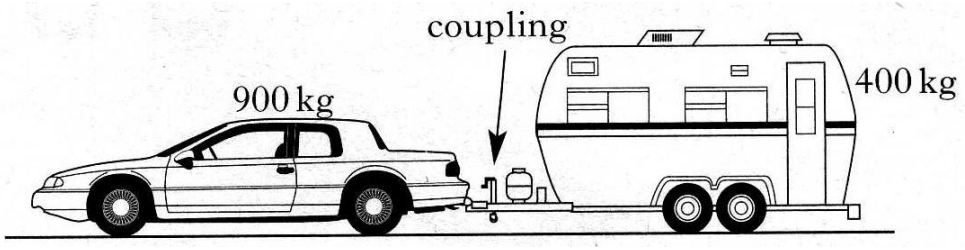
Higher Forces Questions

1. **State** each of **Newton's three laws** of motion.

2. a) A pair of **forces** acting on an object are **balanced**, **what two facts** can be stated about these forces?

b) **State the two possible motions** that an object can have if balanced forces are acting on it?

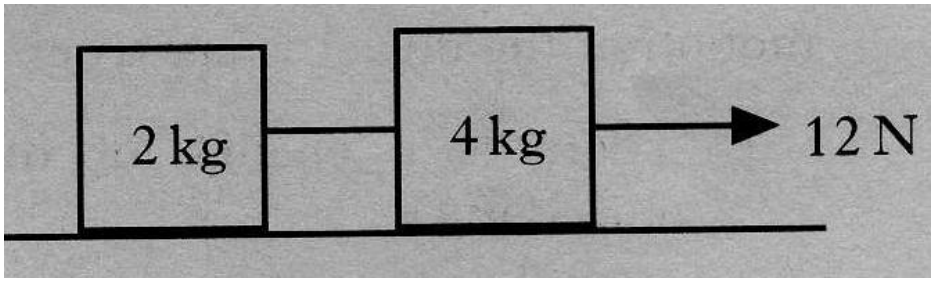
3. A car of mass 900kg pulls a caravan of mass 400kg along a straight horizontal road with an acceleration of 2.0ms^{-2}.



Assuming that the frictional forces on the caravan are negligible, **calculate the tension in the coupling** between the car and the caravan.

4. Two boxes on a frictionless horizontal surface are joined together by a string as shown.

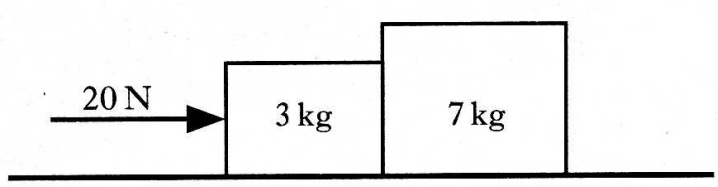
The 4kg box is being pulled to the right by a constant horizontal force of 12N.



Calculate the tension force in the string between the two boxes.

5. A horizontal force of 20N is applied as shown to two wooden blocks of masses 3kg and 7kg.

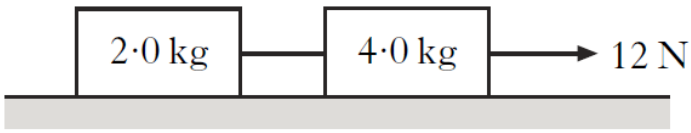
The blocks are in contact with each other on a frictionless horizontal surface.



Calculate the **magnitude** of the **horizontal force** acting on the **7kg block**.

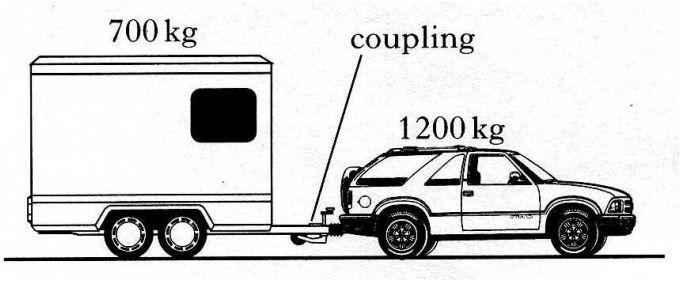
6. Two boxes on a frictionless horizontal surface are joined together by a string.

A constant horizontal force of 12N is applied as shown in the diagram below.



Calculate the tension in the string joining the two boxes if the string snaps between them.

7. A car of mass 1200kg pulls a horsebox of mass 700kg along a straight horizontal road.



Assuming that frictional forces are negligible, **calculate the tension in the coupling** between the car and the horsebox if they **accelerate** at **2.0ms^{-2}**.

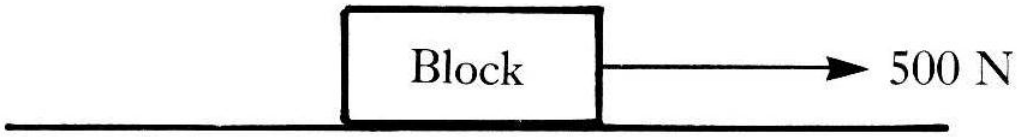
8. A train engine of mass 10,000kg is linked to a carriage of mass 6,000kg.

