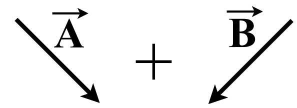
Physics 101 Sample Exam 1

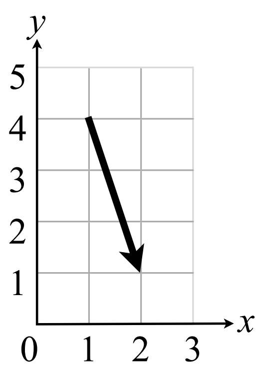
2016

$\boxed{3}$ **1.** <u>C</u> The two vectors $\vec{A}$ and $\vec{B}$ are shown. Both vectors have the same length and are tilted at 45° angles. What direction does $\vec{A}+\vec{B}$ point?

A) $\uparrow$ **B)** $\leftarrow$ **C)** $\downarrow$ **D)** $\rightarrow$

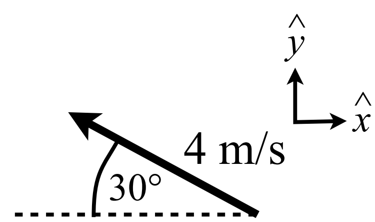


$\boxed{3}$ **2.** Write this vector in component form. Include minus signs where appropriate.



$$\underline{\ \mathbf{1}\ }\ \hat{x} + \underline{\ \mathbf{-3}\ }\ \hat{y}$$

$\boxed{3}$ **3.** This vector has a magnitude of 4 m/s. Write this vector in component form; you needn't simplify.



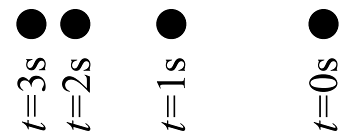
$$\underline{\ -3.46\ }\ \hat{x} + \underline{\ 2\ }\ \hat{y}\,\mathrm{m/s}$$

Or $-4\cos 30°\hat{x} + 4\sin 30°\hat{y}$ m/s

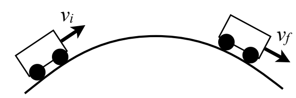
$\boxed{3}$ **4.** A car is moving with velocity $\vec{v} = 2\hat{x} - 5\hat{y}$. What is its speed $|\vec{v}|$?

$$\sqrt{2^2 + (-5)^2} = \sqrt{29} = \boxed{5.4\,\mathrm{m/s}}$$

3 **5.** <u>D</u> What does this motion diagram represent?
A) A ball rolls to the right and is speeding up
B) A ball rolls to the right and is slowing down
C) A ball rolls to the left and is speeding up
D) A ball rolls to the left and is slowing down



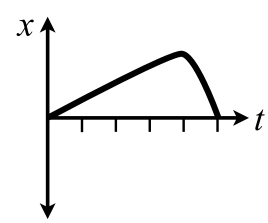
6. A car is driving over a hill, as shown.

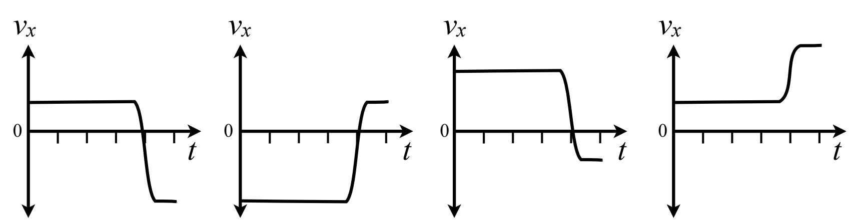


2 (a) <u>D</u> In what direction does the car's change in velocity $\Delta\vec{v}$ point?
A) $\leftarrow$ **B)** $\uparrow$ **C)** $\rightarrow$ **D)** $\downarrow$ **E)** $\nearrow$ **F)** $\searrow$

2 (b) <u>D</u> What direction does the car's average acceleration $\vec{a}$ point, as it goes over the hill?
A) $\leftarrow$ **B)** $\uparrow$ **C)** $\rightarrow$ **D)** $\downarrow$ **E)** $\nearrow$ **F)** $\searrow$

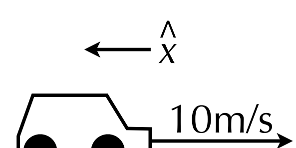
3 **7.** <u>A</u> The figure shows the graph of an object's position with respect to time. Which of the following graphs *best* illustrates the object's velocity over the same time interval? (Think of the graphs below as rough sketches, and don't get tripped up by minutiae.)





