Newton’s second law: net force and acceleration

Physics · Year 11 · Starting

Read the explanations and worked teaching examples, then attempt the practice. Type in the answer fields or write on a printed copy. Save the PDF to keep typed responses. PDF responses are not submitted to the platform.

Name: _____ Date: _____

Take the time you need. Complete each phase and revisit any step you cannot yet explain.

Get ready

Learning goal

Use forces on one constant-mass object to calculate and explain horizontal acceleration.

- Combine forces with a stated direction convention.
- Select and rearrange F = ma for the required quantity.
- Find a required push when an opposing force acts.
- Explain balanced forces and the direction of acceleration.

The idea in context

Two carts can have different pushes but the same acceleration. Compare their net forces and masses.

Before you begin

Equality and inverse operations

Rightwards can be positive and leftwards negative. Add signed forces. An equation stays equal when the same valid operation is performed on both sides.

net force: The combined effect of all forces acting on the same object.

acceleration: Change in velocity per second; its direction follows net force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Watch the prerequisite 1

Solve 2x – 10 = 6.

Step 1

Before: 2x – 10 = 6

Action: Add ten to both sides.

After: 2x – 10 + 10 = 6 + 10; 2x = 16

Why: The opposite terms sum to zero.

$$\begin{array}{ccc} 2x - 10 & = & 6 \\ +10 & & +10 \\ \hline 2x \quad \cancel{-10} & \cancel{+10} & = \quad 16 \end{array}$$

Opposite terms sum to zero.

$$2x = 16$$

Apply +10 to both sides

2x – 10 equals 6. Apply +10 to each side. Result: 2x equals 16. The marked opposite terms sum to zero.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: 2x = 16

Action: Divide both sides by two.

After: 2x/2 = 16/2; x = 8

Why: The matching factor two reduces to one.

$$\begin{array}{ccc} 2x & = & 16 \\ /2 & & /2 \\ \hline \end{array}$$

Apply the same action to both sides.

$$x = 8$$

Apply /2 to both sides

2x equals 16. Apply /2 to each side. Result: x equals 8.

Step 3

Before: x = 8

Action: Substitute into the original equation.

After: 2 × 8 – 10 = 16 – 10 = 6

Why: The original equation is satisfied.

x = 8. Both operations preserve equality.

Complete the missing step 1

Complete: 3y – 6 = 9. Add the same quantity to both sides, then divide both sides.

Hint 1: Use equal operations to isolate the unknown.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Hint 2: Add six to both sides: $3y - 6 + 6 = 9 + 6$.

Hint 3: Now $3y = 15$. Divide both sides by three; simplify the unknown.

Try a fresh question 1

Solve $4z + 3 = 19$ and check.

Hint 1: Use the same operation on both sides.

Hint 2: Subtract three from both sides.

Hint 3: $4z = 16$. Divide both sides by four, then check in the original equation.

Signed quantities and opposing forces

A chosen direction gives positive and negative contributions. Same-direction forces add; opposing directions subtract in magnitude. Keep the direction of the larger contribution.

positive direction: The direction chosen to give positive signed components; the opposite direction is negative.

Watch the prerequisite 1

Combine 9 N rightwards and 5 N leftwards.

Step 1

Before: The forces oppose each other.

Action: Choose rightwards positive.

After: Rightward force +9 N; leftward force −5 N

Why: The signs describe directions, not different kinds of force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = (+9) + (−5)

Action: Add the signed contributions.

After: F = 9 − 5 = +4 N

Why: Five opposing units balance; four rightward units remain.

Right: 9 units; left: 5 units

9 − 5 = 4

Net force: 4 N rightwards

Combine opposite directions

Right: 9 units; left: 5 units 9 − 5 = 4 Net force: 4 N rightwards

Step 3

Before: Net effect 4 N rightwards.

Action: Compare with the original directions.

After: The larger original force points right.

Why: The result direction agrees. Both original forces still act.

4 N rightwards.

Complete the missing step 1

Complete the signed sum for 7 N right and 3 N left: F = (+__) + (−__).

Hint 1: Use direction signs before arithmetic.

Hint 2: The rightward force is positive and leftward force negative.

Hint 3: Write 7 − 3 and subtract; the sign gives direction.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Try a fresh question 1

Combine 2 N right and 8 N left using rightwards positive.

Hint 1: Use the signed direction convention.

Hint 2: Write the sum (+2) + (–8).

Hint 3: The leftward magnitude is greater; subtract and state the direction.

Division, mass, force and acceleration units

Mass is measured in kg, force in N and acceleration in $\mathrm{m\,s^{-2}}$. One newton is $\mathrm{kg\,m\,s^{-2}}$. Dividing net force by mass gives acceleration, not speed.

mass: A measure of inertia, measured in kilograms.

force: A push or pull, measured in newtons.

velocity: Speed together with direction, measured in metres per second.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Watch the prerequisite 1

Explain and calculate 12 N divided by 3 kg.

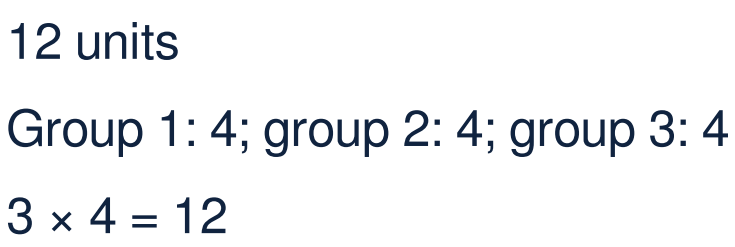
Step 1

Before: 12 divided among three equal groups.

Action: Divide twelve by three.

After: 12/3 = 4

Why: Three groups of four reconstruct twelve.



Division into equal groups

12 units Group 1: 4; group 2: 4; group 3: 4 3 × 4 = 12

Step 2

Before: One newton is one kg m s^{-2}.

Action: Replace the newton unit with its definition.

After: 12 N/3 kg = (12 kg m s^{-2})/(3 kg)

Why: Numerical division and unit division are separate.

Step 3

Before: (12 kg m s^{-2})/(3 kg)

Action: Divide numbers and reduce matching kilogram factors.

After: (12/3)(kg/kg) m s^{-2} = 4 m s^{-2}

Why: Kilogram divided by kilogram is one. The acceleration unit remains.

4 m s^{-2}.

Complete the missing step 1

Complete (10 N)/(2 kg) = (10/2)(kg/kg) m s^{-2} and name the quantity.

Hint 1: Separate numerical division from unit division.

Hint 2: Replace N with kg m s^{-2}.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Hint 3: Divide ten by two and reduce the matching kilogram factors.

Try a fresh question 1

Calculate (6 N)/(4 kg). Explain its unit and whether the result must be a whole number.

Hint 1: Use numerical and unit division.

Hint 2: Write (6/4)(kg/kg) m s^{-2}.

Hint 3: Reduce the kilogram ratio to one and complete the numerical quotient.

Starting-point question 1

Which equal operation removes –4 in y – 4 = 7?

Starting-point question 2

What isolates y in 3y = 12?

Starting-point question 3

Combine +9 N and –5 N.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Starting-point question 4

Combine 3 N right and 7 N left.

Starting-point question 5

What is 12/3?

Starting-point question 6

Does m s^{-2} describe velocity or acceleration?

Watch — I do

Find the force that belongs in the equation

Study one trolley. Choose rightwards positive. Include every horizontal force. The upward support force balances weight in this level-surface model. The diagram is schematic.

F = sum of signed horizontal forces

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Rightwards positive.

Arrow lengths use the same force scale.

Horizontal forces on one trolley

A 2.0 kilogram trolley has 12 newtons rightwards and 4.0 newtons leftwards. Upward support balances downward weight. Only the horizontal forces are shown. Arrow lengths are proportional to force magnitude within this diagram.

Use Newton’s second law

For constant mass in this horizontal model, F denotes the signed horizontal net force. Acceleration has the same direction as F. Mass is in kilograms; force in newtons; acceleration in metres per second squared.

