Answer **all** the questions in the spaces provided.

1 **(a)** State the conditions for a body to be in equilibirum.

1. .....

.....

2. .....

[2]

.....

(b) An athlete uses a machine in the gym where he hinges at the knee joint to move his lower legs up as shown in Fig. 1.1. There is a constant downward force of 25 N exerted at point A on each feet at constant distance L from point B, as shown in Fig. 1.2. The combined weight of a foot and one lower leg is 30 N acting at L/2 from the knee joint. When the legs are raised, there is a force F at distance L/4 from knee joint and at angle of θ to the leg as shown in Fig 1.2.

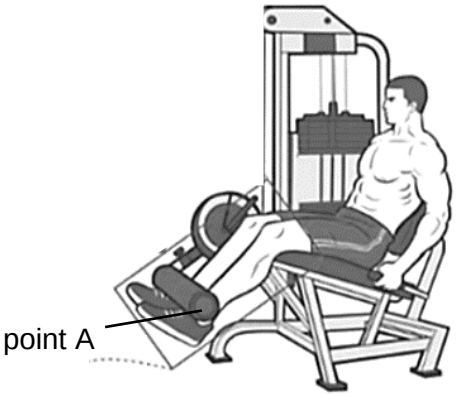

Fig. 1.1

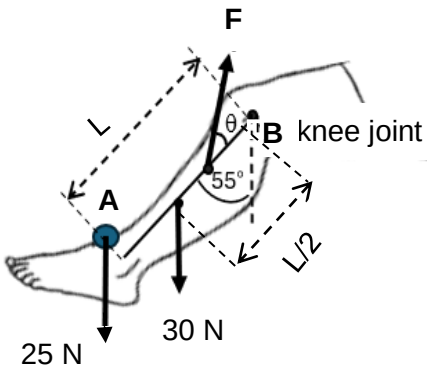

Fig 1.2

It is given that L = 40 cm. At position shown in Fig. 1.2, the lower leg and feet are at equilbrium at angle of 55° to the vertical, and θ = 25°.

(i) By taking moments about point B at the knee joint, calculate the force F exerted on the lower leg in Fig 1.2.

force, F = ... N [2]

(ii) For the lower leg to be in equilibrium, there is a force *R* at the knee joint.

Draw on Fig.1.2, a labelled arrow to represent the force *R.* [1]

(iii) At the beginning, the feet are down as shown in Fig. 1.3.

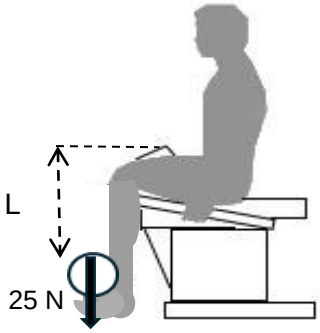

Fig 1.3

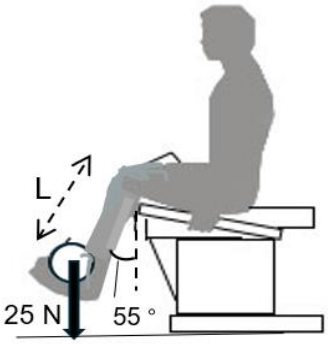

Fig 1.4

He raises his legs until they are at an angle of 55° to the vertical as shown in Fig. 1.4. Calculate the work done to raise one lower leg to this position at constant speed. Assume that the knee joint is a point that stays in place throughout.

[2]

(iv) Hence calculate the power exerted by the athlete in raising one leg to the position shown in Fig 1.4 if the time taken is 5.0 s.

Power exerted = ... W [1]