PhysTEC-opoly: A PhysTEC/GFO-themed Monopoly

(Note: Editorialized remarks are from Chrsitine O'Donnell, an APS Senior Program Manager who designed the game. Any questions should be directed to her at odonnell@aps.org)

Welcome to PhysTEC-opoly! This game celebrates and promotes both the Physics Teacher Education Coalition (PhysTEC) and Get the Facts Out (GFO).

PhysTEC is an NSF grant-funded project of the American Physical Society (APS) and the American Association of Physics Teachers (AAPT) to address the shortage of physics teachers in the US – our dream is that every student has the opportunity to learn physics in high school. GFO grew out of PhysTEC into its own NSF grant-funded project to change the conversation around STEM teacher recruitment.

Play PhysTEC-opoly

As with classic Monopoly, this game is intended for groups of **2-8 players**.

Accessing the game

The currently maintained version of PhysTEC-opoly is available as an online JavaScript game at https://caodonnell.github.io/games/PhysTEC-opoly.html (adapted from this Github repo).
Each space on the PhysTEC-opoly board is from our work in physics teacher education (PTE):
- The Railroad spaces represent various "steps" in the PTE process
- The Utilities are based on teacher needs
- Jail is instead a Recertification space
- Houses are instead called Diplomas, and Hotels are now called Cohorts
- The Street Properties are PhysTEC 5+ Club Awardees, which are PhysTEC Member Institutions that have graduated at least 5 new physics teachers in a single year; as of the 2023 5+ Club Award cycle, we also recognize non-doctoral PhysTEC Member Institutions that have graduated at least 5 new physics teachers in the past 3 years

- ○ Property costs are based on the local cost of living, and rents are based on teacher salaries
- ○ Changing the amounts for property costs/rents also means all other values in the game had to change as well, including players' starting cash ($10,000)
- ○ All amounts have been rounded to the nearest $10

Because PhysTEC has more than twenty-two 5+ Club Sites (the usual number of Street Properties in a Monopoly game), there are multiple boards; the link above serves as a homepage for all our PhysTEC-opoly boards. Two important notes for when you select a board:

- The page may initially display a warning about it being unable to function without JavaScript, but that should disappear in a couple of seconds when the game loads. If this warning does not go away, please check your browser settings.

- Each page view generates a unique game (and I unfortunately do not have the web design skills to make a version where multiple users can access the same game), so if you are playing with multiple people, one person will have to volunteer to host the game.

Gameplay quirks

Please note the following constraints on the game due to how it is programmed:

- The game is programmed with Monopoly's Official Rules, which may make it difficult to implement your own house rules. For example, my house rules don't have auctions, and mortgages are also handled differently. However, you may be able to adapt some of your house rules (e.g., if you don't hold auctions when someone chooses to not buy a property, all players can agree to "exit" auctions without bidding).

- The player order is determined randomly behind-the-scenes.

- Please see the tables above to be familiar with **which properties are PhysTEC-opoly versions of Utilities and Railroads** (Classroom Supplies and PD Workshops; Pre-service Teaching, In-service Teaching, Physics Teacher Educ., and PhysTEC Community) versus **Street Properties on Board 1 and Board 2** (5+ Club sites). **I would also recommend paying attention to the tables of property rents, since some properties will earn higher rents than you would expect for their color-group.**

- To view what properties each player owns, click the "**View Stats**" button on the right side under the player boxes. This screen will also indicate whether someone holds a "Get Out of Recertification Free" card.

- Unlike in actual Monopoly, you can only build/sell on owned properties during your turn.
  - ○ Click on the "Manage" tab in the control box in the middle of the board.

- - Click on the **name** of the property you want to build on or sell from. Select the correct button at the top.
    - Note that you can only start building on PhysTEC 5+ Club properties when you own **all** properties within a color-group. If you want to build an additional Diploma and/or upgrade to a Cohort on a property, then all of the other properties within the same color-group must also be built up (e.g., you can't add a second Diploma until each of the properties in the color-group have 1 Diploma).

- If you want information from the deed card for a property, you can view the tables in this document or access the card in the game.
    - When you land on an unowned property, in the "Buy" tab of the central management box, click/hover on the name (it'll look like a hyperlink - blue and underlined) to see the deed card.
    - You can also view the deed card by hovering over the **color box** to the left of the property's name in the following places:
        - While it's your turn, click the "Manage" tab in the control box;
        - While looking at a player's properties during "Trade" mode; and
        - Opening the "View Stats" box.

