M1 Graphs, SUVAT and Forces practice 2

(Bonus Questions)

Name.....

Q1.

A single force of magnitude 4 newtons acts on a particle of mass 50 grams.

Find the magnitude of the acceleration of the particle.

Circle your answer.

12.5 m s^{-2} 0.08 m s^{-2} 0.0125 m s^{-2} 80 m s^{-2}

(Total 1 mark)

Q2.

A motorcycle accelerates uniformly along a straight horizontal road so that, when it has travelled 20 metres, its velocity has increased from 12 m s^{-1} to 16 m s^{-1}.

(a) Find the acceleration of the motorcycle.

(3)

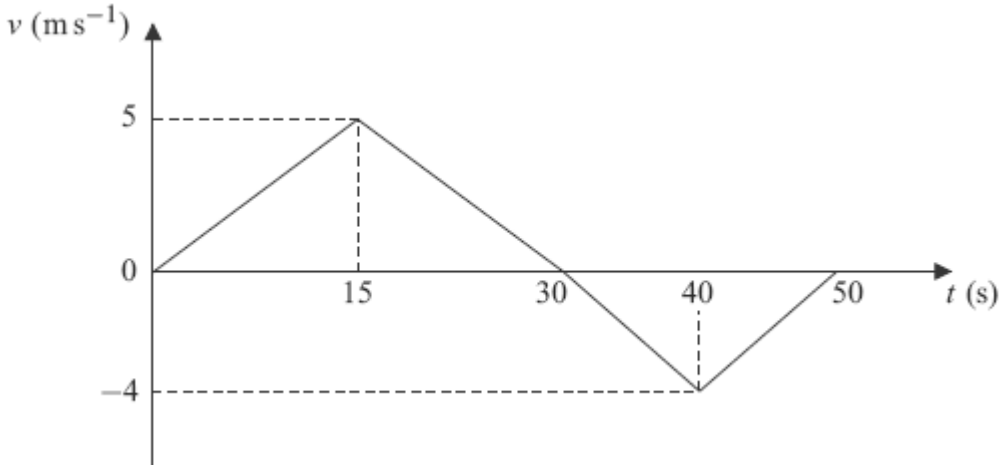
(b) Find the time that it takes for the motorcycle to travel this distance.

(3)

(Total 6 marks)

Q3.

The graph shows how the velocity of a particle varies during a 50-second period as it moves forwards and then backwards on a straight line.



(a) State the times at which the velocity of the particle is zero.

(2)

(b) Show that the particle travels a distance of 75 metres during the first 30 seconds of its motion.

(2)

(c) Find the total distance travelled by the particle during the 50 seconds.

(4)

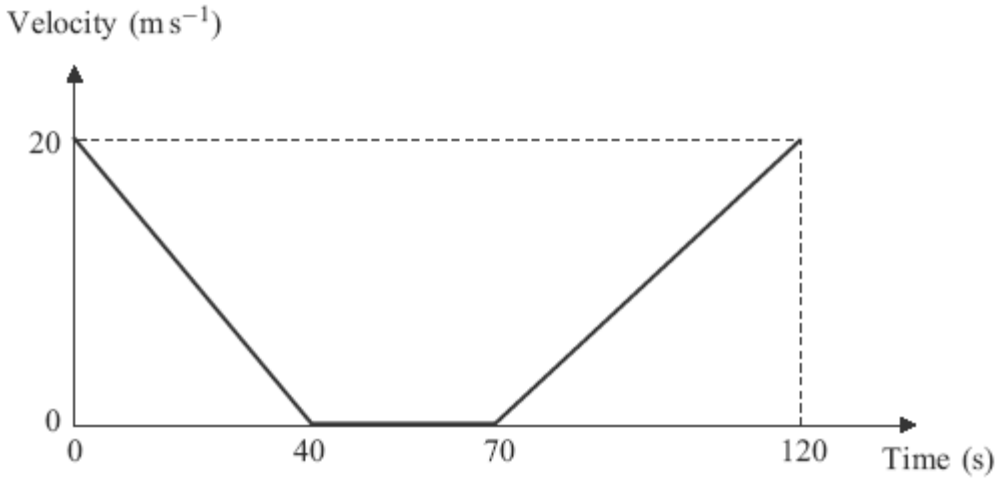
(d) Find the distance of the particle from its initial position at the end of the 50-second period.

(2)

(Total 10 marks)

Q4.

A bus slows down as it approaches a bus stop. It stops at the bus stop and remains at rest for a short time as the passengers get on. It then accelerates away from the bus stop. The graph shows how the velocity of the bus varies.



Assume that the bus travels in a straight line during the motion described by the graph.

(a) State the length of time for which the bus is at rest.

(1)

(b) Find the distance travelled by the bus in the first 40 seconds.

(2)

(c) Find the total distance travelled by the bus in the 120-second period.

(2)

(d) Find the average speed of the bus in the 120-second period.

(2)

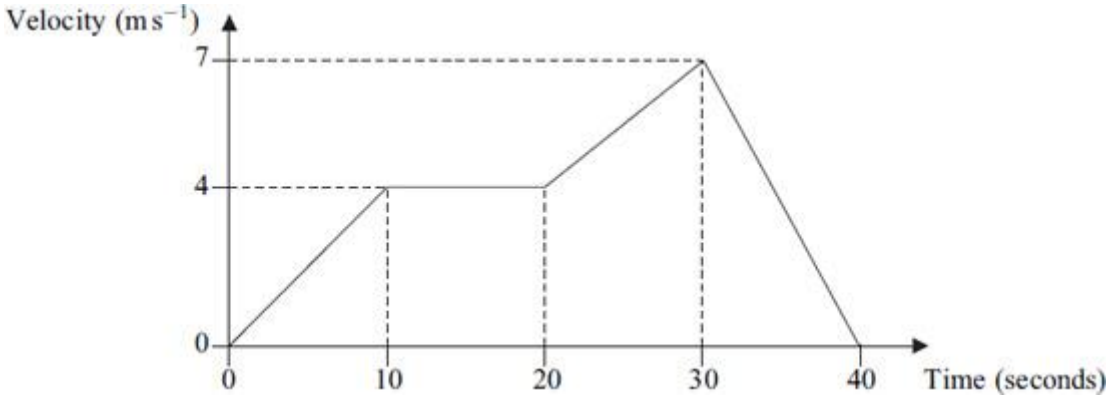
(e) If the bus had not stopped but had travelled at a constant 20 m s^{-1} for the 120-second period, how much further would it have travelled?

