Dynamics Review Checklist

Newton's Laws

2.1.1A – Explain Newton's 1st Law (the Law of Inertia) and the relationship between mass and inertia.

Which of the following has the greatest amount of inertia?

(a) 10 kg object (c) 20 kg object
(b) 15 kg object (d) 25 kg object

(d)

Which of the following has the greatest amount of inertia?

(a) 3 kg object moving at 2 m/s
(b) 0.5 kg object moving at 200 m/s
(c) 8 kg object moving at 0.1 m/s
(d) 10 kg object moving at 6 m/s

(d)

2.1.1B – Explain Newton's 2nd Law and the relationship between net force and acceleration.

The net force acting on an object is zero. Which of the following statements could possibly be applied to this object? (There may be more than one answer!)

(1) The object must be accelerating.
(2) The object must not be accelerating.
(3) The object may be accelerating.
(4) The object may be moving with a constant speed.
(5) The object must be moving with a constant speed.
(6) The object must be motionless.
(7) The object cannot be motionless.
(8) The object may be motionless.

(2), (4), (8)

A 20 newton net force acts on a 5.0 kilogram object. What rate of acceleration will this object experience?

4 m/s^2

An object of mass M experiences a net force F causing it to accelerate at rate A. At what rate would an object of mass 2M accelerate if pushed with net force F?

(a) 2A (b) A (c) A/2 (d) A/4

(c)

2.1.1C – Explain Newton's 3rd Law and the relationship between action/reaction pairs. Explain the origin of normal force.

A man in a rowboat jumps off the boat and onto a nearby dock. What is the reaction of the boat to the man's forward jump?

The boat will move away from the dock

A 100 newton force is applied to a surface. With what amount of force must the surface push back? What is the force that the surface pushes back with called?

100 newtons; normal force

2.1.1D – Explain the relationship between mass and weight. Explain the origin of normal force.

What is the weight of a 5.0 kilogram object when it is near the surface of the Earth?

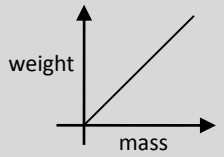
49.05 newtons

If the acceleration due to gravity on Planet X is 6.0 meters per second^2, what is the weight of a 4.0 kilogram object on Planet X?

24 newtons

A 2.5 kilogram object is transported from the Earth to the Moon. When the object arrives on the Moon, its weight is _____ less _____ compared to than that on Earth. Its mass is _____ the same _____ compared to that on Earth.

Sketch a graph of the relationship between mass and weight on the axes below. What does the slope of this graph represent?

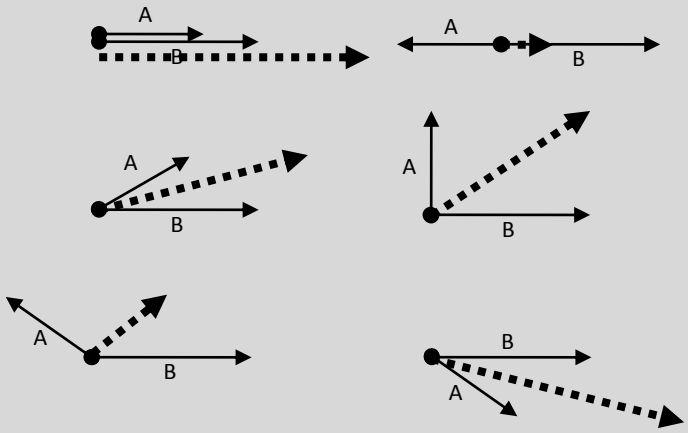


The slope of this graph is the acceleration due to gravity (g)

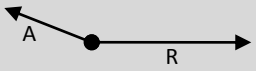
Forces on Angles – Top/Down View

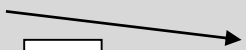
2.1.2A – Explain how net force is determined in a top/down view force vector diagram. Determine the vector that is "missing" from a system given a single vector and resultant.

Sketch the resultant force in each of the following sets of diagrams.



