3 **(a)** A body moving with uniform speed *v* in a circle of radius *r* experience an acceleration a.

(i) Explain why the acceleration is directed towards the centre of the circle.

.....

.....

.....

..... [2]

(ii) Write the expression of the acceleration *a* in terms of *v* and *r*.

..... [1]

(b) The Mars helicopter, Ingenuity, completed its first flight outside Earth on 19 April 2021.

To understand the difficulty of this flight, we will consider a simple model of Ingenuity comprising of a pair of rotating blades and a body, as shown in Fig. 3.1.

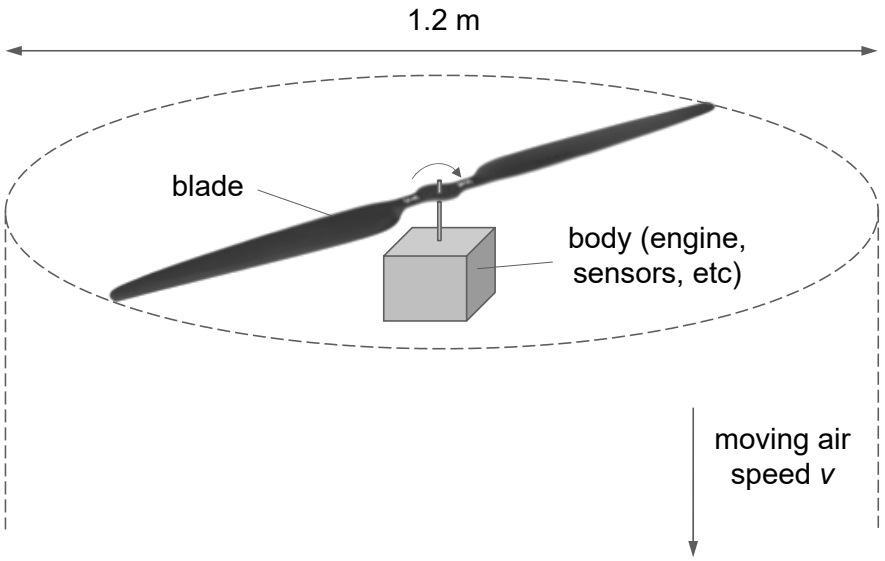

Fig. 3.1

The mass of the model is 1.8 kg.

When the motor is switched on, the air moves with a speed *v* in a uniform cylinder of diameter 1.2 m.

(i) The density of air on Earth is 1.2 kg m^{-3}.
Determine the speed v of the air when the model is hovering at a constant height from the surface of the Earth.

v = ... m s^{-1} [3]

(ii) The density of air on Mars is 0.020 kg m^{-3} and the gravitational field strength near the surface of Mars is 38% that of Earth.

When the model operates on Mars, the same blades will need to rotate at a much higher angular velocity than in **(b)(i)**. The blades are therefore subjected to a larger amount of stress.

Explain why the blades

1. need to rotate at a higher angular velocity,

.....

.....

[1]

2. experience a larger stress by referring to your answer in **(a)**.

.....

.....

.....

..... [2]

[Total: 9]