A **B** **C** **D**

8. A car is driving at 10 m/s to the right and is slowing down. We define $\hat{x}$ so that it points to the *left*. (**That last bit is important!**)

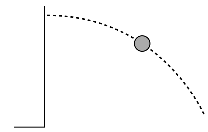


2 (a) <u>D</u> The car's *velocity* is
A) 10 m/s **B)** −10 m/s **C)** $+10\hat{x}$ m/s **D)** $-10\hat{x}$ m/s

2 (b) <u>A</u> The car's *speed* is
A) 10 m/s **B)** −10 m/s **C)** $+10\hat{x}$ m/s **D)** $-10\hat{x}$ m/s

2 (c) <u>A</u> The acceleration of the car points to the
A) left **B)** right

9. In this figure, a ball has been thrown in the air, and is moving upward. Downward is the $+\hat{y}$ direction.

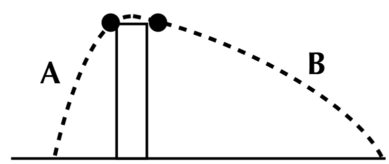


$\boxed{2}$ (a) B The ball's vertical acceleration a_y is
A) $-9.8\,\mathrm{m/s^2}$ **B)** $9.8\,\mathrm{m/s^2}$ **C)** Neither of these

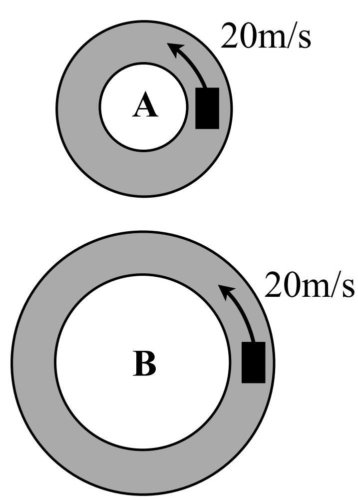
$\boxed{2}$ (b) B The ball's acceleration points
A) up ↑ **B)** down ↓

$\boxed{3}$ (c) A When the ball reaches its maximum height, which of the following is true?
A) Its velocity is zero **B)** Its acceleration is zero
C) Both are true **D)** Neither is true

$\boxed{3}$ **10.** C Two balls are thrown from the top of a tower at the same time; their trajectories are as shown. Which ball hits the ground first?
A) Ball A **B)** Ball B **C)** Both hit at the same time.



$\boxed{3}$ **11.** A Two cars travel at the same, constant speed around two circular roadways, as shown. Car B is driving around the larger track. Which is true?
A) Car A has the greater acceleration.
B) Car B has the greater acceleration.
C) Both cars have the same nonzero acceleration.
D) The cars are not accelerating.



$\boxed{3}$ **12.** ___C___ A car starts at rest, and accelerates at $3\,\mathrm{m/s^2}$. After 1 second, how fast is it moving?
A) $1\,\mathrm{m/s}$ **B)** $1.5\,\mathrm{m/s}$ **C)** $3\,\mathrm{m/s}$

That's the definition of acceleration: $3\,\mathrm{m/s^2} = 3\,\frac{\mathrm{m/s}}{\mathrm{s}}$, so the car gains $3\,\mathrm{m/s}$ every second.

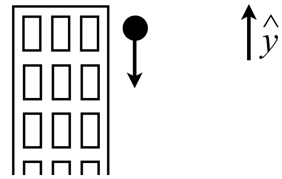
$\boxed{3}$ **13.** A car accelerates at a constant rate. At time $t = 0\,\mathrm{s}$, it is moving at $25\,\mathrm{m/s}$. Four seconds later, it is moving at $15\,\mathrm{m/s}$. How far does it travel in those four seconds? *(Hint: use a table.)*

$\Delta x =$ NEED $\quad v_{ix} = 25\,\mathrm{m/s} \quad v_{fx} = 15\,\mathrm{m/s} \quad a_x =$ DKDC $\quad \Delta t = 4\,\mathrm{s}$

So we use the equation without the acceleration in it:

$$\begin{aligned}\Delta x &= \frac{1}{2}(v_{ix} + v_{fx})\Delta t \\ &= \frac{1}{2}(25 + 15)(4) \\ &= \boxed{80\,\mathrm{m}}\end{aligned}$$

14. Consider this problem (which we will not solve). "A ball is dropped from the top of a tall building. How long does it take to fall 5 meters?" Let's say that $+\hat{y}$ points up.



$\boxed{4}$ (a) Fill in the table with the information known. Write "NEED" next to the variable that we want to solve for. *Remember units!*

Δy	–5m
v_{iy}	0m/s
v_{fy}	
a_y	–9.8m/s^2
Δt	NEED

$\boxed{3}$ (b) ___C___ Which equation would you use to solve this problem?