Computer players

The main game page includes both a version of each board that only allows for human players, as well as a version that has computer players enabled. While the gameplay with computer players is the same, I personally find some of the computer players' choices to be strange (and sadly I don't have the bandwidth to fix all of these issues):

- Computer players are very finicky about which trades they will suggest themselves and which trades they will accept from other players. If you are trying to initiate a trade with a Computer Player, and they suggest a counter-offer, I generally find that they won't accept anything less than their counter (i.e., it's not really a negotiation).

- If a player resigns after being bankrupted by a computer player, per Monopoly's Official Rules, all of the resignee's properties go to the creditor computer player. However, if those properties are mortgaged, the computer player cannot unmortgage the properties themselves, and so a human player will have to make those decisions.

- If a computer player lands on a property, they will (probably*) always buy it.

- If a player chooses to not buy a property they land on, computer players will (probably*) always put in at least an initial bid** in the auction.

These are noted as "probably" because while I haven't found any exceptions, I also haven't looked closely enough at the code to confirm there won't be exceptions.
*** The main way to prevent a computer player from putting in a bid is if another player puts in a high enough bid such that the computer decides it does not make sense to offer more.*

Translation table between Classic Monopoly and PhysTEC-opoly

	Classic name	Classic function	PhysTEC-opoly term	PhysTEC-opoly function
Starting funds	---	Each player starts the game with $1,000	---	Each player starts the game with $10,000
Board spaces	Go	Each player receives $200 when they pass GO	Go	Each player receives $2000 when they pass GO
	Jail	To get out of jail, a player has to roll a double or pay a $50 fine	Re-certification	To get out of jail, a player has to roll a double or pay a $500 fee
	Income Tax	Player pays $200	Income Tax	Player pays $500
	Luxury Tax	Player pays $100	Insurance Premiums	Player pays $200
Utilities	Water Works	Utilities cost $150 to own. If a player lands on a utility and the owner only holds that one utility, the cost is 4 times the dice total. If the owner holds both utilities, the cost is 10 times the dice total.	Classroom Supplies	Utilities cost $1500 to own. If a player lands on a utility and the owner only holds that one utility, the cost is 40 times the dice total. If the owner holds both utilities, the cost is 100 times the dice total.
	Electric Company		PD (Professional Development) Workshops	
Railroad	Short Line	Railroad stops cost $200 to own. If a player lands on a railroad stop, the cost depends on how many stops the owner holds: 1 stop costs $25, 2 stops cost $50, 3 stops cost $100, and all 4 stops cost $200.	Pre-service Teaching	Railroad stops cost $2000 to own. If a player lands on a railroad stop, the cost depends on how many stops the owner holds: 1 stop costs $250, 2 stops cost $500, 3 stops cost $1000, and all 4 stops cost $2000.
	Reading Railroad		In-service Teaching	
	B & O Railroad		Physics Teacher Educ(ation)	
	Pennsylvania Railroad		PhysTEC Community	
Buildings	Houses	---	Diplomas	---
	Hotels		Cohorts	

Board 1: 5+ Club Property Values

	Notes:
	If a player needs money, they may mortgage their properties, including railroad and utility spaces. The mortgage value is half the property's cost, rounded to the nearest $10 (e.g., a $2000 Railroad space has a $1000 mortgage value; ASU costs $1250 and has a mortgage value of $630). To unmortgage a property, you must pay 110% of the mortgage value, rounded to the nearest $10 (e.g., a Railroad space costs $1100 to unmortgage; ASU would cost $690 to unmortgage). The "year" in the second column indicates when the institution was added to the game, and thus when the in-game cost and rent prices were set.

Name	Year	Group	Cost	Base rent	Group rent	Rent with 1 Diploma	Rent with 2 Diplomas	Rent with 3 Diplomas	Rent with 4 Diplomas	Rent with a Cohort	Building cost (each Diploma, or to upgrade 4 Diplomas into a Cohort)
City College of NY (New York)	2022	Dark Blue	2,050	1,090	1,150	1,290	2,570	3,860	5,150	6,440	1000
CSU (California State University) Long Beach	2022	Dark Blue	2,060	1,180	1,230	1,360	2,710	4,070	5,430	6,780	1000
Rutgers (The State University of New Jersey)	2022	Green	1,750	1,050	1,080	1,140	2,280	3,420	4,560	11,400	1000
CU (University of Colorado) Boulder	2022	Green	1,610	830	980	1,090	2,180	3,270	4,370	6,550	1000
Boston University	2022	Green	1,550	890	1,070	1,120	2,250	3,370	4,490	6,740	1000
UT Austin	2022	Yellow	1,430	980	1,010	1,030	2,060	3,080	4,110	5,140	800
Towson University	2022	Yellow	1,380	1,020	1,080	1,110	2,230	3,340	4,460	5,570	800
Univ(ersity) of WI (Wisconsin) - River Falls	2022	Yellow	1,310	710	730	770	1,550	2,320	3,090	3,860	800
University of Minnesota	2022	Red	1,310	860	940	1,070	2,150	3,220	4,290	8,580	800
Rowan	2022	Red	1,260	970	990	1,070	2,140	3,210	4,280	6,420	800

