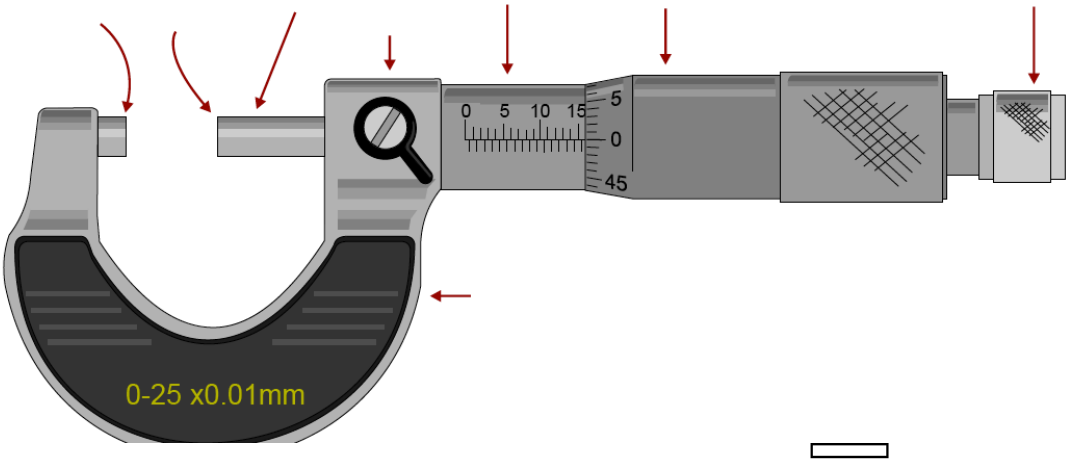
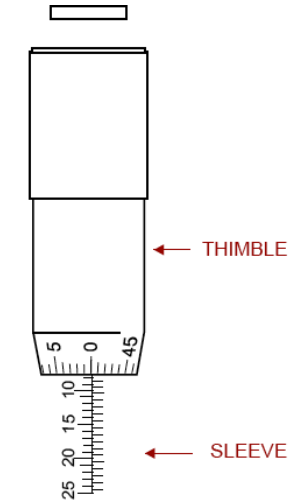
AS PHYS Mock Revision 2013

UNIT 1 - STANDARDS AND THEIR MEASUREMENT: This unit includes topic 1 and 2 from the CIE syllabus for AS course.

Complete the drawing of the micrometer by adding the names / labels of the various parts.



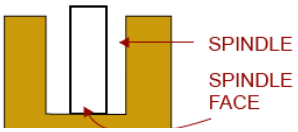
2. Complete the drawing of the depth gauge micrometer shown opposite. Add appropriate colour and shade.

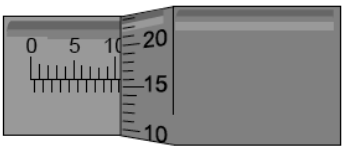


3. Below is a description of the depth gauge micrometer and how it is used to measure the depth of a blind hole. Add the missing words to complete the paragraph.

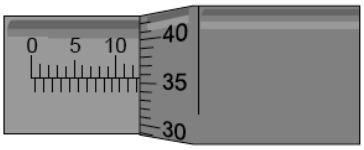
The _____ gauge micrometer is a _____ measuring instrument, used by engineers to measure depths. Each revolution of the _____ moves the spindle face 0.5mm towards the bottom of the blind hole. The diagram below shows how the depth gauge is used. The ratchet is turned _____ until the _____ face touches the bottom of the blind hole. The scales are read in exactly the same way as the scales of a normal micrometer .

rachet clockwise spindle depth precision





SLEEVE READS FULL mm =
SLEEVE READS ½ mm =
THIMBLE READS =
TOTAL MEASUREMENT =



SLEEVE READS FULL mm =
SLEEVE READS ½ mm =
THIMBLE READS =
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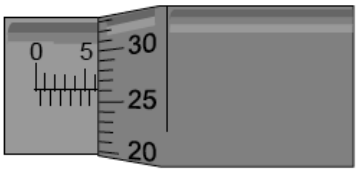
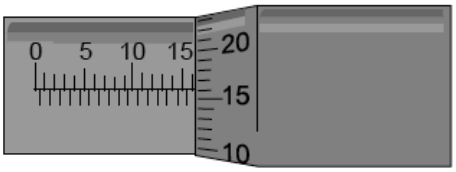


SLEEVE READS FULL mm =
SLEEVE READS ½ mm =
THIMBLE READS =
TOTAL MEASUREMENT =



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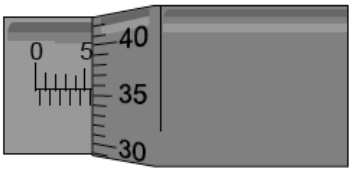
TOTAL MEASUREMENT =



SLEEVE READS FULL mm =
SLEEVE READS ½ mm =
THIMBLE READS =
TOTAL MEASUREMENT =

May/June 2010 paper 21 Question 1 a

A unit is often expressed with a prefix. For example, the gram may be written with the prefix 'kilo' as the kilogram. The prefix represents a power-of-ten. In this case, the power-of-ten is 10^3.

