**110 Practice Final**

A student determines the force acting on a particle as 0.000400 N.

1b) How many sig figs are in this number?

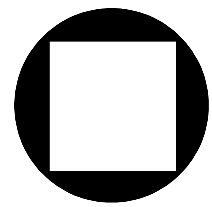
1c) Write the number in correct *scientific* notation with units.

**1d) Challenge:** rite the number with the appropriate prefix according to *engineering* notation. Engineering notation is similar to scientific notation except the exponent of ten must be divisible by three and the number must be written with no leading zeros.

2a) Three numbers are given as $A = 7.7$, $B = 7.9$, and $C = 0.0365$. Compute $D = \frac{C}{A^2+B^2}$ and write your answer with correct sig figs in proper scientific notation. Assume all number have units of $\text{grams}^{-1} = \frac{1}{g}$. Please do not confuse this with the magnitude of the acceleration due to gravity.

**2b) Challenge:** also write the number with the appropriate prefix according to engineering convention.

A circular gasket is to be made from sheet rubber of density $\rho$. The gasket will be cylindrical diameter $d$ and thickness $t$ is. A square hole of side $s$ cut from the center of the cylinder as shown in the figure (top view).



3a) Determine an expression for the *mass* of the gasket in terms of the given variables.

3b) What is the total surface area of such a gasket?

3c) Extra credit: what is the largest hole (and commensurate minimum mass) for such a gasket?

A ball is thrown horizontally from the top of a building of height $h$. Assume the height of the thrower is negligible. A second ball is simultaneously thrown vertically (upwards) from the building. A third ball is simultaneously thrown downwards. All balls are thrown with identical speed $v$.

4a) Which ball hits the ground first? Clearly indicate any ties.

4b) Which ball hits the ground with the greatest speed? Clearly indicate any ties.

4c) Determine the elapsed time between the first and the last impact.

4d) Challenge: Now include a fourth and a fifth ball. Assume these balls are launched at angles of $30.0°$ above and below the horizontal respectively. Again they are thrown from the same building of height $h$ with identical speed $v$. Re-rank the balls in terms of elapsed time during flight.

Variation: a ball is launched with speed $v$ from a building of height $h$ at an angle of $30.0°$ above the horizontal. Assuming the base of the building is considered as the origin, determine the $(x, y)$ coordinates of max height.

5a) What is the *speed* of the ball at max height?

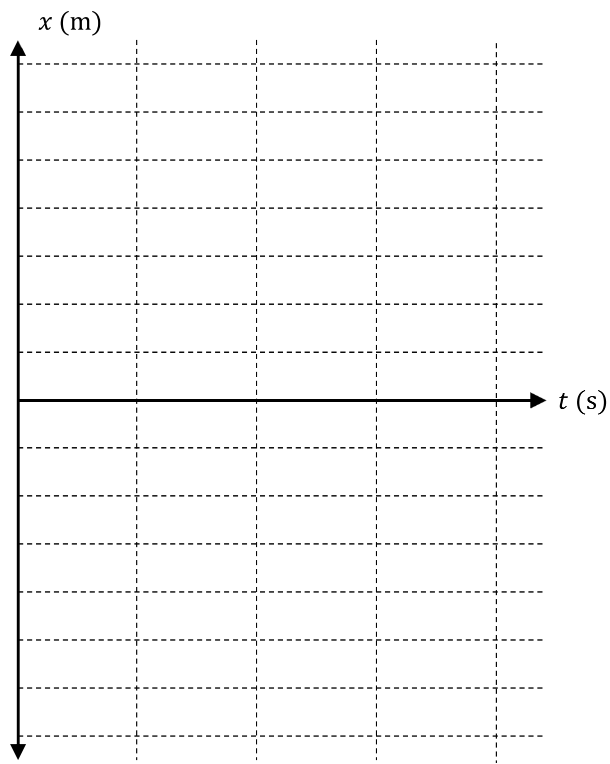
5b) What is the *acceleration* of the ball at max height?