(2)

(Total 9 marks)

Q5.

The graph shows how the velocity of a train varies as it moves along a straight railway line.



(a) Find the total distance travelled by the train.

(4)

(b) Find the average speed of the train.

(2)

(c) Find the acceleration of the train during the first 10 seconds of its motion.

(2)

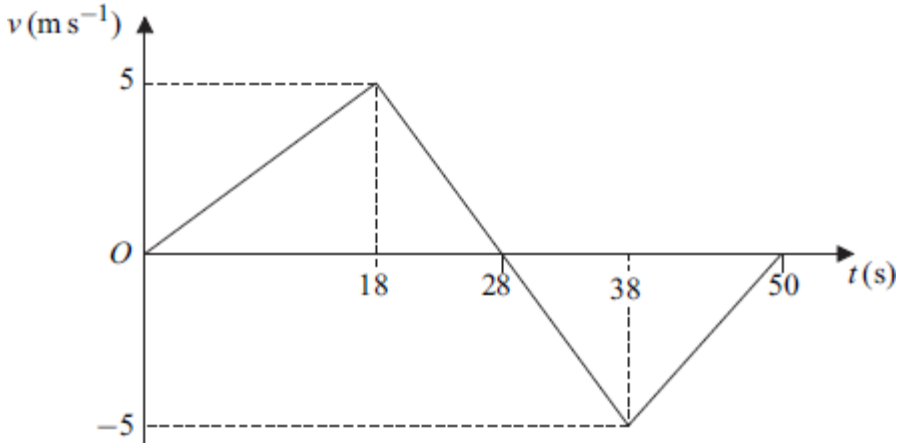
(d) The mass of the train is 200 tonnes. Find the magnitude of the resultant force acting on the train during the first 10 seconds of its motion.

(2)

(Total 10 marks)

Q6.

The diagram shows a velocity−time graph for a train as it moves on a straight horizontal track for 50 seconds.



(a) Find the distance that the train moves in the first 28 seconds.

(2)

(b) Calculate the total distance moved by the train during the 50 seconds.

(3)

(c) Hence calculate the average speed of the train.

(2)

(d) Find the displacement of the train from its initial position when it has been moving for 50 seconds.

(1)

(e) Hence calculate the average velocity of the train.

(2)

(f) Find the acceleration of the train in the first 18 seconds of its motion.

(1)

(Total 11 marks)

Q7.

A pair of cameras records the time that it takes a car on a motorway to travel a distance of 2000 metres. A car passes the first camera whilst travelling at 32 m s^{-1}.
The car continues at this speed for 12.5 seconds and then decelerates uniformly until it passes the second camera when its speed has decreased to 18 m s^{-1}.

(a) Calculate the distance travelled by the car in the first 12.5 seconds.

(1)

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

(3)

(c) Sketch a speed–time graph for the car on this 2000-metre stretch of motorway.

(3)

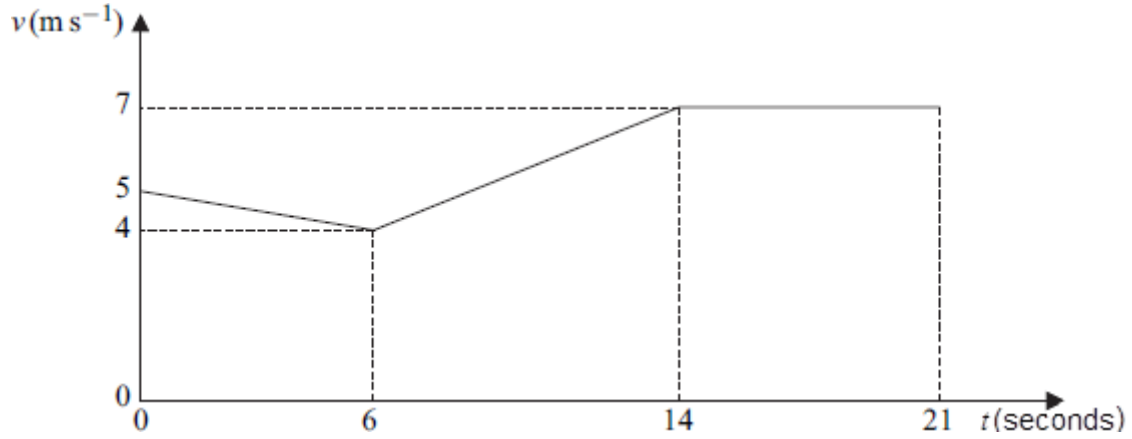
(d) Find the average speed of the car on this 2000-metre stretch of motorway.

(2)

(Total 9 marks)

Q8.

The graph shows how the speed of a cyclist, Hannah, varies as she travels for 21 seconds along a straight horizontal road.



(a) Find the distance travelled by Hannah in the 21 seconds.

