

# Mark Scheme F=ma Past Paper Questions

## Jan 2002 to Jan 2009

8(a)(i) (use of  $v^2 = u^2 + 2as$  gives)  $0 = 25^2 - 2 \times 9.81 \times s$  ✓  
 $19.6 s = 625$  and  $s = 32$  m ✓

(ii)  $t = \frac{25}{9.81} = 2.5$  s ✓

**Q8 Jan 2002**

(iii) (use of  $v^2 = u^2 + 2as$  gives)  $v^2 = 25^2 - 2 \times 9.81 \times 16$  ✓  
(allow C.E. from (a)(i))  
and  $v = 18$  m s<sup>-1</sup> ✓

max(4)

(b) time to stop the ball is greater ✓  
∴ rate of change of momentum is less ✓  
[or work done on ball is the same but greater distance ✓ ∴ less force ✓] (2)  
(6)

5(a) (use of  $F = ma$  gives)  $F = 1.3 \times 10^3 \times 2.5$  ✓  
 $= 3250$  N ✓ (3.25 × 10<sup>3</sup>) (2)

(b)(i) driving force = 3250 + 410 = 3660 N ✓  
(allow C.E. from (a))

**Q5 Jun 2002**

(ii) (use of  $P = Fv$  gives)  $P = 3660 \times 2.2$  ✓  
(allow C.E. from(i))  
 $= 8100$  W ✓ (8.1 × 10<sup>3</sup>) (3)

(c) (component of) car's weight opposes motion  
[or overcomes gravity  
or more work is done as car gains potential energy] ✓ (1)  
(6)

3(a) displacement is a vector ✓  
ball travels in opposite directions ✓ max(1)

**Q3 Jan 2003**

(b) velocity is rate of change of displacement  
average speed is rate of change of distance  
velocity is a vector [or speed is a scalar]  
velocity changes direction any two ✓ ✓ (2)

(c)(i)  $a = \frac{(-6.0 - 8.0)}{0.10}$  ✓  
 $= (-)140$  m s<sup>-1</sup> ✓ (allow C.E. for incorrect values of  $\Delta v$ )

(c)(ii)  $F = 0.45 \times (-)140 = (-)63$  N ✓ (allow C.E. for value of  $a$ )

(c)(iii) away from wall ✓  
at right angles to wall ✓  
[or back to girl ✓ ✓]  
[or opposite to direction of velocity at impact ✓ ✓] (5)  
(8)

2

(a)(i) (use of  $F = ma$  gives)  $1.8 \times 10^3 = 900 a$  ✓  
 $a = 2.0 \text{ m s}^{-2}$  ✓

**Q2 Jan 2004**

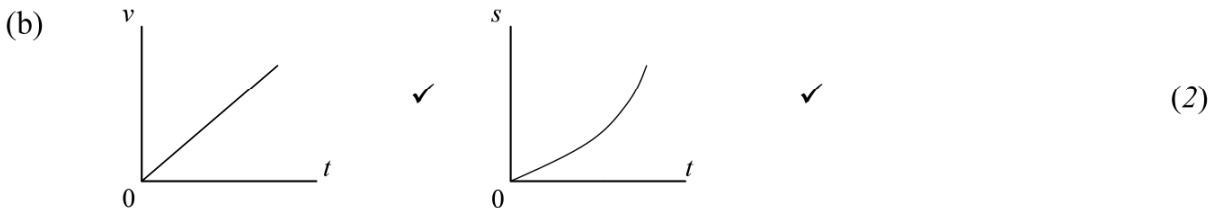
(ii) (use of  $v = u + at$  gives)  $v = 2.0 \times 8.0 = 16 \text{ m s}^{-1}$  ✓  
(allow C.E. for  $a$  from (i))

(iii) (use of  $p = mv$  gives)  $p = 900 \times 16$  ✓  
 $= 14 \times 10^3 \text{ kg m s}^{-1}$  (or N s) ✓ ( $14.4 \times 10^3 \text{ kg m s}^{-1}$ )  
(allow C.E. for  $v$  from(ii))

(iv) (use of  $s = ut + \frac{1}{2}at^2$  gives)  $s = \frac{1}{2} \times 2.0 \times 8^2$  ✓  
 $= 64 \text{ m}$  ✓  
(allow C.E. for  $a$  from (i))

(v) (use of  $W = Fs$  gives)  $W = 1.8 \times 10^3 \times 64$  ✓  
 $= 1.2 \times 10^5 \text{ J}$  ✓ ( $1.15 \times 10^5 \text{ J}$ )  
(allow C.E. for  $s$  from (iv))

[or  $E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 900 \times 16^2$  ✓  
 $= 1.2 \times 10^5 \text{ J}$  ✓  
(allow C.E. for  $v$  from (ii))] (9)



(c)(i) decreases ✓  
air resistance increases (with speed) ✓

(ii) eventually two forces are equal (in magnitude) ✓  
resultant force is zero ✓  
hence constant/terminal velocity (zero acceleration)  
in accordance with Newton's first law ✓  
correct statement and application of Newton's first or second law ✓

max(5)  
(16)

**Question 2**

**Q2 Jan 2005**

(a) vector quantities have direction (as well as magnitude) and scalar quantities do not ✓ (1)

