

Physics Education Laboratory Lecture 07 PCK for Dynamics

Francesco Longo - 18/10/23





- a. What patterns did you notice in the placement of the dots?
- b. How can you use the distances between the dots to describe the motion of the bowling ball?

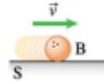
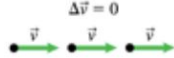

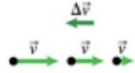
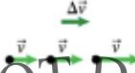
https://mediaplayer.pearsoncmg.com/assets/_frames.true/secs-experiment-video-1

Laboratory on Dynamics



Observational Experiment Table 3.1

How are motion and forces related?

Observational experiment	Analysis	
	Motion diagram	
<p>Experiment 1. A bowling ball B rolls on a very hard, smooth surface S without slowing down.</p> 	<p>$\Delta \vec{v} = 0$</p> 	
<p>Experiment 2. A ruler R lightly pushes the rolling bowling ball opposite the ball's direction of motion. The ball continues to move in the same direction, but slows down.</p> 		
<p>Experiment 3. A ruler R lightly pushes the rolling bowling ball in the direction of its motion. The ball speeds up.</p> 		

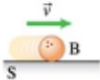
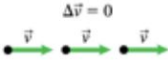
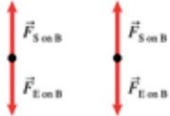

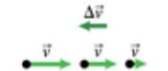
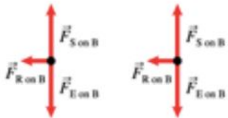
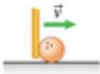
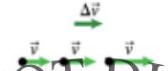
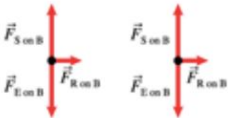
Pattern

- In all the experiments, the vertical forces add to zero and cancel each other. We consider only forces exerted on the ball in the horizontal direction.
- In the first experiment, the sum of the forces exerted on the ball is zero; the ball's velocity remains constant.
- In the second and third experiments, when the ruler pushes the ball, the velocity change arrow ($\Delta \vec{v}$ arrow) points in the same direction as the sum of the forces.

Summary: The $\Delta \vec{v}$ arrow in all experiments is in the same direction as the sum of the forces. Notice that there is no pattern relating the direction of the velocity \vec{v} to the direction of the sum of the forces. In Experiment 2, the velocity and the sum of the forces are in opposite directions, but in Experiment 3, they are in the same direction.

Observational Experiment Table 3.1

How are motion and forces related?

Observational experiment	Analysis	
	Motion diagram	Force diagrams for first and third positions
<p>Experiment 1. A bowling ball B rolls on a very hard, smooth surface S without slowing down.</p> 	<p>$\Delta \vec{v} = 0$</p> 	
<p>Experiment 2. A ruler R lightly pushes the rolling bowling ball opposite the ball's direction of motion. The ball continues to move in the same direction, but slows down.</p> 	<p>$\Delta \vec{v}$</p> 	
<p>Experiment 3. A ruler R lightly pushes the rolling bowling ball in the direction of its motion. The ball speeds up.</p> 	<p>$\Delta \vec{v}$</p> 	

Pattern

- In all the experiments, the vertical forces add to zero and cancel each other. We consider only forces exerted on the ball in the horizontal direction.
- In the first experiment, the sum of the forces exerted on the ball is zero; the ball's velocity remains constant.
- In the second and third experiments, when the ruler pushes the ball, the velocity change arrow ($\Delta \vec{v}$) points in the same direction as the sum of the forces.

Summary: The $\Delta \vec{v}$ arrow in all experiments is in the same direction as the sum of the forces. Notice that there is no pattern relating the direction of the velocity \vec{v} to the direction of the sum of the forces. In Experiment 2, the velocity and the sum of the forces are in opposite directions, but in Experiment 3, they are in the same direction.