(4)

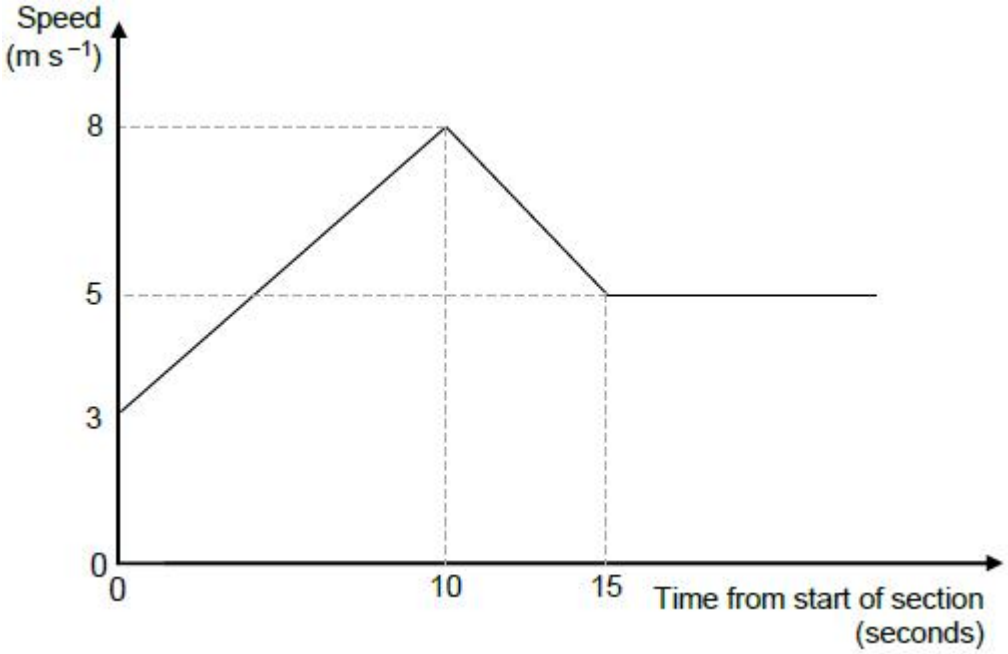
(b) Find Hannah's average speed during the 21 seconds.

(2)

(Total 6 marks)

Q9.

The graph shows how the speed of a cyclist varies during a timed section of length 120 metres along a straight track.



(a) Find the acceleration of the cyclist during the first 10 seconds.

(1)

(b) After the first 15 seconds, the cyclist travels at a constant speed of 5 m s^{-1} for a further T seconds to complete the 120-metre section.

Calculate the value of T.

(4)

(Total 5 marks)

Q10.

A car is travelling at a speed of 20 m s^{-1} along a straight horizontal road. The driver applies the brakes and a constant braking force acts on the car until it comes to rest.

(a) Assume that no other horizontal forces act on the car.

(i) After the car has travelled 75 metres, its speed has reduced to 10 m s^{-1}. Find the acceleration of the car.

(3)

(ii) Find the time taken for the speed of the car to reduce from 20 m s^{-1} to zero.

(2)

(iii) Given that the mass of the car is 1400 kg, find the magnitude of the constant braking force.

(2)

(b) Given that a constant air resistance force of magnitude 200 N acts on the car during the motion, find the magnitude of the constant braking force.

(1)

(Total 8 marks)

Q11.

A car is travelling at a speed of 20 m s^{-1} along a straight horizontal road. The driver applies the brakes and a constant braking force acts on the car until it comes to rest. Assume that no other horizontal forces act on the car.

(a) After the car has travelled 75 metres, its speed has reduced to 10 m s^{-1}. Find the acceleration of the car.

(3)

(b) Find the time taken for the speed of the car to reduce from 20 m s^{-1} to zero.

(2)

(c) Given that the mass of the car is 1400 kg, find the magnitude of the constant braking force.

(2)

(Total 7 marks)

Q12.

A motorcycle and rider, of total mass 300 kg, are accelerating in a straight line along a horizontal road at 2.2 m s^{-2}.

(a) Show that the magnitude of the resultant force acting on the motorcycle is 660 N.

(1)

(b) A forward driving force of P newtons together with a resistance force of magnitude 400 newtons act on the motorcycle. Find P.

(2)

(c) Find the time that it would take for the speed of the motorcycle to increase from 12 m s^{-1} to 23 m s^{-1}.

(3)

(Total 6 marks)

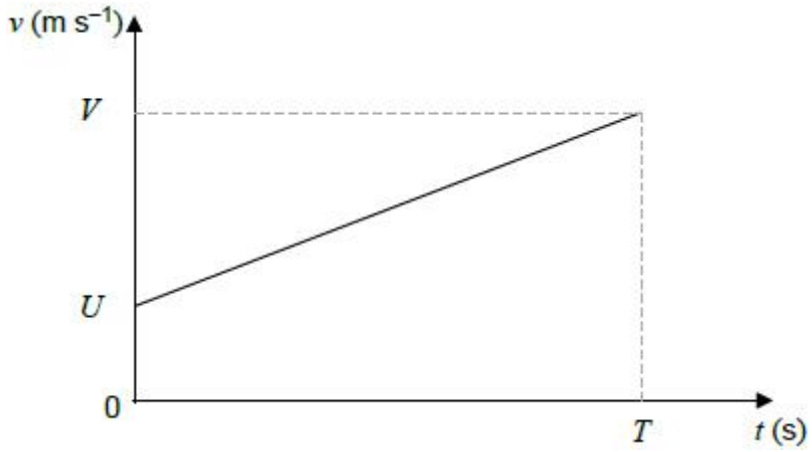
Q13.

A particle moves on a straight line with a constant acceleration, a m s $^{-2}$.

The initial velocity of the particle is U m s $^{-1}$

After T seconds the particle has velocity V m s $^{-1}$

This information is shown on the velocity-time graph.



The displacement, S metres, of the particle from its initial position at time T seconds is given by the formula

$$S = \frac{1}{2}(U + V)T$$

(a) By considering the gradient of the graph, or otherwise, write down a formula for a in terms of U, V and T.

