شكراً لتحميلك هذا الملف من موقع المناهج الإماراتية

حل مراجعة الوحدة الخامسة Two in Forces and Displacement بعدين في والقوى الإزاحة Dimension

تاريخ نشر الملف على موقع المناهج: 2024-02-07 11:04:59

التواصل الاجتماعي بحسب الصف التاسع المتقدم

روابط مواد الصف التاسع المتقدم على تلغرام

التربية الاسلامية	اللغة العربية	اللغة الانجليزية	الرياضيات

المزيد من الملفات بحسب الصف التاسع المتقدم والمادة فيزياء في الفصل الثاني

1	مراجعة الوحدة الرابعة Dimension One in Forces القوى في بعد واحد
2	حل مراجعة الوحدة الرابعة Dimension One in Forces القوى في بعد واحد
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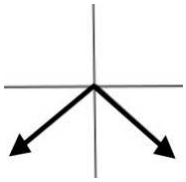
ID Resources: Topic 5– Displacement & Forces in Two Dimension

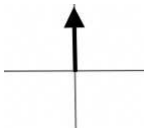
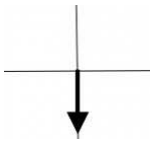
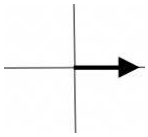
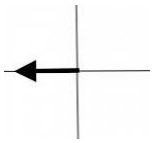
Subtopic 5.1: Vectors

1. A(n) _____ is a vector that is equal to the sum of two or more vectors.

√ A. resultant
B. graphical representation
C. displacement
D. addition vector

2. Two forces act on an object as shown below. What is the direction of the resultant of the two forces?



A. 
√ B. 
C. 
D. 

3. The resultant of a 20 N force acting on an object to the right and a 30 N force acting on the object to the left is ___.

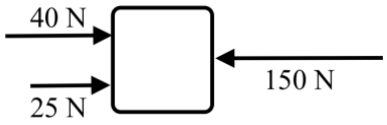
A. 50 N acting to the left
B. 10 N acting to the right
√ C. 10 N acting to the left
D. 30 N acting to the right

4. A student covers the following displacements. What are the magnitude and direction of his net displacement?

$$\overrightarrow{d_1} = 12\ m\ East$$
$$\overrightarrow{d_2} = 6.0\ m\ West$$
$$\overrightarrow{d_3} = 2.0\ m\ West$$

√ A. 4.0 m East
B. 8.0 m East
C. 16 m West
D. 18 m West

5. The figure below shows three forces acting on an object.



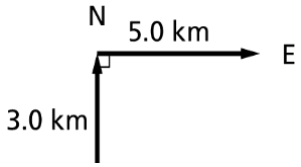
What is the resultant force on the object?

A. 85 N, to the right
√ B. 85 N, to the left
C. 115 N, to the right
D. 115 N, to the left

6. Which of the following can NOT be the magnitude of the resultant of vector magnitudes 3 and 4 units?

√ A. 0
B. 1
C. 3
D. 7

7. The figure shows the displacement vectors of a car. What is the magnitude of the resultant vector?

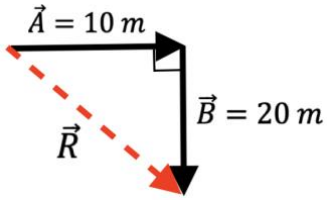


A. 2.0 km
B. 2.8 km
C. 4.0 km
√ D. 5.8 km

8. A car moves 65 km due east then 45 km due west. What is its total displacement?

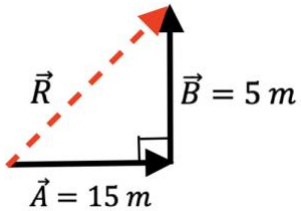
√ A. 20 km
B. 79 km
C. 110 km
D. 6250 km

9. The figure below shows two vectors A and B. What is the magnitude of the resultant vector $\vec{R}$, if vector $\vec{A} = 10\ m, east$ and vector $\vec{B} = 20\ m, south$ as shown below?



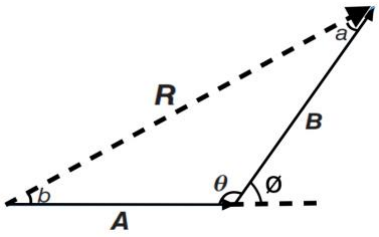
A. 10.4 m
B. 15.0 m
√ C. 22.4 m
D. 30.0 m

10. The figure below shows two vectors A and B. What is the magnitude of the resultant vector $\vec{R}$ if $\vec{A} = 15\ m, east$ and $\vec{B} = 5\ m, north$?



A. 14.1 m
√ B. 15.8 m
C. 17.2 m
D. 20.0 m

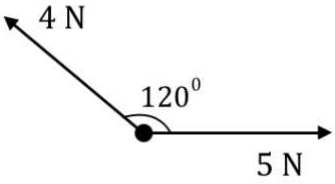
11. The diagram below shows two vectors A and B. Which of the following equations will give the correct resultant of the two vectors?



√ A. $R = \sqrt{A^2 + B^2 - 2AB\cos\theta}$
B. $R = \sqrt{A^2 + B^2 - 2AB\cos ø}$
C. $R = A^2 + B^2 - 2AB\cos\theta$
D. $R = A^2 + B^2 - 2AB\cos ø$

12. The figure below shows two forces 4 N and 5 N acting on an object. What is the resultant force on the object?

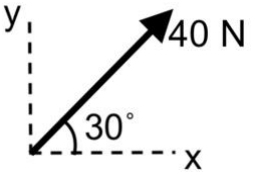
√ A. $\sqrt{21}$
B. $\sqrt{41}$
C. 21
D. 41



13. The process of breaking a vector into its components is called _____.

A. vector reduction
B. graphical representation
√ C. vector resolution
D. equilibrant

14. What is the **x**-component and **y**-component of the 40 N force vector shown below?

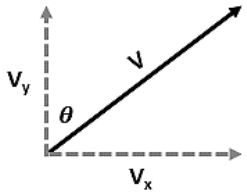


	x-component	**y-component**
A.	20 N	35 N
√ B.	35 N	20 N
C.	40 N	80 N
D.	80 N	40 N

15. What is the y-component of a 95.3 N force that is exerted at 57.1° to the horizontal?

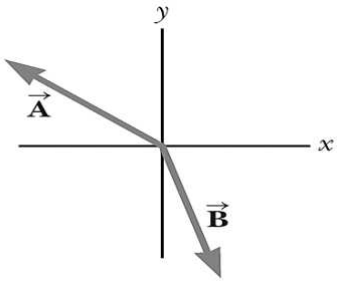
A. 52 N
B. 61 N
√ C. 80 N
D. 95 N

16. A velocity vector v, makes an angle θ with the vertical direction as shown below. what are the correct expressions for its x −component v_x and y −component v_y?



		v_x	v_y
√	A.	$v \sin\theta$	$v \cos\theta$
	B.	$v \cos\theta$	$v \sin\theta$
	C.	$v \sin\theta$	$v \tan\theta$
	D.	$v \cos\theta$	$v \tan\theta$

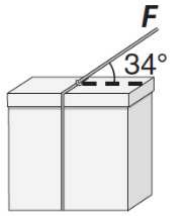
17. The figure below shows two vectors $\vec{A}$ and $\vec{B}$ lying in the xy plane. What are the signs of the x and y components of $\vec{A}$ and $\vec{B}$?



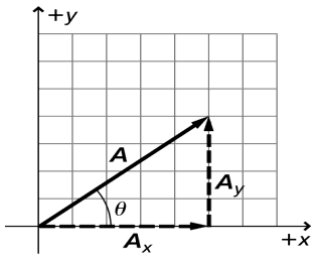
		$\vec{A}_x$	$\vec{A}_y$	$\vec{B}_x$	$\vec{B}_y$
	A.	+	+	−	−
	B.	+	−	+	−
√	C.	−	+	+	−
	D.	−	+	−	+

18. As shown in the figure below, a string exerts a force of 18 N on a box at an angle of 34° from the horizontal. What is the horizontal component of the force on the box?

