AQA Combined Science (2016) Physics equations

Recall & Apply (21 in total)

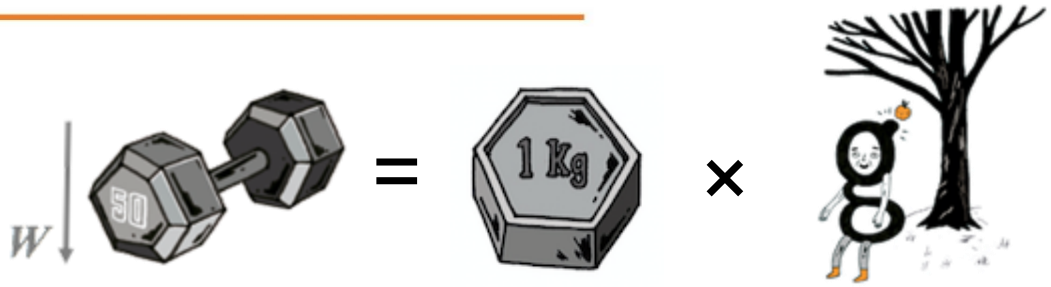
Commissioned by The PiXL Club Ltd. February 2016

Students should be able to **recall and apply** the following equations using **standard SI units.**

These equations have been taken directly from the AQA Combined Science GCSE specification 2016.

AQA Combined (2016)

Knowledge!



weight = mass × gravitational field strength

$$W = m \times g$$

N	kg	N/kg

Don't forget the SI units

Skills!

weight = mass × gravitational field strength

$$W = m\,g$$

Rearrange to make gravitational field strength g the subject:

$$\frac{W}{m} = \frac{\cancel{m}\,g}{\cancel{m}}$$

1 divide both sides by *m*

2 the *m's cancel out*

3 rearrange so g is on the left

$$\frac{W}{m} = g$$

$$g = \frac{W}{m}$$

Skills!

weight = mass × gravitational field strength

$$W = m\,g$$

Rearrange to make mass m the subject:

$$\frac{W}{g} = \frac{m\,\cancel{g}}{\cancel{g}}$$

1 divide both sides by g

2 the g's cancel out

3 rearrange so m is on the left

$$\frac{W}{g} = m$$

$$m = \frac{W}{g}$$

Practice!

1. Kirstie has a mass of 60 kg.
   Calculate Kirstie's weight on Earth, if the gravitational field strength is 10 N/kg?

2. On the Moon Kirstie, of mass 60 kg, would have a weight of 100 N.
   Calculate the gravitational field strength on the Moon.

3. Chris weighs 730 N.
   Calculate his mass, if the gravitational field strength is 10 N/kg?

Practice - workings

1. Kirstie has a mass of 60 kg.

Calculate Kirstie's weight on Earth, if the gravitational field strength is 10 N/kg?

weight = mass × gravitational field strength

$$W = m\,g$$

$$W = 60 \times 10$$

Answer W = 600 N

Don't forget the SI units

Practice - workings

2. On the Moon Kirstie, of mass 60 kg, would have a weight of 100 N. Calculate the gravitational field strength on the Moon.

weight = mass × gravitational field strength

$$W = m\,g$$

Rearrange to *m* the subject:

$$g = \frac{W}{m} \qquad g = \frac{100}{60}$$

Answer g = 1.67 N/kg

Don't forget the SI units

Practice - workings

3. Chris weighs 730 N.
Calculate his mass, if the gravitational field strength is 10 N/kg?

weight = mass × gravitational field strength

$$W = m\,g$$

$$m = \frac{W}{g} \qquad m = \frac{730}{10}$$

Answer m = 73 kg

Don't forget the SI units

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Knowledge!

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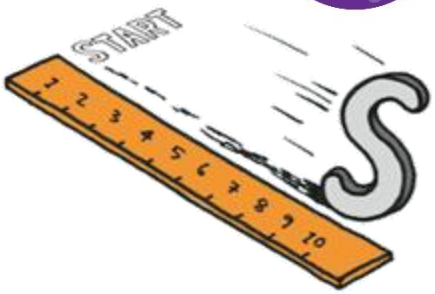


work done = **force** × **distance**

$W = F \times s$

J = N × m

Don't forget the SI units

Skills!

work done = force × distance

$$W = F\,s$$

Rearrange to force F the subject:

$$\frac{W}{s} = \frac{F\,\cancel{s}}{\cancel{s}}$$

1 divide both sides by *s*

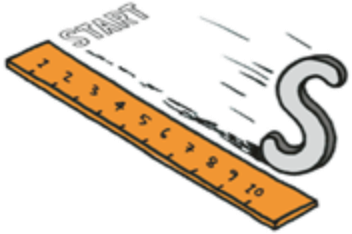
2 the *s's cancel out*

3 rearrange so F is on the left

$$\frac{W}{s} = F$$

$$F = \frac{W}{s}$$

Skills!



work done = force × distance

$$W = F\,s$$

Rearrange to distance s the subject:

$$\frac{W}{F} = \frac{F\,s}{F}$$

1 divide both sides by F

2 cancel out the F's

3 rearrange so s is on the left

$$\frac{W}{F} = s$$

$$s = \frac{W}{F}$$

Practice!

1. A student lifts a book onto a shelf 2.5 m high.
   The book has a weight of 15 N.
   Calculate the work done by the student.

2. A box is pushed with a force of 25 N up a slope.
   The work done on the box was 2000 J.
   Calculate the distance the box was pushed up the slope.

3. An electric motor raises a lift a distance of 20 m.
   The electric motor increases the store of gravitational potential energy by 450,000 J.
   Calculate the weight of the lift.

Practice - workings

1. A student lifts a book onto a shelf 2.5 m high.
The book has a weight of 15 N.
Calculate the work done by the student.

Work done = force x distance

$$W = F\,s$$

Answer W = 37.5 J

Don't forget the SI units

Practice - workings

2. A box is pushed with a force of 25 N up a slope.
The work done on the box was 2000 J.
Calculate the distance the box was pushed up the slope.

Distance = work done / force

$$s = W / F$$

Answer s = 80 m

Don't forget the SI units

Practice - workings

3. An electric motor raises a lift a distance of 20 m.
The electric motor increases the store of gravitational potential energy by 450,000 J.
Calculate the weight of the lift.

Force = work done / distance

$$F = W / s$$

Answer F = 22,500 N

Don't forget the SI units

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Knowledge!

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force applied to a spring = spring constant × extension

$F = k \times e$

N

N/m

m

Don't forget the SI units

Skills!

force applied to a spring = spring constant × extension

$$F = k\,e$$

Rearrange to make spring constant k the subject:

$$\frac{F}{e} = \frac{k\,\cancel{e}}{\cancel{e}}$$

1 divide both sides by *e*

2 the *e's cancel out*

3 rearrange so k is on the left

$$\frac{F}{e} = k$$

$$k = \frac{F}{e}$$

Skills!

force applied to a spring = spring constant × **extension**

$$F = k\,e$$

Rearrange to extension e the subject:

$$\frac{F}{k} = \frac{\cancel{k}\,e}{\cancel{k}}$$

1 divide both sides by k

2 the k's *cancel out*

3 rearrange so e is on the left

$$\frac{F}{k} = e$$

$$e = \frac{F}{k}$$

Practice!

1. A trampoline uses springs to support the jump mat. A single spring was tested for quality control. The spring had a spring constant of 4500 N/m. Calculate the force needed to give an extension of 0.15 m.

2. Calculate the extension of the spring if a force of 800 N was applied to a spring with a spring constant of 3200 N/m.

3. If a spring had an extension of 0.2 m when a force of 1200 N was applied calculate the spring constant of the spring.

Practice - workings

1. A trampoline uses springs to support the jump mat.
A single spring was tested for quality control.
The spring had a spring constant of 4500 N/m.
Calculate the force needed to give an extension of 0.15 m.

