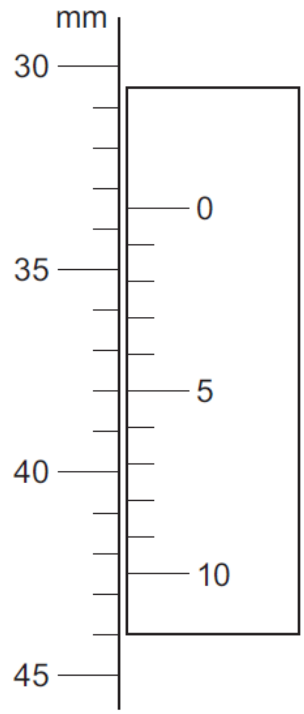
Section A

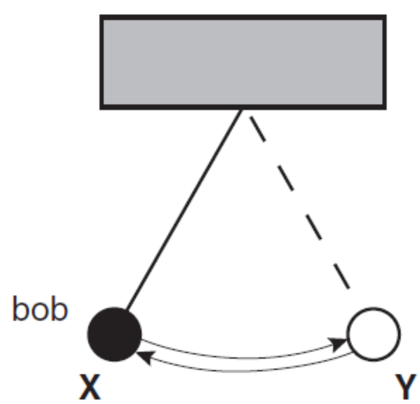
1. The diagram shows part of a vernier scale.



What is the correct reading?

A 30.5 mm **B** 33.5 mm **C** 38.0 mm **D** 42.5 mm

2. One oscillation of a swinging pendulum occurs when the bob moves from **X** to **Y** and back to **X** again.



Using a stopwatch, which would be the most accurate way to measure the time for one oscillation of the pendulum?

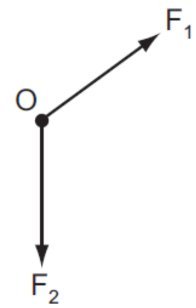
A Time 20 oscillations and multiply by 20.

B Time 20 oscillations and divide by 20.

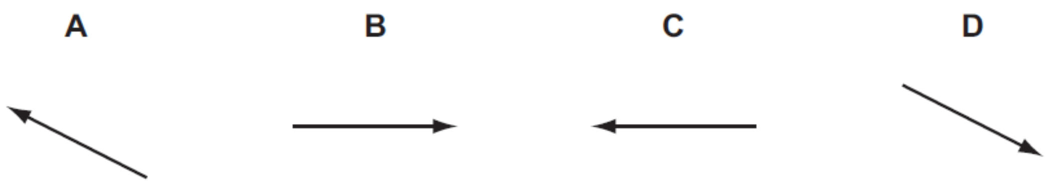
C Time one oscillation.

D Time the motion from **X** to **Y**, and double it.

3. Two forces F1 and F2 act on an object O in the directions shown.

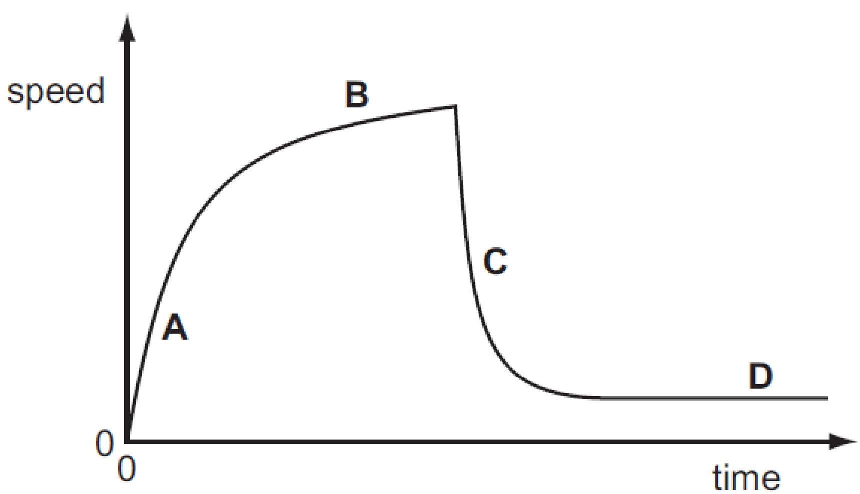


What is the direction of the resultant force?

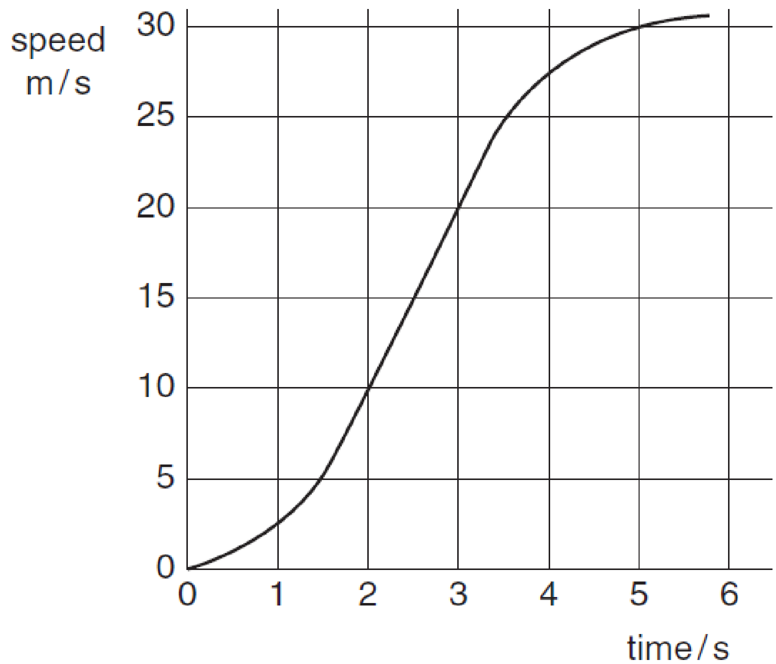


4. The speed-time graph for a falling skydiver is shown below. The skydiver alters his fall first by spreading his arms and legs and then by using a parachute.

Which part of the graph shows the diver falling with terminal velocity?



5. The graph shows the speed of a car as it accelerates from rest. During part of this time the acceleration is uniform.



What is the size of this uniform acceleration?

A 5 m/s^2 **B** 6 m/s^2 **C** 10 m/s^2 **D** 20 m/s^2

6. When a block of wood of mass 2 kg is pushed along the horizontal flat surface of a bench, the friction force is 4 N.

When the block is pushed along the bench with a force of 10 N, it moves with a constant

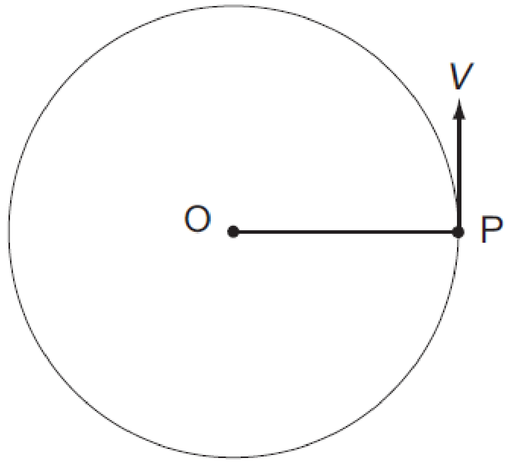
A speed of 3 m/s.

B speed of 5 m/s.

C acceleration of 3 m/s^2.

D acceleration of 5 m/s^2.

7. A particle P is moving in a horizontal circle about O. It moves at constant speed V.



Which statement is true?

A A force of constant size is acting in the direction of *V*.

B A force of constant size is acting towards O.

C The force on P varies in size as it moves around the circle.

D There are no forces acting on P.

