AS Mechanics Practice Paper A
45 Marks

45 Minutes

1. A motorbike of mass 200kg is travelling with speed 32ms^{-1}. The motorbike stops the engine and comes to rest, without braking, due to resistance forces totaling 150N.

a. Given that the time taken is $\frac{128}{3}$ to come to a stop with an acceleration of -0.75, find the distance travelled by the motorbike before it comes to a stop.

(2)

b. Find how long it will take before the motorbike will stop. **(2)**

(Total marks: 4)

2. A car starts from the point A. At time t seconds after leaving A, the distance the car from A is s m, where $s = 25t - 0.5t^2$, $0 \leq t \leq 20$. The car reaches the point B when $t = 20$.

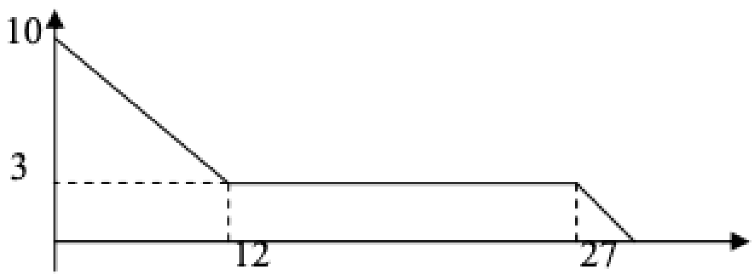
Find the distance AB.

(Total marks: 2)

3. A train is travelling at 10 m s^{-1} on a straight horizontal track. The driver sees a red signal 135 m ahead and immediately applies the brakes.

The train immediately decelerates with constant deceleration for 12 s, reducing its speed to 3 m s^{-1}. The driver then releases the brakes and allows the train to travel at a constant speed of 3 m s^{-1} for a further 15 s.

He then applies the brakes again and the train slows down with constant deceleration, coming to rest as it reaches the signal.



a. Find the distance travelled by the train from the moment when the brakes are first applied to the moment when its speed first reaches 3 m s^{-1}.

(2)

b. Find the total time from the moment when the brakes are first applied to the moment when the train comes to rest.

(5)

(Total marks: 7)

4. A car moves with constant acceleration along a straight horizontal road. The car passes the point A with speed 5 m s $^{-1}$ and 4 s later it passes the point B, where $AB = 50$ m.

a. Find the acceleration of the car. **(3)**

When the car passes the point C, it has speed 30 m s $^{-1}$.

b. Find the distance AC. **(3)**

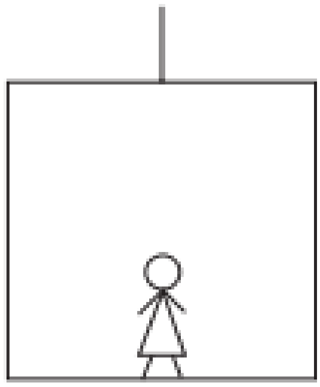
(Total marks: 6)

5. A particle of mass 5 kg is moving with constant acceleration $a = 4\mathbf{i} - 2\mathbf{j}$ when acted on by two forces, $F_1 = (6\mathbf{i} - 5\mathbf{j})$ N and $F_2 = (14\mathbf{i} - 5\mathbf{j})$ N.

Find the magnitude of the resultant of the two forces **(3)**

(Total marks: 3)

6.



A lift of mass 250 kg is being raised by a vertical cable attached to the top of the lift. A woman of mass 60 kg stands on the horizontal floor inside the lift, as shown in Figure 3.

The lift ascends vertically with constant acceleration 2 m s $^{-2}$. There is a constant downwards resistance of magnitude 100 N on the lift.

a. By modelling the woman as a particle, find the magnitude of the normal reaction exerted by the floor of the lift on the woman.

