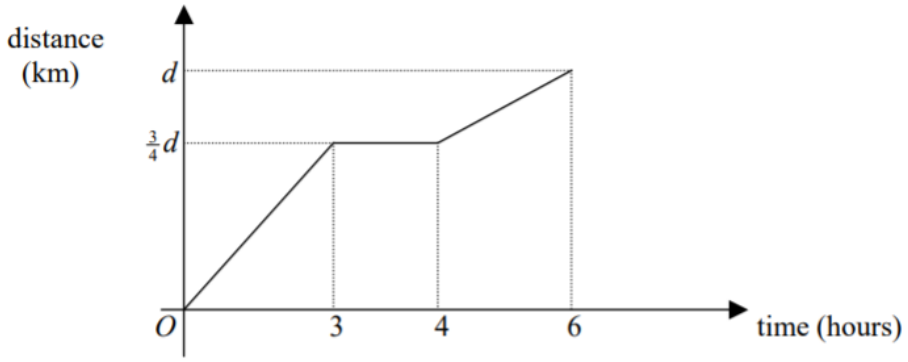
AS Mechanics Practice Paper C
45 Marks

45 Minutes

1.



The figure shows a distance-time graph for a car journey from Birmingham to Newquay which included a stop for lunch at a service station near Exeter. During the first part of the journey three-quarters of the total distance, d, was covered in 3 hours. After a 1 hour stop, the remaining distance was completed in 2 hours.

a. Calculate, in the form k : 1, the ratio of the average speed during the first 3 hours of the journey to the average speed during the last 2 hours of the journey.

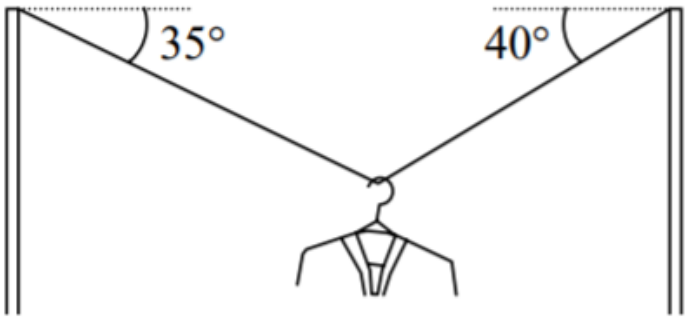
(4)

Given that the average speed of the car over the whole journey (excluding the stop) was 80 kmh^{-1}

b. Find the average speed of the car on the first part of the journey. **(4)**

(Total 8 marks)

2. The figure shows a washing line suspended at either end by vertical rigid poles. A jacket of mass 0.7 kg is suspended in equilibrium part of the way along the line. The sections of the washing line on either side of the jacket make angles of 35° and 40° with the horizontal.



a. Find the tension in the washing line on each side of the jacket. **(7)**

b. Explain why, in practice, the angles are likely to be very similar in value. **(1)**

(Total 8 marks)

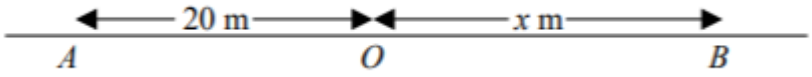
3. A particle P moves with a constant velocity $(3\mathbf{i} + 2\mathbf{j})$ ms $^{-1}$ with respect to a fixed origin O. It passes through the point A whose position vector is $(2\mathbf{i} + 11\mathbf{j})$ m at t = 0

a. Find the angle in degrees that the velocity vector of P makes with the vector i **(2)**

b. Calculate the distance of P from O when t = 2 **(4)**

(Total 6 marks)

4. The points A, O and B lie on a straight horizontal track as shown in the figure. A is 20 m from O and B is on the other side of O at a distance x m from O.



At time t = 0, a particle P starts from rest at O and moves towards B with uniform acceleration of 3 ms^{-2}. At the same instant, another particle Q, which is at the point A, is moving with a velocity of 3 ms^{-1} in the direction of O with uniform acceleration of 4 ms^{-2} in the same direction.