8. An aircraft, flying at a constant height, is gaining speed.

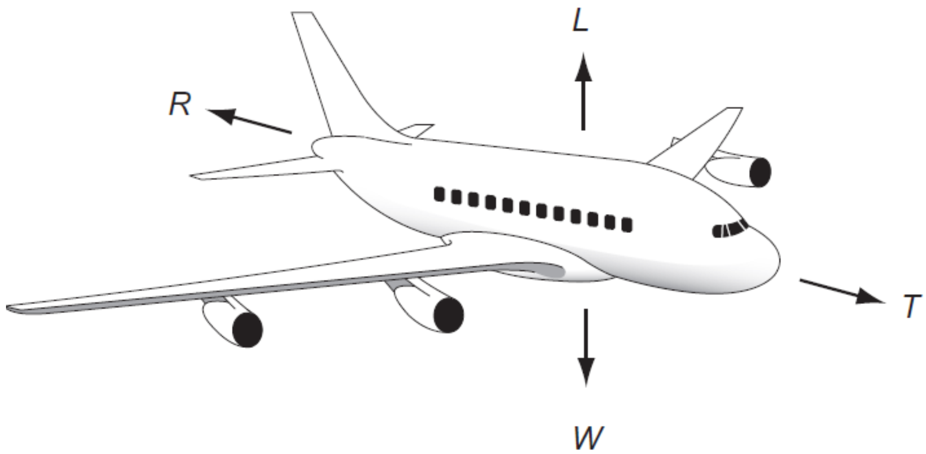
The four forces acting are

L lift due to the wings

R air resistance

T the thrust due to the engines

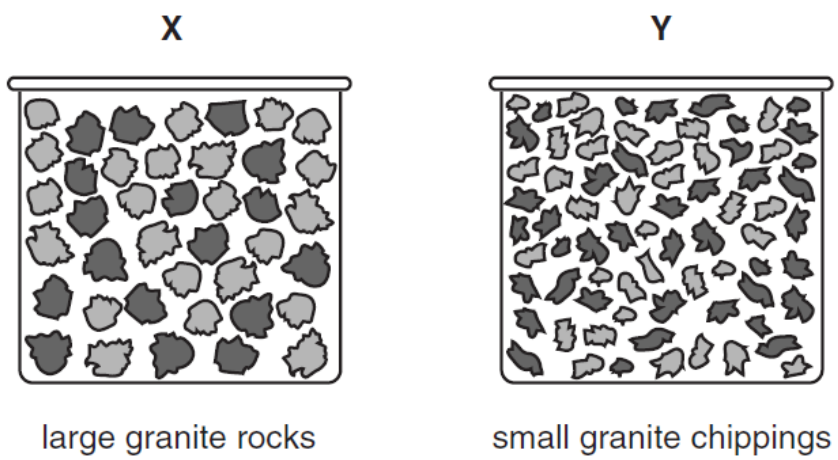
W the weight



Which row is correct?

	vertical forces	horizontal forces
A	$L = W$	$T = R$
B	$L > W$	$T > R$
C	$L = W$	$T > R$
D	$L > W$	$T = R$

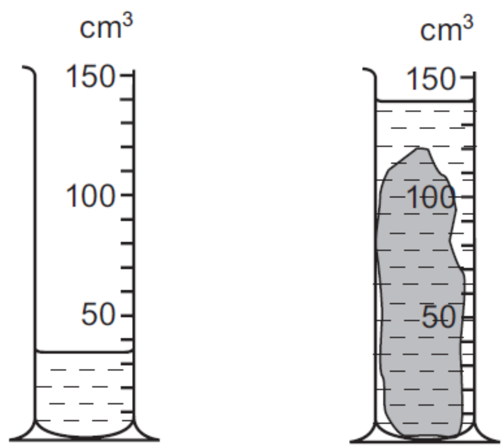
9. A box **X** full of large granite rocks is weighed. An identical box **Y** full of small granite chippings is then weighed.



Which box weighs more and why?

	heavier box	reason
A	**X**	there is more air in box **X**
B	**X**	the density of a chipping is less than a rock
C	**Y**	there is less air in box **Y**
D	**Y**	the density of a chipping is greater than a rock

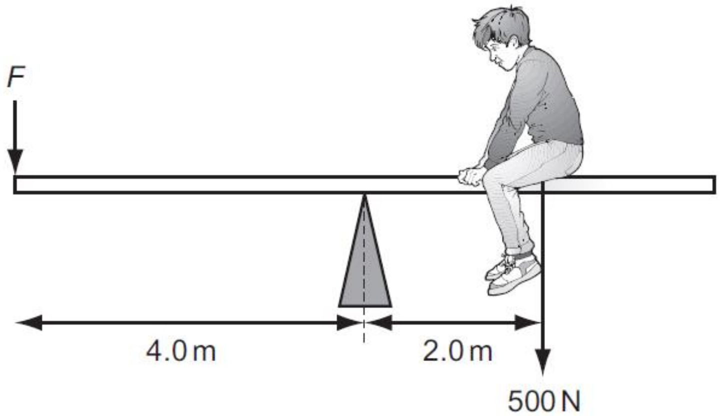
10. A lump of metal has a mass of 210 g. It is lowered into a measuring cylinder containing water. The level of the water rises from 35 cm^3 to 140 cm^3.



What is the density of the metal?

A 0.67 g/cm^3 **B** 1.5 g/cm^3 **C** 2.0 g/cm^3 **D** 6.0 g/cm^3

11. The diagram shows a boy of weight 500 N sitting on a see-saw. He sits 2.0 m from the pivot.



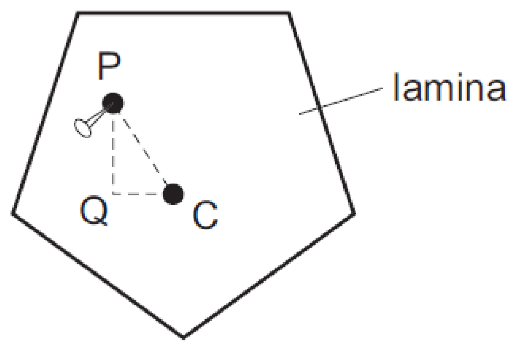
What is the force F needed to balance the see-saw?

A 250 N **B** 750 N **C** 1000 N **D** 3000 N

12. A flat lamina is freely suspended from point P.

The weight of the lamina is 2.0 N and the centre of mass is at C.

PC = 0.50 m
PQ = 0.40 m
QC = 0.30 m



The lamina is displaced to the position shown.

What is the moment that will cause the lamina to swing?

A 0.60 N m clockwise

B 0.80 N m anticlockwise

C 1.0 N m clockwise

D 1.0 N m anticlockwise

13. The table shows how the extension of a spring varies with load.

load / N	0	2	4	6	8	10	12	14	16
extension / cm	0	3	6	9	12	15	20	27	38

Between which two loads would you find the limit of proportionality?

A 0 N and 2 N

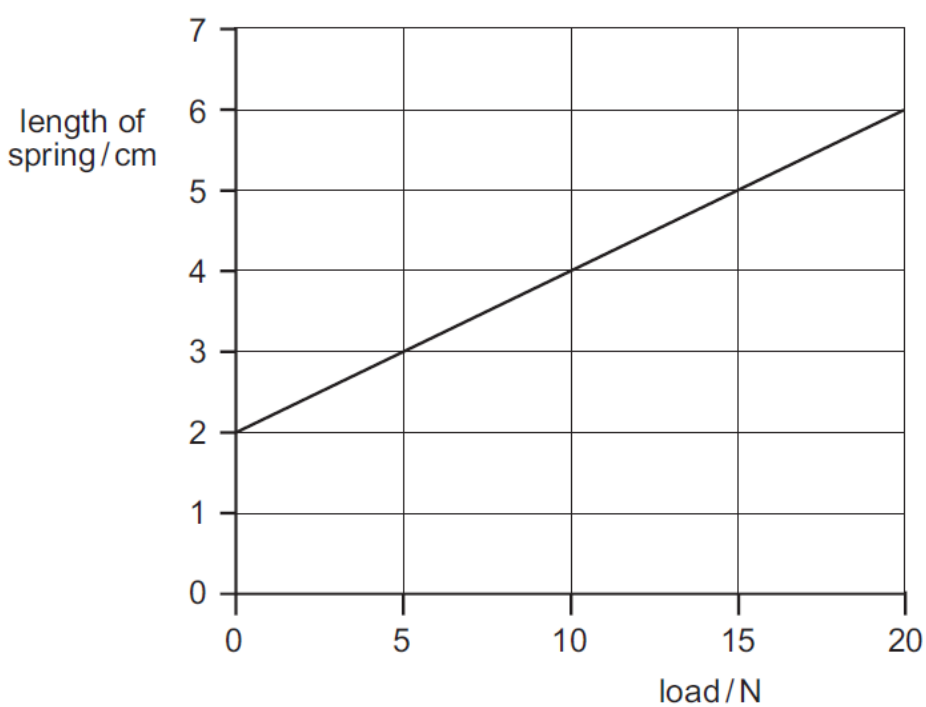
B 8 N and 10 N

C 10 N and 12 N

D 14 N and 16 N

14. A spring balance is calibrated to give readings in newtons.

The graph shows how the length of the spring varies with the load.