(1)

(b) Hence show that $V^2 = U^2 + 2aS$.

(3)

(Total 4 marks)

Q14.

A car travels on a straight horizontal race track. The car decelerates uniformly from a speed of 20 m s^{-1} to a speed of 12 m s^{-1} as it travels a distance of 640 metres.
The car then accelerates uniformly, travelling a further 1820 metres in 70 seconds.

(a) (i) Find the time that it takes the car to travel the first 640 metres.

(3)

(ii) Find the deceleration of the car during the first 640 metres.

(3)

(b) (i) Find the acceleration of the car as it travels the further 1820 metres.

(3)

(ii) Find the speed of the car when it has completed the further 1820 metres.

(3)

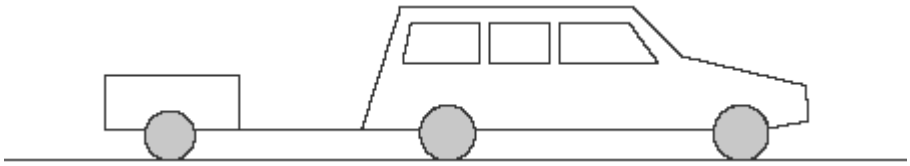
(c) Find the average speed of the car as it travels the 2460 metres.

(2)

(Total 14 marks)

Q15.

A car, of mass 1400 kg, is towing a trailer, of mass 600 kg. The two vehicles accelerate together at 1.3 m s^{-2} along a straight horizontal road.



(a) Find the distance that the car and trailer would travel while accelerating from rest to 13 m s^{-1}.

(3)

(b) A forward driving force, of magnitude 3900 N, acts on the car. A resistance force, of magnitude 800 N, also acts on the car.

(i) A resistance force, of magnitude P newtons, acts on the trailer. Find P.

(3)

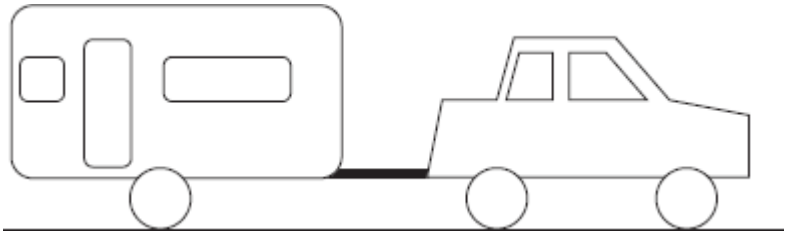
(ii) Find the magnitude of the force that the car exerts on the trailer.

(3)

(Total 9 marks)

Q16.

A car, of mass 1200 kg, tows a caravan, of mass 1000 kg, along a straight horizontal road. The caravan is attached to the car by a horizontal tow bar, as shown in the diagram.



Assume that a constant resistance force of magnitude 200 newtons acts on the car and a constant resistance force of magnitude 300 newtons acts on the caravan.
A constant driving force of magnitude *P* newtons acts on the car in the direction of motion. The car and caravan accelerate at 0.8 m s^{-2}.

(a) (i) Find *P*.

(3)

(ii) Find the magnitude of the force in the tow bar that connects the car to the caravan.

(3)

(b) (i) Find the time that it takes for the speed of the car and caravan to increase from 7 m s^{-1} to 15 m s^{-1}.

(3)

(ii) Find the distance that they travel in this time.

(3)

(c) Explain why the assumption that the resistance forces are constant is unrealistic.

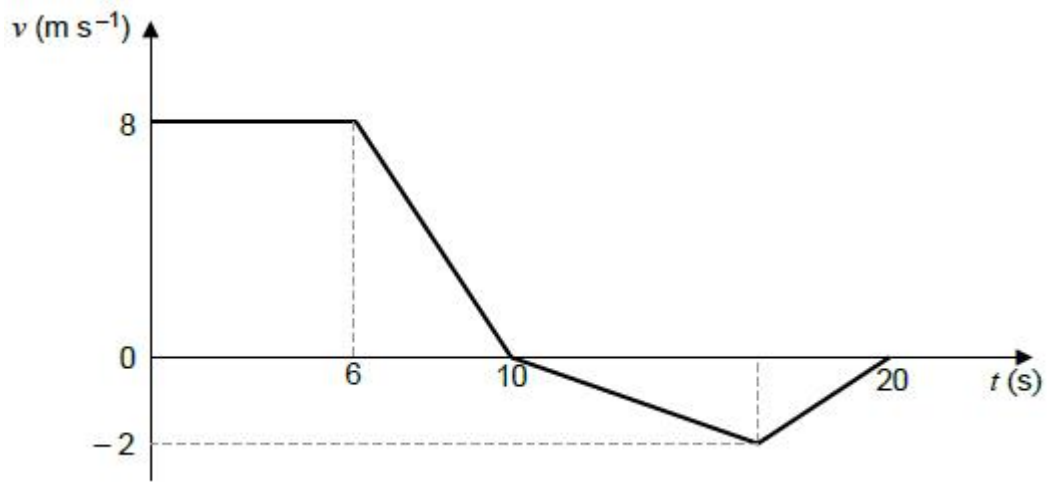
(1)

(Total 13 marks)

Q17.

The graph below models the velocity of a small train as it moves on a straight track for 20 seconds.

The front of the train is at the point *A* when $t = 0$
The mass of the train is 800kg.



(a) Find the total distance travelled in the 20 seconds.

(3)

(b) Find the distance of the front of the train from the point *A* at the end of the 20 seconds.

(1)

(c) Find the maximum magnitude of the resultant force acting on the train.

(2)

(d) Explain why, in reality, the graph may not be an accurate model of the motion of the train.

(1)

(Total 7 marks)

Mark schemes

Q1.

Marking Instructions	AO	Marks	Typical Solution
Circles correct answer	AO1.1b	B1	80 m s^{-2}
			Total 1 mark

Q2.

