Practice Physics Exam: Chapter 4

IMPORTANT: Except for multiple-choice questions, you will receive no credit if you show only an answer, even if the answer is correct. Always show in the space on your answer sheet some sketches, words, or equations which clearly justify your answer. Show the equations you use and the values substituted into them whenever equations are necessary. If you go from a formula directly to an answer without showing the values used, you will lose points. Points will also be deducted for missing or erroneous units.

Be sure that your calculator is set to the “DEGREES” mode.

$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$ $0 \leqq F_f \leqq \mu_s F_{support}$ $F_f = \mu_k F_{support}$

1. The fundamental units of the Newton, the unit of force in our system of measurement, the SI (Système International d’Unités), are

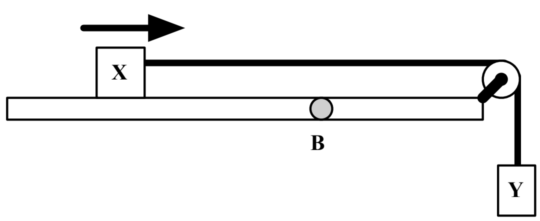
   (a) $\frac{\text{kg m}}{\text{s}^2}$

   (b) $\frac{\text{kg m}}{\text{s}}$

   (c) $\frac{\text{kg}}{\text{m/s}^2}$

   (d) $\frac{\text{kg m}^2}{\text{s}^2}$

   For questions 2 and 3 refer to the following diagram. The diagram shows two blocks X and Y which are connected by a very light string. The string goes over a very smooth pulley. When released, block Y pulls block X in the direction of the arrow on a table so smooth that friction is negligible. For you nit pickers, and you know who you are, wind and air resistance are negligible, too.



2. After block Y is released and before block X reaches point B, the speed of block X is

   (a) constant.

   (b) continuously increasing.

   (c) continuously decreasing.

   (d) increasing for a while, and then constant.

   (e) constant for a while, then decreasing.

3. When block X reaches point B the string breaks. Block X then (before it reaches the end of the table)

   (a) stops at B.

   (b) keeps moving at a constant speed.

   (c) slows down.

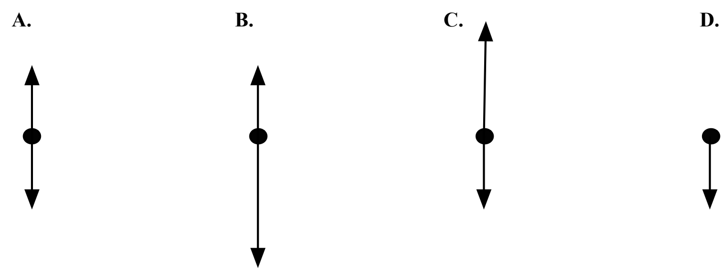
   (d) speeds up.

   (e) speeds up for a while, then slows down.

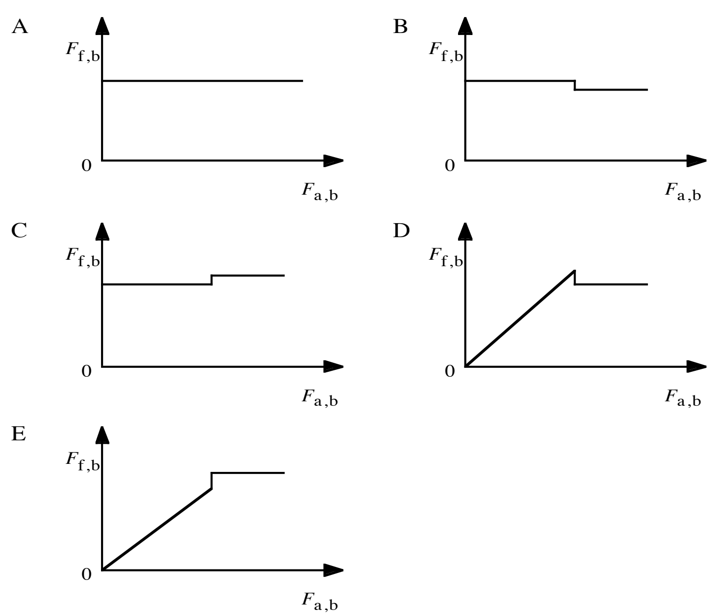
4. A brick is thrown and hits a window, breaks through the glass, and ends up on the floor inside the room. We know that

   (a) the force the brick exerted on the glass was bigger than the force the glass exerted on the brick.
   (b) the force the brick exerted on the glass was the same size as the force the glass exerted on the brick.
   (c) the force the brick exerted on the glass was less than the size of the force the glass exerted on the brick.
   (d) the brick did not slow down as it broke the glass.