A) $\Delta y = \frac{1}{2}(v_{iy} + v_{fy})\Delta t$

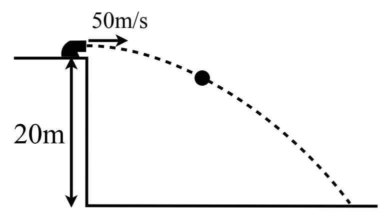
B) $v_{fy} = v_{iy} + a_y \Delta t$

C) $\Delta y = v_{iy}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

D) $\Delta y = v_{fy}\Delta t - \frac{1}{2}a_y(\Delta t)^2$

E) $v_{fy}^2 = v_{iy}^2 + 2a_y \Delta y$

15. A cannonball is fired horizontally from the top of a 20 meter tall cliff, with an initial speed of 50 m/s. We want to find the final velocity of the cannonball, right before it hits the ground. You may choose $\hat{y}$ to point up or down, whichever you prefer, but let's assume $\hat{x}$ points to the right.



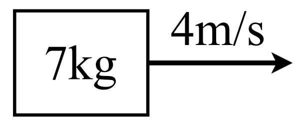
Δx	XC	Δy	20m
v_{ix}	50m/s	v_{iy}	0m/s
v_{fx}	NEED	v_{fy}	NEED
a_x	0m/s^2	a_y	+9.8m/s^2
	Δt		

$\boxed{3}$ (a) Find v_{fx}.

$\boxed{3}$ (b) Find v_{fy}.

$\boxed{+2}$ (c) **Extra Credit:** How far away does the cannonball land from the base of the cliff? (This isn't *tricky*, per se, but it involves a little more math so I made it extra credit.)

16. A 7 kg block is moving at 4 m/s.



[2] (a) **B** What is its mass?
A) 0.7 N **B)** 7 kg **C)** 28 kg **D)** 69 N

[2] (b) **D** What is its weight?
A) 0.7 N **B)** 7 kg **C)** 28 kg **D)** 69 N

[3] (c) Find its kinetic energy.

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}(7\,\text{kg})(4\,\text{m/s})^2 = \boxed{56\,\text{J}}$$

17. For the following descriptions, indicate whether the force being described is
G) gravity **K) kinetic friction** **N) normal force** **S) static friction** **T) tension**
Not all choices are necessarily used, some may be used more than once. Each blank gets one answer.

[2] (a) **G** A noncontact force

[2] (b) **S** The centripetal force when a car drives in a circle

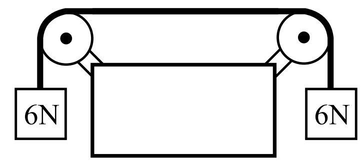
[2] (c) **S** The force that pushes me forward when I walk

[2] (d) **K** The force that does negative work on me when I slide down a sliding board

[2] (e) **G** The Newton's Third Law "twin" to the Earth's force of gravity on me

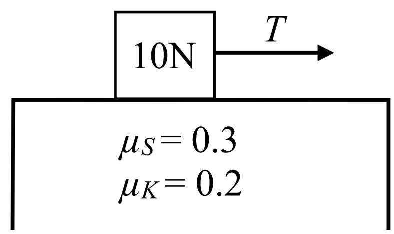
3 **18.** ___B___ Two 6 N blocks are attached to each other by a massless rope. What is the tension in the rope?

A) 3 N **B)** 6 N **C)** 12 N

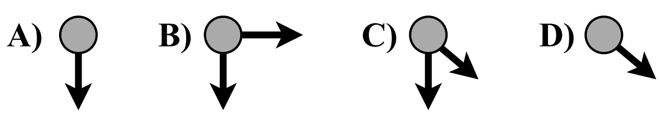


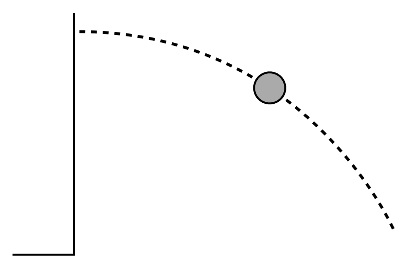
3 **19.** ___B___ A stationary 10 N block is pulled on by a rope. The coefficients of friction between block and table is $\mu_S = 0.3$ and $\mu_K = 0.2$. What is the minimum force T that makes the block start to move?

A) 2 N **B)** 3 N **C)** 5 N **D)** 10 N **E)** 50 N



3 **20.** ___A___ A ball is thrown horizontally from the side of a building. When the ball is in the middle of the air, which of the following shows all the different forces acting on the ball (besides air resistance, which we're ignoring).

