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.

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

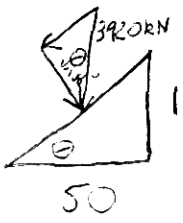
The outer surface of the rail is now hardened, more stiff and brittle. The structure of the metal is one of large unexamined grains that have been formed when the rails were quenched

(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**

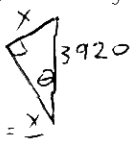
If the power required to overcome rolling resistance at this velocity is 450 kW, calculate the overall power needed to climb the gradient.

60 km/h = 16.667 m s^{-1}

400 tonnes assume g = 9.8 m s^{-2}
= 3920 kN



Force acting parallel to slope



$\sin\theta = \frac{x}{3920}$

$x = 3920 \sin\theta$

$x = 78.33$ kN

$\tan\theta = \frac{1}{50}$

$\theta = 1.145°$

450 kW to overcome rolling resistance

$P = Fv$

$P = 450\text{kW} + 78.33\text{kN} \times 16.667$

$P = 1755$ kW

Power = 1755 kW

Question 13 continues on page 16

Marks

Question 13 (continued)

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

- A magnet applies a force to a current carrying conductor and visa versa. In an electric motor there are fixed permanent magnets inside the motor on the armature there are coils of current carrying wire which apply forces to the magnets which then counteract this by pushing the coils around resulting in a turning force called torque.

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

- Electric motors are used in trains to turn the wheels of the train and keep it moving along the track
- Electric motors are used to generate the rotary motion to turn the gears on a cable car system that pulls the cables which move the cars (chairs).

End of Question 13