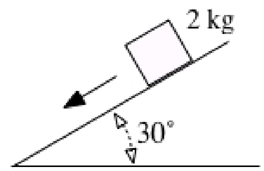
5. The itsy bitsy spider was descending by a silk thread from a water spout at a steady, downward velocity. Which of the following force diagrams best represents the forces to which the itsy bitsy spider is subject?



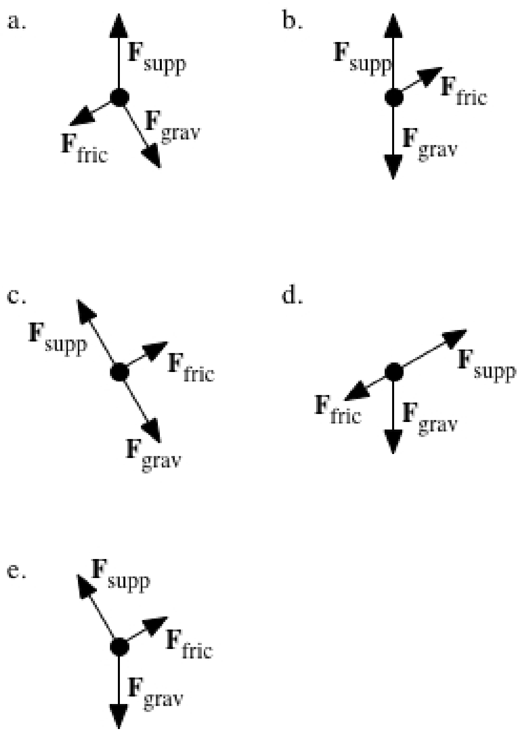
6. A horizontal force $F_{agent,block}$ is applied to a wooden block at rest on a rough horizontal table. $F_{agent,block}$ is increased uniformly from zero. Which of the following graphs best describes the variation of the frictional force $F_{friction,block}$ acting on the block as well?

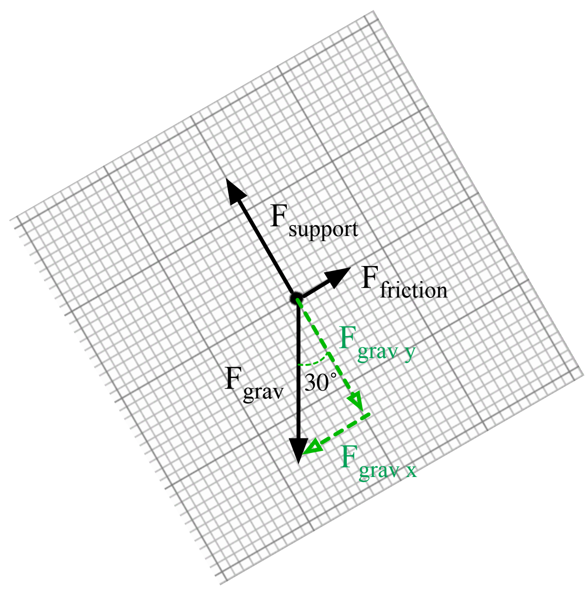


For items 7 and 8



7. A 2-kilogram block slides down a 30° ramp as shown above with an acceleration of 2 meters per second per second. Which of the following diagrams best represents the gravitational force $\mathbf{F_{grav}}$, the frictional force $\mathbf{F_{fric}}$, and the supporting force normal to the surface $\mathbf{F_{supp}}$ that act on the block? e is the correct choice.