(a) $16^2 = 12^2 + 2a \times 20$

Use of CA equation(s) to find a

M1

Correct equation for a

A1

$$a = \frac{16^2 - 12^2}{40} = 2.8\ \text{m s}^{-1}$$

Correct acceleration

A1

3

(b) $16 = 12 + 2.8t$

Use of CA equation(s) to find t

M1

Correct equation for t

A1

$$t = \frac{16 - 12}{2.8} = 1.43\ \text{s}$$

Correct t

A1

3

[6]

Q3.

(a) $t = 0$, $t = 30$, $t = 50$ seconds

B1: Any one correct time

B1

B1: The other two correct times
Deduct one mark for each extra time if more than three times are given.
(eg 0, 15, 30, 50 scores B1 B0)

(eg 0, 15, 30, 40, 50 scores B0 B0)
Condone 49 or 48 instead of 50

B1

2

(b) $s_1 = \frac{1}{2} \times 30 \times 5 = 75 \text{ m}$ **AG**

M1: Finding distance by calculation of area. (Must see use of 0.5 or ½)

M1

A1: Correct answer from correct working. (If candidates use two constant acceleration equations, both must be seen for the M1 mark.)

A1

2

(c) $s_2 = \frac{1}{2} \times 4 \times 20 = 40 \text{ m}$

M1: Finding distance using area of the second triangle.

M1

A1: Correct distance (ignore any negative igns). (If candidates use two constant acceleration equations, both must be seen for the M1 mark.)
Accept 38/36 from use of 49/48 instead of 0

A1

$s = 75 + 40 = 115$ m

M1: Addition of the 75 metres and their distance. (75 – 40 = 35 OE scores M0)

M1

A1F: Correct result using their value for second area.
eg Accept 113/111 from use of 49/48 instead of 50

A1F

4

(d) $s = 75 - 40 = 35$ m

M1: Difference between 75 and their value for the second distance.
(Allow their istance – 75)
(75 – (– 40) = 115 OE scores M0)

M1

A1F: Correct result using their value for second area.
(eg 40 – 75 = – 35 M1A0)

eg Accept 37/39 from use of 49/48 instead of 50

A1F

2

[10]

Q4.

(a) 30 seconds

B1: Correct statement of time.

B1

1

(b) $s_1 = \frac{1}{2} \times 40 \times 20 = 400\,\text{m}$

M1: A method for calculating the first distance. Must see 40 and $\frac{1}{2}$.

M1

A1: Correct distance.

A1

OR

$s_1 = \frac{1}{2} \times (20 + 0) \times 40 = 400\,\text{m}$

(M1)(A1)

OR

$a = -\frac{20}{40} = -\frac{1}{2}$

$0^2 = 20^2 + 2\left(-\frac{1}{2}\right)s$

$s = 20^2 = 400\,\text{m}$

Note on third method: Must see $-\frac{1}{2}$ *or* $-\frac{20}{40}$ *plus attempt to find distance for M1.*

(M1)(A1)

2

(c) $s_2 = \frac{1}{2} \times 50 \times 20 = 500\text{m}$

M1: Method for finding the second distance and calculating the total distance.

M1

OR

$s_2 = \frac{1}{2} \times (0 + 20) \times 50 = 500\ \text{m}$

(M1)

OR

$a = \frac{20}{50} = \frac{2}{5}$

$20^2 = 0^2 + 2\left(\frac{2}{5}\right)s$

$s = 20^2 \times \frac{5}{4} = 500\ \text{m}$

Note on third method: Must see $\frac{2}{5}$ *or* $\frac{20}{50}$ *plus attempt to find distance.*

(M1)

Total = 400 + 500 = 900 m

A1F: Correct total distance. Award the follow through mark for correct addition of 500 and their answer to (b).

A1F

2

(d) $v_{AVERAGE} = \frac{900}{120} = 7.5\ \text{ms}^{-1}$

M1: Their total distance divided by 120

M1

A1F: Correct average speed based on their answer to (c).

A1F

2

(e) 120 × 20 – 900 = 1500 m

M1: Multiplication of 20 and 120 to find distance.
Note: Award M1 if 2400 seen in this part.
A1F: Correct difference based on their answer to (c) provided final answer is positive.

M1A1F

2

[9]

Q5.

(a) $s = \frac{1}{2} \times 10 \times 4 + 10 \times 4 + \frac{1}{2} \times (4+7) \times 10 + \frac{1}{2} \times 7 \times 10$

(= 20 + 40 + 55 + 35)

M1: Any one term correct.

M1: A second term correct.

A1: Correct expression for total distance.

M1M1A1

= 150 m

A1: Total distance correct.

A1

OR

$s = \frac{1}{2} \times (10 + 20) \times 4 + \frac{1}{2} \times (4 + 7) \times 10 + \frac{1}{2} \times 7 \times 10$

(= 60 + 55 + 35)

= 150 m

(M1M1A1)
(A1)

OR

$s = \frac{1}{2} \times 10 \times 4 + 10 \times 4 + 10 \times 4 + \frac{1}{2} \times 10 \times 3 + \frac{1}{2} \times 7 \times 10$

(= 20 + 40 + 40 + 15 + 35)

= 150 m

(M1M1A1)
(A1)

4

(b) Average Speed = $\frac{150}{40}$ = 3.75 m s^{-1}

M1: Their total distance divided by 40.

M1

A1F: Correct average speed based on their distance from part (a). Must be correct to three or more significant figures.

A1F

2

(c) $a = \frac{4}{10}$ = 0.4 m s^{-2}

M1: Any division involving the numbers 10 and 4.

M1

A1: Correct acceleration. CAO

A1

***Note on use of constant acceleration equations**:*

award M1 for correct equation with correct values and A1 for correct final answer.