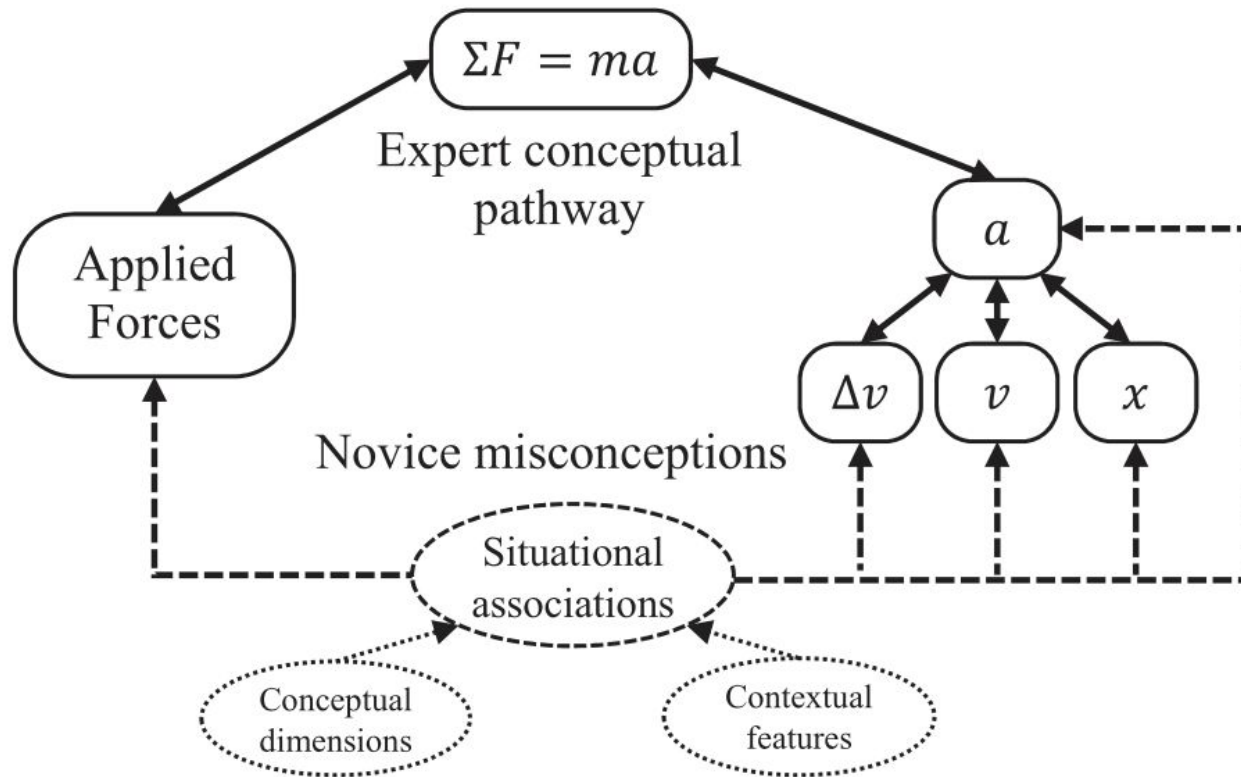


Figure 1. Conceptual framework of force and motion showing connections among variables, relations, and conceptual ideas. The two-way arrows indicate possible pathways of connections within a learner's knowledge structure. The solid lines represent experts' conceptual pathway, while the dashed lines represent novices' possible pathways.

Teacher Desmos: a useful tool ...



<https://teacher.desmos.com>

The screenshot shows the Desmos website homepage. At the top, a white box contains the text "Let's learn together." and "We're on a mission to help every student learn math and love learning math." with a "Graphing Calculator" button. Below this, a section titled "Using Desmos in a classroom?" has two columns: "Students" with a "Student Homepage" button and "Teachers" with a "Browse Activities" button. A "Global Math Art Contest Finalists" section displays five student projects with their names and locations. At the bottom, a "Desmos + Partners" section lists logos for the University of Cambridge, Smarter Balanced, Pearson, NWEA, and Savvas Learning Company.

Let's learn together.

We're on a mission to help every student learn math and love learning math.

[Graphing Calculator](#)

Using Desmos in a classroom?

Students
Have a code from your teacher? Head to the student homepage to enter it.
[Student Homepage](#)

Teachers
Interactive and creative activities for your math class.
[Browse Activities](#)

Global Math Art Contest Finalists
[View all finalists](#)

 Charvi Sood Workingham, UK	 Ezra Oppenheimer Ontario, Canada	 YY Yokohama, Japan	 Student California, USA	 Benjamin Lacasse Québec, Canada
-----------------------------------	---	---------------------------	--------------------------------	--

Desmos + Partners
Our tools power [assessments](#) and major curricula. [Learn more](#)

Teacher Desmos: a useful tool ...

What We Do

Desmos wants to build a world where every student learns math and loves learning math, where a student's access to the power and beauty of math doesn't depend on their place of birth, race, ethnicity, gender, or any other aspect of their identity.