$F = ma$

$a = F/m$

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

$$F = m \times a$$

$$/\, m \qquad /\, m$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Select the equation for the unknown

Find net force first. If a push P acts rightwards against resistance R, P – R = ma. Add R to both sides to find P. This arrangement determines the signs.

P – R = ma
P – R + R = ma + R
P = ma + R

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

$$\begin{array}{ccc} P - 3 & = & 8 \\ +3 & & +3 \\ \hline P - 3 + 3 & = & 11 \end{array}$$

Opposite terms sum to zero.

$$P = 11$$

Apply +3 to both sides

P – 3 equals 8. Apply +3 to each side. Result: P equals 11. The marked opposite terms sum to zero.

Acceleration is a change in velocity

A negative acceleration points left under our convention. Whether speed rises or falls also depends on velocity direction. Zero net force gives zero acceleration and unchanged velocity, including a possible nonzero velocity.

$F = 0 \Rightarrow a = 0$; velocity remains unchanged

v right, a right: speed increases

v left, a right: speed decreases initially

a zero: velocity stays unchanged

Compare velocity and acceleration

v right, a right: speed increases v left, a right: speed decreases initially a zero: velocity stays unchanged

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Watch — worked models

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Follow the model

A 2.0 kg trolley has 12.0 N rightwards and 4.0 N leftwards. Find acceleration.

Step 1

Before: One trolley on a level surface.

Action: Draw and label the forces.

After: Mass 2.0 kg; horizontal forces 12.0 N and 4.0 N.

Why: Support balances weight; only horizontal motion is considered.

Rightwards positive.

Arrow lengths use the same force scale.

Horizontal forces on one trolley

A 2.0 kilogram trolley has 12.0 newtons rightwards and 4.0 newtons leftwards. Upward support balances downward weight. Only the horizontal forces are shown. Arrow lengths are proportional to force magnitude within this diagram.

Step 2

Before: 12.0 N right; 4.0 N left.

Action: Choose rightwards positive.

After: $F = +12.0 + (-4.0) = 8.0\ \text{N}$

Why: Signs record direction. Net force is a combined effect, not an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: F = ma

Action: Divide both sides by mass.

After: F/m = ma/m; a = F/m

Why: Mass divided by itself is one; acceleration remains.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 4

Before: a = F/m

Action: Substitute net force and mass.

After: a = 8.0/2.0 = 4.0 m s^{-2}

Why: The acceleration is 4.0 m s^{-2} rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 5

Before: $a = 4.0\ m\ s^{-2}$

Action: Check force and units.

After: $ma = 2.0 \times (4.0) = 8.0\ N$

Why: The force agrees; N/kg equals metres per second squared.

$4.0\ m\ s^{-2}$ rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Follow the model

A 2.0 kg trolley has 4.0 N rightwards and 10.0 N leftwards. Find acceleration.

Step 1

Before: One trolley on a level surface.

Action: Draw and label the forces.

After: Mass 2.0 kg; horizontal forces 4.0 N and 10.0 N.

Why: Support balances weight; only horizontal motion is considered.

Rightwards positive.

Arrow lengths use the same force scale.

Horizontal forces on one trolley

A 2.0 kilogram trolley has 4.0 newtons rightwards and 10.0 newtons leftwards. Upward support balances downward weight. Only the horizontal forces are shown. Arrow lengths are proportional to force magnitude within this diagram.

Step 2

Before: 4.0 N right; 10.0 N left.

Action: Choose rightwards positive.

After: $F = +4.0 + (-10.0) = -6.0$ N

Why: Signs record direction. Net force is a combined effect, not an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: F = ma

Action: Divide both sides by mass.

After: F/m = ma/m; a = F/m

Why: Mass divided by itself is one; acceleration remains.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 4

Before: a = F/m

Action: Substitute net force and mass.

After: a = –6.0/2.0 = –3.0 m s^{-2}

Why: The acceleration is 3.0 m s^{-2} leftwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 5

Before: $a = -3.0\ m\ s^{-2}$

Action: Check force and units.

After: $ma = 2.0 \times (-3.0) = -6.0\ N$

Why: The force agrees; N/kg equals metres per second squared.

$3.0\ m\ s^{-2}$ leftwards.

Follow the model

A 4.0 kg trolley needs $2.0\ m\ s^{-2}$ rightwards acceleration against 3.0 N leftwards resistance. Find the rightward push.

Step 1

Before: Unknown push P; known mass and acceleration.

Action: Find the required net force first.

After: $F = ma = 4.0 \times 2.0 = 8.0\ N$

Why: The required net force differs from the push because resistance also acts.

Step 2

Before: P rightwards; 3.0 N leftwards.

Action: Write the signed force equation.

After: $P - 3.0 = 8.0$

Why: Rightwards is positive.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: $P - 3.0 = 8.0$

Action: Add 3.0 to both sides.

After: $P - 3.0 + 3.0 = 8.0 + 3.0$; $P = 11.0$ N

Why: The opposite resistance terms sum to zero.

$$\begin{array}{ccc} P - 3 & = & 8 \\ +3 & & +3 \\ \hline P \quad -3 \quad +3 & = & 11 \end{array}$$

Opposite terms sum to zero.

$$P = 11$$

Apply +3 to both sides

P – 3 equals 8. Apply +3 to each side. Result: P equals 11. The marked opposite terms sum to zero.

Step 4

Before: $P = 11.0$ N

Action: Subtract resistance and divide by mass.

After: $(11.0 - 3.0)/4.0 = 2.0\ \text{m s}^{-2}$

Why: The requested acceleration is recovered.

Push 11.0 N rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Follow the model

A 3.0 kg trolley needs 2.0 m s^{-2} rightwards acceleration against 1.0 N leftwards resistance. Find the rightward push.

Step 1

Before: Unknown push P; known mass and acceleration.

Action: Find the required net force first.

After: $F = ma = 3.0 \times 2.0 = 6.0$ N

Why: The required net force differs from the push because resistance also acts.

Step 2

Before: P rightwards; 1.0 N leftwards.

Action: Write the signed force equation.

After: $P - 1.0 = 6.0$

Why: Rightwards is positive.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: P – 1.0 = 6.0

Action: Add 1.0 to both sides.

After: P – 1.0 + 1.0 = 6.0 + 1.0; P = 7.0 N

Why: The opposite resistance terms sum to zero.

$$\begin{array}{rcr} P - 1 & = & 6 \\ +1 & & +1 \\ \hline P & -1 +1 & = 7 \end{array}$$

Opposite terms sum to zero.

$$P = 7$$

Apply +1 to both sides

P – 1 equals 6. Apply +1 to each side. Result: P equals 7. The marked opposite terms sum to zero.

Step 4

Before: P = 7.0 N

Action: Subtract resistance and divide by mass.

After: $(7.0 - 1.0)/3.0 = 2.0\ \text{m s}^{-2}$

Why: The requested acceleration is recovered.

Push 7.0 N rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Follow the model

A net force of 9.0 N rightwards gives acceleration 3.0 m s^{-2} rightwards. Find mass.

Step 1

Before: F = ma

Action: Divide both sides by nonzero acceleration.

After: F/a = ma/a; m = F/a

Why: The factor a/a reduces to one.

$$F = m \times a$$

$$/\,a \qquad /\,a$$

$$\frac{F}{a} = \frac{m \times \cancel{a}}{\cancel{a}}$$

a/a = 1; m remains.

$$m = F/a$$

Divide both sides by a; matching factors reduce to one

F equals m times a. Divide both sides by a. The numerator and denominator factors a reduce to one; m remains. m equals F divided by a. The divisor must be nonzero.

Step 2

Before: m = F/a

Action: Substitute.

After: m = 9.0/3.0 = 3.0 kg

Why: Matching force and acceleration directions give positive mass.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: $m = 3.0\ \text{kg}$

Action: Multiply mass by acceleration.

After: $3.0 \times 3.0 = 9.0\ \text{N}$

Why: This matches net force. If acceleration and net force are both zero, they cannot determine mass.

3.0 kg.

Follow the model

A net force of 12 N leftwards produces acceleration $4.0\ \text{m s}^{-2}$ leftwards. Find mass.

Step 1

Before: Force and acceleration point left.