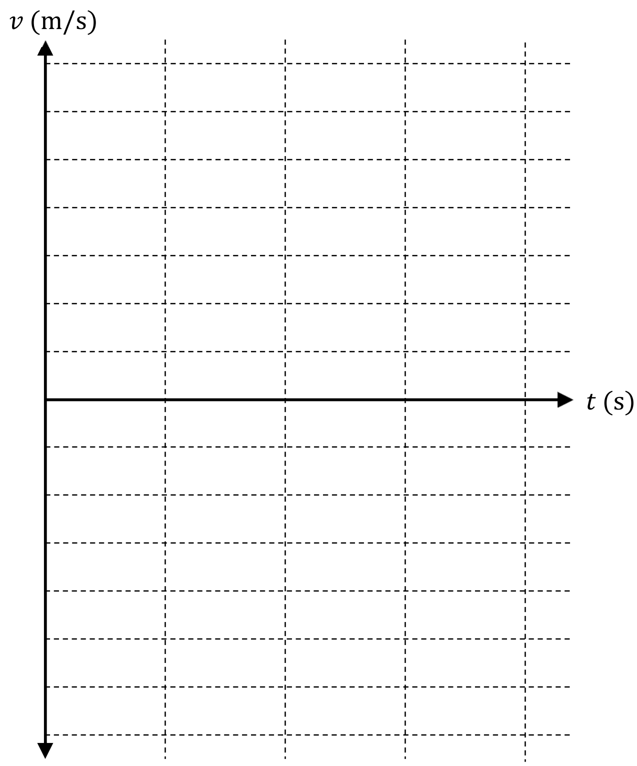
5c) What is the location of impact?

5d) What is the *velocity* of the ball at impact?

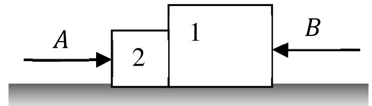
Ms. Jones is observe to move in one dimension with constant acceleration. Ms. Jones is initially 4.0 m to the left of the origin moving to the left with speed 2.0 m/s. At time $t = 4.0$ s Ms. Jones passes by the origin and continues moving to the right.
6a) Determine the acceleration of Ms. Jones.
6b) At what time does Ms. Jones reverse direction?
6c) Determine the speed of Ms. Jones as she passes the origin.
****6d) Write equations for both position and velocity as functions of time in the table at right. Use your equations to plot position and velocity versus time on the plots below.

| | |
|---|---|
| 6a | |
| 6b | |
| 6c | |
| 6d | |



Two blocks are pushed by Angela and Bob. Both Angela and Bob exert horizontal forces on the blocks with magnitudes $A$ and $B$ respectively. The floor is level and has negligible friction. Both blocks are made of the same material so we may assume $m_1 > m_2$. The normal force between the blocks has magnitude $n_{12}$.




7a) If the blocks *accelerate to the right*, which of the following equations/inequalities holds? Circle the best answer.

$A < B$ $A = B$ $A > B$ Impossible to determine without more information

7b) If the blocks *accelerate to the right*, which of the following equations/inequalities holds? Circle the best answer.

$A < n_{12}$ $A = n_{12}$ $A > n_{12}$ Impossible to determine without more information

7c) If the blocks *move with constant speed to the left*, which of the following equations/inequalities holds?

$A < B$ $A = B$ $A > B$ Impossible to determine without more information

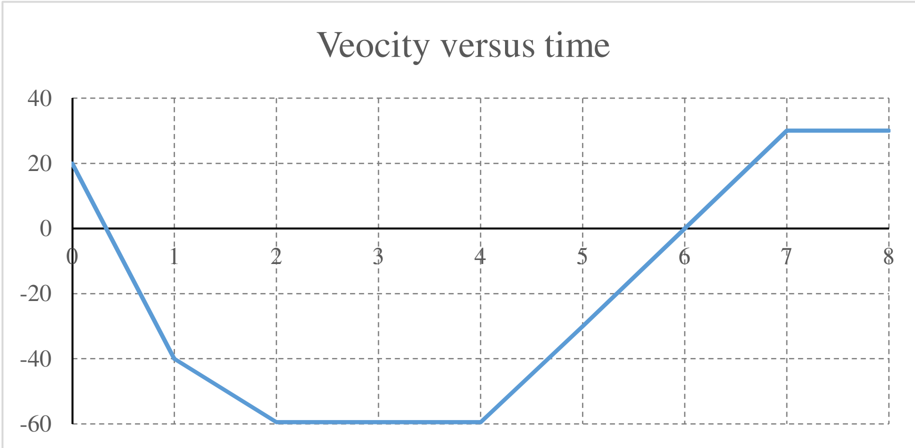
7d) If the blocks *move with constant speed to the left*, which of the following equations/inequalities holds?

