

Sheet1

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Sheet1

QUEST,C,254

In the "SI" system of units, what does : m/s mean?

A micrometer can make measurements to the nearest 0.01mm. Express this precision in terms of metres.

A cube has sides of .3m x .3m x .3m What is its volume, expressed in cubic cm.?

An object's mass is measured to be 70 grams. When immersed in water in a measuring cylinder, the level rises from 27ml to 47ml.

A motor car is specified to be capable of travelling at 100 miles per hour. Is "100 m.p.h." a speed or a velocity?

A car is moving along a straight road. It's velocity changes from 15 to 25 m/s in 5 s. What is it's uniform acceleration?

A piece of ticker-tape represents a time-interval of 1/10th second (five dots) and its length is 5cm. Knowing the direction in a photograph, you may have to calculate the area under a speed-time graph (= distance travelled). This is likely to involve finding the area under a curve.

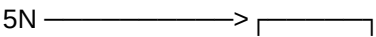
You may have to calculate the area under a speed-time graph (= distance travelled). This is likely to involve finding the area under a curve.

A motor car accelerates from rest at 1.5 m/s<sup>2</sup>. What is its speed after 10 seconds, in m/s ?

Newton's 2nd law can be summarised as  $F = ma$ . Use it to calculate what force is required to produce an acceleration of 1.5 m/s<sup>2</sup> on a mass of 200kg.

An astronaut's mass is 70kg. On the earth he weighs 686N, what does he weigh on the moon? [Acceleration due to moon's gravity is 1.6 m/s<sup>2</sup>]

Earlier in CALFACTS we have reviewed: (a) Distance (b) Displacement (c) Acceleration (d) Velocity. Which of these is a scalar?

What is the resultant force on this body:  (LEFT)

Hooke's Law applies to springs as well as straight wires. A spring of length 20cm extends to 30cm when a weight of 5N is hung from it.

If you stand in the middle of a plank which is supported at both ends, is the surface touching your feet in compression or tension?

What are the units for a moment of a force?

Consider two laminas, one square and one an equilateral triangle, both with sides of the same length. If both are stood on one edge, which has the larger area?

Calculate the force needed to cause a mass of 3kg to continue in circular motion around a horizontal circle of radius 1.5m with a constant speed of 2m/s.

What is the work done when a force of 30N moves through a distance of 6 metres?

A person weighing 500N runs up some stairs to a height of 5m in 4 seconds. What power was needed to do this?

A lever can be used to overcome a load of 500N by the application of an effort of 50N. What is the mechanical advantage ?

Using a simple lever, a load of 100N is moved 2m by the application of an effort of 20N through a distance of 11m. What is the work done?

When a floor is polished with wax, how is friction likely to change?

A filing cabinet weighs 450N and its base measures 1m by 0.5m. Calculate the pressure exerted by the filing cabinet on the floor.

Mercury is very much more dense than water. If a barometer were made using water rather than mercury in a tube, do you think it would be practical?

[Paper 3 & extended knowledge question]. Calculate the pressure in Pascals at the bottom of a column of water 10m high.

A candle is a source of chemical energy - when it is lit, what other form(s) of energy is the chemical energy converted to?

A car of mass 500kg is travelling at a velocity of 15m/s in a certain direction. What is the car's Kinetic Energy?

What energy conversion takes place when an electric storage heater is being supplied with electricity?

What major energy changes are occurring in the four-stroke petrol engine cycle?

A piece of copper and a piece of cork are both at the same temperature, which is below your body temperature. When you touch them, which feels colder?

An electric kettle uses which main method of heat transfer?

In very hot countries it is advantageous to paint buildings white and to wear white clothes - true or false?

How is a temperature of -196°C expressed in the Kelvin scale?

If a narrower capillary is used for a mercury-in-glass thermometer what does this do to its sensitivity?

The specific heat capacity of ice is 210 J/kg K. How much heat is required to raise the temperature of 500g of ice from -20°C to 0°C?

40,000 J of electrical energy raises the temperature of 1kg water by 9.5°C. Calculate the approximate specific heat capacity of water.

