

2003 HIGHER SCHOOL CERTIFICATE EXAMINATION
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. ^{water cooled - all perlite}

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

• Structure - more carbon gets into the steel after quenching, therefore more cementite phases. The grain structure is mainly ~~martensite~~ ^{stressed} martensite, ^{tiny} grains.

• Properties - a harder wearing material, suitable for train tracks. Decreased tensile strength, ~~but~~ decreased toughness and increased brittleness.

- (b) A suburban train weighing ^{400 000 kg} 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 ^{16.67 m/s} 450 kW, ^{450 x 10³} calculate the overall power needed to climb the gradient. work

$$P = \frac{W}{t}$$

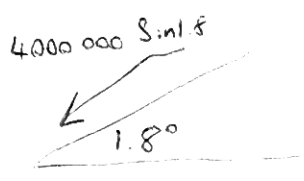
$$450 \times 10^3 = \frac{W}{1}$$

$$W = 450 \times 10^3$$

$$W = Fs$$

$$125\,643 \times s = 450 \times 10^3$$

$$s = 3.58 \text{ s}$$



$$P = \frac{W}{t}$$

$$= Fv$$

$$= 125\,643.04 \times 16.67$$

$$= 2\,094\,469.47 \text{ J}$$

$$\text{Power} = \frac{2.09 \text{ MJ}}{s}$$

$$\therefore \text{Force uphill is } 400000 \sin 1.8^\circ$$

$$= 125\,643.04 \text{ N}$$

$$= \text{force to be overcome.}$$

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Question 13 (continued)

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

A current is passed through a winding of copper coils. ~~These~~ These coils are placed in a magnetic field, according to Faraday, a ^{current carrying} conductor in a magnetic field experiences a force, and that force rotates the coils, which are attached to an axle, which the spins when current is flowing.

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

- Trains - using electricity from overhead cables, they use motors for their propulsion, then when they break the motor is used to generate electricity.
- Cars - used in windscreen wipers. The motor moves a wiper which makes driving in rain safer.

End of Question 13