Equations of Motion

Question Paper

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Kinematics
Sub Topic	Equations of Motion
Paper Type	Multiple Choice
Booklet	Question Paper

Time Allowed: **46 minutes**

Score: **/38**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

1 An insect jumps with an initial vertical velocity of $1.0\,\text{m s}^{-1}$, reaching a maximum height of $3.5 \times 10^{-2}\,\text{m}$. Assume the deceleration is uniform.

What is the magnitude of the deceleration?

A $3.6\,\text{m s}^{-2}$ **B** $9.8\,\text{m s}^{-2}$ **C** $14\,\text{m s}^{-2}$ **D** $29\,\text{m s}^{-2}$

2 A body having uniform acceleration a increases its velocity from u to v in time t.

Which expression would **not** give a correct value for the body's displacement during time t?

A $ut + \frac{1}{2}at^2$

B $vt - \frac{1}{2}at^2$

C $\frac{(v+u)(v-u)}{2a}$

D $\frac{(v-u)t}{2}$

3 A sprinter runs a 100 m race in a straight line. He accelerates from the starting block at a constant acceleration of $2.5\,\text{m s}^{-2}$ to reach his maximum speed of $10\,\text{m s}^{-1}$. He maintains this speed until he crosses the finish line.

Which time does it take the sprinter to run the race?

A 4 s **B** 10 s **C** 12 s **D** 20 s

4 The acceleration of free fall on the Moon is one-sixth of that on Earth.

On Earth it takes time t for a stone to fall from rest a distance of 2 m.

What is the time taken for a stone to fall from rest a distance of 2 m on the Moon?

A $6t$ **B** $\frac{t}{6}$ **C** $t\sqrt{6}$ **D** $\frac{t}{\sqrt{6}}$

5 What is the correct name for a material containing long-chain molecules that are tangled and coiled?

A amorphous metal

B amorphous polymer

C crystalline metal

D crystalline polymer

6 In an experiment to determine the acceleration of free fall g, a ball-bearing is held by an electromagnet. When the current to the electromagnet is switched off, a clock starts and the ball-bearing falls. After falling a distance h, the ball-bearing strikes a switch to stop the clock which measures the time t of the fall.

Which expression can be used to calculate the value of g?

A $\frac{ht^2}{2}$ **B** $\frac{th^2}{2}$ **C** $\sqrt{\frac{2t}{h^2}}$ **D** $\frac{2h}{t^2}$

7 An object is thrown with velocity $5.2\,\text{m s}^{-1}$ vertically upwards on the Moon. The acceleration due to gravity on the Moon is $1.62\,\text{m s}^{-2}$.

What is the time taken for the object to return to its starting point?

A 2.5 s **B** 3.2 s **C** 4.5 s **D** 6.4 s

8 A ship of mass 8.4×10^7 kg is approaching a harbour with speed $16.4\,\text{m s}^{-1}$. By using reverse thrust it can maintain a constant total stopping force of 920 000 N.

How long will it take to stop?

A 15 seconds

B 150 seconds

C 25 minutes

D 250 minutes

9 An experiment is performed to measure the acceleration of free fall g. A body falls between two fixed points. The four measurements shown below are taken.

Which measurement is **not** required for the calculation of g?

A the distance fallen by the body

B the initial velocity of the body

C the mass of the body

D the time taken for the body to fall

10 In a cathode-ray tube, an electron is accelerated uniformly in a straight line from a speed of $4 \times 10^3\,m\,s^{-1}$ to $2 \times 10^7\,m\,s^{-1}$ over a distance of 10 mm.

What is the acceleration of the electron?

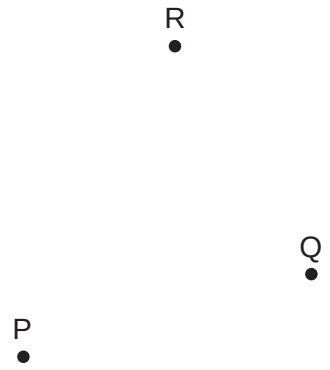
A $2 \times 10^3\,m\,s^{-2}$

B $2 \times 10^6\,m\,s^{-2}$

C $2 \times 10^{13}\,m\,s^{-2}$

D $2 \times 10^{16}\,m\,s^{-2}$

11 One object moves directly from P to R.



In a shorter time, a second object moves from P to Q to R.