Action: Choose rightwards positive.

After: $F = -12\ \text{N}$; $a = -4.0\ \text{m s}^{-2}$

Why: Both quantities use the same sign convention.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by nonzero a.

After: F/a = ma/a; m = F/a

Why: The matching acceleration factor reduces to one.

$$F = m \times a$$

$$/\ a \qquad /\ a$$

$$\frac{F}{a} = \frac{m \times \cancel{a}}{\cancel{a}}$$

a/a = 1; m remains.

$$m = F/a$$

Divide both sides by a; matching factors reduce to one

F equals m times a. Divide both sides by a. The numerator and denominator factors a reduce to one; m remains. m equals F divided by a. The divisor must be nonzero.

Step 3

Before: m = F/a

Action: Substitute both signed values.

After: m = (−12)/(−4.0) = 3.0 kg

Why: A negative divided by a negative is positive; direction does not create negative mass.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: m = 3.0 kg

Action: Multiply by signed acceleration.

After: ma = 3.0 × (–4.0) = –12 N

Why: The result reproduces the leftward net force.

3.0 kg.

Follow the model

A trolley already moves rightwards at 3.0 m s^{-1}. Opposing forces are each 6.0 N. Describe motion.

Step 1

Before: +6.0 N and –6.0 N

Action: Add signed forces.

After: F = 6.0 – 6.0 = 0 N

Why: Forces balance.

Step 2

Before: a = F/m

Action: Use zero net force.

After: a = 0/m = 0 m s^{-2}

Why: Any positive mass gives zero acceleration.

Step 3

Before: Initial velocity 3.0 m s^{-1} rightwards.

Action: Keep velocity unchanged.

After: Velocity remains 3.0 m s^{-1} rightwards.

Why: Zero acceleration does not imply zero velocity.

Constant velocity 3.0 m s^{-1} rightwards while forces remain balanced.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Follow the model

A stationary trolley has opposing horizontal forces each 8.0 N. Describe its motion while they stay balanced.

Step 1

Before: Initial velocity is zero; forces +8.0 N and −8.0 N.

Action: Add the signed forces.

After: $F = 8.0 - 8.0 = 0$ N

Why: The two forces balance.

Step 2

Before: $a = F/m$ for positive mass.

Action: Use the net force zero.

After: $a = 0/m = 0\ \text{m s}^{-2}$

Why: There is no change in velocity.

Step 3

Before: Initial velocity zero; acceleration zero.

Action: Keep the initial velocity.

After: The trolley remains stationary.

Why: Contrast the moving balanced-force example: the same zero acceleration preserves whichever velocity the object already had.

It remains stationary while the forces stay balanced.

Together — We do

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Follow the guided example

Together: a 3 kg trolley has a 13 N push right and 4 N resistance left. Complete F = __ – __, then 3a = __, and explain each operation.

Step 1

Before: Forces act in opposite horizontal directions.

Action: Choose rightwards as positive.

After: Push = +13 N; resistance = –4 N

Why: The signs identify direction on one axis.

Step 2

Before: F = __ – __

Action: Include both forces and subtract their magnitudes.

After: F = 13 – 4 = 9 N rightwards

Why: Newton's second law uses the resultant.

Step 3

Before: F = ma; F = 9 N; m = 3 kg

Action: Substitute the resultant and mass.

After: 9 = 3a

Why: Acceleration is the unknown; the same relation can be written 3a = 9.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $3a = 9$

Action: Divide both sides by three.

After: $(3a)/3 = 9/3$; $a = 3\ \text{m s}^{-2}$ rightwards

Why: Matching factors reduce to one; $\text{N/kg} = \text{m s}^{-2}$.

$$\begin{array}{ccc} 3a & = & 9 \\ \div 3 & & \div 3 \end{array}$$

Apply the same action to both sides.

$$a = 3$$

Apply ÷ 3 to both sides

3a equals 9. Apply ÷ 3 to each side. Result: a equals 3.

Step 5

Before: $a = 3\ \text{m s}^{-2}$ rightwards

Action: Multiply back and compare the direction.

After: $ma = 3 \times 3 = 9\ \text{N} = 13 - 4$

Why: The stronger rightward force and acceleration point right.

Net force is 9 N rightwards; acceleration is $3\ \text{m s}^{-2}$ rightwards.

Explain a step in your own words or add your working.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 1

Rightwards positive.

Arrow lengths use the same force scale.

Horizontal forces on one trolley

A 3.0 kilogram trolley has 15 newtons rightwards and 3.0 newtons leftwards. Upward support balances downward weight. Only the horizontal forces are shown. Arrow lengths are proportional to force magnitude within this diagram.

Complete the method: a 3.0 kg trolley has 15 N rightwards and 3.0 N leftwards. Fill F = 15 – __, then a = F/__.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 2

$$4.0\ \text{N right} + 2.0\ \text{N right}$$

$$F = 4.0 + 2.0$$

$$a = F/2.0$$

Same-direction forces

4.0 N right + 2.0 N right F = 4.0 + 2.0 a = F/2.0

Two forces 4.0 N and 2.0 N both act rightwards on a 2.0 kg object. Choose addition or subtraction, then find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 3

$$\begin{array}{ccc} P - 1 & = & 6 \\ +1 & & +1 \\ \hline P - 1 + 1 & = & 7 \end{array}$$

Opposite terms sum to zero.

$$P = 7$$

Apply +1 to both sides

P – 1 equals 6. Apply +1 to each side. Result: P equals 7. The marked opposite terms sum to zero.

Complete P – 1.0 = ma for a 3.0 kg trolley needing 2.0 m s^{-2} rightward acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 17

Complete the mass method for F = 18 N rightwards and a = 6.0 m s^{-2} rightwards: 18 = m × 6.0. Show division beneath both sides.

Question 18

A trolley moves right at 1.5 m s^{-1}. Forces of 4.0 N act right and left. Complete the net force, acceleration and subsequent velocity.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

With help

Apply the method: teaching example

Solve a trolley problem with less help: mass 2 kg, 11 N right and 5 N left.

Question 4

Rightwards positive.

Arrow lengths use the same force scale.

Horizontal forces on one trolley

A 2.0 kilogram trolley has 10 newtons rightwards and 16 newtons leftwards. Upward support balances downward weight. Only the horizontal forces are shown. Arrow lengths are proportional to force magnitude within this diagram.

A 2.0 kg object has 10 N rightwards and 16 N leftwards. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 4 — continued

Question 5

A net force of 16 N rightwards produces 4.0 m s^{-2} rightwards acceleration. Find mass.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 6

A 5.0 kg trolley needs 2.0 m s^{-2} rightwards against 4.0 N resistance. Find push.

Question 7

Solve $4z + 3 = 19$ and check.

On my own

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 8

A 2.0 kg object has 14 N rightwards and 6.0 N leftwards. Find net force and acceleration.

Question 9

A 3.0 kg object has 9.0 N rightwards and 15 N leftwards. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 10

Forces 6.0 N and 4.0 N both act rightwards on a 5.0 kg object. Find acceleration.

Question 11

A 4.0 kg object accelerates at 1.5 m s^{-2} rightwards. Find net force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 12

Net force 12 N rightwards produces acceleration 3.0 m s^{-2} rightwards. Find mass.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 13

A 3.0 kg trolley needs 2.0 m s^{-2} rightwards acceleration against 4.0 N resistance. Find push.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 14

A trolley moves right at 2.0 m s^{-1}. Opposing forces are each 6.0 N. Describe subsequent motion.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 15

An 8.0 N net force acts on a 2.0 kg cart, then on a 4.0 kg cart. Compare accelerations.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 16

Which conclusion follows from zero net force?

Circle your answer:

A. Velocity remains unchanged.

B. The object must be stationary.

C. No forces can act on the object.

Come back

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 19

A 2 kg object has net force 8 N rightwards. Find acceleration.

Question 20

A 3 kg object has net force 9 N leftwards. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 21

A 5 kg object has net force 20 N rightwards. Find acceleration.

Question 22

A 4 kg object has net force 6 N rightwards. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 23

A 3 kg object has zero net force. Find acceleration. Can its speed be determined?

