1 Fig. 3.1 shows an early water-powered device used to raise a heavy load. The heavy load rests on piston B.

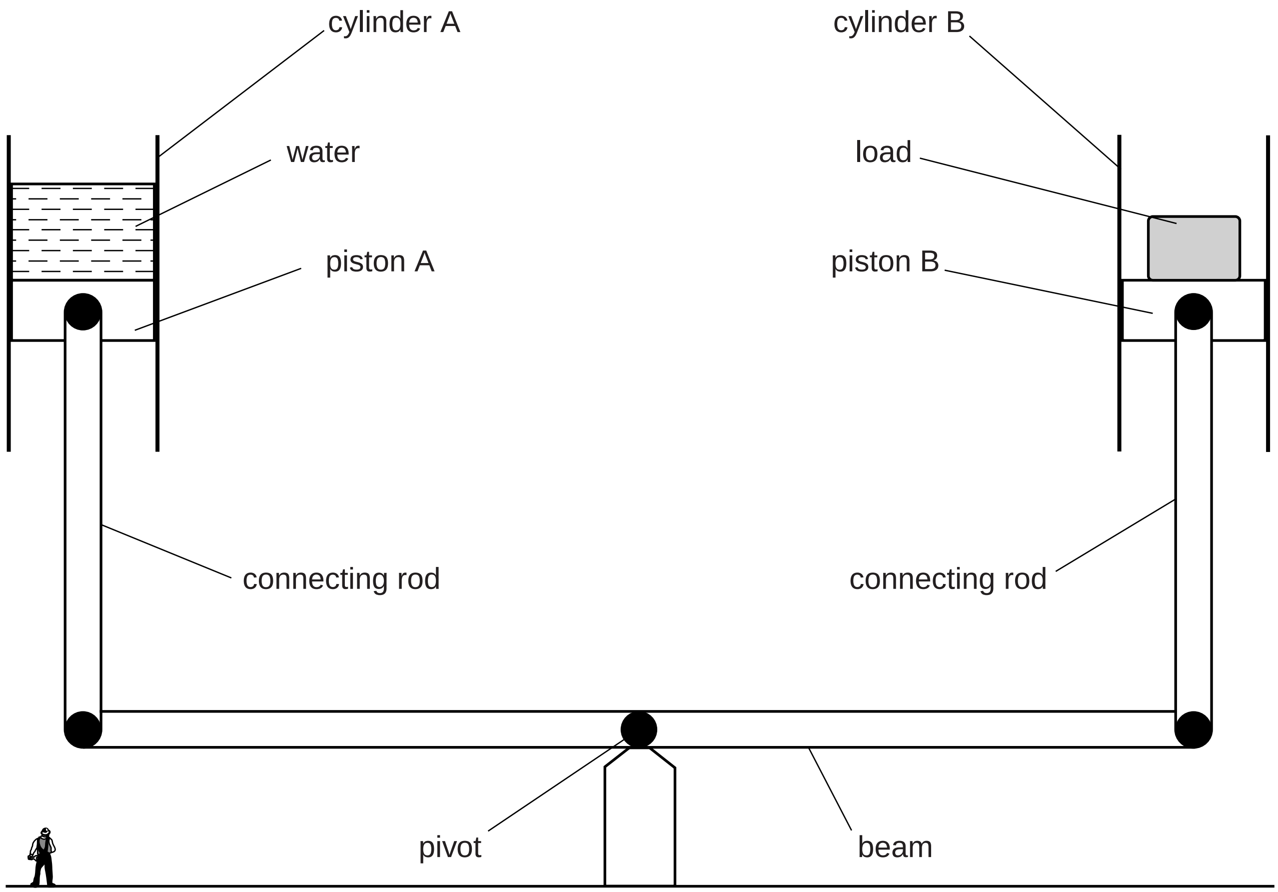


Fig. 3.1 (not to scale)

Initially, a large weight of water in cylinder A pushes piston A down. This causes the left-hand end of the beam to move down and the right-hand end of the beam to move up. Piston B rises, lifting the heavy load.

(a) The weight of water in cylinder A is 80 kN.

Calculate the mass of water in cylinder A.

mass = ... [2]

(b) The density of water is 1000 kg / m^3.

Calculate the volume of water in cylinder A.

volume = ... [2]

(c) Piston A moves down a distance of 4.0 m.

