

Mark Scheme Terminal Velocity Past Paper Questions

Jan 2002 to Jan 2009

- 5(a) decreases for the first four seconds ✓
zero for the remaining six seconds ✓ (2)

Q5 Jan 2002

- (b) $E_k = \frac{1}{2} \times 1.4 \times 10^3 \times 16^2$ ✓
 $= 1.8 \times 10^5 \text{ J}$ ✓
(accept $v = 15 \text{ m s}^{-1}$ from misleading graph and $E_k = 1.6 \times 10^5 \text{ J}$) (2)

- (c) (use of $P = Fv$ gives) $20 \times 10^3 = F \times 30$ ✓
 $F = 670 \text{ N}$ ✓ (2)
(6)

- 7(a) ball bearing accelerates at first as resultant force is downwards ✓
resistive force increases with speed ✓
when resultant force on ball is zero, terminal velocity reached ✓ (3)

Q7 Jan 2002

- (b) show ball bearing takes same time ✓
to travel equal distances ✓
[or measure velocity at different points ✓ with appropriate method ✓] (2)
(5)

- 6(a)(i) 70 m s^{-1} ✓

Q6 Jan 2003

- (a)(ii) $v = 9.81 \times 2.0$ ✓
 $= 20 \text{ m s}^{-1}$ ✓ (19.6 m s^{-1})
- (a)(iii) $v = \sqrt{(70^2 + 19.62^2)} = 73 \text{ m s}^{-1}$ ✓
direction: $\tan \theta = \frac{19.6}{70} = 0.28$
 $\theta = 15.6^\circ$ ✓ ($\pm 0.1^\circ$) (to horizontal) ✓
(allow C.E. for values of v from (i) and (ii))
[or use of correct scale drawing] (5)

- (b)(i) air resistance is greater than weight ✓
(hence) resultant force is upwards ✓
hence deceleration (Newton's second law) ✓

- (b)(ii) air resistance decreases as speed decreases ✓
weight equals air resistance (hence constant speed)
(hence) resultant force is zero (Newton's first law) ✓
- max(4)
(9)

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Q3 Jun 2003

- (i) weight greater than air resistance
 [or (initially only) weight/gravity acting] ✓
 hence resultant force downwards or therefore acceleration (2nd law) ✓
 air resistance or upward force increases with speed ✓
 until air resistance equals weight or resultant force is zero ✓
 leaf moves at constant velocity (1st law)
 [or 1st law applied correctly] ✓
- (ii) air resistance depends on shape
 [or other correct statement about air resistance] ✓
 air resistance less significant ✓
 air resistance less, therefore greater velocity
 [or average velocity greater
 or accelerates for longer] ✓

max(5)
(5)

Question 3		
(a)	weight/gravity causes raindrop to accelerate/move faster (initially) ✓ resistive forces/friction increase(s) with speed ✓ resistive force (eventually) equals weight ✓ [or upward forces equal downward forces] Q3 Jun 2005 resultant force is now zero ✓ [or forces balance or in equilibrium] no more acceleration ✓ [or correct application of Newton's Laws] [if Newton's third law used, then may only score first two marks]	Max 4
(b) (i)	$E_k (= \frac{1}{2} mv^2) = \frac{1}{2} \times 7.2 \times 10^{-9} \times 1.8^2 \checkmark$ $= 1.2 \times 10^{-8} \text{ J} \checkmark (1.17 \times 10^{-8} \text{ J})$	4
(b) (ii)	work done ($= mgh$) $= 7.2 \times 10^{-9} \times 9.81 \times 4.5 \checkmark$ $= 3.2 \times 10^{-7} \text{ J} \checkmark (3.18 \times 10^{-7} \text{ J})$	
(c)	$v_{\text{resultant}} = \sqrt{(1.8^2 + 1.4^2)} \checkmark$ $= 2.2(8) \text{ m s}^{-1} \checkmark$ $\theta = \tan^{-1} (1.4/1.8) = 38^\circ \checkmark (37.9^\circ)$ [or correct scale diagram]	3