Cambridge International AS & A Level

Mathematics 9709/42

Paper 4 Mechanics October/November 2024

Question No(3)

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A cyclist is riding along a straight horizontal road. The total mass of the cyclist and his bicycle is 90 kg. The power exerted by the cyclist is 250 W. At an instant when the cyclist's speed is

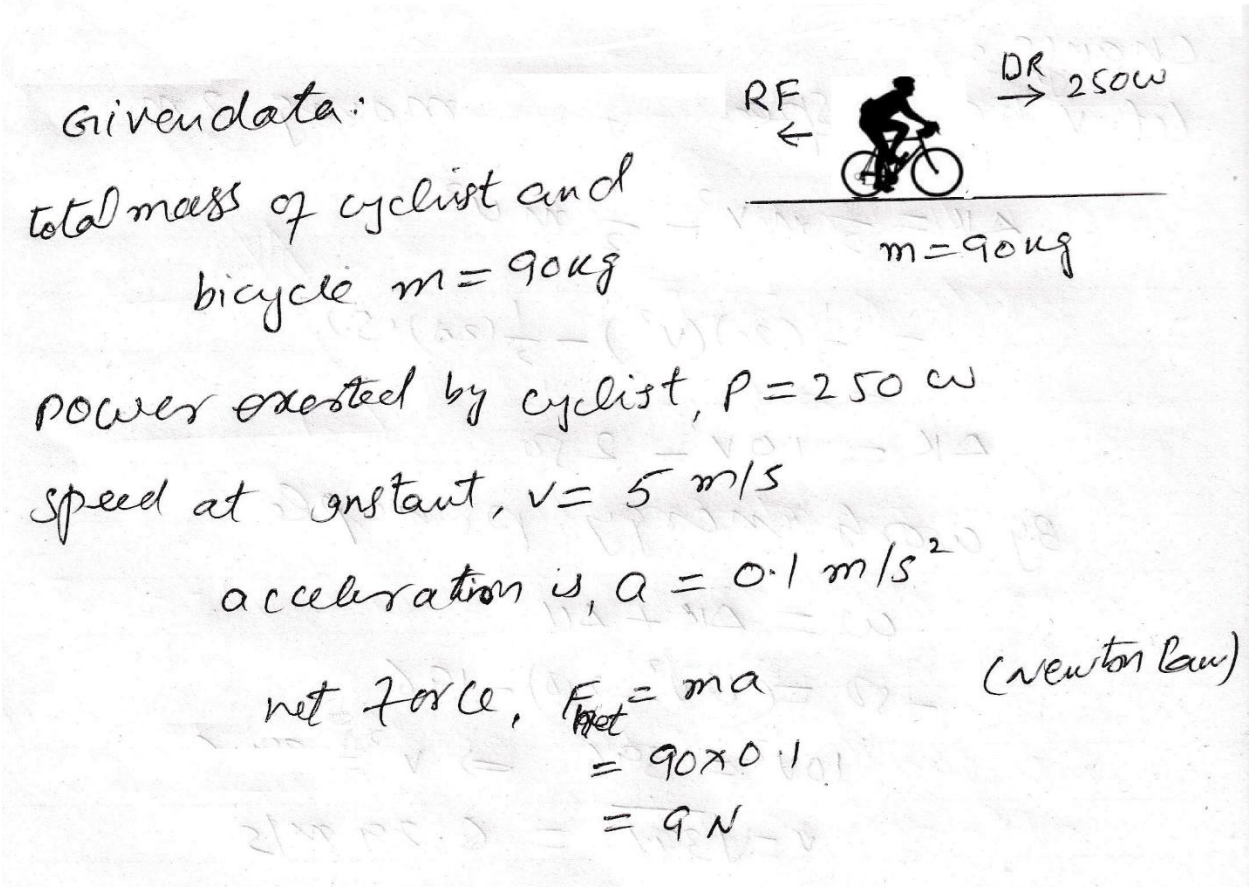
5 ms^{-1}, his acceleration is 0.1 m s^{-2}, .

(a) Find the value of the constant resistance to motion acting on the cyclist.

The cyclist comes to the bottom of a hill inclined at 2° to the horizontal.

(b) Given that the power and resistance to motion are unchanged, find the steady speed which the cyclist could maintain when riding up the hill.

Solution:



DATE :- (7)

F_r = resistance force = ?

$F_d - F_r = F_{net} = 9N$

For driving force

power = $F_d \cdot$ veloaity

$P = F_d \cdot v$

$250 = F_d \cdot 5$

$F_d = \frac{250}{5} = 50$

AS $F_d - F_r = F_{net}$

$50 - F_r = 9$

$F_r = 50 - 9$

$F_r = 41\ N$

(b)

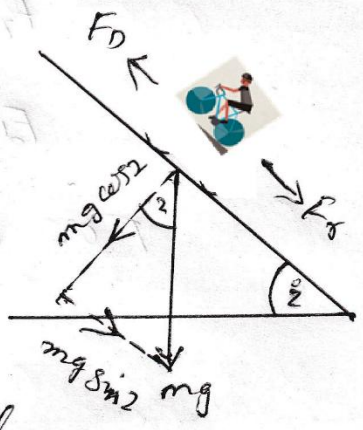
Now the data is

angle, $\theta = 2$

power, $P = 250\ w$

resistance force, $F_r = 41\ N$

mass, $m = 90\ kg$



Forces acting along the hill

$$F_d = F_r + mg\sin 2 \quad \longrightarrow (1)$$

But $F_d = \frac{P}{V}$

$$F_d = \frac{250}{V}$$

Equation (1) becomes

$$\frac{250}{V} = 41 + 90 \times 9.8 \sin 2$$

$$V = \frac{250}{41 + 90 \times 9.8 \times 0.0349}$$

$$V = \frac{250}{71.781}$$

$$V = 3.48\ m/s$$