Calculate the gravitational potential energy lost by the water.

loss of gravitational potential energy = ... [2]

(d) The heavy load lifted by piston B gains 96 kJ of gravitational potential energy.

Calculate the efficiency of the device.

efficiency = ... [2]

[Total: 8]

2 On a windy day, a parachutist of mass 85 kg jumps from an aeroplane.

Fig. 3.1 shows the parachutist falling through the air at a constant vertical velocity of 8.4 m/s downwards.

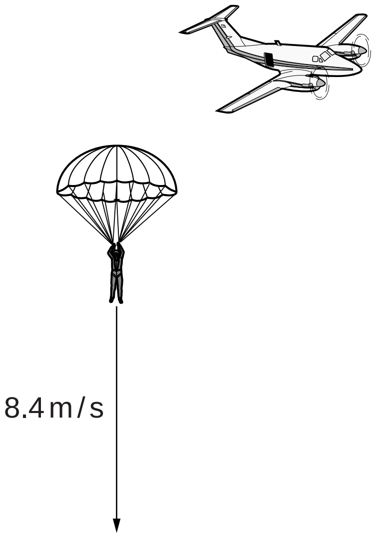


Fig. 3.1

(a) Distinguish between *speed* and *velocity*.

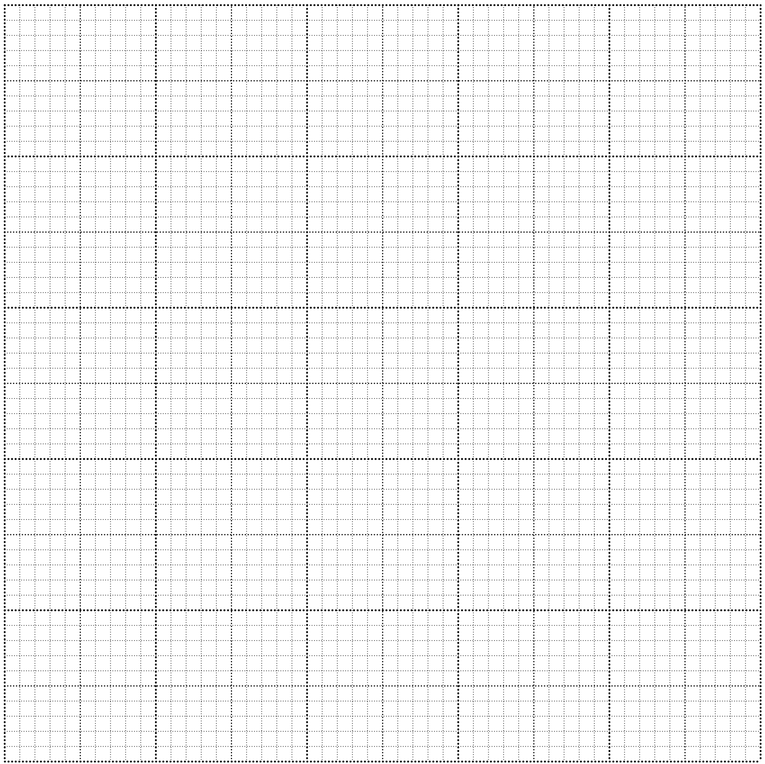
....

.... [1]

(b) As the parachutist falls, the wind is moving him towards the right of the diagram, at a horizontal velocity of 6.3 m/s.

(i) On Fig. 3.1, draw an arrow to show the horizontal velocity of the parachutist. [1]

(ii) On the grid below, draw a vector diagram to determine graphically the size and direction of the resultant velocity of the parachutist.



size = ...

direction = ...
[4]

(iii) Calculate the kinetic energy of the parachutist.

kinetic energy = ... [3]

[Total: 9]

