Pearson Edexcel Level 3 GCE

Wednesday 13 October 2021

Afternoon (Time:) | Paper Reference **8MA0/22**

Mathematics

Paper 22: Mechanics
Advanced Subsidiary

Candidates must have: Mathematical Formulae and Statistical Tables (Green), calculator

Please check that all individual papers contained within this packet are for the same qualification, paper and syllabus code as the information listed above.

These question papers are due to be sat on **Wednesday 13 October 2021 - Afternoon**.

If you have opened this pack before the above date, please keep this pack secure and contact our Investigations team via pqsmalpractice@pearson.com immediately. They'll advise you on the next steps.

As you know, section 11.8 of the JCQ Instructions for Conducting Examinations (ICE) requires that *"A board/flipchart/whiteboard should be visible to all candidates showing the:*

a) centre number, subject title and paper number; and
b) the actual starting and finishing times, and date, of each examination"

In addition, we ask that you please also make sure the correct syllabus code is included within the above information.

Thank you for your continued assistance in delivering our examinations. Should you have any queries please contact us on the relevant number provided here:

UK Centres: 03444 632 535

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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Paper reference **8MA0/22**

Mathematics

Advanced Subsidiary
PAPER 22: Mechanics

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

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** 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.
- Unless otherwise indicated, wherever a value of g is required, take $g = 9.8\ \text{m s}^{-2}$ and give your answer to either 2 significant figures or 3 significant figures.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 30. There are 3 questions.
- 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.
- Good luck with your examination.

Turn over

Pearson

1. At time $t = 0$, a small stone is thrown vertically upwards with speed $14.7\,\text{m s}^{-1}$ from a point A.

At time $t = T$ seconds, the stone passes through A, moving downwards.

The stone is modelled as a particle moving freely under gravity throughout its motion.

Using the model,

(a) find the value of T,

(2)

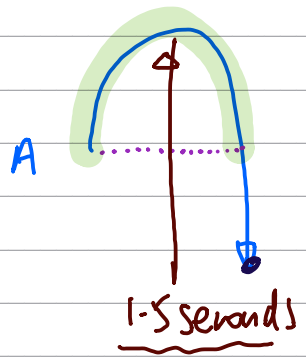
(b) find the total distance travelled by the stone in the first 4 seconds of its motion.

(4)

(c) State one refinement that could be made to the model, apart from air resistance, that would make the model more realistic.

(1)

a)



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$u = 14.7$
$s = 0$
$v = -14.7$
$a = -9.8$
$t = T$

$v = u + at$
$-14.7 = 14.7 - 9.8T$

$T = 3$ seconds

b)

$a = -9.8$
$u = 14.7$
$s = ?$
$t = 1.5$
$v = 0$

$\left(\frac{v+u}{2}\right)t = s$

$\left(\frac{14.7}{2}\right)(1.5) = s$

$s = 11.025$

In the next 2.5 seconds,

$a = -9.8$
$t = 2.5$
$s = ?$
$u = 0$

$s = ut + \frac{1}{2}at^2$

$= -4.9(2.5)^2 = -30.625$

P 6 6 8 0 7 A 0 2 1 2

Question 1 continued

total distance

= 41.65 metres

≃ 41.7 m
(3sf)

11.025

30.625

(Total for Question 1 is 7 marks)

2. A particle P moves along a straight line.

At time t seconds, the velocity $v\,\mathrm{m\,s^{-1}}$ of P is modelled as

$$v = 10t - t^2 - k \qquad t \geqslant 0$$

where k is a constant.

$\frac{dv}{dt} = 10 - 2t$

(a) Find the acceleration of P at time t seconds.

(2)

The particle P is instantaneously at rest when $t = 6$

(b) Find the other value of t when P is instantaneously at rest.

(4)

(c) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 6$

(4)

$V=0$ when $t=6$

$10t - t^2 - K = 0$

$60 - 36 - t = 0$

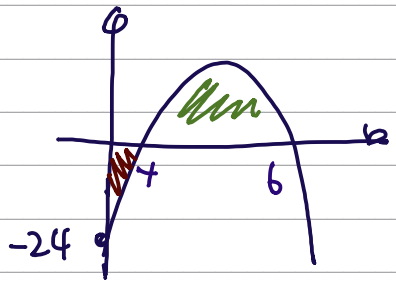
$t = 24$

$\Rightarrow V = 10t - t^2 - 24$

$V = 0$

$t = 4 \qquad t = 6$

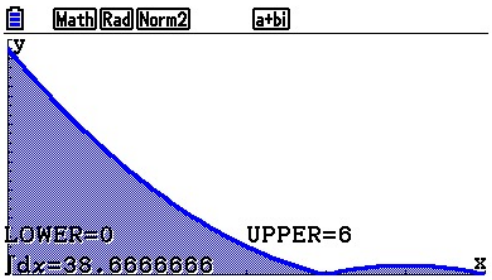
c)

