Work, Energy and Power 2

1.

(a) In a downhill ski race the total distance between the start and the finish is 1800 m. The total vertical drop is 550 m. The weight of a skier (including his equipment) is 900 N and the time of his descent is 65 s.

(i) Calculate the average speed of the skier for the race.

average speed .... m s^{-1} [2]

(ii) Calculate the loss of gravitational potential energy of the skier.

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

(b) The average resistive force acting against the skier is 250 N.

(i) Calculate the work done against this resistive force.

work done .... J [2]

(ii) If the skier does no work, calculate

1. his kinetic energy as he passes the finish,

kinetic energy .... J [1]

2. his speed as he passes the finish.

speed .... m s^{-1} [3]

(iii) State whether in practice the final speed of the skier is likely to be greater or less than the value calculated in part **(ii) 2.** Explain your answer.

....

....

....[2]

2.

(a) **(i)** Explain the concept of work and relate it to power.

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....

....[2]

(ii) Define the joule.

....

....[1]

(b) A cable car is used to carry people up a mountain. The mass of the car is 2000 kg and it carries 80 people, of average mass 60 kg. The vertical height travelled is 900 m and the time taken is 5 minutes.

(i) Calculate the gain in gravitational potential energy of the 80 people in the car.

gravitational potential energy gain = ... J [2]

(ii) Calculate the minimum power required by a motor to lift the cable car and its passengers to the top of the mountain.

power = ... unit .... [3]

3.

(a) A car of total mass 800 kg is travelling along a level road at 25 m s^{-1}. The thinking time of the driver is 0.65 s and the braking distance for the car travelling at this speed is 40 m.

(i) Calculate the overall stopping distance.

stopping distance = ... m

(ii) Calculate the kinetic energy of the car before the brakes are applied.

kinetic energy = ... J

(iii) Calculate the average braking force of the car.

braking force = ... N

[7]

(b) Explain why the following factors affect the stopping distance of a car.

(In this question, marks are available for the quality of written communication.)

(i) a wet road

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(ii) tyre tread

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....

(iii) downward slope in the road.

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.... [7]

[Total: 14]

4.

(a) Define

(i) power ....

....

....[1]

(ii) a joule ....

....

....[1]

(b) Fig. 4.1 shows part of a fairground ride with a carriage on rails.

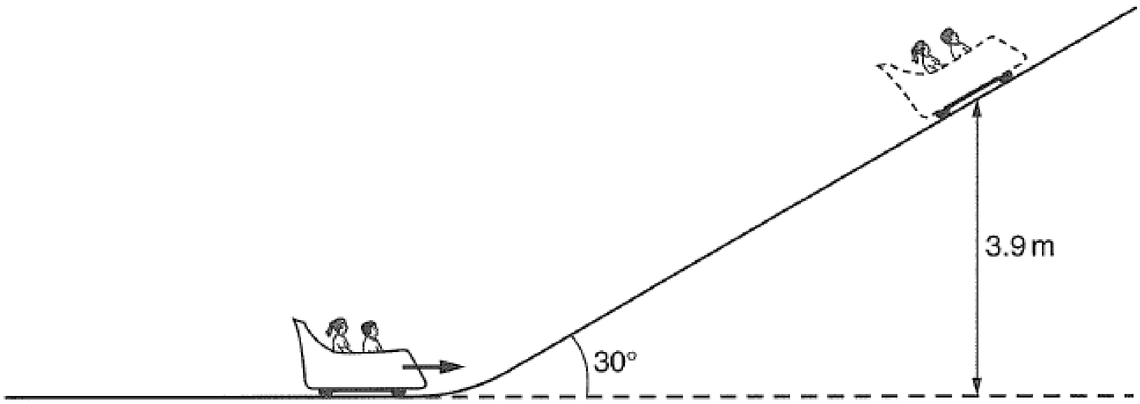

Fig. 4.1

The carriage of mass 500 kg is travelling towards a slope inclined at 30° to the horizontal. The carriage has a kinetic energy of 25 kJ at the bottom of the slope. The carriage comes to rest after travelling up the slope to a vertical height of 3.9 m.

(i) Show that the potential energy gained by the carriage is 19 kJ.

[2]

(ii) Calculate the work done against the resistive forces as the carriage moves up the slope.

work done = ... kJ [1]

(iii) Calculate the resistive force acting against the carriage as it moves up the slope.

resistive force = ... N [3]

5.

(a) Explain the quantities

(i) gravitational potential energy

....

....

.... [2]

(ii) kinetic energy

....

....

.... [2]

(iii) power.

....

....

.... [1]

(b) Water leaves a reservoir and falls through a vertical height of 130 m and causes a water wheel to rotate. The rotating wheel is then used to produce 110 kW of electrical power.

(i) Calculate the velocity of the water as it reaches the wheel, assuming that all the gravitational potential energy is converted to kinetic energy.

velocity = ... $m\,s^{-1}$ [3]

(ii) Calculate the mass of water flowing through the wheel per second, assuming that the production of electrical energy is 100% efficient.

mass of water per second = ... unit .... [3]

(iii) State and explain **two** reasons why the mass of water flowing per second needs to be greater than the value in **(ii)** in order to produce this amount of electrical power.