(3)

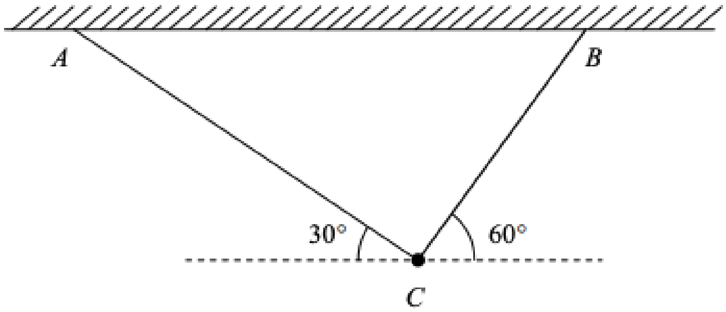
The tension in the cable must not exceed 10 000 N for safety reasons, and the maximum upward acceleration of the lift is 3 m s $^{-2}$. A typical occupant of the lift is modelled as a particle of mass 75 kg and the cable is modelled as a light inextensible string. There is still a constant downwards resistance of magnitude 100 N on the lift.

b. Find the maximum number of typical occupants that can be safely carried in the lift when it is ascending with an acceleration of 3 m s $^{-2}$.

(7)

(Total marks: 10)

7.



A particle of weight W newtons is attached at C to the ends of two light inextensible strings AC and BC. The other ends of the strings are attached to two fixed points A and B on a horizontal ceiling. The particle hangs in equilibrium with AC and BC inclined to the horizontal at 30° and 60° respectively, as shown in the figure.

a. Given the tension in AC is 50 N, calculate the tension in BC, to 3 significant figures. **(3)**

b. Given the tension in AC is 50 N, calculate the value of W. **(3)**

(Total marks: 6)

8. Particle A has velocity (8**i** – 3**j**) ms^{-1} and particle B has velocity (15**i** – 8**j**) ms^{-1} where **i** and **j** are perpendicular, horizontal unit vectors.

a. Find the speed of B. **(2)**

b. Find the velocity of B relative to A. **(2)**

c. Find the acute angle between the relative velocity found in part (b) and the vector **i**, giving your answer in degrees correct to 1 decimal place.

(3)

(Total marks: 7)

Total Marks for Paper: 45

Mark Scheme

1a	Use of suvat	**M1**
	$s = 683$ m	**A1**
1b	Use of suvat	**M1**
	$t = 42.7$ s	**A1**

2	Sub in t = 20 into $s = 25t - 0.5t^2$	**M1**
	$s = 500 - 200$ $s = 300\ m$	**A1**

3a	Distance in 1st 12 seconds = $\frac{1}{2} \times (10 + 3) \times 12$	**M1**
	= $78m$	**A1**
3b	Distance from $t = 12$ to $t = 27 = 15 \times 3 = 45$	**B1**
	Distance in last section = $135 - 45 = 12m$	**M1** **A1**
	$t = 8s$	**A1**
	Hence total time = 27 + 8 = 35s	**A1**

4a	$s = ut + \frac{1}{2}at^2$	**M1**
	$50 = 5 \times 4 + \frac{1}{2} \times a \times 4^2$	**A1**
	$30 = 8a$ $a = 3.75ms^{-1}$	**A1**
4b	$30^2 = 5^2 + 2 \times 3.75 \times s$	**M1** **A1**
	$s = 116\frac{2}{3}\ m$	**A1**

5	Resultant Force = $F1 + F2$ Resultant = $(6\mathbf{i} - 5\mathbf{j}) + (14\mathbf{i} - 5\mathbf{j})$	**M1**
	Resultant force = 20**i**	**A1**
	Magnitude = 20N	**A1**

6a	$R - 60g = 60 \times 2$	**M1** **A1**
	$R = 708\ N$	**A1**
6b	$75n$	**B1**
	$10000 - Mg - 100 = M \times 3$	**M1** **A1** **A1**
	Using $M = 250 + 75n$ $n = 6.9$	**M1** **A1**
	Therefore, 6 people	**A1**

7a	$Resolving\ (Horizontally): T + \cos 60 = 50 \cos 30$	**M1** **A1**
	$T = 86.6\ N$	**A1**
7b	$Resolving\ (vertically): W = 50 \sin 30 + T \cos 30$	**M1** **A1**
	= $100N$	**A1**

8a	$Speed\ of\ B = \sqrt{15^2 + (-8)^2} = 17ms^{-1}$	**M1** **A1**
8b	Velocity of B relative to A = (15**i** – 8**j**) – (8**i** – 3**j**)	**M1**
	= (7**i** – 5**j**)ms^{-1}	**A1**
8c	Required angle	**B1**
	= $\tan^{-1}\left(\frac{5}{7}\right)$	**M1**
	= 35.5°	**A1**