Force = spring constant x extension

$$F = k\,e$$

Answer F = 675 N

Don't forget the SI units

Practice - workings

2. Calculate the extension of the spring if a force of 800 N was applied to a spring with a spring constant of 3200 N/m.

Extension = force / spring constant

$$e = F / k$$

Answer e = 0.25 m

Don't forget the SI units

Practice - workings

3. If a spring had an extension of 0.2 m when a force of 1200 N was applied.
Calculate the spring constant of the spring.

Spring constant = force / extension

$$k = F / e$$

Answer k = 6000 N/m

Don't forget the SI units

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Knowledge!

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distance travelled = speed × time

$s = v \times t$

Don't forget the SI units

m m/s s

Skills!

distance travelled = **speed** × time

$$s = v\,t$$

Rearrange to make speed v the subject:

$$\frac{s}{t} = \frac{v\cancel{t}}{\cancel{t}}$$

1 divide both sides by *t*

2 the *t's cancel out*

3 rearrange so v is on the left

$$\frac{s}{t} = v$$

$$v = \frac{s}{t}$$

Skills!

distance travelled = speed × time

$$s = v\,t$$

Rearrange to make time t the subject:

$$\frac{s}{v} = \frac{\cancel{v}\,t}{\cancel{v}}$$

1 divide both sides by v

2 the v's *cancel out*

3 rearrange so t is on the left

$$\frac{s}{v} = \frac{t}{}$$

$$t = \frac{s}{v}$$

Practice!

1. A cyclist has an average speed of 8 m/s.
   Calculate the distance the cyclist would travel in 20 seconds.

2. A car travels along a motorway at a constant speed of 70 mph.
   Calculate how long it would take to travel 175 miles.

3. The new HS2 high speed train is expected to complete a journey from Birmingham to London in 50 minutes. The distance the train will travel would be 120 miles.
   Calculate the speed of the HS2 train.

Practice - workings

1. A cyclist has an average speed of 8 m/s.
Calculate the distance the cyclist would travel in 20 seconds.

Distance travelled = speed x time

$$s = v\,t$$

Answer s = 160 m

Practice - workings

2. A car travels along a motorway at a constant speed of 70 mph.
Calculate how long it would take to travel 175 miles.

Time = distance / speed

$$t = s / v$$

Answer t = 2.5 hours

Allow 2 hours 30 minutes
Do NOT allow 2 hours 50 minutes

Practice - workings

3. The new HS2 high speed train is expected to complete a journey from Birmingham to London in 50 minutes. The distance the train will travel would be 120 miles.
Calculate the speed of the HS2 train.

Speed = distance / time

$$v = s / t$$

Answer v = 144 mph

Don't forget to convert 50 minutes into hours to give an answer in mph.

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Knowledge!

m/s

Δv

PiXL Science

acceleration = change in velocity / time taken

a → m/s²

$a = \frac{\Delta v}{t}$

t → s

Don't forget the SI units

Remember! Δ means change in

Skills!

acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$

Rearrange to make change in velocity Δv the subject:

$$a \times t = \frac{\Delta v \times t}{t}$$

$$a \times t = \Delta v$$

1 multiply both sides by *t*

2 the *t's cancel out*

3 rearrange so Δv is on the left

$$\Delta v = a\ t$$

Skills!

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

Rearrange to make time taken t the subject:

$$a \times t = \frac{\Delta v \times t}{t}$$

$$\frac{a \times t}{a} = \frac{\Delta v}{a}$$

1 multiply both sides by t

2 the t's *cancel out*

3 divide both sides by a

4 the a's *cancel out*

$$t = \frac{\Delta v}{a}$$

Practice!

1. A car accelerates from rest to 20 m/s in 12 seconds.
   Calculate the acceleration of the car.

2. A rocket has an acceleration of 5.25 m/s^2 at take off.
   Assuming a constant rate of acceleration, calculate the speed of the rocket 3 seconds after take off.

3. A lorry has a velocity of 15 m/s.
   The lorry accelerates with an acceleration 1.4 m/s^2 until it reaches a velocity of 18 m/s.
   Calculate how long the lorry was accelerating for.

Practice - workings

1. A car accelerates from rest to 20 m/s in 12 seconds. Calculate the acceleration of the car.

Acceleration = change in speed / time

$$a = \frac{\Delta v}{t}$$

Answer $a = 1.67\ m/s^2$

Do not give more than 2 decimal places unless specifically asked. Ensure correct rounding.

Practice - workings

2. A rocket has an acceleration of 5.25 m/s^2 at take off. Assuming a constant rate of acceleration, calculate the speed of the rocket 3 seconds after take off.

Change in speed = acceleration x time

$$\Delta v = a\ t$$

Answer $\Delta v = 15.75$ m/s

Practice - workings

3. A lorry has a velocity of 15 m/s.
The lorry accelerates with an acceleration 1.4 m/s^2 until it reaches a velocity of 18 m/s.
Calculate how long the lorry was accelerating for.

Time = change in velocity / acceleration

$$t = \Delta v / a$$

Answer $t = 2.14$ s

Remember to use the change in velocity not the final velocity.

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Knowledge!

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resultant force = mass × acceleration

$$F = m \times a$$

N kg m/s^2

Don't forget the SI units

Skills!

resultant force = mass × acceleration

$$F = m\ a$$

Rearrange to make mass m the subject:

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

1 divide both sides by *a*

2 the *a's cancel out*

3 rearrange so m is on the left

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

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

Skills!

resultant force = mass × **acceleration**

$$F = m\ a$$

Rearrange to make acceleration a the subject:

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

1 divide both sides by m

2 the m's cancel out

3 rearrange so a is on the left

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

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

Practice!

1. A bus has a mass of 14,000 kg.
   Calculate the driving force applied by the motor if the acceleration of the bus was 0.75 m/s^2.

2. A cyclist applies a driving force of 150 N as she pedals her bike. The cyclist has a mass of 60 kg and the bike has a mass of 15 kg.
   Calculate the acceleration of the cyclist.

3. A motorcycle requires a braking force of 1500 N to have a deceleration of 5 m/s^2.
   Calculate the combined mass of the motorcycle and rider.

Practice - workings

1. A bus has a mass of 14,000 kg.
Calculate the driving force applied by the motor if the acceleration of the bus was 0.75 m/s^2.

Force = mass x acceleration

$$F = ma$$

Answer F = 10,500 N

Practice - workings

2. A cyclist applies a driving force of 150 N as she pedals her bike. The cyclist has a mass of 60 kg and the bike has a mass of 15 kg.

Calculate the acceleration of the cyclist.

Acceleration = force / mass

$$a = F / m$$

Answer $a = 2\ m/s^2$

Ensure units are correct.
Don't forget to add mass of bike and rider together.

Practice - workings

3. A motorcycle requires a braking force of 1500 N to have a deceleration of 5 m/s^2.
Calculate the combined mass of the motorcycle and rider.

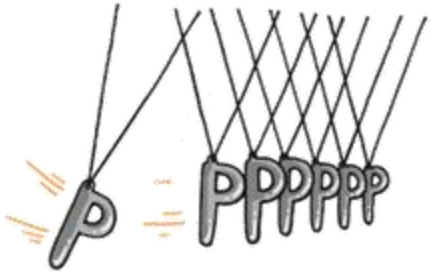
Mass = force / acceleration

$$m = F / a$$

Answer m = 300 kg

Remember the unit of mass (kg) has lower case k and lower case g.

Knowledge - HT!



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momentum = mass × velocity

$p = m \times v$

kgm/s kg m/s

HIGHER TIER ONLY

Don't forget the SI units

Skills – HT!

momentum = **mass** × velocity

$$p = m\,v$$

Rearrange to make mass m the subject:

$$\frac{p}{v} = \frac{m\,\cancel{v}}{\cancel{v}}$$

1 divide both sides by v

2 the v's *cancel out*

3 rearrange so m is on the left

$$\frac{p}{v} = m$$

$$m = \frac{p}{v}$$

HIGHER TIER ONLY

Skills - HT!

momentum = mass × **velocity**

$$p = m\,v$$

Rearrange to make velocity v the subject:

$$\frac{p}{m} = \frac{\cancel{m}\,v}{\cancel{m}}$$

1 divide both sides by m

2 the m's cancel out

3 rearrange so v is on the left

$$\frac{p}{m} = v$$

$$v = \frac{p}{m}$$

HIGHER TIER ONLY

Practice - HT!

