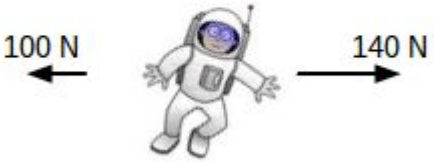
Our Dynamic Universe

Forces, Energy & Power: Unbalanced Forces

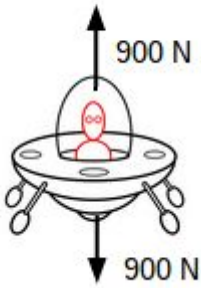
1) Find the unbalanced force and acceleration in the following situations:

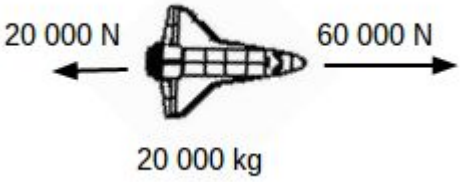
mass of spacecraft 250 kg

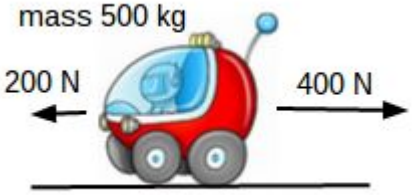
mass of astronaut 80 kg

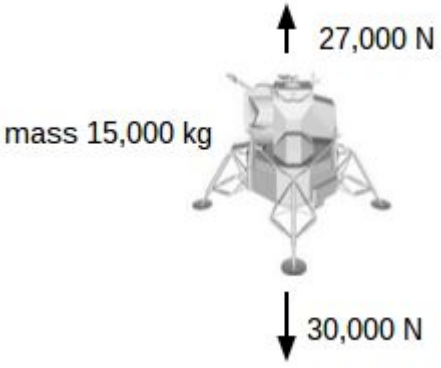


Mass of spacecraft 200 kg







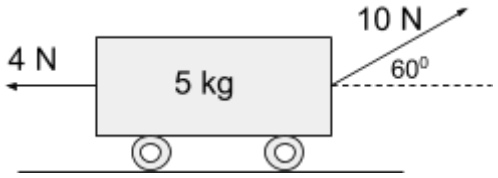


Answers:

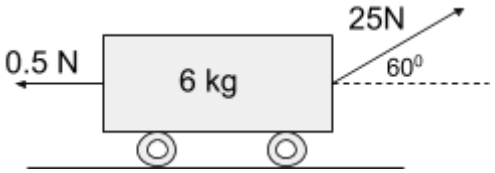
500 N to the right, acceleration 2 ms^{-2}
Balanced force, no acceleration
200 N to the right, acceleration 0.4 ms^{-2}
40 N to the right, acceleration 0.5 ms^{-1}
40,000 N to the right, acceleration 2 ms^{-2}
3000 N down, acceleration 0.2 ms^{-2}

2) Find the resultant force acting on the following objects and their acceleration.

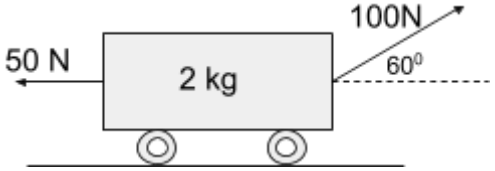
a)



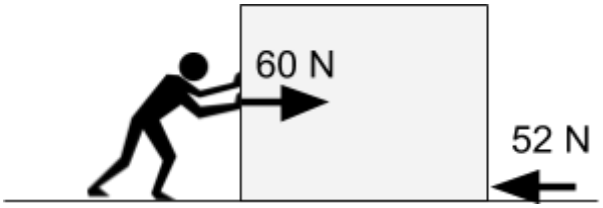
b)



c)



3) A 20 kg box is pushed with a force of 60 N against a frictional force of 52 N. Calculate the unbalanced force acting on the box and its acceleration.

