1 Fig. 4.1 shows a small wind-turbine used to generate electricity.

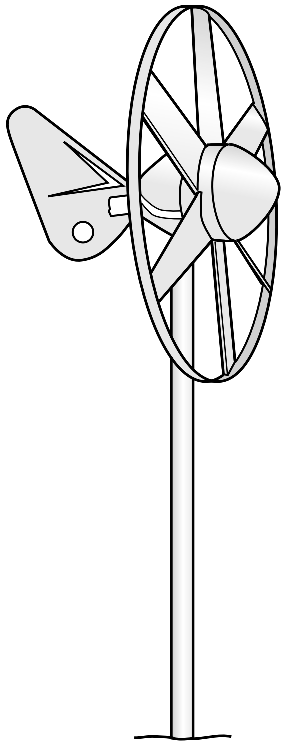

Fig. 4.1

The wind-turbine drives an electric generator.

The wind blows with a velocity of 7.0 m/s at right angles to the plane of the turbine. The mass of air passing per second through the turbine is 6.7 kg.

(a) **(i)** Calculate the kinetic energy of the air blown through the turbine per second.

kinetic energy = ... [2]

(ii) Only 8% of this energy is converted to electrical energy.

Calculate the power output of the electric generator.

power output = ... [2]

(b) The volume of air passing through the turbine each second is 5.6 m^3 (flow rate is 5.6 m^3/s).

Calculate the density of the air.

density of air = ... [2]

(c) The turbine turns a generator.

Describe the essential action within the generator that produces electricity.

....

....

.... [2]

[Total: 8]

2 Fig. 3.1 shows a long, plastic tube, sealed at both ends. The tube contains 0.15 kg of small metal spheres.

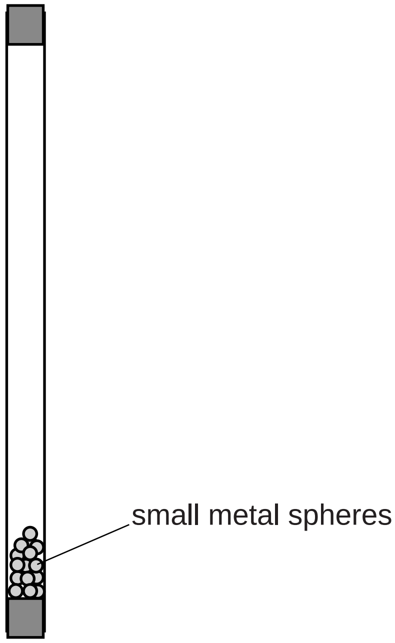

Fig. 3.1

A physics teacher turns the tube upside down very quickly and the small metal spheres then fall through 1.8 m and hit the bottom of the tube.

(a) Calculate

(i) the decrease in gravitational potential energy as the spheres fall 1.8 m,

decrease in gravitational potential energy = ... [2]

(ii) the speed of the spheres as they hit the bottom of the tube.

speed = ... [3]

(b) The gravitational potential energy of the spheres is eventually transformed to thermal energy in the metal spheres. The physics teacher explains that this procedure can be used to determine the specific heat capacity of the metal.

(i) State one other measurement that must be made in order for the specific heat capacity of the metal to be determined.

....

....[1]

(ii) Suggest a source of inaccuracy in determining the specific heat capacity using this experiment.

....

....[1]

(iii) The teacher turns the tube upside down and lets the spheres fall to the bottom 100 times within a short period of time.

Explain why turning the tube upside down 100 times, instead of just once, produces a more accurate value of the specific heat capacity.

....

....

....[2]

[Total: 9]

