SUVAT Equations - Past Edexcel Exam Questions

1. **(Question 4 - M1 June 2018)**

4. A ball of mass 0.2 kg is projected vertically downwards with speed U m s^{-1} from a point A which is 2.5 m above horizontal ground. The ball hits the ground. Immediately after hitting the ground, the ball rebounds vertically with a speed of 10 m s^{-1}. The ball receives an impulse of magnitude 7 Ns in its impact with the ground. By modelling the ball as a particle and ignoring air resistance, find

(a) the value of U.

(6)

After hitting the ground, the ball moves vertically upwards and passes through a point B which is 1 m above the ground.

(b) Find the time between the instant when the ball hits the ground and the instant when the ball first passes through B.

(4)

(c) Sketch a velocity-time graph for the motion of the ball from when it was projected from A to when it first passes through B. (You need not make any further calculations to draw this sketch.)

(3)

2. **(Question 6 - M1 June 2017)**

6. 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 ms^{-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)

3. **(Question 4 - M1 June 2016)**

4. Two trains M and N are moving in the same direction along parallel straight horizontal tracks. At time $t = 0$, M overtakes N whilst they are travelling with speeds $40\,\text{m s}^{-1}$ and $30\,\text{m s}^{-1}$ respectively. Train M overtakes train N as they pass a point X at the side of the tracks.

After overtaking N, train M maintains its speed of $40\,\text{m s}^{-1}$ for T seconds and then decelerates uniformly, coming to rest next to a point Y at the side of the tracks.

After being overtaken, train N maintains its speed of $30\,\text{m s}^{-1}$ for 25 s and then decelerates uniformly, also coming to rest next to the point Y.

The times taken by the trains to travel between X and Y are the same.

(a) Sketch, on the same diagram, the speed-time graphs for the motions of the two trains between X and Y.

(4)

Given that $XY = 975$ m,

(b) find the value of T.

(8)

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4. **(Question 2 - M1 June 2015)**

2. A small stone is projected vertically upwards from a point O with a speed of $19.6\,\text{m s}^{-1}$.

Modelling the stone as a particle moving freely under gravity,

(a) find the greatest height above O reached by the stone,

(2)

(b) find the length of time for which the stone is more than 14.7 m above O.

(5)

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5. **(Question 7 - M1 June 2015)**

7. 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 in the space below 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)

6. **(Question 3 - M1 June 2014)**

3. A ball of mass 0.3 kg is released from rest at a point which is 2 m above horizontal ground. The ball moves freely under gravity. After striking the ground, the ball rebounds vertically and rises to a maximum height of 1.5 m above the ground, before falling to the ground again. The ball is modelled as a particle.

(a) Find the speed of the ball at the instant before it strikes the ground for the first time.

(2)

(b) Find the speed of the ball at the instant after it rebounds from the ground for the first time.

(2)

(c) Find the magnitude of the impulse on the ball in the first impact with the ground.

(2)

(d) Sketch, in the space provided, a velocity-time graph for the motion of the ball from the instant when it is released until the instant when it strikes the ground for the second time.

(3)

(e) Find the time between the instant when the ball is released and the instant when it strikes the ground for the second time.

(4)

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7. **(Question 4 - M1 June 2013)**

4. A lorry is moving along a straight horizontal road with constant acceleration. The lorry passes a point A with speed u m s^{-1}, ($u < 34$), and 10 seconds later passes a point B with speed 34 m s^{-1}. Given that $AB = 240$ m, find

(a) the value of u,

(3)

(b) the time taken for the lorry to move from A to the mid-point of AB.

(6)

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8. **(Question 5 - M1 June 2013)**

5. A car is travelling along a straight horizontal road. The car takes 120 s to travel between two sets of traffic lights which are 2145 m apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for 30 s until its speed is 22 m s^{-1}. The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

(a) Sketch, in the space below, a speed-time graph for the motion of the car between the two sets of traffic lights.

(2)

(b) Find the value of T.

(3)

A motorcycle leaves the first set of traffic lights 10 s after the car has left the first set of traffic lights. The motorcycle moves from rest with constant acceleration, a m s^{-2}, and passes the car at the point A which is 990 m from the first set of traffic lights. When the motorcycle passes the car, the car is moving with speed 22 m s^{-1}.