The specific latent heat of vaporization of water is 2,260,000 J/kg. How much energy is required to convert 100g of water to steam?

How long does it take a 2kW electric kettle to boil dry, assuming that it has just brought 1kg of water to the boil? (Note: specific heat capacity of water is 4200 J/kg K)

When ether is wiped onto the skin it feels cold because...

What mechanism of heat transfer predominates inside a refrigerator?

If someone has difficulty in removing a metal screw-top from a glass bottle, it can help to run hot water over the cap for a while.

From 0°C to 4°C, water behaves in an unusual manner. Explain what happens to its DENSITY over this temperature range.

A cubic metre of gas is heated to change its temperature from 300K to 400K at constant pressure. What is its final volume?

A container of gas is at a temperature of 300K (room temperature). At what temperature would the pressure be doubled, assuming the volume is constant?

Sheet1

ANS1,C,30  
Mass per Second  
.00001 metre  
27 c.c.  
3.5 kg/cubic metre  
Speed  
10 metres/second  
.005 metres/second  
Area = base x height  
150 m/s  
666.67 N  
112N  
Scalar: a,b Vector: c  
19N, direction left.  
17.5 N  
Tension  
Newtons  
The square one  
4 N  
5J  
625 J  
Mechanical Advantage = 10  
110%  
Increases  
225 Pa  
Higher  
101,396 Pa  
Light  
56.25kJ  
Electric to Potential  
Thermal-Mechanical  
Both the same  
Conduction  
True  
469K  
Increases sensitivity  
1050 kJ  
380 kJ/kg K  
22,600 Joules  
19.17 minutes  
It anaesthetises the skin  
Conduction  
Water lubricates metal/glass.  
Stays the same  
0.75 cu metre  
600K

Sheet1

RESP1,C,200

No, the units for mass are kg.

Right! mm (millimetres) are metres divided by 1,000. Dividing 0.01mm by 1,000 equals .00001. If you were to express the same

Not correct. You need to convert metres to centimetres before doing the multiplication. .3m = 30cm.

Not right - this value is the density measured in g/c.c. Convert grams to kg and c.c. to cubic metres before calculating the

Yes you are right. Distance (miles) per unit Time (hours) is specified with no mention of direction. In this case, direction is

No - this is the CHANGE in velocity. Divide it by 5 to get the RATE of CHANGE of velocity.

No - you may have made your mistake when dividing by 1/10. This is the same as multiplying by 10.

No. This is the area of any rectangle.

No you are a factor of 10 out

No - you have DIVIDED the mass by the acceleration.

That's right! He weighs about 1/6th of his "earth" weight. His mass remains constant.

Displacement is distance with the direction specified. Therefore it is a Vector

No, there are forces of 9N acting to the right, and a force of 10N acting to the left. The forces do not all act in the same direction

Careful... the EXTENSION of the spring is only 15cm (35cm - 20cm).

No. This would mean that this surface was being "stretched"

A force is measured in Newtons, but the moment of a force is defined as the force x distance. Therefore metres must appear in

No - use a scale diagram to understand this. When you have drawn both laminas to scale, find their centres by drawing perpendicular

No. The formula is  $mv^2/r$

No - Work is Force x Distance.

Review the units of work and power....

That's right! Note that mechanical advantage is a ratio and has no units

You have inverted the formula for efficiency. Machine efficiencies will always be less than 100%. Review the definition...

No - the polishing introduces wax into the irregularities on the floor, making it smoother.

No - you have multiplied by 0.5 instead of dividing by 0.5.

Correct! As water is less dense, the column of water will have to be higher to equal the pressure on the surface of the water in

Correct! Substituting these values into  $p = \rho gh$  gives the answer. As a mercury barometer will read about 76cm high at sea-level

Partly right, but there is also a small heat output.

Correct! K.E. is  $\frac{1}{2}mv^2$ .

No. There has been no change in the POSITION of the radiator.

This is part of the process, but go back one stage and consider what form the energy is supplied to the engine.

Not to the touch - the better conductor will conduct heat away from your hand more quickly.

No - liquids are not very good conductors of heat.