Notes:

If a player needs money, they may mortgage their properties, including railroad and utility spaces.

The mortgage value is half the property's cost, rounded to the nearest $10 (e.g., a $2000 Railroad space has a $1000 mortgage value; ASU costs $1250 and has a mortgage value of $630).

To unmortgage a property, you must pay 110% of the mortgage value, rounded to the nearest $10 (e.g., a Railroad space costs $1100 to unmortgage; ASU would cost $690 to unmortgage).

The "year" in the second column indicates when the institution was added to the game, and thus when the in-game cost and rent prices were set.

Name	Year	Group	Cost	Base rent	Group rent	Rent with 1 Diploma	Rent with 2 Diplomas	Rent with 3 Diplomas	Rent with 4 Diplomas	Rent with a Cohort	Building cost (each Diploma, or to upgrade 4 Diplomas into a Cohort)
Arizona State University	2022	Red	1,250	920	1,010	1,060	2,110	3,170	4,230	6,340	800
Middle TN (Tennessee) State Univ(ersity)	2022	Orange	1,200	840	950	1,050	2,100	3,160	4,210	5,260	500
Georgia State Univ(ersity)	2022	Orange	1,190	940	1,040	1,150	2,300	3,450	4,590	6,890	500
Texas State University	2022	Orange	1,110	1,030	1,040	1,080	2,160	3,250	4,330	5,410	500
University of Central FL (Florida)	2022	Purple	1,050	850	850	910	1,820	2,730	3,640	5,460	500
Brigham Young Univ(ersity)	2022	Purple	940	880	960	1,050	2,110	3,160	4,210	22,110	500
University of Cincinnati	2022	Purple	920	930	1,120	1,210	2,430	3,640	4,850	7,280	500
SUNY Buffalo State	2022	Sky Blue	920	720	910	1,010	2,020	3,020	4,030	10,070	250
Michigan State Univ(ersity)	2022	Sky Blue	910	780	940	960	1,910	2,870	3,830	6,700	250
Western Michigan Univ(ersity)	2022	Sky Blue	880	810	1,000	1,000	2,000	3,000	3,990	4,990	250
Illinois State University	2022	Brown	850	770	900	1,000	1,990	2,990	3,990	9,970	250
Virginia Tech	2022	Brown	750	730	750	790	1,590	2,380	3,170	3,970	250

Board 2: 5+ Club Properties

	Notes:
	If a player needs money, they may mortgage their properties, including railroad and utility spaces.
	The mortgage value is half the property's cost, rounded to the nearest $10 (e.g., a $2000 Railroad space has a $1000 mortgage value; ASU costs $1250 and has a mortgage value of $630).
	To unmortgage a property, you must pay 110% of the mortgage value, rounded to the nearest $10 (e.g., a Railroad space costs $1100 to unmortgage; ASU would cost $690 to unmortgage).
	The "year" in the second column indicates when the institution was added to the game, and thus when the in-game cost and rent prices were set.

