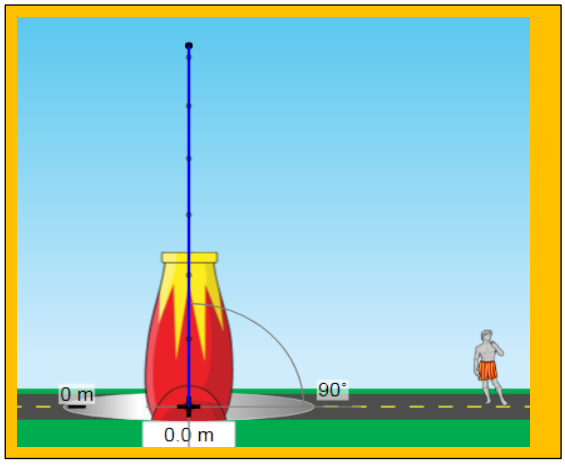
NORTHERN CAPE DEPARTMENT OF EDUCATION

PHYSICAL SCIENCES

GRADE 12

VERTICAL PROJECTILE MOTION



AUTUMN SCHOOL

2020

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phys

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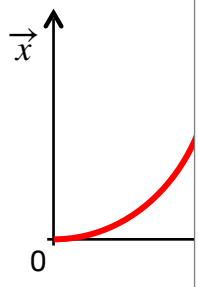
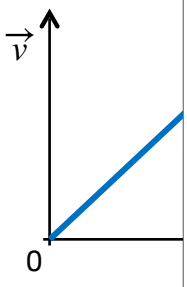
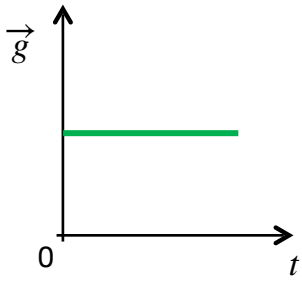
Vertical Projectile Motion

<table>
<tr><th colspan="5">VERTICAL PROJECTILE MOTION</th></tr>
<tr><th>Projectile</th><th colspan="4">Equations of motion</th></tr>
<tr><td rowspan="6">Projectile is an object upon which the only force acting is the force of gravity.
The motion of a projectile is called free fall.
Free fall is the motion in which an object experiences negligible air resistance and constant acceleration due to gravitational force only.
Free fall is the motion of an object upon which the only force acting is the force of gravity.</td><td>Position</td><td>Displacement</td><td>Velocity</td><td>Acceleration</td></tr>
<tr><td>$\vec{y}_f = \vec{y}_i + \Delta\vec{y}$
$\Delta\vec{y}$ – Displacement, which is the change in position.</td><td>$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$\Delta y = \frac{v_f^2 - v_i^2}{2a}$
$\Delta y = \left(\frac{v_i + v_f}{2}\right) \Delta t$</td><td>$v_f = v_i + a \Delta$
$v_f^2 = v_i^2 + 2a \Delta y$</td><td>Magnitude constant:
$a = 9{,}8\ m \bullet s^{-2}$
Direction is always downwards (towards the centre of the Earth).</td></tr>
<tr><td colspan="4">Graphs</td></tr>
<tr><td>Direction of motion</td><td>Position vs time</td><td>Velocity vs time</td><td>Acceleration vs time</td></tr>
<tr><td>Vertically downwards
(speed increases)
(constant acceleration)</td><td> 
</td><td> 
</td><td> 
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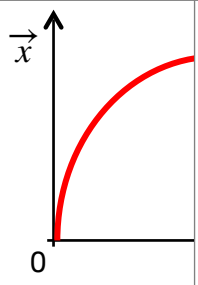
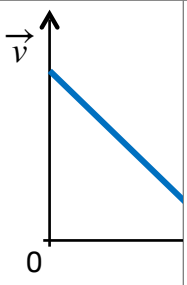
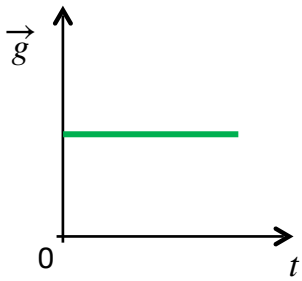
<tr><td>Vertically upwards
(speed decreases)
(constant acceleration)</td><td> 
</td><td> 
</td><td> 
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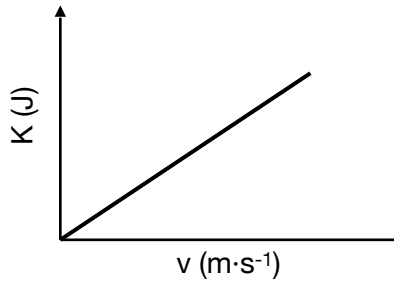
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