(b) vector: e.g. velocity, acceleration, momentum ✓  
scalar: e.g. mass, temperature, energy ✓ (2)

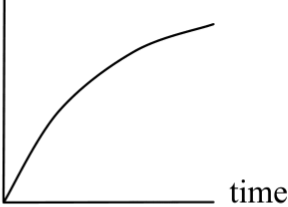
(c)(i) addition of forces (12 + 8) ✓  
(use of  $F = ma$  gives)  $a = \frac{(12+8)}{6.5} = 3.1 \text{ m s}^{-2}$  ✓ ( $3.08 \text{ m s}^{-2}$ )

(ii) subtraction of forces (12 - 8) ✓  
 $a = \frac{(12-8)}{6.5} = 0.62 \text{ m s}^{-2}$  ✓ ( $0.615 \text{ m s}^{-2}$ ) (4)

(7)

Question 6		
(a)	component (parallel to ramp) = $7.2 \times 10^3 \times \sin 30$ ✓ (= $3.6 \times 10^3$ N)	1
(b)	$\text{mass} = \frac{7.2 \times 10^3}{9.81} = 734 \text{ (kg) } \checkmark$ $a = \frac{3600}{734} = 4.9(1) \text{ m s}^{-2} \checkmark$	<p style="text-align: right;"><b>Q6 Jun 2005</b></p> <p style="text-align: right;">2</p>
(c)	(use of $v^2 = u^2 + 2as$ gives) $0 = 18^2 - (2 \times 4.9 \times s)$ ✓ $s = 33(.1) \text{ m}$ ✓ (allow C.E. for value of $a$ from (b))	2
(d)	frictional forces are acting ✓ increasing resultant force [or opposing motion] ✓ hence higher deceleration [or car stops quicker] ✓ energy is lost as thermal energy/heat ✓	Max 2

Question 1		
(a)	scales ✓ six points correctly plotted ✓ trendline ✓	<p style="text-align: right;"><b>Q1 Jan 2006</b></p> <p style="text-align: right;">3</p>
(b)	$\text{average acceleration} = \frac{26}{25} \checkmark$ $= 1.0(4) \text{ m s}^{-2} \checkmark$ (allow C.E. for incorrect values used in acceleration calculation)	2
(c)	area under graph ✓ $= 510 \pm 30 \text{ m}$ ✓	2
(d)	(graph to show force starting from $y$ -axis) decreasing (not a straight line) ✓ to zero (at end of graph) ✓	2
(e)	(since) gradient of a velocity-time graph gives acceleration ✓ first graph shows acceleration is decreasing ✓	2
	<b>Total</b>	<b>11</b>

Question 6			
			<b>Q6 Jun 2006</b>
(a)	(i)	(use of $a = \frac{\Delta v}{\Delta t}$ gives) $a = \frac{4.5}{3600} \checkmark$ $= 1.25 \times 10^{-3} \text{ ms}^{-2} \checkmark$	<b>4</b>
	(ii)	(use of $v^2 = u^2 + 2as$ gives) $0 = 4.5^2 - 2 \times 1.25 \times 10^{-3} \times s \checkmark$ $s \left( = \frac{20.25}{2.5 \times 10^{-3}} \right) = 8.1 \times 10^3 \text{ m} \checkmark$	
(b)		distance  time	increasing curve $\checkmark$ correct curve $\checkmark$  <b>2</b>
(c)		gradient (slope) of graph represents speed $\checkmark$ hence graph has decreasing gradient $\checkmark$	<b>2</b>
		<b>Total</b>	<b>8</b>

Question 5			
			<b>Q5 Jan 2008</b>
(a)	(i)	(use of $F = ma$ ) $a = 1.9 \times 10^5 / 5.6 \times 10^4 = 3.4 \text{ ms}^{-2} \checkmark$	<b>3</b>
	(ii)	(use of $v^2 = u^2 + 2as$ ) $82^2 = 2 \times 3.4 \times s \checkmark$ $s = 989 \text{ m} \checkmark$ c.e. from (i)	
(b)		air resistance increases with speed $\checkmark$ hence runway will be longer $\checkmark$	
(c)	(i)	(use of $F_h = F \cos \theta$ ) $F_h = 1.9 \times 10^5 \times \cos 22$ $F_h = 1.8 \times 10^5 \text{ N} \checkmark$	<b>2</b>
	(ii)	$F_v = 1.9 \times 10^5 \times \sin 22 = 7.1 \times 10^4 \text{ N} \checkmark$	
		<b>Total</b>	<b>7</b>

Question 2		
(a)	<p style="text-align: right;"><b>Q2 Jun 2008</b></p> <p><b>resultant</b> force must be zero ✓  because sledge is moving at constant velocity ✓  (or zero acceleration)</p>	<b>2</b>
(b)	parallel component = $4.5 \times 9.81 \times \sin 22 = 16.5 \text{ N}$ ✓ perpendicular component = $4.5 \times 9.81 \times \cos 22 = 41 \text{ N}$ ✓ (if components swapped -1) (if no g then 1 max but must have unit as kg)	<b>2</b>
(c)	same as (b) (i) e.g. $16.5 \text{ N}$ ✓ same as (b) (ii) e.g. $41 \text{ N}$ ✓ (ignore units)	<b>2</b>
		<b>6</b>