$A < n_{12}$ $A = n_{12}$ $A > n_{12}$ Impossible to determine without more information

7e) Write down all action-reaction pairs for forces acting on block 1.

| | **Action** | **Reaction** |
|---|---|---|
| 1 | Block 2 pushes to the right on block 1 using normal force. | |
| 2 | | |
| 3 | | |
| 4 | | |

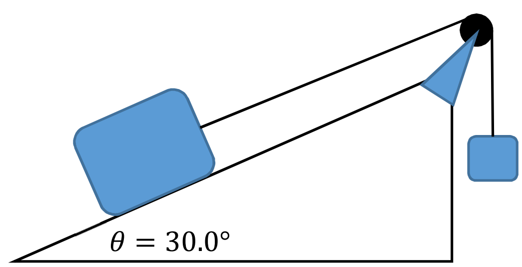
A plot of **velocity versus time** for an object moving along the $x$-axis is shown at right.




8a) Which axis represents time?
8b) What are the assumed units on each axis?
8c) Over what time intervals (or at what time) is the object *slowing down*?
8d) Over what time intervals (or at what time) is the object *at rest*?
8e) Over what time intervals (or at what time) is the object *speeding up*?
8f) Over what time intervals (or at what time) is the object moving *with constant speed*?
8g) What is the acceleration at time $t = 6.0$ s?
8h) When is the *magnitude* of the acceleration the greatest?
8h) After one second of motion, the object ends up at the origin. Determine the *initial* position of the object.

9) Student **A** jogs with speed 8.50 m/s directed 30.0° *east of south* relative to earth. Student **B** moves with speed 4.00 m/s directed 12.0° *south of west* relative to student **A**. How fast, and in what direction, is student **B** moving *relative to the earth*? Include a sketch of the final velocity of **B** relative to the earth so I can be certain you understand the direction. Be sure to clearly label the size of the arrow and an angle!

The block on the incline has mass $m$. The other block is called the hanging mass. Assume the coefficients of friction between the block and the incline are $\mu_s = 0.30$ and $\mu_k = 0.20$. For now, assume the hanging mass will be used to pull the other block *up the incline*.

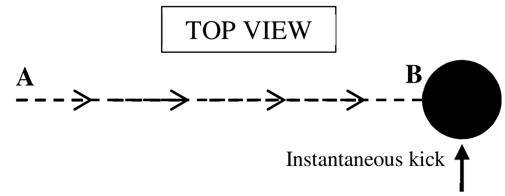



10a) Do an FBD for each block separately. Suggestion: write $f$ for the force of friction…not $\mu n$.
10b) Write down the force equations.
10c) If the hanging mass is $3m$, determine the acceleration of the system.
10d) What is the acceleration is the hanging mass is removed?
**10e) Challenge:** For what range of values can be used as the hanging mass if the blocks are to remain stationary?

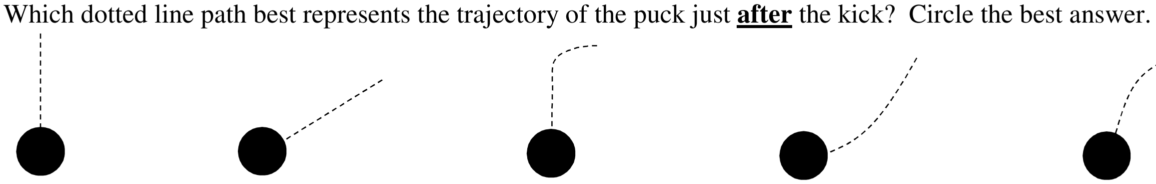
11) Convert $\frac{33\text{ cents}}{\text{in}^2}$ to $\frac{\$}{\text{km}^2}$. Write your final answer using the best choice of prefix (I'm guessing M$ or G$).

A spaceship accelerates from rest with constant rate or $6.29\,\frac{\text{mi}}{\text{day}^2}$.
12a) What is this acceleration in both $\frac{\text{m}}{\text{s}^2}$ and $g$'s. Is this acceleration sufficient to cause an astronaut to black out?
12b) How long to cover the first 10.0 km of distance?
12c) How far has ship traveled as it reaches 1% of the speed of light? Note: speed of light (in vacuum) is $3 \times 10^8\,\frac{\text{m}}{\text{s}}$.

