

## Answer on Question #39585, Physics, Mechanics | Kinematics | Dynamics

a) The speed of an aeroplane is 1200m/s. The engines take in 80 kg of air per second and mix it with 40 kg of fuel. This mixture is expelled after it ignites and it moves at a velocity of 3000m/s relative to the aeroplane. Calculate the thrust of the engine.

b) A 2400 W engine pulls a 200 kg block at constant speed up a 12.0 m long, 25.0° incline. Determine how long does it takes to cover this distance.

### Solution:

a) Thrust is the force which moves an aircraft through the air. Thrust is generated by the propulsion system of the airplane.

Thrust is a mechanical force which is generated through the reaction of accelerating a mass of gas, as explained by Newton's third law of motion. A gas or working fluid is accelerated to the rear and the engine and aircraft are accelerated in the opposite direction.

From Newton's second law of motion, we can define a force  $F$  to be the change in momentum of an object with a change in time. Momentum is the object's mass  $m$  times the velocity  $V$ . So, between two times  $t_1$  and  $t_2$ , the force is given by:

$$F = \frac{(mV)_2 - (mV)_1}{t_2 - t_1}$$

$$F = \Delta p / \Delta t$$

Relative to the aircraft, the initial velocity of the air is 1200 m/s (backwards) and the final velocity is 3000 m/s (also backwards).

Mass of air per second  $m_1 = 80$  kg.

The fuel is carried on the aircraft so it has initial velocity 0 and final velocity 3000 m/s.

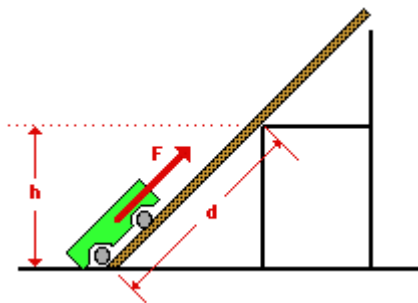
Mass of fuel per second  $m_2 = 40$  kg.

Change of momentum in 1 second ( $t_2 - t_1$ )

$$\Delta p = m_1 (v_2 - v_1) + m_2 (v_2) = 80 \cdot (3000 - 1200) + 40 \cdot 3000 = 264000 \text{ Ns}$$

$$F = 264000 / 1 = 264000 \text{ N}$$

b) A 2400 W engine pulls a 200 kg block at constant speed up a 12.0 m long, 25.0° incline. Determine how long does it takes to cover this distance.



Power  $P = 2400$  W

mass  $m = 200$  kg

distance  $d = 12.0$  m

angle of incline  $\theta = 25.0^\circ$

time = ?

Power may be defined as the rate of doing work or the rate of using energy.

Power = Work / time

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

Work is equal to potential energy of the block on the height  $h$ .

$$W = mgh$$

$$h = d \sin \theta$$

Time is

$$t = \frac{W}{P} = \frac{mgd \sin \theta}{P}$$
$$t = \frac{200 \cdot 9.8 \cdot 12.0 \cdot \sin 25^\circ}{2400} = 4.142 \text{ s}$$

**Answer.** a) 264000 N,

b) 4.142 s.