When added together, vectors A and B produce resultant R. If the diagram below shows vector and the resultant R, which of the vectors below best represents vector B that when added to A will produce R?



(a) 

(a)

(c) 

(b) 

(d) 

2.1.2C – Describe vector arrangements in which the net force is maximized or minimized.

Two forces of 10 newtons and 25 newtons act concurrently on an object.

a. If the angle between the two vectors is 0°, what is the resultant force?

35 newtons

b. If the angle between the two vectors is 180°, what is the resultant force?

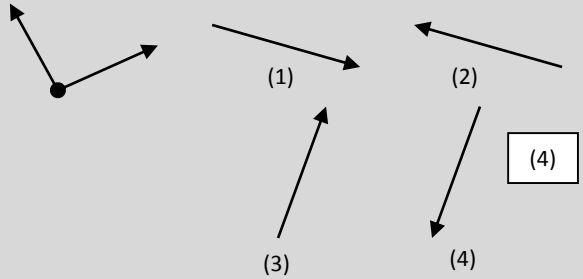
15 newtons

What happens to the resultant produced by two forces if the angle between them is changed from 20° to 80°?

The resultant force would decrease.

2.1.2B – Determine the equilibrant to a system. Determine whether or not equilibrium can be established in a system. Select a force that 'could' produce equilibrium in a system.

Which of the following is an equilibrant to the system shown below?



Which of the following systems could produce equilibrium?

(a) 3N, 5N, 7N
(b) 10N, 30N, 45N
(c) 2N, 2N, 2N
(d) 5N, 7N, 9N
(e) 12N, 15N, 30N

(a), (c), (d)

Which of the following could produce equilibrium when combined with a 10N and 15N force?

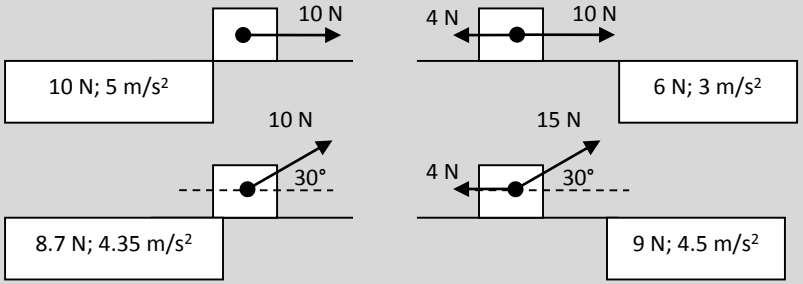
(a) 2N
(b) 6N
(c) 10N
(d) 15N
(e) 20N
(f) 30N

(b), (c), (d), (e)

Forces on Angles – Side View

2.1.2C – Explain how net force is determined in a side-view vector diagram. Use the net force to determine the acceleration of the object.

Determine the net force and acceleration in each of the diagrams. (Assume that all objects have a mass of 2.0 kilograms and all surfaces are frictionless)



A 50 newton force is applied to a 4.0 kilogram object on a frictionless, horizontal surface at an angle of 20° above the horizontal. If the angle is changed to 60°, what effect will this have on the net force acting on the object?

The net force will decrease.

Friction

2.1.3A – Calculate the maximum force of static friction. Determine the amount of static friction acting on an object that is motionless. Determine the minimum coefficient of friction in a system.

A 2.0 kilogram wooden object is on a wooden surface. What is the maximum force of friction that can be produced in this system?

8.2 newtons

A motionless 3.0 kilogram object steel object on a copper surface is pushed with a 2.0 newton force. What is the force of static friction?

2 newtons

What is the minimum coefficient of static friction between a 25 newton object and a surface if it is pushed with a force of 10 newtons and does not move?

0.4

2.1.3B – Calculate the force of kinetic friction. Determine net force in a system that is sliding. Determine the coefficient of kinetic friction in a sliding system. Determine: net force; applied force; friction force; and/or acceleration.

A 3.0 kilogram wooden object is sliding along a wooden surface. What is the force of friction acting on the object?