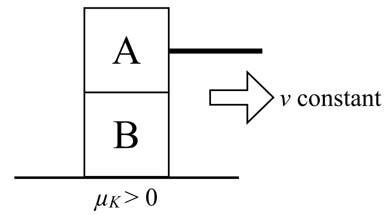


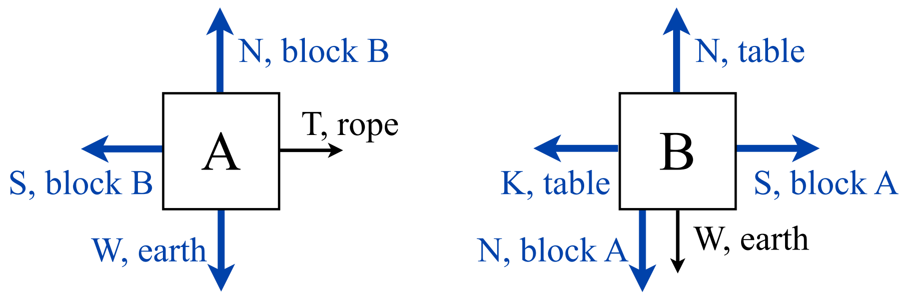


3 **21.** Describe a scenario where an object is moving in a circle, and the centripetal force is a normal force. You can draw a picture if you like, but use words as well.

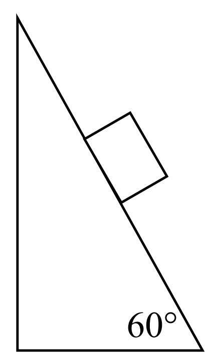
Answers vary: a rollercoaster in a loop-de-loop, a marble spun around in a cup, etc.

6 **22.** A stack of two blocks is being dragged along a floor (which is *not* frictionless), by a rope attached to the top block. The stack is moving at a constant velocity. On the blocks below, draw all the forces acting on both blocks, and label them with the type of force (N, K, S, T, W) and the object exerting that force. I've drawn a couple as examples.

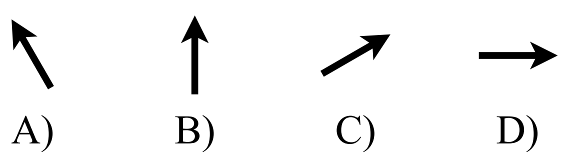




23. A block is sitting still on a 60° ramp with coefficient of static friction μ_S (which must be very high if the block doesn't slide!)

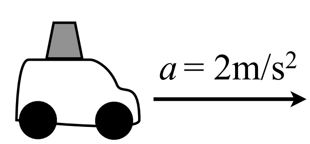


2 (a) <u>C</u> What direction does the normal force of the ramp on the block point?



2 (b) <u>A</u> If the block has mass m, the force of static friction $|\vec{S}|$ on the block is
A) $mg\sin 60°$ **B)** $mg\cos 60°$ **C)** $mg\tan 60°$ **D)** $\mu_S mg$ **E)** $\mu_S mg\cos 60°$

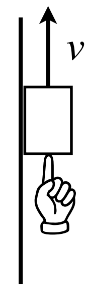
3 **24.** <u>D</u> A 7 kg mass is sitting on the roof of a car, which is accelerating at $2\,\mathrm{m/s^2}$. The coefficient of static friction between mass and car is $\mu_s = 0.4$. What is the static frictional force on the mass? Ignore air resistance.
A) $27.4\,\mathrm{N} \leftarrow$ **B)** $-14\,\mathrm{N} \leftarrow$ **C)** $-5.6\,\mathrm{N} \leftarrow$
D) $+14\,\mathrm{N} \rightarrow$ **E)** $+27.4\,\mathrm{N} \rightarrow$



Static friction is the only force on the mass, and the mass is accelerating. Because $F = ma$, the static friction is ma:

$$\vec{S} = m\vec{a} = (7\,\mathrm{kg})(2\,\mathrm{m/s^2} \rightarrow) = \boxed{14\,\mathrm{N} \rightarrow}$$

25. A block is being slid up a wall by my finger. The wall exerts a **kinetic friction force** (which I'll call $\vec{K}_{on\,block}$) on the block.



$\boxed{3}$ (a) __D__ What direction does $\vec{K}_{on\,block}$ point?
A) $\leftarrow$ **B)** $\uparrow$ **C)** $\rightarrow$ **D)** $\downarrow$

$\boxed{3}$ (b) __D__ What is the Newton's 3rd Law twin of $\vec{K}_{on\,block}$?
A) The force of gravity on the block
B) The force of my finger on the block
C) The normal force of the wall on the block
D) The frictional force of the block on the wall