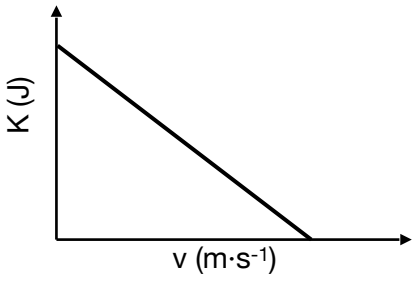
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the graphs below correctly represents the relationship between the kinetic energy (K) of a free-falling object and its speed (v)?

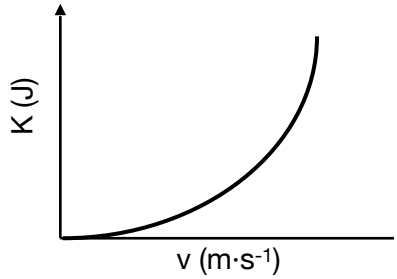
A



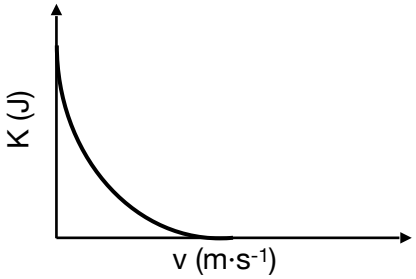
B



C



D



(2)

1.2 The statements below describe the motion of objects.

(i) A feather falls from a certain height inside a vacuum tube.

(ii) A box slides along a smooth horizontal surface at constant speed.

(iii) A steel ball falls through the air in the absence of air friction.

Which of the following describes UNIFORMLY ACCELERATED motion CORRECTLY?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii) (2)

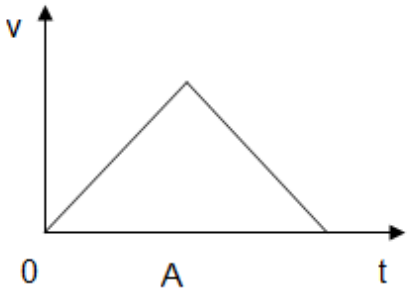
1.3 An object is thrown vertically upwards from the ground.

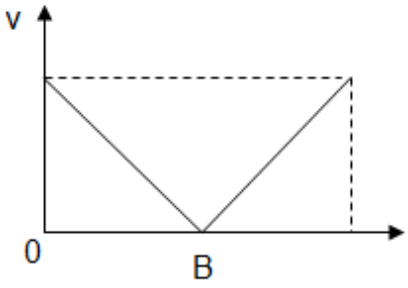
Which ONE of the following is CORRECT regarding the direction of the acceleration of the object as it moves upwards and then downwards? Ignore the effects of air resistance.

