C’EST

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Magnétorésistance

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Magnétorésistance VS

C'EST QUOI CETTE COURBE ?

Magnétorésistance VS Champ

C'EST QUOI CETTE COURBE ?

Magnétorésistance VS Champ magnétique

C'EST QUOI CETTE COURBE ?

Magnétorésistance VS Champ magnétique

C'EST QUOI CETTE COURBE ?

Magnétorésistance VS
Champ magnétique

C'EST QUOI CETTE COURBE ?

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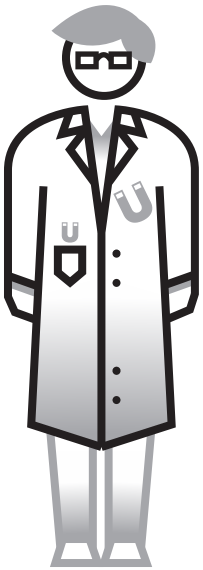

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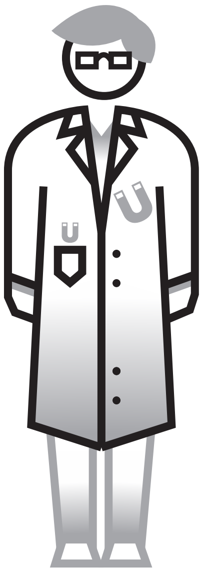

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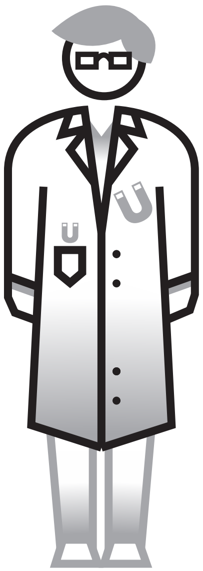

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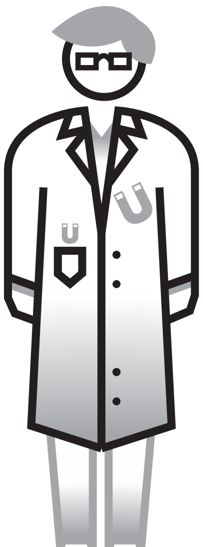

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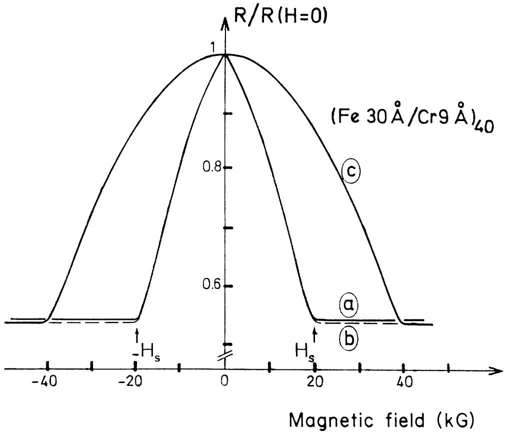


FIG. 2. Magnetoresistance of a [(Fe 30 Å)/(Cr 9 Å)]$_{40}$ superlattice of 4.2 K. The current is along [110] and the field is in the layer plane along the current direction (curve *a*), in the layer plane perpendicular to the current (curve *b*), or perpendicular to the layer plane (curve *c*). The resistivity at zero field is 54 $\mu\Omega$ cm. There is a small difference between the curves in increasing and decreasing field (hysteresis) that we have not represented in the figure. The superlattice is covered by a 100-Å Ag protection layer. This means that the magnetoresistance of the superlattice alone should be slightly higher.

of Grünberg *et al.*[4] and by the spin-polarized low-energy electron-diffraction experiments of Carbone and Alvarado.[10] The AF coupling between the Fe layers has been ascribed to indirect exchange interactions through the Cr layers, but a theoretical model of these interactions is still lacking.[4,9]

The magnetoresistance of the Fe/Cr superlattices has been studied by a classical ac technique on small rectangular samples. Examples of magnetoresistance curves at 4.2 K are shown in Figs. 2 and 3. The resistance decreases during the magnetization process and becomes practically constant when the magnetization is saturated. The curves *a* and *b* in Fig. 2 are obtained for applied fields in the plane of layers in the longitudinal and transverse directions, respectively. The field H_S is the field needed to overcome the AF couplings and to saturate the magnetization (compare with Fig. 1). In contrast, fields applied perpendicularly to the layers (curve *c*) have to overcome not only the AF coupling but also the magnetic anisotropy, so that the magnetoresistance is saturated at a field higher than H_S.

The most remarkable result exhibited in Figs. 2 and 3 is the huge value of the magnetoresistance. For $t_{\mathrm{Cr}}=9$ Å and $T=4.2$ K, see Fig. 2, there is almost a factor of 2 between the resistivities at zero field and in the saturated state, respectively (in absolute value, the resistivity change is about 23 $\mu\Omega$ cm). By comparison of the results for three different samples in Fig. 3, it can be seen

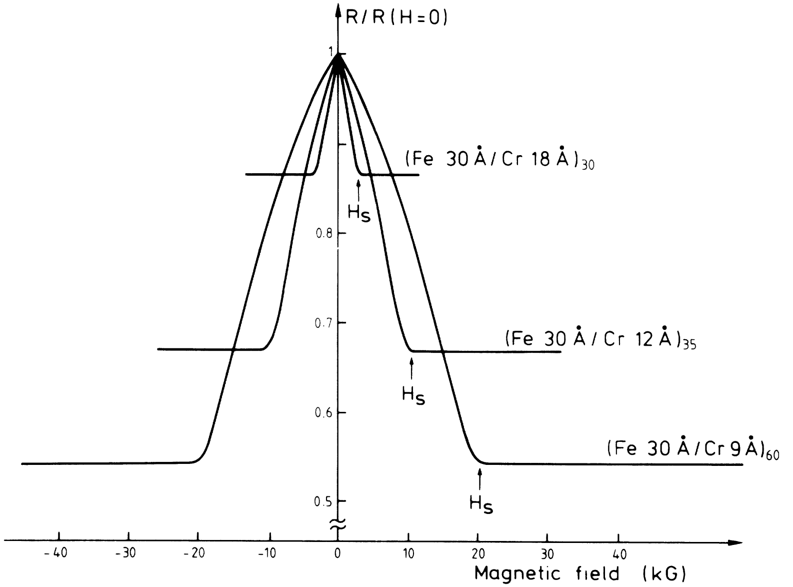
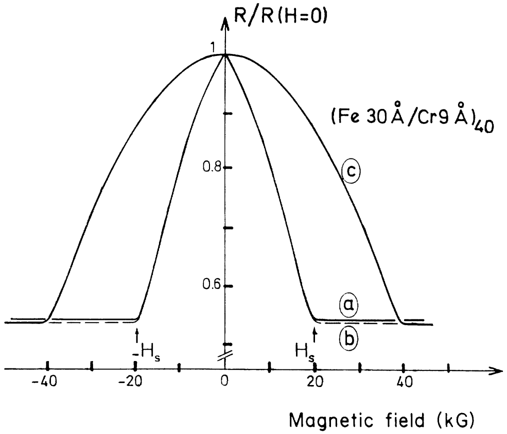


FIG. 3 Magnetoresistance of three Fe/Cr superlattices at 4.2 K. The current and the applied field are along the same [110] axis in the plane of the layers.



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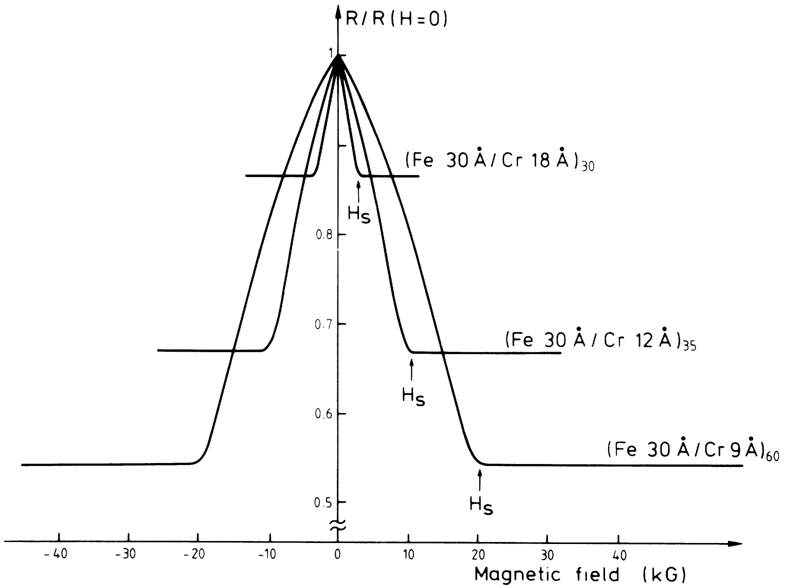