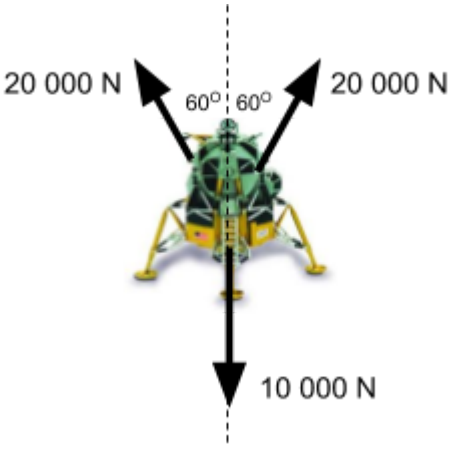


4) The diagram below shows the forces acting on a lunar lander from its engines.

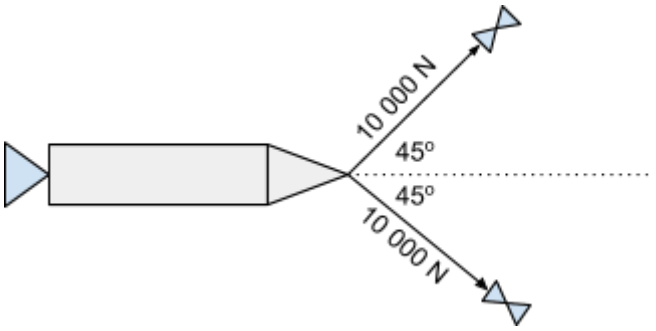
a) Calculate the resultant vertical force acting on the lunar lander.

b) Determine the vertical acceleration of the lander.

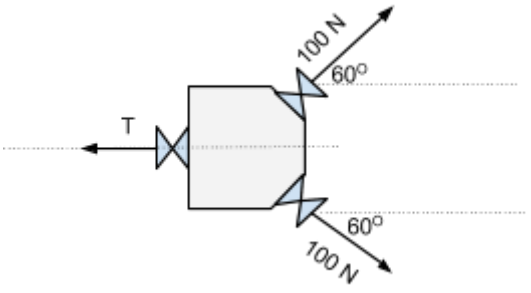
c) Describe the effect on the vertical acceleration if the top engines are fired with the same force but at a larger angle to the vertical.



5) The diagram below shows the aerial view of two small tugboats pulling a rocket along the ocean with forces and directions shown.
Assuming that the frictional forces can be ignored, determine the resultant force acting on the rocket and its acceleration.

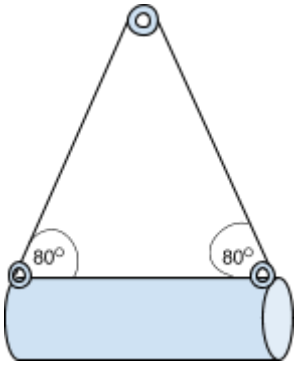


6) A 2 kg space probe has an acceleration of 4 ms^{-2}. The diagram below shows all the forces acting on it due to the thrust from its engines.



a) Calculate the unbalanced force acting on the space probe. [8N]
b) Determine the force T generated by the back engine. [92N]

7) The total downward force acting on the metal pipe below is 12,000 N
Calculate the tension (pulling force acting on the ropes.) if the pipe is stationary

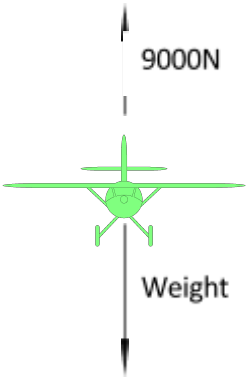


[6385 N]

8) A rocket of mass 8000 kg has an initial upwards acceleration of 15 ms^{-2}.

a) Draw a diagram showing all the vertical forces acting on the rocket at the instant of launch.
b) Calculate the weight of the rocket. ***[784,000 N]***
c) Calculate the unbalanced force acting on the rocket. ***[120,000 N]***
d) Determine the thrust force produced by the rocket at launch. ***[198,400 N]***

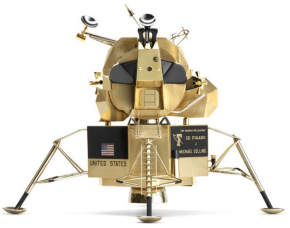
9) An aircraft of mass of 1000 kg. It has the following vertical forces acting on it.