Complete Fig. 1.1 to show each prefix with its symbol and power-of-ten.

prefix	symbol	power-of-ten
kilo	k	10^3
nano	n	.....
centi	.....	10^{-2}
.....	M	10^6
.....	T	10^{12}

Fig. 1.1

[4]

May/June 2010 paper 21 Question 1 b

Complete Fig. 2.1 to show whether each of the quantities listed is a vector or a scalar.

	vector / scalar
distance moved	.....
speed	.....
acceleration	.....

Fig. 2.1

[3]

May/June 2009, Paper 22, question 1(a)

(a) State the most appropriate instrument, or instruments, for the measurement of the following.

(i) the diameter of a wire of diameter about 1 mm

..... [1]

(ii) the resistance of a filament lamp

..... [1]

(iii) the peak value of an alternating voltage

..... [1]

Oct/Nov 2008, Paper 2, question 1

1 **(a)** The current in a wire is I. Charge Q passes one point in the wire in time t. State

(i) the relation between I, Q and t,

..... [1]

(ii) which of the quantities I, Q and t are base quantities.

.....

..... [2]

May/June 2008, Paper 2, question 1

Make reasonable estimates of the following quantities.

(a) the frequency of an audible sound wave

frequency = ... Hz [1]

(b) the wavelength, in nm, of ultraviolet radiation

wavelength = ... nm [1]

(c) the mass of a plastic 30 cm ruler

mass = ... g [1]

(d) the density of air at atmospheric pressure

density = ... kg m^{-3} [1]

(b) The current in the wire is due to electrons, each with charge q, that move with speed v along the wire. There are n of these electrons per unit volume.
For a wire having a cross-sectional area S, the current I is given by the equation

$$I = nSqv^k,$$

where k is a constant.

(i) State the units of I, n, S, q and v in terms of the base units.

I .....

n .....

S .....

q .....

v .....

[3]

(ii) By considering the homogeneity of the equation, determine the value of k.

k = ... [2]

Oct/Nov 2007, Paper 1, question 1

The equation relating pressure and density is $p = \rho gh$.

How can both sides of this equation be written in terms of base units?

A $[\mathrm{N\,m^{-1}}] = [\mathrm{kg\,m^{-3}}]\,[\mathrm{m\,s^{-1}}]\,[\mathrm{m}]$

B $[\mathrm{N\,m^{-2}}] = [\mathrm{kg\,m^{-3}}]\,[\mathrm{m\,s^{-2}}]\,[\mathrm{m}]$

C $[\mathrm{kg\,m^{-1}\,s^{-2}}] = [\mathrm{kg\,m^{-3}}]\,[\mathrm{m\,s^{-2}}]\,[\mathrm{m}]$

D $[\mathrm{kg\,m^{-1}\,s^{-1}}] = [\mathrm{kg\,m^{-1}}]\,[\mathrm{m\,s^{-2}}]\,[\mathrm{m}]$

May/June 2010, Paper 22, question 1

1 A metal wire has a cross-section of diameter approximately 0.8 mm.

(a) State what instrument should be used to measure the diameter of the wire.

.....[1]

(b) State how the instrument in **(a)** is

(i) checked so as to avoid a systematic error in the measurements,

.....

.....[1]

(ii) used so as to reduce random errors.

.....

.....

.....[2]

Oct/Nov 2009, Paper 22, question 1

1 A simple pendulum may be used to determine a value for the acceleration of free fall g. Measurements are made of the length L of the pendulum and the period T of oscillation.

The values obtained, with their uncertainties, are as shown.

$T = (1.93 \pm 0.03)\,\text{s}$
$L = (92 \pm 1)\,\text{cm}$

(a) Calculate the percentage uncertainty in the measurement of

(i) the period T,

uncertainty = ... % [1]

(ii) the length L.

uncertainty = ... % [1]

(b) The relationship between T, L and g is given by

$$g = \frac{4\pi^2 L}{T^2}.$$

Using your answers in **(a)**, calculate the percentage uncertainty in the value of g.

uncertainty = ... % [1]

(c) The values of L and T are used to calculate a value of g as 9.751 m s^{-2}.

(i) By reference to the measurements of L and T, suggest why it would not be correct to quote the value of g as 9.751 m s^{-2}.

.....

..... [1]

(ii) Use your answer in **(b)** to determine the absolute uncertainty in g.

Hence state the value of g, with its uncertainty, to an appropriate number of significant figures.

g = ... ± ..... m s^{-2} [2]

Oct/Nov 2009, Paper 12, question 11

11 The diagrams show two ways of hanging the same picture.

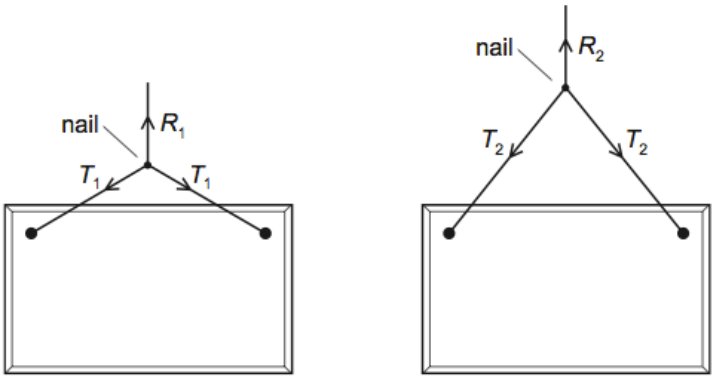


diagram 1 diagram 2

In both cases, a string is attached to the same points on the picture and looped symmetrically over a nail in a wall. The forces shown are those that act on the nail.

