1 State the symbol of the SI unit for the following physical quantities.

(a) Temperature
(b) Density
(c) Weight
(d) Acceleration

2 For each of the following formula, derive their based units.

(a) Force = mass × acceleration
(b) Work = Force × displacement
(c) Pressure = $\frac{Force}{Area}$

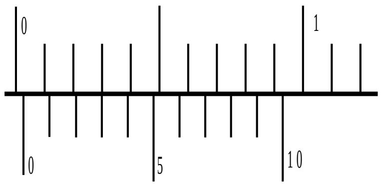
3 Write the following measurements in standard form.

(a) 365.8 m
(b) 2 560 mm
(c) 0.095 6 kg
(d) 0.000 033 9 Mm

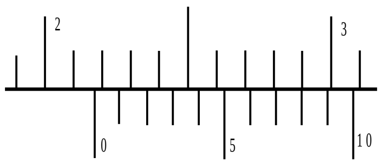
4 Conversion of units. (Give your answers to 2 significance figures)

(a) Convert 2.6 m^2 to km^2
(b) Convert 65 km/h to m/s
(c) Convert 16 kg/m^3 to g/cm^3
(d) Convert 0.55 ms to μs

5 In a factory, regular stacks, each containing 150 pieces of paper, are measured using a pair of vernier calipers. The reading of one stack is shown.



Before measurement



During measurement

(a) What is the zero error shown?
(b) Calculate the thickness of one piece of paper.

6 A small pebble released from the top of a deep well took 3.0 s to hit the surface of water in the well. Assume that air resistance is negligible,

(a) write the magnitude of acceleration of the pebble and explain how you arrived at the answer.

(b) sketch the speed-time graph of the pebble. Clearly label the speed and time at which the pebble hits the surface of the water.

(c) calculate the distance travelled by the pebble from the point of release until it hits the surface of the water in the well.

(d) sketch a distance-time graph of the motion of the pebble. Clearly label the distance and time at the start and end of the motion.

7 A model rocket is launched from rest. Its engine delivers a constant acceleration of 8.2 m/s^2 for a full 5.0 s, after which the fuel is used up. Assuming that the rocket was launched vertically and that air resistance is not significant,

(a) sketch a velocity-time graph to show the variation of velocity to time of the rocket motion from launch until it returns to Earth.

(b) find the maximum altitude reached by the rocket.

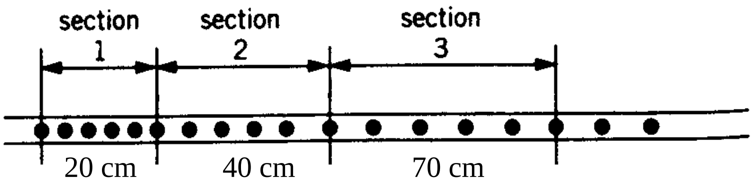
(c) find the total time the rocket is in flight.

8 A man shoots a ball vertically upwards at an initial speed of 50 m/s. What is the distance travelled by the ball 7.0 s after the shoot?

9 A student placed a trolley on a runway. A length of paper tape was attached to the trolley and this tape passed through a ticker-timer that operates at a frequency of 20 dots per second. The student then tilted the runway to an angle at which the trolley accelerated when released from the top. The diagram shows the tape produced as the trolley ran down the slope. The tape has been divided into three sections, each section containing 5 spaces between adjacent dots.

(a) Which section of the tape was closest to the trolley, and how does the tape indicate that the trolley accelerated as it ran down the runway?

(b) The student calculated that the average velocity of the trolley during ***section 1*** was 80 cm/s. Show how this result was calculated.