A hockey puck is sliding from point **A** to point **B** across some ice with negligible friction and negligible air resistance. You may assume the ice surface is level. As a result, the puck slides with constant velocity. When the puck reaches point **B** the puck is kicked. The kick takes only a tiny fraction of a second and is directed due north as seen from the overview at right.




13a) Which dotted line path best represents the trajectory of the puck just **after** the kick? Circle the best answer.



14a) Assume the speed of the puck just before the kick is $v_i$. Just after the kick the speed is $v_f$. Which of the following statements are true? Circle the best answer or answers.

| | |
|---|---|
| A | $v_f = v_i$ |
| B | $v_f > v_i$ |
| C | $v_f < v_i$ |
| D | None of the previous statements are correct. |

15a) Along the path chosen in part a, how does the speed of the puck change? Remember, this is **after** the kick has taken place.

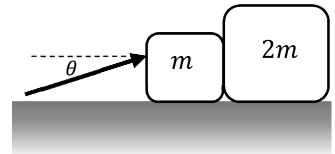
| | |
|---|---|
| A | Increases |
| B | Decreases |
| C | Remains constant |
| D | Impossible to determine without more information. |

16a) Which of the following forces act on the puck **after** the kick has occurred? Remember, we are assuming friction is negligible air resistance and negligible friction. Circle all that apply.

| | |
|---|---|
| A | The downwards force of gravity. |
| B | A horizontal force in the direction of motion associated with momentum. |
| C | The normal force from the table. |

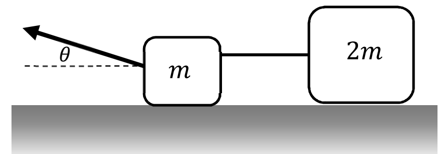
17) Estimate the number of pizzas required for a class of hungry physics students on Wed.
18) Estimate the velocity of the big and small hands on a clock. Write your answers in m/s using scientific notation.
19) Estimate the number of chairs on AHC's campus. List your assumptions.

Two blocks are pushed along a floor by a force with magnitude $F$ at angle $\theta$ as shown in the figure. Assume the coefficients of friction between the block and the incline are $\mu_s = 0.30$ and $\mu_k = 0.20$. It is safe to assume the blocks are not lifted off the ground.




20a) Draw an FBD and write the force equations.
20b) Assuming the angle remains fixed, what minimum force ($F_{min}$) is required to get the blocks moving?
20c) If $F = F_{min}$, determine the normal force acting *between the blocks*.

Variation: change the figure to the one shown at right. In this case the blocks are not touching each other but are instead held together by a massless, inextensible string.




21a) Again draw both FBDs.
21b) Assuming the angle remains fixed, what minimum force ($F_{pizza}$) is required to cause tension in the string?
21c) Assuming the angle remains fixed, what minimum force ($F_{min}$) is required to get the blocks moving? If $F = 2F_{min}$, determine the tension force acting in the string between the blocks.

**Brain puzzlers/dinner party conversation starters:**

a) Assume the blocks of mass $m$ and $2m$ are both cubes made of wood with the same density. How much larger (as a percent) is the side of the large block?
b) In terms of FBD's and force equations, what is the difference between pushing a block and pulling a block? Not much or something major?
c) While we are discussing pushing and pulling, think about tensions and normal forces. Which is a push and which is a pull? Does it ever make sense to have a $n < 0$ or $T < 0$? Strictly speaking, is $n$ the normal force or should it have a different dictionary definition?
d) Now think about a Type II superconductor suspended *beneath* a magnetic strip. The superconductor is attracted *upwards* yet it is not pulled into contact with the magnets. While you could call it a pull/tension, I like to think of it as a *normal force with negative magnitude*! Just when you think you've got it down…
e) Suppose the blocks were switched so that $2m$ was on the left and had the forces applied to it instead. Which of the above results would change if any? Note: to be a good physicist/engineer you don't necessarily need to know the answer to this. Ideally, at this point you should be skeptical of your intuition telling you anything! Hopefully your gut instinct is to think, "I suspect this but I don't really know. To figure it out I will draw new FBDs and start cranking away…". This is what is fun about physics: you guess, work it out, and sometimes the answers you really think you know will surprise in wonderful ways.

Note: notable omissions from this study guide are cross products, dot products, creating unit vector from arbitrary vector, and graphical vector addition (tail-to-tip method). Do some of those problems as well…