A. 10 N
√ B. 15 N
C. 21 N
D. 32 N



19. The coordinate system below shows the components of vector A. How is the direction of a vector, A, measured?



A. counterclockwise from the +y-axis
B. counterclockwise from the –y-axis
√ C. counterclockwise from the +x-axis
D. clockwise from the +x-axis

20. A vector A has x- and y-components A_x and A_y. The angle the vector makes with the x-axis is ___ .

√ A. $tan^{-1}\frac{A_y}{A_x}$
B. $tan^{-1}\frac{A_x}{A_y}$
C. $tan\frac{A_x}{A_y}$
D. $cos^{-1}\frac{A_x}{A_y}$

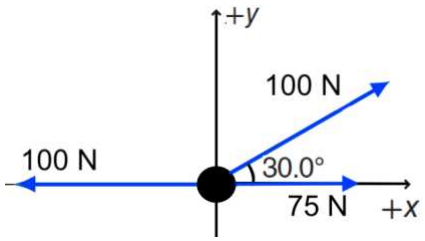
21. A vector makes an angle, θ, with the horizontal. The horizontal and vertical components of the vector will be equal in magnitude if angle θ is _____.

A. 30°
√ B. 45°
C. 60°
D. 90°

22. A vector in the xy plane has a magnitude of 25 m and an x component of 12 m. The angle it makes with the positive x axis is ____.

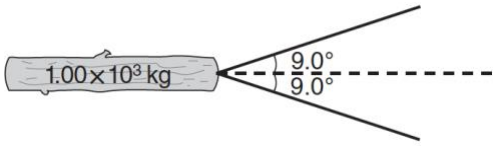
A. 26°
B. 29°
√ C. 61°
D. 64°

23. The diagram below shows three force vectors acting at a point. What is the resultant force?



A. 62 N
√ B. 79 N
C. 162 N
D. 275 N

24. Two tractors in the figure below pull against a $1.00 \times 10^3\ kg$ log. If the angle of the tractors' chains in relation to each other is 18.0° and each tractor pulls with a force of $8.00 \times 10^2\ N$, how large is the force exerted by the tractors on the log?



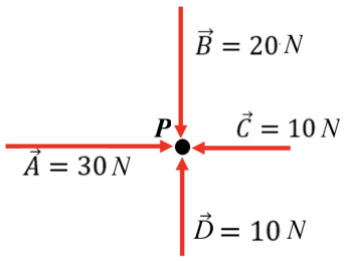
A. 250 N
B. $7.90 \times 10^2\ N$
√ C. $1.58 \times 10^3\ N$
D. $9.80 \times 10^3\ N$

Free Response:

1. True or false?

a. The term used to describe a force that equals the sum of two or more forces is the resultant force. (True)
b. The resultant of two force vectors 5 N and 11 N lies between 6 N and 16 N. (True)

2. Four force vectors $\vec{A}, \vec{B}, \vec{C}$ and $\vec{D}$ are acting on a point P as shown in the figure (not to scale).



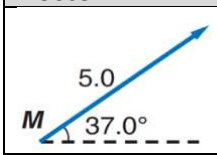
a. What is the resultant force vector along the horizontal direction?
Resultant force vector along the horizontal = 30 N – 10 N = 20 N

b. What is the resultant force vector along the vertical direction?
Resultant force vector along the vertical = 10 N – 20 N = -10 N

c. What is the magnitude of the net resultant force on the point P?
$R = \sqrt{(20)^2 + (-10)^2} = 22.4\ N$

3. Three vectors M, K and L are as shown in the table below.

a. Find the components of the vectors.

Vector	x- component	y-component
	$M_x = M\cos\theta$ $M_x = 5.0\cos 37.0^\circ$ $M_x = 4.0$	$M_y = M\sin\theta$ $M_y = 5.0\sin 37.0^\circ$ $M_y = 3.0$
	$K_x = K\cos\theta$ $K_x = -4.0\cos 0^\circ$ $K_x = -4.0$	$K_y = K\sin\theta$ $K_y = -4.0\sin 0^\circ$ $K_y = 0$
	$L_x = L\cos\theta$ $L_x = 6.0\cos 0^\circ$ $L_x = 6.0$	$L_y = K\sin\theta$ $L_y = 6.0\sin 0^\circ$ $L_y = 0$

b. Find the sum of the three vectors.

$R_x = 4.0 - 4.0 + 6.0 = 6.0$

$R_y = 3.0 + 0 + 0 = 3.0$

$R = \sqrt{(R_x)^2 + (R_y)^2} = \sqrt{(6.0)^2 + (3.0)^2} = 6.7\ units$

c. Subtract vector K from vector L.

$\vec{L} - \vec{k} = 6.0 - (-4.0) = 10\ units$

4. Rank the following according to the magnitude of the net resultant force, from least to the greatest.

A. 20 N up + 10 N down

B. 20 N up + 10 N left

C. 20 N up + 10 N up

D. 20 N up $A < D < B < C$

5. The following steps for adding vectors are in scrambled order. In the space provided, write which step is first, second, third, and fourth.

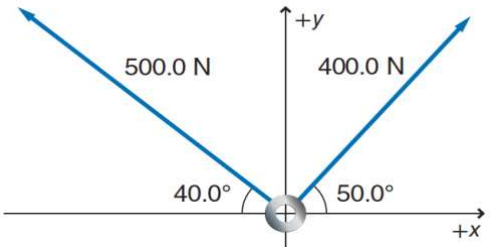
__2__ A. Move vectors so they are tip-to-tail.

__4__ B. Measure the length and direction of resultant vector.

__1__ C. Choose a scale and draw the vectors.

__3__ D. Draw the resultant vector.

6. Two forces are acting on the ring in figure. What is the magnitude and direction of the net force acting on the ring?



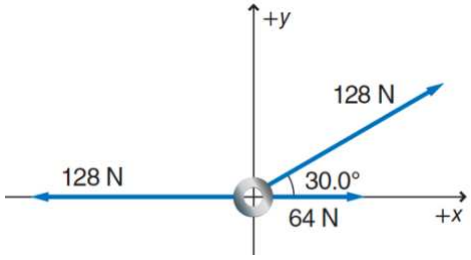
The angle between the two forces is:

$180 - (40 + 50) = 90^{\circ}$

$F_{net} = \sqrt{(500\ N)^2 + (400\ N)^2} = 640\ N$

$\theta = tan^{-1}\left(\frac{500\ N}{400\ N}\right) = 51.3^{\circ}$

7. Three forces are acting on the ring as shown in the figure. What is the magnitude and direction of the net force acting on the ring?



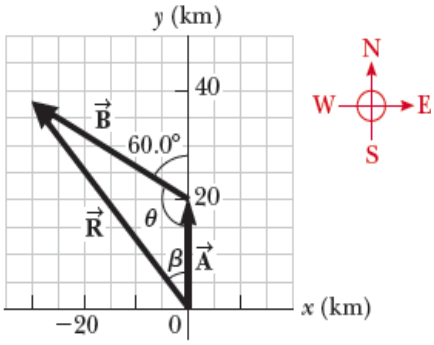
$F_x = (64\cos 0^{\circ})N + (128\cos 30^{\circ})N + (128\cos 180^{\circ})N = 47\ N$

$F_y = (64\sin 0^{\circ})N + (128\sin 30^{\circ})N + (128\sin 180^{\circ})N = 64\ N$

$F_{net} = \sqrt{(F)^2 + (F)^2} = \sqrt{(47N)^2 + (64\ N)^2} = 79\ N$

$\theta = tan^{-1}\left(\frac{F_y}{F_x}\right) = tan^{-1}\left(\frac{64\ N}{47\ N}\right) = 54^{\circ}$

8. A car travels 20.0 km due north and then 35.0 km in a direction 60.0° west of north as shown in the figure below. Find the magnitude and direction of the car's resultant displacement.



