

# 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)  $70 \text{ m s}^{-1}$  ✓

### Q6 Jan 2003

- (a)(ii)  $v = 9.81 \times 2.0$  ✓  
 $= 20 \text{ m s}^{-1}$  ✓ ( $19.6 \text{ m s}^{-1}$ )
- (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)

3

**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 <b>increase(s)</b> with <b>speed</b> ✓ resistive force (eventually) equals weight ✓ [or upward forces equal downward forces] <b>Q3 Jun 2005</b> 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]	<b>Max 4</b>
(b) (i)	$E_k (= \frac{1}{2} mv^2) = \frac{1}{2} \times 7.2 \times 10^{-9} \times 1.8^2 \checkmark$ $= 1.2 \times 10^{-8} \text{ J} \checkmark (1.17 \times 10^{-8} \text{ J})$	<b>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]	<b>3</b>