800 N, and so only one mark is available.
(b) (i)	$250 + F_R = 1800$ gives $F_R = 1550$ N	1	You know from **a** that the total resistive force is 1800 N when the speed is 10 m s^{-1}.
(ii)	new air resistance force $= 4 \times F_R = 6200$ N	1	The force due to air resistance is proportional to $(\text{speed})^2$, and the speed has doubled.
(iii)	total resistive force $= 6200 + 250 = 6450$ N	1	You are told that the frictional force of 250 N is constant. Comparing the values of power in **(a)** and **(b)(ii)**, it is clear that this car requires its power to be increased by more than 7 times when the speed is doubled in this way.
	use of $P = F v$ gives $P = 6450 \times 20 = 1.3 \times 10^5$ W	1	