AQA – Kinematics – A2 Mathematics P2

1. June/2020/Paper_2/No.10

A vehicle is driven at a constant speed of $12\,\text{m s}^{-1}$ along a straight horizontal road.

Only one of the statements below is correct.

Identify the correct statement.

Tick (✓) **one** box.

[1 mark]

The vehicle is accelerating ☐

The vehicle's driving force exceeds the total force resisting its motion ☐

The resultant force acting on the vehicle is zero ☐

The resultant force acting on the vehicle is dependent on its mass ☐

2. June/2020/Paper_2/No.12

A particle, P, is moving with constant velocity $8\mathbf{i} - 12\mathbf{j}$

A second particle, Q, is moving with constant velocity $a\mathbf{i} + 9\mathbf{j}$

Q travels in a direction which is parallel to the motion of P.

Find a.

Circle your answer.

[1 mark]

-6 -5 5 6

3. June/2020/Paper_2/No.14

At time t seconds a particle, P, has position vector $\mathbf{r}$ metres, with respect to a fixed origin, such that

$$\mathbf{r} = (t^3 - 5t^2)\mathbf{i} + (8t - t^2)\mathbf{j}$$

(a) Find the exact speed of P when $t = 2$

[4 marks]

(b) Bella claims that the magnitude of acceleration of P will never be zero.

Determine whether Bella's claim is correct.

Fully justify your answer.

[3 marks]

4. June/2020/Paper_2/No.16

Two particles *A* and *B* are released from rest from different starting points above a horizontal surface.

A is released from a height of h metres.

B is released at a time t seconds after *A* from a height of kh metres, where $0 < k < 1$

Both particles land on the surface 5 seconds after *A* was released.

Assuming any resistance forces may be ignored, prove that

$$t = 5(1 - \sqrt{k})$$

Fully justify your answer.

[5 marks]

5. June/2020/Paper_2/No.17

A ball is projected forward from a fixed point, P, on a horizontal surface with an initial speed $u\,\mathrm{m\,s^{-1}}$, at an acute angle θ above the horizontal.

The ball needs to first land at a point at least d metres away from P.

You may assume the ball may be modelled as a particle and that air resistance may be ignored.

Show that

$$\sin 2\theta \geq \frac{dg}{u^2}$$

[6 marks]

6. June/2020/Paper_2/No.19

A particle moves so that its acceleration, $a\,\text{m s}^{-2}$, at time t seconds may be modelled in terms of its velocity, $v\,\text{m s}^{-1}$, as

$$a = -0.1v^2$$

The initial velocity of the particle is $4\,\text{m s}^{-1}$

(a) By first forming a suitable differential equation, show that

$$v = \frac{20}{5 + 2t}$$

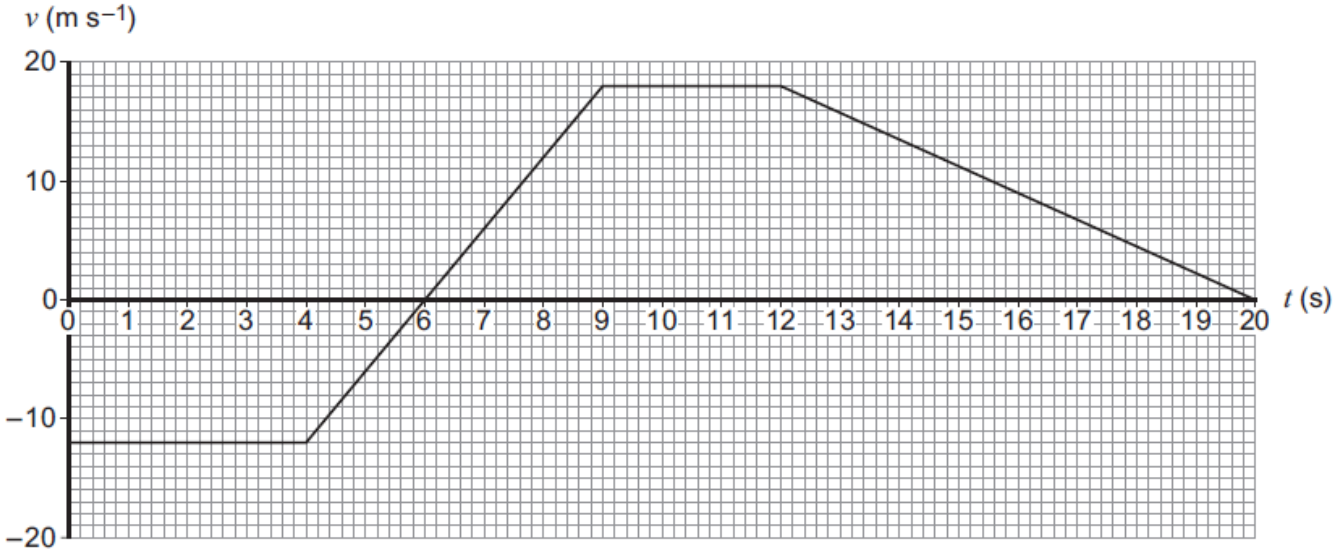
[6 marks]

(b) Find the acceleration of the particle when $t = 5.5$

[2 marks]

7. June/2019/Paper_2/No.10

The diagram below shows a velocity-time graph for a particle moving with velocity $v\,\text{m s}^{-1}$ at time t seconds.



Which statement is correct?

Tick (✓) **one** box.

[1 mark]

- The particle was stationary for $9 \leq t \leq 12$ ☐
- The particle was decelerating for $12 \leq t \leq 20$ ☐
- The particle had a displacement of zero when $t = 6$ ☐
- The particle's speed when $t = 4$ was $-12\,\text{m s}^{-1}$ ☐

8. June/2019/Paper_2/No.16

An elite athlete runs in a straight line to complete a 100-metre race.

During the race, the athlete's velocity, $v\,\text{m s}^{-1}$, may be modelled by

$$v = 11.71 - 11.68e^{-0.9t} - 0.03e^{0.3t}$$

where t is the time, in seconds, after the starting pistol is fired.

(a) Find the maximum value of v, giving your answer to one decimal place.

Fully justify your answer.

[8 marks]

(b) Find an expression for the distance run in terms of t.

[6 marks]

(c) The athlete's actual time for this race is 9.8 seconds.

Comment on the accuracy of the model.

[2 marks]

9. June/2019/Paper_2/No.13

In a school experiment, a particle, of mass m kilograms, is released from rest at a point h metres above the ground.

At the instant it reaches the ground, the particle has velocity $v\,\text{ms}^{-1}$

(a) Show that

$$v = \sqrt{2gh}$$

[2 marks]

(b) A student correctly used $h = 18$ and measured v as 20

The student's teacher claims that the machine measuring the velocity must have been faulty.

Determine if the teacher's claim is correct.

Fully justify your answer.

[3 marks]