

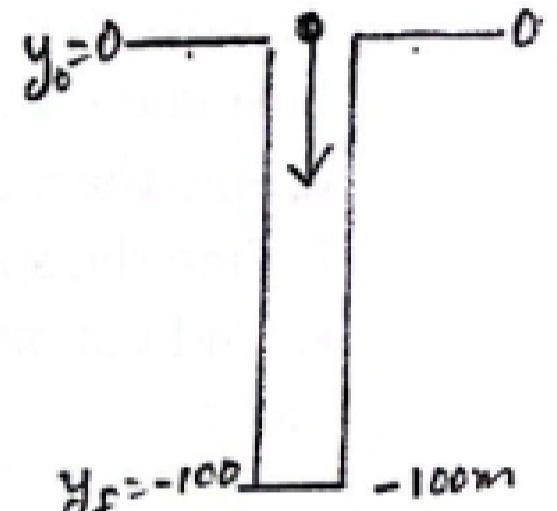
One dimensional kinematics.

Astronauts explore a newly discovered distant planet called W with an unknown gravitational acceleration constant g_w . Let up be the $+\hat{y}$ direction and $y = 0$ at the surface of the planet.

Hint: Draw a picture. You do not need to know the mass of the rock.

1. A rock is dropped with initial speed of zero from the surface into a 100 meters deep hole. The final speed at impact is $1 \frac{m}{s}$. Find the average velocity vector,

- a) $-0.15 \frac{m}{s} \hat{y}$, b) $+0.25 \frac{m}{s} \hat{y}$, c) $-0.50 \frac{m}{s} \hat{y}$, d) $+0.75 \frac{m}{s} \hat{y}$, e) $-1.0 \frac{m}{s} \hat{y}$



2. Find the displacement vector,

- a) $-100m \hat{y}$, b) $+200m \hat{y}$, c) $-300m \hat{y}$, d) $+400m \hat{y}$, e) $-500m \hat{y}$

3. Find the time interval of the drop.

- a) 0 s, b) 10s, c) 20s, d) 200s, e) 400s

4. Find the gravitational acceleration vector.

- a) $+0 \frac{m}{s^2} \hat{y}$, b) $+0.001 \frac{m}{s^2} \hat{y}$, c) $-0.002 \frac{m}{s^2} \hat{y}$, d) $-0.005 \frac{m}{s^2} \hat{y}$, e) $+0.0035 \frac{m}{s^2} \hat{y}$

5. Find the value of g_w .

- a) $+0 \frac{m}{s^2}$, b) $+0.001 \frac{m}{s^2}$, c) $+0.002 \frac{m}{s^2}$, d) $+0.005 \frac{m}{s^2}$, e) $+0.0035 \frac{m}{s^2}$

$$|\vec{v}_0| = 0, \quad \vec{v}_f = -1 \frac{m}{s} \hat{y}$$

$$1. \quad \vec{v}_{avg} = \frac{1}{2} (\vec{v}_f + \vec{v}_i) = \frac{1}{2} (-1 \frac{m}{s} \hat{y}) = \boxed{-0.5 \frac{m}{s} \hat{y}}$$

$$2. \quad \Delta \vec{y} = \vec{y}_f - \vec{y}_i = (-100m - (0m)) \hat{y} = \boxed{-100m \hat{y}}$$

$$3. \quad \text{USE } \vec{v}_{avg} = \frac{\Delta \vec{y}}{\Delta t} = -0.5 \frac{m}{s} \hat{y} = \frac{-100m \hat{y}}{\Delta t} \Rightarrow \Delta t = \frac{100m}{0.5 \frac{m}{s}} = \boxed{200s}$$

