

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⁻¹ ✓

max(4)

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

5(a) (use of $F = ma$ gives) $F = 1.3 \times 10^3 \times 2.5$ ✓
 $= 3250$ N ✓ (3.25 $\times 10^3$) (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 $\times 10^3$) (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⁻¹ ✓ (allow C.E. for incorrect values of Δv)

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

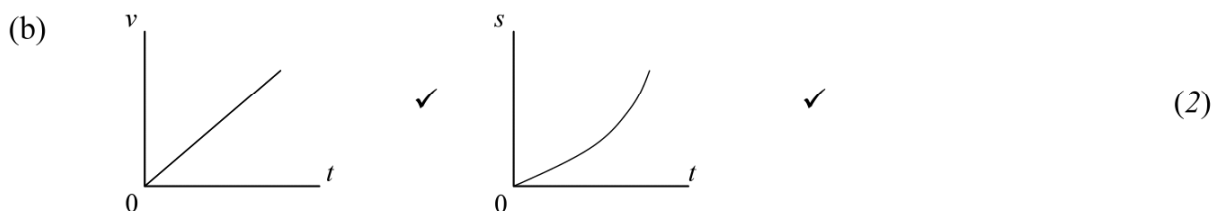
- (c)(iii) away from wall ✓
 at right angles to wall ✓
 [or back to girl ✓ ✓]
 [or opposite to direction of velocity at impact ✓ ✓] (5)
(8)

2

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

Q2 Jan 2004

[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)

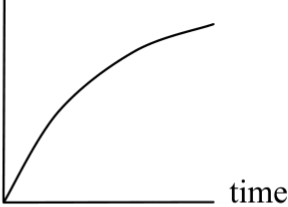
Question 2

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 m s^{-2})
- (ii) subtraction of forces (12 - 8) ✓
 $a = \frac{(12-8)}{6.5} = 0.62 \text{ m s}^{-2}$ ✓ (0.615 m s^{-2}) (4)
(7)

Question 6		
(a)	component (parallel to ramp) = $7.2 \times 10^3 \times \sin 30$ ✓ (= 3.6×10^3 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;">Q6 Jun 2005</p> <p style="text-align: center;">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)	$\text{scales} \checkmark$ $\text{six points correctly plotted} \checkmark$ $\text{trendline} \checkmark$	<p style="text-align: right;">Q1 Jan 2006</p> <p style="text-align: center;">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)	$\text{area under graph} \checkmark$ $= 510 \pm 30 \text{ m} \checkmark$	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
	Total	11

Question 6			
			Q6 Jun 2006
(a)	(i)	(use of $a = \frac{\Delta v}{\Delta t}$ gives) $a = \frac{4.5}{3600} \checkmark$ $= 1.25 \times 10^{-3} \text{ ms}^{-2} \checkmark$	4
	(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	2
(c)		gradient (slope) of graph represents speed \checkmark hence graph has decreasing gradient \checkmark	2
		Total	8

Question 5			
			Q5 Jan 2008
(a)	(i)	(use of $F = ma$) $a = 1.9 \times 10^5 / 5.6 \times 10^4 = 3.4 \text{ ms}^{-2} \checkmark$	3
	(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 $F_h = F \cos \theta$) $F_h = 1.9 \times 10^5 \times \cos 22$ $F_h = 1.8 \times 10^5 \text{ N} \checkmark$	2
	(ii)	$F_v = 1.9 \times 10^5 \times \sin 22 = 7.1 \times 10^4 \text{ N} \checkmark$	
		Total	7

Question 2		
(a)	resultant force must be zero ✓ because sledge is moving at constant velocity ✓ (or zero acceleration)	Q2 Jun 2008 2
(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)	2
(c)	same as (b) (i) e.g. 16.5 N ✓ same as (b) (ii) e.g. 41 N ✓ (ignore units)	2
		6