1. A shopping trolley rolls down a gentle slope at a steady speed of 1.2 m/s.
   The shopping trolley has a mass of 15 kg.
   Calculate the momentum of the shopping trolley.

2. A bus travels down a road with a speed of 15 m/s.
   The bus has a momentum of 210,000 kgm/s.
   Calculate the mass of the bus.

3. Drones are used for photography.
   A drone has a momentum of 8 kgm/s and a mass of 400 g.
   Calculate the velocity of the drone.

HIGHER TIER ONLY

Practice – workings - HT

1. A shopping trolley rolls down a gentle slope at a steady speed of 1.2m/s.
The shopping trolley has a mass of 15 kg.
Calculate the momentum of the shopping trolley.

momentum = mass x velocity

$$p = m\ v$$

Answer p = 18 kgm/s

HIGHER TIER ONLY

Remember you can get the equation for momentum when given the units as kg (mass) is multiplied by m/s (velocity).

Practice – workings - HT

2. A bus travels down a road with a speed of 15 m/s.
The bus has a momentum of 210,000 kgm/s.
Calculate the mass of the bus.

mass = momentum / velocity

$$m = p / v$$

Answer m = 14,000 kg

HIGHER TIER ONLY

Practice – workings - HT

3. Drones are used for photography.
A drone has a momentum of 8 kgm/s and a mass of 400 g.
Calculate the velocity of the drone.

velocity = momentum / mass

$$v = p / m$$

Answer $v = 20$ m/s

Remember the standard unit of mass is the kg and there are 1000 grams in 1 kg.

HIGHER TIER ONLY

Knowledge!

$= \frac{1}{2}$

$\times$

^{2}

kinetic energy = 0.5 × mass × (speed)^2

$E_k = \frac{1}{2} m \times (v)^2$

J

kg

m/s^2

Don't forget the SI units

Skills!

kinetic energy = 0.5 × **mass** × (speed)^2

$$E_k = \frac{1}{2} m v^2$$

We can write the equation as: $E_k = \frac{m v^2}{2}$

Rearrange to make mass *m* the subject:

$$2 \times E_k = \frac{m v^2}{2} \times 2$$

$$2 \times E_k = m v^2$$

$$2 \times \frac{E_k}{v^2} = m$$

1 multiply both sides by *2*

2 the *2's cancel out*

3 divide both sides by v^2

4 the v^2*'s cancel out*

$$m = \frac{2E_k}{v^2}$$

Skills!

kinetic energy = 0.5 × mass × (**speed**)^2

$$E_k = \frac{1}{2} m v^2$$

We can write the equation as: $E_k = \frac{m v^2}{2}$

Rearrange to make speed v the subject:

$$2 \times E_k = \frac{m v^2}{2} \times 2$$

$$2 \times \frac{E_k}{m} = \frac{m v^2}{m}$$

$$2 \times \frac{E_k}{m} = v^2$$

$$\sqrt{\frac{2 E_k}{m}} = v$$

1 multiply both sides by *2*

2 the *2's cancel out*

3 divide both sides by *m*

4 the *m's cancel out*

5 square root to remove the square

$$v = \sqrt{\frac{2E_k}{m}}$$

Practice!

1. A bullet has a mass of 16 g and is fired at a speed of 400 m/s from a hand gun.
   Calculate the kinetic energy of the bullet.

2. A moving car has 14,000 J of kinetic energy. The car has a mass of 900 kg.
   Calculate the velocity of the car.

3. A book falls off a shelf. Just before impact the book had 2.25 J of kinetic energy. The speed of the book just before impact was 3 m/s.
   Calculate the mass of the book.

Practice - workings

1. A bullet has a mass of 16 g and is fired at a speed of 400 m/s from a hand gun.
Calculate the kinetic energy of the bullet.

kinetic energy = 0.5 × mass × (speed)^2

$$E_k = \frac{1}{2} m v^2$$

Answer $E_k = 1280$ J

Remember to convert grams to kilograms.
Do not square everything in the equation only the speed.

Practice - workings

2. A moving car has 14,000 J of kinetic energy. The car has a mass of 900 kg.
Calculate the velocity of the car.

$(\text{Speed})^2 = 2 \times \text{kinetic energy} / \text{mass}$

$$v^2 = 2 E_k / m$$

Answer $v = 5.58$ m/s

Remember to square root v^2 to get v.

Practice - workings

3. A book falls off a shelf. Just before impact the book had 2.25 J of kinetic energy. The speed of the book just before impact was 3 m/s. Calculate the mass of the book.

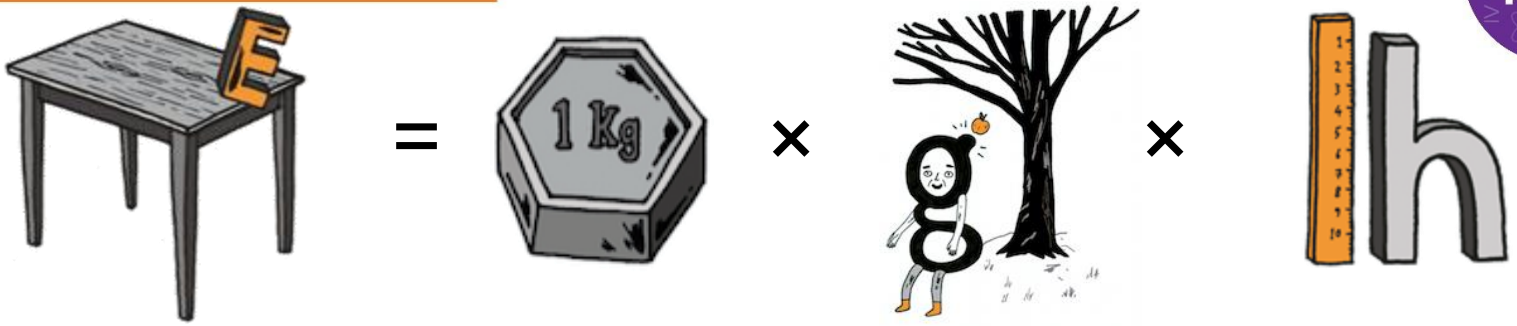
Mass = 2 x kinetic energy / (speed)^2

$$m = 2 E_k / v^2$$

Answer $m = 0.5$ kg

Don't forget the SI units

Knowledge!



gravitational potential energy = mass x gravitational field strength (g) x height

$$E_p = m \times g \times h$$

E_p	m	g	h
J	kg	N/kg	m

Don't forget the SI units

Skills!

gravitational potential energy = mass x gravitational field strength (g) x height

$$E_p = m\,g\,h$$

Rearrange to make mass *m* the subject:

$$\frac{E_p}{g\,h} = \frac{m\,\cancel{g}\,\cancel{h}}{\cancel{g}\,\cancel{h}}$$

$$\frac{E_p}{g\,h} = m$$

1 divide both sides by *gh*

2 the *gh's cancel out*

3 rearrange so *m* is on the left

$$m = \frac{E_p}{g\,h}$$

Skills!

gravitational potential energy = mass x gravitational field strength (g) x height

$$E_p = m\ g\ h$$

Rearrange to make gravitational field strength g the subject:

$$\frac{E_p}{m\ h} = \frac{\cancel{m}\ g\ \cancel{h}}{\cancel{m}\ \cancel{h}}$$

$$\frac{E_p}{m\ h} = g$$

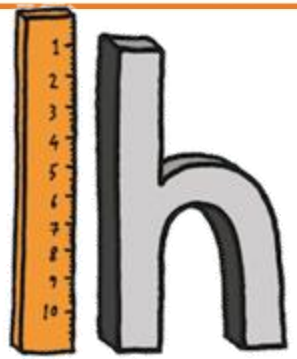
1 divide both sides by mh

2 the mh's cancel out

3 rearrange so g is on the left

$$g = \frac{E_p}{m\ h}$$

Skills!



gravitational potential energy = mass x gravitational field strength (g) x height

$$E_p = m\ g\ h$$

Rearrange to make height *h* the subject:

$$\frac{E_p}{m\ g} = \frac{\cancel{m\ g}\ h}{\cancel{m\ g}}$$

$$\frac{E_p}{m\ g} = h$$

1 divide both sides by *mg*

2 the *mg's cancel out*

3 rearrange so *h* is on the left

$$h = \frac{E_p}{m\ g}$$

Practice!