3 Fig. 3.1 shows a water turbine that is generating electricity in a small tidal energy scheme.

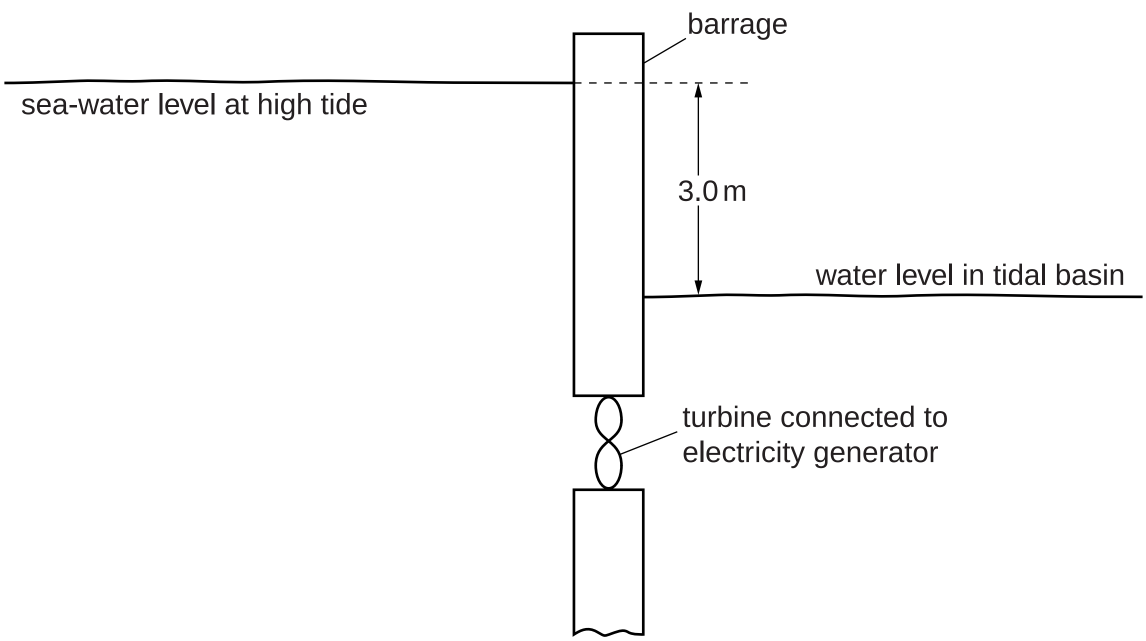


Fig. 3.1

At high tide, 1.0 m^3 of sea-water of density 1030 kg/m^3 flows through the turbine every second.

(a) Calculate the loss of gravitational potential energy when 1.0 m^3 of sea-water falls through a vertical distance of 3.0 m.

loss of gravitational potential energy = ... [3]

(b) Assume that your answer to **(a)** is the energy lost per second by the sea-water passing through the turbine at high tide. The generator delivers a current of 26 A at 400 V.

Calculate the efficiency of the scheme.

efficiency = ...% [3]

(c) At low tide, the sea-water level is lower than the water level in the tidal basin.

(i) State the direction of the flow of water through the turbine at low tide.

....

(ii) Suggest an essential feature of the turbine and generator for electricity to be generated at low tide.

....

....

....
[2]

[Total: 8]

4 **(a)** State what is meant by the *centre of mass* of a body.

....

....

.... [1]

(b) Fig. 4.1 shows an athlete successfully performing a high jump.

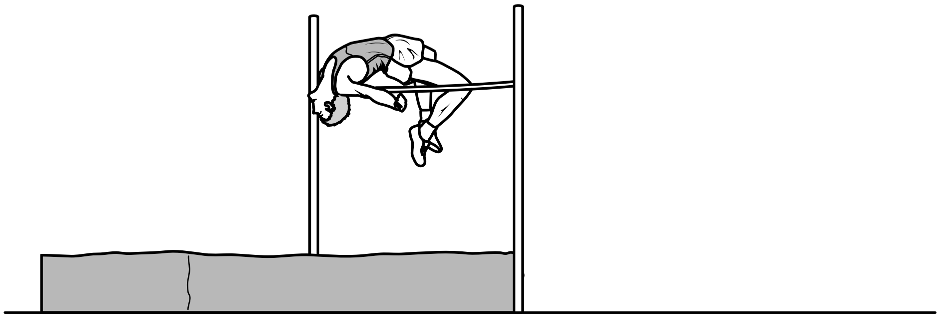


Fig. 4.1

The height of the bar above the ground is 2.0 m. The maximum increase in gravitational potential energy (g.p.e.) of the athlete during the jump is calculated using the expression g.p.e. = mgh.

Explain why the value of h used in the calculation is much less than 2.0 m.

....

....

.... [1]

(c) Fig. 4.2 shows, in order, five stages of an athlete successfully performing a pole-vault.

