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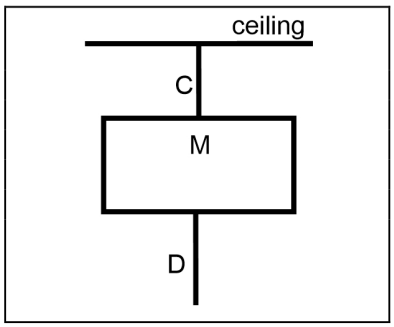
Assignment 04b: Newton's laws of motion (IP)

1. (a) The metal head of a hammer is loose. To tighten it, it is being dropped down onto a table.

To do so **most efficiently**, should we

- drop the hammer with handle end down,
- drop the hammer with the head down, or
- either way will give us the same results? Explain your answer. [2]

(b) An inelastic cord C is suspended from the ceiling on one end and tied to a block of mass M on the other end. Another cord D is attached to the bottom of the block.



Explain, using Newton's 1st law, why *"If you give a sudden jerk to D, it will break first, but if you pull D with a gradually increasing force, C will break first"*. [2]

2. A 110 kg motorbike carrying a 50.0 kg rider coasts to a stop in 51 m. It was originally travelling at 15 m s^{-1}. Calculate the braking force exerted by the road on the motorbike and rider. [3]

3. Fig. 3.1 shows the horizontal forces acting on a moving car of mass 9.0 x 10^2 kg. The forward driving force **remains constant** throughout its journey.

Fig. 3.1

Fig. 3.2 shows the total resistive force that acts on the car as time passes.

Fig. 3.3 shows the speed-time graph for the first 24 s of the motion of the car along a straight road.

Fig. 3.2:

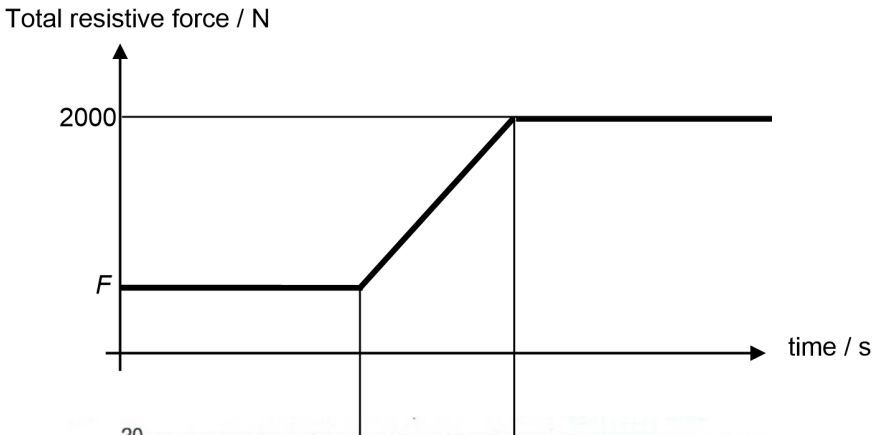
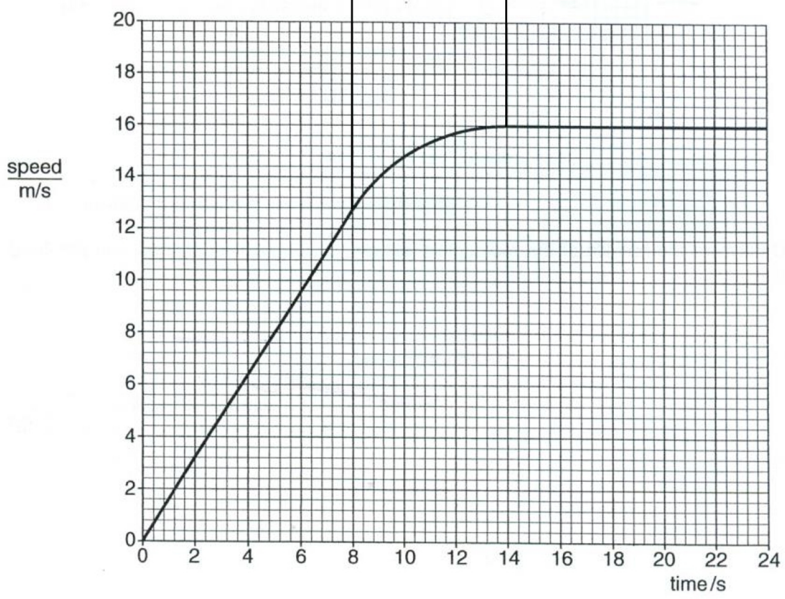


Fig. 3.3:



(a) State the terminal ~~velocity~~ (speed) of the car. [1]

(b) Hence, state the (magnitude of) forward driving force of the car. [1]