Question 24

A 4 kg object has 18 N rightwards and 6 N leftwards. Find net force and acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 25

Forces 6 N and 4 N both act rightwards on a 2 kg object. Find acceleration.

Question 26

A 3 kg object has 4 N rightwards and 10 N leftwards. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 27

A 5 kg object has 8 N rightwards, 5 N rightwards and 3 N leftwards. Find acceleration.

Question 28

A 3 kg object accelerates at 2 m s^{-2} leftwards. Find net force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 29

Net force 15 N rightwards gives acceleration 3 m s^{-2} rightwards. Find mass.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 30

A 2 kg object has 10 N rightwards and 4 N leftwards. A learner calculates a = 10/2. Repair the method.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 31

A 10 kg shopping trolley moves east. Push is 18 N east and resistance 8 N west. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 32

A 0.5 kg model train has driving force 1.5 N east and resistance 0.5 N west. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 33

A 20 kg crate moves right against 4 N resistance. Find the push for 0.5 m s^{-2} rightward acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 34

Two helpers push a 4 kg trolley east with 6 N and 9 N. Resistance is 3 N west. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 35

A delivery robot accelerates at $2\,\text{m}\,\text{s}^{-2}$ leftwards under net force 24 N leftwards. Find mass.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 36

A 6 kg trolley moves right at 2 m s^{-1} with forces 13 N right and 13 N left. Describe motion.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 37

Net force 12 N rightwards acts on carts of 3 kg and 6 kg. Calculate and compare accelerations.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 38

Cart A: mass 3 kg, forces 18 N right and 6 N left. Cart B: mass 3 kg, forces 15 N right and 3 N left. Does A accelerate more?

Come back — fresh retrieval

Retrieval 1

A 4 kg object has 20 N right and 8 N left. Find acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Retrieval 1 — continued

Retrieval 2

Net force 10 N produces acceleration 2 m s^{-2} in the same direction. Find mass.

Retrieval 3

A 2 kg trolley needs 3 m s^{-2} rightwards against 2 N resistance. Find push.

Retrieval 4

An object moves left while accelerating right. Explain its immediate speed change and what balanced forces would mean.

Apply your understanding

Predict the change in acceleration when mass doubles while net force doubles. Justify.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Original: a = F/m

New: a = (2F)/(2m)

Matching factors reduce: a unchanged

Compare both changes

Original: a = F/m New: a = (2F)/(2m) Matching factors reduce: a unchanged

Lesson review

- Combine forces with a stated direction convention.
- Select and rearrange F = ma for the required quantity.
- Find a required push when an opposing force acts.
- Explain balanced forces and the direction of acceleration.

Use the learning goal to review your work. Explain the main idea in your own words and identify a step to revisit.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Practice hints

Try each question first. Cover the hints and reveal one at a time when you need support.

Question 1

1. Find net force before acceleration.
2. Write F = 15 – 3.0.
3. The net force is 12 N. Divide it by the stated mass.

Question 2

1. Use directions to combine forces.
2. Both signed forces are positive.
3. Add the forces, then divide their sum by 2.0 kg.

Question 3

1. Find required net force first.
2. Calculate ma = 3.0 × 2.0.
3. P – 1.0 = 6.0. Add the resistance to both sides.

Question 4

1. Combine signed forces on the same object.
2. Choose rightwards positive: F = 10 – 16.
3. F = –6.0 N; divide by 2.0 kg and interpret the sign.

Question 5

1. Identify the unknown as mass.
2. Divide F = ma by nonzero acceleration on both sides.
3. m = 16/4.0. Calculate and use kilograms.

Question 6

1. Net force and pushing force differ.
2. Find F = ma = 5.0 × 2.0.
3. P – 4.0 = 10. Add 4.0 to both sides.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 7

1. Use the same operation on both sides.

2. Subtract three from both sides.

3. $4z = 16$. Divide both sides by four, then check in the original equation.

Question 8

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

Question 9

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

Question 10

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

Question 11

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

Question 12

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

Question 13

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 14

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

Question 15

1. Identify the unknown and the forces on one object.

2. Choose rightwards positive and write the signed net force where needed.

3. Choose $F = ma$, $a = F/m$ or $m = F/a$; substitute the given values and interpret direction.

Question 16

1. Identify the relationship being tested.

2. Use the definitions before comparing the options.

3. Reject options that contradict the relationship; select the remaining option.

Question 17

1. Identify mass as the unknown.

2. Divide both sides of $18 = m \times 6.0$ by the nonzero acceleration.

3. The matching acceleration factors reduce to one; finish $18/6.0$ and use kilograms.

Question 18

1. Distinguish velocity from a change in velocity.

2. Calculate $F = 4.0 - 4.0$.

3. Net force and acceleration are zero; preserve the velocity it already had.

Question 19

1. Identify the unknown and use forces on the same object.

2. Write the signed net force or the required net force ma.

3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 20

1. Identify the unknown and use forces on the same object.

2. Write the signed net force or the required net force ma.

3. Isolate the unknown with equal operations; substitute values, then check units and direction.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 21

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 22

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 23

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 24

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 25

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 26

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 27

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 28

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 29

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 30

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 31

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 32

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 33

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 34

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 35

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 36

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 37

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

Question 38

1. Identify the unknown and use forces on the same object.
2. Write the signed net force or the required net force ma.
3. Isolate the unknown with equal operations; substitute values, then check units and direction.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Practice answers and review

Starting-point answers

Starting-point question 1
Add four to both sides.

Starting-point question 2
Divide both sides by three; $y = 4$.

Starting-point question 3
+4 N rightwards.

Starting-point question 4
4 N leftwards.

Starting-point question 5
4.

Starting-point question 6
Acceleration.

Practice answers

Question 1

Step 1
Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 15 - 3.0 = 12$ N

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (12)/3 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 4\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 3 \times (4) = 12\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 15 - 3.0 = 12\ N$ rightwards. $a = 12/3.0 = 4.0\ m\ s^{-2}$ rightwards. Check: $3.0 \times 4.0 = 12\ N$.

$F = 15 - 3.0 = 12\ N$ rightwards. $a = 12/3.0 = 4.0\ m\ s^{-2}$ rightwards.

Check: $3.0 \times 4.0 = 12\ N$.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 2

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 4.0 + 2.0 = 6.0\ N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (6)/2 = 3 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 3\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 2 \times (3) = 6\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

Same direction: $F = 4.0 + 2.0 = 6.0\ N$ rightwards. $a = 6.0/2.0 = 3.0\ m\ s^{-2}$ rightwards.

Same direction: $F = 4.0 + 2.0 = 6.0\ N$ rightwards. $a = 6.0/2.0 = 3.0\ m\ s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 3

Step 1

Before: Unknown push P; known mass and acceleration.

Action: Find the required net force first.

After: $F = ma = 3.0 \times 2.0 = 6.0\ N$

Why: The required net force differs from the push because resistance also acts.

Step 2

Before: P rightwards; 1.0 N leftwards.

Action: Write the signed force equation.

After: $P - 1.0 = 6.0$

Why: Rightwards is positive.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: P – 1.0 = 6.0

Action: Add 1.0 to both sides.

After: P – 1.0 + 1.0 = 6.0 + 1.0; P = 7.0 N

Why: The opposite resistance terms sum to zero.

$$\begin{array}{rcr} P - 1 & = & 6 \\ +1 & & +1 \\ \hline P & -1 +1 & = 7 \end{array}$$

Opposite terms sum to zero.

$$P = 7$$

Apply +1 to both sides

P – 1 equals 6. Apply +1 to each side. Result: P equals 7. The marked opposite terms sum to zero.

Step 4

Before: P = 7.0 N

Action: Subtract resistance and divide by mass.

After: (7.0 – 1.0)/3.0 = 2.0 m s^{-2}

Why: The requested acceleration is recovered.

ma = 3.0 × 2.0 = 6.0 N. P – 1.0 = 6.0. Add 1.0 to both sides: P = 7.0 N rightwards. Check: (7.0 – 1.0)/3.0 = 2.0 m s^{-2}.

ma = 3.0 × 2.0 = 6.0 N.