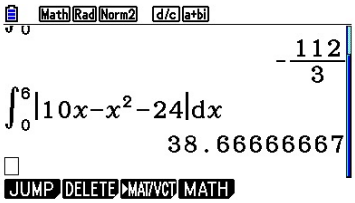


$\int_0^4 10t - t^2 - 24\,dt = \frac{-112}{3}$

$\int_4^6 10t - t^2 - 24\,dt = \frac{4}{3}$

$\Rightarrow \frac{112}{3} + \frac{4}{3} = \frac{116}{3}$





P 6 6 8 0 7 A 0 4 1 2

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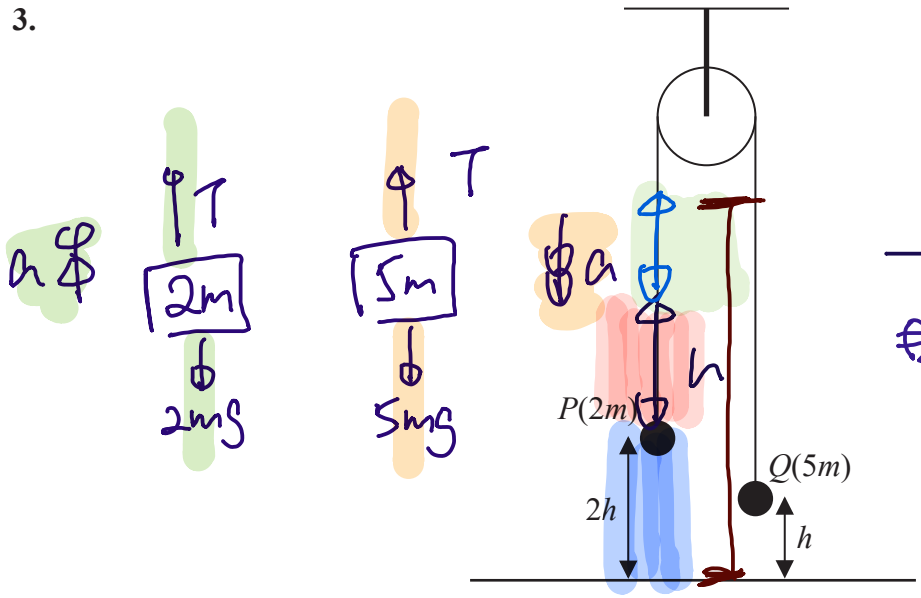
3.



$5mg - T = 5ma$

$T - 2mg = 2ma$

$\oplus\ T + 5ma = 5mg$

$T - 2ma = 2mg$

$7ma = 3mg$

$a = \frac{3}{7}g$

Figure 1

A ball P of mass $2m$ is attached to one end of a string.

The other end of the string is attached to a ball Q of mass $5m$.

The string passes over a fixed pulley.

The system is held at rest with the balls hanging freely and the string taut.

The hanging parts of the string are vertical with P at a height $2h$ above horizontal ground and with Q at a height h above the ground, as shown in Figure 1.

The system is released from rest.

In the subsequent motion, Q does not rebound when it hits the ground and P does not hit the pulley.

The balls are modelled as particles.

The string is modelled as being light and inextensible.

The pulley is modelled as being small and smooth.

Air resistance is modelled as being negligible.

$T - \frac{6}{7}mg = 2mg$

$T = \frac{20}{7}mg$

Using this model,

(a) (i) write down an equation of motion for P,

(ii) write down an equation of motion for Q,

(4)

(b) find, in terms of h only, the height above the ground at which P first comes to instantaneous rest.

(7)

(c) State one limitation of modelling the balls as particles that could affect your answer to part (b).

(1)

In reality, the string will not be inextensible.

(d) State how this would affect the accelerations of the particles.

(1)

Question 3 continued

$u=0$

$a=\frac{3}{7}g$

$s=h$

$v=?$

$v^2-u^2=2as$

$v=\sqrt{2(\frac{3}{7}g)h}$

stage 2

$v=0$

$u=\sqrt{\frac{6}{7}gh}$

$a=-g$

$s=$ _

$\frac{6}{7}gh=2gs$

$s=\frac{3}{7}h$

$2h+h+\frac{3}{7}h=\frac{24}{7}h$

3(c)	e.g. The distance that Q falls to the ground would not be exactly h oe	B1	3.5b
		(1)	
3(d)	e.g. The accelerations of the balls would not have equal magnitude (allow 'wouldn't be the same' oe) B0 if they say 'inextensible => acceleration same'	B1	3.5a
		(1)	