1. A rollercoaster car has a mass of 400 kg and has a height of 20 m.
   Calculate the gravitational potential energy of the rollercoaster car at the top of the track.
   Assume g = 10 N/kg.

2. A skydiver has 4.5 x 10^6 J of gravitational potential energy before stepping out a plane. The skydiver has a mass of 75 kg. Assume g = 10 N/kg
   Calculate the height of the skydiver.

3. A leaf falls 15 m off a tree. The leaf had 0.06 J of gravitational potential energy before falling. Assuming g = 10 N/kg, calculate the mass of the leaf in grams.

Practice - workings

1. A rollercoaster car has a mass of 400 kg and has a height of 20 m. Calculate the gravitational potential energy of the rollercoaster car at the top of the track.
Assume g = 10 N/kg.

GPE = mass x gravitational field strength x height

$$E_p = m\ g\ h$$

Answer $E_p = 80{,}000$ J

Practice - workings

2. A skydiver has 4.5 x 10^6 J of gravitational potential energy before stepping out a plane. The skydiver has a mass of 75 kg.
Assume g = 10 N/kg
Calculate the height of the skydiver.

Height = GPE / (mass x gravitational field strength)

$$h = E_p / (m\ g)$$

Answer h = 6000 m

Do get used to using standard form. Students will also need practice at using scientific calculators BEFORE the exam.

Practice - workings

3. A leaf falls 15 m off a tree. The leaf had 0.06 J of gravitational potential energy before falling.
Assuming g = 10 N/kg, calculate the mass of the leaf in grams.

Mass = GPE / (gravitational field strength x height)

$$m = E_p / (g\ h)$$

Answer $m = 0.4$ g

Remember to read the question and give the correct units – in this question grams.

Knowledge!

J

E

power = energy transferred / time

P

W

$$P = \frac{E}{t}$$

t

s

Don't forget the SI units

Skills!

power = $\frac{\text{energy transferred}}{\text{time}}$

$$P = \frac{E}{t}$$

Rearrange to make energy transferred E the subject:

$$P \times t = \frac{E \times \cancel{t}}{\cancel{t}}$$

$$P \times t = E$$

1 multiply both sides by *t*

2 the t's *cancel out*

3 rearrange so E is on the left

$$E = P\,t$$

Skills!

power = $\frac{\text{energy transferred}}{\text{time}}$

$$P = \frac{E}{t}$$

Rearrange to make time t the subject:

$$P \times t = \frac{E \times \cancel{t}}{\cancel{t}}$$

$$\frac{\cancel{P} \times t}{\cancel{P}} = \frac{E}{P}$$

1 multiply both sides by t

2 the t's *cancel out*

3 divide both sides by P

4 the P's *cancel out*

$$t = \frac{E}{P}$$

Practice!

1. Cranes are used to lift heavy building materials on a building site. One crane transfers 20,000 J of gravitational potential energy to the building materials in 16 seconds.
   Calculate the useful power output of the crane.

2. An energy efficient light bulb has a power rating of 7 W.
   Calculate the amount of energy transferred in 2 hours.

3. Professional cyclists can produce a steady power output of 240 W.
   Calculate the time taken for the cyclist to transfer 30,000 J of energy.

Practice - workings

1. Cranes are used to lift heavy building materials on a building site. One crane transfers 20,000 J of gravitational potential energy to the building materials in 16 seconds.
Calculate the useful power output of the crane.

Power = Energy transferred / time

$$P = E / t$$

Answer P = 1250 W

If you can't remember the watt is the standard unit of power, then use J/s which you can work out from the equation.

Practice - workings

2. An energy efficient light bulb has a power rating of 7 W.
Calculate the amount of energy transferred in 2 hours.

Energy = power x time

$$E = P\,t$$

Answer E = 50,400 J

There are 3,600 seconds in an hour, as 60 seconds in a minute and 60 minutes in an hour.

Practice - workings

3. Professional cyclists can produce a steady power output of 240 W. Calculate the time taken for the cyclist to transfer 30,000 J of energy.

Time = energy / power

$$t = E / P$$

Answer t = 125 s

Do NOT convert into minutes unless specifically asked to. A mistake doing the conversion will lose you marks.

Practice!

1. Cranes are used to lift heavy building materials on a building site. One crane transfers 20,000 J of gravitational potential energy to the building materials in 16 seconds.
   Calculate the useful power output of the crane.

2. An energy efficient light bulb has a power rating of 7 W.
   Calculate the amount of energy transferred in 2 hours.

3. Professional cyclists can produce a steady power output of 400W.
   Calculate the time taken for the cyclist to transfer 30,000 J of energy.

Practice - workings

1. Cranes are used to lift heavy building materials on a building site. One crane transfers 20,000 J of gravitational potential energy to the building materials in 16 seconds.
Calculate the useful power output of the crane.

Power = Energy transferred / time

$$P = E / t$$

Answer P = 1250 W

If you can't remember the watt is the standard unit of power, then use J/s which you can work out from the equation.

Practice - workings

2. An energy efficient light bulb has a power rating of 7 W.
Calculate the amount of energy transferred in 2 hours.

Energy = power x time

$$E = P\,t$$

Answer E = 50,400 J

There are 3,600 seconds in an hour, as 60 seconds in a minute and 60 minutes in an hour.

Practice - workings

3. Professional cyclists can produce a steady power output of 400 W. Calculate the time taken for the cyclist to transfer 30,000 J of energy.

Time = energy / power

$$t = E / P$$

Answer $t = 75$ s

Do NOT convert into minutes unless specifically asked to. A mistake doing the conversion will lose you marks.

Knowledge!

J

↑

W

↑

power = work done

time

↓

P

↓

W

$$P = \frac{W}{t}$$

↓

t

↓

s

Don't forget the SI units

Skills!

power = $\frac{\text{work done}}{\text{time}}$

$$P = \frac{W}{t}$$

Rearrange to make work done W the subject:

$$P \times t = \frac{W \times t}{t}$$

1 multiply both sides by t

2 the t's *cancel out*

3 rearrange so W is on the left

$$P \times t = W$$

$$W = P\,t$$

Skills!

power = $\frac{\text{work done}}{\text{time}}$

$$P = \frac{W}{t}$$

Rearrange to make time t the subject:

$$P \times t = \frac{W \times t}{t}$$

$$\frac{P \times t}{P} = \frac{W}{P}$$

1 multiply both sides by t

2 the t's cancel out

3 divide both sides by P

4 the P's cancel out

$$t = \frac{W}{P}$$

Practice!

1. An electric motor is used to raise a lift.
   If the electric motor does 20,000 J of work raising the lift over 40 seconds, calculate the power of the electric motor.

2. Tegan cycles up a hill and measures her power output to be 120 W.
   If it takes Tegan 30 seconds to get up the hill, calculate how much work Tegan has done.

3. A motor in a petrol car has a power rating of 73 kW.
   Calculate the amount of work done by the motor moving the car along a horizontal track for 25 minutes.