Given that the Q collides with P at B, find the value of x. **(10)**

(Total 10 marks)

5. A particle P moves along a straight line. The speed of P at time t seconds $(t \geq 0)$ is v m s $^{-1}$, where $v = (pt^2 + qt + r)$ and p, q and r are constants.

When $t = 2$ the speed of Phas its minimum value.

When $t = 0$, $v = 11$ and when $t = 2$, $v = 3$

a. Find the acceleration of P when $t = 3$ **(8)**

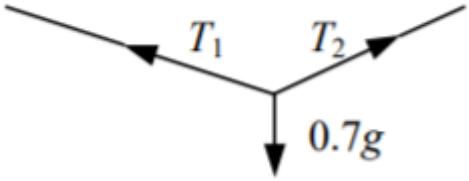
b. Find the distance travelled by P in the third second of the motion. **(5)**

(Total 13 marks)

Total Marks for Paper: 45

Mark Scheme

1a	Ratio is $\frac{\frac{3}{4}d}{3}:\frac{\frac{1}{4}d}{2}$	**M1 A1**
	$\frac{1}{4}:\frac{1}{8}=2:1$	**M1 A1**
1b	80 kmh^{-1} for 5 hours = 400 km	**M1**
	$\frac{3}{4} of\ 400 = 300\ km$	**M1**
	Average speed on first part of journey = $\frac{300}{3} = 100$ kmh^{-1}	**M1 A1**

2a		
	Resolve vertically: $T_1 \sin 35 + T_2 \sin 40 - 0.7g = 0$	**M1 A1**
	Resolve horizontally: $T_2 \cos 40 - T_1 \cos 35 = 0$	**M1**
	From 2, $T_2 = 1.609\ T_2$	**M1**
	Sub into (1) to get $T_1 = 5.44$ N	**M1 A1**
	Therefore $T_2 = 5.82$ N	**A1**
2b	Jacket likely to slide to a position near centre of line	**B1**

3a	Required angle = $\tan^{-1}\left(\frac{2}{3}\right) = 33.7^{o}$	**M1 A1**
3b	When $t = 2, position\ vector\ of\ A$ is (2 + 6)**I** + (11 + 4)**j** $= 8\boldsymbol{i} + 15\boldsymbol{j}$	**M1 A1**
	$OP = \sqrt{8^2 + 15^2} = 17m$	**M1 A1**

4	For P: $x = 0 + \frac{3}{2}t^2$	**M1**
	For Q: $x + 20 = 3t + 2t^2$	**M1 A1**
	Elimating x: $\frac{1}{2}t^2 + 3t - 20 = 0$	**M1 A1**
	$t^2 + 6t - 40 = 0$ (t + 10) (t – 4)	**M1 A1**
	t = 4s is the only positive answer	**A1**
	When t = 4, $x = \frac{3}{2}(4)^2 = 24$	**M1 A1**

5a	$t = 0, v = 11$ $Therefore\ r = 11$	**B1**
	$t = 2, v = 3$ $Therefore, 4p + 2q + 11 = 3$	**M1**
	$4p + 2q = -8$	**A1**
	Differentiate to find acceleration	**M1**

	$a = 2pt + q$	**A1**
	$t = 2, a = 0$ $4p + q = 0$	**M1**
	$-q + 2q = -8$ $q = -8$ $p = 2$	**A1**
	When $t = 3, a = 4t - 8$ $a = 4\ ms^{-2}$	**A1**
5b	Integrate $\int 2(t-2)^2 + 3\ dt = \frac{2}{3}(t-2)^3 + 3t\ (+c)$	**M1**
	At most one error seen	**A1**
	All correct	**A1**
	$\left[\frac{2}{3}(t-2)^3 + 2t\right]_2^3 = \left(\frac{2}{3} + 9\right) - (0 + 6)$ $(18 - 36 + 33) - (\frac{16}{3} - 16 + 22)$	**M1**
	$= 3\frac{2}{3}$ m	**A1**