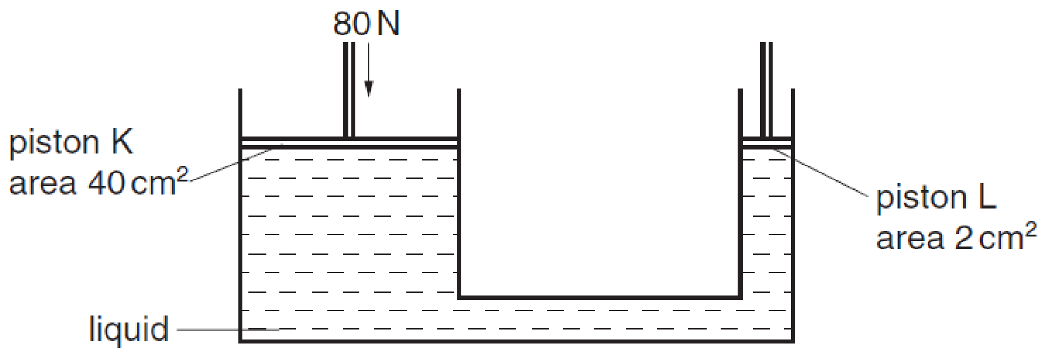
A load causes the spring of the balance to extend by 3 cm.

What is the balance reading?

A 3 N **B** 5 N **C** 10 N **D** 15 N

15. The system shown in the diagram contains an incompressible liquid.

A downward force of 80 N is exerted on the piston K.



What will be the upward force on piston L?

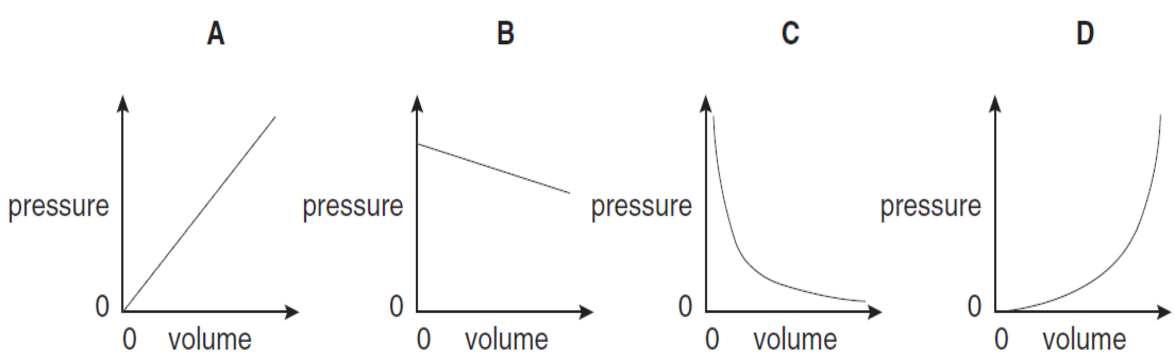
A 1 N

B 4 N

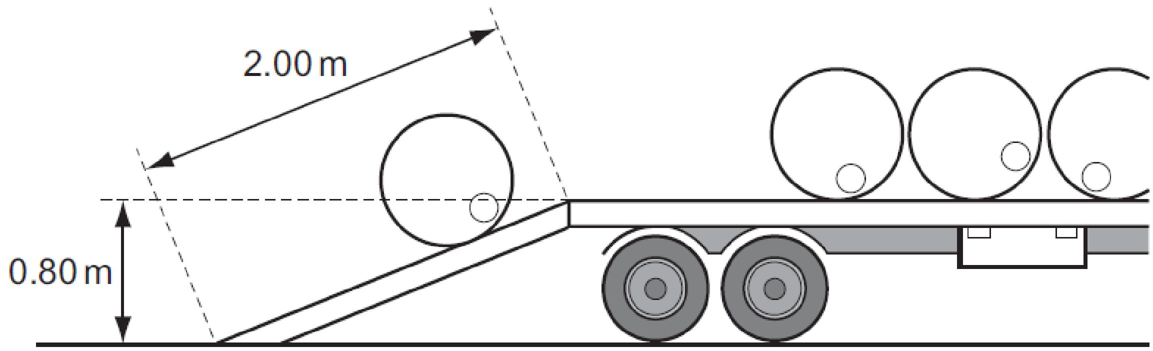
C 80 N

D 1600 N

16. Which graph shows the relationship between the pressure and volume of a fixed mass of gas at constant temperature?



17. A workman rolls a barrel of weight 2000 N up a plank of length 2.00 m and on to a lorry. The back of the lorry is 0.80 m above the horizontal surface of the road.



What is the work done on the barrel against gravity?

A 1000 J **B** 1600 J **C** 2500 J **D** 4000 J

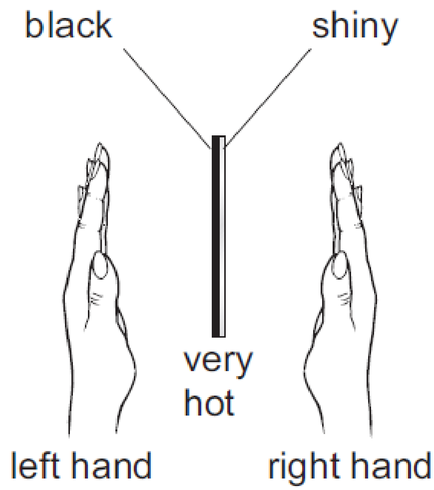
18. The efficiency of an electrical generator is 65 %.

Which useful output can be expected if the energy input to the generator is 12 kJ?

A 4.2 kJ **B** 7.8 kJ **C** 19 kJ **D** 780 kJ

19. The diagram shows a thick copper plate that is very hot. One side is black, the other is shiny.

A student places her hands the same distance from each side as shown.



Her left hand feels warmer than her right hand.

Which statement is the correct conclusion from the experiment?

A The black side is hotter than the shiny one.

B The black side radiates more heat.

C The shiny side radiates more heat.

D The shiny side is cooling down faster than the black side.

20. The heat from the hot water in a metal radiator passes through the metal and then spreads around the room.

What are the main processes by which the heat is transferred through the radiator and then spread around the room?

	through the metal radiator	around the room
A	conduction	conduction
B	conduction	convection
C	radiation	conduction
D	radiation	convection

Section B

1. Fig. 1.1 shows a lorry accelerating in a straight line along a horizontal road.

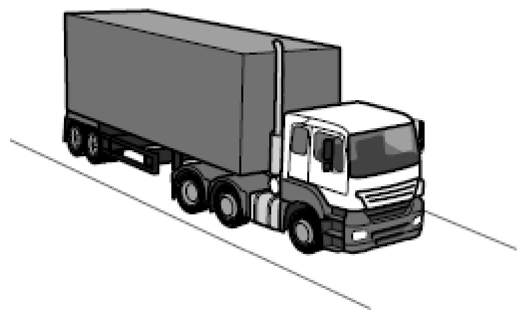


Fig 1.1

(a) The driving force on the lorry in the forward direction is *D* and the total backward force on the lorry is *B*.