Practice - workings

1. An electric motor is used to raise a lift.
If the electric motor does 20,000 J of work raising the lift over 40 seconds.
Calculate the power of the electric motor.

Power = work done / time

$$P = W / t$$

Answer P = 500 W

Practice - workings

2. Tegan cycles up a hill and measures her power output to be 120 W.
If it takes Tegan 30 seconds to get up the hill.
Calculate how much work Tegan has done.

Work done = power x time

$$W = P \ t$$

Answer W = 3600 J

Practice - workings

3. A motor in a petrol car has a power rating of 73 kW.
Calculate the amount of work done by the motor moving the car along a horizontal track for 25 minutes.

Work done = Power x time

$$W = P\,t$$

Answer $W = 1.1 \times 10^8$ J

Did you convert 73 kW to 73,000 W?
What about 25 minutes to 1500 s?

Knowledge!

efficiency = useful output energy transfer / total input energy transfer

J

J

Don't forget the SI units

Skills!

$$\text{efficiency \%} = \frac{\textbf{useful output energy transfer}}{\text{total input energy transfer}}$$

Rearrange to make useful output energy transfer the subject:

$$\text{efficiency} \times \text{total input} = \frac{\text{useful output} \times \cancel{\text{total input}}}{\cancel{\text{total input}}}$$

$$\text{efficiency} \times \text{total input} = \text{useful output}$$

1 multiply both sides by *total input*

2 the *total input's cancel out*

3 rearrange so *useful output* is on the left

useful output = efficiency x total input

Skills!

$$\text{efficiency \%} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

Rearrange to make total input energy transfer the subject:

$$\text{efficiency} \times \text{total input} = \frac{\text{useful output} \times \cancel{\text{total input}}}{\cancel{\text{total input}}}$$

$$\frac{\cancel{\text{efficiency}} \times \text{total input}}{\cancel{\text{efficiency}}} = \frac{\text{useful output}}{\text{efficiency}}$$

1 multiply both sides by *total input*

2 the *total input's cancel out*

3 divide both sides by *efficiency*

4 cancel out *efficiency*

5 rearrange so *total output* is on the left

$$\text{total input} = \frac{\text{useful output}}{\text{efficiency}}$$

Practice!

1. An electric motor is supplied with 16,500 J of electrical energy.
   The motor is used to lift a box, which gains 9500 J of gravitational potential energy.
   Calculate the efficiency of the motor.

2. A coal fired power station has an efficiency of 40 %.
   If the output of the power station is 2.5 MJ of electrical energy, calculate the energy supplied by the coal.

3. An electric car has an efficiency of 0.68.
   Calculate the useful energy output if 6,000 J of electrical energy is supplied to the car by mains electricity.

Practice - workings

1. An electric motor is supplied with 16,500 J of electrical energy. The motor is used to lift a box, which gains 9500 J of gravitational potential energy.
Calculate the efficiency of the motor.

Efficiency = useful energy output / total energy input

Answer Efficiency = 0.58

57.6 % (or 58 %) is also allowed. 0.58 % though will lose one mark in the exam, likewise 57.6 with no unit.

Practice - workings

2. A coal fired power station has an efficiency of 40 %. If the output of the power station is 2.5 MJ of electrical energy.
Calculate the energy supplied by the coal.

Total energy input = useful energy output / efficiency

Answer total energy input = 6.25 MJ

Make sure that when you divide by the efficiency that it is as a decimal – in this case 0.4. Alternatively, find 1 % by dividing by 40 then multiply by 100 (%) to find the total energy input.

Practice - workings

3. An electric car has an efficiency of 0.68.
Calculate the useful energy output if 6,000 J of electrical energy is supplied to the car by mains electricity.

Useful energy output = total energy input x efficiency

Answer useful energy output = 4080 J

As the efficiency is a decimal no conversions are needed, as it would be if a percentage was used.

Knowledge!

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

J

J

Don't forget the SI units

Skills!

$$\text{efficiency \%} = \frac{\text{useful power output}}{\text{total power input}}$$

Rearrange to make useful power output the subject:

$$\text{efficiency} \times \text{total power input} = \frac{\text{useful power output} \times \text{total power input}}{\text{total power input}}$$

$$\text{efficiency} \times \text{total power input} = \text{useful power output}$$

1 multiply both sides by *total power input*

2 the *total power input's cancel out*

3 rearrange so *useful power output* is on the left

useful output = efficiency x total input

Skills!

$$\text{efficiency \%} = \frac{\text{useful power output}}{\text{total power input}}$$

Rearrange to make total power input the subject:

efficiency x total P input = useful P output x total P input / total input

efficiency x total P input / efficiency = useful P output / efficiency

1 multiply both sides by *total power input*

2 the *total power input's cancel out*

3 divide both sides by *efficiency*

4 rearrange so *total power input* is on the left

total power input = useful power out / efficiency

Practice!

1. An electric motor has a power output of 300 W.
   If the electrical power supplied to the motor is 750 W
   calculate the efficiency of the electric motor.

2. A coal fired power station has an efficiency of 32 %.
   The power output of the power station is 400 MW.
   Calculate the input power for the power station.

3. A model steam train has an efficiency of 23 %.
   The fuel supplied to the model train gives a power input of 20 W.
   Calculate the useful power output of the train.

Practice - workings

1. An electric motor has a power output of 300 W.
If the electrical power supplied to the motor is 750 W.
Calculate the efficiency of the electric motor.

efficiency = useful power output / total power input

Answer Efficiency = 0.4

As a decimal efficiency has no units. Remember no machine can be more than 100 % efficient.

Practice - workings

2. A coal fired power station has an efficiency of 32 %.
The power output of the power station is 400 MW.
Calculate the input power for the power station.

total power input = useful power output / efficiency

Answer total power input = 1250 MW

Remember there must be a greater total power in than useful power out.

Practice - workings

3. A model steam train has an efficiency of 23 %.
The fuel supplied to the model train gives a power input of 20 W.
Calculate the useful power output of the train.

useful power output = efficiency x total power input

Answer Useful power output = 4.6 W

Just keep an eye on the units being used. Sometimes the question will be in non-standard units e.g., MW.

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Knowledge!

PiXL Science

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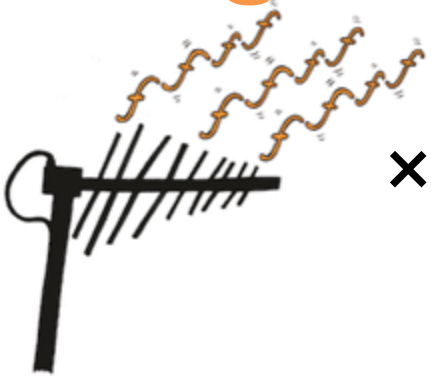

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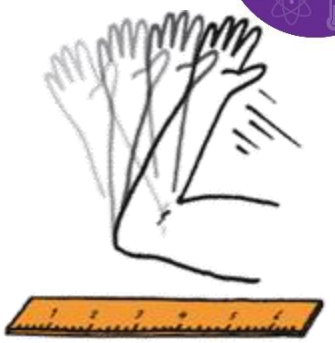


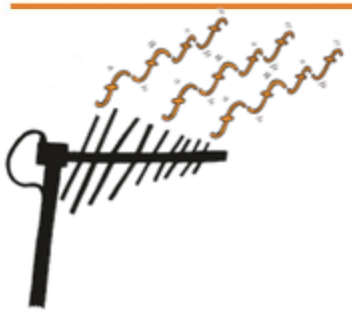
wave speed = frequency × wavelength

$v = f \times \lambda$

m/s Hz m

Don't forget the SI units

Skill!



wave speed = **frequency** × wavelength

$$v = f\lambda$$

Rearrange to make frequency f the subject:

$$\frac{v}{\lambda} = \frac{f\cancel{\lambda}}{\cancel{\lambda}}$$

1 divide both sides by λ

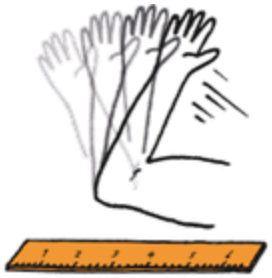
2 the λ's *cancel out*

3 rearrange so f is on the left

$$\frac{v}{\lambda} = f$$

$$f = \frac{v}{\lambda}$$

Skills!



wave speed = frequency × **wavelength**

$$v = f\lambda$$

Rearrange to make wavelength λ the subject:

$$\frac{v}{f} = \frac{f\lambda}{f}$$

1 divide both sides by f

2 the f's cancel out

3 rearrange so λ is on the left

$$\frac{v}{f} = \lambda$$

$$\lambda = \frac{v}{f}$$

Practice!