P – 1.0 = 6.0.

Add 1.0 to both sides: P = 7.0 N rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Check: $(7.0 - 1.0)/3.0 = 2.0\ \text{m s}^{-2}$.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 4

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 10 - 16 = -6.0\ \text{N}$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: $a = (-6)/2 = -3\ \mathrm{m\,s^{-2}}$

Why: N/kg gives $\mathrm{kg\,m\,s^{-2}/kg}$; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = -3\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 2 \times (-3) = -6\ N$; leftwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 10 - 16 = -6.0\ N$. $a = -6.0/2.0 = -3.0\ m\ s^{-2}$, or $3.0\ m\ s^{-2}$ leftwards.

$F = 10 - 16 = -6.0\ N$. $a = -6.0/2.0 = -3.0\ m\ s^{-2}$, or $3.0\ m\ s^{-2}$ leftwards.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 5

Step 1

Before: $F = 16\ N$; $a = 4\ m\ s^{-2}$

Action: Identify mass as the unknown.

After: $F = ma$

Why: Use matching directions for force and acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by nonzero a.

After: F/a = ma/a; m = F/a

Why: The matching a factors reduce to one.

$$F = m \times a$$

$$/\ a \qquad /\ a$$

$$\frac{F}{a} = \frac{m \times \cancel{a}}{\cancel{a}}$$

a/a = 1; m remains.

$$m = F/a$$

Divide both sides by a; matching factors reduce to one

F equals m times a. Divide both sides by a. The numerator and denominator factors a reduce to one; m remains. m equals F divided by a. The divisor must be nonzero.

Step 3

Before: m = F/a

Action: Substitute both signed values.

After: m = (16)/(4) = 4 kg

Why: Matching signs give positive mass. Force divided by acceleration leaves kilograms.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: m = 4 kg

Action: Multiply by the given acceleration.

After: ma = 4 × (4) = 16 N

Why: The force matches the original data.

F = ma. Divide both sides by a: m = F/a = 16/4.0 = 4.0 kg. Check: 4.0 × 4.0 = 16 N.

F = ma.

Divide both sides by a: m = F/a = 16/4.0 = 4.0 kg.

Check: 4.0 × 4.0 = 16 N.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 6

Step 1

Before: Unknown push P; known mass and acceleration.

Action: Find the required net force first.

After: F = ma = 5.0 × 2.0 = 10.0 N

Why: The required net force differs from the push because resistance also acts.

Step 2

Before: P rightwards; 4.0 N leftwards.

Action: Write the signed force equation.

After: P − 4.0 = 10.0

Why: Rightwards is positive.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: P – 4.0 = 10.0

Action: Add 4.0 to both sides.

After: P – 4.0 + 4.0 = 10.0 + 4.0; P = 14.0 N

Why: The opposite resistance terms sum to zero.

$$\begin{array}{ccc} P - 4 & = & 10 \\ +4 & & +4 \\ \hline P & -4 \;+4 & = 14 \end{array}$$

Opposite terms sum to zero.

$$P = 14$$

Apply +4 to both sides

P – 4 equals 10. Apply +4 to each side. Result: P equals 14. The marked opposite terms sum to zero.

Step 4

Before: P = 14.0 N

Action: Subtract resistance and divide by mass.

After: (14.0 – 4.0)/5.0 = 2.0 m s^{-2}

Why: The requested acceleration is recovered.

F = 5.0 × 2.0 = 10 N. P – 4.0 = 10. Add 4.0 to both sides: P = 14 N rightwards. Check: (14 – 4.0)/5.0 = 2.0 m s^{-2}.

F = 5.0 × 2.0 = 10 N.

P – 4.0 = 10.

Add 4.0 to both sides: P = 14 N rightwards.

Check: (14 – 4.0)/5.0 = 2.0 m s^{-2}.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 7

Step 1

Before: $4z + 3 = 19$

Action: Subtract three from both sides.

After: $4z + 3 - 3 = 19 - 3$; $4z = 16$

Why: The opposite terms sum to zero.

$$\begin{array}{ccc} 4z + 3 & = & 19 \\ -3 & & -3 \\ \hline 4z \quad \cancel{+3} & \quad \cancel{-3} & = \quad 16 \end{array}$$

Opposite terms sum to zero.

$$4z = 16$$

Apply −3 to both sides

4z + 3 equals 19. Apply −3 to each side. Result: 4z equals 16. The marked opposite terms sum to zero.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: 4z = 16

Action: Divide both sides by four.

After: 4z/4 = 16/4; z = 4

Why: The matching factor four reduces to one.

$$\begin{array}{ccc} 4z & = & 16 \\ /4 & & /4 \\ \hline \end{array}$$

Apply the same action to both sides.

$$z = 4$$

Apply /4 to both sides

4z equals 16. Apply /4 to each side. Result: z equals 4.

Step 3

Before: z = 4

Action: Substitute into the original equation.

After: 4 × 4 + 3 = 16 + 3 = 19

Why: The result satisfies the original equality.

Subtract 3 from both sides: 4z + 3 – 3 = 19 – 3; 4z = 16. Divide both sides by 4: z = 4. Check: 4 × 4 + 3 = 19.

Subtract 3 from both sides: 4z + 3 – 3 = 19 – 3; 4z = 16.

Divide both sides by 4: z = 4.

Check: 4 × 4 + 3 = 19.

• Uses the stated physical or chemical relationship.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 8

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 14 - 6.0 = 8.0\ \text{N}$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (8)/2 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 4\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 2 \times (4) = 8\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 14 - 6.0 = 8.0\ N$ rightwards. $a = 8.0/2.0 = 4.0\ m\ s^{-2}$ rightwards.

$F = 14 - 6.0 = 8.0\ N$ rightwards. $a = 8.0/2.0 = 4.0\ m\ s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 9

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 9.0 - 15 = -6.0\ N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: $a = (-6)/3 = -2 \text{ m s}^{-2}$

Why: N/kg gives $\text{kg m s}^{-2}/\text{kg}$; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = -2\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 3 \times (-2) = -6\ N$; leftwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 9.0 - 15 = -6.0\ N$. $a = -6.0/3.0 = -2.0\ m\ s^{-2}$; $2.0\ m\ s^{-2}$ leftwards.

$F = 9.0 - 15 = -6.0\ N$. $a = -6.0/3.0 = -2.0\ m\ s^{-2}$; $2.0\ m\ s^{-2}$ leftwards.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 10

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 6.0 + 4.0 = 10\ N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (10)/5 = 2 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 2\,m\,s^{-2}$

Action: Check force and direction.

After: $ma = 5 \times (2) = 10\,N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 6.0 + 4.0 = 10\,N$ rightwards. $a = 10/5.0 = 2.0\,m\,s^{-2}$ rightwards.

$F = 6.0 + 4.0 = 10\,N$ rightwards. $a = 10/5.0 = 2.0\,m\,s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 11

Step 1

Before: $m = 4\,kg$; $a = 1.5\,m\,s^{-2}$

Action: Find net force directly.

After: $F = ma$

Why: Mass and acceleration are both supplied.

Step 2

Before: $F = ma$

Action: Substitute and multiply.

After: $F = 4 \times (1.5) = 6\,N$

Why: $kg\,m\,s^{-2}$ is the newton unit; force follows the acceleration direction.

Step 3

Before: $F = 6\,N$

Action: Divide by the original mass.

After: $F/m = (6)/4 = 1.5\,m\,s^{-2}$

Why: The original acceleration is recovered.

$F = ma = 4.0 \times 1.5 = 6.0\,N$ rightwards.

$F = ma = 4.0 \times 1.5 = 6.0\,N$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 12

Step 1

Before: $F = 12\,N$; $a = 3\,m\,s^{-2}$

Action: Identify mass as the unknown.

After: $F = ma$

Why: Use matching directions for force and acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by nonzero a.