a) Calculate the weight of the aircraft. ***[9800N]***
b) Find the unbalanced force acting on the aircraft. ***[800N down]***
c) Calculate the acceleration of the aircraft. ***[0.8 ms^{-2}]***

10) Find the initial acceleration of a firework of mass 2kg which has an initial thrust of 30.4N.
Draw your force diagram first before completing the question. ***[5.4 ms^{-2}]***

11) On July 21st 1969 astronauts Neil Armstrong and Buzz Aldrin landed on the Moon. They descended to the surface in the Lunar Module.



Just before they landed the lunar module had a downward acceleration of $1ms^{-2}$.
The lunar module had a mass of 15000 kg and the gravitational field strength of the moon is 1.67 N/kg.

a) Calculate the weight of the lunar module ***[25,050N]***
b) Draw a diagram showing the vertical forces acting on the lunar module.
c) Calculate the unbalanced force acting on the lunar module just before it landed. ***[15000N]***
d) Find the magnitude and direction of the thrust from the lunar module`s engines. ***[10,050N upwards]***

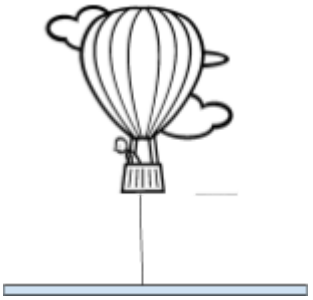
12) A helicopter has a mass of 30 000 kg. It hovers above the sea during a rescue mission for some missing sailors.

a) Draw a force diagram of the vertical forces acting on the helicopter.
b) Find the thrust produced by the helicopter's blades if it accelerates upwards at $2ms^{-2}$. ***[354,000N]***
c) A parcel is dropped from the helicopter while it is hovering. If the parcel takes 3 seconds to hit the water. Determine the height the parcel was dropped from?
[44m]

13) An advertising balloon is tethered to the ground outside a supermarket.
The balloon has a mass of 4 kg and the rope is considered massless.

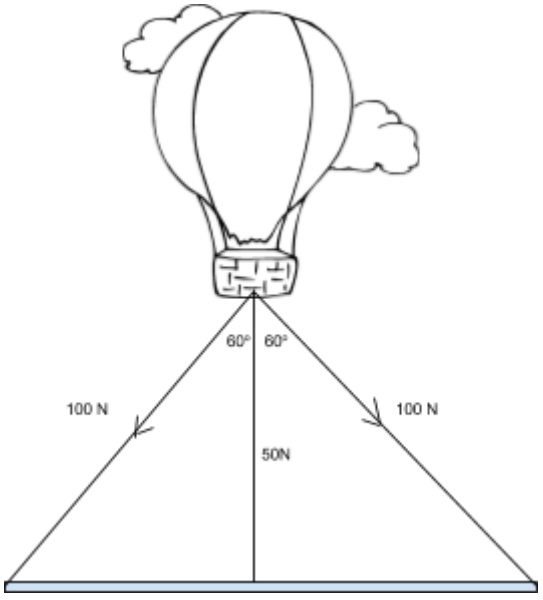
a) Draw a diagram of all the vertical forces acting on the balloon.
b) If the buoyancy force of the balloon is 40 N then calculate the tension force in the rope. ***[0.8 N]***

14) A hot air balloon is tied to the ground by a length of rope.
The mass of the hot air balloon is 600 kg and the tension force of the rope is 12 N.



a) Calculate the buoyancy force of the balloon. ***[600N]***
b) If the rope is cut determine the acceleration of the balloon. ***[0.02 ms^{-2}]***

15) A weather balloon of mass 200 kg is held down with three ropes as shown in the diagram.



a) Draw a sketch of **all** the vertical forces acting on the balloon.
b) Determine the buoyancy force acting upwards on the balloon. ***[2110 N]***
c) Calculate the acceleration of the balloon if all the ropes are cut. ***[0.75 ms^{-2}]***