2

(d) F = 200000 × 0.4 = 80000 N

M1: Multiplication of, 2 × 10^n, for any integer n, by candidate's acceleration from part (c).

A1F: Correct force based on their answer to part (c) multiplied by 200000.

M1A1F

Note: use of a = 2.5 gives 500000 N

Accept 80 kN

2

[10]

Q6.

(a) $s_1 = \frac{1}{2} \times 5 \times 28 = 70$ m

M1: For $\frac{1}{2} \times 5 \times 28$ or equivalent.

A1: Correct distance

M1A1

2

(b) $s = 70 + \frac{1}{2} \times 5 \times 22$

B1: For ± $\frac{1}{2} \times 5 \times 22$ or equivalent.

M1: For adding the distances.

B1M1

= 70 + 55

= 125 m

A1F: Correct distance. Follow through their answer from part (a) only.

A1F

3

(c) Average speed = $\frac{125}{50}$ = 2.5 ms^{-1}

M1: For their answer to (b) divided by 50.

M1

A1F: Correct average speed. Follow through answers from part (b).

A1F

2

(d) Displacement from O = 70 – 55 = 15 m

B1: Correct displacement.

B1

1

(e) Average velocity = $\frac{15}{50}$ = 0.3 ms^{-1}

M1: For their answer to (d) divided by 50, provided they have subtracted in (d).

M1

A1F: Correct average velocity. Follow through answers from part (d).

Award no marks if the final answer is 0.

A1F

2

(f) $a = \frac{5}{18}$ = 0.278 ms^{-2}

B1: Correct acceleration. Accept $\frac{5}{18}$ *or equivalent fraction or 0.277 or AWRT 0.278.*

Condone 0.28.

B1

1

[11]

Q7.

(a) s = 32 × 12.5 = 400 m

B1: Correct distance.

B1

1

(b) 1600 = $\frac{1}{2}$(32 + 18)t

M1: Seeing 2000 – candidate's answer to part (a) calculated

dM1: Use of constant acceleration equation(s) to find t, with u = 32 and v = 18

M1dM1

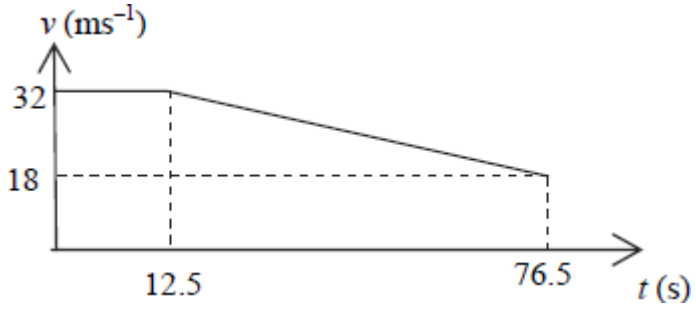
$t = \frac{1600}{25}$ = 64 seconds

A1: Correct time. Accept only 64

A1

3

(c)



B1: Shape of the graph.

B1

B1: Correct velocities (ie 18 and 32) on vertical axis.

B1

B1F: Correct times (ie 12.5 and 76.5) on the horizontal axis.

B1F

(Follow through incorrect answers to part (b)).

Award marks for graph if seen in earlier parts.

3

(d) Average Speed = $\frac{2000}{12.5 + 64}$ = 26.1 ms^{-1}

M1: Use of 2000 over candidate's total time (not 64 or 12.5).

M1

A1F: Correct speed. AWRT 26.1.

FT candidate's answer to part (b) or (c).

A1F

2

[9]

Q8.

(a) $S = \frac{1}{2}$ (5 + 4) × 6 + $\frac{1}{2}$ (4 + 7) × 8 + 7 × 7

M1: Method based on three (or four or more!) areas / distances or equivalent added together.

A1: Correct calculation or value for one area / distance for one time period (eg 0 to 6 seconds).

M1A1

= 27 + 44 + 49

A1: Correct calculation or value for area / distance for another time period.

A1

= 120 m

A1: Correct final distance.

A1

For example 24 + 44 + 49 = 117 scores M1A1A1A0.

4

(b) Average Speed = $\frac{120}{21}$ = 5.71 m s^{-1}

M1: Their answer to part (a) divided by 21.

M1

A1F: Correct average speed.

Accept $5\frac{5}{7}$ or $\frac{40}{7}$.

A1F

2

[6]

Q9.

	Marking Instructions	AO	Marks	Typical Solution
(a)	Finds correct acceleration	AO1.1b	B1	0.5 m s^{-2}
(b)	Identifies $5T$ as the distance travelled after the first 15 seconds	AO3.4	B1	Distance at constant speed = $5T$ Distance in first 15 secs = $\frac{1}{2} \times (3 + 8) \times 10 + \frac{1}{2} \times (8 + 5) \times 5$ = 55 + 32.5 = 87.5 $5T$ + 87.5 = 120 So T = 6.5
	Uses the information given to form an equation to find T (award mark for either trapezium expression separate, totalled or implied)	AO3.1b	M1	
	Correctly calculates the distance for the first 15 secs	AO1.1b	A1	
	Deduces the values of T from the mathematical models applied	AO2.2a	A1	
				Total 5 marks

Q10.

(a) (i) $10^2 = 20^2 + 2 \times a \times 75$

M1: Use of a constant acceleration equation to find a, with v = 10 and u = 20.

$20^2 = 10^2 + 2 \times a \times 75$ scores M0

A1: Correct equation.

M1A1

$a = \frac{100 - 400}{150}$ = – 2 ms^{-2}

A1: Correct acceleration.

A1

For two equation methods award no marks until an equation for a is obtained.

3

(ii) $0 = 20 - 2t$

M1: Using a constant acceleration equation, with $u = 20$ and $v = 0$, to find t using their acceleration from (a) even if positive.

Using $s = 75$ scores M0

M1

$t = 10$ seconds

A1: Correct time from correct working CSO.

