Leave blank

6. Two cars A and B are moving in the same direction along a straight horizontal road. Car A is moving with uniform acceleration $0.4\,\text{m s}^{-2}$ and car B is moving with uniform acceleration $0.5\,\text{m s}^{-2}$. At the instant when B is 200 m behind A, the speed of A is $35\,\text{m s}^{-1}$ and the speed of B is $44\,\text{m s}^{-1}$. Find the speed of B when it overtakes A.

(9)

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3. A cyclist starts from rest at the point O on a straight horizontal road. The cyclist moves along the road with constant acceleration $2\,\text{m}\,\text{s}^{-2}$ for 4 seconds and then continues to move along the road at constant speed. At the instant when the cyclist stops accelerating, a motorcyclist starts from rest at the point O and moves along the road with constant acceleration $4\,\text{m}\,\text{s}^{-2}$ in the same direction as the cyclist. The motorcyclist has been moving for T seconds when she overtakes the cyclist.

(a) Sketch, on the same axes, a speed-time graph for the motion of the cyclist and a speed-time graph for the motion of the motorcyclist, to the time when the motorcyclist overtakes the cyclist.

(4)

(b) Find, giving your answer to 1 decimal place, the value of T.

(6)

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3. A van travels with constant acceleration along a straight horizontal road.

The van passes a point A with speed $u\,\text{m s}^{-1}$ and 20 seconds later passes a point B with speed $28\,\text{m s}^{-1}$

The distance AB is 400 m.

(a) Show that $u = 12$

(2)

(b) Find the time taken for the van to travel from A to the midpoint of AB.

(5)

The van has mass 1200 kg.

During its motion the van experiences a constant resistive force of magnitude 260 N

(c) Find the magnitude of the driving force exerted by the engine of the van as it travels from A to B.

(3)

Leave blank

7. A train travels along a straight horizontal track between two stations A and B. The train starts from rest at A and moves with constant acceleration until it reaches its maximum speed of 108 km h^{-1}. The train then travels at this speed before it moves with constant deceleration coming to rest at B. The journey from A to B takes 8 minutes.

(a) Change 108 km h^{-1} into m s^{-1}.

(2)

(b) Sketch a speed-time graph for the motion of the train between the two stations A and B.

(2)

Given that the distance between the two stations is 12 km and that the time spent decelerating is three times the time spent accelerating,

(c) find the acceleration, in m s^{-2}, of the train.

(6)

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6. A car starts from rest at a point A and moves along a straight horizontal road. The car moves with constant acceleration 1.5 m s^{-2} for the first 8 s. The car then moves with constant acceleration 0.8 m s^{-2} for the next 20 s. It then moves with constant speed for T seconds before slowing down with constant deceleration 2.8 m s^{-2} until it stops at a point B.

(a) Find the speed of the car 28 s after leaving A.

(3)

(b) Sketch, in the space provided, a speed–time graph to illustrate the motion of the car as it travels from A to B.

(2)

(c) Find the distance travelled by the car during the first 28 s of its journey from A.

(4)

The distance from A to B is 2 km.

(d) Find the value of T.

(4)

Leave blank

1. Three forces $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ act on a particle P.

$\mathbf{F}_1 = (2\mathbf{i} + 3a\mathbf{j})$ N; $\mathbf{F}_2 = (2a\mathbf{i} + b\mathbf{j})$ N; $\mathbf{F}_3 = (b\mathbf{i} + 4\mathbf{j})$ N.

The particle P is in equilibrium under the action of these forces.

Find the value of a and the value of b.

(6)

Leave blank

8. [*In this question, the horizontal unit vectors* **i** *and* **j** *are directed due east and due north respectively and position vectors are given relative to a fixed origin O.*]

Two speedboats, A and B, are each moving with constant velocity. The velocity of A is $20\,\text{km h}^{-1}$ due west and the velocity of B is $40\,\text{km h}^{-1}$ on a bearing of 150°. The boats are modelled as particles.

At noon, the position vector of A is $60\mathbf{i}$ km and B is at the origin O. At time t hours after noon, the position vector of A is $\mathbf{r}$ km and the position vector of B is $\mathbf{s}$ km.

(a) Find the velocity of B in the form $(p\mathbf{i} + q\mathbf{j})\,\text{km h}^{-1}$

(3)

(b) Find expressions for $\mathbf{r}$ and $\mathbf{s}$ in terms of t, $\mathbf{i}$ and $\mathbf{j}$.

(3)

(c) Find the time, to the nearest minute, at which the distance between the boats is the same as it was at noon.

(8)

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6. [*In this question* **i** *and* **j** *are horizontal unit vectors directed due east and due north respectively and position vectors are given relative to a fixed origin O.*]

At 12:00, a ship P sets sail from a harbour with position vector $(15\mathbf{i} + 36\mathbf{j})$ km.
At 12:30, P is at the point with position vector $(20\mathbf{i} + 34\mathbf{j})$ km.

Given that P moves with constant velocity,

(a) show that the velocity of P is $(10\mathbf{i} - 4\mathbf{j})\,\text{km h}^{-1}$

(2)

At time t hours after 12:00, the position vector of P is $\mathbf{p}$ km.

(b) Find an expression for $\mathbf{p}$ in terms of $\mathbf{i}$, $\mathbf{j}$ and t.

(2)

A second ship Q is also travelling at a constant velocity.

At time t hours after 12:00, the position vector of Q is given by $\mathbf{q}$ km, where

$$\mathbf{q} = (42 - 8t)\mathbf{i} + (9 + 14t)\mathbf{j}$$

Ships P and Q are modelled as particles.

If both ships maintained their course,

(c) (i) verify that they would collide at 13:30

(ii) find the position vector of the point at which the collision would occur.

(4)

At 12:30 Q changes speed and direction to avoid the collision.

Ship Q now travels due north with a constant speed of $15\,\text{km h}^{-1}$

Ship P maintains the same constant velocity throughout.

(d) Find the exact distance between P and Q at 14:30

(7)