

QQQ – Mechanics Year 1 – Chapter 9 – SUVAT Equations (Version 1)

Total Marks: 23

(23 = Platinum, 21 = Gold, 18 = Silver, 16 = Bronze)

1. 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}

(Total 1 marks)

AQA June 2019 Paper 1 Q11

2. An unmanned craft lands on the planet Mars. A small bolt falls from the craft onto the surface of the planet. It falls 1.5 m from rest in 0.9 s.

Calculate the acceleration due to gravity on Mars.

[2]

(Total 2 marks)

OCR MEI October 2021 Paper 1 Q2

3. In this question use $g = 9.8 \text{ m s}^{-2}$

A ball is launched vertically upwards from the Earth's surface with velocity $u \text{ m s}^{-1}$

The ball reaches a maximum height of 15 metres.

You may assume that air resistance can be ignored.

Find the value of u

[3 marks]

(Total 3 marks)

AQA June 2024 Paper 1 Q16

4. A man throws a tennis ball into the air so that, at the instant when the ball leaves his hand, the ball is 2 m above the ground and is moving vertically upwards with speed 9 m s^{-1}

The motion of the ball is modelled as that of a particle moving freely under gravity and the acceleration due to gravity is modelled as being of constant magnitude 10 m s^{-2}

The ball hits the ground T seconds after leaving the man's hand.

Using the model, find the value of T . (4)

(Total 4 marks)

Edexcel June 2018 Mechanics Q6

5. Jermaine and his friend Meena are walking in the same direction along a straight path.

Meena is walking at a constant speed of $u \text{ m s}^{-1}$

Jermaine is walking 0.2 m s^{-1} more slowly than Meena.

When Jermaine is d metres behind Meena he starts to run with a constant acceleration of 2 m s^{-2} , for a time of t seconds, until he reaches her.

(a) Show that

$$d = t^2 - 0.2t$$

[4 marks]

(b) When Jermaine's speed is 7.8 m s^{-1} , he reaches Meena.

Given that $u = 1.4$ find the value of d . **[2 marks]**

(Total 6 marks)

AQA June 2022 Paper 1 Q16

6. A small stone is projected vertically upwards with speed 39.2 m s^{-1} from a point O .

The stone is modelled as a particle moving freely under gravity from when it is projected until it hits the ground 10 s later.

Using the model, find

- (a)** the height of O above the ground, **(3)**
- (b)** the total length of time for which the speed of the stone is less than or equal to 24.5 m s^{-1} **(3)**
- (c)** State one refinement that could be made to the model that would make your answer to part (a) more accurate. **(1)**

(Total 7 marks)

Solutions

1.

Scheme	Marks	AO
Circles correct answer	B1	1.1b
	(1 mark)	

Typical solution

$$2 \text{ m s}^{-1}$$

2.

Scheme	Marks	AO
Using <i>suvat</i> equation(s) with $s = 1.5$, $u = 0$, $t = 0.9$ $s = ut + \frac{1}{2}at^2$		
$1.5 = \frac{1}{2}a \times 0.9^2$	M1	3.1b
Giving $a = 3.70 \text{ m s}^{-2}$	A1	1.1
	[2]	

Notes

M1: Allow for chain of equations leading to a value for a

A1: Allow for 3.7

3.

Scheme	Marks	AO
Uses $v^2 = u^2 + 2as$ Condone sign errors	M1	3.4
Substitutes consistent values to find u eg $a = -9.8$, $v = 0$, $s = 15$ $a = 9.8$, $v = 0$, $s = -15$	A1	3.3

Obtains $u = 17$ CSO AWRT 17 ACF	A1	1.1b
	(3 marks)	

Typical solution

$$a = -9.8, v = 0, s = 15$$

$$0 = u^2 + 2(-9.8)(15)$$

$$u = 17$$

4.

Scheme	Marks	AO
Equation in t only	M1	2.1
$-2 = 9t - \frac{1}{2} \times 10t^2$	A1	1.1b
$5t^2 - 9t - 2 = 0 = (5t + 1)(t - 2)$	DM1	1.1b
$T = 2$ (only)	A1	1.1b
	(4)	
	(4 marks)	

Notes

M1: Complete method to give equation in t only. This mark is for a complete method for the TOTAL time i.e. for finding sufficient equations, with usual rules, correct no. of terms in each equation but condone sign errors and g does not need to be substituted

A1: A correct equation **or** correct equations (e.g. if they find the speed, 11 m s^{-1} , when the ball strikes the ground and then use that to find the total time **or** if they split the time (e.g. 0.9 s up and 1.1 s down or 0.9 s + 0.9 s + 0.2 s))

N.B. $g = 10$ must be substituted in all equations used.