Magnitude:

$R = \sqrt{A^2 + B^2 - 2ABcos\theta}$

$R = \sqrt{(20.0\ km)^2 + (35.0\ km)^2 - 2(20.0\ km)(35.0\ km)cos120^{\circ}} = 48.2\ km$

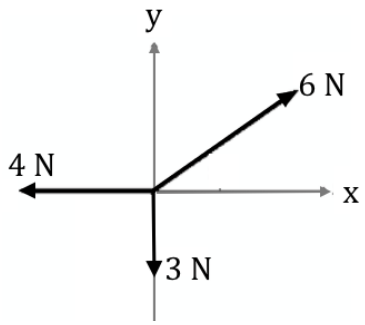
Direction:

$\frac{sin\beta}{B} = \frac{sin\theta}{R}$

$sin\beta = \frac{B}{R}sin\theta = \frac{35.0\ km}{48.2\ km}sin120^{\circ} = 0.629$

$\beta = 38.9^{\circ}$. The resultant displacement is 48.2 km in a direction 38.9° west of north

9. The three forces shown below act on a particle.



a. Find the x and y components of the 6 N force.

$F_{65,x} = Fcos\theta = (6.0\ N)\cos 30^{\circ} = 6 \times 0.9 = 5.4\ N$

$F_{65,y} = Fsin\theta = (6.0\ N)\sin 30^{\circ} = \frac{6}{2} = 3\ N$

b. Calculate the magnitude of the resultant of the three forces.

$\sum F_x = 5.4\ N - 4\ N = 1.4\ N$

$\sum F_y = 3\ N - 3\ N = 0$

$R = \sqrt{1.4^2 + 0^2} = 1.4\ N$

Subtopic 5.2: Friction

1. An object is being pulled across a rough surface by a force *F* to the right as shown below. The object remains at rest.

What type of frictional force acts on the object and what is its direction?

		Type	Direction
√	A.	Static	To the left
	B.	Kinetic	To the right
	C.	Rolling	Upward
	D.	Sliding	Downward

2. It is more difficult to start moving a heavy couch from rest than it is to keep pushing it with constant velocity, because _____.

	A.	the normal force is greater when the couch is at rest
	B.	the coefficient of kinetic friction is greater than the coefficient of static friction
√	C.	the coefficient of static friction is greater than the coefficient of kinetic friction
	D.	there is no friction when the couch moves with constant velocity

3. Once you start moving an object that is initially at rest, it becomes easier to continue moving the object because the _____.

	A.	normal force is smaller when the couch is at rest
√	B.	coefficient of kinetic friction is less than the coefficient of static friction
	C.	coefficient of static friction is less than the coefficient of kinetic friction
	D.	coefficient of static friction is equal to the coefficient of kinetic friction

4. Compared to the force needed to start sliding a crate across a rough level floor, the force needed to keep it sliding with constant speed, once it is moving is ____

√	A.	less
	B.	more
	C.	the same
	D.	zero

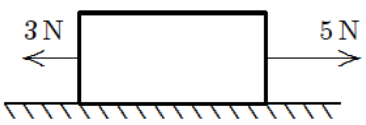
5. A boy push a heavy box at rest on the floor across the floor. He gradually increases the force of his push until the box moves when he keeps the pushing force constant. The force of friction ___.

	A.	decreases and then increases
√	B.	increases and then decreases
	C.	remains the same
	D.	continues to increase

6. A brick slides on a horizontal surface. Which of the following will increase the magnitude of the frictional force on it?

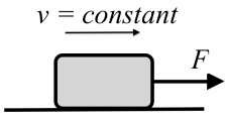
√	A.	Putting a second brick on top
	B.	Decreasing the surface area of contact
	C.	Increasing the surface area of contact
	D.	Decreasing the mass of the brick

7. The block shown below moves with constant velocity on a horizontal surface. Two of the forces on it are shown. A frictional force exerted by the surface is the only other horizontal force on the block. The frictional force is _____.



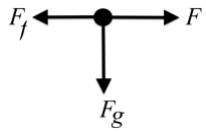
	A.	0
√	B.	2 N, leftward
	C.	2 N rightward
	D.	Slightly more than 2 N, leftward

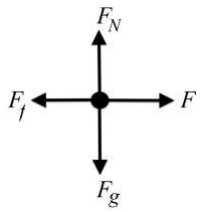
8. A force F is applied to a box on a rough surface and the box moves to the right with a **constant velocity** as shown below.

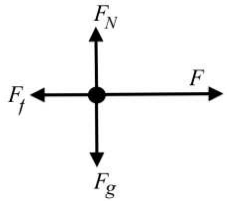


Which of the following is a correct free body diagram for the box?

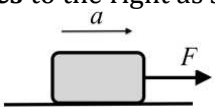
A. 

B. 

√ C. 

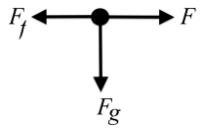
D. 

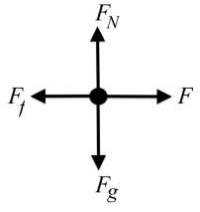
9. A force F is applied to a box on a rough surface and the box **accelerates** to the right as shown below.

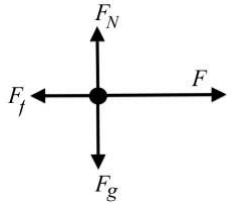


Which of the following is a correct free body diagram for the box?

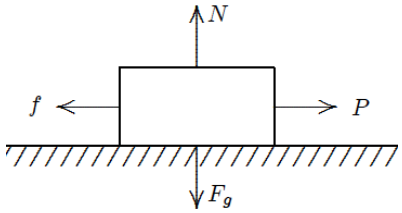
A. 

B. 

C. 

√ D. 

10. A boy pulls a wooden box along a rough horizontal floor at constant speed by means of a force P as shown. In the diagram f is the magnitude of the force of friction, N is the magnitude of the normal force, and F_g is the magnitude of the force of gravity. Which of the following must be true?



√ A. $P = f \text{ and } N = F_g$

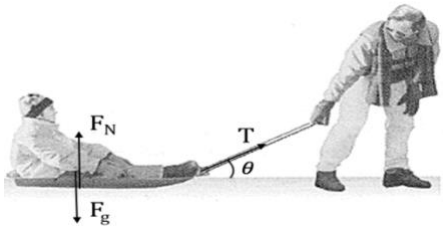
B. $P = f \text{ and } N > F_g$

C. $P > f \text{ and } N < F_g$

D. $P > f \text{ and } N = F_g$

Question 11 and 12

A child is pulled forward on a sled as shown in the figure below.



11. The magnitude of the normal force exerted by the ground on the sledge is __.

A. equal to the total weight of the child plus the sledge

B. greater than the total weight

√ C. less than the total weight

D. possibly greater than or less than the total weight, depending on the size of the weight relative to the tension in the rope

12. Which of the following correctly relates the normal force F_N, the tension T and the total weight F_g?

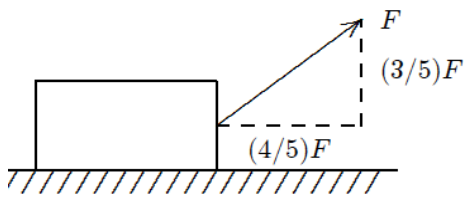
A. $F_N = F_g$

B. $F_N = F_g + T\sin\theta$

√ C. $F_N = F_g - T\sin\theta$

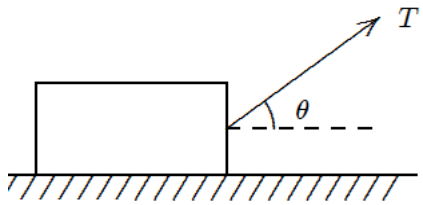
D. $F_N = F_g - T\cos\theta$

13. A 400 N block is dragged along a horizontal surface by an applied force F as shown. The coefficient of kinetic friction is $\mu = 0.4$ and the block moves at constant velocity. The magnitude of F is:



A. 100 N
√ B. 150 N
C. 200 N
D. 290 N

Questions 14 and 15
A block of mass m is pulled at **constant velocity** along a rough horizontal floor by an applied force T as shown.