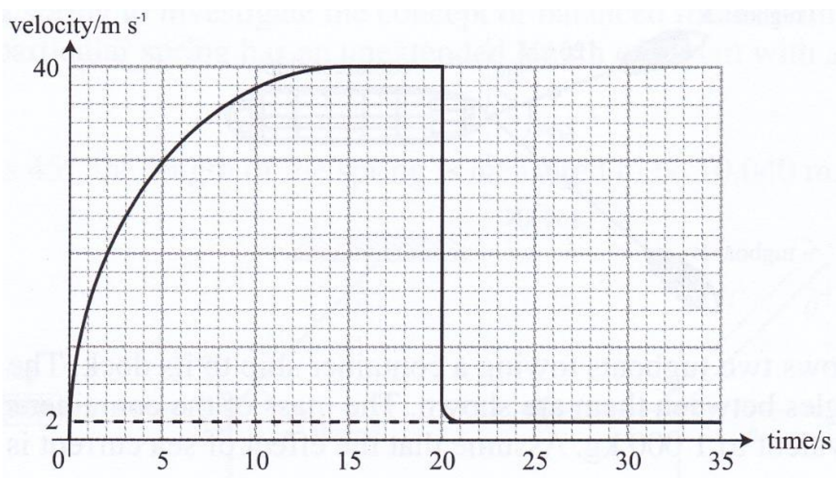


(c) What was the average velocity of the trolley during ***section 3***?

(d) Define acceleration.

(e) Calculate the acceleration of the trolley.

10 In an army war exercise, a 50 kg crate of ammunition was dropped from high altitude. The parachutes are deployed 20.0 s after the crate is released. The graph shows the velocity-time pattern of the motion of the crate. The crate touched down 35.0 s after its release.

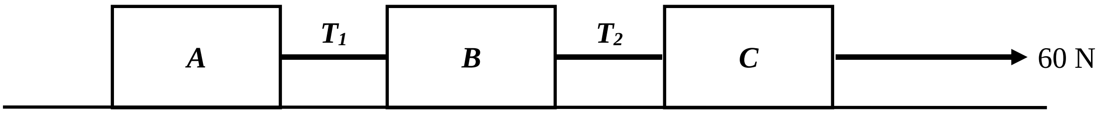


(a) Describe the motion of the crate from 0 to 35 s.
(b) Explain how the net force acting of the crate changes from 0 to 20 s.
(c) State the net force acting of the crate from 15 s to 20 s.
(d) From the graph, state the speed of the crate just before it lands.
(e) Calculate the impact force on the crate upon landing if it sinks 2 cm into the ground.

11 A car of mass 2 000 kg moves along a straight, level road. The engine enables a forward force of 6 000 N to act on the car. An opposing force, comprising air resistance and frictional forces, of 4 000 N also act against the car.
(a) Draw a free body force diagram showing all the forces acting on it.
(b) Calculate the acceleration of the car.
(c) As the car goes faster with the same forward force, it undergoes decreasing acceleration. Explain why this happens.

12 A lift, held by a cable, has a mass of 400 kg. Calculate the tension in the cable when it is
(a) stationary
(b) moving upwards at a constant speed of 3.0 m/s
(c) moving downwards at a constant speed of 1.0 m/s
(d) moving upwards at a constant acceleration of 2.0 m/s^2
(e) moving upwards at a constant deceleration of 4.0 m/s^2
(f) moving downwards at a constant acceleration of 1.0 m/s^2
(g) moving downwards at a constant deceleration of 2.0 m/s^2

13 ***A***, ***B*** and ***C*** are three identical blocks resting on a smooth surface. A force of 60 N is applied at one end as shown. What are the tensions T_1, between blocks ***A*** and ***B***, and T_2, between blocks ***B*** and ***C*** in the strings?



14 There are two kinds of quantities in physics, ***scalars*** and ***vectors***.

(a) What is the difference between a vector quantity and a scalar quantity?

(b) Give one example of a vector quantity and one example of a scalar quantity.

(c) A student ***X***, starting at a point ***P***, walks due North for 1.0 h at a constant speed of 4.0 km/h and then, at the same constant speed, walks 4.0 km due East, finishing at a point ***Q***. In the same total time but a different constant speed, a second student ***Y*** walks directly from ***P*** to ***Q***.