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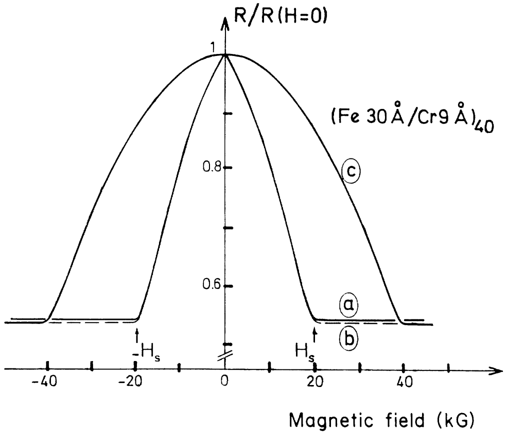

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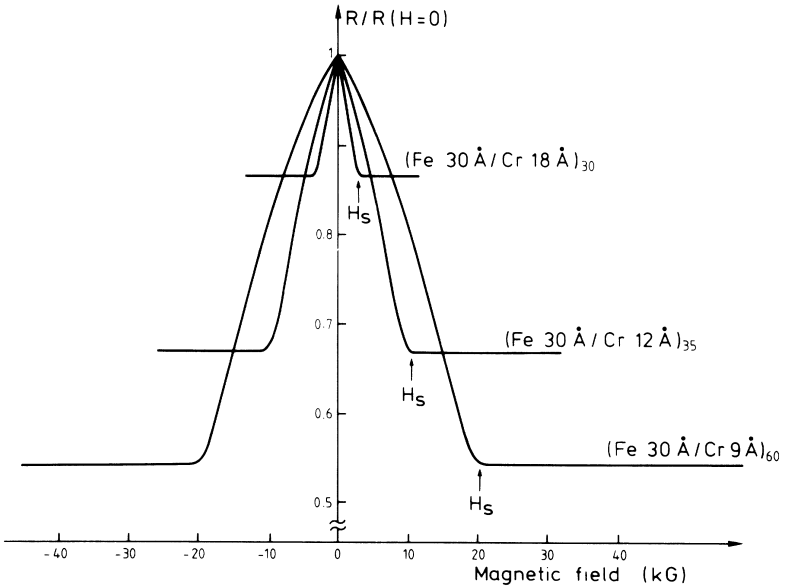

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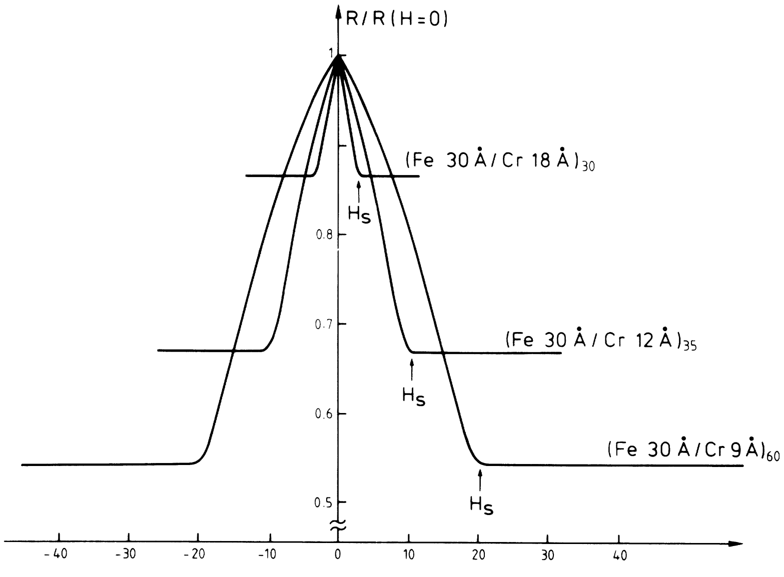
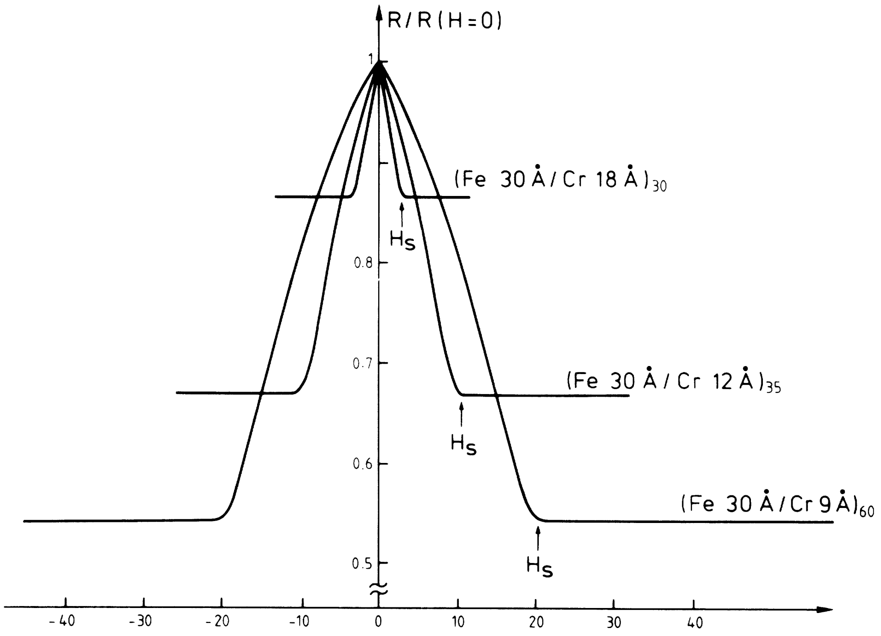

R / R (H = 0)
1
0.8
0.7
0.6
0.5
(Fe 30 Å / Cr 18 Å)$_{30}$
(Fe 30 Å / Cr 12 Å)$_{35}$
(Fe 30 Å / Cr 9 Å)$_{60}$
H_S
H_S
H_S
- 40
- 30
- 20
-10
0
10
20
30
40