(i) State and explain whether *D* or *B* is the larger force.

(ii) Suggest one possible cause of the backward force *B*.

(b) The weight of the lorry is 300 000 N.
The gravitational field strength *g* is 10 N / kg.

(i) Calculate the mass of the lorry.

(ii) The resultant force on the lorry is 15 000 N. Calculate the acceleration of the lorry.

2. Fig. 2.1 shows a manometer used to measure the pressure difference between the air inside a plastic container and the atmosphere outside.

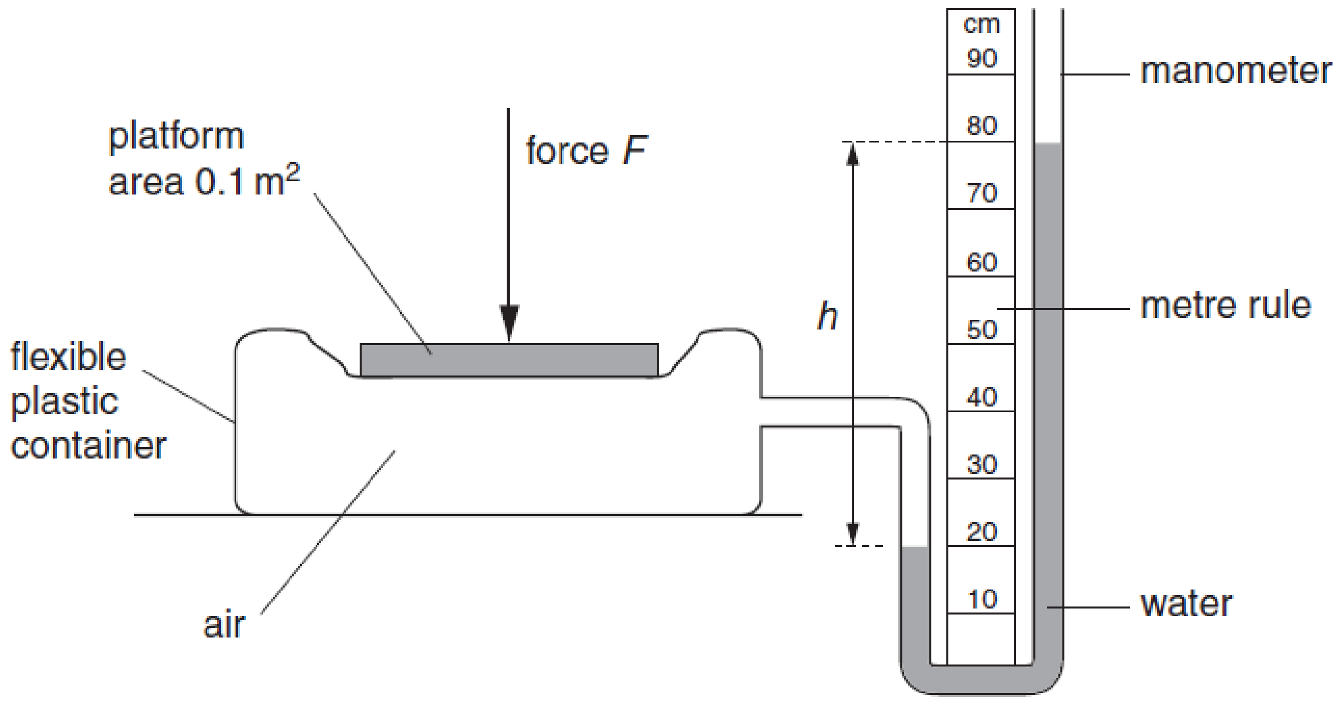


Fig 2.1

A pressure difference of 100 Pa causes a one centimetre difference in water levels.

(a) Using Fig. 2.1, determine the pressure difference in Pa shown by the manometer.

(b) State what changes, if any, occur to the distance *h* in Fig. 2.1 if

(i) the manometer tube is narrower,

(ii) a liquid denser than water is used in the manometer.

(c) The pressure difference measured by the manometer is caused by the force *F*. This force is the weight of a student standing on the platform. The cross-sectional area of the platform is $0.1 m^2$.

(i) State the formula that relates pressure, force and area.

(ii) Calculate the weight of the student.

3. Fig. 3.1 shows apparatus used to investigate the turning effect of a force.

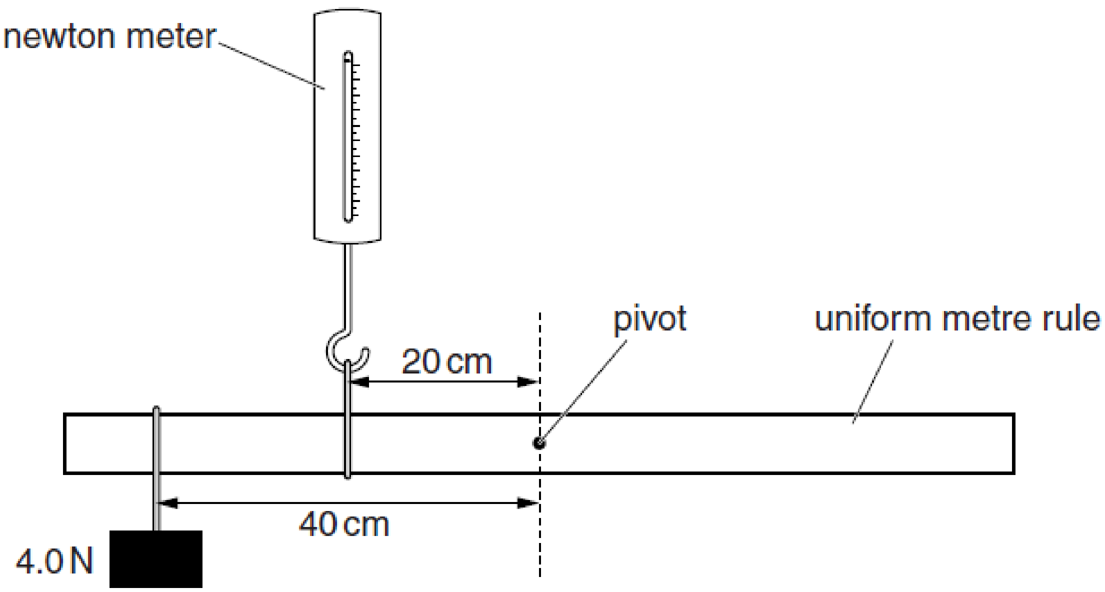


Fig 3.1

The uniform metre rule is freely pivoted at its centre.
The newton meter is 20 cm from the pivot and a 4.0 N weight is 40 cm from the pivot.
The metre rule is in equilibrium.

(a) State the principle of moments for a body in equilibrium.

(b) Calculate the reading on the newton meter.

(c) The weight of the metre rule is 1.2 N.

Calculate the size of the force exerted on the metre rule by the pivot.

4. A large test-tube contains wax above its melting point. It is placed in a cool room. Fig. 4.1 shows how the temperature T of the wax changes in a time of 30 minutes.