Yes! It reduces the absorption of radiant heat energy

No - note that the Celsius value is NEGATIVE.

Correct! The same increase in volume of mercury will have to go further up the capillary tube compared to when a wider tube

Careful with units: convert 500g to kg.

No - you have multiplied when you should have divided - check formula....

A factor of 10 out - energy =  $0.1 \times L$ .

Well done! Time in minutes =  $1 \times 2,300,000$  (N.B. Much longer to ----- boil dry than to

No, this would not explain the feeling of cold - remember that ether evaporates quickly.

No. Shelves and walls of a refrigerator are thermal insulators.

No - the water is unable to penetrate into most of the metal-glass contact.

No. Check what happens to its VOLUME over this temperature range, and then use DENSITY = MASS/VOLUME

You have substituted incorrectly in the equation - always think about whether the answer seems right.... the gas EXPANDS

Yes! You use  $p_{initial} \times 2 \times p_{initial}$  ----- = ----- 300 T final

Sheet1

ANS2,C,30  
Miles per Second  
10 metres  
2700 c.c.  
285.7 kg/cubic metre  
Velocity  
50 metres/second squared  
0.5 metres/second  
Area = side1 x side2 x side3  
15 m/s  
1.5kN  
686N  
Scalar: a,c Vector: b  
1N, direction left.  
3.33 N  
Compression  
Newtons/metre  
The triangular one  
18 N  
180J  
10 kW  
Mechanical Advantage = 0.1  
18.2%  
Decreases  
0.0011 Pa  
Lower  
10,139,616 Pa  
Light and Heat  
73.575kJ  
Electric to Internal  
Chemical-Mechanical  
Copper feels colder  
Convection  
False  
-469K  
Decreases sensistivity  
1050 J  
141.6 J/kg K  
None  
1150 minutes  
It causes convection currents  
Convection  
Glass contracts  
Increases  
1 cu metre  
150K

Sheet1

RESP2,C,200

Careful, the distance unit "miles" is not part of the SI system of units. Try again.

No. To convert mm into metres you must divide by 1,000. Think about the size of your answer - 10 metres is the height of a house.

Wrong - convert each individual dimension from metres to centimetres BEFORE multiplying...

Wrong - you've divided volume by mass. Density = Mass / Volume.

There is no direction specified, just distance (miles) in time (hrs) Velocity is DISPLACEMENT in time.

Wrong. You must divide the change in velocity by the time the change occurred over.

Yes! Note that if the body was accelerating uniformly as in the earlier example, then the average velocity represents the velocity at the midpoint.

Wrong - review your Maths formulae for areas of rectangles and triangles.

Correct answer! Using  $v = u + at$  you get

$$v = 0 + (1.5 \times 10) \text{ m/s.}$$

Correct answer! The force in newtons is equal to  $1,000 \times 1.5$ . The answer of 1,500 newtons has been expressed in kilonewtons.

His MASS will remain constant, but his WEIGHT will be proportional to the gravitational acceleration. Therefore, on the moon his weight is 1/6th of his weight on Earth.

Acceleration is the rate of change of velocity. We have already established that velocity is a vector...

Yes.  $10\text{N} - 9\text{N} = 1\text{N}$ ! You can do the same thing with scaled drawings: trivial in this case, but very useful for more complex shapes.

No - you need a greater force to produce a greater extension.  $3.33\text{N}$  is LESS than  $5\text{N}$ .

Yes! The combined force of your weight and the plank's weight acts to push the plank down in the centre. This puts the upper end of the plank in tension.

No... the moment is defined as force MULTIPLIED by distance, not divided.

That's right! This means that this shape is more stable (unlikely to topple over if disturbed) than the square one.

No. The formula is  $mv^2/r$

Right! Work done =  $30 \times 6$  Joules (Newton metres)

Power is work DIVIDED by time....

You have worked out the inverse ratio. Divide the load by the effort

No - use the last formula on the information page.

Yes - as well as cleaning off dirt, the polishing action fills in small depressions which could collect dirt - this also happens to the surface of the metal.

Wrong. You have divided area by force.

No. Water is less dense than mercury, therefore the column will have to be higher to produce the same force downwards as the mercury.