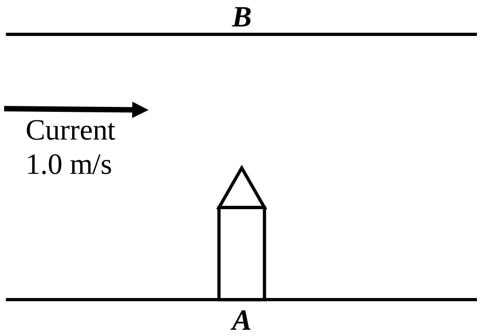
(i) Calculate the total distance walked by student ***X***;

(ii) Determine by drawing a vector diagram, the

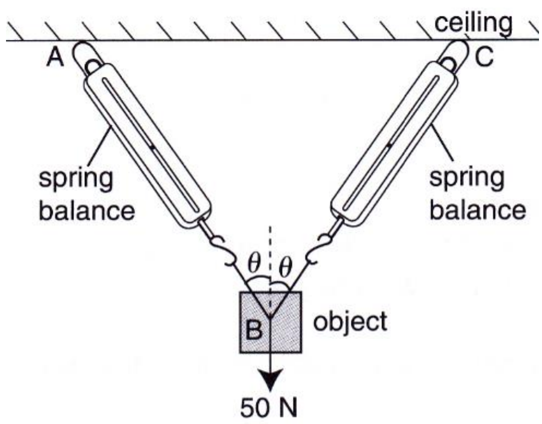
1 distance walked by student ***Y***

2 velocity of student ***Y***.

15 A boat wants to move from point ***A*** to ***B*** across the Singapore River. The current is moving from the left to the right at a speed of 1.0 m/s. In which direction should the boatman point the nose of his boat if the speed of the boat in still water is 3.0 m/s? Draw a scale diagram to solve the problem.



16 An experiment is conducted to illustrate the addition of forces on a stationary object, by using the setup shown. The two spring balances are attached to the ceiling and an object of mass 5 kg is hung between the spring balances. ***AB*** and ***BC*** are of equal length.



(a) (i) By means of a scale diagram, find the reading on each spring balance when θ is 30°.

(ii) State qualitatively how your answer in (a)(i) would differ if θ is increased to 60°.

(iii) Explain why it is not possible for the weight to be in equilibrium when θ is 90°.

(b) The experiment is conducted in a lift which is accelerating downwards at 2.0 m/s^2.

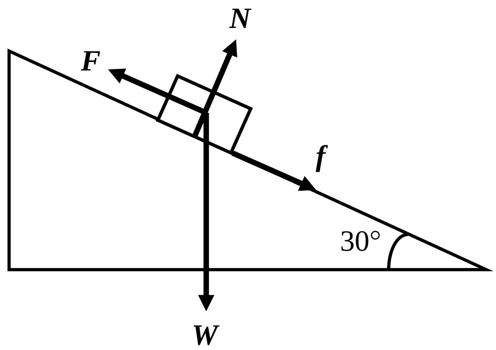
(i) Calculate the magnitude and direction of the resultant force on the object.

(ii) Explain whether you would expect the readings on each spring balance to be larger or smaller than your answer in (a)(i), if θ is also 30°.

17 An object is pulled up a slope with a force of 300 N. If the object moves with a constant speed of 2.0 m/s,

(a) what is the friction on the slope?

(b) using a scaled vector diagram, find ***N*** and ***W***, ignore the friction of the slope.



18 A rectangular block of metal is 50 mm long, 35 mm wide and has a thickness of 3.0 mm. It weighs 0.15 N. Calculate the density of the metal in kg/m^3.

19 A cube of sides 3.0 cm each has a density of 6.0 g/cm^3. A hole of volume 1.0 cm^3 is drilled into the cube. The hole is then filled up with a certain material of density 5.0 g/cm^3. Calculate the density of the composite cube.

20 A man is playing golf on a golf course. After being hit, the golf ball with a mass 0.080 kg starts out with a speed of 50.0 m/s.

(a) Calculate the max height reached.

(b) What is the speed of the ball when it has reached a height of 30.0 m?