8. What is the magnitude of the force of gravity acting on the box? $F_{\text{grav}} = mg = 20$ N

9. The magnitude of the frictional force along the plane is most nearly

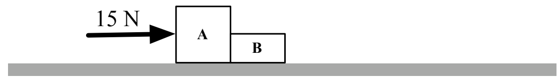
   (a) 2.5 N

   (b) 5 N

   (c) 6 N $F_{\text{net x}} = ma_x = 2 \text{ kg} \times 2 \text{ m/s}^2 = 4$ N. Also $F_{\text{netx}} = F_{\text{grav x}} - F_{\text{fric}} = 4$ N. $\sin 30° = \dfrac{F_{\text{grav x}}}{F_{\text{grav}}}$ Therefore, $F_{\text{grav x}} = 10$ N. So, 4 N = 10 N $-F_{\text{fric}}$

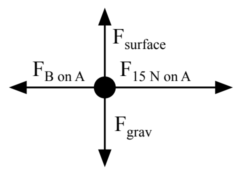
   (d) 10 N

   (e) 16 N

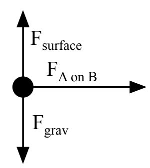


10. As shown above a horizontal force of magnitude 15 N is exerted to the right on Box A. Box A is in contact with and pushes Box B along a very smooth surface of negligible friction. The mass of Box A is 3.0 kg. The mass of Box B is 2.0 kg.

(a) Sketch and label a force diagram for Box A using $F_{agent,object}$ notation on your labels.

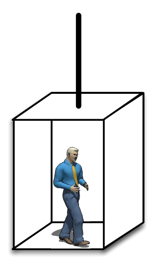


(b) Sketch and label a force diagram for Box B using $F_{agent,object}$ notation on your labels.



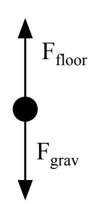
(c) Determine the magnitude of each force on Box A.
15 N force is acting on 5 total kilograms of mass. $F_{\text{net}} = ma$ results in 15 N = 5 kg × a. Thus, a = 3 m/s^2 for the whole shebang. Therefore, just focusing on Box A, the net force on Box A is $F_{\text{net A}} = 3$ kg × 3 m/s^2 = 9 N. Also $F_{\text{net A}} = 15$ N - $F_{\text{B on A}}$ Also $F_{\text{grav}} = mg = -30$ N and, therefore, $F_{\text{surf}} = +30$ N

(d) Determine the magnitude of each force on Box B.
Just focusing on Box B, the net force on Box B is $F_{\text{net B}} = 2$ kg × 3 m/s^2 = 6 N. Also $F_{\text{net B}} = F_{\text{A on B}}$ Therefore, 6 N = $F_{\text{A on B}}$ By Newton's Third Law, $F_{\text{B on A}} = -F_{\text{A on B}}$, so $F_{\text{B on A}} = -6$ N. Also $F_{\text{grav}} = mg = -20$ N and, therefore, $F_{\text{surf}} = +20$ N



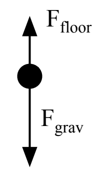
11. An 80 kg man goes for a ride in an elevator just to kill some time. Sketch and label a force diagram for the man in each of the following situations.

(a) Descends at constant speed



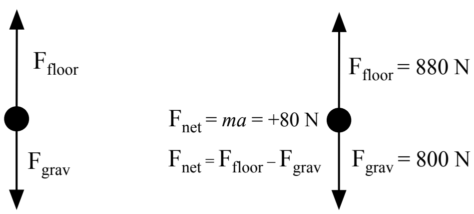
This means that $F_{net} = 0$ and $F_{grav} = mg = -800$ N, and so $F_{floor} = +800$ N

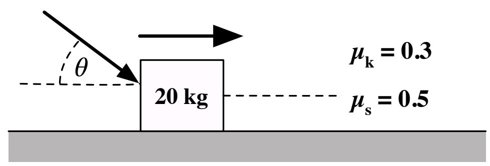
(b) Ascends and slows down with an acceleration of -1 m/s^2.