R/R(H=0)
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0.8
0.7
0.6
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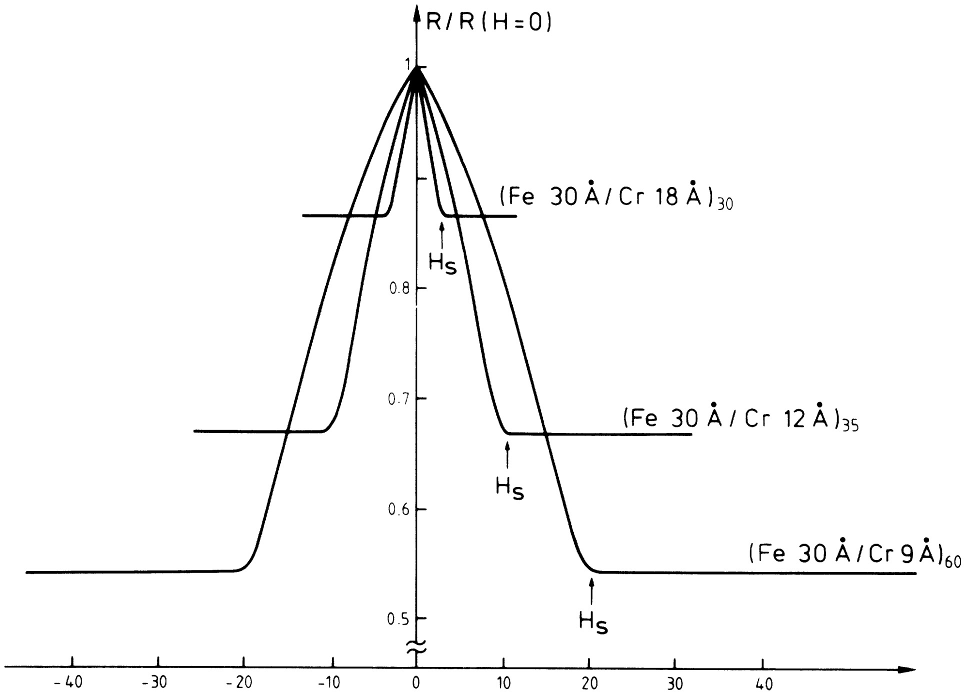
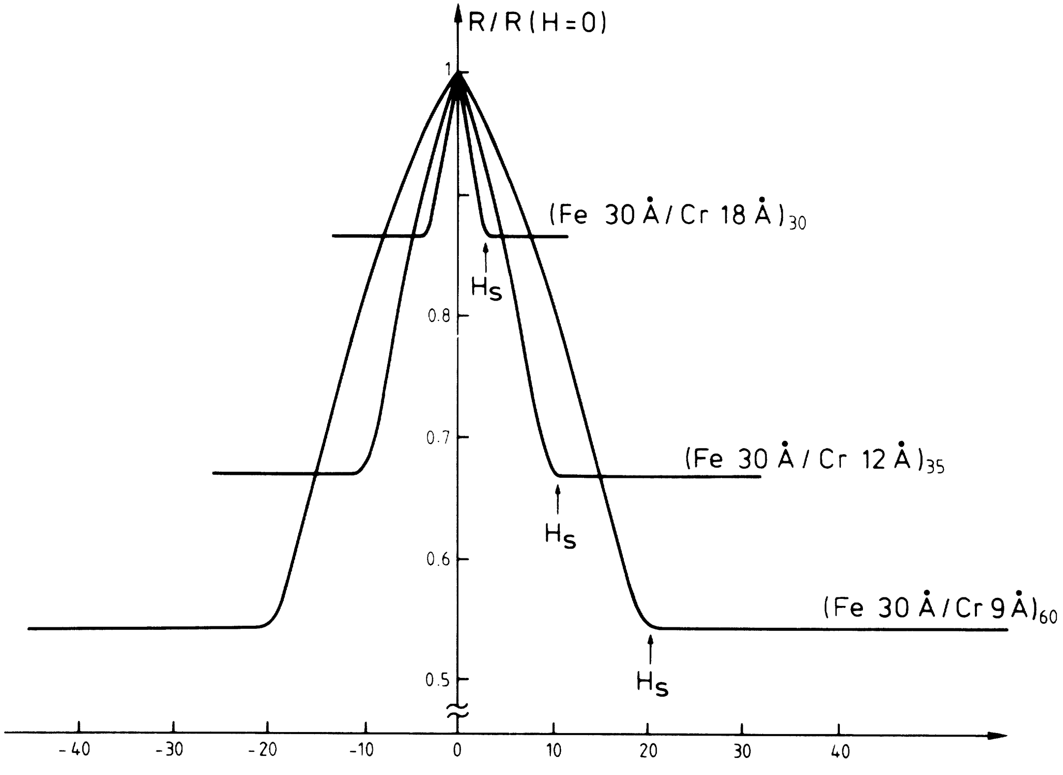
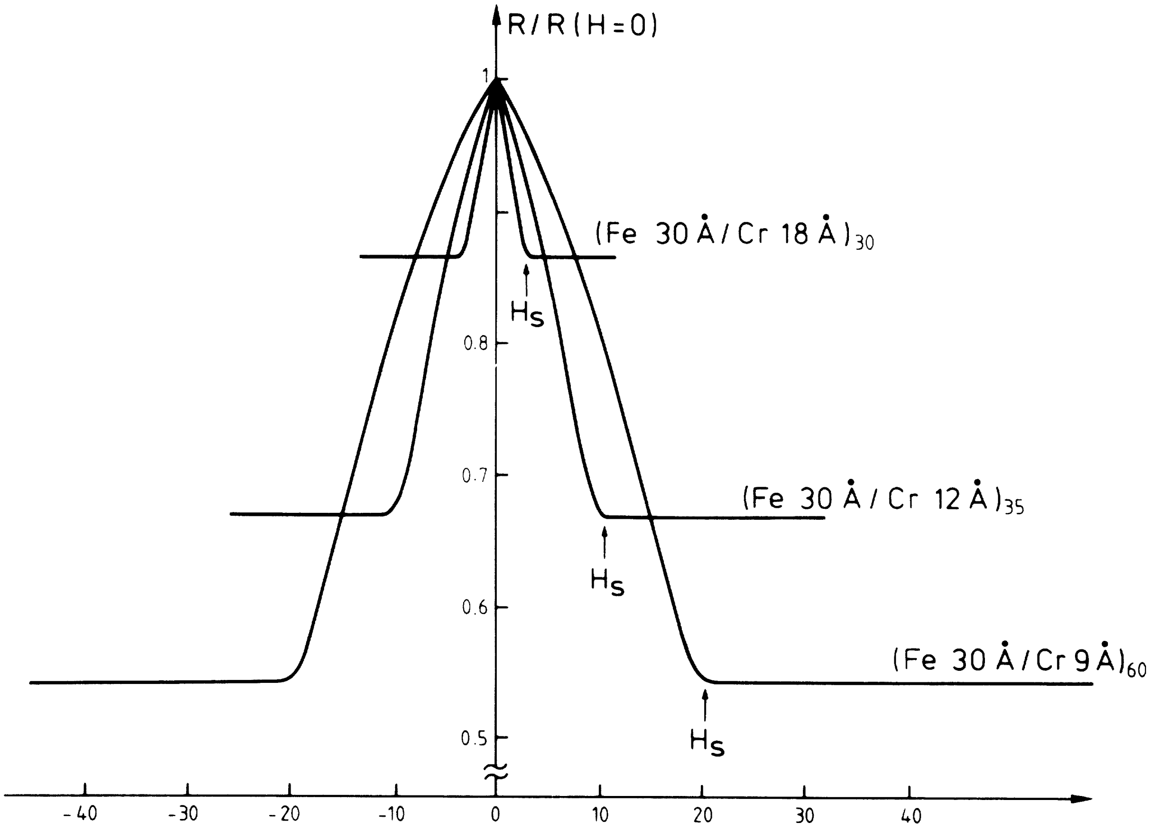
(Fe 30 Å/Cr 18 Å)$_{30}$
(Fe 30 Å/Cr 12 Å)$_{35}$
(Fe 30 Å/Cr 9 Å)$_{60}$
H_s
H_s
H_s
-40
-30
-20
-10
0
10
20
30
40


R / R (H = 0)
1
0.8
0.7
0.6
0.5
- 40
- 30
- 20
- 10
0
10
20
30
40
(Fe 30 Å / Cr 18 Å)$_{30}$
H$_s$
(Fe 30 Å / Cr 12 Å)$_{35}$
H$_s$
(Fe 30 Å / Cr 9 Å)$_{60}$
H$_s$


R / R (H = 0)
1
0.8
0.7
0.6
0.5
(Fe 30 Å / Cr 18 Å)30
(Fe 30 Å / Cr 12 Å)35
(Fe 30 Å / Cr 9 Å)60
Hs
Hs
Hs
- 40
- 30
- 20
-10
0
10
20
30
40


