

T-1. A truck travels 500 meters in 20 seconds. What is its average speed?

<input type="text"/>	m/s
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Solution:

$$v = d/t = 500\text{m} / 20\text{s} = 25\text{m/s}$$

25 m/s

A-1. The brakes are applied to a car traveling at 16 m/s, and it accelerates at -4.0 m/s^2 . How far does the car travel before it comes to rest?

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Solution:

Time to stop: $t = 16 \text{ (m/s)} / (4.0 \text{ m/s}^2) = 4 \text{ s}$

Distance: $16 * t + 0.5 * (-4) * t^2$
 $= 64 - 32 = 32$

32 m

A-2. An object of mass 2.0 kg traveling at 10 m/s hits an object of mass 5.0 kg initially at rest. If the first object comes to rest how fast does the second object move?

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m/s

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Solution:

Momentum conservation

$$2.0 \text{ kg} * 10 \text{ m/s} = 5.0 \text{ kg} * v$$

4 m/s

A-3. A rock thrown downward from a cliff with an initial speed of 5 m/s takes 5 s to hit the river below. How high is the cliff? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration, and neglect air resistance.)

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Solution:

$$y_0 = 0.5 * g * t^2 + v_0 * t$$
$$= 0.5 * 10 * 5^2 + 5 * 5$$

150 m

A-4. An object of mass 5 kg travels a distance of 2 m, during which it is accelerated from rest to a speed 4 m/s by a constant force F . What is the magnitude of F ?

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Solution:

Work: $W = F \cdot \text{distance} = F \cdot 2\text{m}$

Kinetic Energy: $K = 0.5 \cdot 5\text{kg} \cdot (4\text{m/s})^2$

$W = K \rightarrow F = 20 \text{ N}$

20 N

B-1. A massless spring with a force constant of 40 N/m is suspended from the ceiling. A 2 kg mass is attached to the end and lowered to its equilibrium position. How much does the mass cause the spring to stretch? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration.)

B-1. A massless spring with a force constant of 40 N/m is suspended from the ceiling. A 2 kg mass is attached to the end and lowered to its equilibrium position. How much does the mass cause the spring to stretch? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration.)

Solution:

$$40 \text{ N/m} * x = 2 \text{ kg} * 10 \text{ m/s}^2$$

$$\rightarrow x=0.5 \text{ m}$$

0.5 m

B-2. A ball is thrown straight up into the air with a speed 30 m/s. How long will it take to return to the initial position? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration, and neglect air resistance.)

 s

B-2. A ball is thrown straight up into the air with a speed 30 m/s. How long will it take to return to the initial position? (Use $g=10$ m/s² for the free-fall acceleration, and neglect air resistance.)

Solution:

$$30 - gt = -30$$

$$t = (60 \text{ m/s}) / (10 \text{ m/s}^2) = 6 \text{ s}$$

6 s

B-3. Two resistors, 3 ohms each, are connected in parallel with each other across a 12 V battery. What is the current drawn from the battery?

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Solution:

$$1/R_{\text{tot}} = 1/R + 1/R = 2/R$$

$$V = IR_{\text{tot}} = IR/2$$

$$I = 2V/R = 2 * 12\text{v} / 3 \text{ ohms} = 8 \text{ amps}$$

8 A

B-4. If 150 g of water at 20 °C is mixed with 50 g of water at 60 °C, what is the equilibrium temperature?

°C

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Solution:

Heat flow = $mc\Delta T$. Total inward flow=0.

$$0 = 150\text{g} \cdot c \cdot (T - 20^\circ\text{C}) + 50\text{g} \cdot c \cdot (T - 60^\circ\text{C}),$$

where c is the specific heat of water.

30 °C

C-1. A car is turning through a curve of radius 20 m at a constant speed of 10 m/s. What is the magnitude of its acceleration?

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Solution:

$$a = v^2/r = (10 \text{ m/s})^2/(20 \text{ m}) = 5 \text{ m/s}^2$$

5 m/s^2

C-2. A bullet of mass 0.05 kg hits and gets embedded in a wooden block of mass 0.25 kg. Afterwards, the block with bullet embedded is traveling at a speed of 30 m/s. What was the initial speed of the bullet?

m/s

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Solution:

$$m_1 * v_1 = (m_1 + m_2) * v_2$$
$$0.05 v_1 = (0.05 + 0.25) * 30$$

180 m/s

C-3. An astronaut that weighs 800 N on Earth goes to a planet whose mass is 3 times that of Earth, and whose radius is twice that of Earth. What is the astronaut's weight on that planet?