Which statement about the two objects is correct for the journey from P to R?

A They have the same average speed.

B They have the same average velocity.

C They have the same displacement.

D They travel the same distance.

12 An aeroplane travels at an average speed of 600 km h^{-1} on an outward flight and at 400 km h^{-1} on the return flight over the same distance.

What is the average speed of the whole flight?

A 111 m s^{-1} **B** 167 m s^{-1} **C** 480 km h^{-1} **D** 500 km h^{-1}

13 On a particular railway, a train driver applies the brake of the train at a yellow signal, a distance of 1.0 km from a red signal, where the train stops.

The maximum deceleration of the train is 0.20 m s^{-2}.

Assuming uniform deceleration, what is the maximum safe speed of the train at the yellow signal?

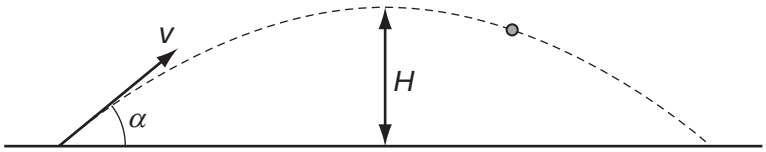
A 14 m s^{-1} **B** 20 m s^{-1} **C** 40 m s^{-1} **D** 400 m s^{-1}

14 A person, travelling on a motorway a total distance of 200 km, travels the first 90 km at an average speed of 80 km h^{-1}.

Which average speed must be obtained for the rest of the journey if the person is to reach the destination in a total time of 2 hours 0 minutes?

A 110 km h^{-1} **B** 120 km h^{-1} **C** 122 km h^{-1} **D** 126 km h^{-1}

15 A cannon fires a cannonball with an initial speed v at an angle α to the horizontal.



Which equation is correct for the maximum height H reached?

A $H = \frac{v \sin\alpha}{2g}$ **B** $H = \frac{g \sin\alpha}{2v}$ **C** $H = \frac{(v \sin\alpha)^2}{2g}$ **D** $H = \frac{g^2 \sin\alpha}{2v}$

16 A goods train passes through a station at a steady speed of $10\,m\,s^{-1}$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of $0.5\,m\,s^{-2}$ just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

How much time passes before the express train overtakes the goods train?

A 6 s **B** 10 s **C** 20 s **D** 40 s

17 The diagram shows an arrangement to stop trains that are travelling too fast.

Trains coming from the left travel at a speed of $50\,m\,s^{-1}$. At marker 1, the driver must apply the brakes so that the train decelerates uniformly in order to pass marker 2 at no more than $10\,m\,s^{-1}$.

The train carries a detector that notes the times when the train passes each marker and will apply an emergency brake if the time between passing marker 1 and marker 2 is less than 20 s.

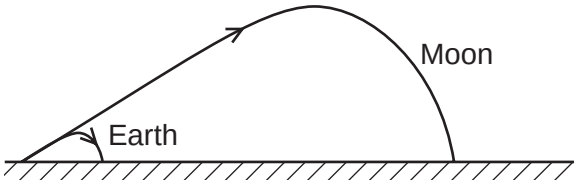
How far from marker 2 should marker 1 be placed?

A 200 m **B** 400 m **C** 500 m **D** 600 m

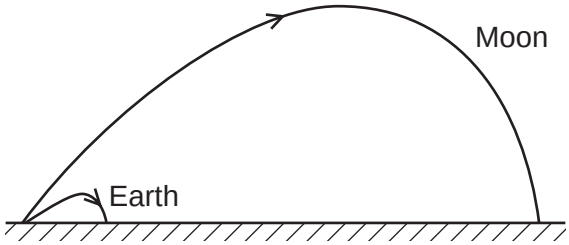
18 A golf ball is hit with the same force and direction on the Earth and on the Moon.