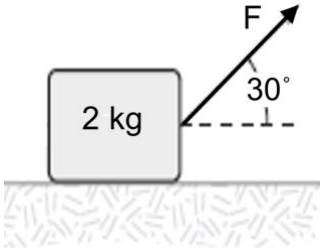
14. The magnitude of the frictional force is:

√ A. $Tcos\theta$
B. $Tsin\theta$
C. mg
D. $mgcos\theta$

15. The vertical component of the force exerted on the block by the floor is:

A. mg
B. $mg - Tcos\theta$
C. $mg + Tcos\theta$
√ D. $mg - Tsin\theta$

Questions 16 and 17
A force F = 10 N is applied on a 2.0 kg block on a surface as shown in the figure below. The block moves with a constant velocity.



16. What is the magnitude of the normal force acting on the block?

A. 10.6 N
√ B. 14.6 N
C. 19.6 N
D. 24.6 N

17. What is the coefficient of friction between the block and the surface?

A. 0.41 N
B. 0.51 N
√ C. 0.68 N
D. 1.46 N

18. When a 12 N horizontal force is applied to a 6.0 N box on a horizontal tabletop, the box remains at rest. The force of static friction acting on the box is _____.

A. 0.5 N
B. 2.0 N
C. 6.0 N
√ D. 12 N

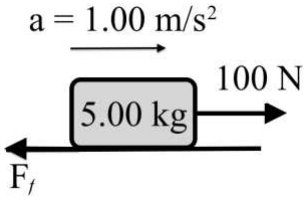
19. An object of weight 8.0 N is pulled across a rough surface. If the coefficient of static friction between the surfaces is 0.15, what is the maximum static friction on the object?

√ A. 1.2 N
B. 1.8 N
C. 2.1 N
D. 2.4 N

20. An object is pulled across a rough surface. The coefficient of static friction between the surfaces is 0.25 and the maximum static friction on the object is 60 N. What is the weight of the object?

A. 120 N
B. 180 N
√ C. 240 N
D. 270 N

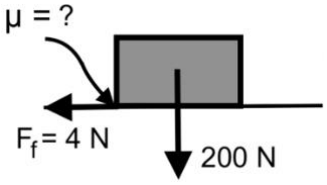
21. A 100 N force of is required to accelerate a 5.00 kg box across a horizontal concrete floor. The box accelerates at 1.00 m/s². What is the frictional force on the box?



A. 5.00 N
√ B. 95.0 N
C. 100 N
D. 105 N

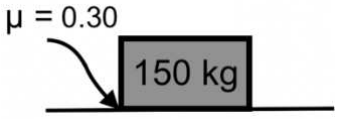
22. An ice-skater who weighs 200 N is gliding across the ice. If the force of friction is 4 N, what is the coefficient of kinetic friction?

√ A. 0.02
B. 0.04
C. 0.20
D. 0.40



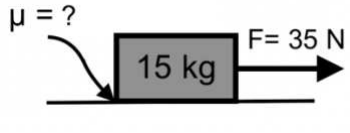
23. A box is at rest on the floor. The mass of the box is 150 kg and the coefficient of static friction between the box and the floor is 0.30. The maximum force of static friction is approximately ____.

A. 150 N
√ B. 450 N
C. 1500 N
D. 4500 N



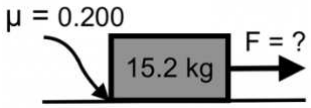
24. If you exert 35 N of horizontal force while pushing a 15 kg box across the floor at a constant velocity, what is the coefficient of kinetic friction between the floor and the box?

A. 0.043
√ B. 0.23
C. 0.43
D. 4.2

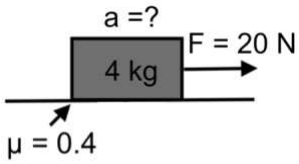


25. How much force against friction is required to keep a 15.2 kg wood crate moving at constant speed across a polished wood floor? The coefficient of kinetic friction is 0.200.

A. 3.04
√ B. 30.4
C. 76.0
D. 760



26. The figure below shows a box moving on a rough horizontal floor. The mass of the box is 4 kg box and the coefficient of kinetic friction 0.4. If a force of 20 N is applied on the block parallel to the floor, what is acceleration of the block? Consider g =10 m/s²



√ A. 1 m/s²
B. 2 m/s²
C. 3 m/s²
D. 4 m/s²

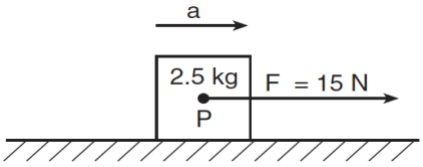
27. A forward horizontal force of 12 N is used to pull a 240 N crate at constant velocity across a horizontal floor. The coefficient of friction is:

A. 0.5
√ B. 0.05
C. 2.0
D. 0.2

28. A 4 kg mass is accelerated by a horizontal force of 15 N. If the magnitude of the acceleration is 3 m/s^2, how much friction is acting on the mass?

√ A. 3 N
B. 5 N
C. 15 N
D. 27 N

Questions 29 and 30
As represented in the diagram below, a constant 15 N force, F, is applied to a 2.5 kg box, accelerating the box to the right at 2.0 m/s^2 across a rough horizontal surface.



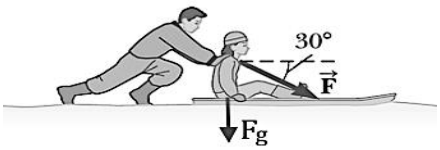
29. What is the magnitude of the net force acting on the box?

A. 3.0 N
B. 4.5 N
√ C. 5.0 N
D. 15 N

30. What is the magnitude of the force of friction on the box?

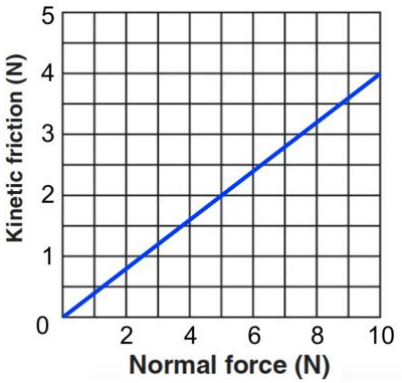
A. 5.0 N
√ B. 10 N
C. 15 N
D. 20 N

31. A person is pushed forward on a sled as shown in the figure below. The magnitude of the normal force exerted by the ground on the sled _____



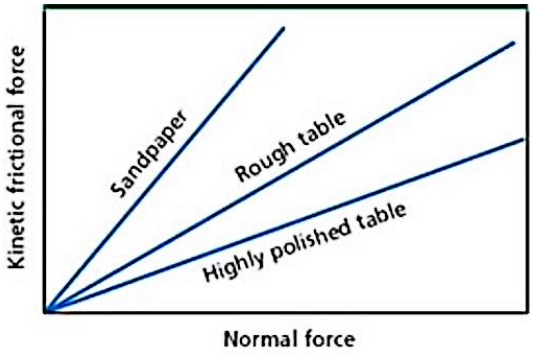
A. is equal to F_g
B. is less than F_g
√ C. is greater than F_g
D. depends on the size of F_g relative to F

32. What is the coefficient of kinetic friction for the surface shown on the graph below?



√ A. 0.4
B. 0.5
C. 2.5
D. 4.0

33. According to this graph, which surface would offer more frictional force if a toy car was pushed across its surface?



A. Highly polished table
B. Rough table
√ C. Sand paper
D. None, as all the surfaces offer the same friction

Free Response:

1. True or false?

a. When there is no relative motion between two surfaces, the force exerted by one surface on the other is called the static friction force- (True)
b. The kinetic friction force is the force exerted on one surface by another when the surfaces are in relative motion. (True)
c. The kinetic friction force is equal to the product of the coefficient of the kinetic friction and the normal force (True)
d. Friction always acts in a direction of the object's motion (False)

2. Choose the correct term from in the brackets to complete the statements.

a. The (static friction/ kinetic friction) keeps increasing until it reaches a maximum value, when the object just begins to slide.
b. The maximum static friction is (greater/lesser) than the kinetic friction for a given surface.
c. If the normal force between two surfaces is doubled, the static friction will be (doubled/ halved).