The engine force acting on the train is 9kN and the force of friction acting against the engine and carriage is 5kN.

Calculate or find:

a) **Acceleration** of the engine and carriage.
b) **Unbalanced force** acting on the **engine**.
c) **Unbalanced force** acting on the **carriage**.

9. A block of weight 1500N is dragged along a horizontal road at a constant speed by a force of 500N.



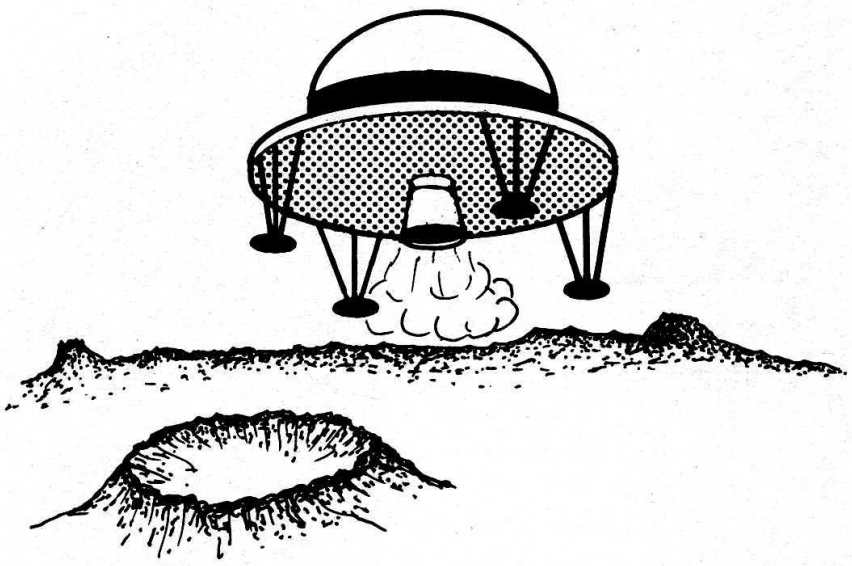
Calculate the frictional force between the block and the road. **(M + D's!!!)**

10. A hot air balloon of mass 300kg has people with a total mass of 250kg on board.

Calculate the upthrust on the balloon if it floats at a constant height.

11.

A lunar landing craft descends vertically towards the surface of the Moon with a constant speed of $2{\cdot}0\,\mathrm{m\,s^{-1}}$. The craft and crew have a total mass of 15 000 kg.
Assume that the gravitational field strength on the Moon is $1{\cdot}6\,\mathrm{N\,kg^{-1}}$.



(*a*) During the first part of the descent the upward thrust of the rocket engine is 24 000 N. Show that this results in the craft moving with a constant speed.

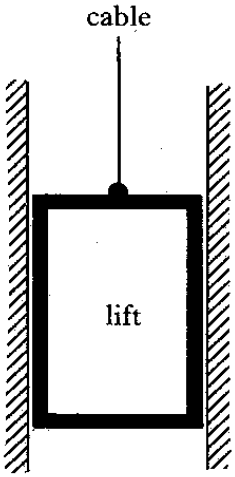
(*b*) The upward thrust of the engine is increased to 25 500 N for the last 18 seconds of the descent.

(i) Calculate the deceleration of the craft during this time.

(ii) What is the speed of the craft just before it lands?

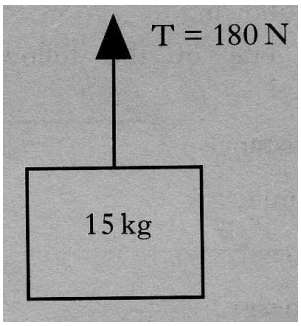
(iii) How far is the craft above the surface of the Moon when the engine thrust is increased to 25 500 N?

12. A lift is raised and lowered by means of a cable.



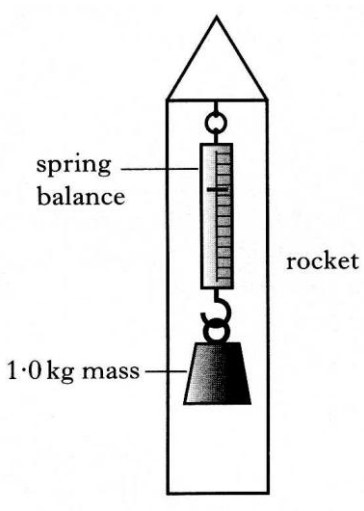
In which two situations would the **tension** in the cable be **greater than** the **weight**?

13. A tension force of 180N is applied vertically upwards to a box of mass 15kg.



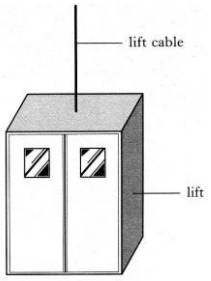
Calculate the **magnitude** and the **direction** of the **acceleration** of the box.