(c) The man hits a second golf ball of identical mass. As the ball travels horizontally at a speed of 15.0 m/s, it hits the leaves of a tree. It then continues to move horizontally for a further 20.0 cm. Find the average resistive force exerted by the leaves of the tree on the ball.

21 When large buildings are being erected, particularly on softer ground, piles are driven into the ground to provide a firmer base. The diagram shows a pile hammer with a mass of 2 500 kg in operation.

(a) Calculate the loss of gravitational potential energy when the hammer falls 1.80 m to hit the pile.

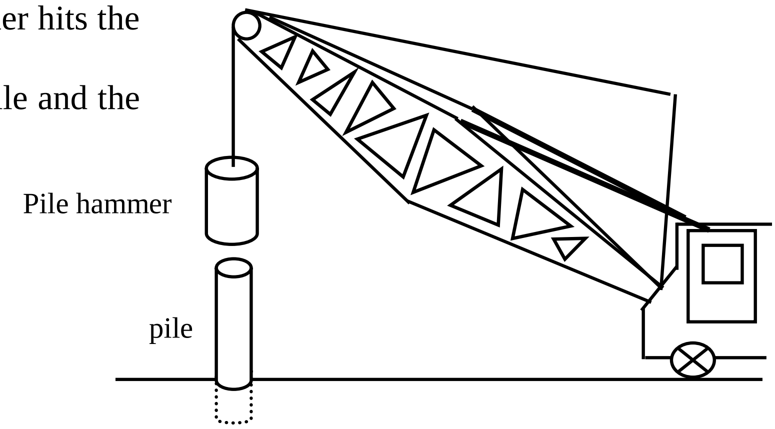
(b) What is the speed at which the hammer hits the pile?

(c) The total mechanical energy of the pile and the hammer just after impact is 27 000 J.

(i) How much energy is lost?

(ii) What has happened to the 'lost energy'?

(d) The pile is knocked into the ground a distance of 10.0 cm. Calculate the average frictional force exerted on the pile while it is moving down.



22 ***Fig A*** shows a gymnast of mass 48.0 kg jumping on a trampoline who can achieve a maximum height of 5.00 m. ***Fig B*** shows the speed-time graph of her motion on the trampoline.

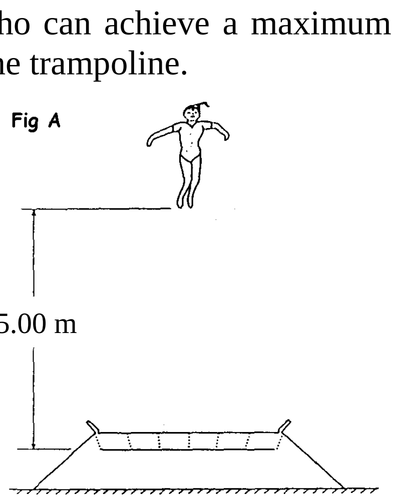
(a) At which point(s) did she achieve maximum gravitational potential energy?

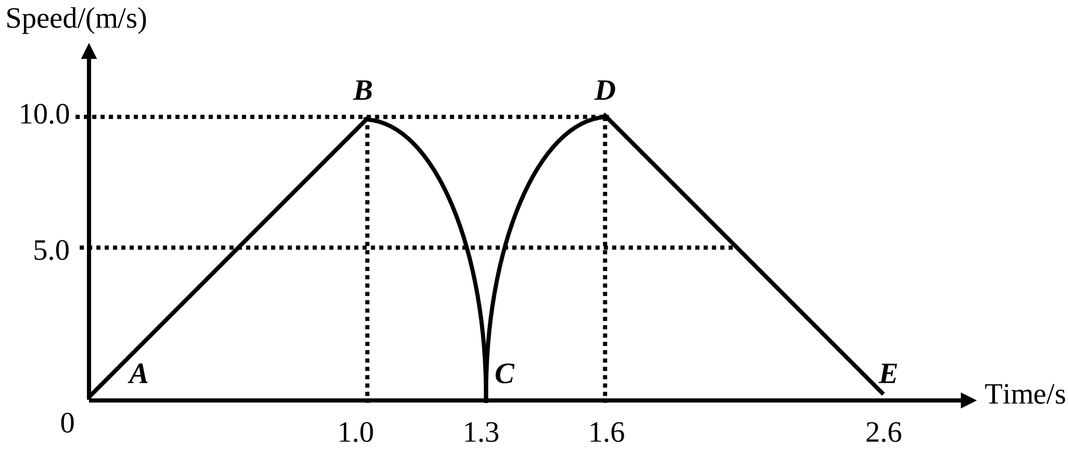
(b) State and explain the energy changes between point ***A*** and ***C***.