R / R (H = 0)
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0.8
0.7
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0.5
(Fe 30 Å / Cr 18 Å)$_{30}$
(Fe 30 Å / Cr 12 Å)$_{35}$
(Fe 30 Å / Cr 9 Å)$_{60}$
H_s
H_s
H_s
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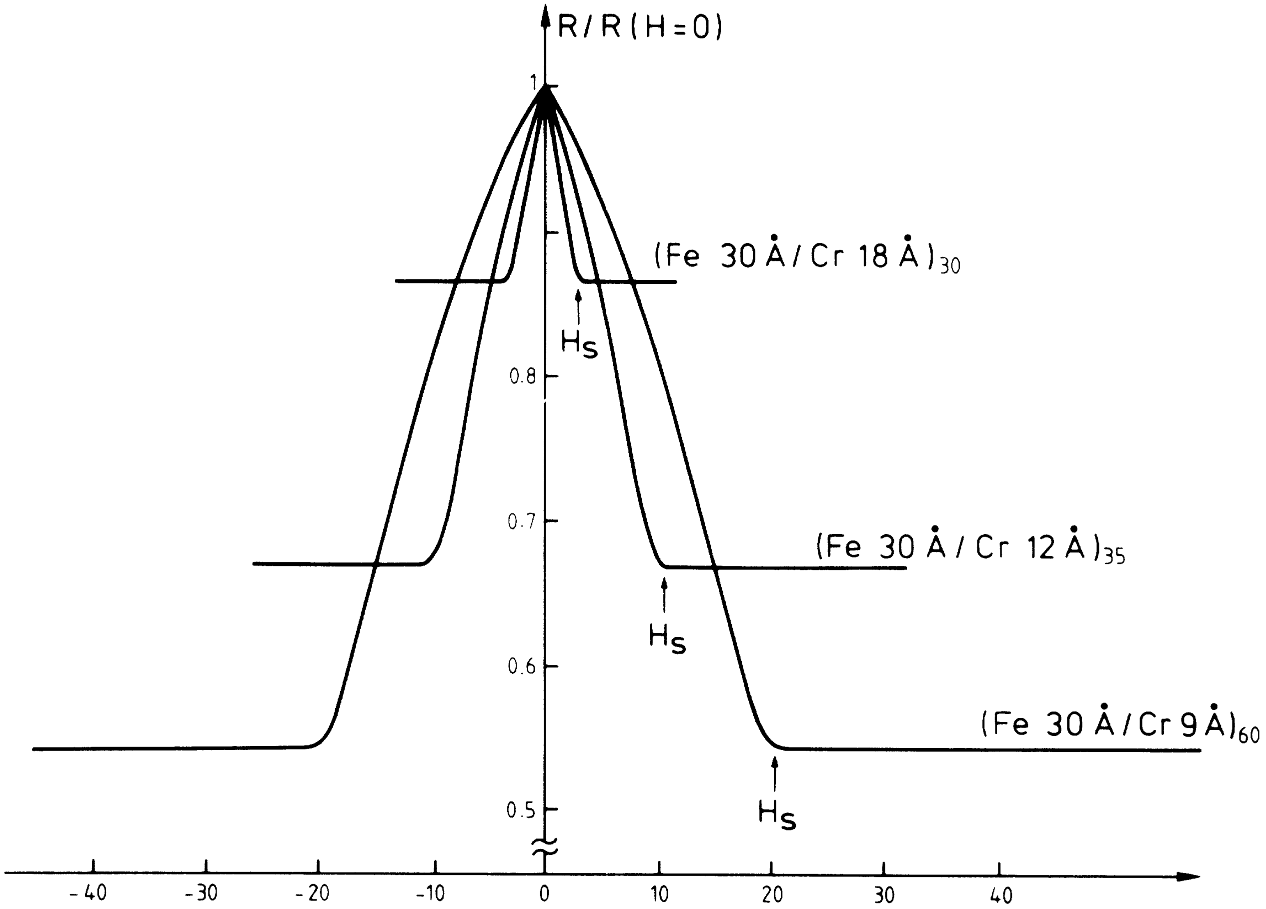
R / R (H = 0)
1
0.8
0.7
0.6
0.5
(Fe 30 Å / Cr 18 Å)$_{30}$
(Fe 30 Å / Cr 12 Å)$_{35}$
(Fe 30 Å / Cr 9 Å)$_{60}$
H$_s$
H$_s$
H$_s$
- 40
- 30
- 20
-10
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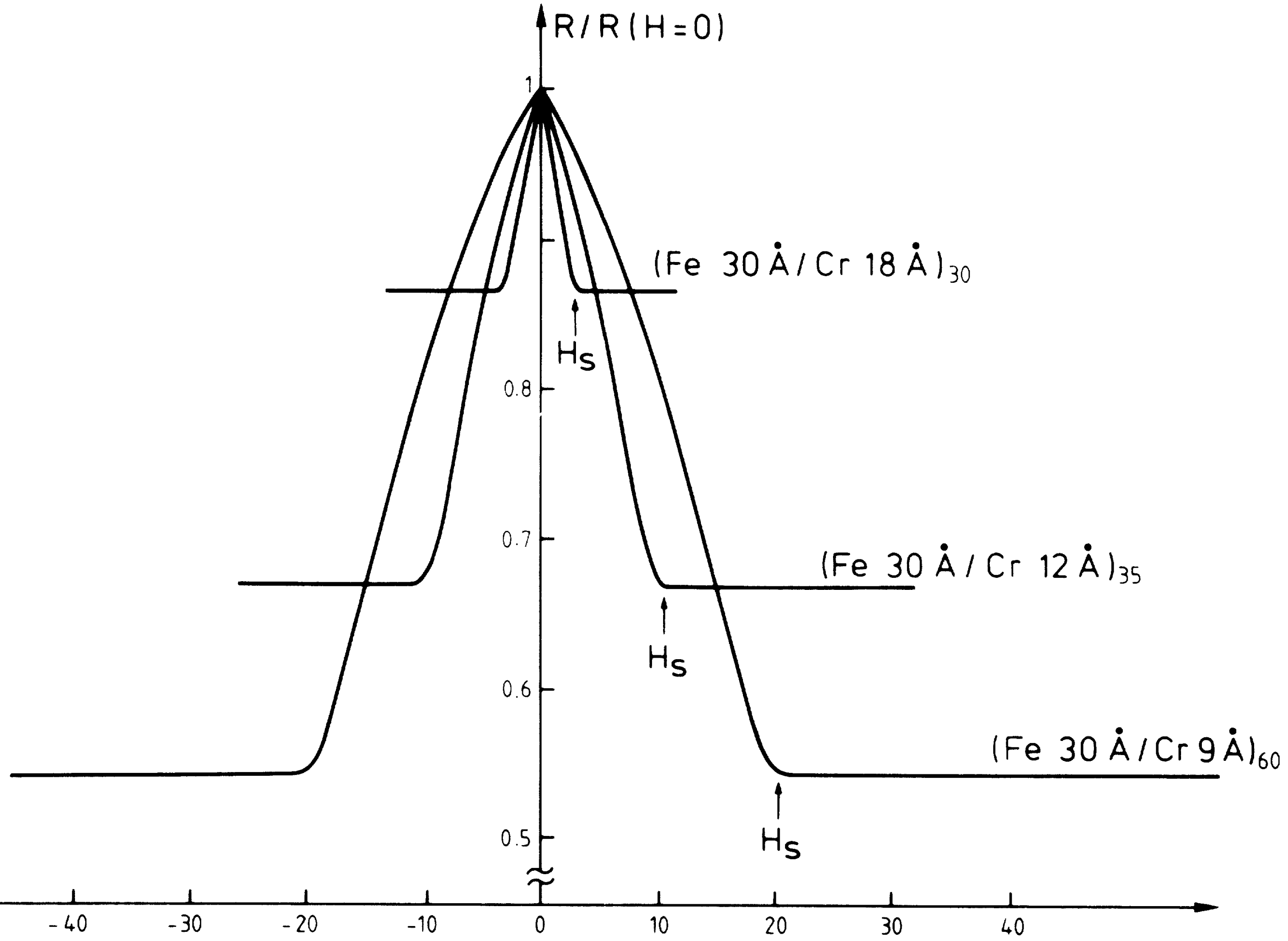
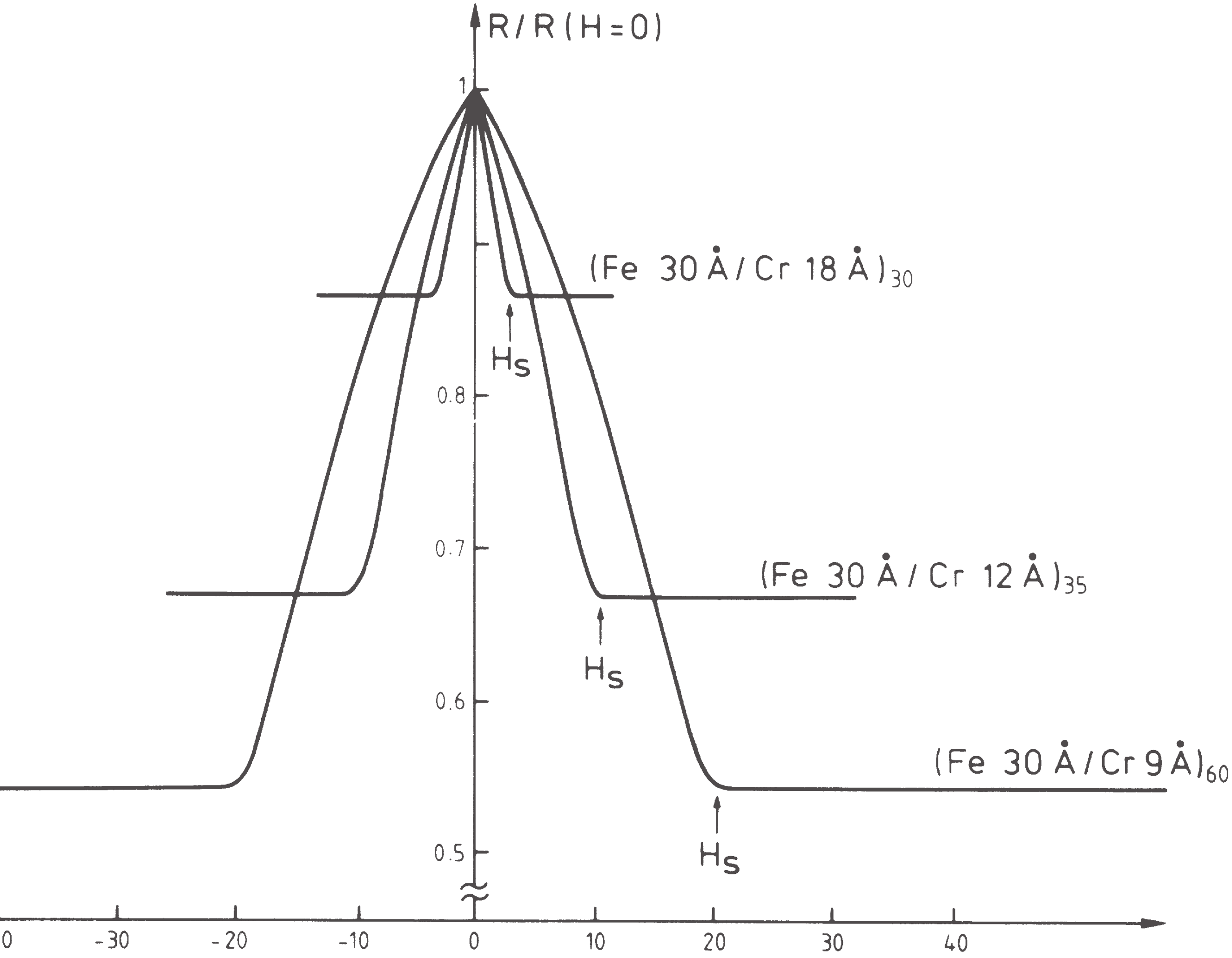

R / R (H = 0)
1
0.8
0.7
0.6
0.5
(Fe 30 Å / Cr 18 Å)$_{30}$
(Fe 30 Å / Cr 12 Å)$_{35}$
(Fe 30 Å / Cr 9 Å)$_{60}$
H_s
H_s
H_s
-40
-30
-20
-10
0
10
20
30
40