A1

2

(iii) $F = 1400 \times 2$

M1: Use of $F = ma$ with ± their acceleration and mass of 1400.

M1

$= 2800$ N

A1F: Correct force. Follow through the magnitude of their acceleration. Answer must be positive. Sign changes do not need to be justified.

A1F

2

(b) $F = 2800 - 200 = 2600$ N

B1F: The magnitude of their force minus 200.
Do not award if M1 not awarded in (a)(iii).
Final answer must be positive.
Follow through only if their answer to (a)(iii) is greater than 200.

B1F

1

[8]

Q11.

(a) $10^2 = 20^2 + 2 \times a \times 75$

M1: Use of a constant acceleration equation to find a, with $v = 10$ and $u = 20$.

$20^2 = 10^2 + 2 \times a \times 75$ scores M0

A1: Correct equation.

M1A1

$a = \dfrac{100 - 400}{150} = -2$ ms^{-2}

A1: Correct acceleration.

For two equation methods award no marks until an equation for a is obtained.

A1

3

(b) $0 = 20 - 2t$

M1: Using a constant acceleration equation, with $u = 20$ and $v = 0$, to find t using their acceleration from (a) even if positive.
Using $s = 75$ scores M0

M1

$t = 10$ seconds

A1: Correct time from correct working CSO.

A1

2

(c) $F = 1400 \times 2 = 2800$ N

M1: Use of $F = ma$ with ± their acceleration and mass of 1400.
A1F: Correct force. Follow through the magnitude of their acceleration. Answer must be positive. Sign changes do not need to be justified.

M1A1F

2

[7]

Q12.

(a) Resultant Force = 300 × 2.2
= 660 N AG

B1: Correct value from correct multiplication.

B1

1

(b) $P - 400 = 660$
$P = 1060$

M1: Three term equation of motion

M1

A1: Correct value for P

A1

2

(c) $23 = 12 + 2.2t$

M1: Use of a constant acceleration equation to find t.

M1

A1: Correct equation

A1

$t = \frac{23 - 12}{2.2} = 5$ s

A1: Correct time

A1

3

[6]

Q13.

	Marking Instructions	AO	Marks	Typical Solution
(a)	States correct expression for a	AO1.1b	B1	$a = \frac{V - U}{T}$
(b)	Rearranges to make T the subject of the formula	AO2.1	R1	$T = \frac{V - U}{a}$
	Uses given expression for S and attempts to eliminate T	AO2.1	R1	$S = \frac{1}{2}(U + V) \times \frac{V - U}{a}$ $2as = (U + V)(V - U)$
	Completes argument to reach required result **AG** Only award if they have a completely correct solution, which is clear, easy to follow and contains no slips	AO2.1	R1	$V^2 = U^2 + 2aS$ **(AG)**
				Total 4 marks

Q14.

(a) (i) $640 = \frac{1}{2}(12 + 20)t$

M1: Use of constant acceleration equation to find t with s = 640, 20 and 12.

A1: Correct equation.

M1A1

$t = \frac{640 \times 2}{32} = 40$ s

A1: Correct time.

A1

For two equation methods, award no marks until an equation for t is obtained.

Using a = 0.2 to find t = –40 scores M1A0A0

3

(ii) $12^2 = 20^2 + 2 \times a \times 640$

M1: Use of constant acceleration equation to find a with u = 20 and v = 12.

A1F: Correct equation.

M1A1

$a = \frac{12^2 - 20^2}{2 \times 640} = -0.2 \text{ m s}^{-2}$

(Deceleration = 0.2 m s^{-2})

A1F: Correct deceleration.

Do not award for a = 0.2

Accept –0.2 or $\pm \frac{1}{5}$ *m* s^{-2} *for deceleration*

A1

3

OR

$12 = 20 + 40a$

(M1A1F)

$a = \frac{-8}{40} = -0.2 \text{ m s}^{-2}$

(Deceleration = 0.2 m s^{-2})

(A1F)

(3)

OR

$640 = 20 \times 40 + \frac{1}{2} a \times 40^2$

(M1A1F)

$a = \frac{-160}{800} = -0.2 \text{ms}^{-1}$

(Deceleration = 0.2 m s^{-2})

(A1F)

(3)

Follow through incorrect times from part (a).

Accept $\frac{8}{40}$ *= 0.2 provided that the equations*
20 = 12 + 40 a or $20^2 = 12^2 + 1280a$ *are not seen*

$a = \frac{8}{40}$ *= 0.2 scores M1A1A0 unless a is defined as deceleration*

(b) (i) $1820 = 12 \times 70 + \frac{1}{2} \times a \times 70^2$

M1: Constant acceleration equation to find a with
u = 12 (or 20),
s = 1820 and t = 70.
A1F: Correct equation.

M1A1

$a = \frac{1820 - 21 \times 70}{2450} = 0.4 \text{ m s}^2$

A1F: Correct acceleration. Accept $\frac{2}{5}$ *m s^{-2} oe.*

A1

3

(ii) $1820 = \frac{1}{2} (12 + v) \times 70;$

M1: Constant acceleration equation to find v with
s = 1820 and t = 70.
A1F: Correct equation.

M1A1

$v = \frac{1820}{35} - 12 = 40 \text{ m s}^{-1}$

A1F: Correct velocity.

A1

3

OR

$v = 12 + 0.4 \times 70$

(M1A1F)

$= 40 \text{ m s}^{1\text{d}^\circ}$

(A1F)

(3)

OR

$v^2 = 12^2 + 2 \times 0.4 \times 1820$

(M1A1F)

$v = \sqrt{1600} = 40 \text{ m}^{1\text{d}^\circ}$

(A1F)

(3)

OR

$1820 = 70v - \frac{1}{2} \times 0.4 \times 70^2$

(M1A1F)

$v = 40$ m s^{-1} cao

(A1F)

(3)

For two equation methods, award no marks until an equation for v is obtained.