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Solution:

$$F(\text{Earth}) = GMm/r^2 = 800 \text{ N}$$

$$F(\text{planet}) = G(3M)m/(2r)^2$$
$$= (3/4) * GMm/r^2 = (3/4) * F(\text{Earth})$$

600 N

C-4. On a frictionless track a roller coaster has speed 4 m/s when it is at height 1 m. What is its speed when it is at its minimum height of 0 m? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration, and neglect air resistance.)

m/s

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Solution:

Energy conservation

$$0.5 v_0^2 + g \cdot h = 0.5 v^2$$

$$8 + 10 = 0.5 v^2 \rightarrow v = 6$$

6 m/s

D-1. A 2-meter stick has a mass of 200 g. A small 400 g mass is attached at the 160 cm mark. At which mark is the center of mass?

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Solution:

$$(200 \text{ g} * 100 \text{ cm} + 400 \text{ g} * 160 \text{ cm}) / (200 \text{ g} + 400 \text{ g}) = 140 \text{ cm}$$

140 cm

D-2. Masses of 5 kg and 3 kg hang vertically and are connected by a massless string that passes over a massless and frictionless pulley. When the masses are released, what is the magnitude of the acceleration of the 3 kg mass? (Use $g=10$ m/s^2 for the free-fall acceleration, and neglect air resistance.)

m/s^2

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Solution:

$$F = (5 \text{ kg} + 3 \text{ kg}) * a,$$

$$F = (5 \text{ kg} - 3 \text{ kg}) * 10 \text{ m/s}^2$$

$$\rightarrow a = 2.5 \text{ m/s}^2$$

$$2.5 \text{ m/s}^2$$

D-3. A car of mass 1700 kg is parked on a hill inclined at angle 30 degrees from the horizontal. What is the force of static friction on the car? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration)

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Solution:

Friction force cancels gravity component along plane, mg

$$\sin(\theta) = 1700 * 10 * 0.5 = 8500$$

8500 N

D-4. To leave the Earth, an escape velocity of 11.2 km/s is required. What is a required escape velocity to leave a planet that has the same radius as Earth and 36 times Earth's density.

km/s

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Solution:

Escape velocity $v = \sqrt{2GM/R}$

The mass of the planet is 36 times greater than Earth. $V = \sqrt{2G(36M)/R} = 6*v$

67.2 km/s

S-1. There is a 50 kg block on a frictionless, horizontal surface. A woman pushes it with a force of 300 N. What is the acceleration of the block?

m/s^2

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Solution:

$$F=ma \rightarrow a = F/m = (300 \text{ N}) / (50 \text{ kg})$$

$$6 \text{ m/s}^2$$

S-2. A man stands on a bathroom scale in an elevator, which reads 800 N when the elevator is stopped. What would the reading be while the elevator is accelerating upward at 6 m/s^2 ? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration.)

S-2. A man stands on a bathroom scale in an elevator, which reads 800 N when the elevator is stopped. What would the reading be while the elevator is accelerating upward at 6 m/s^2 ? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration.)

Solution:

$$\text{Total acceleration } = a = g + 6 \text{ m/s}^2 = 16 \text{ m/s}^2$$

$$800\text{N} \cdot (a/g) = 1280 \text{ N}$$

1280 N

S-3. A ball is thrown at a vertical wall 30 meters away, with a velocity 30 m/s at an angle of 45° . At what height above the starting point will it strike the wall? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration.)

S-3. A ball is thrown at a vertical wall 30 meters away, with a velocity 30 m/s at an angle of 45° . At what height above the starting point will it strike the wall? (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration.)

Solution:

$$v_x = 30 \text{ m/s} * \cos 45 = 15 \sqrt{2}$$

$$\rightarrow t = x/v_x = \sqrt{2} \text{ s}$$

$$h = v_y * t - gt^2/2 = 30 - 10 = 20$$

20 m

S-4. A stone thrown from the top of a building with a speed 10 m/s straight upward. The building is 15 m high. Determine a speed of the stone when it hits the ground. (Use $g=10 \text{ m/s}^2$ for the free-fall acceleration.)

m/s

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Solution:

By energy conservation,

$$0.5 M (10 \text{ m/s})^2 + M (10 \text{ m/s}^2) (15 \text{ m}) = 0.5 M v^2 \rightarrow v^2=400$$

$(\text{m/s})^2 \rightarrow v=20 \text{ m/s}$

20 m/s
