AQA MBM1 Jan 01 Q2

2 A particle moves in the horizontal plane that contains the perpendicular unit vectors **i** and **j**. Initially it is at the origin and has velocity $18\mathbf{i}\ \text{ms}^{-1}$. After accelerating for 10 seconds its velocity is $(30\mathbf{i} + 8\mathbf{j})\ \text{ms}^{-1}$. Assume that the acceleration of the particle is constant.

(a) Find the acceleration of the particle. *(2 marks)*

(b) Find the position vector of the particle when its velocity is $(36\mathbf{i} + 12\mathbf{j})\ \text{ms}^{-1}$. *(6 marks)*

2 (a)	$30\mathbf{i}+8\mathbf{j}=18\mathbf{i}+10\mathbf{a}$ $a=1.2\mathbf{i}+0.8\mathbf{j}$	M1 A1	**(2)**	M1: use of $\mathbf{v}=\mathbf{u}+\mathbf{a}t$
(b)	$36\mathbf{i}+12\mathbf{j}=18\mathbf{i}+(1.2\mathbf{i}+0.8\mathbf{j})t$ $t=\frac{36-18}{1.2}=15$ or $t=\frac{12}{0.8}=15$	M1 m1 A1		M1: use of $\mathbf{v}=\mathbf{u}+\mathbf{a}t$ m1: forming linear equation for t
	$\mathbf{r}=18\mathbf{i}\times15+\frac{1}{2}(1.2\mathbf{i}+0.8\mathbf{j})\times15^2$ $=405\mathbf{i}+90\mathbf{j}$	M1 A1 A1	**(6)**	M1: use of $\mathbf{r}=\mathbf{u}t+\frac{1}{2}\mathbf{a}t^2$
		TOTAL	**8**	

AQA MBM1 Jan 01 Q5

5 A car, of mass 900 kg, is initially at rest. On a short journey the car

I. accelerates uniformly for T seconds to a speed of $20\ \text{ms}^{-1}$,
II. then travels at this speed for a period of time,
III. then decelerates uniformly for $2T$ seconds before coming to rest.

(a) In one journey the car moves for a total of 40 seconds and travels a total of 620 m. Using this information:

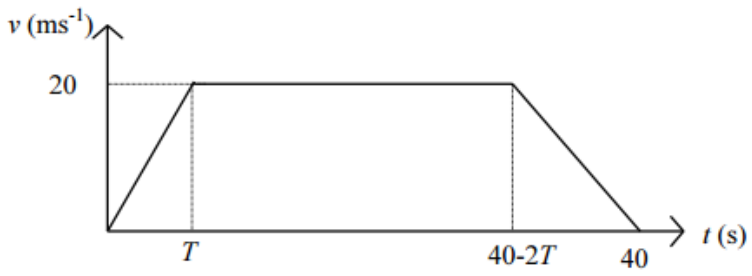
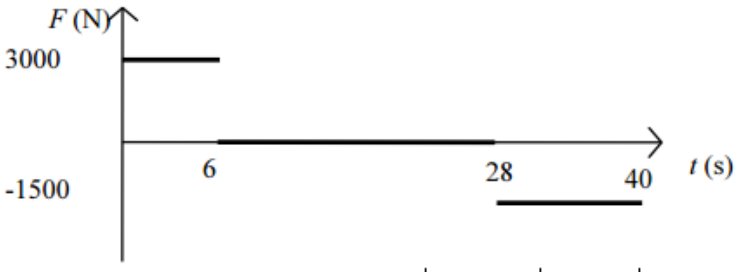
(i) sketch a velocity-time graph and hence, or otherwise, find T; *(5 marks)*

(ii) calculate the magnitude of the resultant force on the car, during each stage of the journey; *(2 marks)*

(iii) sketch a graph to show how the resultant force acting on the car varies with time; *(3 marks)*

(iv) find the speed of the car after it has travelled 20 m. *(3 marks)*

(b) In the case when $T = 5$, find the time that it would take the car to complete a 1000 m journey. *(3 marks)*

Question	Solution	Marks	Total Marks	Comments
5 (a)(i)				
		B1 B1		
	$620 = \frac{1}{2} \times (40 + (40 - 3T)) \times 20$	M1A1		M1: use of area under graph to find T
	$620 = 800 - 30T$ $T = 6$ seconds	A1	**(5)**	
(ii)	Stage 1 $F = 900 \times \frac{20}{6} = 3000$ N Stage 2 $F = 0$	B1		
	Stage 3 $F = 900 \times \frac{20}{12} = 1500$ N	B1	**(2)**	
(iii)				
		B1 B1 B1	**(3)**	
(iv)	$v^2 = 0^2 + 2 \times \frac{20}{6} \times 20$	M1 A1		M1: use of $v^2 = u^2 + 2as$
	$v = 11.5$ ms^{-1}	A1	**(3)**	
(b)	$1000 = \frac{1}{2} \times (t + (t - 15)) \times 20$	M1 A1		M1: forming equation for t based on area under graph
	$100 = 2t - 15$ $t = 57.5$ seconds	A1	**(3)**	
		TOTAL	**16**	

AQA MBM1 Nov 02 Q7

7 At time $t = 0$, a boat is travelling due east at a speed of $3\,\text{m s}^{-1}$. The unit vectors **i** and **j** are directed east and north respectively.

(a) Write down the initial velocity of the boat in vector form. *(1 mark)*

(b) The boat has a constant acceleration of $(0.1\mathbf{i} + 0.2\mathbf{j})\,\text{m s}^{-2}$. Find an expression for the velocity of the boat at time t seconds. *(2 marks)*

(c) When $t = T$, the boat is travelling north east. Form an equation that T must satisfy, and solve it to show that $T = 30$. *(4 marks)*

(d) Find the distance of the boat from its initial position when $t = 20$. *(5 marks)*

Question	Solution	Marks	Total	Comments
7(a)	$\mathbf{u} = 3\mathbf{i}$	B1	1	Correct velocity
(b)	$\mathbf{v} = 3\mathbf{i} + (0.1\mathbf{i} + 0.2\,\mathbf{j})t$	M1		Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$
		A1	2	Correct velocity
(c)	$\mathbf{v} = (3 + 0.1t)\mathbf{i} + 0.2t\,\mathbf{j}$	M1		Velocity in two components
	$3 + 0.1t = 0.2t$	M1		Equation to find t
		A1		Correct equation
	$t = \dfrac{3}{0.1} = 30\,\text{s}$	A1	4	Correct time
(d)	$\text{r} = 3\,\text{i} \times 20 + \frac{1}{2}(0.1\,\text{i} + 0.2\,\text{j}) \times 20^2$	M1		Use of $\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$
		A1		Correct expression
	$= 60\mathbf{i} + 20\mathbf{i} + 40\,\mathbf{j}$			
	$= 80\mathbf{i} + 40\,\mathbf{j}$	A1		Correct displacement
	$d = \sqrt{80^2 + 40^2} = 89.4\,\text{m}$	m1		Finding distance
		A1	5	Correct distance
	Total		**12**	

AQA MBM1 Nov 03 Q8

8 At time $t = 0$, a particle is at the origin and moving with velocity $(4\mathbf{i} + 2\mathbf{j})\,\text{m s}^{-1}$. When $t = 10$ seconds the position vector of the particle is $(44\mathbf{i} + 28\mathbf{j})$ metres. The particle is moving with constant acceleration.

(a) Find the acceleration of the particle. *(4 marks)*

(b) Find the position vector of the particle at time t. *(3 marks)*

(c) At time $t = T$, the position vector of the particle is $(96\mathbf{i} + 72\mathbf{j})$ metres.

(i) Find T. *(4 marks)*

(ii) Find the speed of the particle at this time. *(3 marks)*

8(a)	$44\mathbf{i}+28\mathbf{j}=10(4\mathbf{i}+2\mathbf{j})+50\mathbf{a}$ $\mathbf{a}=0.08\mathbf{i}+0.16\mathbf{j}$	M1 A1 M1 A1	4	Equation to find **a** using position vector Correct equation Solving for **a** Correct **a**
(b)	$\mathbf{r}=(4\mathbf{i}+2\mathbf{j})t+\frac{1}{2}(0.08\mathbf{i}+0.16\mathbf{j})t^2$ $=(4t+0.04t^2)\mathbf{i}+(2t+0.08t^2)\mathbf{j}$	M1 A1 A1	3	Equation for **r** One component correct Second component correct
(c)(i)	$96=4T+0.04T^2$ $\quad 72=2T+0.08T^2$ $T=20$ or -120 $\quad T=20$ or -45 Hence $T=20$	M1 A1 M1 A1	4	Forms and solves equation for one component Correct solutions Forms and solves equation for other component Correct solutions plus correct conclusion
(d)	$\mathbf{v}=(4\mathbf{i}+2\mathbf{j})+(0.08\mathbf{i}+0.16\mathbf{j})\times 20$ $=5.6\mathbf{i}+5.2\mathbf{j}$ $v=\sqrt{5.6^2+5.2^2}=7.64\ \text{ms}^{-1}$	M1 A1 A1	3	Finding **v** at $t=20$ Correct **v** Finding correct speed
	Total		**14**	
	TOTAL		**80**	