Class 11: Different kinds of force

Test 1

1. Next Wednesday (Feb 11) 11:00-11:50 in this class room.
2. From beginning up to projectile motion.
3. No formula or cheat sheet.
4. 8 multiple choice problems (5 points each) and 2 long (30 points each) problems. Total 100 points.
5. Calculators allowed, but not the program function (though I don't think it will help).
6. Please bring photo ID.
7. No reschedule of test even though you have more than two tests that day.
8. Next Monday classwork will be a multiple choice exercise on the test materials. This classwork will not be returned.

Difference between spring balance and balance scale

Can be used to measure force

Can be used to measure mass

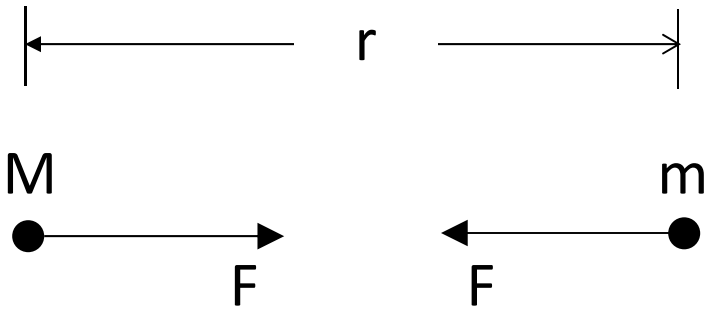
Fundamental forces

PROPERTIES OF THE INTERACTIONS

Property \ Interaction	Gravitational	Weak (Electroweak)	Electromagnetic (Electroweak)	Strong: Fundamental	Strong: Residual
Acts on:	Mass – Energy	Flavor	Electric Charge	Color Charge	See Residual Strong Interaction Note
Particles experiencing:	All	Quarks, Leptons	Electrically charged	Quarks, Gluons	Hadrons
Particles mediating:	Graviton (not yet observed)	W^+ W^- Z^0	γ	Gluons	Mesons
Strength relative to electromag for two u quarks at: 10^{-18} m	10^{-41}	0.8	1	25	Not applicable to quarks
Strength relative to electromag for two u quarks at: 3×10^{-17} m	10^{-41}	10^{-4}	1	60	
for two protons in nucleus	10^{-36}	10^{-7}	1	Not applicable to hadrons	20

Forces experienced in daily life

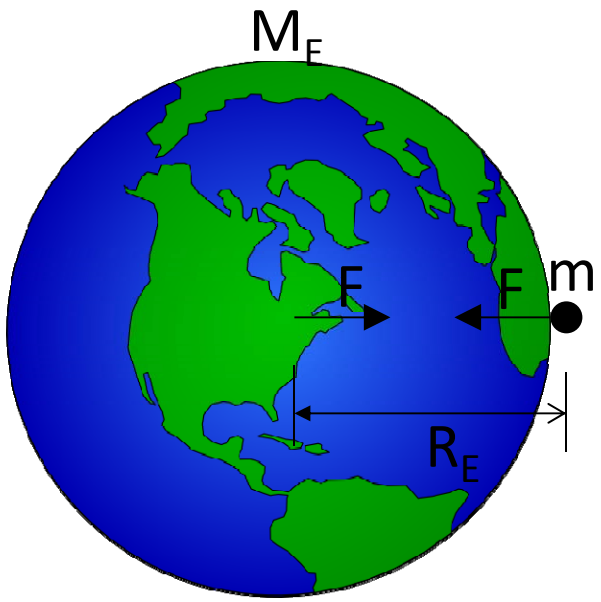
Gravitational force

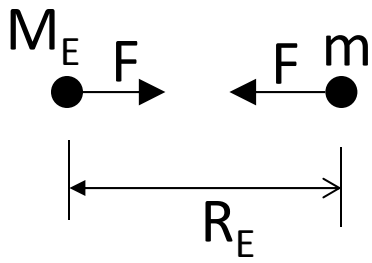


$$F = G\frac{Mm}{r^2}$$

1. Gravitational force is an interactive force – force acting on M and force acting on m are equal in magnitude but opposite in direction.
2. Gravitational force between two masses is always attractive.
3. G is a universal constant. $G = 6.67384 \times 10^{-11}\ Nm^2kg^{-2}$

Weight and gravitational force





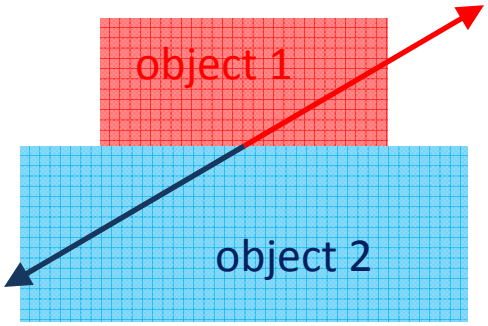
$$F = G\frac{M_E m}{R_E^{\,2}}$$

1. Your weight is due to gravitational force from Earth.
2. $M_E = 5.972\times10^{24}$ kg and $R_E = 6.371\times10^{6}$ m