In diagram 1, the string loop is shorter than in diagram 2.

Which information about the magnitude of the forces is correct?

A $R_1 = R_2$ $T_1 = T_2$

B $R_1 = R_2$ $T_1 > T_2$

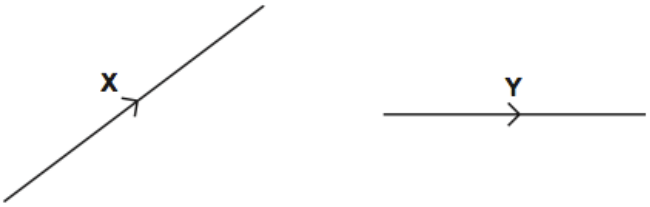
C $R_1 > R_2$ $T_1 < T_2$

D $R_1 < R_2$ $T_1 = T_2$

Space for working

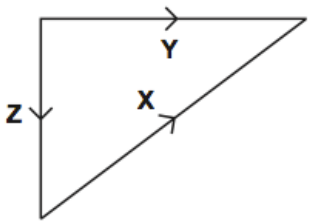
Oct/Nov 2007, Paper 1, question 3

3 The diagram shows two vectors **X** and **Y**.

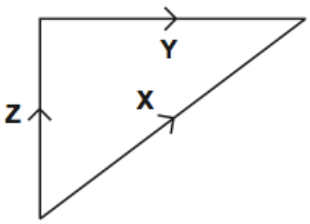


In which vector triangle does the vector **Z** show the magnitude and direction of vector **X–Y**?

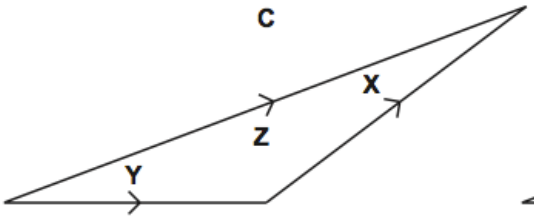
A



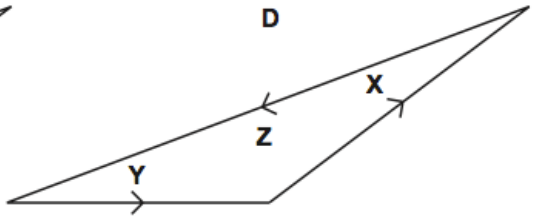
B



C



D



UNIT 2 – MOTION, FORCE AND ENERGY

This unit includes topics 3, 4, 5 and 6 from the CIE syllabus for AS course.

May/June 2010, Paper 22, question 2

2 **(a)** The distance *s* moved by an object in time *t* may be given by the expression

$$s = \frac{1}{2}at^2$$

where *a* is the acceleration of the object.

State two conditions for this expression to apply to the motion of the object.

1. .....

.....

2. .....

.....

[2]

(b) A student takes a photograph of a steel ball of radius 5.0 cm as it falls from rest. The image of the ball is blurred, as illustrated in Fig. 2.1.
The image is blurred because the ball is moving while the photograph is being taken.

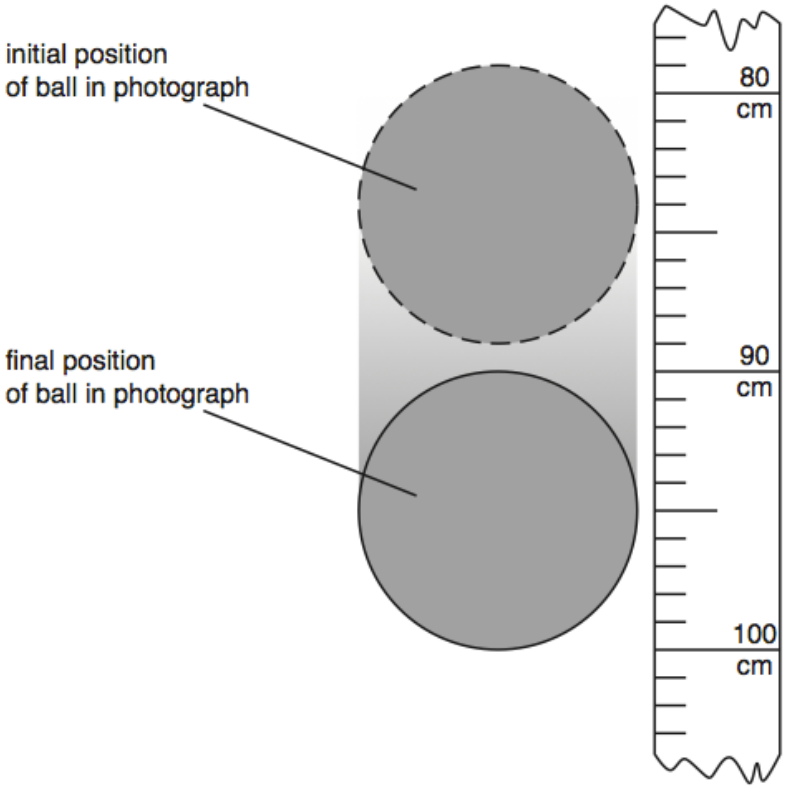


Fig. 2.1

The scale shows the distance fallen from rest by the ball. At time $t = 0$, the top of the ball is level with the zero mark on the scale. Air resistance is negligible.