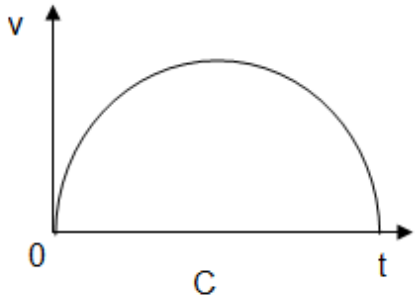
	OBJECT MOVING UPWARDS	**OBJECT MOVING DOWNWARDS**
A	Downwards	Upwards
B	Upwards	Downwards
C	Downwards	Downwards
D	Upwards	Upwards

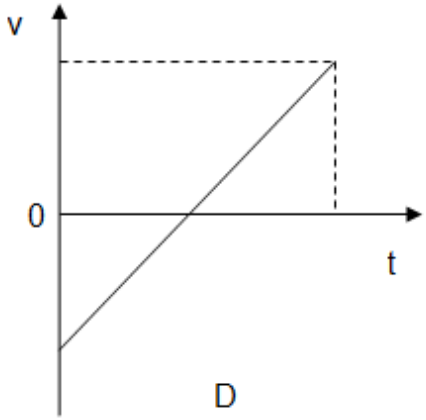
(2)

1.4 A boy throws a tennis ball vertically upwards, and after a time it returns to the boy's hands. Which ONE of the following velocity versus time graphs best represents the motion of the ball? Ignore air friction.









(2)

1.5 A ball dropped from a height, *h,* strikes the ground and bounces vertically upwards to its original height. Which ONE of the following position versus time graphs best represents the motion of the ball? Ignore the effects of air friction.

(2)

QUESTION 2 (Start on a new page.)

Ball **A** is projected vertically upwards at a velocity of 16 $m \cdot s^{-1}$ from the ground. Ignore the effects of air resistance. **Use the ground as zero reference.**

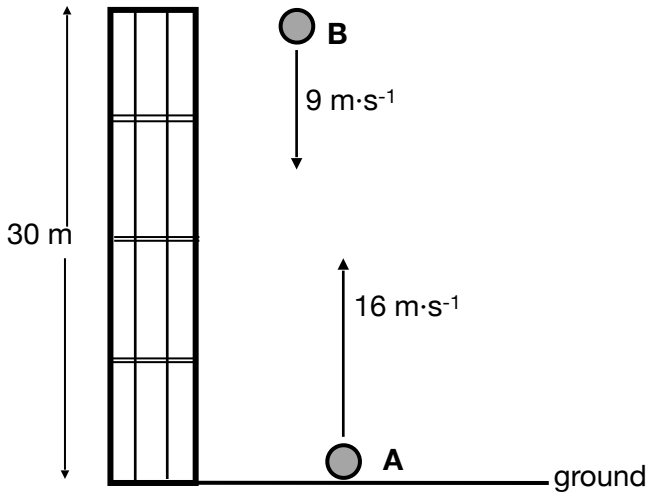
2.1 Calculate the time taken by ball **A** to return to the ground. (4)

2.2 Sketch a velocity-time graph for ball **A**.

Show the following on the graph:

(a) Initial velocity of ball **A**
(b) Time taken to reach the highest point of the motion
(c) Time taken to return to the ground (3)

ONE SECOND after ball **A** is projected upwards, a second ball, **B**, is thrown vertically downwards at a velocity of 9 $m \cdot s^{-1}$ from a balcony 30 m above the ground. Refer to the diagram below.



2.3 Calculate how high above the ground ball **A** will be at the instant the two balls pass each other. (6)

[13]

QUESTION 3 (Start on a new page.)

A man throws ball **A** downwards with a speed of 2 $m \cdot s^{-1}$ from the edge of a window, 45 m above a dam of water. One second later he throws a second ball, ball **B**, downwards and observes that both balls strike the surface of the water in the dam at the same time. Ignore air friction.