DM1: Dependent on first M1, for solving a 3 term quadratic to find T **or** for solving their equations to find T **or** for solving their equations and adding their split times to find T

A1: $T = 2$ only (i.e. A0 if they give two times)

N.B. If solving a correct quadratic, the DM1 can be implied by a correct answer i.e. the method does not need to be shown, but if there is no method shown and the answer is wrong then award DM0 A0.

5.

Mark scheme (a)

Scheme	Marks	AO
Uses appropriate constant acceleration equation to find expression for displacement of Jermaine t seconds after acceleration begins, with at least one term correct.	M1	3.1b
Obtains fully correct equation for Jermaine's displacement PI $s = (u - 0.2)t + 0.5 \times 2t^2$ Or $s = (u - 0.2)t + 0.5 \times 2t^2 - d$	A1	1.1b
Forms a correct expression for Meena's displacement. $s = ut \text{ or } s = ut + d$ Do not accept $ut - d$	B1	3.1b
Completes reasoned argument to obtain given result. AG	R1	2.1
	(4)	

Typical solution

Jermaine's displacement

$$s = (u - 0.2)t + 0.5 \times 2t^2$$

Reaches Meena when $s = ut + d$

$$ut + d = (u - 0.2)t + t^2$$

$$ut + d = ut - 0.2t + t^2$$

$$d = t^2 - 0.2t$$

Mark scheme (b)

Scheme	Marks	AO
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Uses appropriate constant acceleration equation to find value for t	M1	3.1b
Uses given equation to find correct value of d Accept 10.2 or 10.23	A1	1.1b
	(2)	
	(6 marks)	

Typical solution

$$7.8 = (1.4 - 0.2) + 2t$$

$$t = 3.3 \implies d = 10.23$$

6.

Mark scheme (a)

Scheme	Marks	AO
Attempt to find the displacement after 10 s	M1	3.1b
$39.2 \times 10 - \frac{1}{2}g \times 10^2$ OR $-39.2 \times 10 + \frac{1}{2}g \times 10^2$	A1	1.1b
98 (m) (must be positive)	A1	1.1b
	(3)	

Notes

If they use $g = 9.81$ or 10 in this question, penalise once for whole question.

Penalise explicit use of $g = 9.81$ or 10 once for the whole question the first time it occurs.

M1 Complete method, using $s = ut + \frac{1}{2}at^2$ or possibly $s = vt - \frac{1}{2}at^2$ with the motion reversed, or an 'up and down' method i.e an appropriate equation for the motion from O to the top **AND** an appropriate equation from the top down to the ground **AND** combining to give the total distance

A1 Correct expression (s)

N.B. If using an 'up and down method', this mark is for **all** the intermediate values:

Distance up = 78.4, Time up = 4, time down = 6, distance down = 176.4 **AND** combining correctly i.e. (176.4 – 78.4) or (78.4 – 176.4)

These are the values for $g = 9.8$

A1 cao

Mark scheme (b)

Scheme	Marks	AO
Complete method to find either half the time or the full time	M1	3.1b
Correct equation e.g. $0 = 24.5 - gt$ OR $-24.5 = 24.5 - gt$	A1	1.1b
5 (s)	A1	1.1b
	(3)	

Notes

If they use $g = 9.81$ or 10 in this question, penalise once for whole question.

Penalise explicit use of $g = 9.81$ or 10 once for the whole question the first time it occurs.

M1 Complete method to find half the time or the full time. Allow inequalities.

e.g. for half the time, they may find $t = 4$ and $t = 1.5$ and subtract

e.g. for the full time, they may find $t = 6.5$ and $t = 1.5$ and subtract

A1 Correct equation or equations if they are using more than one.

A1 cao

Mark scheme (c)

Scheme	Marks	AO
e.g. (include) air resistance	B1	3.5c
	(1)	
	(7 marks)	

Notes

B1 e.g. (use) a more accurate value of g , (include) spin of the stone, (include) shape of the stone, (include) size of the stone, (include) wind effects, rotation

B0 if any incorrect extras are included e.g. the mass or weight of the stone

DO NOT ALLOW NEGATIVES OF THESE e.g. there is no air resistance