(c) Find the time it takes for the motorcycle to move from the first set of traffic lights to the point A.

(4)

(d) Find the value of a.

(2)

9. **(Question 4 - M1 June 2012)**

4. A car is moving on a straight horizontal road. At time $t = 0$, the car is moving with speed 20 m s^{-1} and is at the point A. The car maintains the speed of 20 m s^{-1} for 25 s. The car then moves with constant deceleration 0.4 m s^{-2}, reducing its speed from 20 m s^{-1} to 8 m s^{-1}. The car then moves with constant speed 8 m s^{-1} for 60 s. The car then moves with constant acceleration until it is moving with speed 20 m s^{-1} at the point B.

(a) Sketch a speed-time graph to represent the motion of the car from A to B.

(3)

(b) Find the time for which the car is decelerating.

(2)

Given that the distance from A to B is 1960 m,

(c) find the time taken for the car to move from A to B.

(8)

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10. **(Question 5 - M1 June 2012)**

5. 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)

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11. **(Question 1 - M1 June 2011)**

1. At time $t = 0$ a ball is projected vertically upwards from a point O and rises to a maximum height of 40 m above O. The ball is modelled as a particle moving freely under gravity.

(a) Show that the speed of projection is 28 m s^{-1}.

(3)

(b) Find the times, in seconds, when the ball is 33.6 m above O.

(5)

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12. **(Question 4 - M1 June 2011)**

4. A girl runs a 400 m race in a time of 84 s. In a model of this race, it is assumed that, starting from rest, she moves with constant acceleration for 4 s, reaching a speed of 5 m s^{-1}. She maintains this speed for 60 s and then moves with constant deceleration for 20 s, crossing the finishing line with a speed of V m s^{-1}.

(a) Sketch, in the space below, a speed-time graph for the motion of the girl during the whole race.

(2)

(b) Find the distance run by the girl in the first 64 s of the race.

(3)

(c) Find the value of V.

(5)

(d) Find the deceleration of the girl in the final 20 s of her race.

(2)

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13. **(Question 5 - M1 June 2010)**

5. Two cars P and Q are moving in the same direction along the same straight horizontal road. Car P is moving with constant speed $25\ \text{m s}^{-1}$. At time $t = 0$, P overtakes Q which is moving with constant speed $20\ \text{m s}^{-1}$. From $t = T$ seconds, P decelerates uniformly, coming to rest at a point X which is $800\ \text{m}$ from the point where P overtook Q. From $t = 25\ \text{s}$, Q decelerates uniformly, coming to rest at the same point X at the same instant as P.

(a) Sketch, on the same axes, the speed-time graphs of the two cars for the period from $t = 0$ to the time when they both come to rest at the point X.

(4)

(b) Find the value of T.

(8)

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14. **(Question 6 - M1 June 2010)**

6. A ball is projected vertically upwards with a speed of $14.7\ \text{m s}^{-1}$ from a point which is $49\ \text{m}$ above horizontal ground. Modelling the ball as a particle moving freely under gravity, find

(a) the greatest height, above the ground, reached by the ball,

(4)

(b) the speed with which the ball first strikes the ground,

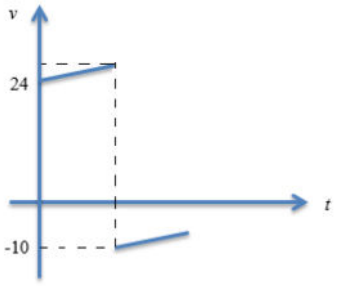
(3)

(c) the total time from when the ball is projected to when it first strikes the ground.