After: F/a = ma/a; m = F/a

Why: The matching a factors reduce to one.

$$F = m \times a$$

$$/\ a \qquad /\ a$$

$$\frac{F}{a} = \frac{m \times \cancel{a}}{\cancel{a}}$$

a/a = 1; m remains.

$$m = F/a$$

Divide both sides by a; matching factors reduce to one

F equals m times a. Divide both sides by a. The numerator and denominator factors a reduce to one; m remains. m equals F divided by a. The divisor must be nonzero.

Step 3

Before: m = F/a

Action: Substitute both signed values.

After: m = (12)/(3) = 4 kg

Why: Matching signs give positive mass. Force divided by acceleration leaves kilograms.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: m = 4 kg

Action: Multiply by the given acceleration.

After: ma = 4 × (3) = 12 N

Why: The force matches the original data.

F = ma. Divide both sides by a: m = F/a = 12/3.0 = 4.0 kg.

F = ma.

Divide both sides by a: m = F/a = 12/3.0 = 4.0 kg.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 13

Step 1

Before: Unknown push P; known mass and acceleration.

Action: Find the required net force first.

After: F = ma = 3.0 × 2.0 = 6.0 N

Why: The required net force differs from the push because resistance also acts.

Step 2

Before: P rightwards; 4.0 N leftwards.

Action: Write the signed force equation.

After: P − 4.0 = 6.0

Why: Rightwards is positive.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: P – 4.0 = 6.0

Action: Add 4.0 to both sides.

After: P – 4.0 + 4.0 = 6.0 + 4.0; P = 10.0 N

Why: The opposite resistance terms sum to zero.

$$\begin{array}{ccc} P - 4 & = & 6 \\ +4 & & +4 \\ \hline P & -4 \;+4 & = 10 \end{array}$$

Opposite terms sum to zero.

$$P = 10$$

Apply +4 to both sides

P – 4 equals 6. Apply +4 to each side. Result: P equals 10. The marked opposite terms sum to zero.

Step 4

Before: P = 10.0 N

Action: Subtract resistance and divide by mass.

After: (10.0 – 4.0)/3.0 = 2.0 m s^{-2}

Why: The requested acceleration is recovered.

Required F = 3.0 × 2.0 = 6.0 N. P – 4.0 = 6.0. Add 4.0 to both sides: P = 10 N rightwards. Check: (10 – 4.0)/3.0 = 2.0 m s^{-2}.

Required F = 3.0 × 2.0 = 6.0 N.

P – 4.0 = 6.0.

Add 4.0 to both sides: P = 10 N rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Check: $(10 - 4.0)/3.0 = 2.0\ \text{m s}^{-2}$.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 14

Step 1

Before: Opposing forces are both 6 N.

Action: Add their signed components.

After: $F = 6 - 6 = 0\ \text{N}$

Why: Equal opposing forces balance.

Step 2

Before: $F = 0$ N; mass is positive.

Action: Use Newton's second law.

After: $a = F/m = 0/m = 0\ \text{m s}^{-2}$

Why: Zero acceleration means no change in velocity.

Step 3

Before: The velocity before the balanced forces is $2\ \text{m s}^{-1}$ rightwards.

Action: Preserve that initial velocity.

After: Velocity remains $2\ \text{m s}^{-1}$ rightwards.

Why: Acceleration changes velocity; it does not specify the initial velocity.

$F = 6.0 - 6.0 = 0$ N, so $a = 0$. It continues at $2.0\ \text{m s}^{-1}$ rightwards while forces remain unchanged.

$F = 6.0 - 6.0 = 0$ N, so $a = 0$.

It continues at $2.0\ \text{m s}^{-1}$ rightwards while forces remain unchanged.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 15

Step 1

Before: Given net force 8 N; mass 2 kg.

Action: Identify acceleration as the unknown.

After: Use F = ma.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (8)/2 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 4\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 2 \times (4) = 8\ N$; in the direction of the net force

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

Step 5

Before: Given net force 8 N; mass 4 kg.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 6

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 7

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (8)/4 = 2 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 8

Before: $a = 2\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 4 \times (2) = 8\ N$; in the direction of the net force

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

Step 9

Before: Accelerations 4 and $2\ m\ s^{-2}$.

Action: Compare the mass change with the acceleration change.

After: Doubling mass halves acceleration at unchanged net force.

Why: The force was held constant.

$a = 8.0/2.0 = 4.0\ m\ s^{-2}$; $a = 8.0/4.0 = 2.0\ m\ s^{-2}$. Both follow the force direction. Doubling mass halves acceleration at unchanged net force.

$a = 8.0/2.0 = 4.0\ m\ s^{-2}$; $a = 8.0/4.0 = 2.0\ m\ s^{-2}$.

Both follow the force direction.

Doubling mass halves acceleration at unchanged net force.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 16

Step 1

Before: The supplied net force is zero.

Action: Use the given resultant directly.

After: $F = 0\ N$

Why: Individual forces may be absent or may cancel; their magnitudes were not supplied.

Step 2

Before: $F = 0\ N$; mass is positive.

Action: Use Newton's second law.

After: $a = F/m = 0/m = 0\ m\ s^{-2}$

Why: Zero acceleration means no change in velocity.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: The velocity before the balanced forces is not specified.

Action: Preserve that initial velocity.

After: Velocity remains unchanged; it need not be zero.

Why: Acceleration changes velocity; it does not specify the initial velocity.

F = ma with positive mass gives a = 0; velocity stays unchanged.

F = ma with positive mass gives a = 0; velocity stays unchanged.

Question 17

Step 1

Before: $F = 18\ \text{N}$; $a = 6\ \text{m s}^{-2}$

Action: Identify mass as the unknown.

After: F = ma

Why: Use matching directions for force and acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by nonzero a.

After: F/a = ma/a; m = F/a

Why: The matching a factors reduce to one.

$$F = m \times a$$

$$/\ a \qquad /\ a$$

$$\frac{F}{a} = \frac{m \times \cancel{a}}{\cancel{a}}$$

a/a = 1; m remains.

$$m = F/a$$

Divide both sides by a; matching factors reduce to one

F equals m times a. Divide both sides by a. The numerator and denominator factors a reduce to one; m remains. m equals F divided by a. The divisor must be nonzero.

Step 3

Before: m = F/a

Action: Substitute both signed values.

After: m = (18)/(6) = 3 kg

Why: Matching signs give positive mass. Force divided by acceleration leaves kilograms.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: m = 3 kg

Action: Multiply by the given acceleration.

After: ma = 3 × (6) = 18 N

Why: The force matches the original data.

Divide both sides by 6.0: 18/6.0 = (m × 6.0)/6.0. Matching 6.0 factors reduce to one, so m = 18/6.0 = 3.0 kg. Check: 3.0 × 6.0 = 18 N.

Divide both sides by 6.0: 18/6.0 = (m × 6.0)/6.0.

Matching 6.0 factors reduce to one, so m = 18/6.0 = 3.0 kg.

Check: 3.0 × 6.0 = 18 N.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 18

Step 1

Before: Opposing forces are both 4 N.

Action: Add their signed components.

After: F = 4 – 4 = 0 N

Why: Equal opposing forces balance.

Step 2

Before: F = 0 N; mass is positive.

Action: Use Newton's second law.

After: $a = F/m = 0/m = 0\ m\ s^{-2}$

Why: Zero acceleration means no change in velocity.

Step 3

Before: The velocity before the balanced forces is $1.5\ m\ s^{-1}$ rightwards.

Action: Preserve that initial velocity.

After: Velocity remains $1.5\ m\ s^{-1}$ rightwards.

Why: Acceleration changes velocity; it does not specify the initial velocity.

F = 4.0 – 4.0 = 0 N. For positive mass, $a = 0/m = 0\ m\ s^{-2}$. Its velocity remains $1.5\ m\ s^{-1}$ rightwards while those forces remain balanced.

F = 4.0 – 4.0 = 0 N.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

For positive mass, $a = 0/m = 0\ m\ s^{-2}$.

Its velocity remains $1.5\ m\ s^{-1}$ rightwards while those forces remain balanced.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 19

Step 1

Before: Given net force 8 N; mass 2 kg.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (8)/2 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 4\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 2 \times (4) = 8\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$a = F/m = 8/2 = 4\ m\ s^{-2}$ rightwards.