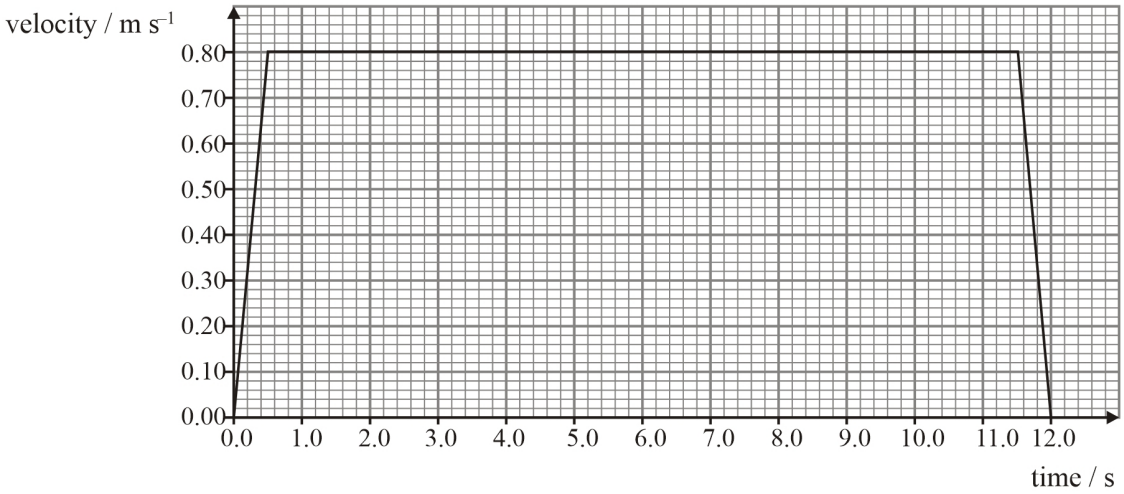
(c) For the first 8.0 s of its journey, calculate

(i) the acceleration of the car, [1]

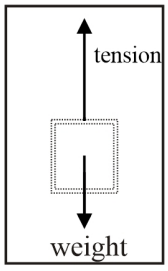
(ii) the total resistive force, *F*, on the car. [2]

(d) Complete the following statements and underline the correct answer to describe the acceleration and forces experienced by the car for the whole journey. [6]

4. An elevator (lift) starts from rest on the ground floor and comes to rest at a higher floor. Its motion is controlled by an electric motor. A simplified graph of the variation of the elevator's velocity with time is shown below.



The elevator is supported by a cable. The diagram below is a free-body force diagram for when the elevator is moving upwards during the first 0.5 s.

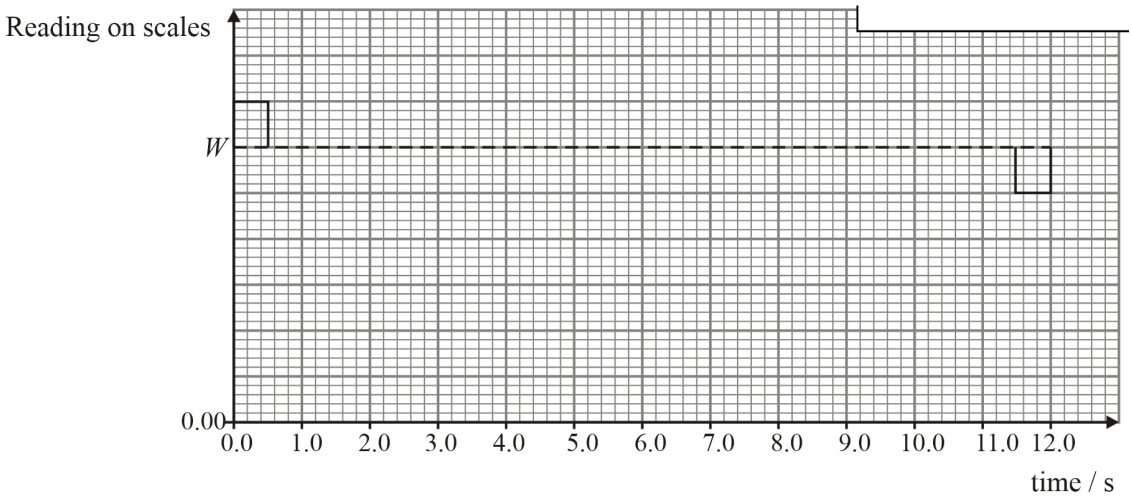


(a) In the space below, draw the tension acting on the elevator during the following time intervals.[2]

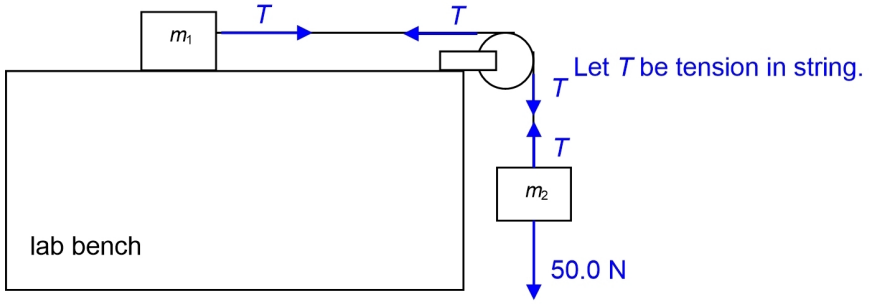
(i) 0.5 s to 11.5 s	(ii) 11.5 s to 12.0 s

(b) A person is standing on weighing scales in the elevator. Before the elevator rises, the reading on the scales is *W*.

