Write your name here

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**Pearson Edexcel GCE**

Centre Number | Candidate Number

# AS and A level Mathematics
# Practice Paper

# Mechanics - Kinematics of a particle moving in a straight line

**You must have:**
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

**Instructions**

- Use black ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer all the questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – there may be more space than you need.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

**Information**

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 8 questions in this question paper. The total mark for this paper is 98.
- The marks for each question are shown in brackets – use this as a guide as to how much time to spend on each question.

**Advice**

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

**1.**

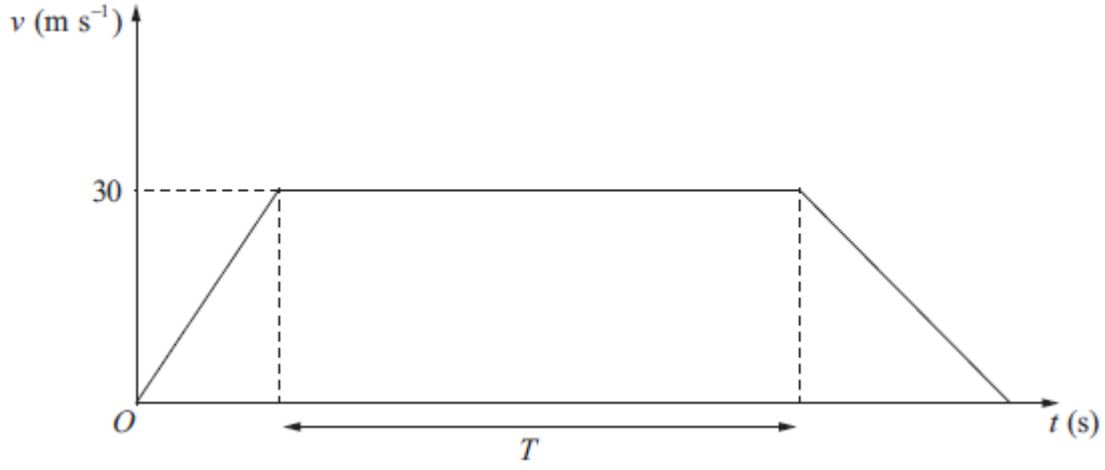


**Figure 4**

The velocity-time graph in Figure 4 represents the journey of a train $P$ travelling along a straight horizontal track between two stations which are 1.5 km apart. The train $P$ leaves the first station, accelerating uniformly from rest for 300 m until it reaches a speed of 30 m $s^{-1}$. The train then maintains this speed for $T$ seconds before decelerating uniformly at 1.25 m $s^{-2}$, coming to rest at the next station.

(*a*) Find the acceleration of $P$ during the first 300 m of its journey.

**(2)**

(b) Find the value of $T$.

**(5)**

A second train $Q$ completes the same journey in the same total time. The train leaves the first station, accelerating uniformly from rest until it reaches a speed of $V$ m $s^{-1}$ and then immediately decelerates uniformly until it comes to rest at the next station.

(c) Sketch on the diagram above, a velocity-time graph which represents the journey of train $Q$.

**(2)**

(d) Find the value of $V$.

**(6)**

**(Total 15 marks)**

**2.** A stone is projected vertically upwards from a point $A$ with speed $u$ m s$^{-1}$. After projection the stone moves freely under gravity until it returns to $A$. The time between the instant that the stone is projected and the instant that it returns to $A$ is $3\frac{4}{7}$ seconds.

Modelling the stone as a particle,

(a) show that $u = 17\frac{1}{2}$,

**(3)**

(b) find the greatest height above $A$ reached by the stone,

**(2)**

(c) find the length of time for which the stone is at least $6\frac{3}{5}$ m above $A$.

**(6)**

**Total 11 marks)**

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**3.** A car accelerates uniformly from rest for 20 seconds. It moves at constant speed $v$ m s$^{-1}$ for the next 40 seconds and then decelerates uniformly for 10 seconds until it comes to rest.

(a) For the motion of the car, sketch

(i) a speed-time graph,

(ii) an acceleration-time graph.