Calculate, to an appropriate number of significant figures,

(i) the time the ball falls before the photograph is taken,

time = ... s [3]

(ii) the time interval during which the photograph is taken.

time interval = ... s [3]

(c) The student in **(b)** takes a second photograph starting at the same position on the scale. The ball has the same radius but is less dense, so that air resistance is not negligible.

State and explain the changes that will occur in the photograph.

.....

.....

.....

.....[2]

May/June 2008, Paper 2, question 3

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3 A shopping trolley and its contents have a total mass of 42 kg. The trolley is being pushed along a horizontal surface at a speed of $1.2\,m\,s^{-1}$. When the trolley is released, it travels a distance of 1.9 m before coming to rest.

(a) Assuming that the total force opposing the motion of the trolley is constant,

(i) calculate the deceleration of the trolley,

deceleration = ... $m\,s^{-2}$ [2]

(ii) show that the total force opposing the motion of the trolley is 16 N.

[1]

(b) Using the answer in **(a)(ii)**, calculate the power required to overcome the total force opposing the motion of the trolley at a speed of $1.2\,m\,s^{-1}$.

power = ... W [2]

(c) The trolley now moves down a straight slope that is inclined at an angle of 2.8° to the horizontal, as shown in Fig. 3.1.

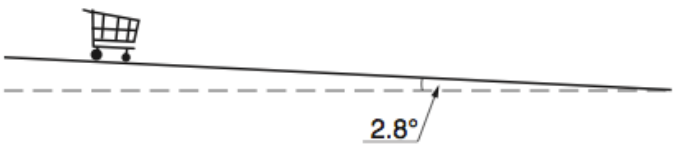

Fig. 3.1

The constant force that opposes the motion of the trolley is 16 N.

Calculate, for the trolley moving down the slope,

(i) the component down the slope of the trolley's weight,

component of weight = ... N [2]

(ii) the time for the trolley to travel from rest a distance of 3.5 m along the length of the slope.

time = ... s [4]

(d) Use your answer to **(c)(ii)** to explain why, for safety reasons, the slope is not made any steeper.

.....

.....[1]

Oct/Nov 2008, Paper 2, question 2

2 A car is travelling along a straight road at speed *v*. A hazard suddenly appears in front of the car. In the time interval between the hazard appearing and the brakes on the car coming into operation, the car moves forward a distance of 29.3 m. With the brakes applied, the front wheels of the car leave skid marks on the road that are 12.8 m long, as illustrated in Fig. 2.1.

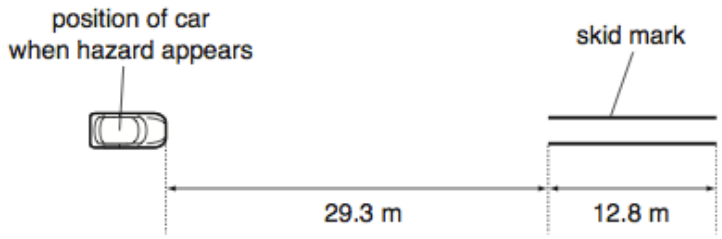

Fig. 2.1

It is estimated that, during the skid, the magnitude of the deceleration of the car is 0.85*g*, where *g* is the acceleration of free fall.

(a) Determine

(i) the speed *v* of the car before the brakes are applied,

v = ... ms^{-1} [2]

(ii) the time interval between the hazard appearing and the brakes being applied.

time = ... s [2]

(b) The legal speed limit on the road is 60 km per hour.
Use both of your answers in **(a)** to comment on the standard of the driving of the car.

.....

.....

.....

..... [3]

Oct/Nov 2009, Paper 21, question 2

2 A sky-diver jumps from a high-altitude balloon.

(a) Explain briefly why the acceleration of the sky-diver

(i) decreases with time,

.....

.....

..... [2]

(ii) is $9.8\,m\,s^{-2}$ at the start of the jump.

.....

..... [1]

(b) The variation with time t of the vertical speed v of the sky-diver is shown in Fig. 2.1.