1. Microwaves have a wavelength of 12 cm. Microwaves travel at a speed of 2.5×10^9 Hz.
   Calculate the speed of microwaves.

2. Red light has a frequency of 700 nm. The speed of light is 3×10^8 m/s.
   Calculate frequency of red light.

3. A water wave has a wave speed of 12 m/s.
   The water wave has frequency of 4 Hz.
   Calculate the wavelength of the water wave.

Practice - workings

1. Microwaves have a wavelength of 12 cm.
Microwaves travel at a speed of 2.5 x 10^9 Hz.
Calculate the speed of microwaves.

Wave speed = frequency x wavelength

$$v = f\lambda$$

Answer $v = 3 \times 10^8$ m/s

300,000,000 m/s is also fine as an answer. 12 cm = 0.12 m.
It is worth remembering that this is the speed of light, and all EM waves in a vacuum – and nothing can travel faster than this.

Practice - workings

2. Red light has a frequency of 700 nm. The speed of light is 3 x 10^8 m/s.

Calculate frequency of red light.

Frequency = wave speed / wavelength

$$f = v / \lambda$$

Answer $f = 4.2 \times 10^{14}$ Hz

Do get used to using standard form, especially at higher level. This is a bit mean at foundation level but could still be asked.

Practice - workings

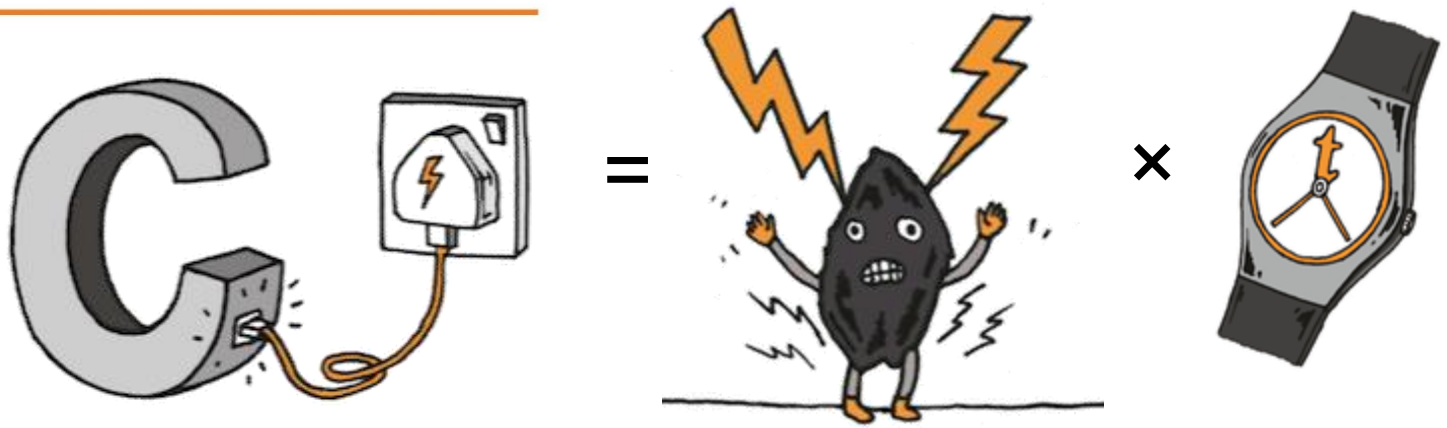
3. A water wave has a wave speed of 12 m/s.
The water wave has frequency of 4 Hz.
Calculate the wavelength of the water wave.

Wavelength = wave speed / frequency

$$\lambda = v / f$$

Answer $\lambda = 3$ m

Knowledge!



charge flow = current × time

$$Q = I \times t$$

C A s

Don't forget the SI units

Skill!

charge flow = **current** × time

$$Q = I\,t$$

Rearrange to make current I the subject:

$$\frac{Q}{t} = \frac{I\cancel{t}}{\cancel{t}}$$

1 divide both sides by t

2 the t's *cancel out*

3 rearrange so I is on the left

$$\frac{Q}{t} = I$$

$$I = \frac{Q}{t}$$

Skills!

charge flow = current × time

$$Q = I\,t$$

Rearrange to make time t the subject:

$$\frac{Q}{I} = \frac{\cancel{I}\,t}{\cancel{I}}$$

1 divide both sides by I

2 the I's cancel out

3 rearrange so Q is on the left

$$\frac{Q}{I} = t$$

$$t = \frac{Q}{I}$$

Practice!

1. A torch has a current of 0.2 A flowing through the bulb. Calculate the amount of charge that would flow in 15 seconds.

2. An electric motor has 200 C of charge flowing through it in 400 seconds.
   Calculate the current flowing through the motor.

3. A phone has a current of 0.05 A flowing during normal use. If a charge of 90 C flows through the circuit, calculate the length of time the phone was in use for.

Practice - workings

1. A torch has a current of 0.2 A flowing through the bulb.
Calculate the amount of charge that would flow in 15 seconds.

Charge flow = current x time

$$Q = I\,t$$

Answer = 3 C

Practice - workings

2. An electric motor has 200 C of charge flowing through it in 400 seconds.

Calculate the current flowing through the motor.

Current = Charge flow / time

$$I = Q / t$$

Answer = 0.5 s

Practice - workings

3. A phone has a current of 0.05 A flowing during normal use.
If a charge of 90 C flows through the circuit, calculate the length of time the phone was in use for.

time = charge flow / current

$$t = Q / I$$

Answer = 1800 s

Don't convert this to minutes unless you have to.

Knowledge!

=

×

potential difference = current × resistance

$$V = I \times R$$

V A Ω

Don't forget the SI units

Skill!

potential difference = **current** × resistance

$$V = I\,R$$

Rearrange to make current I the subject:

$$\frac{V}{R} = \frac{I\cancel{R}}{\cancel{R}}$$

1 divide both sides by R

2 the R's *cancel out*

3 rearrange so I is on the left

$$\frac{V}{R} = I$$

$$I = \frac{V}{R}$$

Skills!

potential difference = current × **resistance**

$$V = I\,R$$

Rearrange to make resistance R the subject:

$$\frac{V}{I} = \frac{I\,R}{I}$$

1 divide both sides by I

2 the I's cancel out

3 rearrange so R is on the left

$$\frac{V}{I} = R$$

$$R = \frac{V}{I}$$

Practice!

1. A lamp is placed into a circuit. The lamp has a resistance of 120 Ω. A current of 0.15 A flows through the lamp.
   Calculate the potential difference across the lamp.

2. Tom tries to find the resistance of a piece of wire using a voltmeter and an ammeter.
   The potential difference across the wire was measured to be 1.75 V and the current flowing through the circuit was 25 mA.
   Calculate the resistance of the wire.

3. An LED was added to a circuit. The potential difference across the LED was 3.5 V. The LED had a resistance of 13 Ω.
   Calculate the current that flowed through the LED.

Practice - workings

1. A lamp is placed into a circuit. The lamp has a resistance of 120 Ω.
A current of 0.15 A flows through the lamp.
Calculate the potential difference across the lamp.