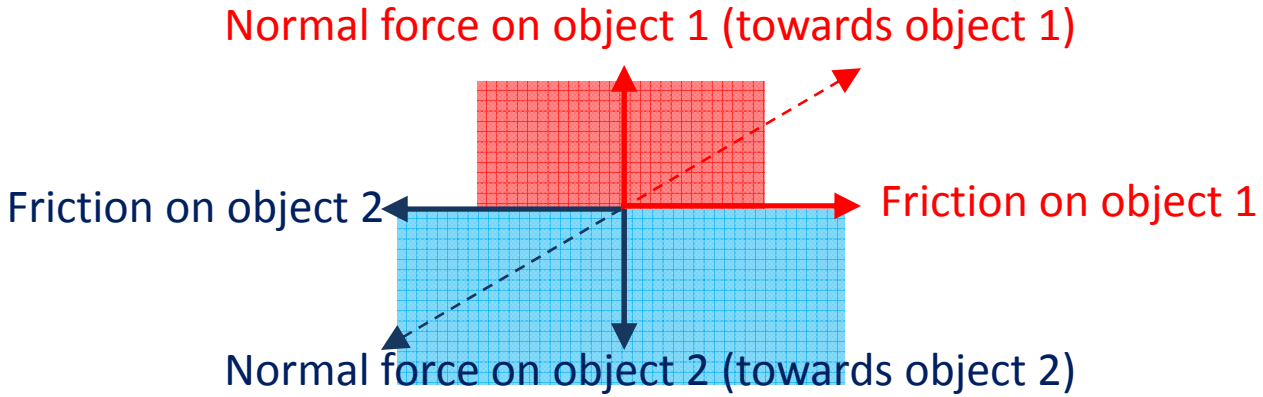
$$\text{Weight} = \left(G\frac{M_E}{R_E^{\,2}}\right)m \approx \left(9.8\ \text{N/kg}\right)m$$

Contact force

When two object are “in contact”, there are contact forces acting between the two objects.



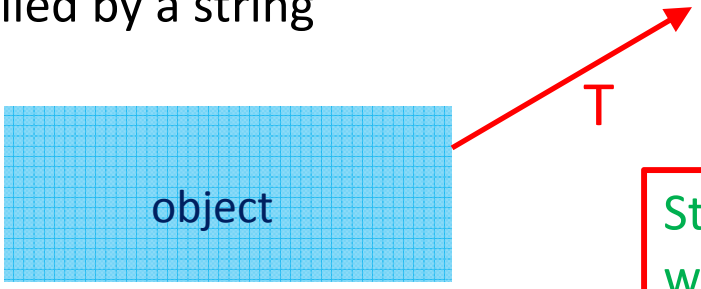
Contact force is an interactive force – contact force acting on object 1 and contact force acting on object 2 are equal in magnitude but opposite in direction.
The component of contact force perpendicular to the surface is called the normal force. The component of contact force parallel to the surface is called the friction.



The two objects will separate from each other if normal force = 0

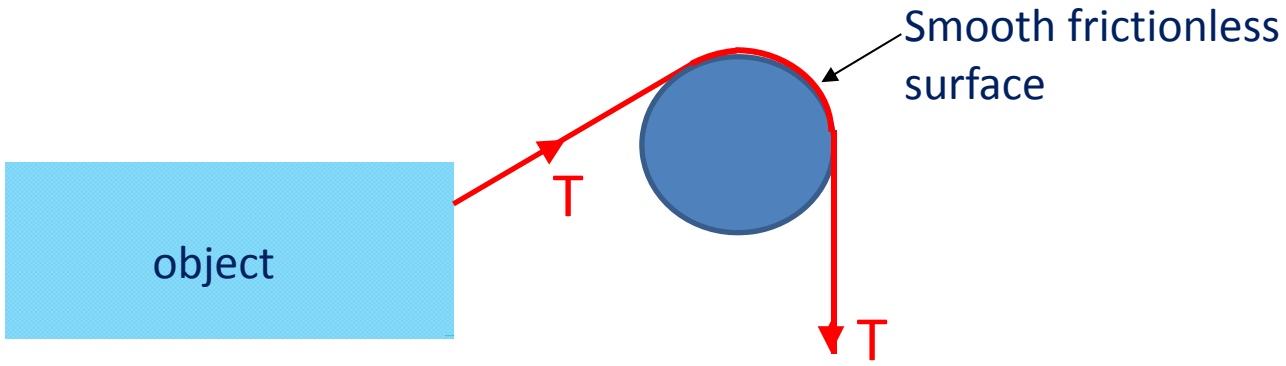
Tension in a string

When an object is pulled by a string



String is slack when T=0

it is pulled by a force equal to the tension in the string, along the string direction.



Direction of a string can be changed without affecting the magnitude of tension in it if it run through a smooth frictionless surface like a pulley – this will not be the case if there is friction.

Force analysis

When you see:

1. An object is in contact with another thing, there is contact force – normal force and friction – between them (problem won't say).
2. When a string is attached to an object, the object may be pulled – never push – by a force equal to the tension in the string (problem may not say).
3. An object on Earth's surface, its weigh (= $9.8 \times m$) is acting on it like a force acting towards the ground. When the object is far from Earth's surface, its weight will become $GM_E m/r^2$ instead of $9.8 \times m$ (problem never say).
4. There may be other applied force acting on it (problem must say).