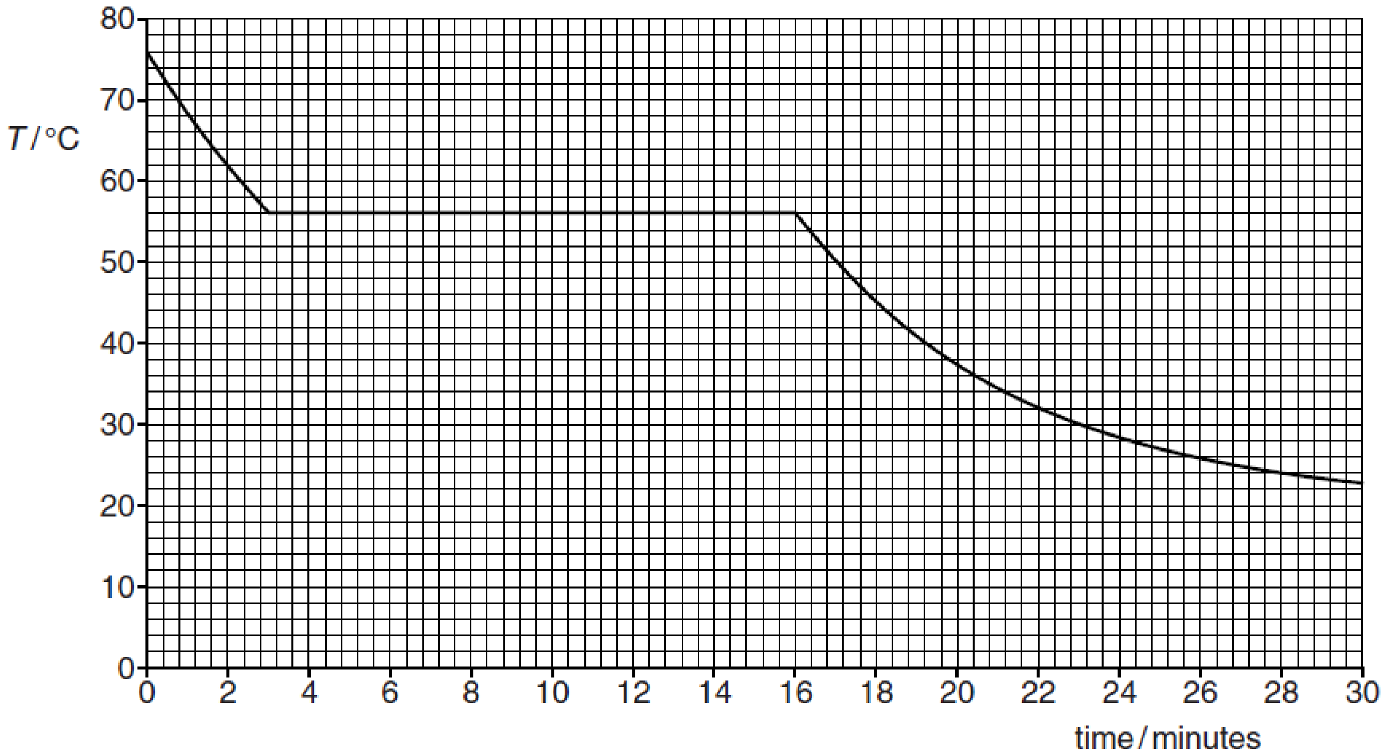


Fig 4.1

Determine the melting point of the wax.

(b) The test-tube contains 110 g of wax that has a specific latent heat of fusion of 210 J / g. Calculate the thermal energy transferred from the wax between 3 and 16 minutes.

(c) (i) State what happens to the wax between 3 and 16 minutes.

(ii) Between 3 and 16 minutes, the temperature of the wax is above room temperature and energy is lost to the room. Explain, in terms of molecules, why the temperature of the wax remains constant.

5. A man of mass 75 kg falls from a platform high above a lake.
Fig. 5.1a shows the man tied to the platform by a long elastic rope (bungee).
Fig. 5.1b shows the man when he has fallen 20 m. After this point the rope begins to stretch.
Fig. 5.1c shows the man at 25 m below the platform where he is first stopped by the rope.

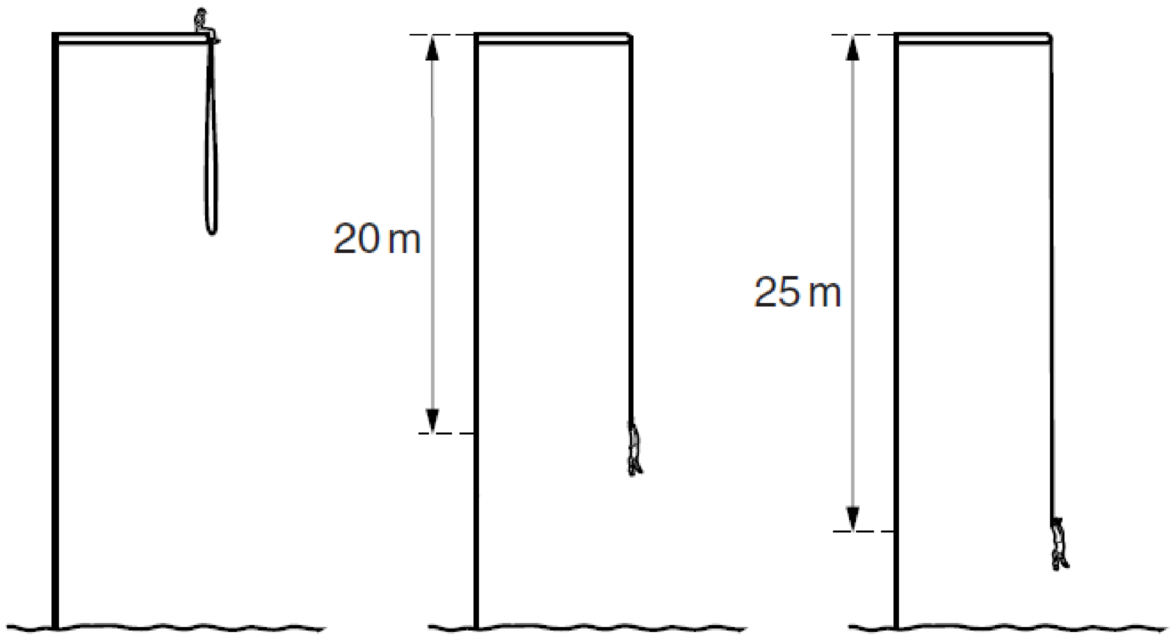


Fig 5.1a **Fig 5.1b** **Fig 5.1c**

(a) As the man falls, his gravitational potential energy changes.

(i) The gravitational field strength is 10 N / kg. Calculate the change in his gravitational potential energy as he falls through 20 m.

(ii) When he is 20 m below the platform, his kinetic energy is equal to the change in his gravitational potential energy calculated in **(i)**. Calculate his speed at this point.

(b) State the energy changes that take place as he falls from 20 m to 25 m below the platform. Ignore the effect of air resistance.