Name	Year	Group	Cost	Base rent	Group rent	Rent with 1 Diploma	Rent with 2 Diplomas	Rent with 3 Diplomas	Rent with 4 Diplomas	Rent with a Cohort	Building cost (each Diploma, or to upgrade 4 Diplomas into a Cohort)
Cal Poly San Luis Obispo	2022	Dark Blue	2,370	1,050	1,280	1,290	2,590	3,880	5,170	7,760	1000
Stony Brook University	2022	Dark Blue	2,040	870	870	930	1,860	2,790	3,730	6,520	1000
CO (Colorado) School of Mines	2024	Green	2,200	1,120	1,140	1,200	2,400	3,610	4,810	6,010	1000
Seattle Pacific Univ(ersity)	2022	Green	1,910	1,170	1,220	1,430	2,870	4,300	5,740	11,470	1000
NJ CTL (New Jersey Center for Teaching & Learning)	2024	Green	1,730	840	1,010	1,210	2,420	3,620	4,830	6,040	1000
The College of NJ (New Jersey)	2022	Yellow	1,540	780	1,000	1,210	2,420	3,620	4,830	10,870	800
Cal Poly Pomona	2024	Yellow	2,540	1,010	1,180	1,520	3,030	4,540	6,060	15,150	800
Towson University	2022	Yellow	1,380	1,020	1,080	1,110	2,230	3,340	4,460	5,570	800
Lewis University	2024	Red	1,330	920	1,000	1,150	2,300	3,450	4,600	5,740	800
University of Minnesota	2022	Red	1,310	860	940	1,070	2,150	3,220	4,290	8,580	800
Arizona State University	2022	Red	1,250	920	1,010	1,060	2,110	3,170	4,230	6,340	800

Notes:

If a player needs money, they may mortgage their properties, including railroad and utility spaces.

The mortgage value is half the property's cost, rounded to the nearest $10 (e.g., a $2000 Railroad space has a $1000 mortgage value; ASU costs $1250 and has a mortgage value of $630).

To unmortgage a property, you must pay 110% of the mortgage value, rounded to the nearest $10 (e.g., a Railroad space costs $1100 to unmortgage; ASU would cost $690 to unmortgage).

The "year" in the second column indicates when the institution was added to the game, and thus when the in-game cost and rent prices were set.

Name	Year	Group	Cost	Base rent	Group rent	Rent with 1 Diploma	Rent with 2 Diplomas	Rent with 3 Diplomas	Rent with 4 Diplomas	Rent with a Cohort	Building cost (each Diploma, or to upgrade 4 Diplomas into a Cohort)
Middle TN (Tennessee) State Univ(ersity)	2022	Orange	1,200	840	950	1,050	2,100	3,160	4,210	5,260	500
Georgia State Univ(ersity)	2022	Orange	1,190	940	1,040	1,150	2,300	3,450	4,590	6,890	500
Texas State University	2022	Orange	1,110	1,030	1,040	1,080	2,160	3,250	4,330	5,410	500
Bridgewater State Univ(ersity)	2024	Purple	1,410	980	1,250	1,310	2,630	3,940	5,250	7,880	500
University of Wyoming	2024	Purple	950	950	990	1,110	2,220	3,330	4,440	5,550	500
SUNY Geneseo	2024	Purple	1,070	1,180	1,260	1,290	2,590	3,880	5,170	12,920	500
University of Kentucky	2022	Sky Blue	920	790	880	980	1,950	2,930	3,900	5,850	250
West Virginia Univ(ersity)	2024	Sky Blue	780	800	860	920	1,830	2,750	3,660	4,580	250
Western Gov(ernors) Univ(ersity)	2024	Sky Blue	830	960	1,010	1,060	2,120	3,180	4,230	5,290	250
University of Arkansas	2022	Brown	780	910	980	1,060	2,110	3,170	4,230	7,390	250
Brigham Young Univ(ersity) - ID (Idaho)	2022	Brown	800	770	820	940	1,880	2,820	3,760	9,390	250

Additional Information about Amounts

In this section, I wanted to provide some additional details on the amounts used in the game. As stated above, all of the amounts were adjusted based on the costs/rents for the PhysTEC 5+ Club properties. (BTW if you'd like to learn more about the program, see our website).

Most teachers end up teaching in districts close to their preparation program, so I used data from (https://www.rentdata.org/states/2024) to set the costs and rents. Specifically, the **cost** to own a PhysTEC 5+ Club game property is the **monthly rental cost for a 2-bedroom apartment**.

The **rents** are based on **average weekly teacher salaries** for a nearby school district (calculated by dividing the annual salary by 52).

- The **base rent** for owning a property is the average weekly salary for **a new teacher with a BA and no teaching experience**.

- The **group rent** for owning all properties in the same color-group is the average weekly salary for **a new teacher with a BA and 5 years of teaching experience**.

- The rent for a property with **1 Diploma** is the average weekly salary for a **1 new teacher with a MA and 5 years of teaching experience**.

- The rent for a property with **2 Diplomas** is the average weekly salary for **2 new teachers with a MA and 5 years of teaching experience**.

- The rent for a property with **3 Diplomas** is the average weekly salary for **3 new teachers with a MA and 5 years of teaching experience**.