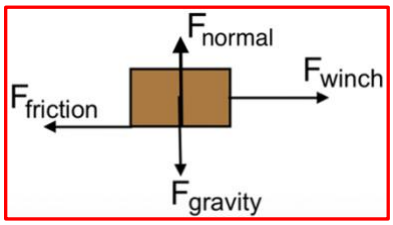
3. Write the term that correctly completes the statement. Use each term once.

coefficient of kinetic friction	**equilibrant**	**static friction**
coefficient of static friction	**kinetic friction**	**vector resolution**
components		

To determine the ___ of a vector, a coordinate system must be chosen.	components
The force of ___ depends on the normal force exerted by an object when there is no motion between the two surfaces.	static friction
The ___ is a force that puts an object into equilibrium.	equilibrant
___ is always less than the maximum value of static friction.	kinetic friction
The ___ is needed to calculate the force of kinetic friction	coefficient of kinetic friction
Breaking a vector down into its components is called ___ .	vector resolution
The ___ is greater than the coefficient of kinetic friction.	coefficient of static friction

4. A crate with a mass of 1000 kg is being pulled along greased tracks by a winch. The winch is exerting a force of 2000 N in the horizontal direction along the tracks. The coefficient of kinetic friction between the crate and the tracks is 0.2.

a. Draw a free-body diagram of the crate.



b. What is the net force acting on the crate in the horizontal direction?

$F_{net} = F_{winch} - F_{friction} = F_{winch} - \mu_k F_N$

$F_{net} = 2000\ N - (0.2 \times 1000 \times 9.8) = 40\ N$

c. Calculate the crate's acceleration.

$a = \frac{F_{net}}{m} = \frac{40\ N}{1000\ kg} = 0.04\ m/s^2$

4. A horizontal force of 50 N is required to keep a 10 kg crate moving with a constant speed on a rough surface.

a. Calculate the normal force acting on the crate.

$F_N = F_g = mg = 10\ kg \times 10\ N/kg = 100\ N$

b. Find the coefficient of kinetic friction between crate and floor.

$F_{f,kinetic} = \mu_k F_N$

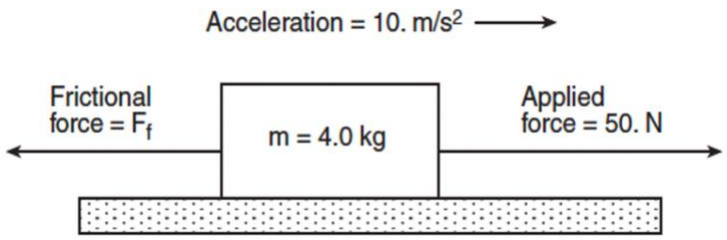
$50\ N = \mu_k (100\ N)$

$\mu_k = 0.5$

c. List the differences between static and kinetic friction.

Static Friction	Kinetic Friction
• Acts between two surfaces which are attempting to move, but are not moving • Increases linearly with the applied force until it reaches a maximum value • It could have a value less than or greater than the value for kinetic friction • The maximum static friction for a given surface is greater than the kinetic friction	• Force acting between two surfaces which are in motion against each other. • Remains constant regardless of the force applied • Kinetic friction is less than the maximum value of static friction for a given surface

5. The diagram below shows a 4 kg object accelerating at 10 m/s² on a rough horizontal surface when a force of 50 N is applied to it as shown below.

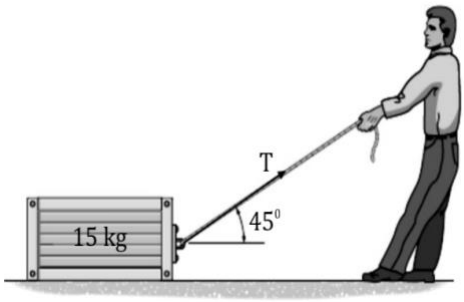


a. What is the magnitude of the frictional force F_f acting on the object?
Applying Newton's Law;
$ma = F_{applied} - F_f \Longrightarrow F_f = F_{applied} - ma$
$F_f = 50\ N - (4\ kg)(10\ m/s^2) = 10\ N$

b. Calculate the normal force exerted on the box.
$F_N = mg = (4kg)(10\ m/s^2) = 40\ N$

c. Find the coefficient of kinetic friction.
$F_f = \mu_k F_N \Longrightarrow \mu_k = \frac{F_f}{F_N} = \frac{10\ N}{40\ N} = 0.25$

6. A man pulls a 15 kg crate by using a rope, which makes an angle of 45° with the horizontal. The tension in the rope exerted on the crate is ***T*** = 120 N, and the coefficient of kinetic friction between the crate and the ground is 0.5.

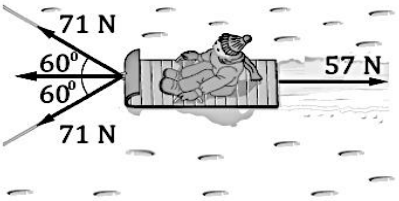


a. Find the normal force exerted by the ground on the crate.
$F_N + T_y - F_g = 0$
$F_N = mg - Tsin\theta = (15 \times 10) - (120 \times \sin 45°) = 65\ N$

b. Find the frictional force between the crate and the ground.
$F_f = \mu_k . F_N = 0.5 \times 65 = 33\ N$

c. Find the acceleration of the crate.
$T_x - F_f = m.a$
$a = \frac{T_x - F_f}{m} = \frac{Tcos\theta - F_f}{m} = \frac{(120 \times \cos 45°) - 33}{15} = 3.5\ m/s^2$

7. A 19 kg child is pulled on a 1.0 kg sled with ropes as shown in the figure below. Both ropes pull with a force of 71 N at an angle of 60° relative to the forward direction, which is the direction of motion. The snow exerts a retarding force on the sled that points opposite to the direction of motion and has a magnitude of 57 N



a. What is the total force by the two ropes in the direction of motion?
$F_{x,ropes} = F_1 cos60° + F_2 cos60°$
$F_{x,ropes} = 2(71 cos60°) = 71\ N$

b. What is the net force acting on the sled and the child?
$\sum F_x = F_{x,ropes} - F_{retarding} = 71 - 57\ N = 14\ N$

c. What is the acceleration of the sled and the child?
$\sum F_x = (m_{sled} + m_{child})a$
$a = \dfrac{\sum F_x}{m_{sled} + m_{child}} = \dfrac{14\ N}{(1.0 + 19)\ kg} = 0.70\ m/s^2$

8. Explain how to find the coefficient of kinetic friction between a wooden block of unknown mass and a tabletop in the laboratory. Include the following in your explanation:

- Measurements required
- Equipment needed
- Procedure
- Equation(s) needed to calculate the coefficient of friction

Example of an acceptable answer:
To determine the coefficient of friction between a block and the table, we would need to measure the normal force or weight of the block, and the force of friction.

- The equipment needed is a spring scale.
- First hang the block on the scale to find its weight.
- Then pull the block at constant speed across the table with the spring scale to find the force of friction.
- Once the weight and friction is measured use the formula $F_f = \mu_k F_N$ to calculate the coefficient of friction.