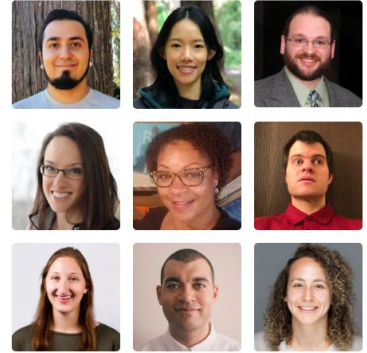
Our free suite of math software tools, including the renowned Desmos Graphing Calculator and Scientific Calculator, are used annually by over 40 million teachers and students around the world. Our tools power core math curricula for many of the world's largest publishers, and our calculators are built into the majority of U.S. state-level assessments and digital college entrance exams. Desmos is also partnered with the Smarter Balanced Assessment Consortium, the International Baccalaureate MYP, and NWEA (view the full list of assessments [here](#)).

Our cutting-edge technology also powers our free [digital classroom activities](#), thoughtfully designed by teachers for teachers to support and celebrate the different ways students come to know mathematics. These activities are guided by our [pedagogical philosophy](#) and open up a world of possibilities for students to explore concepts more deeply, collaborate with their peers on problem-solving, and apply knowledge creatively as mathematicians.

In 2020, we launched our core [middle school math program](#), which pairs the open-source U.S. middle school curriculum from Illustrative Mathematics and Open Up Resources with Desmos' powerful technology, humanizing pedagogy, and intuitive design. We are working with an incredible cohort of schools and districts to implement and further improve this program over the years to come.

Come join us on our journey! [Play with the calculator](#), [check out our classroom activities](#), or [find a career](#) on our growing team. Stay in touch with us on [Twitter](#), [Facebook](#), [Instagram](#), or [email](#). Teachers and school leaders are also welcome to join our [Educators Community](#).

Who We Are [Meet the Team](#)



We're a small but growing team.
Interested in joining? [We're hiring!](#) >

Teacher Desmos: a useful tool ...

The screenshot shows the Desmos website interface. At the top left is the 'desmos' logo. To its right is a search bar with the placeholder text 'Search for an activity' and a magnifying glass icon. Further right are navigation links: 'Math Tools', 'Resources', and 'Educational Ph...', each with a dropdown arrow, and a globe icon. On the left side, there is a vertical navigation menu with the following items: 'Home', 'Most Popular' (underlined), 'YOUR CLASSES' (with sub-items 'Manage Classes' and 'Activity History'), 'YOUR ACTIVITIES' (with sub-items 'Collections' and 'Custom'), and 'FEATURED COLLECTIONS' (with sub-items 'Conics', 'Exponential Functions', 'Functions', 'Inequalities', 'Linear Functions', and 'Linear Systems'). The main content area is titled 'Popular Activities' and contains four activity cards. Each card has a thumbnail image, a title, a 'By Desmos' link, duration, type, and topic tags. The first card is 'Will It Hit the Hoop?' (30-45 minutes, Application, Distance Learning, Quadratic Functions). The second is 'Marbleslides: Lines' (45-60 minutes, Development, Distance Learning, Functions, Linear Functions). The third is 'Match My Parabola' (45-60 minutes, Practice, Distance Learning, Quadratic Functions, Transforming Functions). The fourth is 'Marbleslides: Parabolas' (45-60 minutes, Development, Distance Learning, Quadratic Functions, Transforming Functions). Each card also includes a brief description and a '+ ...' button.

desmos Search for an activity Q Math Tools ▾ Resources ▾ Educational Ph... ▾

Home

Most Popular

YOUR CLASSES

Manage Classes

Activity History

YOUR ACTIVITIES

Collections

Custom

FEATURED COLLECTIONS

Conics

Exponential Functions


Functions

Inequalities

Linear Functions

Linear Systems

Popular Activities




Will It Hit the Hoop?

[By Desmos](#) | 30-45 minutes | Application Distance Learning - ... Quadratic Functions

In this activity, students predict whether various basketball shots will go through the hoop, and then model these shots with parabolas to check their predictions.

+ ⋮




Marbleslides: Lines

[By Desmos](#) | 45-60 minutes | Development Distance Learning - ... Functions Linear Functions

In this delightful and challenging activity, students will transform lines so that the marbles go through the stars. Students will test their ideas by launching the marbles and will have a chance to revise before trying the next challenge.

+ ⋮




Match My Parabola

[By Desmos](#) | 45-60 minutes | Practice Distance Learning - ... Distance Learning - ... Quadratic Functions Transforming Functi...

In this activity, students work through a series of scaffolded quadratic graphing challenges to develop their proficiency with standard, vertex, factored, and other quadratic function forms.