Potential difference = current x resistance

$$V = I R$$

Answer V = 18 V

Practice - workings

2. Tom tries to find the resistance of a piece of wire using a voltmeter and an ammeter.
The potential difference across the wire was measured to be 1.75 V and the current flowing through the circuit was 25 mA.
Calculate the resistance of the wire.

Resistance = potential difference / current

$$R = V / I$$

Answer $R = 70\ \Omega$

Remember the prefixes that are commonly used with each unit. Current is often measured in mA and wavelength nm, for example.

Practice - workings

3. An LED was added to a circuit. The potential difference across the LED was 3.5 V. The LED had a resistance of 13 Ω.
Calculate the current that flowed through the LED.

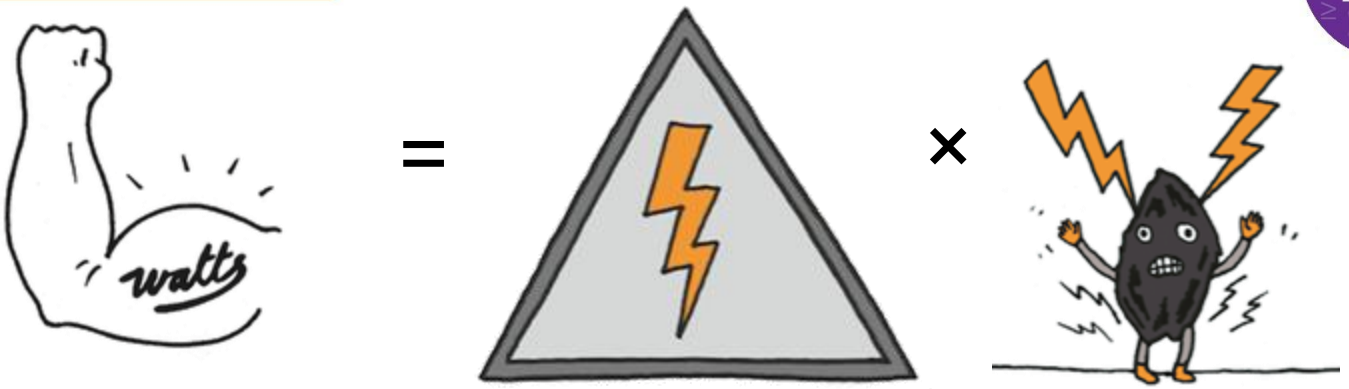
Current = potential difference / resistance

$$I = V / R$$

Answer I = 0.27 A

Get used to rounding answers.
It will not always be neat, especially if real life examples are used.

Knowledge!



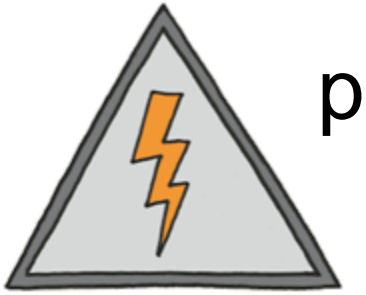
power = potential difference × current

$P = V \times I$

W V A

Don't forget the SI units

Skill!



power = **potential difference** × current

$$P = V\,I$$

Rearrange to make potential difference V the subject:

$$\frac{P}{I} = \frac{V\cancel{I}}{\cancel{I}}$$

1 divide both sides by I

2 the *I's cancel out*

3 rearrange so P is on the left

$$\frac{P}{I} = V$$

$$V = \frac{P}{I}$$

Skills!

power = potential difference × **current**

$$P = V\,I$$

Rearrange to make current I the subject:

$$\frac{P}{V} = \frac{\cancel{V}\,I}{\cancel{V}}$$

1 divide both sides by V

2 the V's cancel out

3 rearrange so I is on the left

$$\frac{P}{V} = I$$

$$I = \frac{P}{V}$$

Practice!

1. An electric kettle is connected to mains electricity at 230 V. The kettle has a current of 6 A flowing when it is boiling the water.
   Calculate the power of the kettle in kW.

2. An old style, incandescent, lightbulb has power rating of 100 W. If the bulb is connected to mains electricity at 230 V 50 Hz ac, calculate the current flowing through the bulb.

3. An electric motor has a power rating of 0.15 W stamped onto the side. If a current of 0.1 A flows through the motor calculate the potential difference across the motor.

Practice - workings

1. An electric kettle is connected to mains electricity at 230 V. The kettle has a current of 6 A flowing when it is boiling the water.
Calculate the power of the kettle in kW.

Power = potential difference x current

$$P = V I$$

Answer $P = 1.38$ kW

To convert watts to kilowatts divide by 1000.

Practice - workings

2. An old style, incandescent, lightbulb has power rating of 100 W. If the bulb is connected to mains electricity at 230 V 50 Hz ac, calculate the current flowing through the bulb.

Current = power / potential difference

$$I = P / V$$

Answer I = 0.43 A

Sometimes a question will involve numbers that are not needed, like the 50 Hz in this question. Knowing what to use and what to ignore is an important skill.

Practice - workings

3. An electric motor has a power rating of 0.15 W stamped onto the side. If a current of 0.1 A flows through the motor, calculate the potential difference across the motor.

Potential difference = power / current

$$V = P / I$$

Answer V = 1.5 V

Ensure that the unit is written as a capital letter – a lower case v is wrong. Get used to dividing by decimals. You will be given a calculator to use in the exam. Don't try and solve these in your head or long hand - it wastes time.

Knowledge!

=

^{2} ×

power = (current)^2 × resistance

$P = I^2 \times R$

W A Ω

Don't forget the SI units

Skill!

power = (current)^2 × resistance

$$P = I^2 R$$

Rearrange to make current I the subject:

$$\frac{P}{R} = \frac{I^2 \cancel{R}}{\cancel{R}}$$

$$\frac{P}{R} = I^2$$

$$\sqrt{\frac{P}{R}} = I$$

1 divide both sides by R

2 the R's *cancel out*

3 square root P/R to remove the square

4 rearrange so I is on the left

$$I = \sqrt{\frac{P}{R}}$$

Skills!

power = (current)^2 × resistance

$$P = I^2 R$$

Rearrange to make resistance R the subject:

$$\frac{P}{I^2} = \frac{I^2 R}{I^2}$$

1 divide both sides by V

2 the V's cancel out

3 rearrange so I is on the left

$$\frac{P}{I^2} = R$$

$$R = \frac{P}{I^2}$$

Practice!

1. Wires heat up as an electric current flows through them.
   Calculate the power loss in a wire that has a resistance of 400 Ω and a current of 0.12 A flowing through it.

2. An LED has a resistance of 13 Ω and transfers electrical energy at a rate of 0.012 W
   Calculate the current flowing through the LED.

3. A phone charger has a power rating of 5 W.
   Calculate the resistance of the phone charger if there is a current of 0.32 A flowing through it.

Practice - workings

1. Wires heat up as an electric current flows through them. Calculate the power loss in a wire that has a resistance of 400 Ω and a current of 0.12 A flowing through it.

$$\text{power} = (\text{current})^2 \times \text{resistance}$$

$$P = I^2 R$$

Answer $P = 5.76$ W

Remember it is only the current that is squared.

Practice - workings

2. An LED has a resistance of 13 Ω and transfers electrical energy at a rate of 0.012 W

Calculate the current flowing through the LED.

$$\text{Current} = \sqrt{(power \ / \ resistance)}$$

$$I = \sqrt{\left(\frac{P}{R}\right)}$$

Answer I = 0.0303 A

Do remember to get the square root of power divided by current – not just the square root of the power then divided by the current. Brackets are your friend.

Practice - workings

A phone charger has a power rating of 5 W.
Calculate the resistance of the phone charger if there is a current of 0.32 A flowing through it.

Resistance = power / (current)^2

$$R = P / I^2$$

Answer $R = 48.8\ \Omega$

Make sure only the current is squared.

Knowledge!