Which diagram best represents the shapes of the paths taken by the golf ball?

A



B



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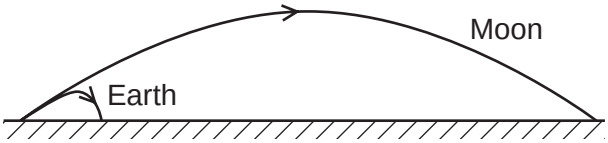
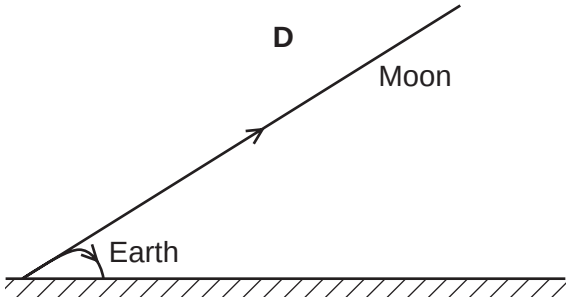


D



19 A science museum designs an experiment to show the fall of a feather in a vertical glass vacuum tube.

The time of fall from rest is to be close to 0.5 s.

What length of tube is required?

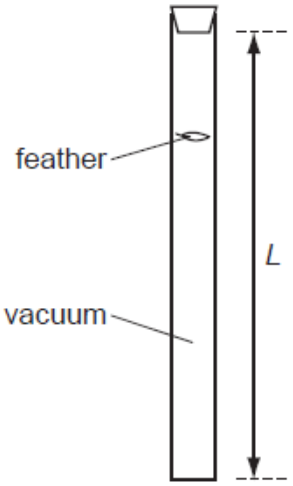
A 1.3 m **B** 2.5 m **C** 5.0 m **D** 10.0 m

20 A bicycle brakes so that it undergoes uniform deceleration from a speed of 8 m s^{-1} to 6 m s^{-1} over a distance of 7 m.

If the deceleration of the bicycle remains constant, what further distance will it travel before coming to rest?

A 7 m **B** 9 m **C** 16 m **D** 21 m

21 The diagram shows a laboratory experiment in which a feather falls from rest in a long evacuated vertical tube of length L.

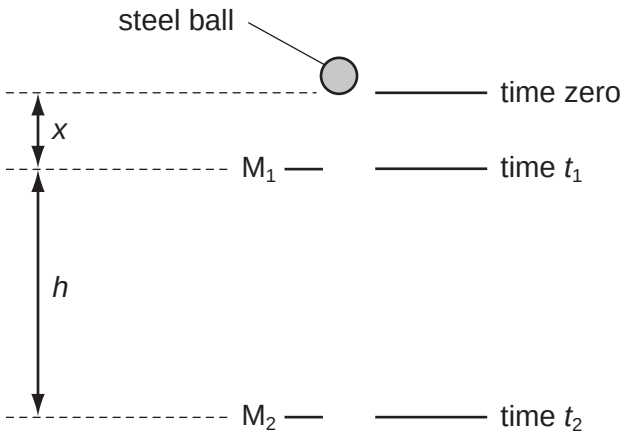


The feather takes time T to fall from the top to the bottom of the tube.

How far will the feather have fallen from the top of the tube in time $0.50\,T$?

A $0.13L$ **B** $0.25L$ **C** $0.38L$ **D** $0.50L$

22 Two markers M_1 and M_2 are set up a vertical distance h apart.



A steel ball is released at time zero from a point a distance x above M_1. The ball reaches M_1 at time t_1 and reaches M_2 at time t_2. The acceleration of the ball is constant.

Which expression gives the acceleration of the ball?

A $\frac{2h}{t_2^2}$ **B** $\frac{2h}{(t_2+t_1)}$ **C** $\frac{2h}{(t_2-t_1)^2}$ **D** $\frac{2h}{(t_2^2-t_1^2)}$

23 A bullet is fired horizontally with speed v from a rifle. For a short time t after leaving the rifle, the only force affecting its motion is gravity. The acceleration of free fall is g.