+ ⋮



Marbleslides: Parabolas

[By Desmos](#) | 45-60 minutes | Development Distance Learning - ... Quadratic Functions Transforming Functi...

In this delightful and challenging activity, students will transform parabolas so that the marbles go through the stars. Students will test their ideas by launching the marbles and will have a chance to revise before trying the next challenge.

+ ⋮

Teacher Desmos: a useful tool ...

desmos



Math Tools ▾


Resources ▾

Educational Ph... ▾



Home

Most Popular

 **Get Started**

Featured Collections

YOUR CLASSES

Manage Classes

Activity History

YOUR ACTIVITIES

Collections

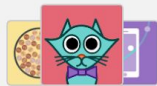
Custom



Starter Screens

By Desmos 6 Activities

These activities offer starter screens that you can co



Modeling

By Desmos 6 Activities

These activities are designed for students who have worked with linear, quadratic, and exponential functions, and who are ready to use these function types to represent real-world phenomena.



Graphing Calculator



Scientific Calculator



Four Function Calculator



Matrix Calculator



Test Practice



Geometry Tool

Download our apps in the [Google Play Store](#) and [iOS App Store](#).

[View All](#)

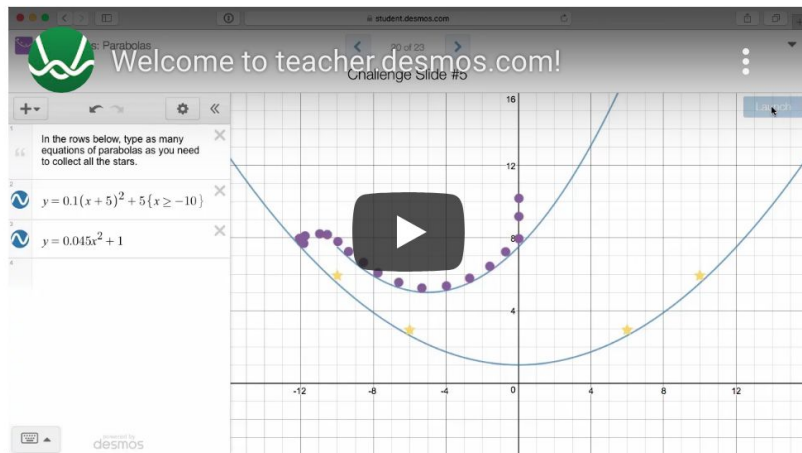
...e divided here by their different purposes.

<https://teacher.desmos.com>

Learn Desmos: Classroom Activities

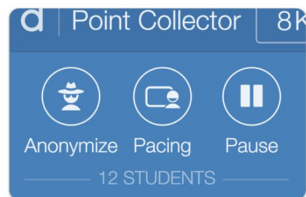
At Desmos, our mission is to help every student learn math and love learning math. With that in mind, we've assembled a collection of unique and engaging digital activities. And best of all? Everything you see at teacher.desmos.com is free. Get started with the video on the right, then dive deeper with the resources below.

Tips for Getting Started



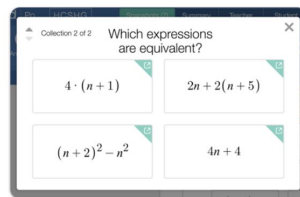
Teacher Desmos: a useful tool ...

Next Steps



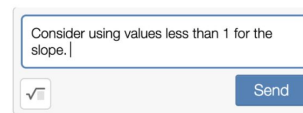
Facilitate Class Conversations

Learn how to facilitate Desmos activities like a pro with our [Classroom Conversation](#) features—Anonymize, Teacher Pacing, and Pause Class.



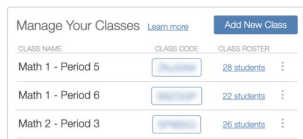
Select and Sequence Student Work

The Desmos teacher dashboard collects a *lot* of student ideas. Use our [Snapshots](#) tool to select and sequence those ideas as you orchestrate class discussions around student thinking.



Send Feedback to Students

Leave [Written Feedback](#) on any student screen. Students will see your comment and develop their mathematical ideas further.



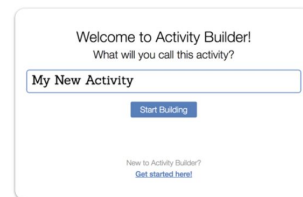
Manage Your Classes

[Create classes](#) to assign activities to the same group of students throughout a school term.



Add Co-teachers

[Co-teaching](#) is easy in Desmos when you and your co-teacher are both near the same computer. But when you're far from each other, you can *still* collaborate.