TRANSFERRED

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energy transferred = power × time

$$E = P \times t$$

J W s

Don't forget the SI units

Skill!

energy transferred = **power** × time

$$E = P\,t$$

Rearrange to make power P the subject:

$$\frac{E}{t} = \frac{P\cancel{t}}{\cancel{t}}$$

1 divide both sides by t

2 the t's cancel out

3 rearrange so P is on the left

$$\frac{E}{t} = P$$

$$P = \frac{E}{t}$$

Skills!

energy transferred = power × time

$$E = P\,t$$

Rearrange to make time t the subject:

$$\frac{E}{P} = \frac{P\,t}{P}$$

1 divide both sides by t

2 the t's cancel out

3 rearrange so t is on the left

$$\frac{E}{P} = t$$

$$t = \frac{E}{P}$$

Practice!

1. An electric oven has a power rating of 5 kW.
   Calculate the amount of energy transferred if the oven is left on for 30 minutes.

2. A kettle transfers 180,000 J of electrical energy in 115 seconds.
   Calculate the power rating of the kettle.

3. An energy efficient lightbulb has a power rating of 6 W.
   Calculate how long the lightbulb was left on for if 12,000 J of energy was transferred.

Practice - workings

1. An electric oven has a power rating of 5 kW.
Calculate the amount of energy transferred if the oven is left on for 30 minutes.

energy transferred = power × time

$$E = P\,t$$

Answer E = 9 MJ or 9,000,000 J

Do remember to convert 5 kW to watts and 30 minutes to 1800 seconds.

Practice - workings

2. A kettle transfers 180,000 J of electrical energy in 115 seconds. Calculate the power rating of the kettle.

Power = energy transferred / time

$$P = E / t$$

Answer P = 1565 W

A whole number answer here is fine as all other quantities are given as whole numbers.

Practice - workings

3. An energy efficient lightbulb has a power rating of 6 W.
Calculate how long the lightbulb was left on for if 12,000 J of energy was transferred.

Time = energy transferred / power

$$t = E / P$$

Answer t = 2000 s

No conversion to minutes or hours needed as it has not been asked for.

Knowledge!

TRANSFERRED

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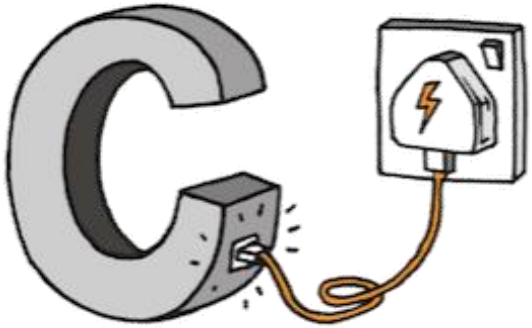

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energy transferred = charge flow × potential difference

$$E = Q \times V$$

J C V

Don't forget the SI units

Skill!

energy transferred = **charge flow** × potential difference

$$E = Q\,V$$

Rearrange to make charge flow Q the subject:

$$\frac{E}{V} = \frac{Q\,\cancel{V}}{\cancel{V}}$$

1 divide both sides by V

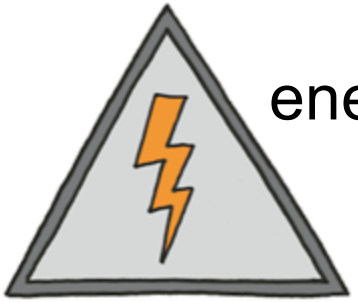
2 the V's cancel out

3 rearrange so Q is on the left

$$\frac{E}{V} = Q$$

$$Q = \frac{E}{V}$$

Skills!



energy transferred = charge flow × **potential difference**

$$E = Q\,V$$

Rearrange to make potential difference V the subject:

$$\frac{E}{Q} = \frac{\cancel{Q}\,V}{\cancel{Q}}$$

1 divide both sides by Q

2 the Q's cancel out

3 rearrange so V is on the left

$$\frac{E}{Q} = V$$

$$V = \frac{E}{Q}$$

Practice!

1. A charge of 120 C flows through a small motor. The motor has a potential difference of 3 V across it. Calculate the energy transferred by the motor.

2. An LED transfers 4 J of electrical energy. The LED has a potential difference of 0.75 V. Calculate the charge flow through the LED.

3. Drones used in aerial photography use electric motors. The motors transfer 6 J of electrical energy per second. If a charge of 4 C flows through the motors each second, calculate the potential difference across the motors.

Practice - workings

1. A charge of 120 C flows through a small motor. The motor has a potential difference of 3 V across it.
Calculate the energy transferred by the motor.

energy transferred = charge flow × potential difference

$$E = Q\ V$$

Answer E = 360 J

Practice - workings

2. An LED transfers 4 J of electrical energy.
The LED has a potential difference of 0.75 V.
Calculate the charge flow through the LED.

Charge flow = energy transferred / potential difference

$$Q = E / V$$

Answer = 5.3C

Practice - workings

3. Drones used in aerial photography use electric motors.
The motors transfer 6 J of electrical energy per second.
If a charge of 4 C flows through the motors each second, calculate the potential difference across the motors.

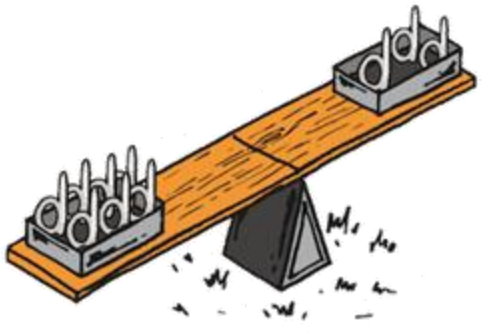
Potential difference = energy transferred / charge flow

$$V = E / Q$$

Answer V = 1.5 V

After rearranging an equation try putting your calculated answer into the original equation to check your answer. You can spot errors quickly by doing this and not throw away marks.

Knowledge!



kg

m

density = mass / volume

ρ

Kg/m³

$$\rho = \frac{m}{V}$$

V

m³

Don't forget the SI units

Skills!

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\rho = \frac{m}{V}$$

Rearrange to make mass m the subject:

$$\rho \times V = \frac{m \times V}{V}$$

1 multiply both sides by V

2 the V's *cancel out*

3 rearrange so m is on the left

$$\rho \times V = m$$

$$m = \rho V$$

Skills!

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\rho = \frac{m}{V}$$

Rearrange to make volume V the subject:

$$\rho \times v = \frac{m \times V}{V}$$

$$\frac{\rho \times V}{\rho} = \frac{m}{\rho}$$

1 multiply both sides by V

2 the V's *cancel out*

3 divide both sides by ρ

4 the ρ's *cancel out*

$$V = \frac{m}{\rho}$$

Practice!

1. A block of lead has a mass of 15 kg.
   The lead block has a volume of 0.0014 m^3.
   Calculate the density of the lead block.

2. Air has a density of 1.225 kg/m^3.
   Calculate the mass of air in a room with a volume of 300 m^3.

3. Coke has a density of 1100 kg/m^3.
   A small bottle of coke has a mass of 450 g.
   Calculate the volume of coke in the bottle.

Practice - workings

1. A block of lead has a mass of 15 kg.
The lead block has a volume of 0.0014 m^3.
Calculate the density of the lead block.

Density = mass / volume

$$\rho = m / V$$

Answer $\rho = 10714\ kg/m^3$

Remember the standard units of density are kg/m^3 NOT kg/m3.

Practice - workings

2. Air has a density of 1.225 kg/m^3.
Calculate the mass of air in a room with a volume of 300 m^3.

mass = density x volume

$$m = \rho V$$

Answer m = 367.5 kg

Don't assume that as air has a low density that it has no mass – a large room full of air can contains tons of it.

Practice - workings

3. Coke has a density of 1100 kg/m^3.
A small bottle of coke has a mass of 450 g.
Calculate the volume of coke in the bottle.

Volume = mass / density

$$V = m / \rho$$

Answer $V = 4.1 \times 10^{-4}$ m^3

Ensure that the same units are used throughout – if density is in kg/m^3, make sure that you convert the mass into kg.