3 Fig. 3.1 shows the descent of a sky-diver from a stationary balloon.

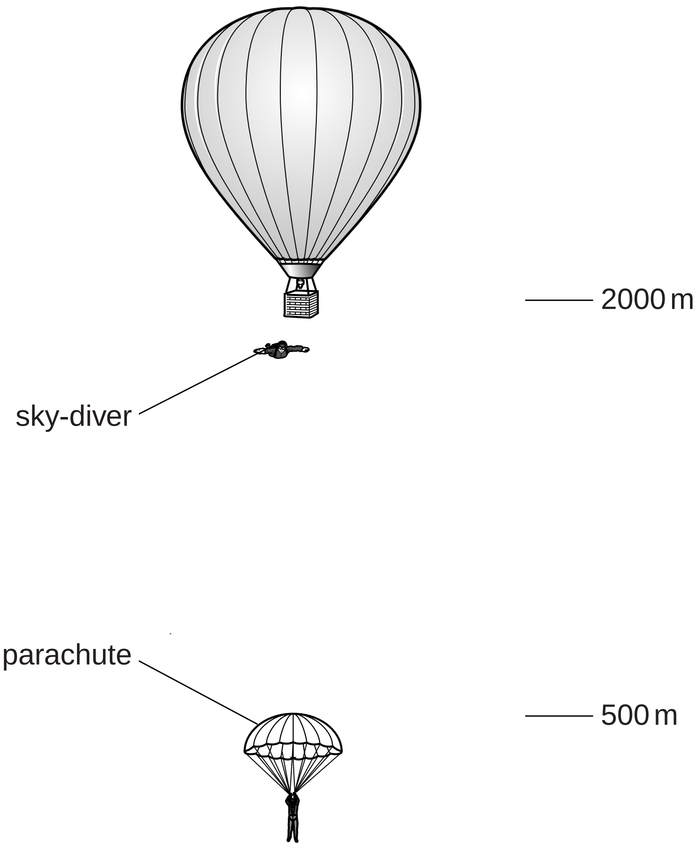

Fig. 3.1 (not to scale)

The sky-diver steps from the balloon at a height of 2000 m and accelerates downwards.

His speed is 52 m/s at a height of 500 m.

He then opens his parachute. From 400 m to ground level, he falls at constant speed.

(a) The total mass of the sky-diver and his equipment is 92 kg.

(i) Calculate, for the sky-diver,

1. the loss of gravitational potential energy in the fall from 2000 m to 500 m,

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

2. the kinetic energy at the height of 500 m.

kinetic energy = ... [2]

(ii) The kinetic energy at 500 m is not equal to the loss of gravitational potential energy. Explain why there is a difference in the values.

....

....

.... [1]

(b) State

(i) what happens to the air resistance acting on the sky-diver during the fall from 2000 m to 500 m,

.... [1]

(ii) the value of the air resistance during the fall from 400 m to ground.

air resistance = ... [1]

[Total: 7]

4 Water is stored in a reservoir at an average vertical height of 350 m above the turbines of a hydroelectric power station.

During a 7.0 hour period, $1.8 \times 10^6\,m^3$ of water flows down from the reservoir to the turbines.

(a) The density of water is $1000\,kg/m^3$.

For this 7.0 hour period, calculate

(i) the mass of water that flows from the reservoir to the turbines,

mass = ... [2]

(ii) the gravitational potential energy transformed as the water flows to the turbines,

energy = ... [2]

(iii) the maximum possible average output power.

power = ... [2]

(b) A hydroelectric power station generates electricity from a renewable energy source.

(i) Explain what is meant, in this context, by *renewable*.

....

.... [1]

(ii) State two other renewable energy sources.

1. ....

2. ....

[2]

[Total: 9]

5 **(a)** State the energy changes that take place when

(i) a cyclist rides down a hill without pedalling,

....

....

(ii) a cyclist pedals up a hill at a constant speed.

....

....

[3]

(b) A car of mass 940 kg is travelling at 16 m / s.

(i) Calculate the kinetic energy of the car.

kinetic energy = ... [2]

(ii) The car is brought to rest by applying the brakes.

The total mass of the brakes is 4.5 kg. The average specific heat capacity of the brake material is 520 J / (kg °C).

Calculate the rise in temperature of the brakes. Assume there is no loss of thermal energy from the brakes.

rise in temperature = ... [3]

[Total: 8]

6 Fig. 3.1 shows a fork-lift truck lifting a crate on to a high shelf in a warehouse.

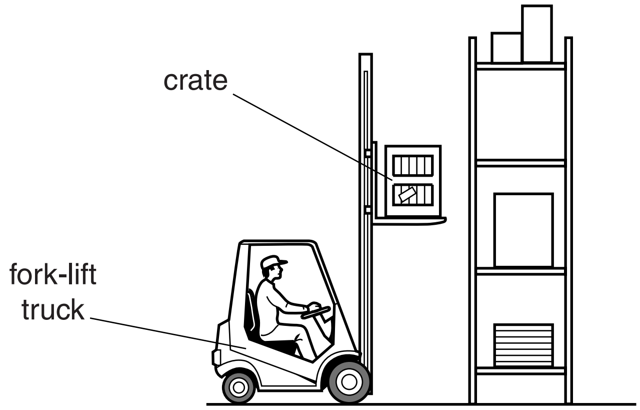

Fig. 3.1

The fork-lift truck lifts a crate of weight 640 N through a vertical distance of 3.5 m in 4.0 s.

(a) Calculate the useful work done in lifting the crate.

work done = ... [2]

(b) A motor drives a mechanism to lift the crate. The current in the motor is 25 A. The motor is connected to a 75 V battery.

Calculate

(i) the energy supplied to the motor in 4.0 s,

energy = ... [2]

(ii) the overall efficiency of the fork-lift truck in lifting the crate.

efficiency = ... [2]

(c) Not all of the energy supplied is used usefully in lifting the crate.

Suggest two mechanisms by which energy is wasted.

1. ....

2. .... [2]

[Total: 8]