Create Custom Activities

Create your own Desmos-powered activities with our custom [Activity Builder](#). Learn the ropes with our collection of video tutorials and editable sample activities.

LE FORZE

Percorso didattico per la classe
seconda della scuola secondaria di
primo grado

EXPLORING FORCE CONCEPT THROUGH A LEARNING PROJECT USING DESMOS



Valentina Bologna

Department of Physics, University of Trieste

Elisabetta Giachin

Department of Physics, University of Trieste

Francesco Longo

Department of Physics, University of Trieste and National Institute for Nuclear Physics (INFN), Trieste

Abstract

Teachers have been asked to integrate new technologies with didactic education as it happened during COVID-19 times; this has been a real opportunity to review disciplinary and methodological approaches and to enhance features that usually traditional teaching does not use. The learning and the epistemological constructions are promoted also by the use of

UNIVERSITÀ DEGLI STUDI DI TRIESTE

DIPARTIMENTO DI FISICA

Corso di Laurea Triennale in Fisica

Sviluppo di un percorso didattico innovativo sul concetto newtoniano di forza

Laureanda:

Elisabetta GIACHIN

Relatore:

Prof. Francesco LONGO

Correlatrice:



































**Prof.ssa Valentina
BOLOGNA**

ANNO ACCADEMICO 2019/2020

<https://ijet.itd.cnr.it/article/view/1190>

LE FORZE

Percorso didattico per la classe
seconda della scuola secondaria di
primo grado

1 Libri appoggiati su un ban... Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità	2 Un bicchiere che si rompe ... Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità	3 Un orologio. Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità	4 Un bambino che calcia il p... Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità	5 Un termometro. Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità
6 Una bomba che esplose. Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità	7 Una piramide costruita con... Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità	8 Una lampadina spenta e p... Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità	9 Trascina le immagini sotto ... 	10 Guarda il video di Alex... Ci sono delle forze?  Sì/No Forza Peso Elasticità Elettricità
11 La forza è una INTERAZIONE tra due sistemi. 1. Com'erano prima che si spingessero? E dopo? Perché si...  Sì/No Forza Peso Elasticità Elettricità	12 Quello che hai appena vis... Nelle successive immagini, fai attenzione se è presente un'interazione tra gli sistemi.  Sì/No Forza Peso Elasticità Elettricità	13 Trascina le immagini sott... 	14 Come possiamo rappres... Per rappresentare l'interazione tra due o più...  Sì/No Forza Peso Elasticità Elettricità	15 Come possiamo rapp... Disegna una forza.  Sì/No Forza Peso Elasticità Elettricità
16 Guarda il video e rappres...  Sì/No Forza Peso Elasticità Elettricità	17 Osserva l'immagine e risp... Applico una forza al carrello. Cosa succede?  Sì/No Forza Peso Elasticità Elettricità	18 Osserva l'immagine e risp...  Sì/No Forza Peso Elasticità Elettricità	19 Guarda il video e rappres...  Sì/No Forza Peso Elasticità Elettricità	20 Vediamo perché entra...  Sì/No Forza Peso Elasticità Elettricità
21 Che cos'è l'accelerazi... Guarda il video e riflett... Che significato...  Sì/No Forza Peso Elasticità Elettricità	22 Che relazione c'è tra la fo... Osserva l'immagine. Come sarà l'accelerazione.  Sì/No Forza Peso Elasticità Elettricità	23 Supponiamo di aver misu... Riporta nel grafico i valori misurati in...  Sì/No Forza Peso Elasticità Elettricità	24 Osserva il grafico e comp...  Sì/No Forza Peso Elasticità Elettricità	25 Quale grafico rappresent...  Sì/No Forza Peso Elasticità Elettricità
26 Osserva il grafico. Che tip...  Sì/No Forza Peso Elasticità Elettricità	27 In linguaggio matematico... Ora prova tu a scrivere in linguaggio...  Sì/No Forza Peso Elasticità Elettricità	28 Che cos'è 'k'? Hai trovato la relazione $F = ka$. $F = ka$ Che cos'è 'k'?  Sì/No Forza Peso Elasticità Elettricità	29 Osserva l'immagine. $F = m \cdot a$ $m = \frac{F}{a}$ $a = \frac{F}{m}$ Il valore numerico rappresenta una grandezza fisica.  Sì/No Forza Peso Elasticità Elettricità	30 Ora prova tu a esprimere... $F = m \cdot a$ $m = \frac{F}{a}$ $a = \frac{F}{m}$ Tieni in considerazione che la unità di...  Sì/No Forza Peso Elasticità Elettricità
31 Trova i valori mancanti.  Sì/No Forza Peso Elasticità Elettricità	32 Fai corrispondere ogni ta... 	33 Osserva l'immagine, rapp... Luca tira un pugno ad un sacco da box di 50 chilogrammi.  Sì/No Forza Peso Elasticità Elettricità	34 Osserva l'immagine e inv...  Sì/No Forza Peso Elasticità Elettricità	