6. Fig. 6.1 shows a glass lens in air and its two focal points F1 and F2.

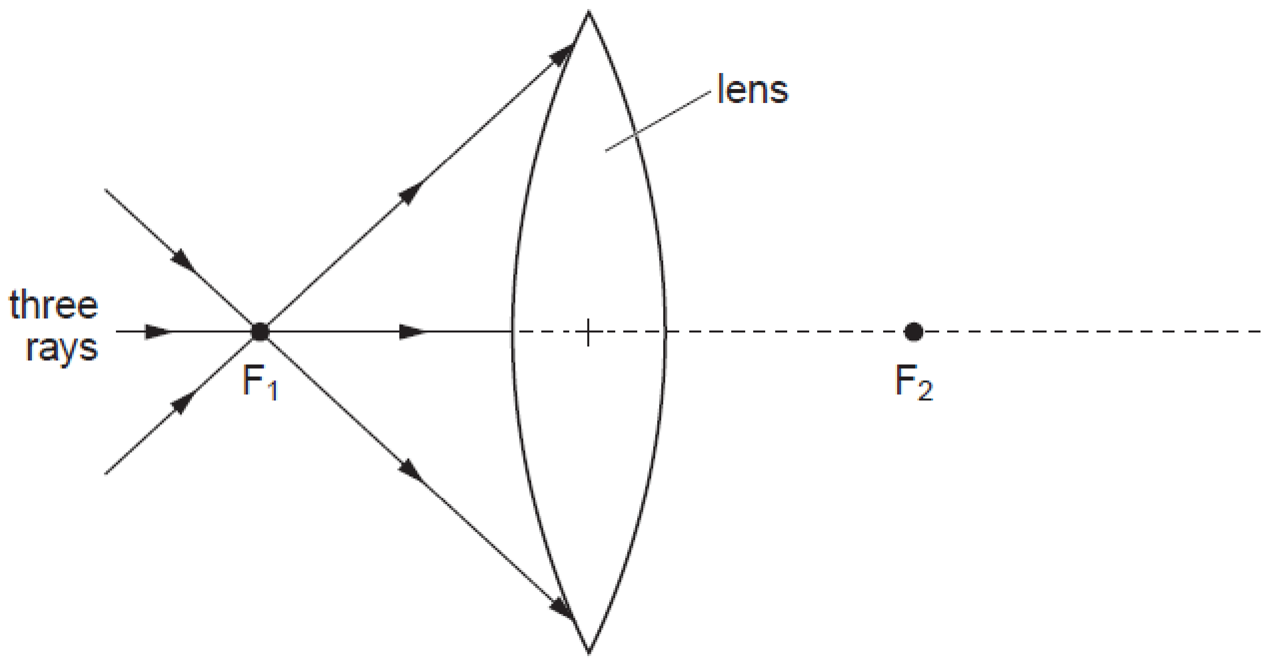


Fig 6.1

Three rays of light pass through F1 to the lens.

(a) On Fig. 6.1, continue the three rays through the lens and into the air.

(b) State what happens to the speed of light on

(i) entering the glass lens from air,

(ii) leaving the lens and returning to the air.

(c) Light of wavelength 6.0×10^{-7} m travels in air at a speed of 3.0×10^{8} m / s.

(i) Calculate the frequency of this light.

(ii) State the effect, if any, on the frequency as the light enters the glass from air.

7. A student produces wavefronts in a ripple tank to demonstrate refraction, as shown in Fig. 7.1. He places a sheet of glass under the water on the right-hand side of the tank. The arrows show the directions of movement of the wavefronts.

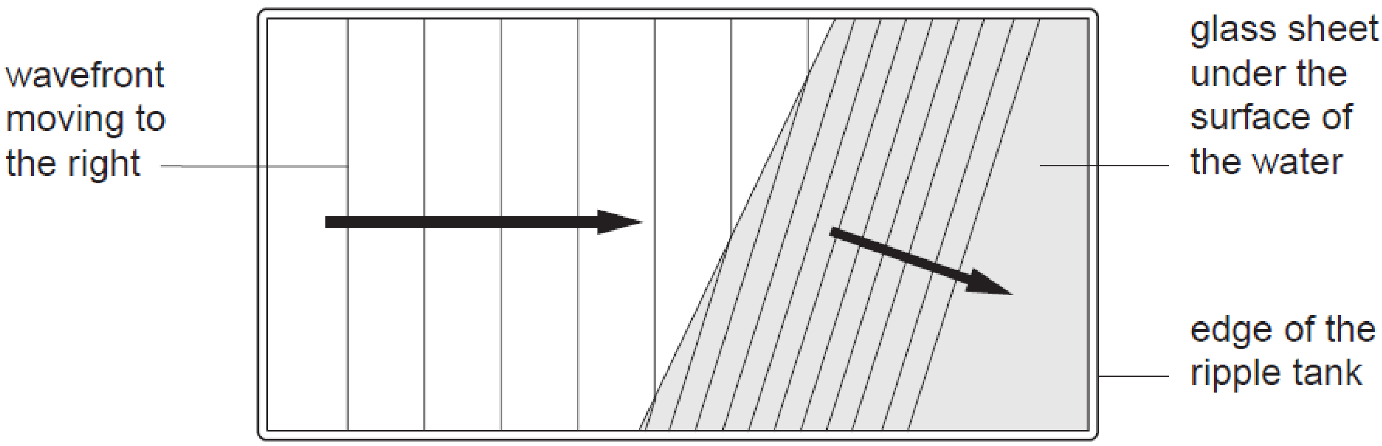


Fig 7.1

(a) State what is meant by a *wavefront*.

(b) State what happens to each of the following quantities as the wavefronts change direction.

(i) wavelength

(ii) speed

(iii) frequency

8. A student traces the path of a ray of blue light as it enters and as it leaves a glass prism. Fig. 9.1 shows the trace obtained by the student.

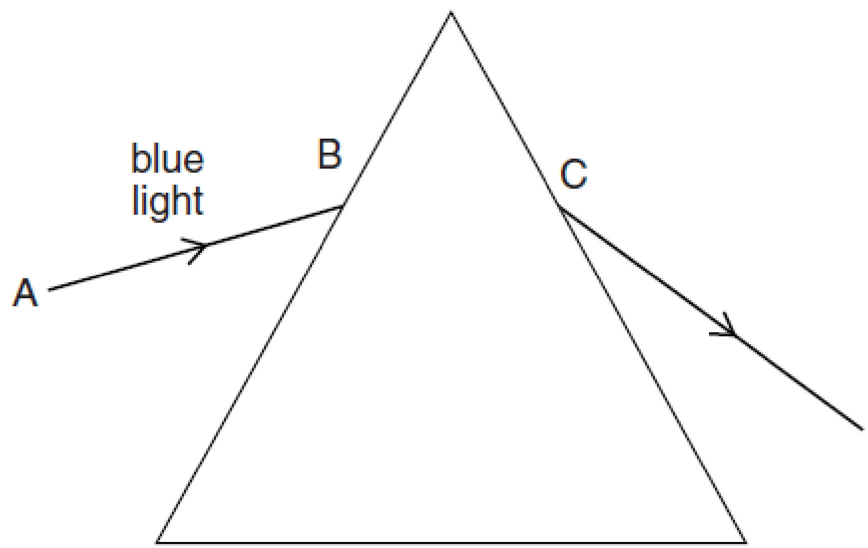


Fig 9.1

(a) On Fig. 9.1, draw and label, at the point B, the normal, the angle of incidence *i* and the angle of refraction *r*.

(b) State, in terms of the properties of light waves, why the light refracts at B.

(c) The angle of incidence for the ray of blue light at B is 45°. The refractive index of the glass is 1.5. Calculate the angle of refraction at B.

(d) The student performs another experiment with a ray of red light along the line AB. On Fig. 9.1, show the path taken by this ray of light as it passes through and leaves the prism.

(e) The student performs another experiment with a semi-circular glass block and a ray of white light. Fig. 9.2 shows the path taken by this ray of light as it enters the glass at P until it hits the straight edge at Q.

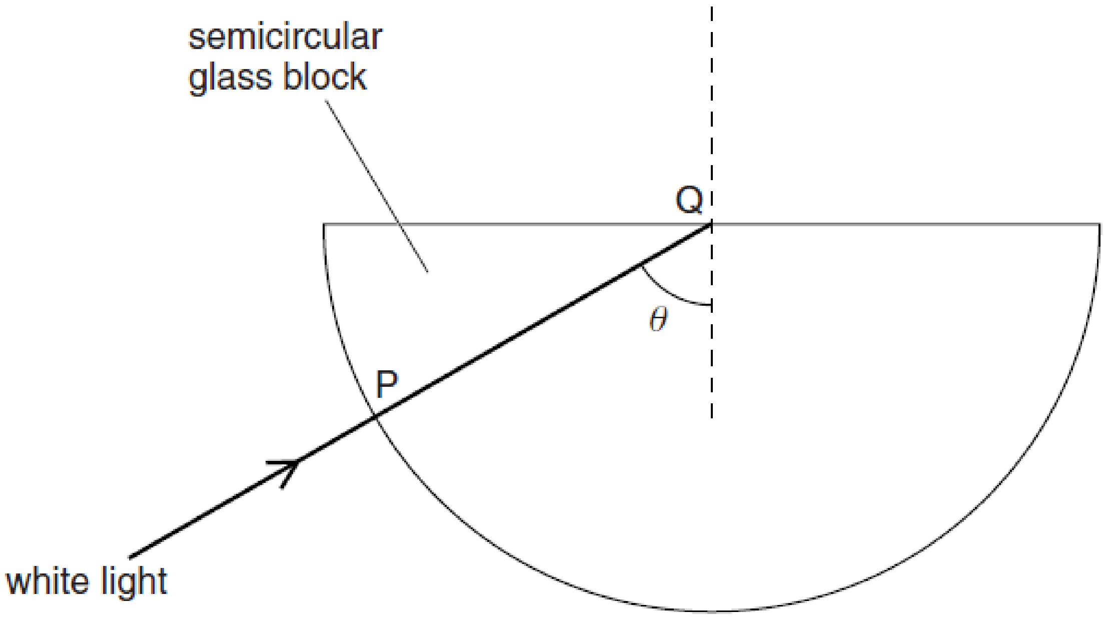


Fig 9.2

The student finds that there is no change in direction as the ray enters the glass at P and that no light passes out of the glass at Q.