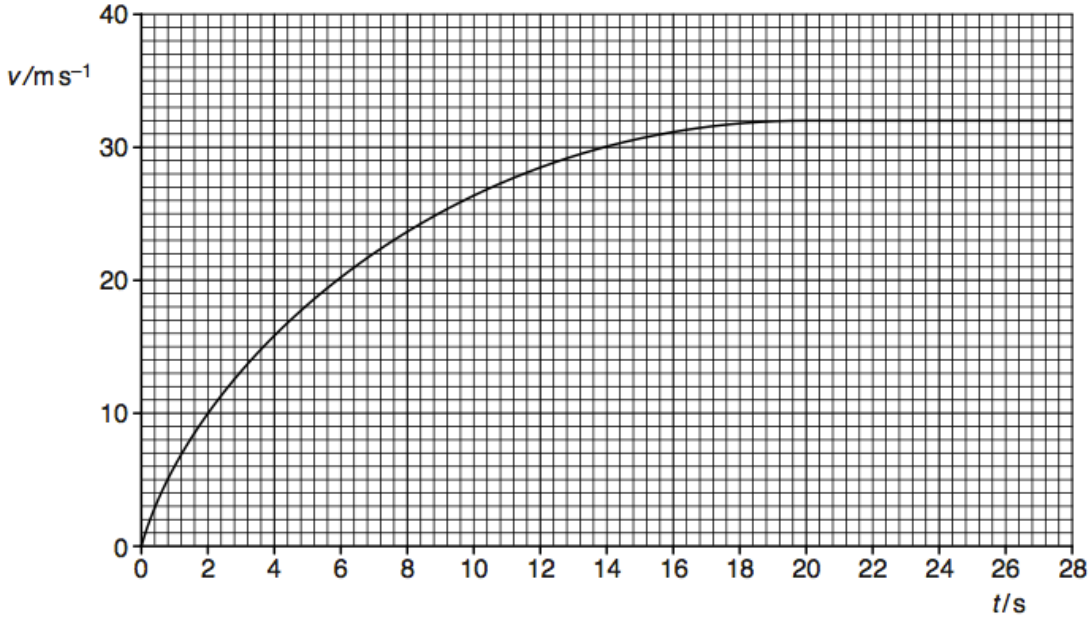

Fig. 2.1

Use Fig. 2.1 to determine the magnitude of the acceleration of the sky-diver at time $t = 6.0\,s$.

acceleration = ... m s^{-2} [3]

(c) The sky-diver and his equipment have a total mass of 90 kg.

(i) Calculate, for the sky-diver and his equipment,

1. the total weight,

weight = ... N [1]

2. the accelerating force at time $t = 6.0\,s$.

force = ... N [1]

(ii) Use your answers in **(i)** to determine the total resistive force acting on the sky-diver at time $t = 6.0\,s$.

force = ... N [1]

Oct/Nov 2009, Paper 22, question 3(a) (b)

3 A small ball is thrown horizontally with a speed of $4.0\,m\,s^{-1}$. It falls through a vertical height of 1.96 m before bouncing off a horizontal plate, as illustrated in Fig. 3.1.

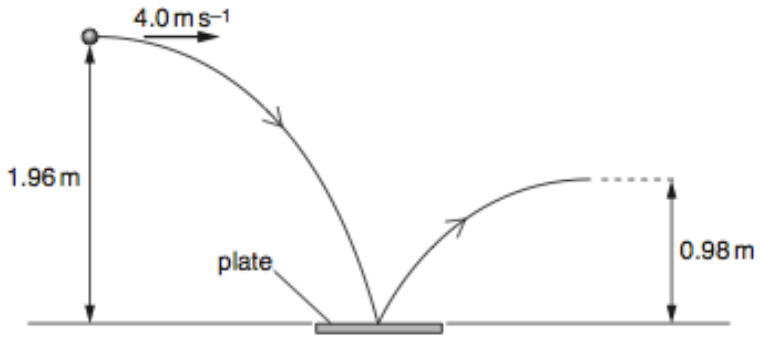

Fig. 3.1

Air resistance is negligible.

(a) For the ball, as it hits the horizontal plate,

(i) state the magnitude of the horizontal component of its velocity,

horizontal velocity = ... $m\,s^{-1}$ [1]

(ii) show that the vertical component of the velocity is $6.2\,m\,s^{-1}$.

[1]

(b) The components of the velocity in **(a)** are both vectors.

Complete Fig. 3.2 to draw a vector diagram, to scale, to determine the velocity of the ball as it hits the horizontal plate.

Fig. 3.2

velocity = ...$m\,s^{-1}$

at ..... ° to the vertical

[3]

May/June 2011, Paper 22, question 2

2 **(a)** A sphere of radius R is moving through a fluid with constant speed v. There is a frictional force F acting on the sphere, which is given by the expression

$$F = 6\pi DRv$$

where D depends on the fluid.

(i) Show that the SI base units of the quantity D are $kg\,m^{-1}\,s^{-1}$.

[3]

(ii) A raindrop of radius 1.5 mm falls vertically in air at a velocity of $3.7\,m\,s^{-1}$. The value of D for air is $6.6 \times 10^{-4}\,kg\,m^{-1}\,s^{-1}$. The density of water is $1000\,kg\,m^{-3}$.

Calculate

1. the magnitude of the frictional force F,

$F =$ ..... N [1]

2. the acceleration of the raindrop.

acceleration = ... $m\,s^{-2}$ [3]

(b) The variation with time t of the speed v of the raindrop in **(a)** is shown in Fig. 2.1.

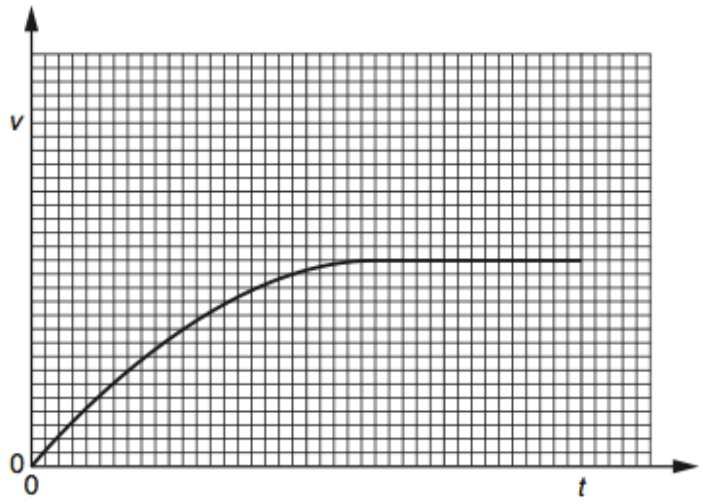

Fig. 2.1

(i) State the variation with time of the **acceleration** of the raindrop.