LE FORZE

Percorso didattico per la classe
seconda della scuola secondaria di
primo grado

	Anonimia 59 studenti	Filtro Cronologico	1 Libri app... Ci sono delle	2 Un bicch... Ci sono delle	3 Un orolo... Ci sono delle	4 Un bam... Ci sono delle	5 Un term... Ci sono delle	6 Una bo... Ci sono delle	7 Una pira... Ci sono delle	8 Una lam... Ci sono delle	9 Trascina ...
Apollonius	:		×	•	•	•	•	•		×	•
Edray Goins	:		×	•	•	•	•	•	•	•	•
John Urschel	:		×	•	•	•	•	•	•	•	•
John Wallis	:		×	•	•	•	•	•	•	×	•
Blaise Pascal	:		×	•	•	•	•	•	•	•	•
Pierre-Simon Lap...	:		×	•	•	•	•	•	•	•	•
Jacques Hadamard	:		×	•	•	•	•	•	•	×	•
Pythagoras	:		×	•	•	•	•	•	•	×	•
Heisuke Hironaka	:		×							×	•
Mary Ellen Rudin	:		×	•	•	•	•	•	•	•	•
Giuseppe Peano	:		×	•	•	•	•	•	•	•	•
Eugenia Cheng	:		×	•	•	•	•	•	•	×	•
Émile Borel	:		×	•	•	•	•	•	•	•	•
Gladys West	:		×	•	•	•	•	•	•	•	•
Grigory Margulis	:		×	•	•	•	•	•	•	×	•

Libri appoggiati su un banco di scuola.



Ci sono delle forze?

SI

NO

Un bicchiere che si rompe per effetto del suono.



Ci sono delle forze?

SI

NO

Un bambino che calcia il pallone.

Ci sono delle forze?

SI

NO



Una piramide costruita con dei magneti.

Ci sono delle forze?

SI



Una bomba che esplode.

Ci sono delle forze?

SI

NO



Una lampadina spenta e poi accesa.

Ci sono delle forze?

SI

NO



Un termometro.

Ci sono delle forze?

SI

NO



Un orologio.

Ci sono delle forze?

SI



Try to understand which are the prior/intuitive students' knowledge: What is a force?

Trascina le immagini sotto al cartellino corretto.

Esempi di NON Forza



Esempi di Forza



Collecting informations → create a dissatisfaction because the student is not sure of his answers...



Guarda il video di Alexander e Pedro, due astronauti nello spazio, e rispondi.



Cosa avete visto?



Condividi con la classe



1. Com'erano prima che si spingessero? E dopo? Perché si sono mossi?

2. Cos'è cambiato dopo la spinta? Ha cambiato posizione solo uno dei due o si sono spostati entrambi?



Condividi con la classe

Quello che hai appena visto è un esempio di interazione.

La forza è una
INTERAZIONE
tra due sistemi

Nelle successive immagini,

fai attenzione se è presente un'interazione tra due sistemi.

Trascina le immagini sotto al cartellino corretto.



Esempi di interazione

Esempi di NON
interazione

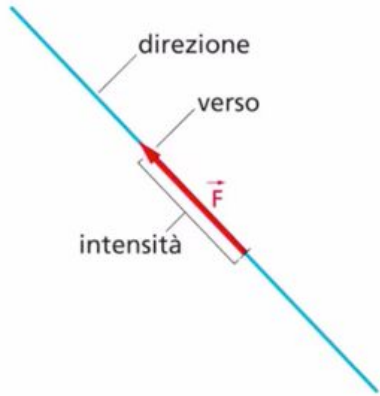


The same images
but another request:
not forces but
interactions

Come possiamo rappresentare la forza?

Per rappresentare l'interazione tra due o più oggetti, scegliamo di utilizzare una FRECCIA.

