This print-out should have 10 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Acceleration 24

02:07, trigonometry, multiple choice, < 1 min, fixed.

001

If you drop an object, it will accelerate downward at a rate of $g = 9.8$ m/s^2.

If you throw it downward instead, its acceleration (in the absence of air resistance) will be

1. 9.8 m/s^2 **correct**

2. less than 9.8 m/s^2.

3. greater than 9.8 m/s^2.

4. Unable to determine.

Explanation:

The acceleration due to the gravity is independent of any initial velocity and remains constant.

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keywords:

AP B 1993 MC 5

02:07, trigonometry, multiple choice, > 1 min, fixed.

002

An object is released from rest on a planet that has no atmosphere. The object falls freely for 3 m in the first second.

What is the magnitude of the acceleration due to gravity on the planet?

1. 1.5 m/s^2

2. 3.0 m/s^2

3. 6.0 m/s^2 **correct**

4. 10.0 m/s^2

5. 12.0 m/s^2

Explanation:

$$\text{Let}: \quad s = 3\text{ m}.$$

$$\begin{aligned} s &= \frac{1}{2}\, a\, t^2 \\ a &= \frac{2\, s}{t^2} \\ &= \frac{2\,(3\text{ m})}{(1.0\text{ s})^2} \\ &= \boxed{6\text{ m/s}^2}. \end{aligned}$$

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keywords:

Collision Course 02

02:07, trigonometry, numeric, > 1 min, normal.

003

An object is thrown downward with an initial speed of 10 m/s from a height of 60 m above the ground. At the same instant, a second object is propelled vertically from ground level with a speed of 40 m/s .

The acceleration of gravity is 9.8 m/s^2 .

At what height above the ground will the two objects pass each other?

Correct answer: 40.944 m.

Explanation:

$$\begin{aligned} \text{Let}: \quad v_{up} &= 40\text{ m/s}, \\ v_{down} &= 10\text{ m/s}, \quad \text{and} \\ h &= 60\text{ m}. \end{aligned}$$

Basic Concepts:

$$\begin{aligned} y_{down} &= h - v_{down}\, t - \frac{1}{2}\, g\, t^2 \\ y_{up} &= v_{up}\, t - \frac{1}{2}\, g\, t^2. \end{aligned}$$

Solution:

The two objects pass one another when $y_{down} = y_{up}$.

$$h - v_{down}\, t - \frac{1}{2}\, g\, t^2 = v_{up}\, t - \frac{1}{2}\, g\, t^2$$

$$h = v_{down}\, t + v_{up}\, t$$

$$\Longrightarrow t = \frac{h}{v_{down} + v_{up}} = 1.2\ \mathrm{s}\,.$$

So,

$$\begin{aligned} H &= v_{up}\, t - \frac{1}{2}\, g\, t^2 \\ &= (40\ \mathrm{m/s})\,(1.2\ \mathrm{s}) \\ &\quad - \frac{1}{2}\,(9.8\ \mathrm{m/s}^2)\,(1.2\ \mathrm{s})^2 \\ &= 40.944\ \mathrm{m}\,. \end{aligned}$$

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keywords:

Falling Stone 02

02:07, trigonometry, numeric, > 1 min, normal.

004

A stone falls freely from rest for 8 s.

The acceleration of gravity is 9.8 m/s^2 .

Calculate the stone's velocity after that time.

Correct answer: −78.4 m/s.

Explanation:

The initial velocity $v_o = 0$, and gravity acts down, so

$$v_f = v_o - gt = -gt$$

005

What was the stone's displacement after that time?

Correct answer: −313.6 m.

Explanation:

The initial position $y_o = 0$, so

$$y = y_o + v_o t - \frac{1}{2} g t^2 = -\frac{1}{2} g t^2$$

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keywords:

Gravity on the Moon 02

02:07, trigonometry, numeric, > 1 min, normal.

006

The acceleration due to gravity on the moon is about one-sixth its value on earth.

If a baseball reaches a height of 50 m when thrown upward by someone on the earth, what height would it reach when thrown in the same way on the surface of the moon?

Correct answer: 300 m.

Explanation:

The height the baseball would reach on either planet can be obtained from

$$v^2 = v_0^2 + 2\, a\, (y - y_0),$$

with $v = 0$. Therefore

$$h = y - y_0 = -\frac{v_0^2}{2\, a}$$

on both planets, and

$$\begin{aligned} \frac{h_{moon}}{h_{earth}} &= \left(-\frac{v_0^2}{2\, g_{moon}}\right) \div \left(-\frac{v_0^2}{2\, g_{earth}}\right) \\ &= \frac{g_{earth}}{g_{moon}} \end{aligned}$$

Thus

$$\begin{aligned} h_{moon} &= h_{earth} \frac{g_{earth}}{g_{moon}} = h_{earth} \frac{g_{earth}}{\frac{1}{6}\, g_{earth}} \\ &= 6\, h_{earth} \end{aligned}$$

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keywords:

Serway CP 02 43

02:07, trigonometry, numeric, > 1 min, normal.

007

A ball is thrown vertically upward with a speed of 25 m/s.

How high does it rise?

Correct answer: 31.8878 m.

Explanation:

$$\begin{aligned} \text{Given :}\quad v_i &= 25\ \mathrm{m/s}\,, \\ g &= 9.8\ \mathrm{m/s}^2\,, \quad \text{and} \\ v_f &= 0\,\mathrm{m/s}\,. \end{aligned}$$

At its highest point, $v_f = 0$ m/s, so

$$v_f{}^2 = v_i{}^2 - 2\, g\, (\Delta y)_{max} = 0$$

$$(\Delta y)_{max} = \frac{v_i{}^2}{2\,g} = \frac{(25 \text{ m/s})^2}{2(9.8 \text{ m/s}^2)} = \boxed{31.8878 \text{ m}}.$$

008

How long does it take to reach its highest point?

Correct answer: 2.55102 s.

Explanation:

At its highest point, $v_f = 0\,\text{m/s}$, so

$$v_f = v_i - g\,\Delta t = 0$$

$$\Delta t = \frac{v_i}{g} = \frac{25 \text{ m/s}}{9.8 \text{ m/s}^2} = \boxed{2.55102 \text{ s}}.$$

009

How long does it take the ball to hit the ground after it reaches its highest point?

Correct answer: 2.55102 s.

Explanation:

$$\text{Given}: \quad v_i = 0 \text{ m/s} \quad \text{and} \quad g = 9.8 \text{ m/s}^2\,.$$

The time for the ball to fall 31.8878 m, starting from rest, is found from

$$\Delta y = v_i\,\Delta t - \frac{1}{2}\,g\,(\Delta t)^2 = -\frac{1}{2}\,g\,(\Delta t)^2$$

since $v_i = 0\,\text{m/s}$.

$$\Delta t = \sqrt{\frac{-2\,\Delta y}{g}} = \sqrt{\frac{-2\,(-31.8878 \text{ m})}{9.8 \text{ m/s}^2}} = \boxed{2.55102 \text{ s}}.$$

Alternate Solution:

The time it takes to rise to its maximum height is the time it will take to fall from its maximum height to the initial position.

010

What is its velocity when it returns to the level from which it started?

Correct answer: −25 m/s.

Explanation:

The velocity after falling for 2.55102 s is found from

$$v_f = v_i - g\,\Delta t$$

since $v_i = 0\,\text{m/s}$.

$$v_f = -\left(9.8 \text{ m/s}^2\right)(2.55102 \text{ s}) = \boxed{-25 \text{ m/s}}.$$

Alternate Solution:

The return velocity has the same magnitude as the initial velocity, but is directed downward.

keywords: