1 **(a)** The source of solar energy is the Sun.

Tick the box next to those resources for which the Sun is also the source of energy.

- ☐ coal
- ☐ geothermal
- ☐ hydroelectric
- ☐ nuclear
- ☐ wind [2]

(b) Fig. 4.1 shows a solar water-heating panel on the roof of a house.

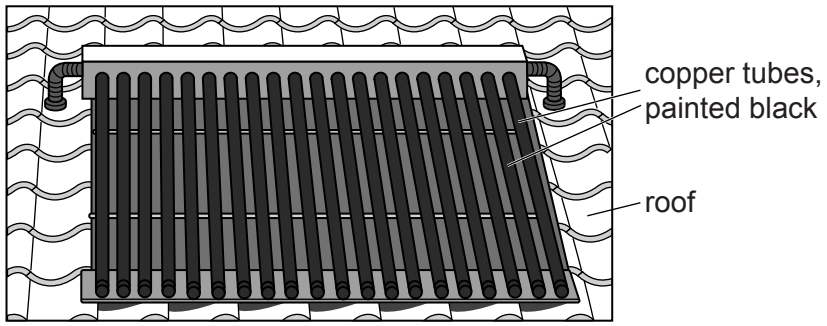

Fig. 4.1

Cold water flows into the copper tubes, which are heated by solar radiation. Hot water flows out of the tubes and is stored in a tank.

(i) Explain why the tubes are made of copper and are painted black.

.....

.....

.....[2]

(ii) In 5.0 s, 0.019 kg of water flows through the tubes. The temperature of the water increases from 20 °C to 72 °C. The specific heat capacity of water is 4200 J / (kg °C).

Calculate the thermal energy gained by the water in 5.0 s.

thermal energy = ...[3]

(iii) The efficiency of the solar panel is 70%.

Calculate the power of the solar radiation incident on the panel.

power = ...[2]

[Total: 9]

2 A train has a total mass of 7.5×10^5 kg.

(a) The train accelerates from rest at a constant rate along a straight, horizontal track. It reaches a speed of 24 m/s in 60 s.

Calculate

(i) the train's acceleration,

acceleration = ... [2]

(ii) the resultant force acting on the train.

force = ... [2]

(b) The train now travels with a constant speed of 24 m/s along a straight, horizontal track. The total force opposing the motion due to friction and air resistance is 7.2×10^4 N.

(i) By considering the work done by the train's engine in 1.0 s, calculate its output power.

power = ... [2]

(ii) The train begins to travel up a slope.

Explain why the power of the train's engine must be increased to maintain the speed of 24 m / s.

.....

.....

.....

.....

..... [3]

[Total: 9]

3 A student wishes to work out how much power she uses to lift her body when climbing a flight of stairs.

Her body mass is 60 kg and the vertical height of the stairs is 3.0 m. She takes 12 s to walk up the stairs.

(a) Calculate

(i) the work done in raising her body mass as she climbs the stairs,

work = ... [2]

(ii) the output power she develops when raising her body mass.

power = ... [2]

(b) At the top of the stairs she has gravitational potential energy.

Describe the energy transformations taking place as she walks back down the stairs and stops at the bottom.

.....

.....

.....

..... [2]

[Total: 6]

4 Fig. 2.1 shows a track for a model car.

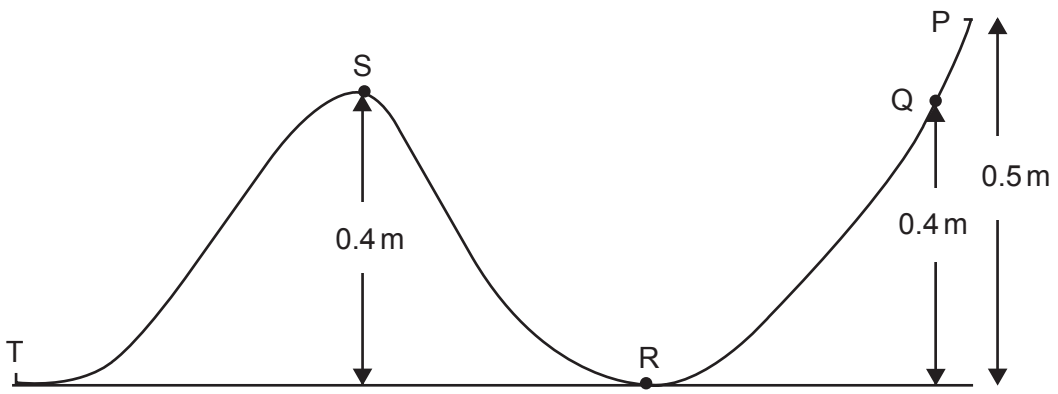

Fig. 2.1

The car has no power supply, but can run down a sloping track due to its weight.

(a) The car is released at Q. It comes to rest just before it reaches S and rolls back.

(i) Describe the motion of the car after it starts rolling back and until it eventually comes to rest.

.....

.....

..... [2]

(ii) Explain in terms of energy transformations why the car, starting at Q, cannot pass S.

.....

.....

..... [1]

(b) A second car, of mass 0.12 kg, is released from P. It continues until it runs off the track at T.