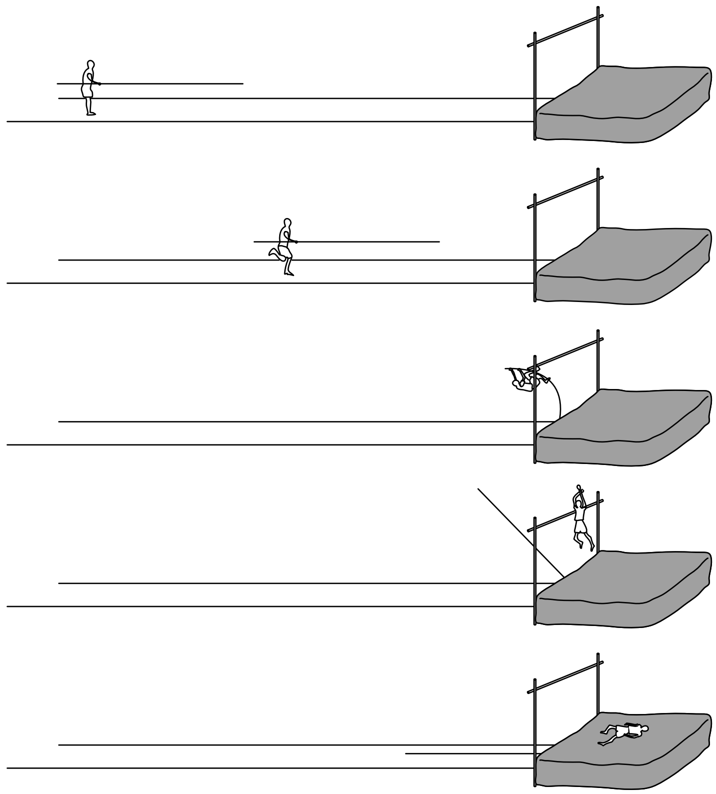


Fig. 4.2

Describe the energy changes which take place during the performance of the pole-vault, from the original stationary position of the pole-vaulter before the run-up, to the final stationary position after the vault.

....

....

....

....

....

....

....

....

....

....

.... [6]

[Total: 8]

5 Solar panels are positioned on the roof of the house shown in Fig. 6.1. They use thermal energy from the Sun to provide hot water in an environmentally friendly way.

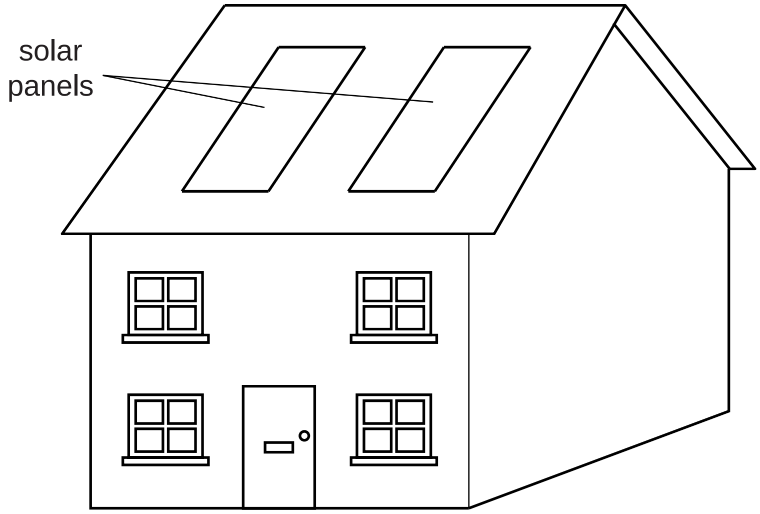


Fig. 6.1

Cold water flows to the panels at 15 °C. During the day, the panels supply 3.8 kg of hot water at 65 °C every hour.

(a) Calculate the average energy that the solar panels deliver to the water in one hour. Specific heat capacity of water = 4200 J / (kg °C).

energy = ... [3]

(b) The solar power incident on the roof during this heating period is 170 W / m^2. The solar panels have a total area of 8.0 m^2.

Calculate the solar energy incident on the panels in one hour.

solar energy = ... [2]

(c) Calculate the efficiency of the solar panels, stating the equation you use.

efficiency = ... [2]

(d) Explain why solar energy is called *renewable* energy.

....

.... [1]

(e) State one disadvantage of using solar energy.

....

.... [1]

[Total: 9]