(3)

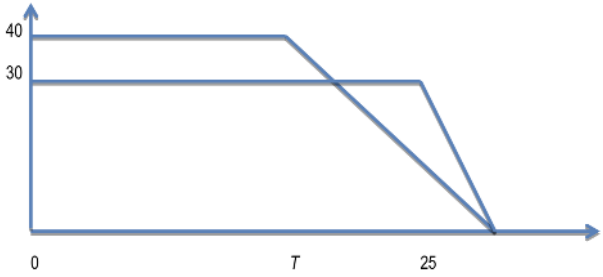
Solutions

1. (a) $U = 24$
   (b) $t = 0.11$ s
   (c) See Diagram:



2. (a) $a = 0.8$ ms^{-2}
   (b) $t = 2.81$ s

3. (a) See Diagram:



   (b) $T = 8.75$

4. (a) 19.6 m
   (b) 2 seconds

5. (a) See Diagram:

(b) i. $2V$

ii. $4V$

iii. $300 - 6V$

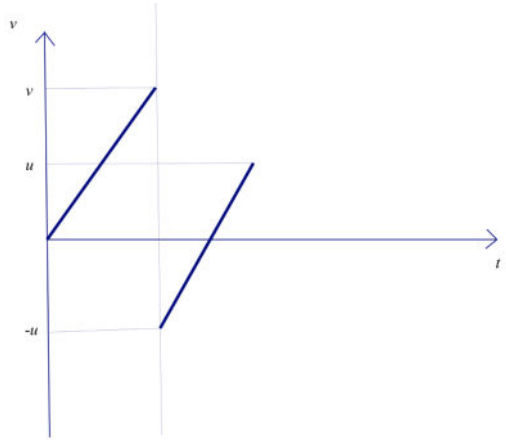
(c) $V = 30$

6. (a) 6.26 ms^{-1}

(b) 5.42 ms^{-1}

(c) NOT EXAMINABLE

(d) See Diagram taking downwards to be positive:

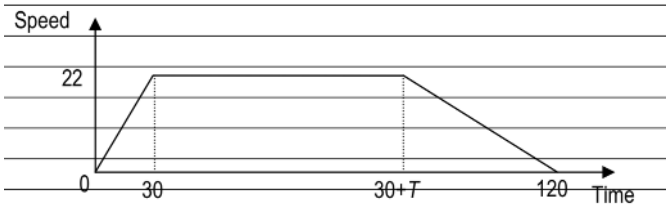


(e) 1.75 seconds

7. (a) $u = 14$

(b) 6 seconds

8. (a) See Diagram:

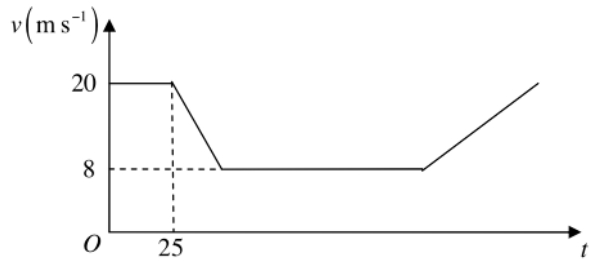


(b) $T = 75$

(c) 50 seconds

(d) $a = 0.792$

9. (a) See Diagram:



(b) 30 seconds

(c) 155 seconds

10. (a) -

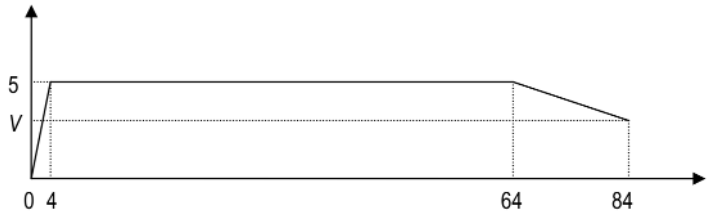
(b) $t = 1.30$ or $t = 2.99$

(c) 0.316 metres

11. (a) -

(b) $t = 1.71$ or $t = 4$

12. (a) See Diagram:

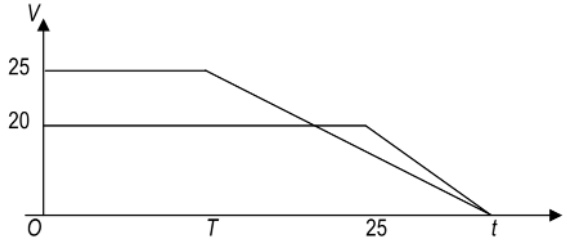


(b) 310 metres

(c) $V = 4$

(d) 0.05 ms^{-2}

13. (a) See Diagram:



(b) $T = 9$

14. (a) 60.0 metres

(b) 34.3 ms^{-1}

(c) 5 seconds