R / R (H = 0)
1
0.8
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(Fe 30 Å / Cr 18 Å)$_{30}$
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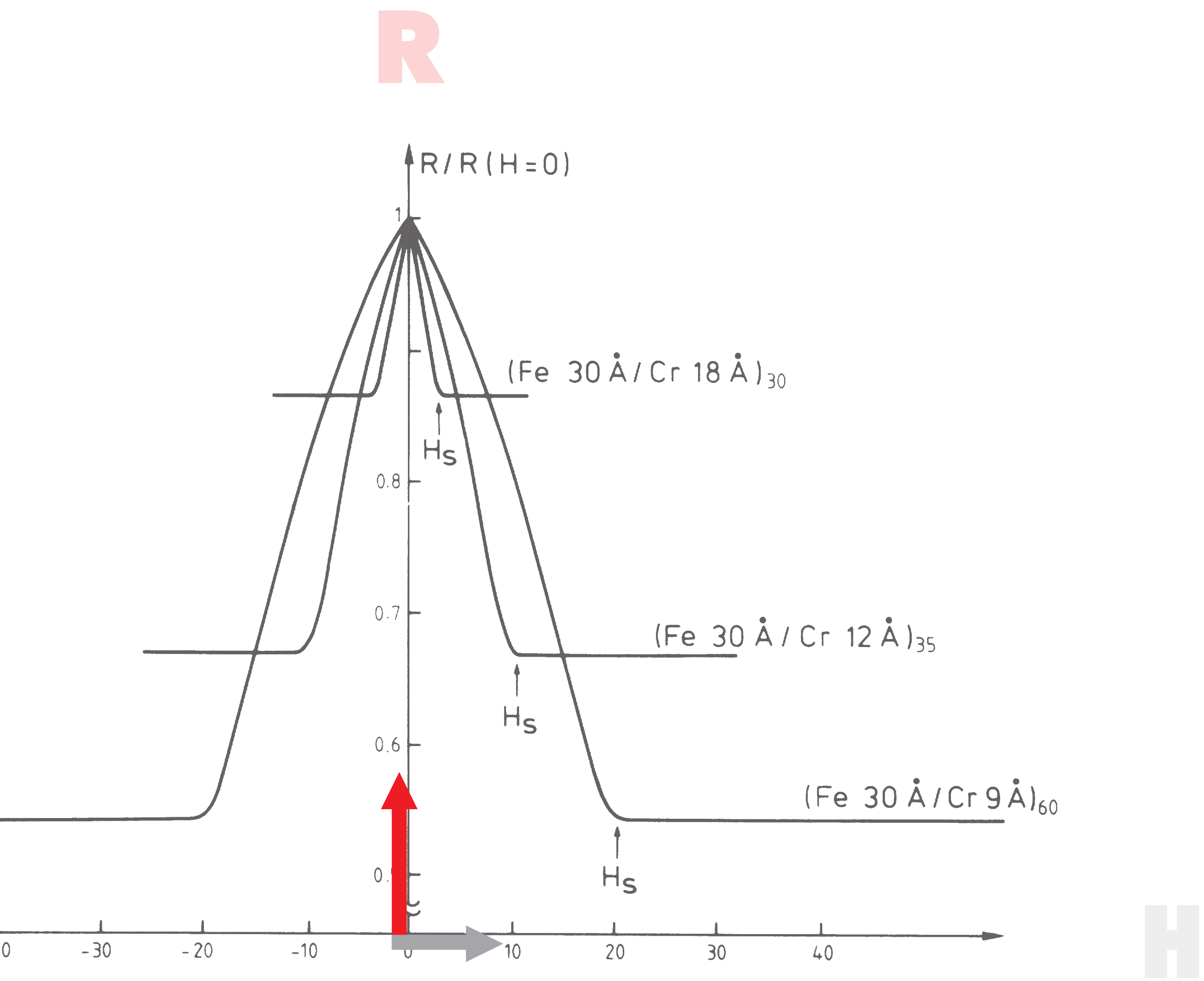
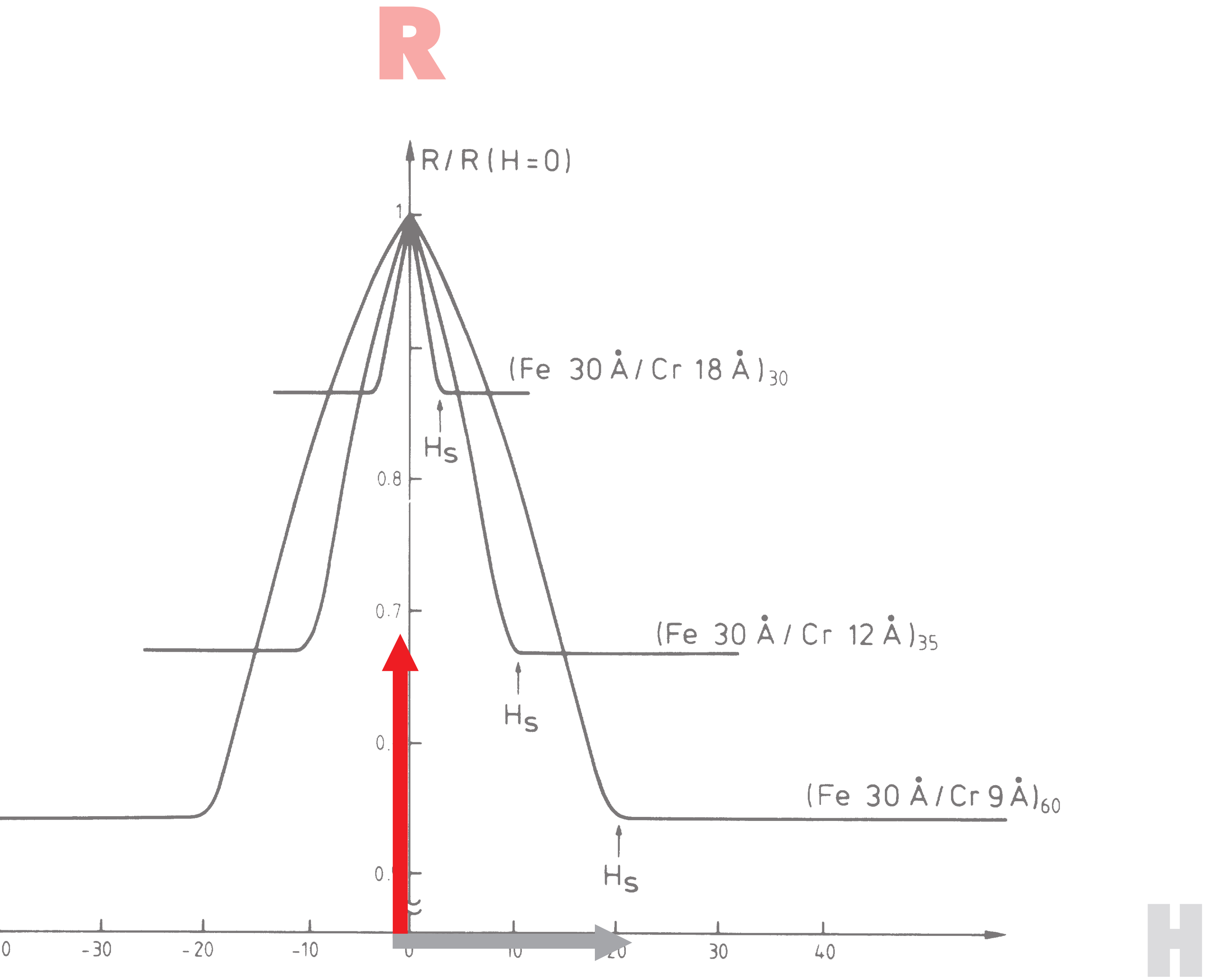
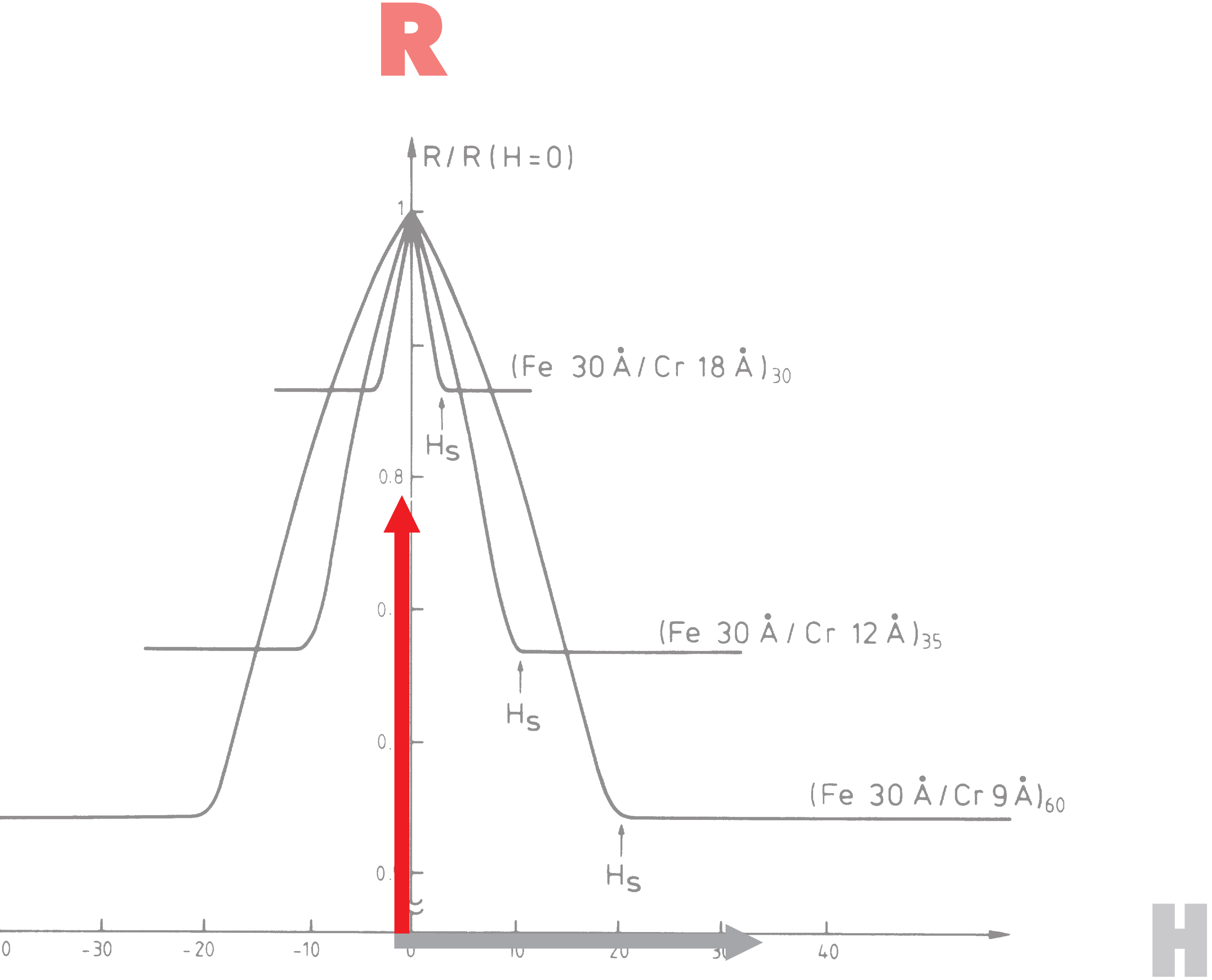
(Fe 30 Å / Cr 9 Å)$_{60}$
H$_S$
H$_S$
H$_S$
0
-30
-20
-10
0
10
20
30
40