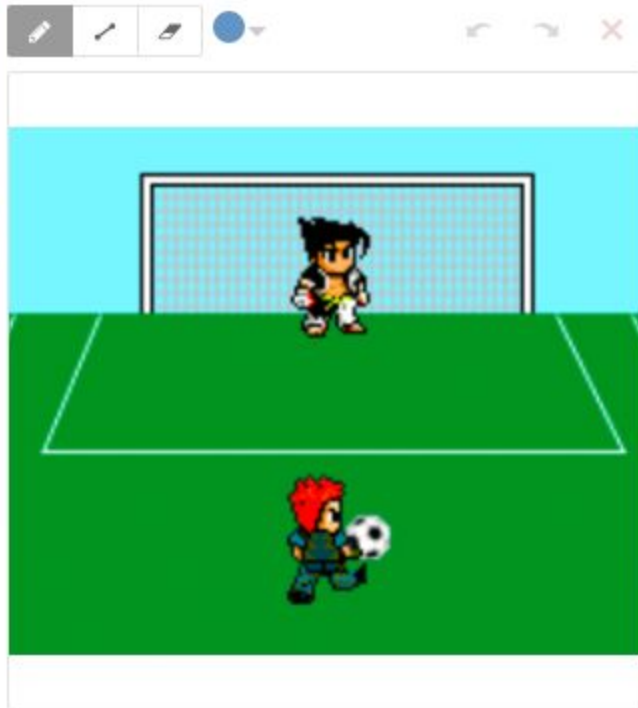
Osserva l'immagine. Che cosa caratterizza la freccia?

 [Condividilo con la classe](#)

Come possiamo rappresentare la forza?



Guarda il video e rappresenta con una freccia la forza applicata sul pallone.



Osserva l'immagine e rispondi.



Applico una forza al carrello. Cosa succede?

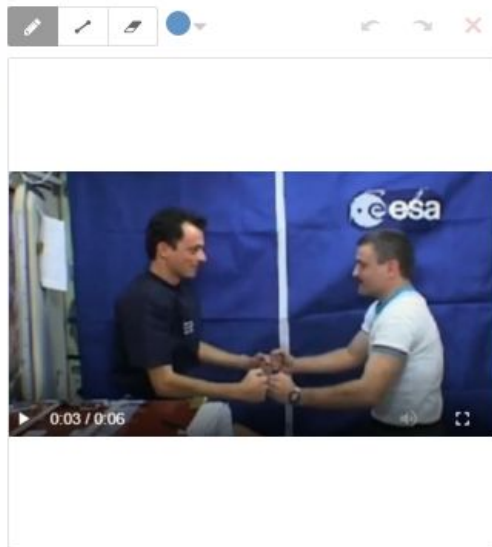
- Il carrello si sposta verso destra.
- Il carrello rimane fermo.
- Il carrello si sposta verso sinistra.

Osserva l'immagine e rispondi.



- Le due squadre esercitano due forze uguali e contrarie.
- La squadra di destra esercita una forza maggiore.
- La squadra di sinistra esercita una forza minore.

Guarda il video e rappresenta con due frecce di colore diverso le due forze esercitate da Alexander e Pedro.



Vediamo perchè entrambi si muovono.



Applying now to understand better what means interaction: knowledge pieces useful

Che cos'è l'accelerazione?



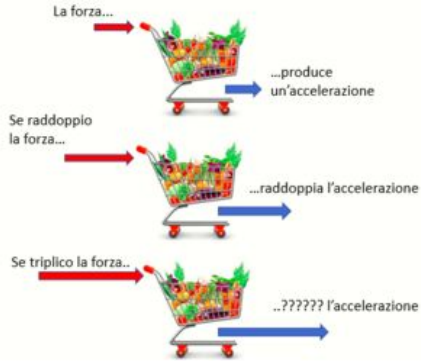
Guarda il video e rifletti.

Che significato ha la tabella del video? La macchina parte da ferma e per raggiungere la velocità di 40 m/s, ad ogni istante varia la sua velocità.

Da che cosa è causata l'accelerazione?

Condividi con la classe

Che relazione c'è tra la forza e l'accelerazione?



Osserva l'immagine. Come sarà l'accelerazione quando triplico la forza?

- L'accelerazione si dimezza.
- L'accelerazione triplica.
- L'accelerazione diminuisce.

Supponiamo di aver misurato i valori di forza e accelerazione applicati al carrello.

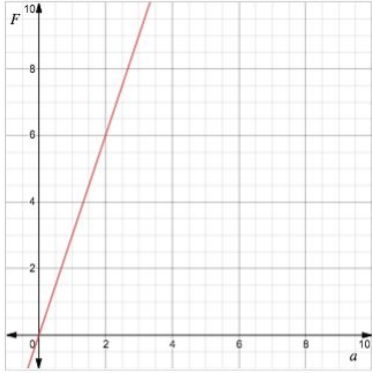


Riporta nel grafico i valori presenti in tabella.