On the axes below, sketch a graph to show how the reading on the scales varies during the whole 12.0 s upward journey of the elevator. (*Note that this is a sketch graph – you do not need to add any values*.) [3]



5. An inextensible string, connecting the objects m_1 and m_2 over a frictionless pulley, is shown in the diagram below.



The 3.00 kg mass, m_1, moves on a frictionless surface while the 5.00 kg mass, m_2, moves vertically when it is released from rest. Take the acceleration due to gravity to be 10 m s^{-2}.

Assume the string is taut throughout the time when the two masses are moving.

(a) Calculate

(i) the acceleration *a* of the whole system, [2]

(ii) the tension T in the string. [2]

(b) A rough wooden surface was placed on the lab bench and the whole experiment was repeated with the mass m_1 moving across the wooden surface when the mass m_2 was released from rest.

Given the constant kinetic friction acting on the mass m_1 is 9.00 N, calculate its acceleration. [2]

6. This question is about equilibrium.

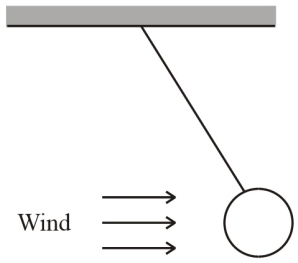
Explain whether each of the following is **in equilibrium** (i.e. net force on object is zero).

(a) A satellite in orbit at constant speed round the Earth.

……..

……..[2]

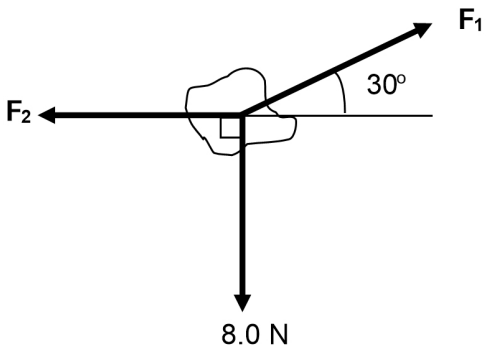
(b) A small sphere suspended on a string and blown to one side by a wind so that the string makes a constant angle with the vertical, as shown below.



……..

……..[2

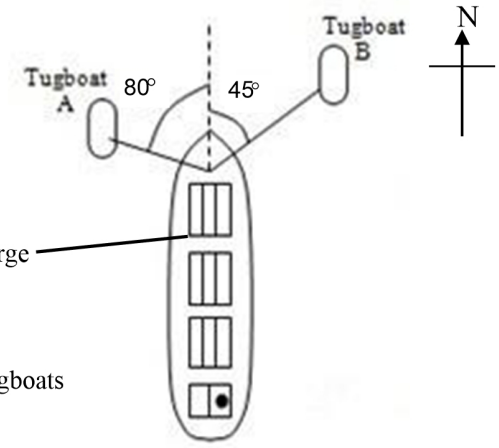
7. (a) The diagram shows the top view of a smooth rock, of mass 2.0 kg, being acted on by three forces. The rock is at rest on a frictionless surface. By using a suitable scale diagram or otherwise, determine the magnitude of the forces $\mathbf{F_1}$ and $\mathbf{F_2}$. [3]



Answer for Question 7 (a):

(b) If the 8.0 N force is increased to 10.0 N while the forces $\mathbf{F_1}$ and $\mathbf{F_2}$ remain constant, calculate the acceleration of the rock. [2]

8. The diagram below, on the left, shows two tugboats towing a barge. The diagram below, on the right, shows the angles made by each tugboat with respect to the North direction. The resultant force of the forces in the two tugboats' cables, acting on the barge, is 94 kN in the North direction.



http://www.giantmarine.com/images/illustrations/02%20-%20Towage/towage_03_larger.jpg

(a) When the barge was towed by the two tugboats, **A** and **B**, it travelled at a constant velocity of 6.0 m s^{-1}.

State the magnitude and the direction of the force provided by the water resistance acting on the barge. [1]

(b) Using a scale of 1.0 cm to represent 10 kN, determine the magnitude of the forces exerted by tugboat **A,** F_A, and tugboat **B,** F_B, on the barge, through the cables. [3]