



Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Mathematics

9MA0 (Applied) (Public release version)

Resource Set 1: Topic 7

Kinematics (Test 2)

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Additional Assessment Materials, Summer 2021

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## **General guidance to Additional Assessment Materials for use in 2021**

### **Context**

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an optional part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

### **Purpose**

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1. At time  $t$  seconds ( $t \geq 0$ ), a particle  $P$  is modelled as having velocity  $\mathbf{v}$  m s<sup>-1</sup>, where

$$\mathbf{v} = (3t^2 - 12t)\mathbf{i} + (9t^2 - 3t)\mathbf{j}$$

and having acceleration  $\mathbf{a}$  m s<sup>-2</sup>.

- (a) Find  $\mathbf{a}$  in terms of  $\mathbf{i}$ ,  $\mathbf{j}$  and  $t$ .

(2)

When  $t = 0$ ,  $P$  is at the origin  $O$ . At time  $t$  seconds ( $t \geq 0$ ),  $P$  has position vector  $\mathbf{r}$  metres relative to  $O$ .

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

(2)

At the instant when  $\mathbf{a} = \lambda\mathbf{j}$ , where  $\lambda$  is a constant,  $P$  is at the point  $A$ .

- (c) Find the position vector of  $A$  relative to  $O$ .

(4)

(Total for Question 1 is 8 marks)

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2. [In this question position vectors are given relative to a fixed origin  $O$ ]

At time  $t$  seconds, where  $t \geq 0$ , a particle,  $P$ , moves so that its velocity  $\mathbf{v}$  m s<sup>-1</sup> is given by

$$\mathbf{v} = 6t\mathbf{i} - 5t^{\frac{3}{2}}\mathbf{j}$$

When  $t = 0$ , the position vector of  $P$  is  $(-20\mathbf{i} + 20\mathbf{j})$  m.

- (a) Find the acceleration of  $P$  when  $t = 4$

(3)

- (b) Find the position vector of  $P$  when  $t = 4$

(3)

(Total for Question 2 is 6 marks)

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3. At time  $t$  seconds, where  $t \geq 0$ , a particle  $P$  moves so that its acceleration  $\mathbf{a}$  m s<sup>-2</sup> is given by

$$\mathbf{a} = 5t \mathbf{i} - 15t^{\frac{1}{2}} \mathbf{j}$$

When  $t = 0$ , the velocity of  $P$  is  $20\mathbf{i}$  m s<sup>-1</sup>

Find the speed of  $P$  when  $t = 4$

**(Total for Question 3 is 6 marks)**

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4. At time  $t$  seconds, where  $t \geq 0$ , a particle  $P$  moves in the  $x$ - $y$  plane in such a way that its velocity  $\mathbf{v}$  m s<sup>-1</sup> is given by

$$\mathbf{v} = t^{\frac{1}{2}} \mathbf{i} - 4t \mathbf{j}.$$

When  $t = 1$ ,  $P$  is at the point  $A$  and when  $t = 4$ ,  $P$  is at the point  $B$ .

Find the exact distance  $AB$ .

**(6)**

**(Total for Question 4 is 6 marks)**

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5. [In this question position vectors are given relative to a fixed origin  $O$ .]

A particle  $P$  moves under the action of a single force  $\mathbf{F}$  newtons. At time  $t$  seconds, where  $t \geq 0$ , the position vector of  $P$ ,  $\mathbf{r}$  metres, is given by

$$\mathbf{r} = (t^3 - 5t)\mathbf{i} + (5t^2 + 6t)\mathbf{j}.$$

The mass of  $P$  is 0.5 kg.

At time  $T$  seconds,  $P$  is moving in the direction of the vector  $(\mathbf{i} + 2\mathbf{j})$ .

(a) Find the value of  $T$ .

(5)

(b) Find the magnitude of  $\mathbf{F}$  when  $t = 2$ .

(4)

(Total for Question 5 is 9 marks)

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6 (i) At time  $t$  seconds, where  $t \geq 0$ , a particle  $P$  moves so that its acceleration  $\mathbf{a}$  m s<sup>-2</sup> is given by

$$\mathbf{a} = (1 - 4t)\mathbf{i} + (3 - t^2)\mathbf{j}$$

At the instant when  $t = 0$ , the velocity of  $P$  is  $36\mathbf{i}$  m s<sup>-1</sup>

(a) Find the velocity of  $P$  when  $t = 4$

(3)

(b) Find the value of  $t$  at the instant when  $P$  is moving in a direction perpendicular to  $\mathbf{i}$

(3)

(ii) At time  $t$  seconds, where  $t \geq 0$ , a particle  $Q$  moves so that its position vector  $\mathbf{r}$  metres, relative to a fixed origin  $O$ , is given by

$$\mathbf{r} = (t^2 - t)\mathbf{i} + 3t\mathbf{j}$$

Find the value of  $t$  at the instant when the speed of  $Q$  is 5 m s<sup>-1</sup>

(6)

(Total for Question 6 is 12 marks)

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