(c) Average Speed = $\frac{640 + 1820}{40 + 70}$

M1: Division of 2460 by their total time (70 + their answer to (a)).

M1

$= \frac{2460}{110} = 22.4$ m s^{-1}

A1F: Correct time. Accept 22.3 or AWRT 22.4

A1F

2

[14]

Q15.

(a) $13^2 = 0^2 + 2 \times 1.3s$

M1: Use of a constant acceleration equation to find distance.

M1

A1: Correct equation

A1

$s = \frac{13^2}{2.6} = 65$ m

A1: Correct distance

A1

3

(b) (i) $3900 - 800 - P = 2000 \times 1.3$

M1: Four term equation of motion for car and trailer.

M1

A1: Correct equation

A1

$P = 3900 - 800 - 2600 = 500$ N

A1: Correct value for P

A1

3

(ii) $T - 500 = 600 \times 1.3$

M1: Three term equation of motion for trailer.

M1

A1: Correct equation

A1F

$T = 500 + 780 = 1280$ N

A1: Correct tension

A1F

3

[9]

Q16.

(a) (i) $P - 500 = 2200 \times 0.8$
$P = 1760 + 500$

M1: Equation of motion for car and caravan as a single body. Must see 2200 (or 1200 + 1000) multiplied by 0.8, and 500 (or 200 + 300). Allow sign errors.

A1: Correct equation.

M1A1

$= 2260$

A1: Correct value for P.

A1

(Award full marks for: (P =) 1760 + 500 = 2260 or similar to obtain correct final answer.)

OR (If finding the tension first)

$P - 1100 - 200 = 1200 \times 0.8$
$P = 960 + 1100 + 200$

M1: Equation of motion for car with their value for the tension.
Must see 1200 multiplied by 0.8, 200 and their tension.
Allow sign errors.

A1: Correct equation.

(M1A1)

$= 2260$

A1: Correct value for P.

(A1)

(Award full marks for: (P =) 960 + 200 + 1100 = 2260 or similar to obtain correct final answer.)

3

(ii) $T - 300 = 1000 \times 0.8$

$T = 300 + 800$

M1: Equation of motion for caravan.

Must see 300 and 1000 multiplied by 0.8.

Allow sign errors.

A1: Correct equation.

M1A1

$= 1100$

A1: Correct tension. CAO

A1

OR

$2260 - 200 - T = 1200 \times 0.8$

$T = 2260 - 200 - 960$

M1: Equation of motion for car. Must see 2260 (or candidate's P), 200 and 1200 multiplied by 0.8. Allow sign errors.

A1: Correct equation.

(M1A1)

$= 1100$ N

A1: Correct tension. CAO

(A1)

If candidates find tension first it must be stated in part (a)(ii) to gain any marks.

The working does not have to be repeated if seen in part (a)(i).

3

(b) (i) $15 = 7 + 0.8t$

M1: Use of a constant acceleration equation to find t, with 7, 15 and 0.8.

A1: Correct equation.

M1A1

$t = \dfrac{15 - 7}{0.8} = 10$ seconds

A1: Correct time. CAO

A1

3

(ii) $15^2 = 7^2 + 2 \times 0.8s$

M1: Use of a constant acceleration equation to find s, with 7, 15 and 0.8.

A1: Correct equation

M1A1

$s = \dfrac{15^2 - 7^2}{1.6}$ = 110 m

A1: Correct distance. CAO

A1

OR

$s = \dfrac{1}{2}(7 + 15) \times 10 = 110\text{m}$

M1: Use of a constant acceleration equation to find s, with 7, 15 and candidate's time.

A1F: Correct equation.

A1F: Correct distance.

(M1A1F)
(A1F)

OR

$s = 7 \times 10 + \dfrac{1}{2} \times 0.8 \times 10^2 = 110$ m

M1: Use of a constant acceleration equation to find s, with 7, 0.8 and candidate's time.

A1F: Correct equation.

A1F: Correct distance.

(M1A1F)
(A1F)

If candidates find distance first it must be stated in part (b)(ii) to gain any marks.

The working does not have to be repeated if seen in part (b)(i).

3

(c) Resistance forces <u>vary with speed</u> (or velocity)
OR Speed (or velocity) changes (or increases)
OR It accelerates

B1: Correct explanation. Must not mention friction in main argument

B1

1

[13]

Q17.

	Marking Instructions	AO	Marks	Typical Solution
(a)	Calculates two (or four) appropriate distances	AO3.1b	M1	$s_1 = \dfrac{1}{2}(6 + 10) \times 8 = 64$ m

	Obtains correct distances	AO1.1b	A1	$s_2 = \frac{1}{2} \times 10 \times 2 = 10$ m
	Obtains correct sum of 'their' distances	AO1.1b	A1F	$s_1 + s_2 = 64 + 10 = 74$ m **OR** $S_1 = 6 \times 8 = 48$ m $S_2 = \frac{1}{2} \times 4 \times 8 = 16$ m $S_3 = \frac{1}{2} \times 4 \times 2 = 4$ m $S_4 = \frac{1}{2} \times 6 \times 2 = 6$ m $S_1 + S_2 + S_3 + S_4 = 74$ m
(b)	Finds difference of 'their' distances from part **(a)**	AO2.2a	B1F	64 − 10 = 54 m
(c)	Calculates magnitude of acceleration	AO3.1b	M1	$a_{max} = \frac{8}{4} = 2$
	Obtains correct resultant force	AO1.1b	A1	$F_{max} = 800 \times 2 = 1600$ N
(d)	Explains that abrupt changes and straight lines in the graph are unlikely in reality	AO3.5b	E1	Change of velocity is unlikely to result in abrupt changes I would expect to see curves on the graph
				Total 7 marks