Which expression gives the value of $\frac{\text{the horizontal distance travelled in time } t}{\text{the vertical distance travelled in time } t}$?

A $\frac{vt}{g}$ **B** $\frac{v}{gt}$ **C** $\frac{2vt}{g}$ **D** $\frac{2v}{gt}$

24 In order that a train can stop safely, it will always pass a signal showing a yellow light before it reaches a signal showing a red light. Drivers apply the brake at the yellow light and this results in a uniform deceleration to stop exactly at the red light.

The distance between the red and yellow lights is x.

What must be the minimum distance between the lights if the train speed is increased by 20 %, without changing the deceleration of the trains?

A $1.20\,x$ **B** $1.25\,x$ **C** $1.44\,x$ **D** $1.56\,x$

25 A moving body undergoes uniform acceleration while travelling in a straight line between points X, Y and Z. The distances XY and YZ are both 40 m. The time to travel from X to Y is 12 s and from Y to Z is 6.0 s.

What is the acceleration of the body?

A $0.37\,\text{m s}^{-2}$ **B** $0.49\,\text{m s}^{-2}$ **C** $0.56\,\text{m s}^{-2}$ **D** $1.1\,\text{m s}^{-2}$

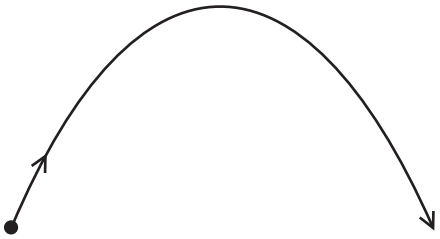
26 On a particular railway, a train driver applies the brake of the train at a yellow signal, a distance of 1.0 km from a red signal, where it stops.

The maximum deceleration of the train is $0.2\,m\,s^{-2}$.

Assuming uniform deceleration, what is the maximum safe speed of the train at the yellow signal?

A $20\,m\,s^{-1}$ **B** $40\,m\,s^{-1}$ **C** $200\,m\,s^{-1}$ **D** $400\,m\,s^{-1}$

27 A stone is thrown upwards and follows a curved path.



Air resistance is negligible.

Why does the path have this shape?

A The stone has a constant horizontal velocity and constant vertical acceleration.

B The stone has a constant horizontal acceleration and constant vertical velocity.

C The stone has a constant upward acceleration followed by a constant downward acceleration.

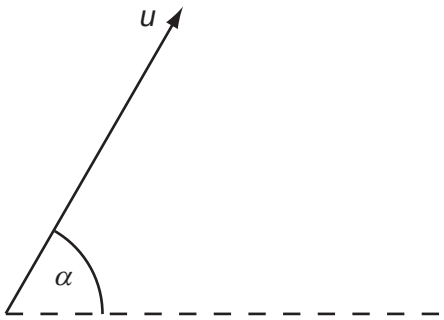
D The stone has a constant upward velocity followed by a constant downward velocity.

28 A stone is dropped from the top of a tower of height 40 m. The stone falls from rest and air resistance is negligible.

What time is taken for the stone to fall the last 10 m to the ground?

A 0.38 s **B** 1.4 s **C** 2.5 s **D** 2.9 s

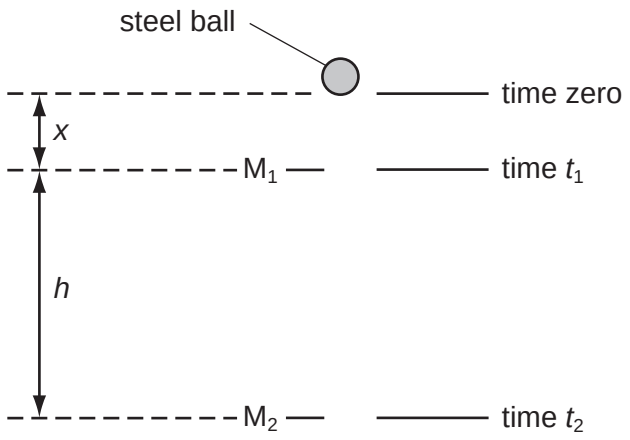
29 A projectile is fired at an angle α to the horizontal at a speed u, as shown.