$a = F/m = 8/2 = 4\ m\ s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 20

Step 1

Before: Given net force $-9\ N$; mass $3\ kg$.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: $a = (-9)/3 = -3 \text{ m s}^{-2}$

Why: N/kg gives $\text{kg m s}^{-2}/\text{kg}$; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = -3\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 3 \times (-3) = -9\ N$; leftwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

With rightwards positive: $a = -9/3 = -3\ m\ s^{-2}$, or $3\ m\ s^{-2}$ leftwards.

With rightwards positive: $a = -9/3 = -3\ m\ s^{-2}$, or $3\ m\ s^{-2}$ leftwards.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 21

Step 1

Before: Given net force 20 N; mass 5 kg.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (20)/5 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 4\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 5 \times (4) = 20\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$a = 20/5 = 4\ m\ s^{-2}$ rightwards.

$a = 20/5 = 4\ m\ s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 22

Step 1

Before: Given net force 6 N; mass 4 kg.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (6)/4 = 1.5 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 1.5\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 4 \times (1.5) = 6\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$a = 6/4 = 1.5\ m\ s^{-2}$ rightwards. Acceleration need not be an integer.

$a = 6/4 = 1.5\ m\ s^{-2}$ rightwards.

Acceleration need not be an integer.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 23

Step 1

Before: Given net force 0 N; mass 3 kg.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (0)/3 = 0 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 0\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 3 \times (0) = 0\ N$; no acceleration

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$a = 0/3 = 0\ m\ s^{-2}$. Initial velocity is needed to determine speed; it may already be moving.

$a = 0/3 = 0\ m\ s^{-2}$.

Initial velocity is needed to determine speed; it may already be moving.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 24

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 18 - 6 = 12\ N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (12)/4 = 3 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 3\,m\,s^{-2}$

Action: Check force and direction.

After: $ma = 4 \times (3) = 12\,N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 18 - 6 = 12\,N$ rightwards; $a = 12/4 = 3\,m\,s^{-2}$ rightwards.

$F = 18 - 6 = 12\,N$ rightwards; $a = 12/4 = 3\,m\,s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 25

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 6 + 4 = 10\,N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (10)/2 = 5 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 5\,m\,s^{-2}$

Action: Check force and direction.

After: $ma = 2 \times (5) = 10\,N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 6 + 4 = 10\,N$ rightwards; $a = 10/2 = 5\,m\,s^{-2}$ rightwards.

$F = 6 + 4 = 10\,N$ rightwards; $a = 10/2 = 5\,m\,s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 26

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 4 - 10 = -6\,N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: $a = (-6)/3 = -2 \text{ m s}^{-2}$

Why: N/kg gives $\text{kg m s}^{-2}/\text{kg}$; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = -2\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 3 \times (-2) = -6\ N$; leftwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 4 - 10 = -6\ N$; $a = -6/3 = -2\ m\ s^{-2}$, or $2\ m\ s^{-2}$ leftwards.

$F = 4 - 10 = -6\ N$; $a = -6/3 = -2\ m\ s^{-2}$, or $2\ m\ s^{-2}$ leftwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 27

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 8 + 5 - 3 = 10\ N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (10)/5 = 2 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 2\,m\,s^{-2}$

Action: Check force and direction.

After: $ma = 5 \times (2) = 10\,N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 8 + 5 - 3 = 10\,N$ rightwards; $a = 10/5 = 2\,m\,s^{-2}$ rightwards.

$F = 8 + 5 - 3 = 10\,N$ rightwards; $a = 10/5 = 2\,m\,s^{-2}$ rightwards.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 28

Step 1

Before: $m = 3\,kg$; $a = -2\,m\,s^{-2}$

Action: Find net force directly.

After: $F = ma$

Why: Mass and acceleration are both supplied.

Step 2

Before: $F = ma$

Action: Substitute and multiply.

After: $F = 3 \times (-2) = -6\,N$

Why: $kg\,m\,s^{-2}$ is the newton unit; force follows the acceleration direction.

Step 3

Before: $F = -6\,N$

Action: Divide by the original mass.

After: $F/m = (-6)/3 = -2\,m\,s^{-2}$

Why: The original acceleration is recovered.

$F = ma = 3 \times (-2) = -6\,N$, or $6\,N$ leftwards.

$F = ma = 3 \times (-2) = -6\,N$, or $6\,N$ leftwards.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Question 29

Step 1

Before: $F = 15\,N$; $a = 3\,m\,s^{-2}$

Action: Identify mass as the unknown.

After: $F = ma$

Why: Use matching directions for force and acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by nonzero a.

After: F/a = ma/a; m = F/a

Why: The matching a factors reduce to one.

$$F = m \times a$$

$$/\ a \qquad /\ a$$

$$\frac{F}{a} = \frac{m \times \cancel{a}}{\cancel{a}}$$

a/a = 1; m remains.

$$m = F/a$$

Divide both sides by a; matching factors reduce to one

F equals m times a. Divide both sides by a. The numerator and denominator factors a reduce to one; m remains. m equals F divided by a. The divisor must be nonzero.

Step 3

Before: m = F/a

Action: Substitute both signed values.

After: m = (15)/(3) = 5 kg

Why: Matching signs give positive mass. Force divided by acceleration leaves kilograms.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: m = 5 kg

Action: Multiply by the given acceleration.

After: ma = 5 × (3) = 15 N

Why: The force matches the original data.

Divide F = ma by a: m = F/a = 15/3 = 5 kg. Check: 5 × 3 = 15 N.

Divide F = ma by a: m = F/a = 15/3 = 5 kg.

Check: 5 × 3 = 15 N.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 30

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: F = 10 – 4 = 6 N; the lone rightward force is not the net force.

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$\begin{array}{ccc} F & = & m \times a \\ / \, m & & / \, m \end{array}$$

$$\frac{F}{m} = \frac{m \times a}{m}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (6)/2 = 3 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 3\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 2 \times (3) = 6\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

They used one force. $F = 10 - 4 = 6\ N$ rightwards; $a = 6/2 = 3\ m\ s^{-2}$ rightwards.

They used one force.

$F = 10 - 4 = 6\ N$ rightwards; $a = 6/2 = 3\ m\ s^{-2}$ rightwards.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 31

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 18 - 8 = 10\ N$ eastwards

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (10)/10 = 1 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 1\ m\,s^{-2}$

Action: Check force and direction.

After: $ma = 10 \times (1) = 10\ N$; eastwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

East positive: $F = 18 - 8 = 10\ N$ east; $a = 10/10 = 1\ m\,s^{-2}$ east.

East positive: $F = 18 - 8 = 10\ N$ east; $a = 10/10 = 1\ m\,s^{-2}$ east.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 32

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 1.5 - 0.5 = 1.0\ N$ eastwards

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (1)/0.5 = 2 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 2\,m\,s^{-2}$

Action: Check force and direction.

After: $ma = 0.5 \times (2) = 1$ N; eastwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 1.5 - 0.5 = 1.0$ N east; $a = 1.0/0.5 = 2\,m\,s^{-2}$ east.

$F = 1.5 - 0.5 = 1.0$ N east; $a = 1.0/0.5 = 2\,m\,s^{-2}$ east.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 33

Step 1

Before: Unknown push P; known mass and acceleration.

Action: Find the required net force first.

After: $F = ma = 20.0 \times 0.5 = 10.0$ N

Why: The required net force differs from the push because resistance also acts.

Step 2

Before: P rightwards; 4.0 N leftwards.

Action: Write the signed force equation.

After: $P - 4.0 = 10.0$

Why: Rightwards is positive.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 3

Before: $P - 4.0 = 10.0$

Action: Add 4.0 to both sides.

After: $P - 4.0 + 4.0 = 10.0 + 4.0$; $P = 14.0\ \text{N}$

Why: The opposite resistance terms sum to zero.

$$\begin{array}{rcr} P - 4 & = & 10 \\ +4 & & +4 \\ \hline P & -4 \quad +4 & = 14 \end{array}$$

Opposite terms sum to zero.

$$P = 14$$

Apply +4 to both sides

P – 4 equals 10. Apply +4 to each side. Result: P equals 14. The marked opposite terms sum to zero.