(i) Explain why the ray does not change direction at P.

(ii) Explain why no light passes out of the glass at Q.

(iii) On Fig. 9.2, draw the complete path followed by this ray.

(iv) The student directs the ray of white light into the glass along different paths, so that the angle θ is slowly reduced. Describe what happens to the ray at Q.

9. Fig. 10.1 shows a car braking system. The brake fluid is an oily liquid.

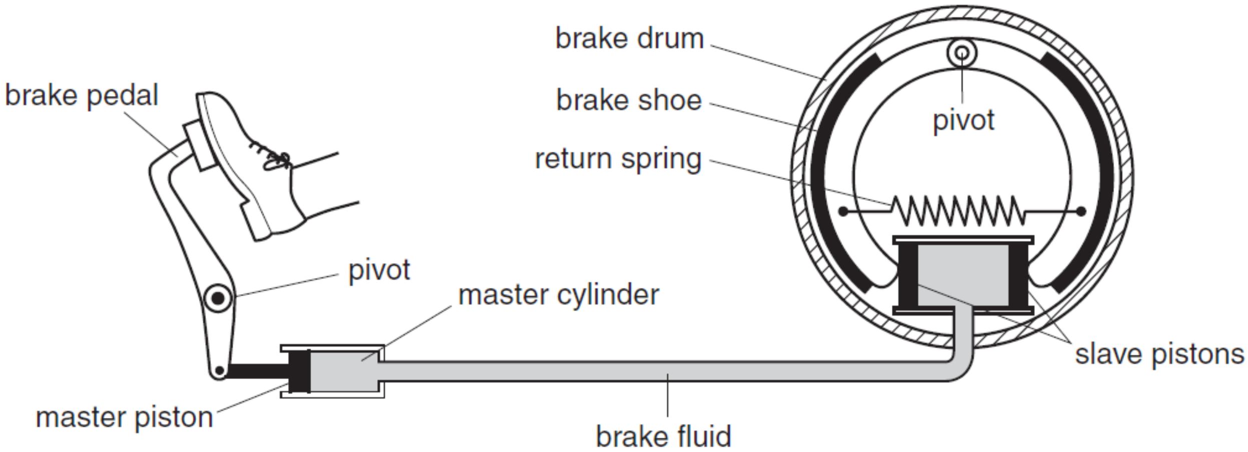


Fig 10.1

The brake drum rotates with the wheel of the car.

(a) Explain how pushing the brake pedal makes the brake shoes rub against the drum.

(b) The cross-sectional area of the master piston is 2.0 cm^2. A force of 140 N is applied to the master piston.

(i) Calculate the pressure created in the brake fluid by the master piston.

(ii) The cross-sectional area of each slave piston is 2.8 cm^2.

Calculate the force exerted on each slave piston by the brake fluid.

(iii) The force exerted on the master piston is greater than the force applied by the foot on the brake pedal. Using the principle of moments, explain this.

(c) Fig. 10.2 shows a master cylinder sealed at one end. Instead of brake fluid, the cylinder contains air.

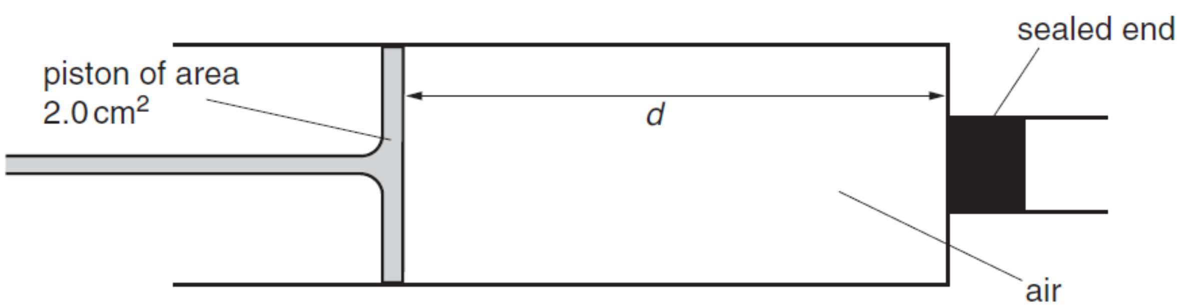


Fig 10.2

When a force is applied to the piston, the length *d* changes from 6.0 cm to 4.0 cm.
The pressure of the air increases but the temperature stays constant.

(i) Describe how the molecules of the air exert a pressure.

(ii) Explain why the pressure increases even though the temperature stays constant.

(iii) The initial pressure of the air inside the cylinder is 1.0×10^5 Pa.
Calculate the final pressure of the air. State the formula that you use in your calculation.

(d) Air bubbles form in the brake fluid of Fig. 10.1. State the effect this has on the braking system.

Section C

1. The IGCSE class is investigating the effect of a load on a metre rule attached to a force meter. The apparatus is shown in Fig. 1.1.

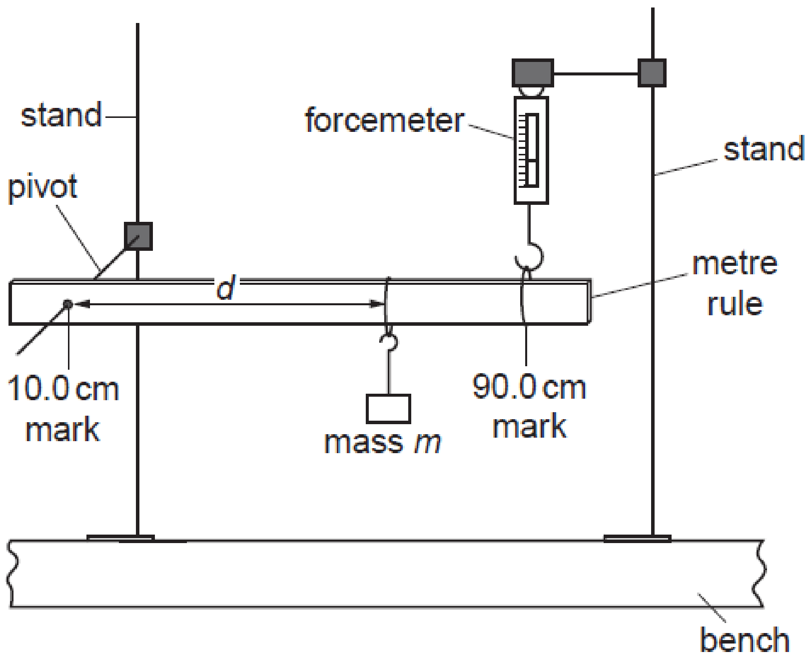


Fig. 1.1

The rule is pivoted near one end at the 10.0 cm mark. Near the other end, at the 90.0 cm mark, the rule is attached to a force meter. A mass is hanging from the rule at a distance d from the pivot.