8.8 newtons

A 20 newton object is pulled along a horizontal surface at a constant speed using a force of 4.0 newtons.

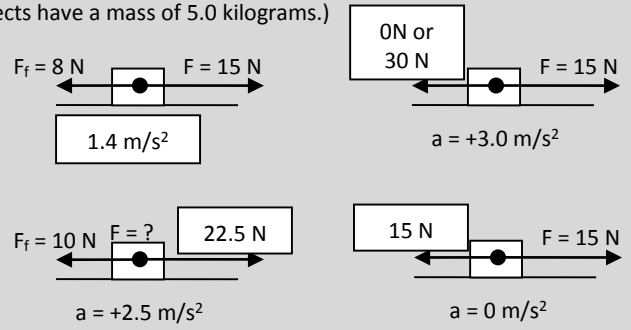
a. What is the force of kinetic friction acting on the object?

4.0 newtons

b. What is the coefficient of kinetic friction in this system?

0.2

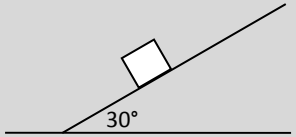
Determine the unknown quantity in each of the systems below. (Assume that all objects have a mass of 5.0 kilograms.)



Inclined Planes

2.1.4A – Determine the components of the weight of an object placed on a frictionless incline. Determine the effects of changing the angle on the components of weight.

A 5.0 kilogram object is placed on a frictionless, 30° incline.



Determine the component of the object's weight that is parallel to the incline.

24.5 N

Determine the component of the object's weight that is perpendicular to the incline.

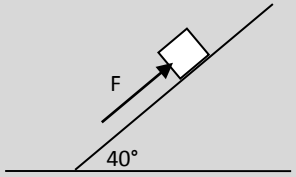
42.5 N

What is the normal force acting on the block? 42.5 N

What is the net force acting on the block? 24.5 N

If the angle were increased to 65°:

- parallel component of weight will (INCREASE/DECREASE/NOT CHANGE) INC
- perpendicular component of weight will (INCREASE/DECREASE/NOT CHANGE) DEC
- normal force will (INCREASE/DECREASE/NOT CHANGE) DEC
- net force will (INCREASE/DECREASE/NOT CHANGE) INC



What is the mass of a 60 newton object that is placed on a frictionless 40° incline?

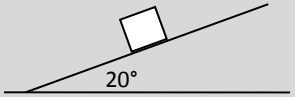
6.1 kg

A force F is used to keep a 60 newton object at rest on a frictionless 40° incline. What is the magnitude of force F?

38.6 N

2.1.4B – Determine the behavior of objects placed on inclines with friction. Determine friction; net force; or applied forces.

A 30 newton object is sliding down a 20° incline at a constant speed.



Determine the component of the object's weight that is parallel to the incline.

10.3 N

Determine the component of the object's weight that is perpendicular to the incline.

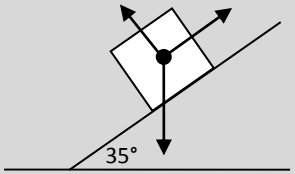
28.2 N

What is the normal force acting on the block? 28.2 N

What is the net force acting on the block? 0 N

What is the force of friction acting on the block? 10.3 N

A 5.0 kilogram block accelerates down a 35° incline at a rate of 2.0 meters per second^2. Sketch all of the forces acting on the block.



What is the net force acting on the block?

10 N

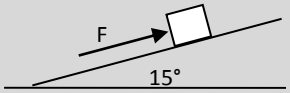
What is the friction force acting on the block?

18.1 N

A force F is used to accelerate a 3.0 kilogram block up an incline at a rate of 2.0 meters per second^2.

How big must force F be if the force of friction acting on the block is 4.0 newtons? (Hint: which way is friction acting in this system?)

10 N



Universal Gravitation

2.2.1A – Calculate the force of gravity acting between two masses.