R
R / R (H = 0)
1
0.8
0.7
0.6
0.
(Fe 30 Å / Cr 18 Å)$_{30}$
(Fe 30 Å / Cr 12 Å)$_{35}$
(Fe 30 Å / Cr 9 Å)$_{60}$
H_s
H_s
H_s
0
-30
-20
-10
0
10
20
30
40
H


R
R / R (H = 0)
1
0.8
0.7
0.
0.
(Fe 30 Å / Cr 18 Å)₃₀
Hs
(Fe 30 Å / Cr 12 Å)₃₅
Hs
(Fe 30 Å / Cr 9 Å)₆₀
Hs
- 30
- 20
-10
0
10
20
30
40
H


R
R / R (H = 0)
1
0.8
0.
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(Fe 30 Å / Cr 18 Å)$_{30}$
Hs
(Fe 30 Å / Cr 12 Å)$_{35}$
Hs
(Fe 30 Å / Cr 9 Å)$_{60}$
Hs
0
- 30
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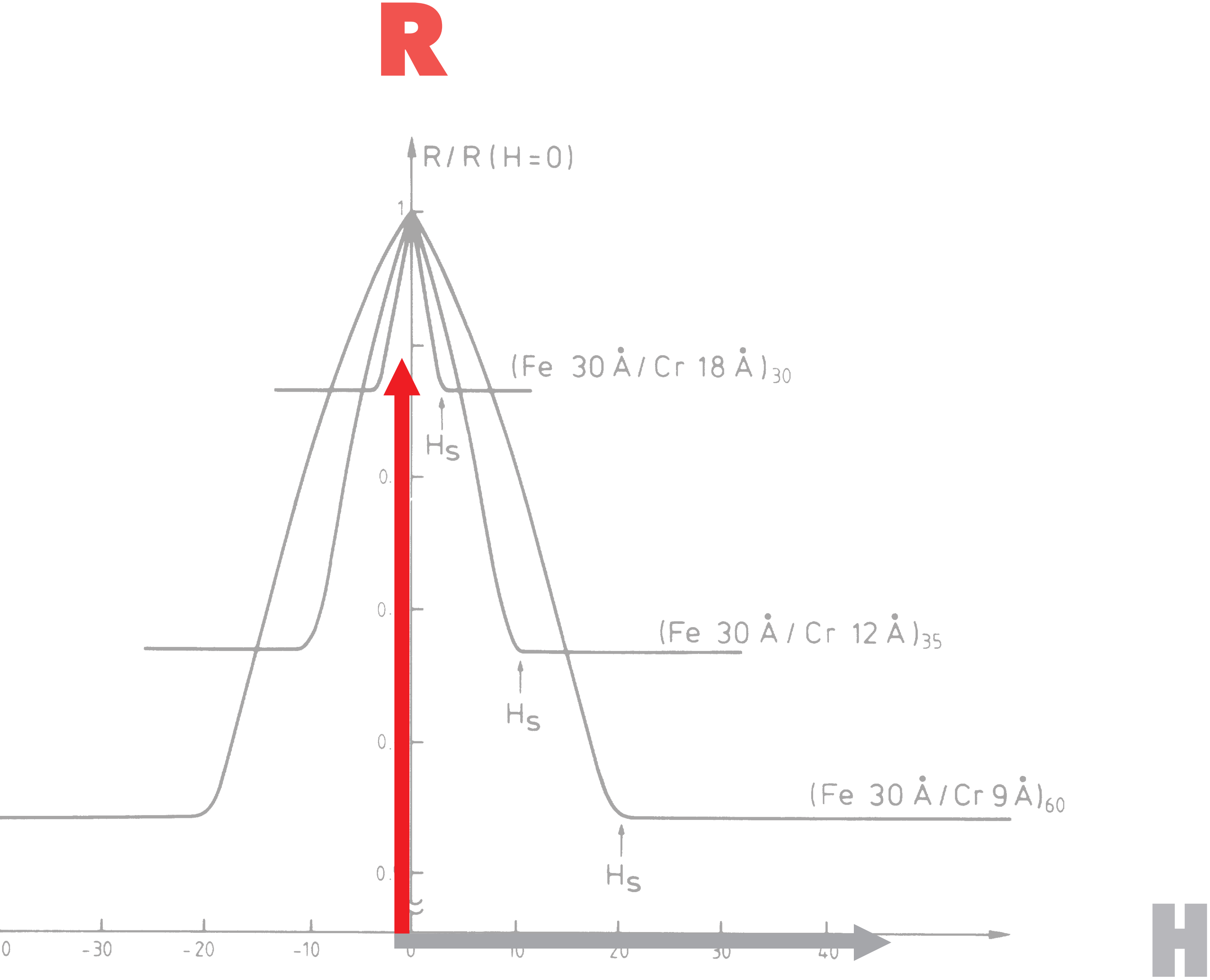
R
R / R (H = 0)
1
0.
0.
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(Fe 30 Å / Cr 18 Å)30
Hs
(Fe 30 Å / Cr 12 Å)35
Hs
(Fe 30 Å / Cr 9 Å)60
Hs
0
- 30
- 20
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20
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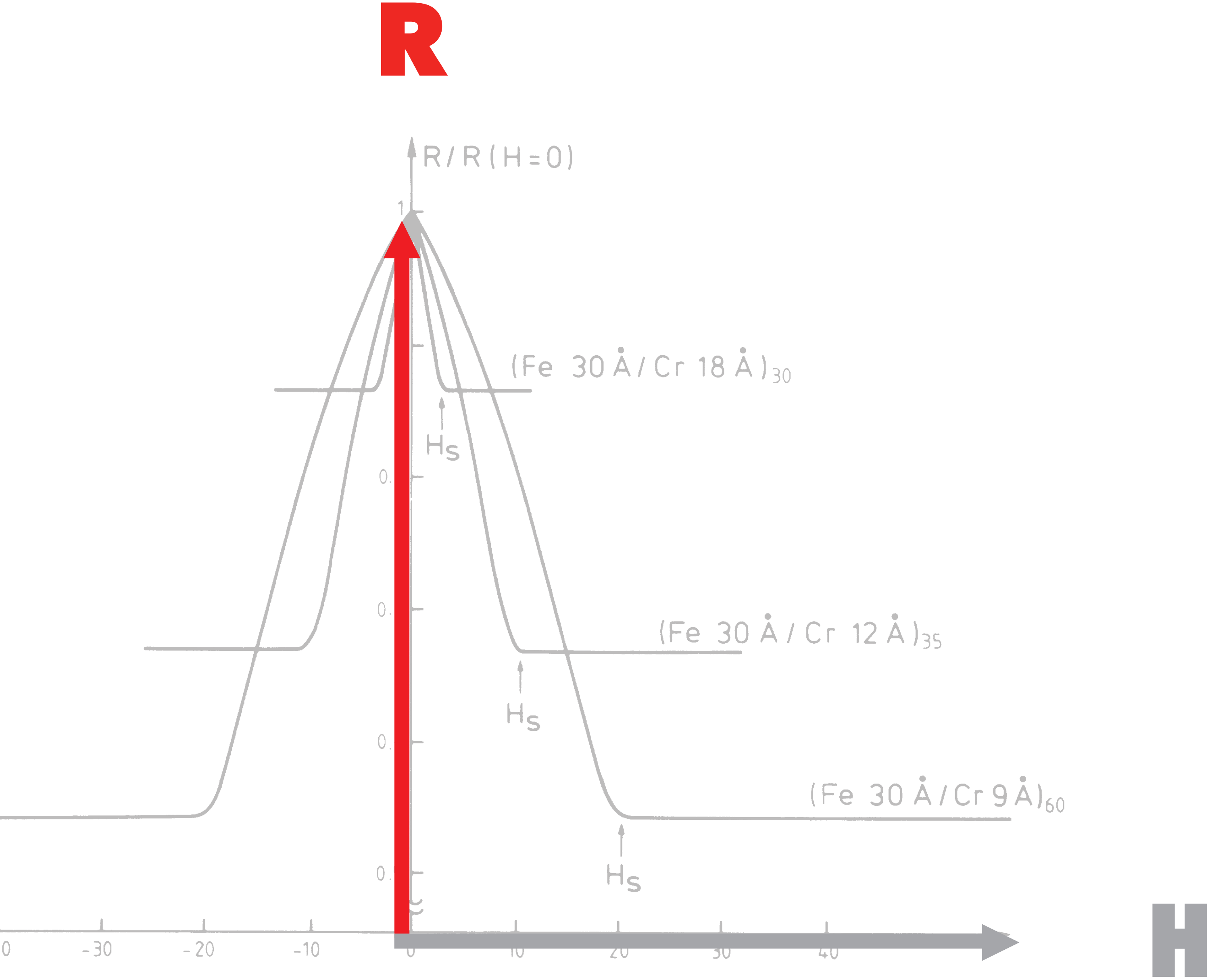
H