9. Compare the coefficient of kinetic friction for the three surfaces shown on the graph below.

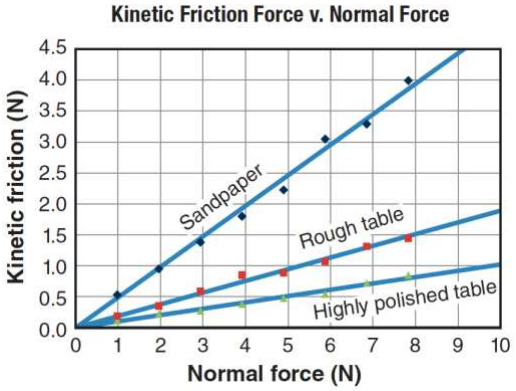
The coefficient of kinetic friction for each surface is most nearly:

$\mu_{sandpaper} = \dfrac{4.5\ N}{9.0\ N} = 0.5$

$\mu_{rough\ table} = \dfrac{2.0\ N}{10\ N} = 0.2$

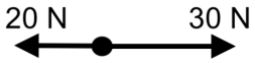
$\mu_{polished\ table} = \dfrac{1.0\ N}{10\ N} = 0.1$

Therefore: $\mu_{sandpaper} > \mu_{Rough\ table} > \mu_{polished\ table}$



Subtopic 5.3: Forces in Two Dimensions

1. What is the equilibrant of the two forces acting on the object below, which will keep the object in equilibrium?

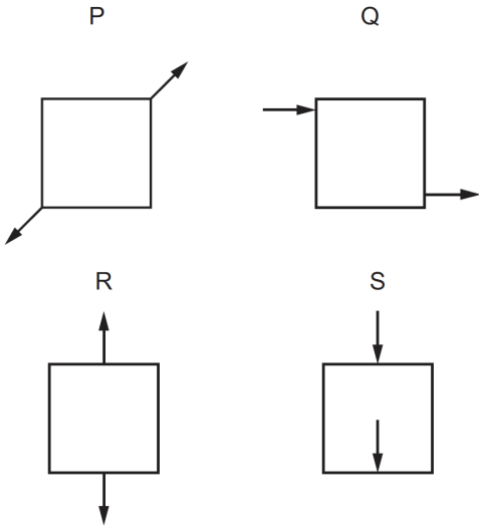


A. 10 N to the right
√ B. 10 N to the left
C. 50 N to the right
D. 50 N to the left

2. A force that produces equilibrium is a(n) ___.

A. net force
B. resultant
√ C. equilibrant
D. constant

3. The diagrams below show the forces acting on four identical solid blocks. Each arrow represents a force of 20 N.



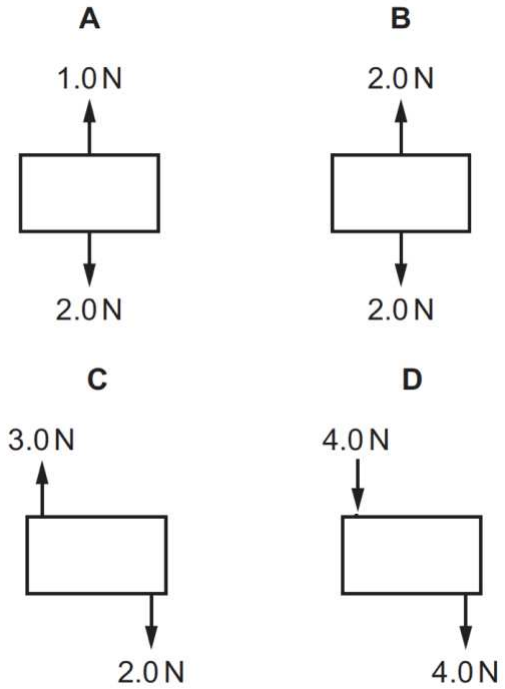
Which blocks are in equilibrium?

√ A. P and R only
B. Q and S only
C. P, Q and R only
D. P, Q, R and S

4. The equilibrant of a force directed 45° west of north has the direction ____.

A. 45° west of north
B. 45° east of north
√ C. 45° south of east
D. 45° west of south

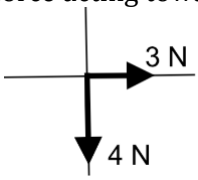
5. Four objects are each acted on by only two forces, as shown.



Which object is in equilibrium?

A. A
√ B. B
C. C
D. D

Question 6 to 8
The figure shows two forces 3 N force acting toward the east and a 4 N force acting toward the south is ___.



6. The magnitude of the equilibrant is ___.

A. −7 N
B. 1 N
√ C. 5 N
D. 7 N

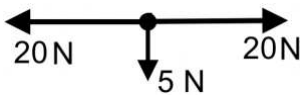
7. The direction of the resultant force is most nearly:

A. →
B. ↓
√ C. ↘
D. ↖

8. The direction of the equilibrant is most nearly ___.

A. →
B. ↓
C. ↘
√ D. ↖

9. The equilibrant of the three forces acting on an object below is ____.

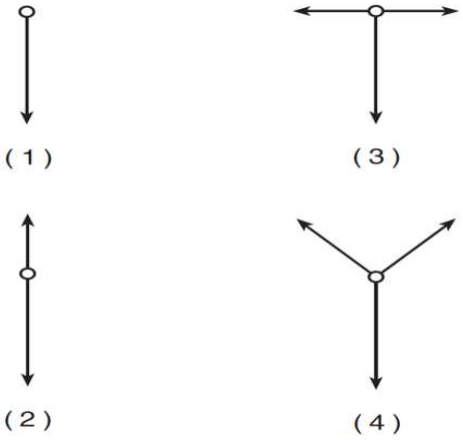


A. 5 N downwards
√ B. 5 N upwards
C. 45 N downwards
D. 45 N upwards

10. Three forces of magnitudes 6N, 8 N and 10 N are acting on a particle in equilibrium. The resultant of the 8 N and 10 N forces has a magnitude of ___.

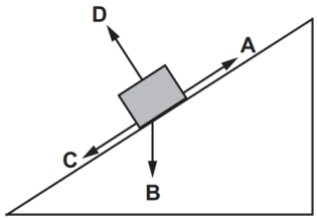
A. 2 N
√ B. 6 N
C. 9 N
D. 18 N

11. An object is in equilibrium. Which force vector diagram could represent the force(s) acting on the object?



A. 1
B. 2
C. 3
√ D. 4

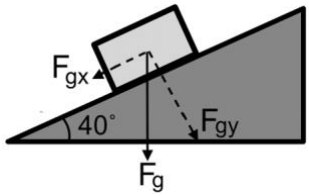
12. A force moves a box up a rough slope. The diagram shows four forces acting on the box.



Which are the forces due to friction and the normal on the box?

	Friction	Normal
A.	A	B
B.	B	A
√ C.	C	D
D.	D	C

13. A 100 N box is resting on a plane inclined at 40° above the horizontal as shown below. What are the components of the weight force parallel and perpendicular to the plane?



A. $F_{gx} = 77\ N$, $F_{gy} = 64\ N$

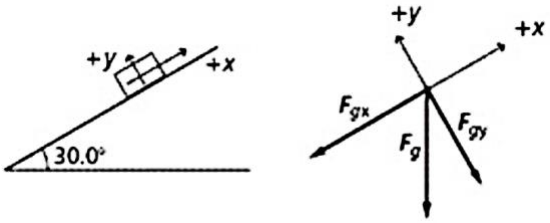
√ B. $F_{gx} = 64\ N$, $F_{gy} = 77\ N$

C. $F_{gx} = 84\ N$, $F_{gy} = 77\ N$

D. $F_{gx} = 64\ N$, $F_{gy} = 84\ N$

Questions 14 and 15

The free-body diagram represents a 227 kg piano resting on an inclined plane.



14. What is the component of the weight parallel to the inclined plane?

A. 11.4 N

B. 11.6 N

√ C. 1110 N

D. 1930 N

15. What is the component of the weight perpendicular to the inclined plane?

A. 11.4 N

B. 11.6 N

C. 1110 N

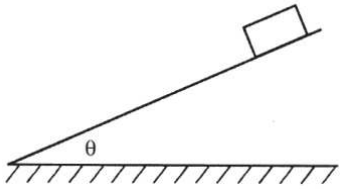
√ D. 1930 N

16. A 475 N trunk is resting on a plane inclined 40.0° above the horizontal. Find the components of the weight force parallel and perpendicular to the plane.

		F_{gx}	F_{gy}
√	A.	305 N	364 N
	B.	364 N	305 N
	C.	305 N	399 N
	D.	399 N	364 N

Questions 17 and 18

A mass is sliding down an incline. As the angle of elevation for the incline increases,



17. the coefficient of kinetic friction between the bottom surface of the block and the surface of the incline will _____.

A. increase

B. decrease

√ C. remain the same

D. become zero

18. the magnitude of the component of its weight perpendicular to the incline ____.

