Cambridge International AS & A Level

---

Mathematics 9709/42

Paper 4 Mechanics May/June 2024

Question No(4)

**Question No (4)**

A car has mass 1400 kg. When the speed of the car is $v\ ms^{-1}$ the magnitude of the resistance to motion is $k\ v^2$ N where k is a constant.

(a) The car moves at a constant speed of 24 $m\ s^{-1}$ up a hill inclined at an angle of $\alpha$ to the horizontal where $\sin\alpha = 0.12$ . At this speed the magnitude of the resistance to motion is 480 N.

(i) Find the value of k.

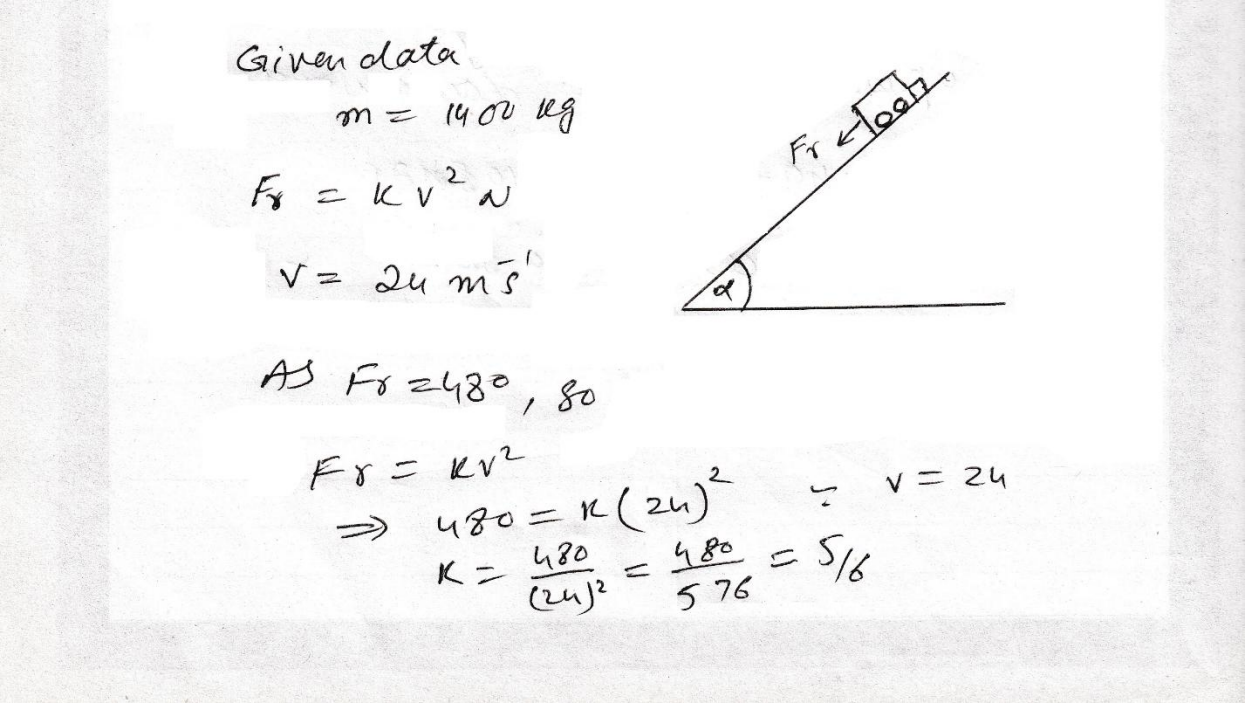
(ii) Find the power of the car's engine.

(b) The car now moves at a constant speed on a straight level road.

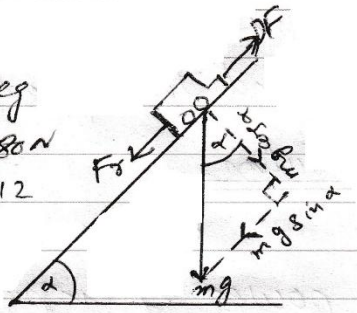
Given that its engine is working at 54 $kW$ , find this speed.

## Solution:

### (a)(i)



**(a)(ii)**




Mass of the car, $m = 1400$ kg

Resistance to the motion, $F_r = 480$ N

inclination of hill, $\sin\alpha = 0.12$

speed, $v = 24$ m/s

Total driving force is

$$DF = F_r + mg\sin\alpha$$

$$= 480 + 1400 \times 9.8 \times 0.12$$

$$= 2126.4$$

$$\text{power} = DF \times \text{velocity}$$

$$= 2126.4 \times 24$$

$$P = 51033.6 \text{ W}$$

$$= \frac{51033.6}{1000} \text{ KW}$$

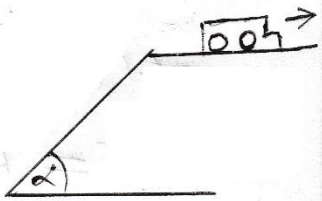
$$P = 51 \text{ KW}$$

**(b)**

Given

power of Engine, $P = 54 \times W$

$= 54000\ W$



Resistance to motion, $R = kV^2$

As the car is moving on Level road, so the gravitational component is not present. car is moving at constant speed, the power provided by the engine is used to overcome the resistance to motion, so

$$P = R \times V$$

$$54000 = (kV^2)\,V$$

$$54000 = kV^3$$

$$54000 = 5/6\ V^3 \qquad k = 5/6 \text{ part(a)(ii)}$$

$$V^3 = \frac{6 \times 54000}{5}$$

$$V = 40.2\ m\,s^{-1}$$