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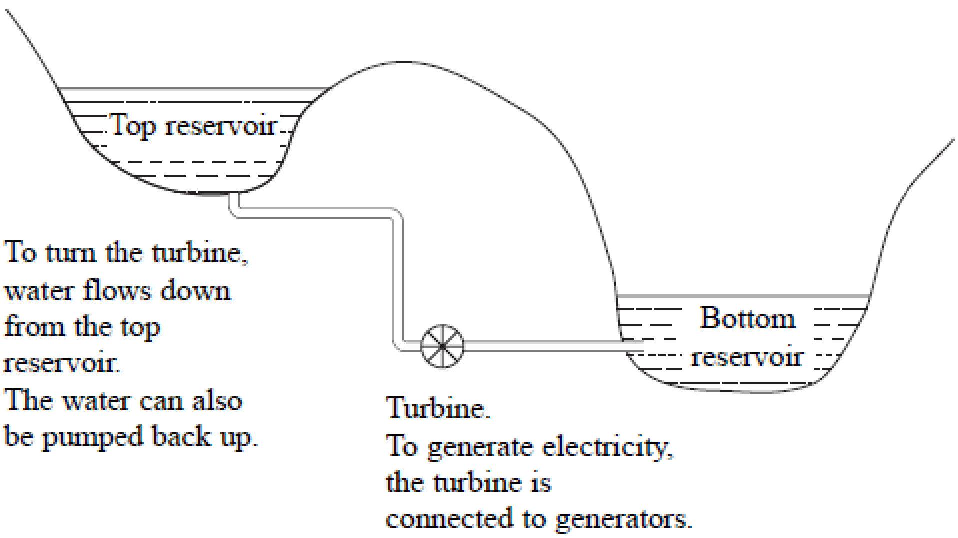
.... [2]

6.

A certain power station generates electricity from falling water. The diagram shows a simplified sketch of the system.



(a) (i) In what form is the energy of the water initially stored?

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(ii) What energy form is this transformed into in order to drive the turbine?

....

(1)

(b) State the principal of conservation of energy.

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....

(2)

(c) The force of the water at the turbine is 3.5×10^8 N and the output power generated is 1.7×10^9 W. Use this data to calculate the minimum speed at which the water must enter the turbine.

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....

(2)

(d) Explain why, in practice, the speed at which the water enters the turbine is much greater than this.

....

....

(1)

(e) When working at this output power, 390 m^3 of water flows through the turbine each second. The top reservoir holds 7.0×10^6 m^3 of water. For how long will electricity be generated?

....

....

....

Time = ...

(1)

(f) This power station is used at peak periods, after which the water is pumped back to the top reservoir. The water has to be raised by 500 m. How much work is done to return all the water to the top reservoir?

(The density of water is 1000 kg m^{-3}.)

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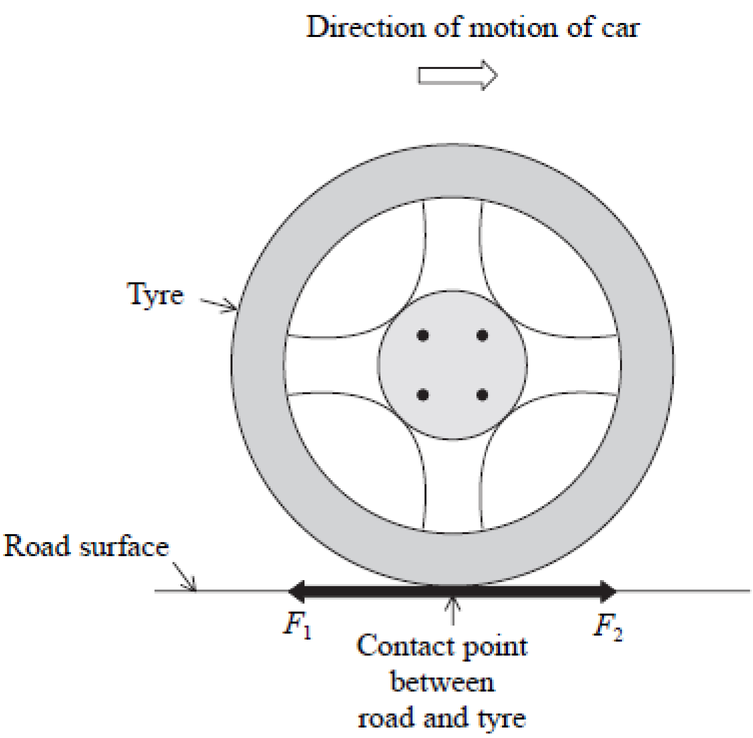
....

Work done = ...

(3)

7.

The force produced by the engine of a car which drives it is ultimately transmitted to the area of contact between the car's tyres and the road surface. The diagram shows a wheel at an instant during the motion of the car when it is being driven forward in the direction indicated.



Two horizontal forces act at the point of contact between the tyre and road due to the transmitted force from the engine. These are shown as F_1 and F_2. Assume that the area of contact between the tyre and road is very small.

(a) Complete the statements

(i) F_1 is the force of the .... on the ....

(ii) F_2 is the force of the .... on the ....

(2)

(b) (i) The total forward force on the car is 400 N when the car is travelling at a constant speed of 10 m s^{-1} along a level road. Calculate the effective power driving the car forward.

....

....

....

Power = ...

(2)

(ii) Hence calculate the total work done by the 400 N force in 5 minutes in maintaining the speed of 10 m s^{-1}.

....

....

Work done = ...

(1)

(c) Although work is done on the car, it continues to move at a constant speed.

Explain why the car is not gaining kinetic energy.

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(2)