**CAPS LESSON PREPARATION**

SUBJECT: **PHYSICAL SCIENCE** GRADE: **12**

KNOWLEDGE AREA: MECHANICS

SECTION/S: VERTICAL PROJECTILE MOTION

DURATION: 30. **Minutes / periods**

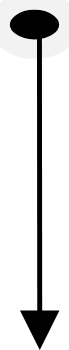
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| **LESSON OBJECTIVES** | **At the end of the lesson learners should know the following:**   * Define the terms free fall and projectile * Describe the motion of a free-falling object that is * Dropped / released from some height above the ground * Thrown vertically downwards * Thrown vertically upwards and caught at the point of projection * Thrown vertically upwards from a certain height and reach the ground below the point of projection. * Use equations of motion to determine position, velocity and displacement of a projectile at any point in time. |

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| **PRE-KNOWLEDGE** | **Grade 10**   * Vectors and scalars. * Describing uniform linear motion – constant velocity and constant acceleration. * Graphs of motion. * Equations of motions.   **Grade 11**   * Newton’s second law of motion. |

**PRESENTATION**

* Define free fall as a type of ***motion*** in which gravitational force is the only force acting on an object.



* Define a projectile as an ***object*** upon which the only force acting is the force of gravity
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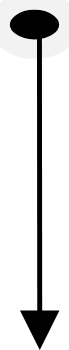
A free body diagram of a free-falling object – **1 MARK**

Fg

1. An object is dropped / released from a height of height of 29,4 m above the ground. Ignore air friction.

***Unpacking the scenario***:

* The object starts from rest: ***vi = 0 m.s-1***
* Ignore air friction: Gravitational force (not gravity) is the only force acting on the object – ***the object is in free fall***

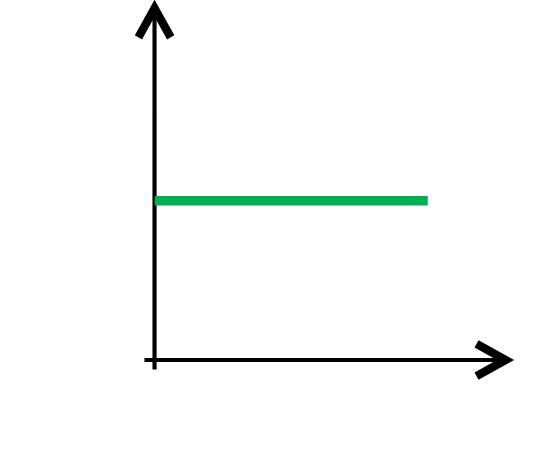
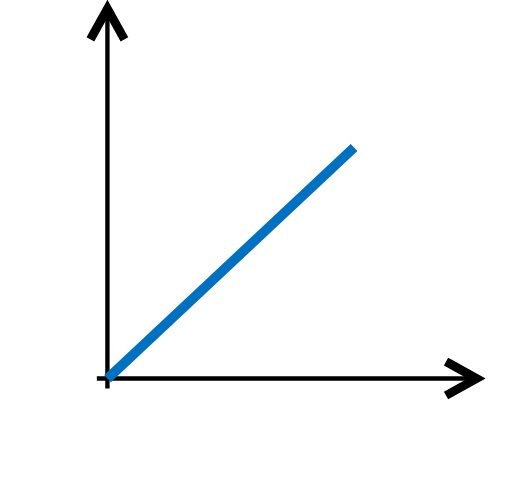


A free body diagram of a free-falling object – **1 MARK**

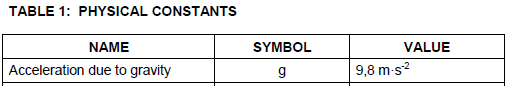
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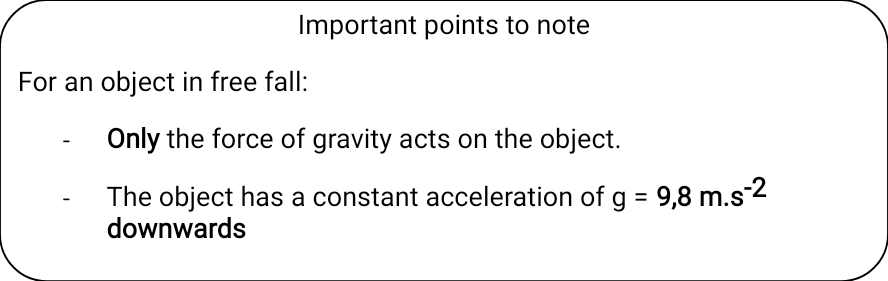
* Since gravity is the only force acting on the object: **Fg is the Fnet acting on the object.**
* According to Newton 2nd law of motion (Grade 11): the object **accelerates uniformly** in the direction of Fg. The object moves faster and faster downwards.
* Constant acceleration of **9,8 m.s-2 downwards** (magnitude and direction). The velocity of the object changes by 9,8 m.s-1 for every second (constant acceleration)
* **From grade 10**

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| Time (s) | 0 | 1 | 2 | 3 |
| Velocity (m.s-1) | 0 | 9,8 | 19,6 | 29,4 |



* v vs t graph is a straight-line graph starting at the origin with a constant gradient (acceleration)
* a vs t graph will be represented by a straight horizontal line (constant acceleration) a = **9,8 m.s-2**





1. For an ***object thrown vertically downwards*** when air friction is ignored:

* We consider the motion from the moment it leaves the hand – thus from the point only gravitational force acts on the object (**free fall**)
* vi is not equal to zero, however, the object’s velocity still changes by the same magnitude per second – ***constant acceleration***.