R
R/R(H=0)
1
0.
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(Fe 30 Å/Cr 18 Å)$_{30}$
Hs
(Fe 30 Å/Cr 12 Å)$_{35}$
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0
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20
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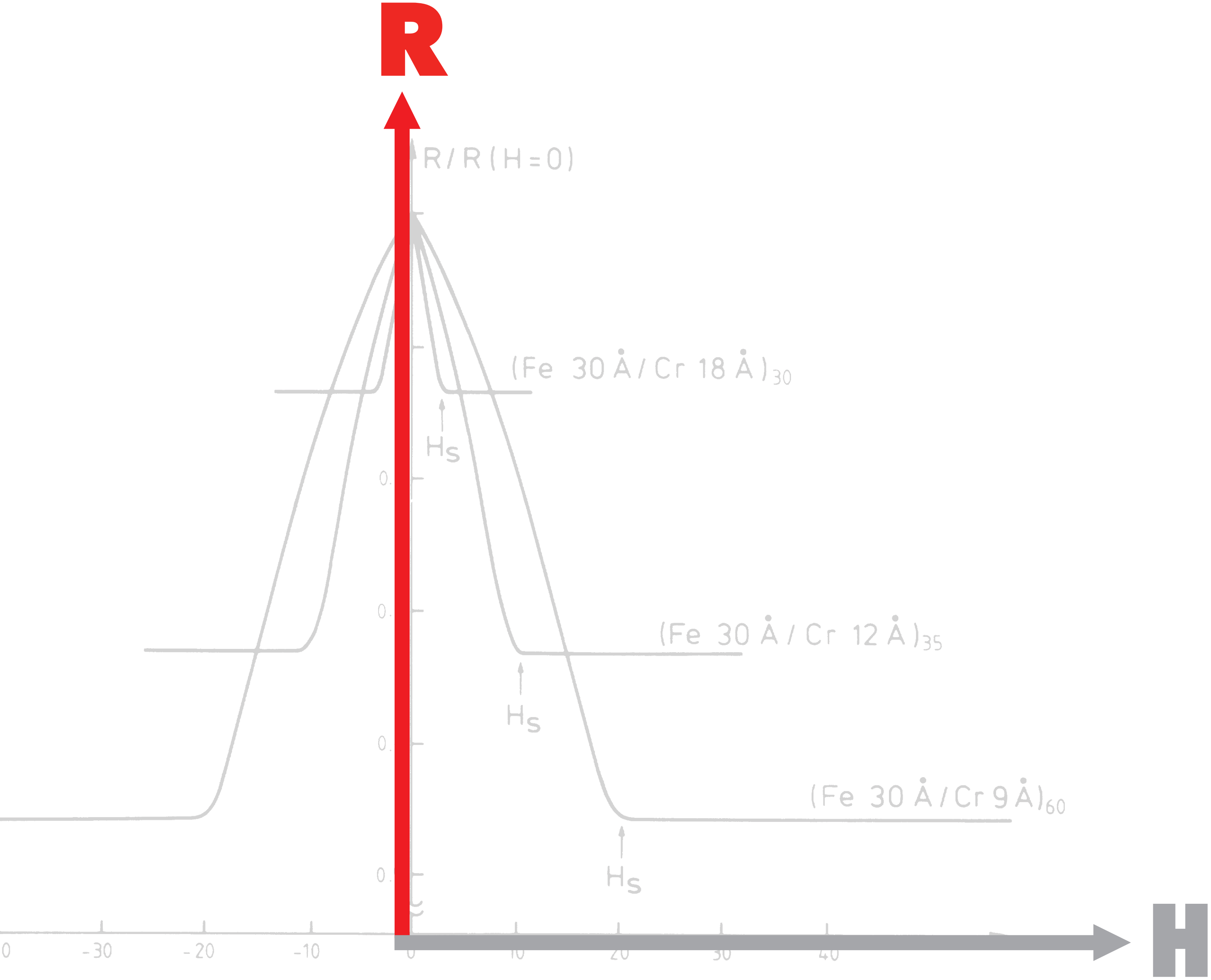
H