Calculate the maximum speed that the car could have at T assuming friction in the car is negligible.

speed = ... [3]

[Total: 6]

5 An electric pump is used to raise water from a well, as shown in Fig. 3.1.

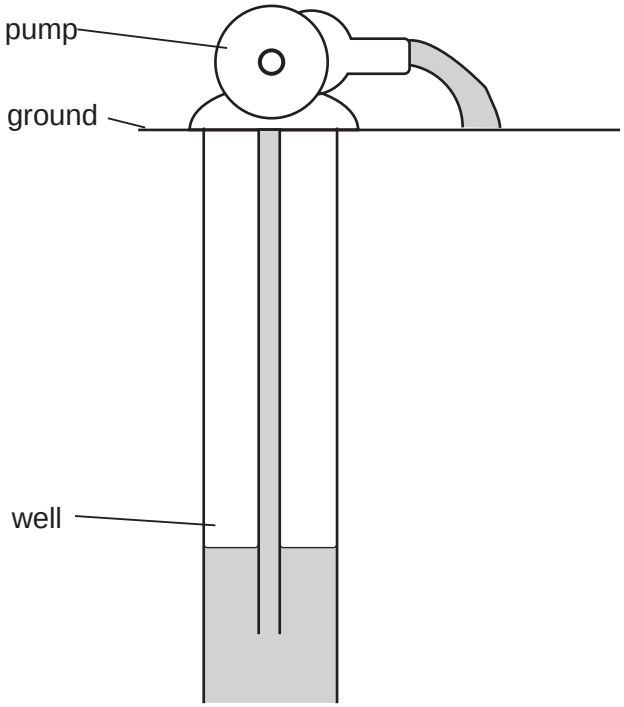

Fig. 3.1

(a) The pump does work in raising the water. State an equation that could be used to calculate the work done in raising the water.

.....[2]

(b) The water is raised through a vertical distance of 8.0 m. The weight of water raised in 5.0 s is 100 N.

(i) Calculate the work done in raising the water in this time.

work done = ...[1]

(ii) Calculate the power the pump uses to raise the water.

power = ...[1]

(iii) The energy transferred by the pump to the water is greater than your answer to **(i)**. Suggest what the additional energy is used for.

.....[1]

[Total : 5]

6 Fig. 3.1 shows water falling over a dam.

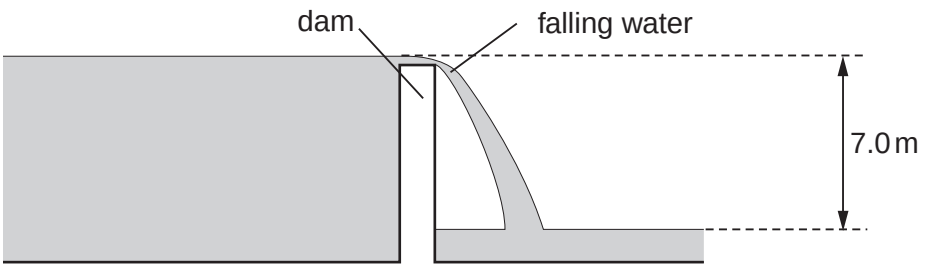

Fig. 3.1

(a) The vertical height that the water falls is 7.0 m.
Calculate the potential energy lost by 1.0 kg of water during the fall.

potential energy = ...[2]

(b) Assuming all this potential energy loss is changed to kinetic energy of the water, calculate the speed of the water, in the vertical direction, at the end of the fall.

speed = ...[3]

(c) The vertical speed of the water is less than that calculated in **(b)**. Suggest one reason for this.

.....

.....[1]

[Total : 6]

7 Fig. 2.1 shows a simple pendulum that swings backwards and forwards between P and Q.

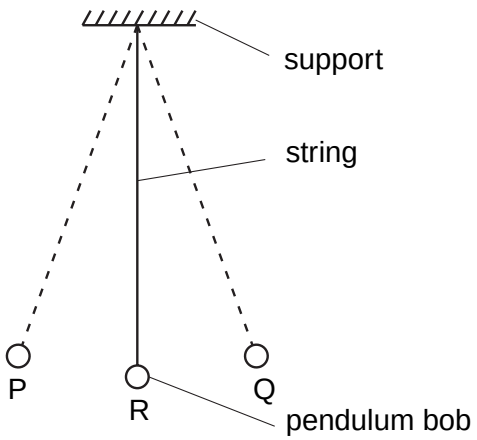

Fig. 2.1

(a) The time taken for the pendulum to swing from P to Q is approximately 0.5 s.

Describe how you would determine this time as accurately as possible.

.....

.....

..... [2]

(b) **(i)** State the two vertical forces acting on the pendulum bob when it is at position R.

1. ....

2. ..... [1]

(ii) The pendulum bob moves along the arc of a circle. State the direction of the resultant of the two forces in **(i)**.

..... [1]

(c) The mass of the bob is 0.2 kg. During the swing it moves so that P is 0.05 m higher than R.

Calculate the increase in potential energy of the pendulum bob between R and P.

potential energy = …… [2]

[Total : 6]