3.1 Calculate the:

3.1.1 Speed with which ball **A** hits the surface of the water (3)

3.1.2 Time it takes for ball **B** to hit the surface of the water (3)

3.1.3 Initial velocity of ball **B** (5)

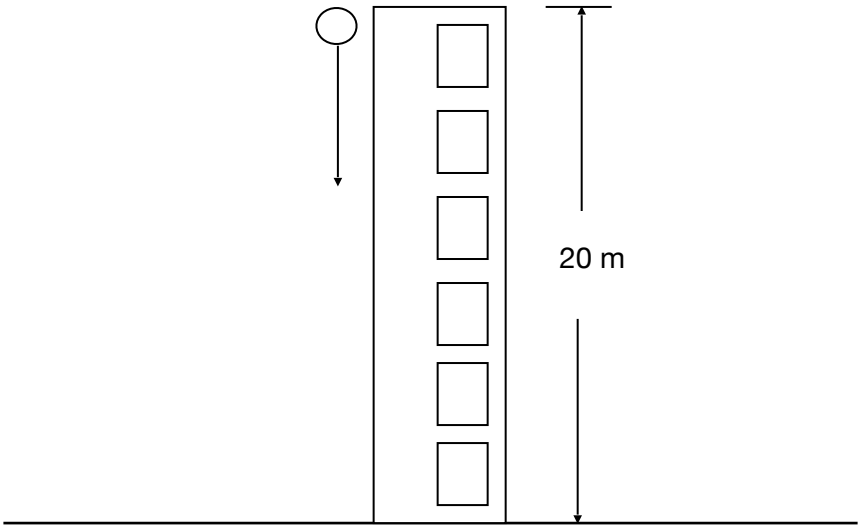
3.2 On the same set of axes, sketch a velocity versus time graph for the motion of balls **A** and **B**. Clearly indicate the following on your graph:

- Initial velocities of both balls **A** and **B**
- The time of release of ball **B**
- The time taken by both balls to hit the surface of the water (5)

[16]

QUESTION 4 (Start on a new page.)

A ball is dropped from the top of a building 20 m high. Ignore the effects of air resistance.



4.1 Define the term *free fall*. (2)

4.2 Calculate the:

4.2.1 Speed at which the ball hits the ground (4)

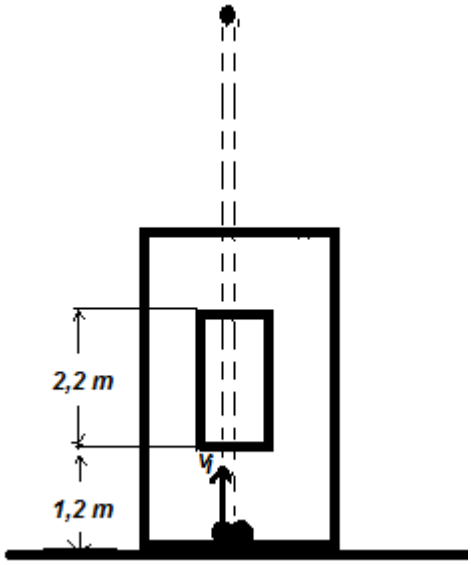
4.2.2 Time it takes the ball to reach the ground (3)

4.3 Sketch a velocity-time graph for the motion of the ball (no values required). (2)

[11]

QUESTION 5

A ball is projected vertically upwards from the ground next to a building. The ball reaches maximum height above the ground before moving downwards. On its way down it passes a window 2,2 m high in the building in 0,2 s. The bottom of the window is 1,2 m above the ground. Ignore the effects of air friction.



5.1 Write down the acceleration of the ball at the maximum height. (2)

5.2 Write down the magnitude of the velocity of the ball at the maximum height. (1)

5.3 Calculate the velocity of the ball at the top of the window. (4)

5.4 Use equations of motion to calculate the initial speed of the ball. (4)

5.5 Calculate the time the ball takes to reach its maximum height above the ground. (3)

5.6 Sketch a velocity-time graph for the motion of the ball from the moment it was projected vertically upwards until it hits the ground for the first time. Indicate the respective time and velocity values on the graph. (3)

[17]