(c) Determine the maximum kinetic energy from the graph.

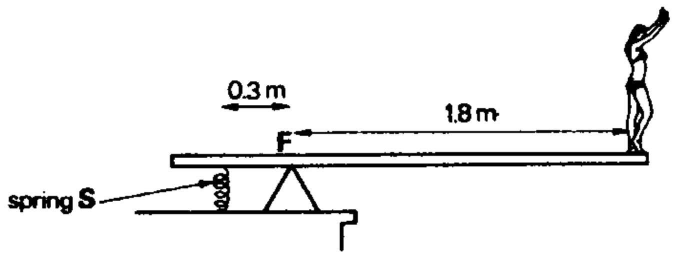
(d) Calculate the power developed by the trampoline on the gymnast between point ***C*** and ***D***.

(e) State one assumption made during your calculation in part (d).





23 The diagram shows one form of diving-board used at swimming pools. The board is pivoted at ***F***. A woman of weight 640 N stands still with her centre of gravity directly above a point 1.80 m from ***F*** as shown. A spring ***S*** holds the diving-board in a horizontal position.



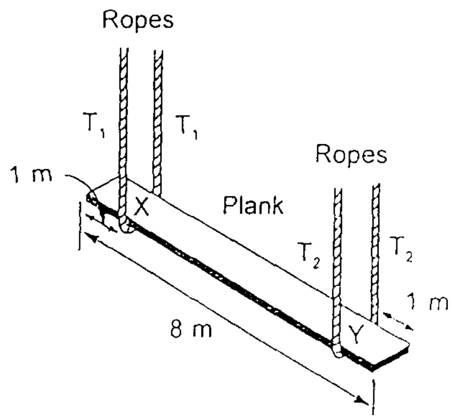
(a) Calculate the moment of the weight of the woman about ***F***.

(b) Assuming that the distance between the spring ***S*** and the point ***F*** is 0.300 m, calculate the force exerted by the spring to balance the weight of the woman.

24 A painter stands on a uniform plank 8 m long and of mass 80 kg. The plank is suspended horizontally by a vertical ropes attached 1 m from each end as shown in the diagram. The mass of the painter is 60 kg.

(a) Calculate the tensions T_1 and T_2 in each rope when the painter is 2 m from the centre of the platform and nearer to T_1.

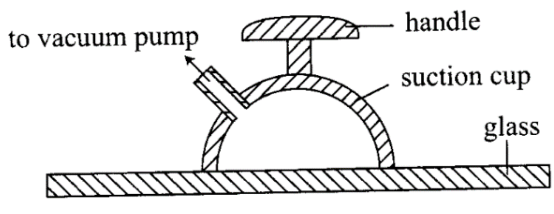
(b) State (with no calculation required) how you would expect the tensions in the rope to vary as the painter moves along the plank from ***X*** to ***Y***.



25 The diagram shows a piece of glass being lifted by a suction cup. Some air inside the suction cup is removed by a vacuum pump. The atmospheric pressure outside the cup prevents the glass from dropping. The area of the glass covered by the cup is 0.002 5 m^2 and the pressure inside the cup is reduced to 60 kPa. Given that the atmospheric pressure is 100 kPa,

(a) calculate the maximum weight of glass that can be lifted with this cup.