Unisci i punti rappresentati nel grafico con una linea.

a (m/x^2)	F (N)
0	0
1	10
2	20
3	30
4	40

Osserva il grafico e completa la tabella.

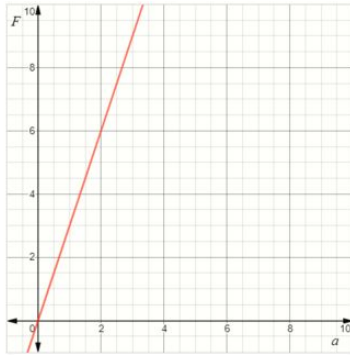


a (m/s ²)	F(N)
0	
1	
	6
3	

Quale grafico rappresenta meglio la relazione tra forza e accelerazione?

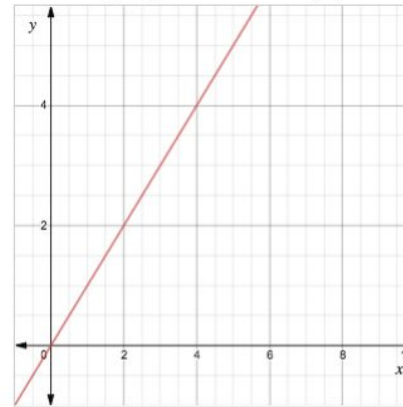


Osserva il grafico. Che tipo di proporzionalità c'è tra forza e accelerazione?



- Proporzionalità diretta (aumenta l'accelerazione, aumenta la forza)
- Proporzionalità inversa (aumenta l'accelerazione, diminuisce la forza)

In linguaggio matematico la proporzionalità diretta si esprime con la relazione $y=kx$



Ora prova tu a scrivere in linguaggio matematico la relazione che c'è tra la forza e l'accelerazione.

Condividi con la classe

Osserva l'immagine, rappresenta le forze e rispondi.



Luca tira un pugno ad un sacco da box di 50 chilogrammi. Sapendo che il sacco si sposta con un'accelerazione di 5 m/s^2 , che forza dovrà applicare Luca per farlo muovere?

Condividi con la classe

Osserva l'immagine e inventa il testo del problema.

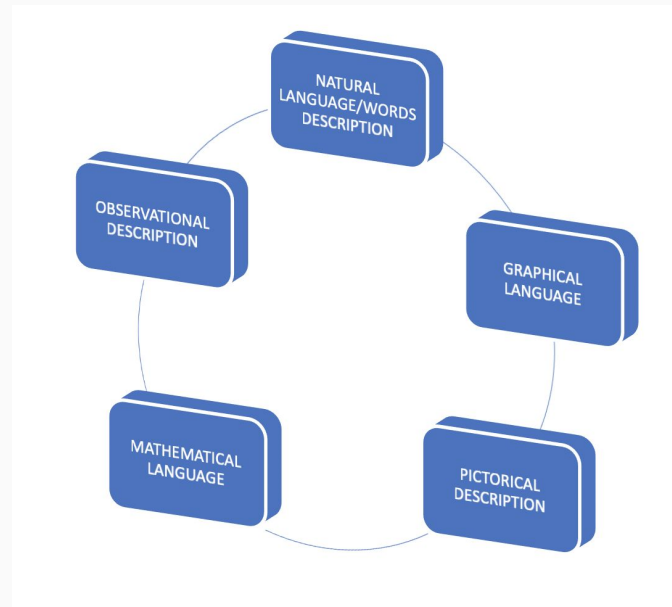


Condividi con la classe

What changes will you suggest for a first year course in a scientific high school?

Kinematics and dynamics concept integration

Rotational Motion DESMOS EDUCATIONAL LABORATORY



ACTIVITY 1: Observe the phenomena

<https://teacher.desmos.com/activitybuilder/custom/61827677ea59770a1ada8332>

ACTIVITY 2: Represent the phenomena

<https://teacher.desmos.com/activitybuilder/custom/6182738298fcb5dbfae73882>

ACTIVITY 3: Integrate languages/descriptions

<https://teacher.desmos.com/activitybuilder/custom/618277f16591badbf9ee0fbe>

Genuine understanding is most likely to emerge...if people possess a number of ways of representing knowledge of a concept or skill and can move readily back and forth among these forms of knowing.

(Gardner, 1991)