- The rent for a property with **4 Diplomas** is the average weekly salary for **4 new teachers with a MA and 5 years of teaching experience**.

- The rent for a property with a **Cohort** is the average weekly salary for **the maximum number of new physics teachers prepared by the PhysTEC 5+ Club site in a single academic year** if they were all new teachers with a MA and 5 years of teaching experience.

Because of the time it takes to research salary and rental cost data, I have opted to not keep the values in the PhysTEC-opoly updated with current values. As a result, the tables above include the year in which data was collected.

In general, rent and salary values were about an order of magnitude greater than the values in a Classic Monopoly game (side bar: I'm an astronomer). As a result, many of the other amounts, such as a player's starting funds and utility costs, are 10 times their value in Classic Monopoly. Additionally, for ease, I have **rounded all values to the nearest $10**, and I might recommend

you do the same for trades and auctions. This decision was motivated by a hope that we can someday play the game in-person with a physical board game :)

For Chance and Community Chest cards that are about events (e.g., not just "move back 3 spaces"), I have changed these to be about actual events, opportunities, and/or situations that physics teachers may encounter.

Sites are split into color-groups based on the cost to own the property, which mirrors the setup of classic Monopoly. However, the game does have **an important quirk for rents for properties with a Cohort**: Because the calculation is based on the maximum number of new physics teachers prepared by a site in a single academic year, **some properties will have higher rental values than those in "more expensive" groups**!

Finally, if you are curious how the new costs/rents compare to Classic Monopoly, please see the Appendix below.

Appendix: Classic Monopoly Street Property Values

	Notes:
	If a player needs money, they may mortgage their properties, including railroad and utility spaces. The mortgage value is half the property's cost (e.g., a $200 Railroad space has a $100 mortgage value). To unmortgage a property, you must pay 110% of the mortgage value (e.g., a Railroad space costs $110 to unmortgage).

Name	Group	Cost	Base rent	Group rent	Rent with 1 House	Rent with 2 Houses	Rent with 3 Houses	Rent with 4 Houses	Rent with a Hotel	Building cost (each House, or to upgrade 4 Houses into a Hotel)
Boardwalk	Dark Blue	400	50	100	200	600	1400	1700	2000	200
Park Place	Dark Blue	350	35	70	175	500	1100	1300	1500	200
Pennsylvania Avenue	Green	320	28	56	150	450	1000	1200	1400	200
North Carolina Ave	Green	300	26	52	130	390	900	1100	1275	200
Pacific Ave	Green	300	26	52	130	390	900	1100	1275	200
Marvin Gardens	Yellow	280	24	48	120	360	850	1025	1200	150
Ventnor Ave	Yellow	260	22	44	110	330	800	975	1150	150
Atlantic Ave	Yellow	260	22	44	110	330	800	975	1150	150
Illinois Ave	Red	240	20	40	100	300	750	925	1100	150
Indiana Ave	Red	220	18	36	90	250	700	875	1050	150
Kentucky Ave	Red	220	18	36	90	250	700	875	1050	150
New York Ave	Orange	200	16	32	80	220	600	800	1000	100
Tennessee Ave	Orange	180	14	28	70	200	550	750	950	100
St James Place	Orange	180	14	28	70	200	550	750	950	100

	Notes:
	If a player needs money, they may mortgage their properties, including railroad and utility spaces. The mortgage value is half the property's cost (e.g., a $200 Railroad space has a $100 mortgage value). To unmortgage a property, you must pay 110% of the mortgage value (e.g., a Railroad space costs $110 to unmortgage).

Name	Group	Cost	Base rent	Group rent	Rent with 1 House	Rent with 2 Houses	Rent with 3 Houses	Rent with 4 Houses	Rent with a Hotel	Building cost (each House, or to upgrade 4 Houses into a Hotel)
Virginia Ave	Pink (Magenta)	160	12	24	60	180	500	700	900	100
States Ave	Pink (Magenta)	140	10	20	50	150	450	625	750	100
St Charles Place	Pink (Magenta)	140	10	20	50	150	450	625	750	100
Connecticut Ave	Light Blue	120	8	16	40	100	300	450	600	50
Vermont Ave	Light Blue	100	6	12	30	90	270	400	550	50
Oriental Ave	Light Blue	100	6	12	30	90	270	400	550	50
Baltic Ave	Brown	60	4	8	20	60	180	320	450	50
Mediterranean Ave	Brown	60	2	4	10	30	90	160	250	50