1. For an object thrown vertically upwards when air friction is ignored:

* We still consider the motion of the object from the instant it leaves the thrower’s hand – thus only gravitational force acts on object (**free fall**)
* The object moves slower and slower until it comes to rest (***constant acceleration***) - Grade 10
* As the object slows down while moving upwards, it is actually accelerating in the direction of the gravitational force (downwards) - ***constant acceleration***.

**Language usage**

* **How long**: implies time (∆t)
* **How fast**: implies speed (scalar) or velocity (vector)
* **How high**: refers to distance or displacement (∆y) between any two points in motion.
* **Dropped**: implies the object is released from rest, **vi = 0 m.s-1**
* **Thrown:** implies that the object is given a non-zero initial velocity (upwards or downwards)

**Examinable scenarios**

* A ball dropped from height “h”
* A ball thrown vertically downward from height “h”
* A ball thrown vertically upwards at a certain non-zero initial velocity
* A ball dropped from a moving object (relative initial velocity)
* Bouncing ball

**Worked example**

A ball is thrown vertically upwards with a speed of 15 m.s-1 from the edge of a balcony and strikes the ground 6 seconds later. Ignore air friction.

**1.1 define the term *free fall*. (2)**

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| ***Basic recall type of question: all or nothing 2/2 or 0/2***  ***Pay attention to the key words and must be used in the correct scientific context.*** |

**1.2 Calculate**

**1.2.1 how high above the balcony the ball travels. (3)**

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| **Choose sign convention** i.e. which motion is taken as positive  Take upwards as positive: **a = - 9,8 m.s-2** and **vi = 15 m.s-1**, take note that the initial velocity and acceleration are in opposite directions.  Consider motion from the point of projection to the highest position whose time we do not know: **vf = 0 m.s-1**  Identify the relevant equation of motion and substitute correctly    02 = 152 + 2(- 9,8)∆y  ∆y = 11,48 m  A calculation problem that carries **3 MARKS** is usually a simple routine calculation – fromula, substitution and answer. Be on the lookout !!! |

**1.2.2 the velocity of the ball when it strikes the ground. (3)**

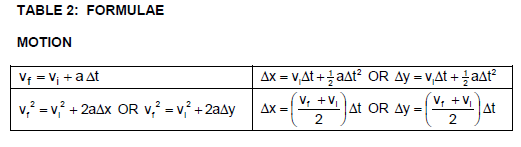
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| Consider the motion from the point of projection (initial position) until the ball strikes the ground (final position)  **a = - 9,8 m.s-2** and **vi = 15 m.s-1**  **∆t = 6 s**  Identify the relevant equation of motion and substitute correctly      vf = 15 + (- 9,8)(6)  vf = - 43,8 m.s-1  vf = 43,8 m.s-1 downwards (magnitude and direction) |

1.2.3 the height of the balcony

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| Consider the motion from the point of projection (initial position) until the ball strikes the ground (final position)  The change of position (∆y) of the ball is essentially the height of the balcony.  **a = - 9,8 m.s-2** and **vi = 15 m.s-1**  **∆t = 6 s**  Identify the relevant equation of motion and substitute correctly:    ∆y = 15(6) + 0,5(- 9,8)(6)2  ∆y = - 86,4 m  Therefore, the height of the balcony is 86,4 m  (Always interpret the answer) |

**Problem-solving Approach**

* Draw the trajectory followed by the projectile (if necessary)
* Put critical points in your trajectory, i.e. Point of launch, Maximum height, point symmetrical to the point of launch and the ground
* **Choose sign convention** i.e. which motion is taken as positive
* When applying equations of motion, always consider motion between any two points (initial and final) and take **direction** into account.
* Refer to the **data sheet**. Copy the relevant equation and subsequently isolate the unknown, without attempting to initially change the subject of the formula.



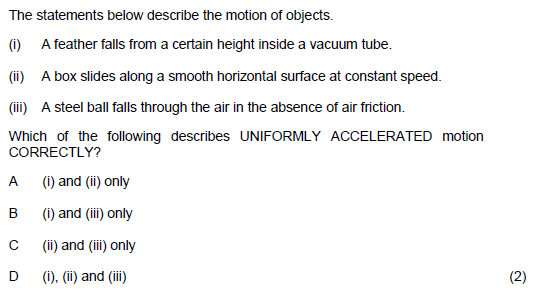
**LEARNER ACTIVITY**

**Multiple choice**

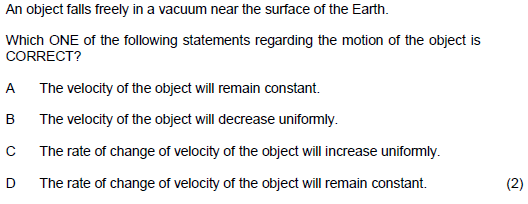
**Question 1**



**Question 2**



**Question 3**



**Question 3**