(a) A student moves the mass to a distance d = 70.0 cm from the pivot. He adjusts the height of the force meter until the rule is again horizontal. He records the reading F on the force meter. He repeats the procedure using d values of 60.0 cm, 50.0 cm, 40.0 cm, 30.0 cm, 20.0 cm and 10.0 cm. The force meter readings are shown in Table 1.1.

Table 1.1

d /	F /
	2.9
	2.5
	2.2
	1.8
	1.5
	1.2
	0.8

(i) Record the *d* values in the table.
(ii) Complete the column headings in the table

(b) The student thinks that *F* is directly proportional to *d*.

(i) Suggest the graph that you could plot to test this idea. You are not asked to plot the graph.

.... against ....

(ii) State the properties of the line that would indicate that *F* is directly proportional to *d*.

1. ....

2. ....

(c) A spirit level is a piece of equipment that is placed on a surface to check whether the surface is horizontal.
Suggest why a spirit level balanced on the rule is not suitable for checking whether the rule is horizontal in this experiment.

(d) Describe briefly how you would check that the rule is horizontal in this experiment. You may draw a diagram.

2. The IGCSE class is investigating the rate of cooling of water.
Fig. 2.1 shows the apparatus.

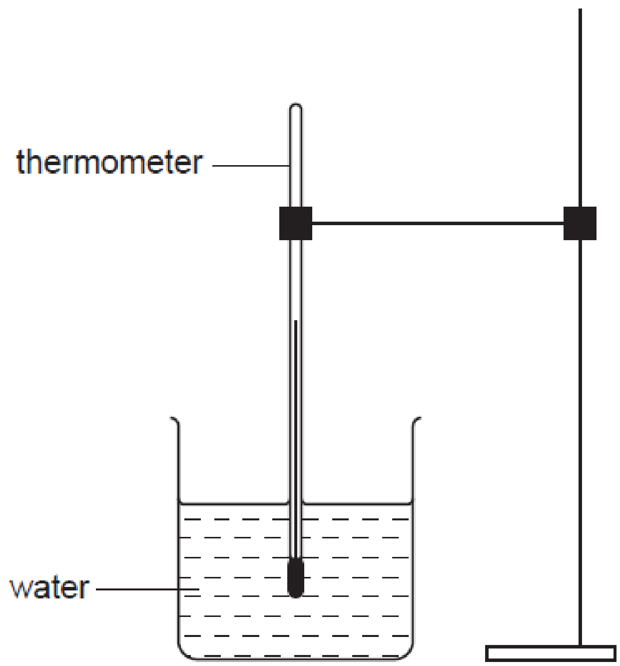
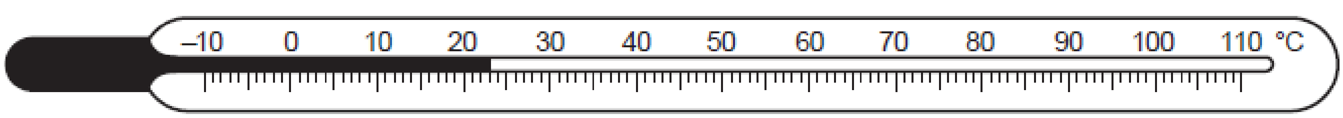


Fig. 2.1

(a) Record the value of room temperature θ_R shown on the thermometer.



θ_R = ...

(b) A student pours approximately 200 cm^3 of hot water into the beaker. She measures the temperature θ of the water. She starts a stop clock and records the temperature θ of the water at 30 s intervals up to time t = 150 s. The readings are shown in Table 2.1.

Table 2.1

t / s	θ / °C
0	86
30	75
60	67
90	61
120	56
150	52

Plot a graph of θ / °C (y-axis) against t / s (x-axis).

(c) As you read these words, this experiment is actually being carried out by candidates in many different countries, using identical apparatus.

Suggest two differences in the conditions in the various laboratories that might lead to different graphs.

3. A student is measuring some small glass spheres.

(a) The student has a 30 cm rule and two rectangular blocks of wood.
In the space below, draw a diagram to show clearly how you would arrange the apparatus to measure the diameter of **one** of the spheres.

(b) The student then determines the average volume of a glass sphere by a displacement method. She pours some cold water into a measuring cylinder and records the volume V of the water, as shown in Fig. 3.1.

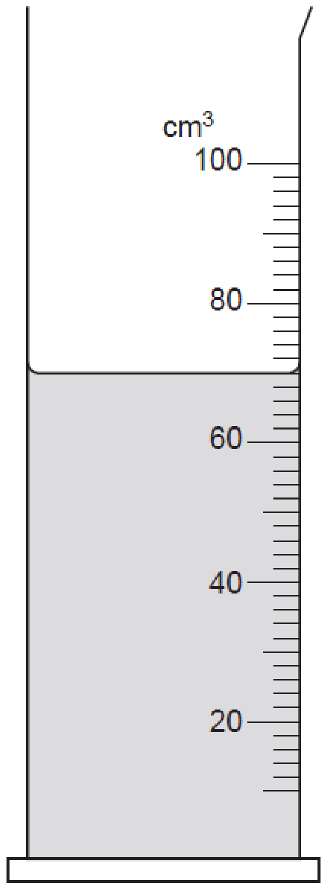


Fig.3.1

(i) On Fig. 3.1, show clearly the line of sight that you would use to obtain an accurate volume reading.

(ii) Using Fig. 3.1, record the volume V of water in the measuring cylinder.

(iii) The student carefully puts 15 of the glass spheres into the measuring cylinder. The new water level reading is 78 cm^3.

Calculate the volume V_1 of **one** sphere.

4. The class is investigating a pendulum.
Figs. 4.1 and 4.2 show the pendulum.

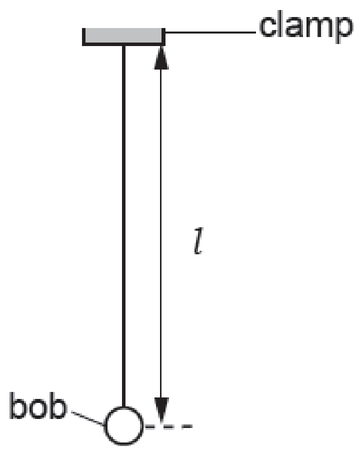


Fig.4.1.

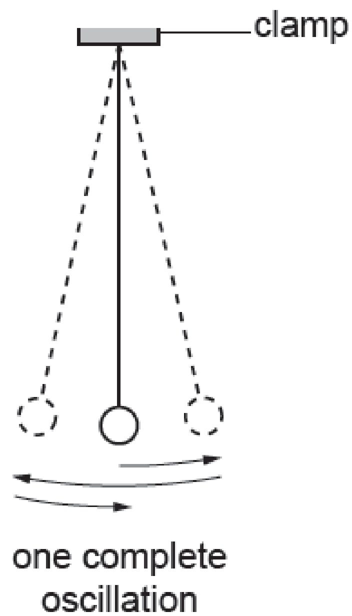


Fig.4.2.

(a) A student adjusts the pendulum until its length l = 50.0 cm.
State one precaution that you would take to measure the length l as accurately as possible.
You may draw a diagram.

(b) The student displaces the pendulum bob slightly and releases it so that it swings. She measures the time t for 20 complete oscillations of the pendulum (see Fig. 4.2).

(i) Record the time t, in s, shown on the stopwatch in Fig. 4.3.

Fig.4.3.

(ii) Calculate the period T of the pendulum. The period is the time for one complete oscillation.

(iii) Explain why measuring the time for 20 oscillations, rather than 1 oscillation, gives a more accurate value for T.

(c) The student adjusts the length of the pendulum until its length l = 100.0 cm. She repeats the procedure and obtains a value for the period T.

T = 2.06 s

Another student suggests that doubling the length l of the pendulum should double the period T.
State whether the results support this suggestion. Justify your answer by reference to the results.

statement ....

justification ....

....

(d) To continue the investigation of the relationship between the length l of the pendulum and the period T, it is necessary to use a range of values of length l.

List additional l values that you would plan to use in the laboratory.