(b) state one change that would allow the suction cup to lift a heavier piece of glass.



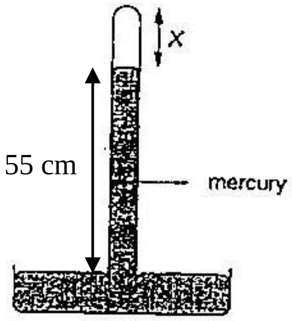
26 A lift of mass 2 500 kg moves upwards with an acceleration of 0.70 m/s^2. The lift is attached to a cable which has a safe tensile stress of 4.5×10^7 Pa. The tensile stress of a cable is the tensile force per unit area of cable. What is the minimum cross-sectional area of the cable that should be used?

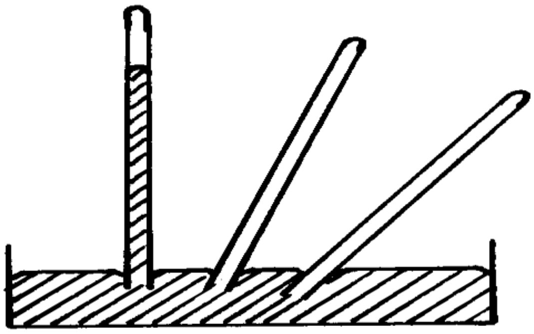
27 A simple mercury barometer is carried to the top of a mountain where the atmospheric pressure is less than at its base.

(a) Calculate the pressure at the top of the mountain in Pa? (density of mercury is 13 600 kg/m^3)

(b) Indicate on the diagram with a "***Z***", the point where the pressure is zero.

(c) How does the length of ***X*** of the space above the mercury and the pressure in this space, change as the barometer is taken from the base to the top of the mountain? Explain.





(d) How would the mercury height be affected if air got into the tube in position ***X***? Explain.

(e) What would happen to this reading if the barometer was tilted at different positions as shown in the diagram? Indicate on the diagram the position of the mercury level inside the tube.

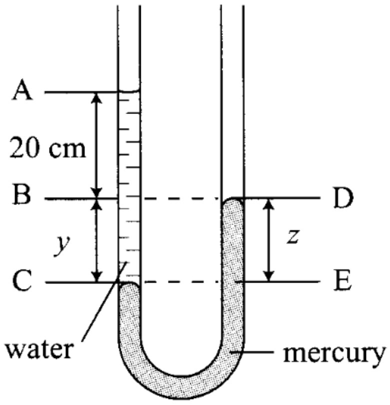
28 The diagram shows a simple U-tube which contains two liquids, water and mercury. Both ends of the U-tube are open to the atmosphere. The density of water is 1 000 kg/m^3 while that of mercury is 13 600 kg/m^3. Take pressure of atmosphere as 100 kPa and the acceleration due to gravity as 10 m/s^2.

(a) State the pair(s) of points that experience(s) the same pressure.

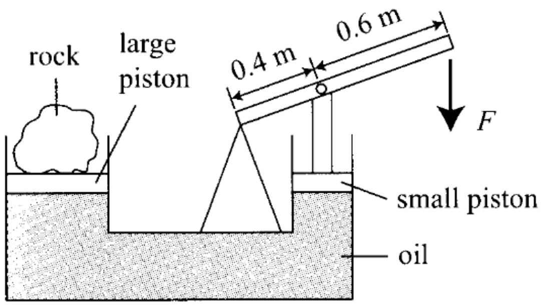
(b) Calculate the height ***y***.

(c) State the total pressure at point ***E*** in Pa.

(d) What is its equivalent in mmHg?



29 The diagram shows a simple hydraulic system used to raise a big rock. The area of small piston is 0.2 m^2 while that of the big piston is 1.2 m^2. Calculate the force exerted on the large piston when a force ***F*** equals to 20 N is applied to the handle.



30 The diagrams show the same glass tube in three different positions. If the atmospheric pressure = 76 cmHg,

(a) calculate the length l_B of the trapped air column.

(b) what is the length l_C of the trapped air column?