Determine the gravitational force of attraction experienced by two 5.0 kilogram masses separated by a distance of 2.5 meters.

2.67×10^{-10} N

Determine the gravitational force of attraction between the Earth and Moon.

1.99×10^{20} N

2.2.1B – Determine the effect of changing variables on the force of gravity.

A gravitational force F attracts two objects with masses M toward each other when they are separated by a distance R.

What would this force be changed to if the mass of both objects were changed to 2M?

(1) F/4 (2) F/2 (3) 2F (4) 4F — (4)

What would this force be changed to if the distance between the two objects were to be tripled?

(1) F/9 (2) F/3 (3) 3F (4) 9F — (1)

If the system were changed as follows, what would force "F" become?

M, 2M, R → 2 F

M, M, 2R → 1/4 F

2M, 2M, R/2 → 16 F

M, M, 4R → 1/16 F

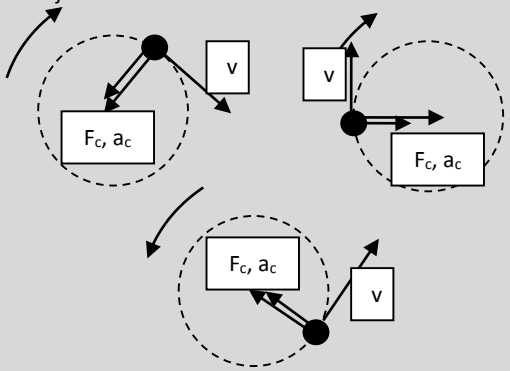
M, 2M, R/5 → 50 F

3M, 2M, R/2 → 24 F

Circular Motion

2.2.2A – Draw vectors to represent centripetal force; centripetal acceleration; and velocity in a circular motion system.

Sketch vectors to show the centripetal force; centripetal acceleration; and velocity of the object in each case.



2.2.2B – Calculate the speed of an object in a circular motion system. Determine the centripetal force and/or acceleration in a circular motion system.

A 3.5 kilogram object is swung in a circular path on the end of a 0.4 meter long string. The object makes one trip around the circle every 0.2 seconds.

Determine the speed of the object. (hint: v = d/t)

12.56 m/s

Determine the centripetal acceleration acting on this object.

394.4 m/s^2

Detemine the centripetal force needed to keep the object moving in a circle.

1380.3 N

2.2.2C – Determine an unknown parameter in a circular motion system with the understanding that the centripetal force is generated by some "other" force.

A 1000 kilogram car with rubber tires is attempting to make a turn on dry asphalt. The car is moving at 10 meters per second and attempts a turn with a radius of 25 meters.

a. Determine the centripetal force needed to make this turn.

4000 N

b. Determine the maximum force of static fricton.

8338.5 N

c. Is the turn possible? Why?

Yes. There is more friction than needed for the turn.

A 1000 kilogram vehicle with rubber tires makes a 30 meter radius turn on dry asphalt. What is the maximum speed with which this turn could have been made?

15.8 m/s

A 1000 kilogram vehicle makes a 40 meter radius turn while moving at 4.0 meters per second. What is the minimum coefficient of static friction between the tires and the road needed to permit this turn?

0.04

Hooke's Law

2.2.3A – Calculate the amount of spring force; spring constant; or distance that a spring will be displaced in a system.

How much force is needed to stretch a spring with a spring constant of 1000 newtons per meter a distance of 0.02 meter?

20 N

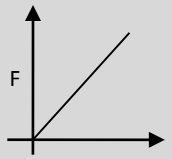
What is the spring constant of a spring that is compressed a distance of 0.04 meter when pushed with a force of 500 newtons?

12500 N/m

What distance will a spring with a spring constant of 450 newtons per meter be stretched when a force of 300 newtons is applied to it?

0.67 m

What does the slope of each of the graphs shown below represent?



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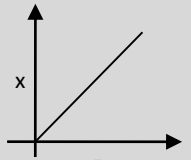

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Sketch a graph for an object that does NOT obey Hooke's Law.