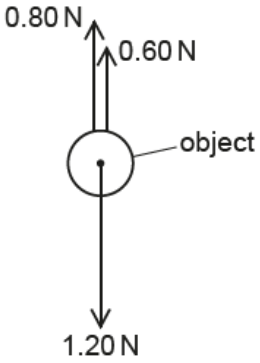
# Forces in action – 2022 GCE Physics A Component 01

**1.** June/2022/Paper_H556/01/No.4

The diagram below shows the directions and magnitudes of the three forces acting on an object at a specific time as it moves through water.




The weight of the object is 1.20 N, the upthrust on the object is 0.80 N and the drag is 0.60 N.

Which statement is correct about this object at this specific time?

**A** It has reached its terminal velocity.

**B** It is accelerating.

**C** It is decelerating.

**D** It is moving upwards.

Your answer ☐ **[1]**

**2.** June/2022/Paper_H556/01/No.17

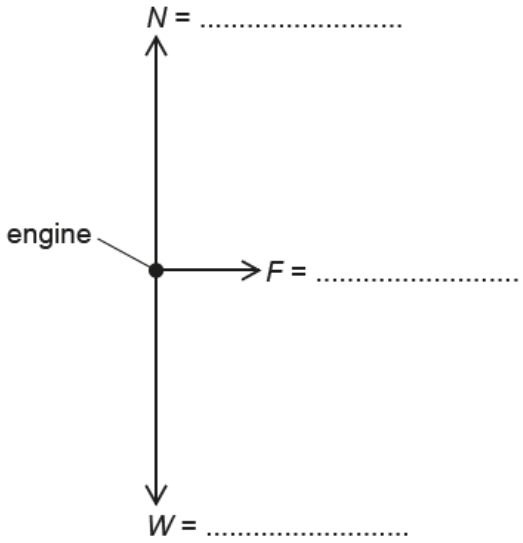
An electric engine of mass 17 000 kg has a constant power output of 280 kW and it can reach a maximum speed of 42 m s$^{-1}$ on horizontal rails. The maximum kinetic energy of the engine is 15 MJ.

**(a)** The engine is initially at rest on long horizontal rails.
Show that the minimum time taken for the engine to reach its maximum speed is about 1 minute.

**[1]**

**(b)** The engine is moving along the horizontal rails at the constant maximum speed of 42 m s$^{-1}$.
The weight of the engine is *W*, the total normal contact force from the rails is *N* and the total friction between the wheels and the rails is *F*.
*F* is responsible for the motion of the engine to the **right**.

Complete the free body diagram for the engine by showing a missing force, and the magnitudes of all the forces. There is space for you to do any calculations below the diagram.




**[3]**

**(c)** The speed of the engine is $42\,m\,s^{-1}$.

The driver sees an obstruction 167 m from the front of the engine. The engine is switched off and the brakes are applied.
The constant force opposing motion is 120 kN. The reaction time of the driver is 0.40 s.

Show with the help of calculations, that the engine will stop before reaching the obstruction.

**[4]**

**3.** June/2022/Paper_H556/01/No.18

A tent is secured by 3 ropes along each of its long sides, as shown in **Fig. 18.1**.

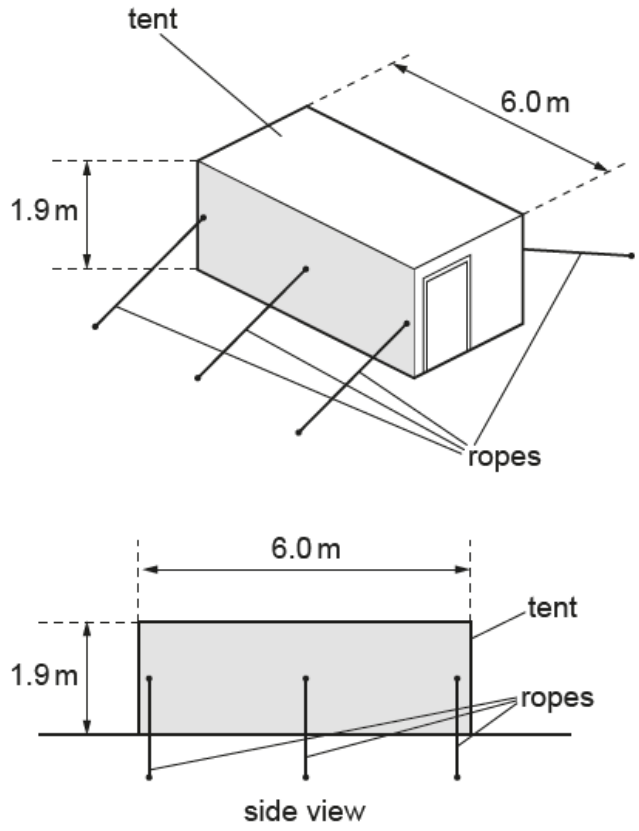



**Fig. 18.1**

**(a)** Wind of speed $12\,m\,s^{-1}$ blows at right angles to the **shaded** side of the tent for 3.0 s. The density of air is $1.2\,kg\,m^{-3}$.

**(i)** Show that the mass of air which hits the tent in this time is about 490 kg.

**[3]**

**(ii)** All of the air incident on the shaded side of the tent is deflected at 90° to the original direction as shown in **Fig. 18.2**.

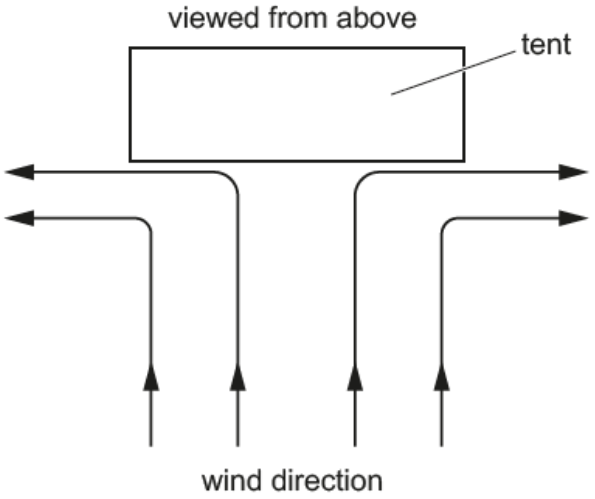



**Fig. 18.2**

Use the information given in **(a)(i)** to calculate the magnitude of the force *F* exerted by the wind on the shaded side of the tent.

*F* = ..... N **[2]**

**(b)*** When the wind speed exceeds 20 m s$^{-1}$ the ropes securing the tent break.

Describe, and explain in terms of forces, how the ropes and the shape of the tent could be modified to withstand wind speed exceeding 40 m s$^{-1}$. **[6]**

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