.....

.....

.....

.....

..... [3]

(ii) A second raindrop has a radius that is smaller than that given in **(a)**. On Fig. 2.1, sketch the variation of speed with time for this second raindrop. [2]

Oct/Nov 2005, Paper 2, question 2

2 **(a)** Explain what is meant by the *centre of gravity* of a body.

.....

.....

..... [2]

(b) An irregularly-shaped piece of cardboard is hung freely from one point near its edge, as shown in Fig. 2.1.

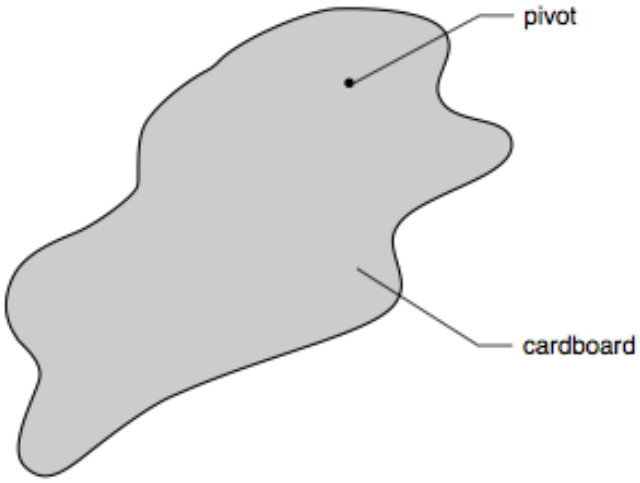

Fig. 2.1

Explain why the cardboard will come to rest with its centre of gravity vertically below the pivot. You may draw on Fig. 2.1 if you wish.

.....

.....

..... [2]

Oct/Nov 2009, Paper 21, question 3

3 A stationary nucleus of mass 220u undergoes radioactive decay to produce a nucleus D of mass 216u and an α-particle of mass 4u, as illustrated in Fig. 3.1.

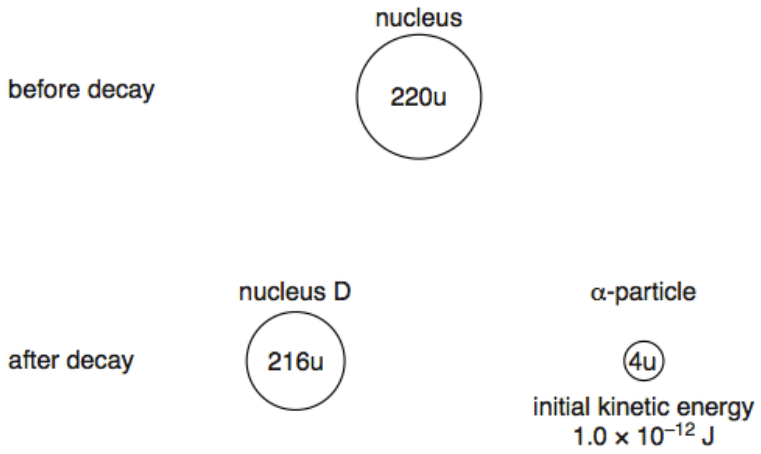

Fig. 3.1

The initial kinetic energy of the α-particle is 1.0×10^{-12} J.

(a) (i) State the law of conservation of linear momentum.

.....

.....

..... [2]

(ii) Explain why the initial velocities of the nucleus D and the α-particle must be in opposite directions.

.....

.....

..... [2]

(b) (i) Show that the initial speed of the α-particle is $1.7 \times 10^{7}\,\text{m s}^{-1}$.

[2]

(ii) Calculate the initial speed of nucleus D.

speed = ... ms^{-1} [2]

(c) The range in air of the emitted α-particle is 4.5 cm.
Calculate the average deceleration of the α-particle as it is stopped by the air.

deceleration = ... ms^{-2} [2]

May/June 2010, Paper 21, question 3(b)

(b) The spring in **(a)** is used to join together two frictionless trolleys A and B of mass M_1 and M_2 respectively, as shown in Fig. 3.2.

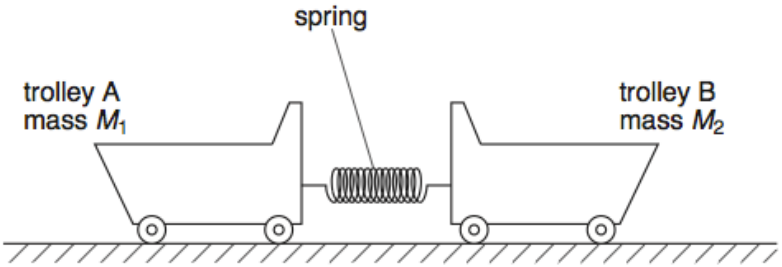

Fig. 3.2

The trolleys rest on a horizontal surface and are held apart so that the spring is extended.

The trolleys rest on a horizontal surface and are held apart so that the spring is extended.

The trolleys are then released.

(i) Explain why, as the extension of the spring is reduced, the momentum of trolley A is equal in magnitude but opposite in direction to the momentum of trolley B.

.....

.....

.....

.....[2]

(ii) At the instant when the extension of the spring is zero, trolley A has speed V_1 and trolley B has speed V_2.
Write down

1. an equation, based on momentum, to relate V_1 and V_2,

.....