No, you are a factor of 10 out. The height of mercury needs to be expressed in units of metres (0.76m).

Yes! A lighted candle is converting chemical energy to light and heat energy.

You may have applied the wrong formula. You need to calculate KINETIC, not potential energy.

Yes! Electric energy is used to heat up a thermal mass like bricks in the radiator - the internal energy of the mass has increased.

The energy starts off in chemical form, and ends up as mechanical, but there is an important intermediate stage - review the information page.

Yes! Copper is the better conductor and takes heat away from your hand faster than the cork.

Yes! - it relies on the circulation of water to heat it all up.

Read the last paragraph of the text again...

No - you ADD 273 to the Celsius value. Note that you cannot have a temperature below 0 K.

Temperature is measured by observing the change in volume of the mercury - if the tube is narrower, the same change in volume produces a larger change in height.

That's right! Heat energy =  $0.5 \times 210 \times 10 = 1050$  joules.

No - you may have used the wrong value for  $\dot{U}$ . You simply use 9.5 for the temperature change (same in °C as in K).

Energy is always needed to cause a change of state - please review the information page carefully...

Wrong - probably not converted from seconds to minutes.

No, this cannot be explained by convection currents. Think about the fact that ether readily evaporates...

Correct! Warm air at the bottom of the refrigerator rises to be cooled by the freezing coils.

Like most materials, glass expands when heated...however you need to think about the RELATIVE expansion of glass with respect to water.

That's right! Contrary to most liquids, water contracts over this temperature range, which means that its volume gets smaller as it cools.

Review Charles' Law - if pressure is constant, volume increases with temperature.

No - pressure is DIRECTLY proportional to temperature. Therefore a higher temperature is needed to produce an increased volume.

Sheet1

ANS3,C,30

Metres per Second

.0001 metre

90 c.c.

3,500 kg/cubic metre

Neither

5 metres/second squared

10 metres/second

Area =  $\frac{1}{2}$  base x height

75 m/s

1,015 N

43.75N

Scalar: a    Vector: b,c

10N, direction right.

10 N

Newtons/metre<sup>2</sup>

8 N

180N

625 W

90.9%

Stays the same

450 Pa

Same

Don't know

Electrical

14MJ

Chemical-Thermal-Mechanical

Cork feels colder

77K

3150 J

4210 J/kg K

226,000 Joules

19,167 minutes

It absorbs heat on evaporation

Radiation

Pressure inside increases

Decreases

100 cu metre

Don't know

Sheet1

RESP3,C,200

That's right! m = metres, s = second, and "/" means "per" or "divided by". \_1 This could a

You are a factor of 10 out. Check your arithmetic...  $1\text{m} = 1,000\text{mm}$

You have performed an addition rather than a multiplication. First, convert cube's sides to cm (.3m = 30cm). Then, multiply the

Well done! Unit conversion is not easy. 70g = .070kg and 20 ml is equal to 20 c.c. = 20/1,000,000 cubic metres. Dividing the

Although "miles per hour" are not SI units, they do describe a Distance in a particular Time. No direction is specified howev

Incorrect. Check your arithmetic, and review information...

Incorrect. Ave velocity = Displacement / Time. In metres, the displacement is .05 m in the known direction. The time inter

Correct! The area is equal to half the base multiplied by the height

No - you may have misused the equations. The correct equation to use is  $v = u + at$

Wrong - Newton's 2nd Law says the Force = Mass x Acceleration. Therefore Force = 1,000 x 1.5 Newtons.

No - you have divided mass by acceleration. Force(weight)=Mass x Acceleration

Correct! Both displacement and acceleration involve a direction being specified

You may have multiplied the vectors acting to the left, rather than adding them. There are 9N acting to the right, and 10N acti

Wrong - 10cm extension is produced by 5N force. A 15cm extension is produced by  $(5 \times 15) = 10\text{ N}$

No... remember  $M = F \times d$  ; F is in Newtons, and d is in metres (not square metres)

Correct! A familiar example of the centripetal force is when corner-ing in a car. The "tighter" the bend (that is, the smaller "r" is

Your units are wrong... work is measured in Newton Metres, otherwise known as Joules, J.