A. increases

√ B. decreases

C. increases, then decreases

D. decreases, then increases

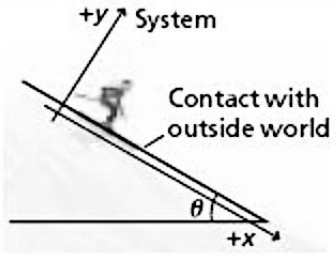
19. If in the diagram below, the skier has mass 45 kg and the slope is at 35°, what is the normal force of the hill on the skier?

A. 250 N

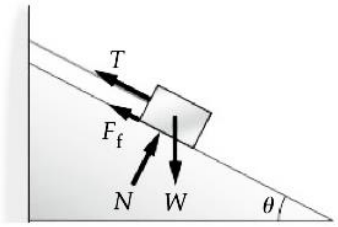
B. 315 N

√ C. 360 N

D. 440 N



Questions 20 and 21
The diagram below shows a box held stationary on a ramp by a string connected to a wall.



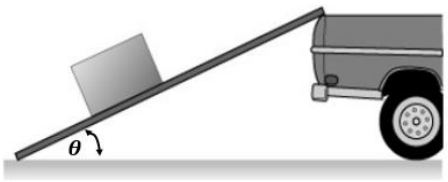
20. Which of the following relationship is true?

A. $T = -F_f$
B. $T = W cos\theta + F_f$
√ C. $W sin\theta = T + F_f$
D. $T + F_f = W$

21. How do the normal force, friction force, and tension change when the angle θ is increased?

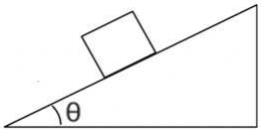
	Normal, N	**Friction, F_f**	**Tension, T**
A.	Increases	Increases	Increases
B.	Decreases	Decreases	Decreases
C.	Increases	Increases	Decreases
√ D. | Decreases | Decreases | Increases |

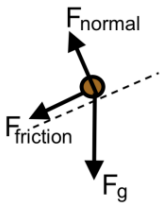
22. A block with a mass 5.0 kg slides down on a frictionless ramp inclined at an angle of 30 ° as shown below. What is the block's acceleration?

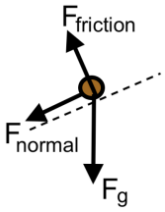


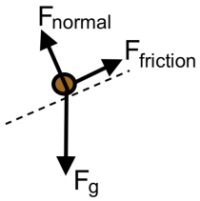
√ A. 4.9 m/s^2
B. 8.7 m/s^2
C. 25 m/s^2
D. 43 m/s^2

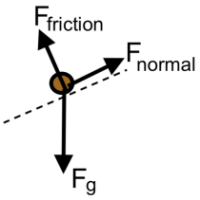
23. A crate is resting on an inclined plane as shown in the figure below. Which is the correct free body diagram for the crate?



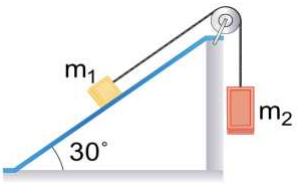
A.


B.


√ C.


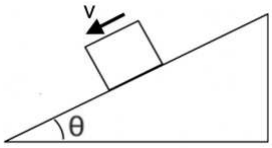
D.


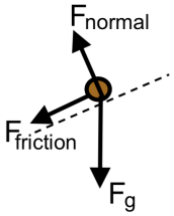
24. Two blocks are attached to each other by a light inextensible string that passes over a frictionless pulley of negligible mass. Mass m_1 is 15 kg and mass m_2 is 30 kg. What is the acceleration of the blocks if the surface of the incline plane is frictionless.

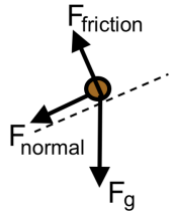


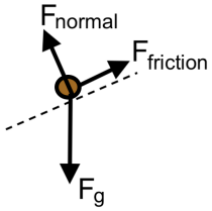
A. 3.3 m/s²
√ B. 5.0 m/s²
C. 8.3 m/s²
D. 15 m/s²

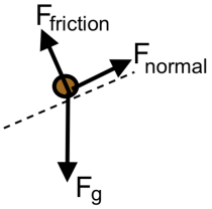
25. A crate moves **DOWN** an inclined plane below with a constant velocity. Which is the correct free body diagram for the crate?



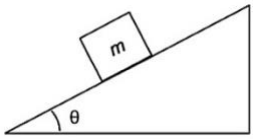
A. 

B. 

√ C. 

D. 

Questions 26 to 29:
A block slides down a frictionless inclined plane that makes an angle θ with the horizontal.



26. Which of the expressions shown below expresses the block's acceleration?

A. $g \cos\theta$
√ B. $g \sin\theta$
C. g
D. $2g$

27. Which of the expressions shown below is equal to the component of the block's weight acting along the plane?

A. mg
√ B. $mg\ sin\theta$
C. $mg \cos\theta$
D. $mg(\sin\theta + \cos\theta)$

28. Which of the expressions shown below is equal to the normal force on the block?

A. mg
B. $mg\ sin\theta$
√ C. $mg \cos\theta$
D. $mg(\sin\theta + \cos\theta)$

29. If the block is at rest on the incline, which of the equations shown below is true regarding the force of static friction f?

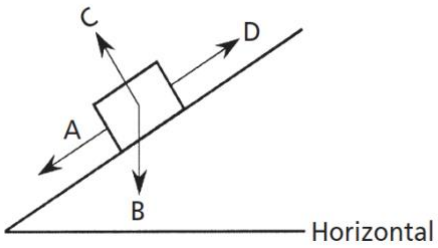
√ A. $f = mg \sin\theta$
B. $f = mg \cos\theta$
C. $f > mg \cos\theta$
D. $f > mg \sin\theta$

Free Response:

1. Are the following statements below regarding objects in equilibrium true or false?

a. If the net force on an object is zero, the object accelerates (false)
b. If the net force on an object is zero, the object is in equilibrium (True)
c. An object is equilibrium must be at rest (False)
d. An object in equilibrium is either at rest or moves with constant velocity (True)
e. An object in equilibrium has zero acceleration. (True)
f. There is always an unbalanced force acting on an object in equilibrium. (False)

2. In the diagram below, a box is at rest on an inclined plane.

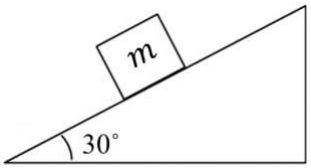


a. In the table below label the forces A, B, C and D.

Force A	Component of the weight of the box parallel to the incline
Force B	Weight of the box
Force C	Normal force
Force D	Frictional force

b. Identify the forces that are equal.
Since the object is at rest, force A is equal to force D

3. A box of mass 5.0 kg is at rest on an inclined plane making an angle of 30° with the horizontal as shown in the figure.



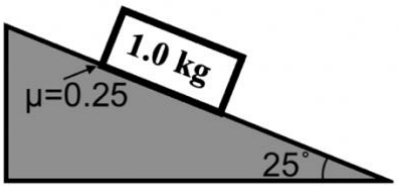
a. What is the component of the weight of the box parallel to the incline?
Component of weight = mg sin θ = (5.0 kg)(9.8) sin (30°) = 24.5 N

b. What is the normal force on the box?
Normal force = mg cos θ = (5.0 kg)(9.8) cos (30°) = 42.4 N

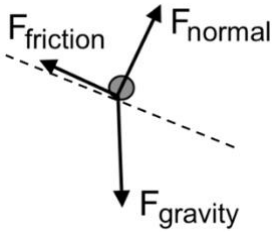
c. What is the frictional force on the box?
Frictional force = 24.5 N

d. What is the coefficient of friction between the box and the surface?
Co-efficient of friction = Frictional force/ Normal force = 24.5/42.4 =0.58

4. A box with a mass of 1.0 kg is sliding down a ramp that makes an angle of 25° with the ground. The coefficient of kinetic friction between the box and the ramp is 0.25. Consider $g = 10\ m/s^2$.



a. Draw a free body diagram of the forces acting on the mass.



b. What are the components of the box's weight?
$F_{gx} = mg\ sin\ \theta = (1.0\ kg)(10\ m/s^2)\ sin\ 25^\circ = 4.2\ N$
$F_{gy} = mg\ cos\ \theta = (1.0\ kg)(10\ m/s^2)\ cos\ 25^\circ = 9.1\ N$

c. How large is the normal force acting on the box?
$F_N = F_{gy} = 9.1\ N$

d. What is the magnitude of the force of friction acting on the box?
$F_{friction} = \mu F_N = (0.25)(9.1\ N) = 2.3\ N$

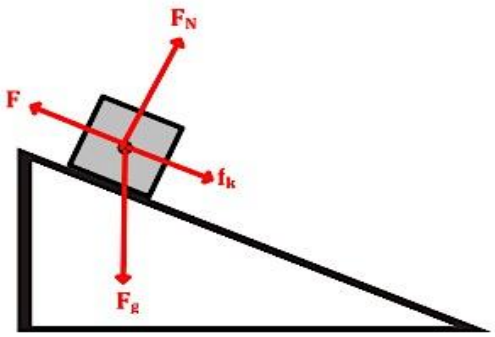
e. How large is the net force acting on the box along the x-axis?