What are the vertical and horizontal components of its velocity after a time t?
Assume that air resistance is negligible. The acceleration of free fall is g.

	vertical component	horizontal component
A	$u \sin \alpha$	$u \cos \alpha$
B	$u \sin \alpha - gt$	$u \cos \alpha - gt$
C	$u \sin \alpha - gt$	$u \cos \alpha$
D	$u \cos \alpha$	$u \sin \alpha - gt$

30 Two markers M_1 and M_2 are set up a vertical distance h apart.



A steel ball is released at time zero from a point a distance x above M_1. The ball reaches M_1 at time t_1 and reaches M_2 at time t_2. The acceleration of the ball is constant.

Which expression gives the acceleration of the ball?

A $\frac{2h}{t_2^2}$ **B** $\frac{2h}{(t_2+t_1)}$ **C** $\frac{2h}{(t_2-t_1)^2}$ **D** $\frac{2h}{(t_2^2-t_1^2)}$

31 An object falls 10.0 m from rest before entering some water.

Assuming negligible air resistance, what is the time taken to reach the water and the speed with which the object reaches the water?

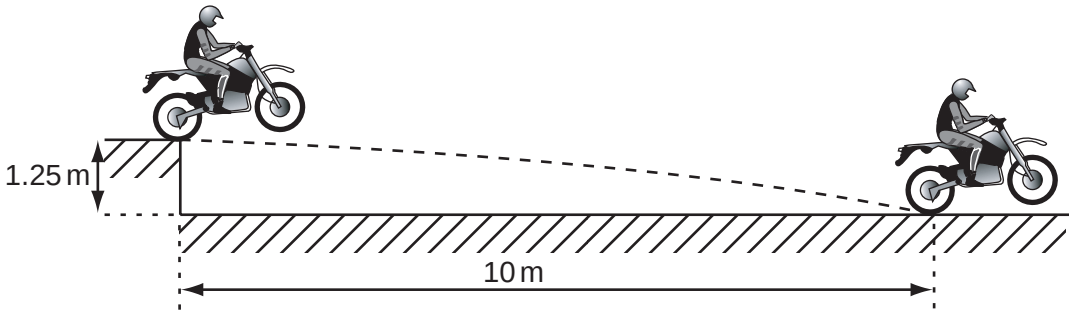
	time / ms	spe / m s^{-1}
A	1.02	10.0
B	1.02	14.0
C	1.43	10.0
D	1.43	14.0

32 A car is travelling with uniform acceleration along a straight road. The road has marker posts every 100 m. When the car passes one post, it has a speed of $10\,m\,s^{-1}$ and, when it passes the next one, its speed is $20\,m\,s^{-1}$.

What is the car's acceleration?

A $0.67\,m\,s^{-2}$ **B** $1.5\,m\,s^{-2}$ **C** $2.5\,m\,s^{-2}$ **D** $6.0\,m\,s^{-2}$

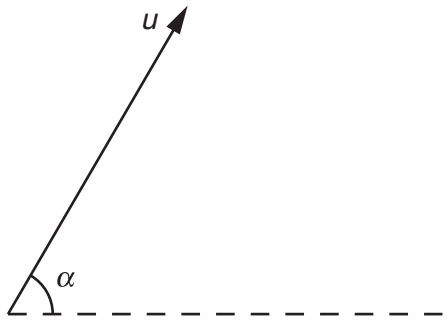
33 A motorcycle stunt-rider moving horizontally takes off from a point 1.25 m above the ground, landing 10 m away as shown.



What was the speed at take-off?

