

Engineering Studies

Section II (continued)

Marks

Question 13 — Personal and Public Transport (10 marks)

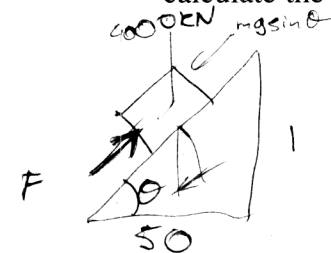
A railway track has rails made of 0.8% carbon steel.

- (a) The surface of the rails has been induction heated and water quenched. Describe the final structure and properties of the rail. 3

The internal rail will have high strength however the surface will be hard but brittle from the quenching. Therefore the final rail will be tough and strong with a hard but brittle surface to resist wear.

- (b) A suburban train weighing 400 tonnes has to climb a gradient of 1 in 50 at a constant velocity of 60 km per hour. 3

If the power required to overcome rolling resistance at this velocity is 450 kW, calculate the overall power needed to climb the gradient.



$\tan \theta = \frac{1}{50}$
 $\theta = 1.145^\circ$

$4000 \sin \theta - F = 0$ (no acceleration)

$\therefore F = 400 \times \frac{1}{50.009}$
 $= 79.98 \text{ kN}$

$W = F \times S$
 $= 4000 \text{ kJ}$
 $t = \frac{4000 \text{ kJ}}{50.009 \text{ km/h} \times \frac{1000}{3600}} = 3.0006 \text{ sec}$

$\therefore P = 4000 \times 3.006 + 450$
 $= 12452.4 \text{ kW}$

Power = 12452.4 kW

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Question 13 (continued)

- (c) (i) Describe how an electric motor is used to convert electricity into rotary motion. 2

Electricity is supplied to the solenoid which sets up a magnetic field. This magnetic field interacts with an external fixed field creating a force on the coil. This force causes rotary motion i.e. the coil spins.

- (ii) Describe TWO different applications of electrical motors that are used in transport systems. 2

In an electric car i.e. smart car electricity is used instead of fuel. An electric motor is then used to rotate the wheels to move the car. ~~It is~~
They are also used to rotate railways to alter the path of the ~~car~~ train.

End of Question 13