$F_{net} = F_{gx} - F_{friction} = 4.2\ N - 2.3\ N = 1.9\ N$

f. Calculate the acceleration of the box as it moves down the ramp.

$$a = \frac{F_{net}}{m} = \frac{1.9\ N}{1.0\ kg} = 1.9\ m/s^2$$

5. A 40 kg crate is pushed up a 45° incline by a force of $300\sqrt{2}$ N, parallel to the incline shown in the figure below. The coefficient of kinetic friction between the crate and the incline is 0.1.



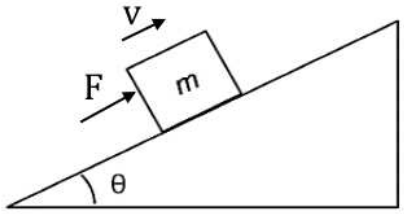
a. Draw the free body diagram for the crate.

b. Calculate the magnitude of the normal force on the crate.
$F_N = F_{gy} = mg\cos\theta = 40 \times 10 \times \cos 45 = 283\ N$

c. Calculate the magnitude of the force of friction on the crate.
$f_k = \mu_k F_N = 0.1 \times 283 = 20.3\ N$

d. Calculate the magnitude of the acceleration of the crate.
$F_{net} = ma$
$F - F_{gx} - f_k = ma$
$F - mg\sin\theta - f_k = ma$
$300\sqrt{2} - 40 \times 10 \times \sin 45 - 20.3 = 40a$
$a = 2.8\ m/s^2$

6. A box of mass 8 kg is placed on an incline at an angle of 30° from the horizontal. A force $\vec{F} = 50\ N$ is applied to the box such that it moves up the incline at a constant velocity.



a. Find the component of the weight along the incline.
$W_{||} = mg\sin\theta = 8(10)\sin 30° = 40\ N$

b. What is magnitude of the kinetic friction acting on the box?
$F_{net} = 0$
$F_f + W_{||} - F = 0$
$F_f = 50\ N - 40\ N = 10\ N$

c. What is the coefficient of kinetic friction?
$F_f = \mu_k F_N = \mu_k(mgcos\theta)$
$10 = \mu_k(8)(10)(\cos 30°)$
$\mu_k = \frac{10}{72} = \frac{5}{36}$

d. As the angle θ is increased, what happens to the coefficient of kinetic friction between the bottom surface of the box and the surface of the incline?
The coefficient of friction will remain the same.

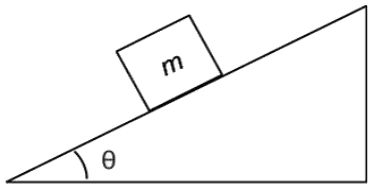
7. A block with a mass $m = 2.0\ kg$ slides down a ramp inclined at an angle $\theta = 30°$ as shown below. The block accelerates at a rate of 2.3 m/s^2.

a. Find the component of the block's weight along the ramp.
$W_{||} = mgsin\theta = 2.0\ kg \times 10\ N/kg \times sin30° = 10\ N$

b. Find the frictional force between the block and the ramp.
$F_{net} = W_{||} - F_f$
$F_f = W_{||} - ma = 10\ N - (2.0\ kg \times 2.3\ m/s^2) = 5.4\ N$

c. Calculate the coefficient of kinetic friction.
$\mu = \frac{F_f}{F_N} = \frac{5.4\ N}{(2.0\ kg \times 10\ m/s^2 \times cos30)} = \frac{5.4\ N}{18\ N} = 0.3$

8. A 10.0 kg block is at rest without slipping on a ramp inclined at an angle of $\theta = 30°$ as shown below.

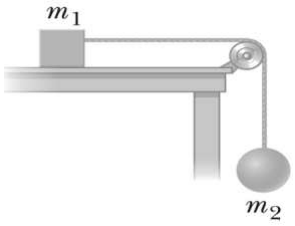


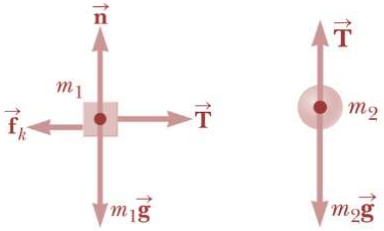
a. Calculate is the normal force exerted by the ramp on the block.
$F_N = mgcos\theta = (10.0\ kg \times 10\ N/kg)cos30° = 90\ N$

b. Find the static friction on the block.
$F_f = Component\ of\ the\ weight\ along\ the\ incline$
$F_f = mgsin\theta = (10.0\ kg \times 10\ N/kg)sin30° = 50\ N$

c. Calculate is the coefficient of static friction.
$\mu = \frac{F_f}{F_N} = \frac{50\ N}{90\ N} = \frac{5}{9} = 0.5$

9. An object with mass $m_1 = 5.0\ kg$ rests on a rough horizontal table and is connected to a cable that passes over a pulley and is then fastened to a hanging object with mass $m_2 = 10.0\ kg$, as shown in the figure below. The coefficient of kinetic friction between the block and the surface is 0.300.





a. Draw the free body diagram for the two masses.

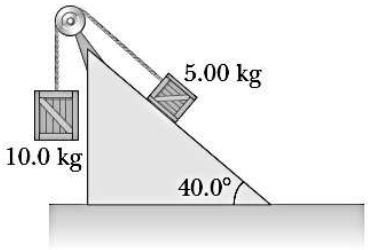
b. Calculate the frictional force on the block.
$f_k = \mu_k n = \mu_k m_1 g = (0.300)(5.00\ kg)(10\ m/s^2) = 15\ N$

c. Calculate the acceleration of the system.

$(m_1 + m_2)a = m_2 g - \mu_k m_1 g$
$a = \dfrac{m_2 g - \mu_k m_1 g}{(m_1 + m_2)} = \dfrac{(10.0\ kg)(10\ m/s^2) - (15\ N)}{(10.00 + 5.00)\ kg} = \dfrac{85\ N}{15\ kg} = 5.7\ N/kg$

d. Find the tension in the string.
$m_2 a = m_2 g - T$
$T = m_2 g - m_2 a = m_2(g - a) = (10.0)(10 - 5.7) = 43\ N$

10. Two packing crates of masses $m_1 = 10.0\ kg$ and $m_2 = 5.00\ kg$ are connected by a light string that passes over a frictionless pulley as in the figure below. The mass m_2 lies on a smooth incline of angle 40°.



a. Find the acceleration of the mass m_1.
$m_1 a + m_2 a = m_1 g - m_2 g sin\theta$
$a = \left(\dfrac{m_1 - m_2 sin\theta}{m_1 + m_2}\right) g = \left(\dfrac{10.0\ kg - (5.00\ kg) sin40.0°}{15.0\ kg}\right) 10\ N/kg$
$a = \dfrac{70}{15} = 4.4\ m/s^2$

b. Find the tension in the string.
$T = m_1(g - a) = (10.0\ kg)(10 - 4.4) = 56\ N$