Mark Scheme F=ma Past Paper Questions

Jan 2002 to Jan 2009

Q8 Jan 2002

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) $t = \dfrac{25}{9.81} = 2.5$ s ✓

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

Q5 Jun 2002

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

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

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

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

Q3 Jan 2003

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

(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) $a = \dfrac{(-6.0 - 8.0)}{0.10}$ ✓
$= (-)140.$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) $1.8 \times 10^3 = 900\,a$ ✓

$a = 2.0\ \mathrm{m\,s^{-2}}$ ✓

Q2 Jan 2004

(ii) (use of $v = u + at$ gives) $v = 2.0 \times 8.0 = 16\ \mathrm{m\,s^{-1}}$ ✓

(allow C.E. for a from (i))

(iii) (use of $p = mv$ gives) $p = 900 \times 16$ ✓

$= 14 \times 10^3\ \mathrm{kg\,m\,s^{-1}}$ (or N s) ✓ ($14.4 \times 10^3\ \mathrm{kg\,m\,s^{-1}}$)

(allow C.E. for v from(ii))

(iv) (use of $s = ut + ½at^2$ gives) $s = \dfrac{1}{2} \times 2.0 \times 8^2$ ✓

$= 64\ \mathrm{m}$ ✓

(allow C.E. for a from (i))

(v) (use of $W = Fs$ gives) $W = 1.8 \times 10^3 \times 64$ ✓

$= 1.2 \times 10^5\ \mathrm{J}$ ✓ (1.15×10^5 J)

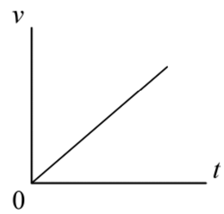
(allow C.E. for s from (iv))

[or $E_k = ½mv^2 = ½ \times 900 \times 16^2$ ✓

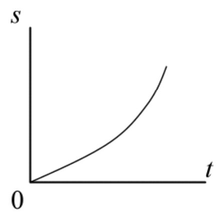
$= 1.2 \times 10^5\ \mathrm{J}$ ✓

(allow C.E. for v from (ii))] (*9*)

(b)



✓



✓ (*2*)

(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) $a = \dfrac{(12+8)}{6.5} = 3.1\ \mathrm{m\,s^{-2}}$ ✓ ($3.08\ \mathrm{m\,s^{-2}}$)

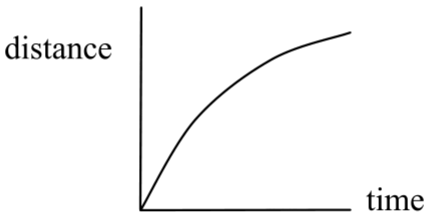
(ii) subtraction of forces (12 − 8) ✓

$a = \dfrac{(12-8)}{6.5} = 0.62\ \mathrm{m\,s^{-2}}$ ✓ ($0.615\ \mathrm{m\,s^{-2}}$) (*4*)

(*7*)

Question 6		
(a)	component (parallel to ramp) = $7.2 \times 10^3 \times \sin 30$ ✓ (= 3.6×10^3 N)	**1**
(b)	**Q6 Jun 2005** mass = $\frac{7.2\times10^3}{9.81} = 734\,(\text{kg})$ ✓ $a = \frac{3600}{734} = 4.9(1)\ \text{m s}^{-2}$ ✓	**2**
(c)	(use of $v^2 = u^2 + 2as$ gives) $0 = 18^2 - (2 \times 4.9 \times s)$ ✓ $s = 33(.1)$ 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)	**Q1 Jan 2006** scales ✓ six points correctly plotted ✓ trendline ✓	**3**
(b)	average acceleration = $\frac{26}{25}$ ✓ $= 1.0(4)\ \text{m s}^{-2}$ ✓ (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**
	Total	**11**

Question 6		Q6 Jun 2006
(a) (i)	(use of $a = \frac{\Delta v}{\Delta t}$ gives) $a = \frac{4.5}{3600}$ ✓ $= 1.25 \times 10^{-3}\,\text{m s}^{-2}$ ✓	4
(ii)	(use of $v^2 = u^2 + 2as$ gives) $0 = 4.5^2 - 2 \times 1.25 \times 10^{-3} \times s$ ✓ $s\left(= \frac{20.25}{2.5\times10^{-3}}\right) = 8.1 \times 10^3\,\text{m}$ ✓	
(b)	 increasing curve ✓ correct curve ✓	2
(c)	gradient (slope) of graph represents speed ✓ hence graph has decreasing gradient ✓	2
	Total	**8**

Question 5		Q5 Jan 2008
(a) (i)	(use of $F = ma$) $a = 1.9 \times 10^5/5.6 \times 10^4 = 3.4\,\text{m s}^{-2}$ ✓	**3**
(ii)	(use of $v^2 = u^2 + 2as$) $82^2 = 2 \times 3.4 \times s$ ✓ s = 989 m ✓ c.e. from (i)	
(b)	air resistance increases with speed ✓ hence runway will be longer ✓	**2**
(c) (i)	(use of $F_h = F\cos\theta$) $F_h = 1.9 \times 105 \times \cos 22$ $F_h = 1.8 \times 105\,\text{N}$ ✓	**2**
(ii)	$Fv = 1.9 \times 10^5 \times \sin 22 = 7.1 \times 10^4\,\text{N}$ ✓	
	Total	**7**

Q2 Jun 2008

Question 2		
(a)	**resultant** force must be zero ✓ because sledge is moving at constant velocity ✓ (or zero acceleration)	2
(b)	parallel component = $4.5 \times 9.81 \times \sin 22 = 16.5$ N ✓ perpendicular component = $4.5 \times 9.81 \times \cos 22 = 41$ 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