3 **(a)** State the principle of conservation of momentum.

.....

.....

.....[2]

(b) The propulsion system of a toy car consists of a propeller attached to an electric motor, as illustrated in Fig. 3.1.

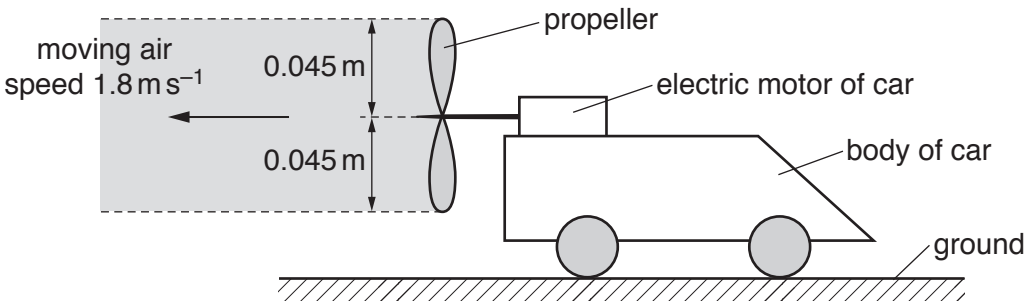

Fig. 3.1

The car is on horizontal ground and is initially held at rest by its brakes. When the motor is switched on, it rotates the propeller so that air is propelled horizontally to the left. The density of the air is 1.3 kg m^{-3}.

Assume that the air moves with a speed of 1.8 m s^{-1} in a uniform cylinder of radius 0.045 m. Also assume that the air to the right of the propeller is stationary.

(i) Show that, in a time interval of 2.0 s, the mass of air propelled to the left is 0.030 kg.

[2]

(ii) Calculate

1. the increase in the momentum of the mass of air in **(b)(i)**,

increase in momentum = ... N s

2. the force exerted on this mass of air by the propeller.

force = ... N
[3]

(iii) Explain how Newton's third law applies to the movement of the air by the propeller.

.....

.....

.....[2]

(iv) The total mass of the car is 0.20 kg. The brakes of the car are released and the car begins to move with an initial acceleration of 0.075 m s^{-2}.

Determine the initial frictional force acting on the car.

frictional force = ... N [2]

[Total: 11]