.....[1]

2. an equation to relate the initial energy E stored in the spring to the final energies of the trolleys.

.....

.....[1]

(iii) 1. Show that the kinetic energy E_K of an object of mass m is related to its momentum p by the expression

$$E_K = \frac{p^2}{2m}.$$

[1]

2. Trolley A has a larger mass than trolley B.
Use your answer in **(ii) part 1** to deduce which trolley, A or B, has the larger kinetic energy at the instant when the extension of the spring is zero.

.....

.....[1]

May/June 2007, Paper 2, question 3

3 (a) Define *density*.

.....[1]

(b) Liquid of density ρ fills a container to a depth h, as illustrated in Fig. 3.1.

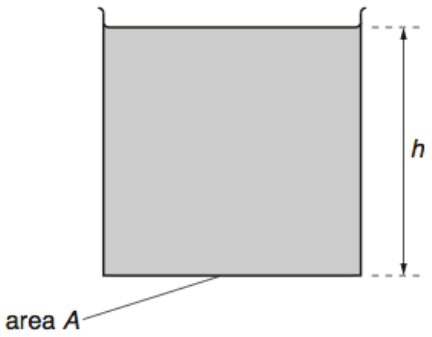

Fig. 3.1

The container has vertical sides and a base of area A.

(i) State, in terms of A, h and ρ, the mass of liquid in the container.

.....[1]

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(i) State, in terms of A, h and ρ, the mass of liquid in the container.

.....[1]

(ii) Hence derive an expression for the pressure p exerted by the liquid on the base of the container. Explain your working.

[2]

(c) The density of liquid water is $1.0\,\text{g}\,\text{cm}^{-3}$. The density of water vapour at atmospheric pressure is approximately $\frac{1}{1600}\,\text{g}\,\text{cm}^{-3}$.

Determine the ratio

(i) $\dfrac{\text{volume of water vapour}}{\text{volume of equal mass of liquid water}}$,

ratio = ...[1]

(ii) $\frac{\text{mean separation of molecules in water vapour}}{\text{mean separation of molecules in liquid water}}$.

ratio = ...[2]

(d) State the evidence for

(i) the molecules in solids and liquids having approximately the same separation,

.....

.....[1]

(ii) strong rigid forces between molecules in solids.

strong: .....

rigid: .....[2]

May/June 2006, Paper 2, question 4

4 **(a)** Define *density*.

.....

.....

..... [1]

(b) A U-tube contains some mercury. Water is poured into one arm of the U-tube and oil is poured into the other arm, as shown in Fig. 4.1.

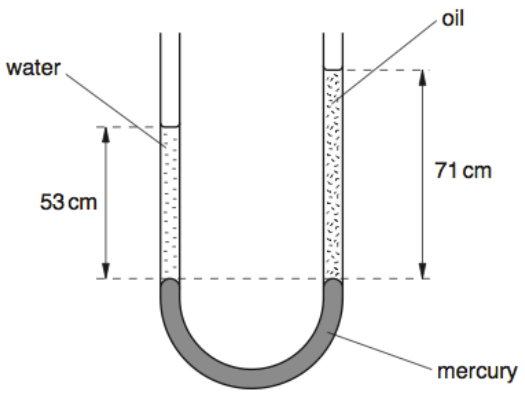

Fig. 4.1

The amounts of oil and water are adjusted until the surface of the mercury in the two arms is at the same horizontal level.

(i) State how it is known that the pressure at the base of the column of water is the same as the pressure at the base of the column of oil.

.....

..... [1]

(ii) The column of water, density $1.0 \times 10^3 \text{ kg m}^{-3}$, is 53 cm high. The column of oil is 71 cm high.

Calculate the density of the oil. Explain your working.

density = ... kg m^{-3} [3]

Oct/Nov 2008, Paper 2, question 3

3 **(a)** Distinguish between the moment of a force and the torque of a couple.

moment of a force .....

.....

.....

torque of a couple .....

.....

.....

[4]

(b) One type of weighing machine, known as a steelyard, is illustrated in Fig. 3.1.

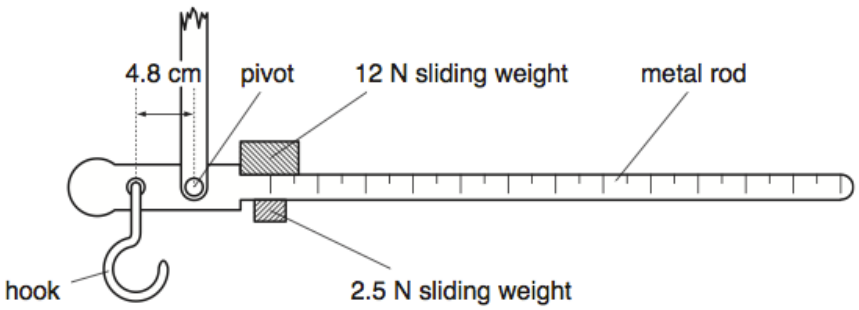

Fig. 3.1

The two sliding weights can be moved independently along the rod.

With no load on the hook and the sliding weights at the zero mark on the metal rod, the metal rod is horizontal. The hook is 4.8 cm from the pivot.

A sack of flour is suspended from the hook. In order to return the metal rod to the horizontal position, the 12 N sliding weight is moved 84 cm along the rod and the 2.5 N weight is moved 72 cm.