Step 4

Before: $P = 14.0\ \text{N}$

Action: Subtract resistance and divide by mass.

After: $(14.0 - 4.0)/20.0 = 0.5\ \text{m s}^{-2}$

Why: The requested acceleration is recovered.

Required $F = 20 \times 0.5 = 10\ \text{N}$ rightwards. $P - 4 = 10$. Add 4 to both sides: $P = 14\ \text{N}$ rightwards. Check: $(14 - 4)/20 = 0.5\ \text{m s}^{-2}$.

Required $F = 20 \times 0.5 = 10\ \text{N}$ rightwards.

$P - 4 = 10$.

Add 4 to both sides: $P = 14\ \text{N}$ rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Check: $(14 - 4)/20 = 0.5\ \text{m s}^{-2}$.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 34

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: $F = 6 + 9 - 3 = 12\ \text{N}$ eastwards

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (12)/4 = 3 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 3\,m\,s^{-2}$

Action: Check force and direction.

After: $ma = 4 \times (3) = 12\,N$; eastwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

$F = 6 + 9 - 3 = 12\,N$ east; $a = 12/4 = 3\,m\,s^{-2}$ east.

$F = 6 + 9 - 3 = 12\,N$ east; $a = 12/4 = 3\,m\,s^{-2}$ east.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 35

Step 1

Before: $F = -24\,N$; $a = -2\,m\,s^{-2}$

Action: Identify mass as the unknown.

After: $F = ma$

Why: Use matching directions for force and acceleration.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by nonzero a.

After: F/a = ma/a; m = F/a

Why: The matching a factors reduce to one.

$$F = m \times a$$

$$/\ a \qquad /\ a$$

$$\frac{F}{a} = \frac{m \times \cancel{a}}{\cancel{a}}$$

a/a = 1; m remains.

$$m = F/a$$

Divide both sides by a; matching factors reduce to one

F equals m times a. Divide both sides by a. The numerator and denominator factors a reduce to one; m remains. m equals F divided by a. The divisor must be nonzero.

Step 3

Before: m = F/a

Action: Substitute both signed values.

After: m = (−24)/(−2) = 12 kg

Why: Matching signs give positive mass. Force divided by acceleration leaves kilograms.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: m = 12 kg

Action: Multiply by the given acceleration.

After: ma = 12 × (–2) = –24 N

Why: The force matches the original data.

Matching signed directions: m = F/a = (–24)/(–2) = 12 kg. Check magnitude: 12 × 2 = 24 N.

Matching signed directions: m = F/a = (–24)/(–2) = 12 kg.

Check magnitude: 12 × 2 = 24 N.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

Question 36

Step 1

Before: Opposing forces are both 13 N.

Action: Add their signed components.

After: F = 13 – 13 = 0 N

Why: Equal opposing forces balance.

Step 2

Before: F = 0 N; mass is positive.

Action: Use Newton's second law.

After: $a = F/m = 0/m = 0\ m\ s^{-2}$

Why: Zero acceleration means no change in velocity.

Step 3

Before: The velocity before the balanced forces is $2\ m\ s^{-1}$ rightwards.

Action: Preserve that initial velocity.

After: Velocity remains $2\ m\ s^{-1}$ rightwards.

Why: Acceleration changes velocity; it does not specify the initial velocity.

F = 13 – 13 = 0 N; a = 0/6 = 0. It continues at $2\ m\ s^{-1}$ rightwards while forces remain balanced.

F = 13 – 13 = 0 N; a = 0/6 = 0.

It continues at $2\ m\ s^{-1}$ rightwards while forces remain balanced.

• Uses the stated physical or chemical relationship.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 37

Step 1

Before: Given net force 12 N; mass 3 kg.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (12)/3 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 4\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 3 \times (4) = 12\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

Step 5

Before: Given net force 12 N; mass 6 kg.

Action: Identify acceleration as the unknown.

After: Use $F = ma$.

Why: Net force is already supplied; do not add it as an extra force.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 6

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 7

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (12)/6 = 2 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 8

Before: $a = 2\,m\,s^{-2}$

Action: Check force and direction.

After: $ma = 6 \times (2) = 12\,N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

Step 9

Before: Masses 3 and 6 kg; accelerations 4 and $2\,m\,s^{-2}$.

Action: Compare both ratios.

After: Mass doubled; acceleration halved.

Why: The same net force acted in both cases.

$a = 12/3 = 4\,m\,s^{-2}$ and $a = 12/6 = 2\,m\,s^{-2}$, both rightwards. Twice the mass gives half the acceleration at unchanged net force.

$a = 12/3 = 4\,m\,s^{-2}$ and $a = 12/6 = 2\,m\,s^{-2}$, both rightwards.

Twice the mass gives half the acceleration at unchanged net force.

- Uses the stated physical or chemical relationship.
- Shows the relevant working and reasoning.
- Checks the result against the original conditions.

Question 38

Step 1

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: Cart A: $F = 18 - 6 = 12\,N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 2

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 3

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (12)/3 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 4

Before: $a = 4\ m\ s^{-2}$

Action: Check force and direction.

After: $ma = 3 \times (4) = 12\ N$; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

Step 5

Before: Rightwards or eastwards is positive.

Action: Combine every signed force on the object.

After: Cart B: $F = 15 - 3 = 12\ N$

Why: Opposing force contributions have opposite signs.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 6

Before: F = ma

Action: Divide both sides by m.

After: F/m = ma/m; a = F/m

Why: The factor m/m reduces to one.

$$F = m \times a$$

$$/\,m \qquad /\,m$$

$$\frac{F}{m} = \frac{\cancel{m} \times a}{\cancel{m}}$$

m/m = 1; a remains.

$$a = F/m$$

Divide both sides by m; matching factors reduce to one

F equals m times a. Divide both sides by m. The numerator and denominator factors m reduce to one; a remains. a equals F divided by m. The divisor must be nonzero.

Step 7

Before: a = F/m

Action: Substitute the signed net force and positive mass.

After: a = (12)/3 = 4 m s^{-2}

Why: N/kg gives kg m s^{-2}/kg; the matching kg factors reduce to one.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Step 8

Before: a = 4 m s^{-2}

Action: Check force and direction.

After: ma = 3 × (4) = 12 N; rightwards

Why: The signed acceleration follows the net force; zero acceleration preserves the initial velocity.

Step 9

Before: Both net forces 12 N; both masses 3 kg.

Action: Compare their calculated accelerations.

After: Both accelerate at 4 m s^{-2} rightwards.

Why: Different individual forces can produce the same net force.

A: F = 18 – 6 = 12 N. B: F = 15 – 3 = 12 N. Both: a = 12/3 = 4 m s^{-2} rightwards. Applied force alone is insufficient; their net forces and masses match.

A: F = 18 – 6 = 12 N.

B: F = 15 – 3 = 12 N.

Both: a = 12/3 = 4 m s^{-2} rightwards.

Applied force alone is insufficient; their net forces and masses match.

• Uses the stated physical or chemical relationship.

• Shows the relevant working and reasoning.

• Checks the result against the original conditions.

With help — worked answer 1

Solve a trolley problem with less help: mass 2 kg, 11 N right and 5 N left.

Step 1

Before: Choose a direction and identify all forces.

Action: Write net force, then isolate acceleration.

After: F = 11 – 5 = 6 N; a = 6/2 = 3 m s^{-2} rightwards

Why: Check 2 × 3 = 6 N.

3 m s^{-2} rightwards.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.

Later retrieval — worked answers

Retrieval 1
F = 20 – 8 = 12 N right; a = 12/4 = 3 m s^{-2} right.

Retrieval 2
m = F/a = 10/2 = 5 kg.

Retrieval 3
F = 2 × 3 = 6 N; P – 2 = 6, so P = 8 N rightwards.

Retrieval 4
Its speed decreases initially because acceleration opposes velocity. With balanced forces acceleration is zero and its existing velocity remains unchanged.

© 2026 EdDots · NSW Education Institute. All rights reserved.
Free sample for personal study and teaching.