Correct answer!  $500 \times 5$  Power = ----- Watts 4

Correct answer. Always make sure that the load and distance units are the same for both the load and the effort!

A polishing action is likely to produce a smoothing effect - what effect will this have on friction?

No. Divide the force by the area (which is  $0.5\text{m}^2$ ).

No. The same height column of water will exert less force downwards compared to mercury, and therefore the pressure will b

The formula you need is Pressure = height x density x gravity (see information page). Height IN METRES is 0.76, density and

There is no electrical energy associated with a candle burning. There is light given off by a candle (which is energy) and on

Check your maths: K.E. =  $0.5 \times 500 \times 15 \times 15$  Joules.

Correct! (We have ignored secondary factors such as sound)

No. Cork will feel warmer than copper because it is not very good at conducting heat away from your hand. That's why cork is

Correct! Temperature in K =  $(-196) + 273 = 273 - 196 = 77$  This happens to be the temperature of liquid nitrogen.

Wrong answer; temperature change is 10 K, mass is 0.5kg. Substitute in  $\text{heat} = m c \Delta T$ .

Well done!  $40,000$  S.H.Capacity = ----- J/kg K 1 x

Correct! Energy =  $0.1 \times 2,260,000\text{ J}$ .

No - check units, especially power which should be 2,000 watts.

Correct! Molecules leaving the ether are of high kinetic energy - what remains is therefore of lower kinetic energy (colder).

There is very little radiation loss from a refrigerator.

Whilst the pressure inside the bottle may increase (there is a safety hazard here), this is not the reason for the top becomi

No... you might expect this to be the case, but in fact over this temperature range water's volume decreases. Therefore, den

No. Read the information page carefully - use the equation given, using 300K as initial temperature and 400K as final temp

You use the formula given in the facts review, with the final pressure equal to  $2 \times p_{\text{initial}}$  (the  $p_{\text{initial}}$ 's cancel out).



Sheet1

ANS4,C,30  
Metres  
.000001 metre  
27,000 c.c.

2 metres/second squared

0.15kN  
428.75N

7.5 N

Newton metres

400 W

100%

900 Pa

Don't know

Don't know  
Don't know  
226,000 Watts  
Don't know

Top expands more than glass

1.33 cu metre

Sheet1

RESP4,C,200

There are two units written here, with a "/" between them, which signifies "per". You have correctly identified the first unit, You are a factor of 10 out. Check your arithmetic... 1m = 1,000mm

Well done! 0.027 cubic metres equals 27,000 cubic centimetres. (easiest method : 30cm x 30cm x 30 cm = 27,000 c.c.)

25 - 15 2

Yes! Acceleration = \_\_\_\_\_ m / s

5

You are a factor of 10 out. Check your conversion from Newtons to kiloNewtons.

No. Consider the mass of 70kg being acted upon by the moon's gravitational acceleration. The weight is a FORCE. New

This is right! If 5N produces a 10cm extension then 7.5 N will produce a 15cm extension. The spring balance makes use of

Correct. You can see from the definition, and from the units, that as d increases, so does the moment. That's why it's easier

Power is work ÷ time. The work done is the force (500N) x distance. Divide this by the time in seconds. Review the details...

Whilst machines can be 100% efficient in theory, in practice there are "losses" which make a machine's efficiency somewhat

Yes! The area the force is applied over is 0.5m<sup>2</sup>, and pressure is the force (450N) divided by the area. Pa = Pascals.

Use Temperature in K = (Temperature in °C) + 273

[Note: questions like this won't be set on papers 1 and 2] Use heat required = mass x specific heat capacity x temp. cha

[Note: questions like this won't be set on papers 1 and 2] Use: 40,000 = mass(1kg) x S.H.Capacity x Ú(9.5 K)

Your units are wrong - energy is measured in Joules, power in Watts.

The formula is: 2,000(watts) x time(secs) = 1 (kg) x 2,300,000

Correct! Both glass and metal expand, but the metal expands more.

That's right! You just use 1 V final

---- = -----

300