Forces

Definitions

Newtons First Law:
Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it (If an object is motionless, it will stay motionless unless acted upon by some force. If an object is moving at a constant velocity, it will continue at that velocity unless acted upon by some force).

Newtons Second Law:
The acceleration of an object of constant mass is proportional to the force acting upon it (a = F/m).

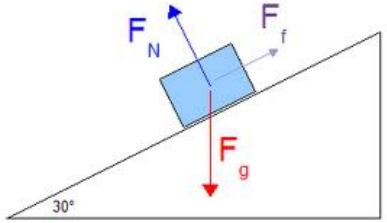
Newtons Third Law:
Whenever one body exerts force upon a second body, the second body exerts an equal and opposite force upon the first body (if you push against a door with a certain force, the door is also pushing with the same force against you).

Hooke's law: The restoring force is proportional to the extension up to the limit of proportionality.

Equations

$F = ma$	Force	F	N
	mass	m	kg
	acceleration	a	m s^{-2}
$F = -kx$	Force	F	N
	Force constant	k	N m^{-1}
	Extension	x	m

Force diagrams



The value of the frictional force required to keep the object from sliding down the slope can be calculated using vectors, vector diagrams and trigonometry.

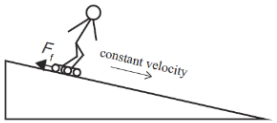
Questions

High Jump (2017;2)

(a) Sarah, a 55.0 kg athlete, is competing in the high jump where she needs to get her body over the crossbar successfully without hitting it. Calculate the size of the force(s) acting on Sarah **just after** she jumps in the air to take- off for the jump.

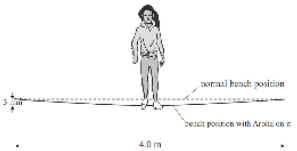
ROLLER SKATING (2017;1)

(b) Katy goes down a carpeted ramp at a constant velocity. On the diagram below, the friction force, F_f, between her skates and the carpet is shown. Draw and name all other forces acting on Katy.



THE SPECTATORS (2010;5)

(c) Aroha has a mass of 55 kg. She steps onto a bench to get a better view. When she gets on to the centre of the bench, it bends downwards 3.00 mm. Calculate the spring constant of the bench.



Terms

Mass: The amount of matter in an object, it is measured in kilograms (kg). The mass of an object remains constant wherever it is.

Weight: The force due to gravity. The weight of an object depends on the mass of the object and the strength of gravity where the object is. On Earth it acts downwards, towards the centre of the Earth.

The resultant (or "net") force: When all the forces acting on a body have been included and are represented by a single force.

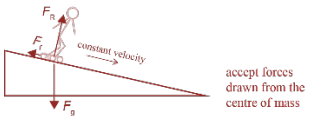
Tips

- Weight = mass x g (At the Earth' surface, g = 9.8 m s^{-2})
- The minus in F = - k x represents the fact that the force is *a restoring force*, that is, the force that allows the object to return to its original shape and position

Answers

(a) $F = mg$ = 55.0 x 9.8 = 539 = 540 N.

(b)



accept forces drawn from the centre of mass

(c)

$$F = kx$$

$$k = \frac{F}{x}$$

$$k = \frac{539}{0.003} = 1.8 \times 10^{5} \text{ N m}^{-1}$$