A $5\,m\,s^{-1}$ **B** $10\,m\,s^{-1}$ **C** $15\,m\,s^{-1}$ **D** $20\,m\,s^{-1}$

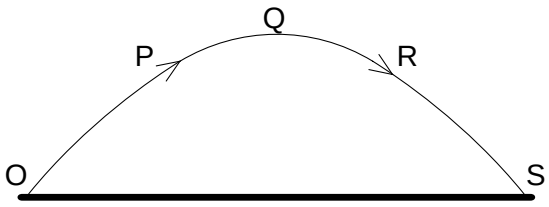
34 A projectile is fired at an angle α to the horizontal at a speed u, as shown.



What will be the vertical and horizontal components of its velocity after a time t? Assume that air resistance is negligible. The acceleration of free fall is g.

	vertical component	horizontal component
A	$u \sin \alpha$	$u \cos \alpha$
B	$u \sin \alpha - gt$	$u \cos \alpha - gt$
C	$u \sin \alpha - gt$	$u \cos \alpha$
D	$u \cos \alpha$	$u \sin \alpha - gt$

35 A projectile is launched at point O and follows the path OPQRS, as shown. Air resistance may be neglected.



Which statement is true for the projectile when it is at the highest point Q of its path?

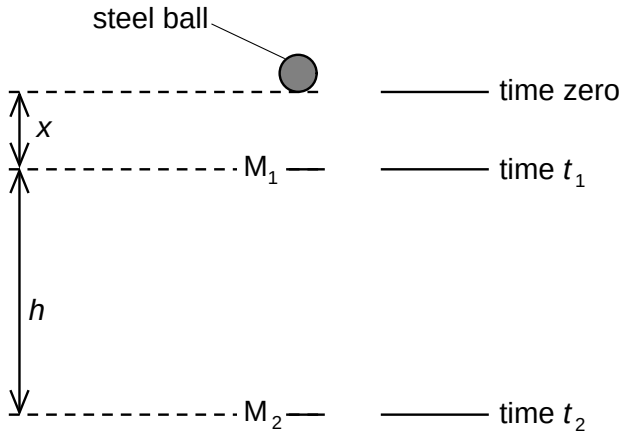
A The horizontal component of the projectile's acceleration is zero.

B The horizontal component of the projectile's velocity is zero.

C The kinetic energy of the projectile is zero.

D The momentum of the projectile is zero.

36 Two markers M_1 and M_2 are set up a vertical distance h apart.



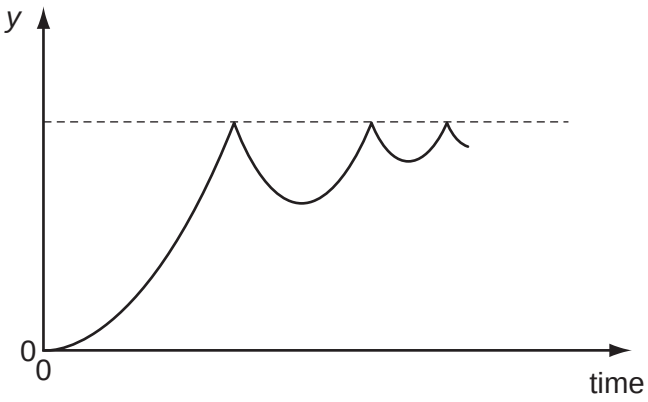
When a steel ball is released from rest from a point a distance x above M_1, it is found that the ball takes time t_1 to reach M_1 and time t_2 to reach M_2.

Which expression gives the acceleration of the ball?

A $\frac{2h}{t_2^2}$ **B** $\frac{2h}{(t_2 + t_1)}$ **C** $\frac{2h}{(t_2 - t_1)^2}$ **D** $\frac{2h}{(t_2^2 - t_1^2)}$

37 A ball is released from rest above a horizontal surface and bounces several times.

The graph shows how, for this ball, a quantity *y* varies with time.



What is the quantity *y*?

A acceleration

B displacement

C kinetic energy

D velocity

38 An experiment is done to measure the acceleration of free fall of a body from rest.

Which measurements are needed?

A the height of fall and the time of fall

B the height of fall and the weight of the body

C the mass of the body and the height of fall

D the mass of the body and the time of fall