2021 ASSESSMENT MATERIALS

AS
MATHS
Mechanics

Total number of marks:39

11 A go-kart and driver, of combined mass 55 kg, move forward in a straight line with a constant acceleration of $0.2\,m\,s^{-2}$

The total driving force is 14 N

Find the total resistance force acting on the go-kart and driver.

Circle your answer.

[1 mark]

0 N 3 N 11 N 14 N

11 A ball moves in a straight line and passes through two fixed points, *A* and *B*, which are 0.5 m apart.

The ball is moving with a constant acceleration of $0.39\,m\,s^{-2}$ in the direction *AB*.

The speed of the ball at *A* is $1.9\,m\,s^{-1}$

Find the speed of the ball at *B*.

Circle your answer.

[1 mark]

$2\,m\,s^{-1}$ $3.2\,m\,s^{-1}$ $3.8\,m\,s^{-1}$ $4\,m\,s^{-1}$

12 One of the following is an expression for the distance between the points represented by position vectors $5\mathbf{i} - 3\mathbf{j}$ and $18\mathbf{i} + 7\mathbf{j}$

Identify the correct expression.

Tick (✓) **one** box.

[1 mark]

$\sqrt{13^2 + 4^2}$ ☐

$\sqrt{13^2 + 10^2}$ ☐

$\sqrt{23^2 + 4^2}$ ☐

$\sqrt{23^2 + 10^2}$ ☐

12 A particle P, of mass m kilograms, is attached to one end of a light inextensible string.

The other end of this string is held at a fixed position, O.

P hangs freely, in equilibrium, vertically below O.

Identify the statement below that correctly describes the tension, T newtons, in the string as m varies.

Tick (✓) **one** box.

[1 mark]

T varies along the string, with its greatest value at O ☐

T varies along the string, with its greatest value at P ☐

$T = 0$ because the system is in equilibrium ☐

T is directly proportional to m ☐

13 A vehicle, which begins at rest at point P, is travelling in a straight line.

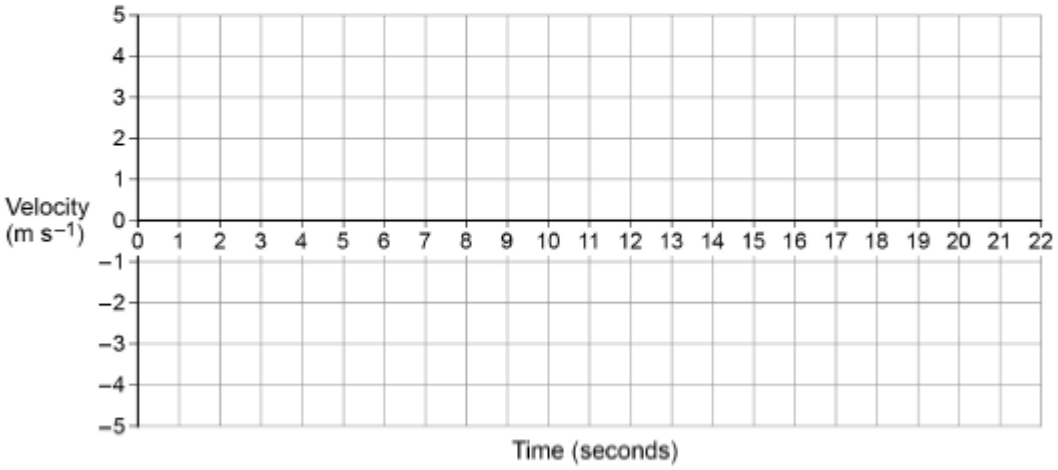
For the first 4 seconds the vehicle moves with a constant acceleration of $0.75\,\text{m s}^{-2}$

For the next 5 seconds the vehicle moves with a constant acceleration of $-1.2\,\text{m s}^{-2}$

The vehicle then immediately stops accelerating, and travels a further 33 m at constant speed.

13 (a) Draw a velocity–time graph for this journey on the grid below.

[3 marks]



13 (b) Find the distance of the car from P after 20 seconds.

[3 marks]

14 A particle of mass 0.1 kg is initially stationary.

A single force **F** acts on this particle in a direction parallel to the vector $7\mathbf{i}+24\mathbf{j}$

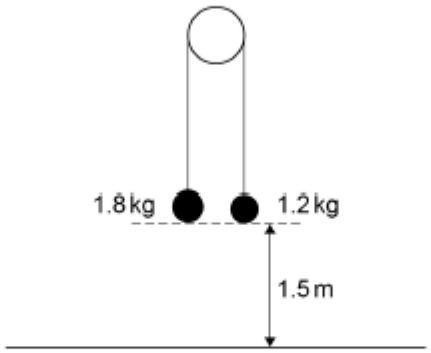
As a result, the particle accelerates in a straight line, reaching a speed of $4\,\text{m s}^{-1}$ after travelling a distance of 3.2 m

Find **F**.

[5 marks]

14 **In this question use $g = 9.81\,\text{m s}^{-2}$**

Two particles, of mass 1.8 kg and 1.2 kg, are connected by a light, inextensible string over a smooth peg.



14 (a) Initially the particles are held at rest 1.5 m above horizontal ground and the string between them is taut.

The particles are released from rest.

Find the time taken for the 1.8 kg particle to reach the ground.

[5 marks]

14 (b) State one assumption you have made in answering part **(a)**.

[1 mark]

14 Two particles, *A* and *B*, lie at rest on a smooth horizontal plane.

A has position vector $\mathbf{r}_A = (13\mathbf{i} - 22\mathbf{j})$ metres
B has position vector $\mathbf{r}_B = (3\mathbf{i} + 2\mathbf{j})$ metres

14 (a) Calculate the distance between *A* and *B*.

[2 marks]

14 (b) Three forces, $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ are applied to particle A, where

$$\mathbf{F}_1 = (-2\mathbf{i} + 4\mathbf{j}) \text{ newtons}$$

$$\mathbf{F}_2 = (6\mathbf{i} - 10\mathbf{j}) \text{ newtons}$$

Given that A remains at rest, explain why $\mathbf{F}_3 = (-4\mathbf{i} + 6\mathbf{j})$ newtons

[1 mark]

14 (c) A force of $(5\mathbf{i} - 12\mathbf{j})$ newtons, is applied to B, so that B moves, from rest, in a straight line towards A.

B has a mass of 0.8 kg

14 (c) (i) Show that the acceleration of B towards A is $16.25\,\text{m s}^{-2}$

[2 marks]

14 (c) (ii) Hence, find the time taken for B to reach A.

Give your answer to two significant figures.

[2 marks]

13 A car, starting from rest, is driven along a horizontal track.

The velocity of the car, $v\,\text{m s}^{-1}$, at time t seconds, is modelled by the equation

$$v = 0.48t^2 - 0.024t^3 \text{ for } 0 \leq t \leq 15$$

13 (a) Find the distance the car travels during the first 10 seconds of its journey.

[3 marks]

13 (b) Find the maximum speed of the car.

Give your answer to three significant figures.

[4 marks]

13 (c) Deduce the range of values of t for which the car is modelled as decelerating.

[2 marks]

15 A particle, P, is moving in a straight line with acceleration $a\,\text{m s}^{-2}$ at time t seconds, where

$$a = 4 - 3t^2$$

15 (a) Initially P is stationary.

Find an expression for the velocity of P in terms of t.

[2 marks]