14. An object of mass **1.0kg** hangs from a spring balance suspended on the inside of a small rocket.



Calculate the reading on the balance when the rocket is accelerating upwards from the Earth's surface at **3.0ms^{-2}**.

15. The lift in a department store has a mass of **1100kg**.

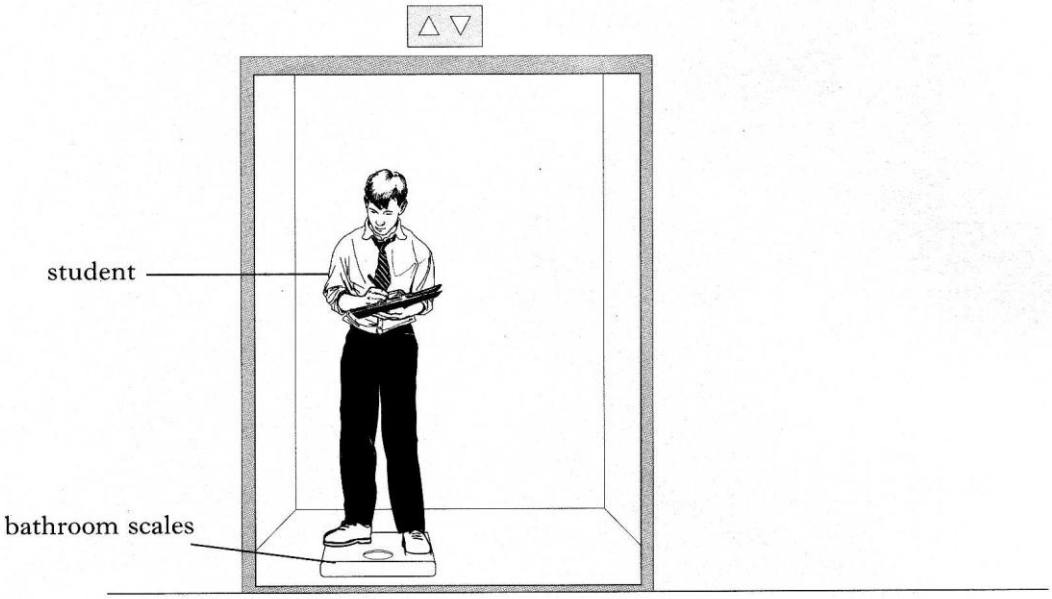


The lift is descending with a constant acceleration of $2.0ms^{-2}$.

Calculate the force applied to the lift by the lift cable.

16.

A student performs an experiment to study the motion of the school lift as it moves upwards.



The student stands on bathroom scales during the lift's journey upwards.
The student records the reading on the scales at different parts of the lift's journey as follows.

Part of journey	*Reading on scales*
At the start (while the lift is accelerating)	678 N
In the middle (while the lift is moving at a steady speed)	588 N
At the end (while the lift is decelerating)	498 N

(*a*) Show that the mass of the student is 60 kg.

(*b*) Calculate the initial acceleration of the lift.

(*c*) Calculate the deceleration of the lift.

(*d*) During the journey, the lift accelerates for 1·0 s, moves at a steady speed for 3·0 s and decelerates for a further 1·0 s before coming to rest.
Sketch the acceleration-time graph for this journey.

17. A skydiver of mass **85kg** is falling vertically.

a) At one point in the journey the air resistance on the skydiver is 135N. **Calculate the acceleration** of the skydiver at this point.

b) At a later stage in the journey the skydiver has a **constant velocity**.

i) What is this constant velocity **more commonly known as**?

ii) **Explain** this constant velocity **in terms of forces**.

18. A rocket of mass **40,000kg** is launched from its take off pad with a thrust of **600,000N**.

a) **Label the forces** and their directions acting on the rocket.

b) **Calculate** the **unbalanced force** acting on the rocket.

c) **Calculate** the **acceleration** of the rocket at take-off.

d) **How will the acceleration of the rocket vary** during its flight:

i) **Within** the Earth's atmosphere?

ii) **Outside** the Earth's atmosphere?

19. A **65kg** pupil is stationary in a lift on the ground floor of a tower block of flats.

The lift then **accelerates** upwards at **1.4ms^{-2}** at the start of its **ascent** until it reaches a constant velocity.

The lift then **decelerates to rest** as it approaches the 15th floor at **1.2ms^{-2}**.

Calculate the Reaction Force (Tension) of the pupil on the lift floor when:

a) **Stationary** on the ground floor.

b) When it is **accelerating upwards**.

c) When **travelling upwards** with a **constant velocity**.

d) When **decelerating** to **rest**.

e) When **stationary** on the **15th floor**.

20. Two PE teachers of mass **85kg** and **95kg** demonstrate to the pupils how to use a ski tow. The ski tow pulls the teachers with an unbalanced force of **45N** with the 95kg teacher at the front. **(Assume the force of friction is negligible!!!)**

a) **Calculate the acceleration** of the teachers when pulled by the ski tow.

b) **Explain what happens to the motion of each of the teachers** if the tow rope snaps between them.

i) 95kg teacher?

ii) 85kg teacher?