**(6)**

Given that the total distance moved by the car is 880 m,

(b) find the value of $v$.

**(4)**

**(Total 10 marks)**

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**4.** A cyclist is moving along a straight horizontal road and passes a point $A$. Five seconds later, at the instant when she is moving with speed 10 m s$^{-1}$, she passes the point $B$. She moves with constant acceleration from $A$ to $B$.

Given that $AB = 40$ m, find

(a) the acceleration of the cyclist as she moves from $A$ to $B$,

**(4)**

(b) the time it takes her to travel from $A$ to the midpoint of $AB$.

**(5)**

**(Total 9 marks)**

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**5.** A car moves along a straight horizontal road from a point $A$ to a point $B$, where $AB = 885$ m. The car accelerates from rest at $A$ to a speed of 15 m s$^{-1}$ at a constant rate $a$ m s$^{-2}$.

The time for which the car accelerates is $\frac{1}{3}T$ seconds. The car maintains the speed of 15 m s$^{-1}$ for $T$ seconds. The car then decelerates at a constant rate of 2.5 m s$^{-2}$ stopping at $B$.

(a) Find the time for which the car decelerates.

**(2)**

(b) Sketch a speed-time graph for the motion of the car.

**(2)**

(c) Find the value of $T$.

**(4)**

(d) Find the value of $a$.

**(2)**

(e) Sketch an acceleration-time graph for the motion of the car.

**(3)**

**(Total 13 marks)**

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**6.** 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 0.5 m s$^{-2}$ until it reaches a speed of $V$ m s$^{-1}$, ($V < 50$). The train then travels at this constant speed before it moves with constant deceleration 0.25 m s$^{-2}$ until it comes to rest at $B$.

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

**(2)**

The total time for the journey from $A$ to $B$ is 5 minutes.

(b) Find, in terms of $V$, the length of time, in seconds, for which the train is

(i) accelerating,

(ii) decelerating,

(iii) moving with constant speed.

**(5)**

Given that the distance between the two stations $A$ and $B$ is 6.3 km,

(c) find the value of $V$.

**(6)**

**(Total 13 marks)**

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**7.** A particle $P$ is projected vertically upwards from a point $A$ with speed $u$ m s$^{-1}$. The point $A$ is 17.5 m above horizontal ground. The particle $P$ moves freely under gravity until it reaches the ground with speed 28 m s$^{-1}$.

(a) Show that $u = 21$.

**(3)**

At time $t$ seconds after projection, $P$ is 19 m above $A$.

(b) Find the possible values of $t$.

**(5)**

The ground is soft and, after $P$ reaches the ground, $P$ sinks vertically downwards into the ground before coming to rest. The mass of $P$ is 4 kg and the ground is assumed to exert a constant resistive force of magnitude 5000 N on $P$.

(c) Find the vertical distance that $P$ sinks into the ground before coming to rest.

**(4)**

**(Total 12 marks)**

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**8.**


**Figure 3**

Two particles $P$ and $Q$, of mass 0.3 kg and 0.5 kg respectively, are joined by a light horizontal rod. The system of the particles and the rod is at rest on a horizontal plane.

At time $t = 0$, a constant force **F** of magnitude 4 N is applied to $Q$ in the direction $PQ$, as shown in Figure 3. The system moves under the action of this force until $t = 6$ s. During the motion, the resistance to the motion of $P$ has constant magnitude 1 N and the resistance to the motion of $Q$ has constant magnitude 2 N.

Find

(a) the acceleration of the particles as the system moves under the action of **F**,

**(3)**

(b) the speed of the particles at $t = 6$ s,

**(2)**

(c) the tension in the rod as the system moves under the action of **F**.

**(3)**

At $t = 6$ s, **F** is removed and the system decelerates to rest. The resistances to motion are unchanged. Find

(d) the distance moved by $P$ as the system decelerates,

**(4)**

(e) the thrust in the rod as the system decelerates.

**(3)**

**(Total 15 marks)**

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**TOTAL FOR PAPER: 98 MARKS**