2 Fig. 2.1 shows an airplane of mass 1.5×10^5 kg, flying horizontally at a constant velocity. The airplane has four engines, two located on each wing, which produce a combined forward thrust of 8.0×10^5 N. The other forces acting on the airplane are drag force, the combined lift of both wings and its weight. The horizontal separation of the lines of action of lift and weight is 0.75 m.

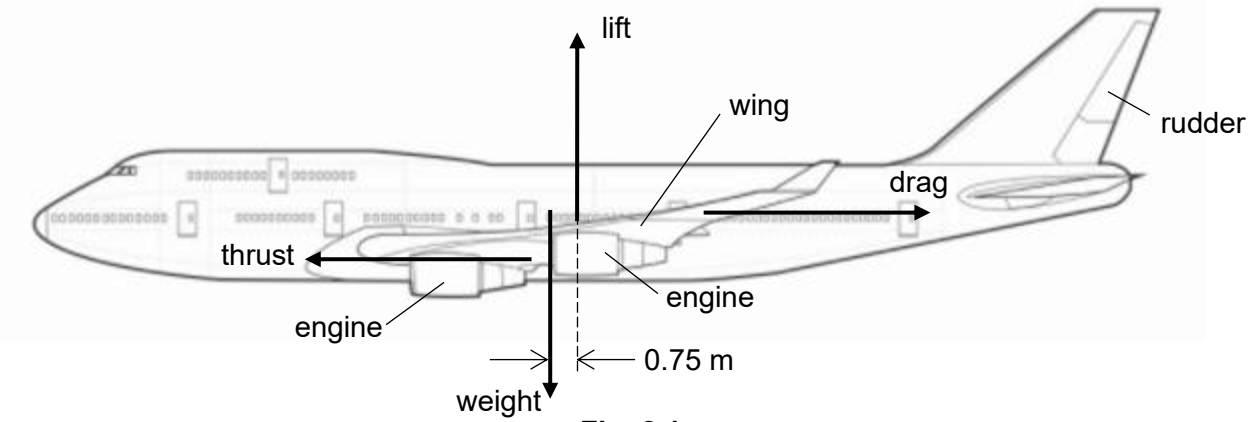

Fig. 2.1

(a) Define the moment of a force about a point.

.....

[1]

.....

(b) Determine the vertical separation of the lines of action of thrust and drag.

vertical separation = ... m [3]

(c) The airplane starts to accelerate forward. Using Newton's First Law of Motion, state and explain the direction of the frictional force acting on a box that is placed on the airplane floor.

.....

.....

.....

[2]

.....

(d) The engines of the airplane are located 10 m and 20 m perpendicularly from the midline of the airplane's body. In a training session, both engines on the right wing are shut down, leaving only the two engines on the left wing working. Each of these engines produce a forward thrust of 2.0×10^5 N. As a result, the airplane rotates in

the horizontal plane. To counter this rotation, the rudder at the tail of the aircraft can be adjusted.

Fig. 2.2 shows the adjustment of the rudder to an angle such that a force *P* acts on the rudder at a point 30 m from centre of gravity C.G. along the midline of the airplane. P acts at an angle of 60° to the midline and is due to the airflow incident on the rudder.

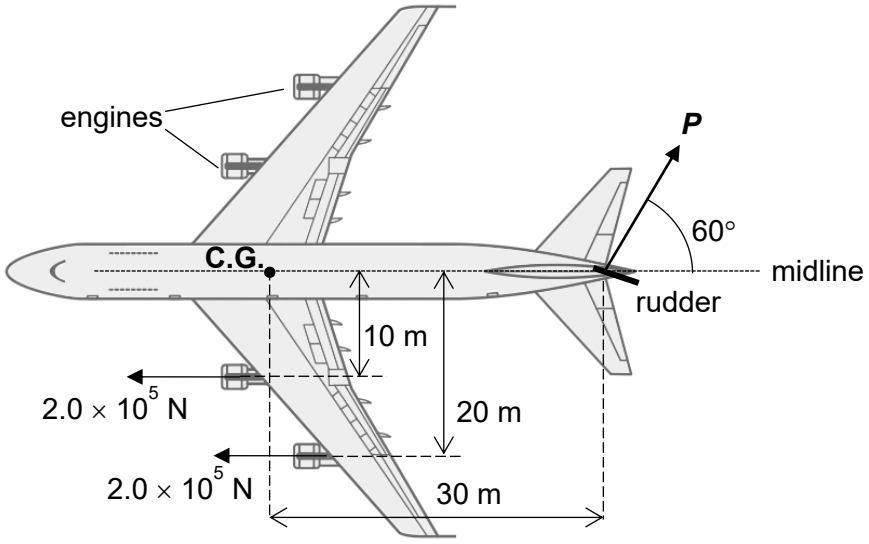

Fig 2.2

Calculate the value for *P* that will prevent the aircraft from rotating.

$$P = \frac{\qquad\qquad}{\qquad\qquad} \text{ N} \qquad [2]$$