(i) Calculate the weight of the sack of flour.

weight = ...N [2]

(ii) Suggest why this steelyard would be imprecise when weighing objects with a weight of about 25 N.

.....

.....[1]

Oct/Nov 2010, Paper 22, question 4

4 **(a)** A metal wire has spring constant k. Forces are applied to the ends of the wire to extend it within the limit of Hooke's law.
Show that, for an extension x, the strain energy E stored in the wire is given by

$$E = \tfrac{1}{2}kx^2.$$

[4]

(b) The wire in **(a)** is now extended beyond its elastic limit. The forces causing the extension are then removed.
The variation with extension x of the tension F in the wire is shown in Fig. 4.1.

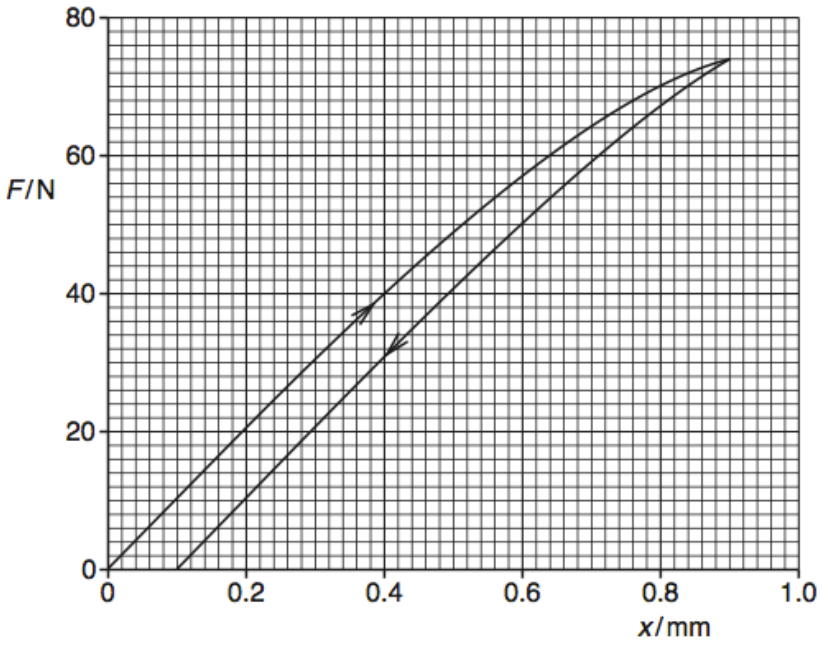

Fig. 4.1

Energy E_S is expended to cause a permanent extension of the wire.

(i) On Fig. 4.1, shade the area that represents the energy E_S. [1]

(ii) Use Fig. 4.1 to calculate the energy E_S.

E_S = ... mJ [3]

(iii) Suggest the change in the structure of the wire that is caused by the energy E_S.

.....

.....[1]

May/June 2010, Paper 23, question 3

3 A cyclist is moving up a slope that has a constant gradient. The cyclist takes 8.0 s to climb the slope.
The variation with time t of the speed v of the cyclist is shown in Fig. 3.1.

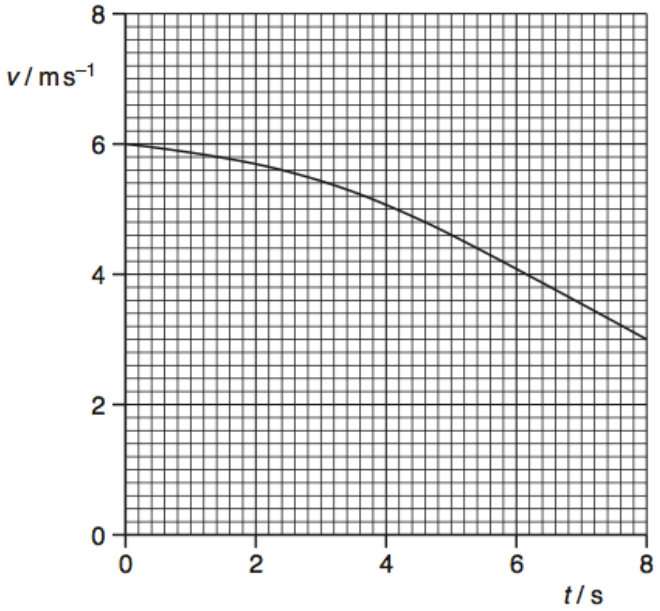

Fig. 3.1

(a) Use Fig. 3.1 to determine the total distance moved up the slope.

distance = ... m [3]

(b) The bicycle and cyclist have a combined mass of 92 kg.
The vertical height through which the cyclist moves is 1.3 m.

(i) For the movement of the bicycle and cyclist between $t = 0$ and $t = 8.0$ s,

1. use Fig. 3.1 to calculate the change in kinetic energy,

change = ... J [2]

2. calculate the change in gravitational potential energy.

change = ... J [2]

(ii) The cyclist pedals continuously so that the useful power delivered to the bicycle is 75 W.
Calculate the useful work done by the cyclist climbing up the slope.

work done = ... J [2]

(c) Some energy is used in overcoming frictional forces.

(i) Use your answers in **(b)** to show that the total energy converted in overcoming frictional forces is approximately 670 J.

[1]

(ii) Determine the average magnitude of the frictional forces.

average force = ...N [1]

(d) Suggest why the magnitude of the total resistive force would not be constant.

.....

.....

.....[2]