This means that $F_{net} = -80$ N and $F_{grav} = mg = -800$ N, and so $F_{floor} = +720$ N

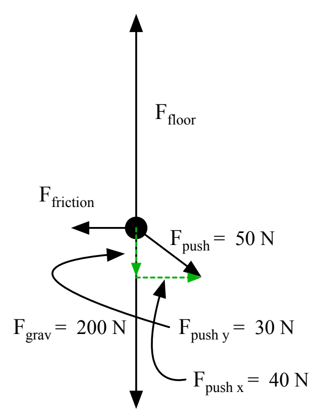
(c) Descends and slows down with an acceleration of $+1$m/s^2. Evaluate each force.





12. This crate is being pushed along a floor by a handle that exerts 50 N on the box at an angle of 37° as shown above. The coefficients of friction between the crate and the floor are $\mu_k = 0.3$ and $\mu_s = 0.5$.

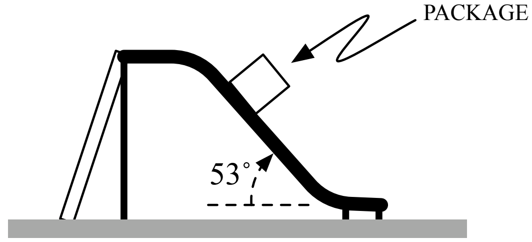
First sketch the force diagram. Use it to guide us in filling out the "force table" to the right:



F_{name}	F_x	F_y
F_{grav}	0	–200 N
F_{floor}	0	–230 N
$F_{friction}$	–40 N	0
F_{push}	40 N	–30 N
F_{net}		0

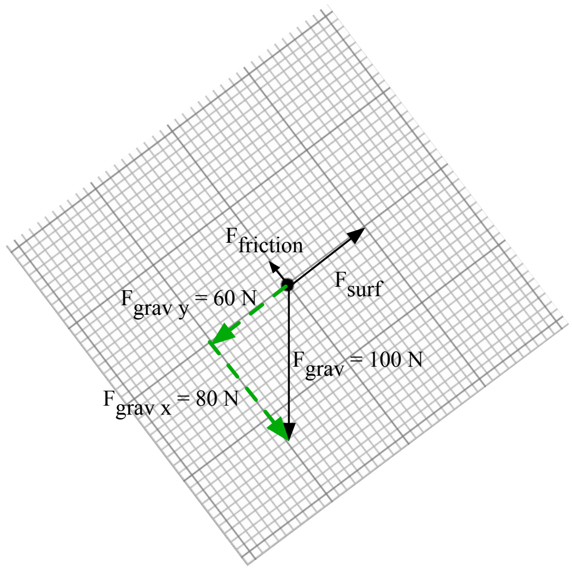
It turns out that kinetic friction force is bigger than the forward push, ($F_{\text{push x}}$. Therefore, if the crate is initially at rest, it will remain at rest with zero acceleration. That means static friction is what we are dealing with and it would be exactly +40 N, because the net force would be zero (no acceleration). If the crate were moving initially, then kinetic friction is -69 N, so the net force would be +40 N – 69 N = -29 N, and the crate would be slowing down with an acceleration of -1.49 m/s^2. You would be told whether it is moving or not if I were to ask you something along this line.

13. A 10.0 kg box slides down a playground slide that is inclined at an angle of 53° with respect to the horizontal. The coefficient of static friction between the slide and the box is $\mu_s = 0.25$ and the coefficient of sliding friction is $\mu_k = 0.20$.



(a) Sketch and label a force diagram for the box at the instant shown. Use $F_{agent,object}$ notation on your labels.

(b) Find the magnitude of each of the forces that you have labeled on your force diagram.



F_{name}	F_x	F_y
F_{grav}	+80 N	−60 N
F_{surf}	0 N	+60 N
F_{fric}	−12 N	0 N
F_{net}	−68 N	0 N

(c) Find the magnitude of the acceleration of the box.

Note that the values of the $x-$ and $y-$components of forces and forces that we had to figure out using Newton's Second Law ($F_{\text{net}} = ma$) are colored in the diagram and in the table to the right. We know that the net force is only in the "x-direction" and amounts to 80 N - 12 N = 68 N. Using Newton's Second Law we can calculate $a = 6.8 \text{ m/s}^2$.