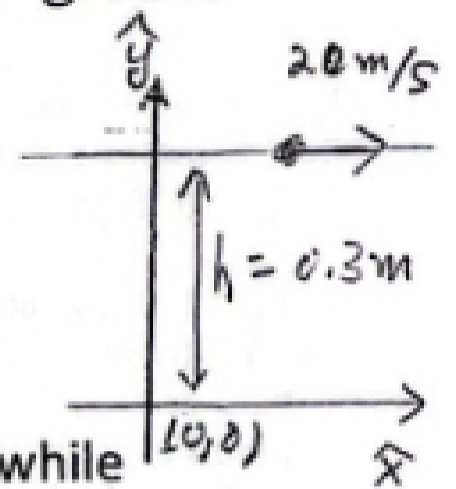
$$4. \quad \text{USE: } \vec{v}_f = \vec{v}_i + \vec{a} \Delta t \Rightarrow -1 \frac{m}{s} \hat{y} = 0 + (200s) \vec{a} \Rightarrow \vec{a} = \frac{-1 \frac{m}{s}}{200s} \hat{y}$$

$$\boxed{\vec{a} = -0.005 \frac{m}{s^2} \hat{y}}$$

$$5. \quad g_w = |a_y| = |-0.005 \frac{m}{s^2}| = \boxed{+0.005 \frac{m}{s^2}}$$

Problem 2.

An object falls off a car traveling with speed of 20 m/s in the +x direction on flat ground. The object was 0.3m above the ground at that instant.



- How long does it takes to hit the ground?
- Find the y component of the velocity vector at impact.
- Find the x component of the velocity vector at impact.
- Find the speed of the object at impact.
- Find the magnitude of the displacement in the x direction while falling.

$$\underline{\underline{A.}} \quad \Delta y = (-0.3 \text{ m}) = (v_i)_y t + \frac{1}{2} a_y t^2 = 0 + \frac{1}{2} (-9.8 \frac{\text{m}}{\text{s}^2}) t^2$$

$$\text{find } t^2 = \frac{(2)(0.3 \text{ m})}{9.8 \frac{\text{m}}{\text{s}^2}} = 0.0612245$$

$$t = 0.247 \text{ s} = \boxed{0.25 \text{ s}}$$

$$\underline{\underline{B.}} \quad v_y = (v_y)_0 + a_y t = 0 + (-9.8 \frac{\text{m}}{\text{s}^2})(0.2475) = \boxed{-2.4 \frac{\text{m}}{\text{s}}}$$

$$\underline{\underline{C.}} \quad v_x = (v_x)_0 + a_x t = (v_x)_0 = \boxed{20.0 \frac{\text{m}}{\text{s}}}$$

$$\underline{\underline{D.}} \quad \text{Speed} = \sqrt{v_x^2 + v_y^2} = \sqrt{(2.4)^2 + (20.0)^2} = \boxed{20.1 \frac{\text{m}}{\text{s}}}$$

$$\underline{\underline{E.}} \quad \Delta x = (v_0)_x t + \frac{1}{2} a_x t^2 = (20 \frac{\text{m}}{\text{s}})(0.247) + 0 = \boxed{4.94 \frac{\text{m}}{\text{s}}}$$

Chapter 5: Newton's law of motion.

- Force: a push or pull
- Mass: measures the difficulty in accelerating an object
- Newton's first law: if the net force on an object is zero, its velocity is constant
- Inertial frame of reference: one in which the first law holds
- Newton's second law:
- Free-body diagram: a sketch showing all the forces on an object
- Newton's third law: If object 1 exerts a force \vec{F} on object 2,
- then object 2 exerts a force $-\vec{F}$ on object 1.
- Contact forces: an action–reaction pair of forces produced by
- two objects in physical contact
- Forces are vectors
- Newton's laws can be applied to each component of the forces independently
- Weight: gravitational force exerted by the Earth on an object
- On the surface of the Earth, $W = mg$
- Apparent weight: force felt from contact with a floor or scale
- Normal force: force exerted perpendicular to a surface by that surface
- Normal force may be equal to, lesser than, or greater than the object's weight

Examples of possible problems include:

Normal force, apparent weight, contact forces, Newton's third law, superpositions of forces, Newton's second law, Newton's first law, and others.