PHY115

Free Falling Motion

Digipen

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Free fall

Free falling bodies

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2. In 1687 → Newton's Laws
   - He published *"Philosophiæ naturalis principia mathematica"*, the laws that describe this experiment.

Video: `https://www.youtube.com/watch?v=QyeF-_QPSbk`

Free fall: Newton's Law:

The magnitude of the acceleration that the Earth makes on a body is:

$$g = G\frac{M}{d^2}$$

d is the distance between the body and the center of the Earth.

- $G = 6,6710^{-11}\ \mathrm{Nm}^2/\mathrm{kg}^2$

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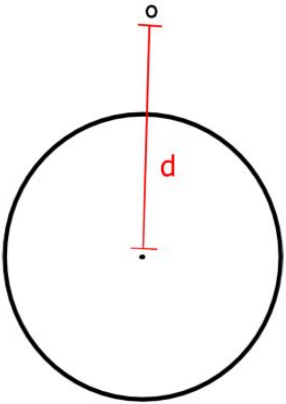
- $G = 6,6710^{-11}$ Nm^2/kg^2
- $M = 5,972 \times 10^{24}$ kg



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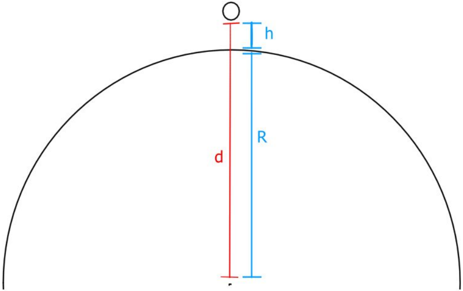
$$g = \frac{GM}{(h+R)^2} = \frac{GM}{\left[R(\underbrace{\frac{h}{R}}_{\approx 0}+1)\right]^2}$$

$$\rightarrow g \approx \frac{GM}{R} \approx 9.8\ m/s^2$$



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- If the effects of the air can be neglected, all bodies fall with the same downward acceleration, regardless of their size or weight.
- If the fall is small compared with the radius of the earth, and if we ignore small effects due to the earth's rotation, the acceleration is constant.

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Near the surface of the sun:

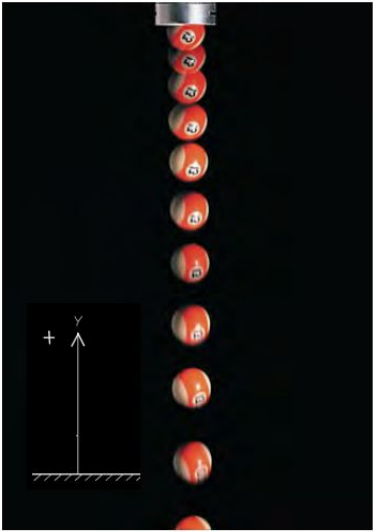
$$g = 270 \ m/s^2 \tag{3}$$

g is always a positive number

Because g is the magnitude of a vector quantity, it is always a positive number.

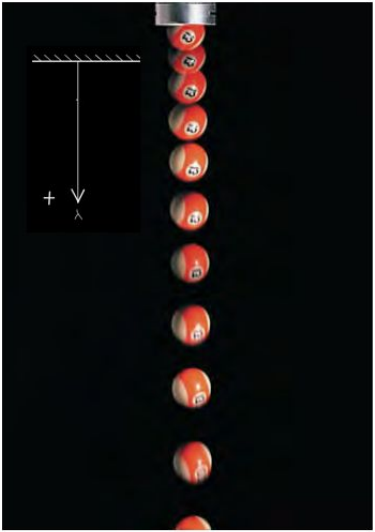
EXAMPLE 3.1

$$x(t) = -\frac{1}{2}gt^2 + v_0 t + x_0 \quad (4)$$



EXAMPLE 3.2

$$x(t) = \frac{1}{2}gt^2 + v_0 t + x_0 \quad (5)$$



EXERCISE 3.1

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A one-euro coin is dropped from the Leaning Tower of Pisa and falls freely from rest. What are its position and velocity after 1.0 s, 2.0 s, and 3.0 s?

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2. the ball's velocity when it is 5.00 m above the railing;
3. the maximum height reached;
4. the ball's acceleration when it is at its maximum height.

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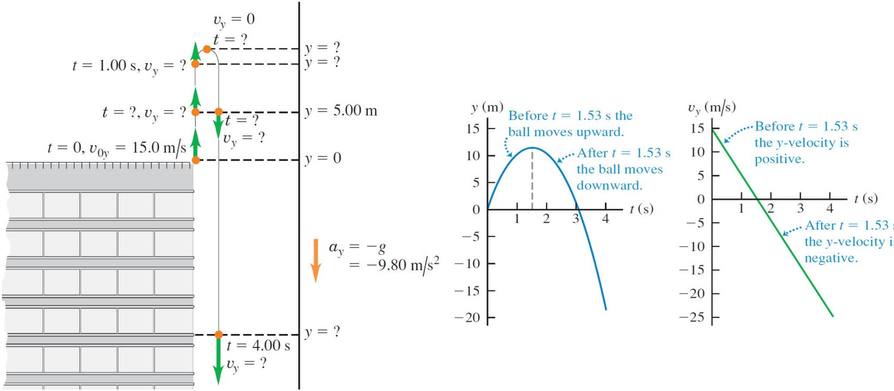

Figure: Figure from Sears and Zemansky's University Physics with Modern Physics, 13th Edition.

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  1. $h\sqrt{2}$
  2. $2h$
  3. $4h$
  4. $8h$
  5. $16h$

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- If you throw the ball upward with double the initial speed, how long does it take to reach its new maximum height?
  1. $t/2$
  2. $t/\sqrt{2}$
  3. t
  4. $t\sqrt{2}$
  5. $2t$