R
R / R (H = 0)
(Fe 30 Å / Cr 18 Å)$_{30}$
H_s
(Fe 30 Å / Cr 12 Å)$_{35}$
H_s
(Fe 30 Å / Cr 9 Å)$_{60}$
H_s
0.
0.
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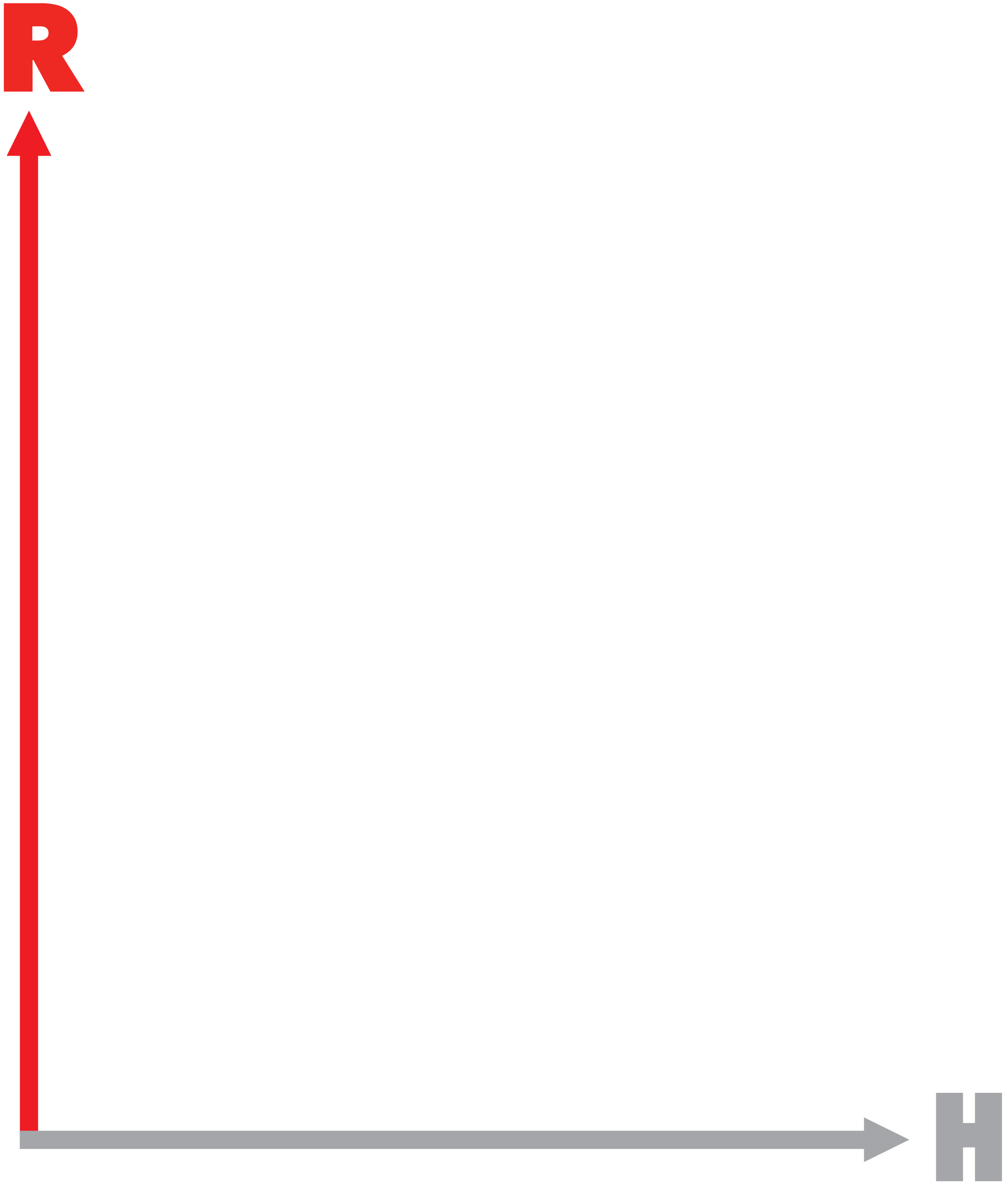
0.
0
- 30
- 20
- 10
0
10
20
30
40
H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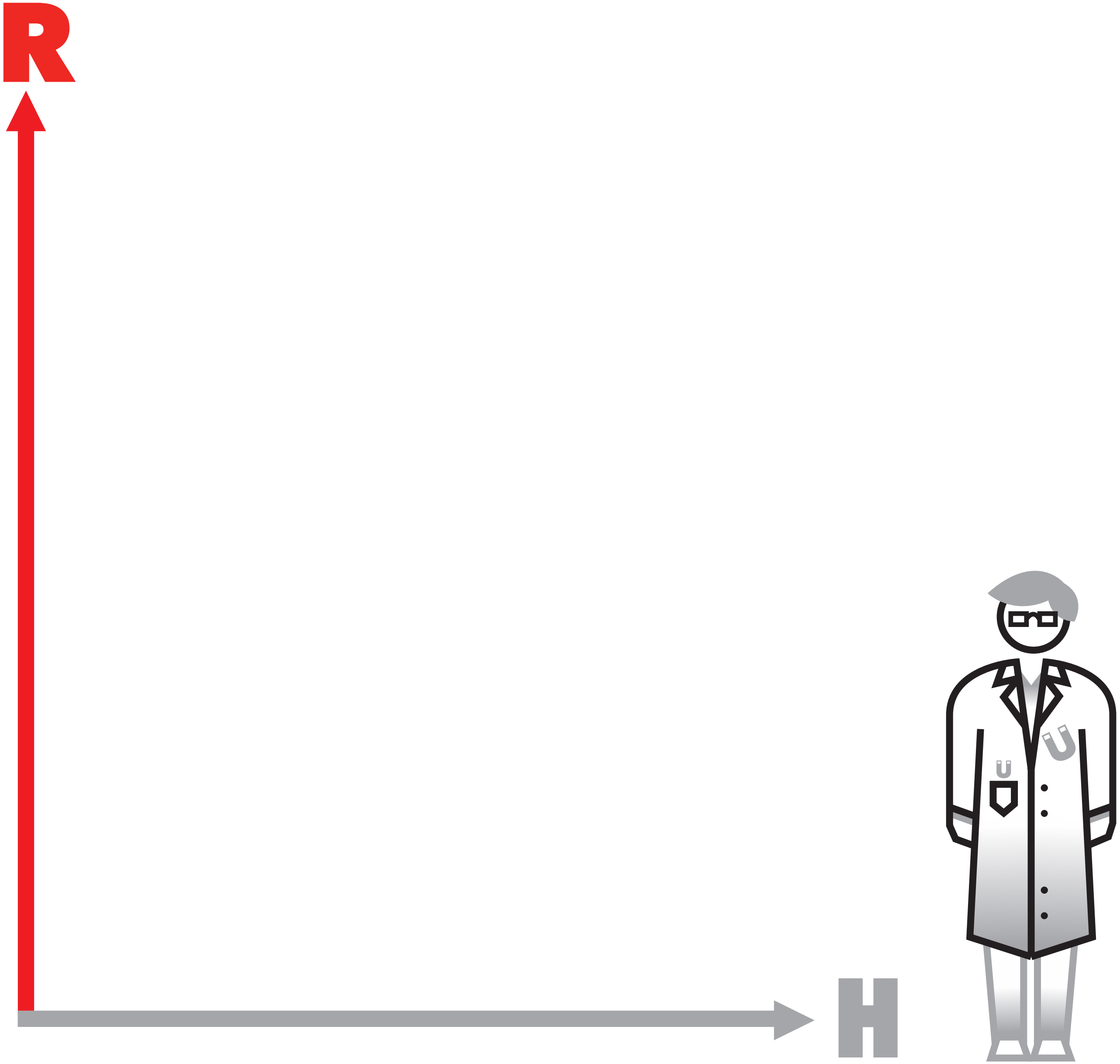
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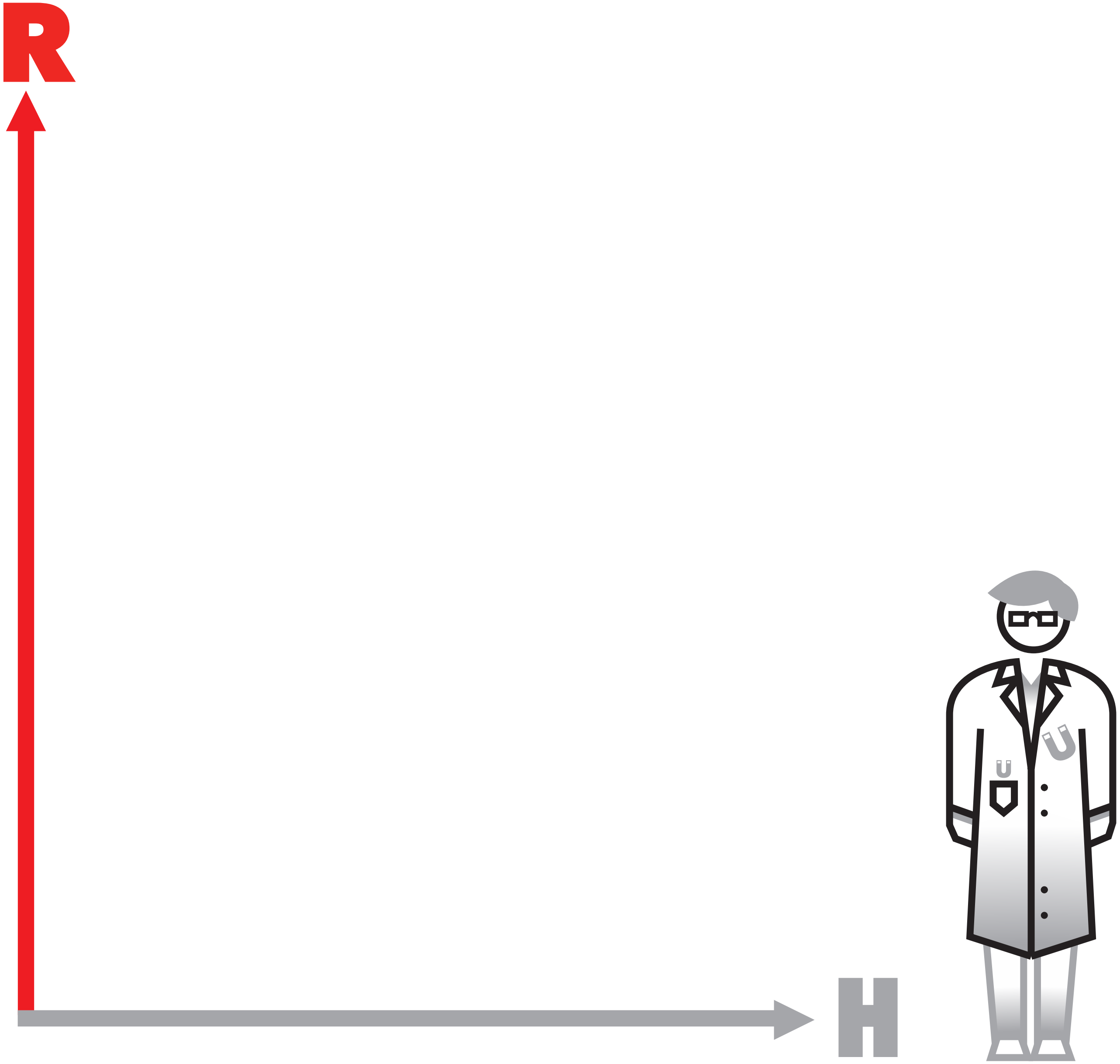
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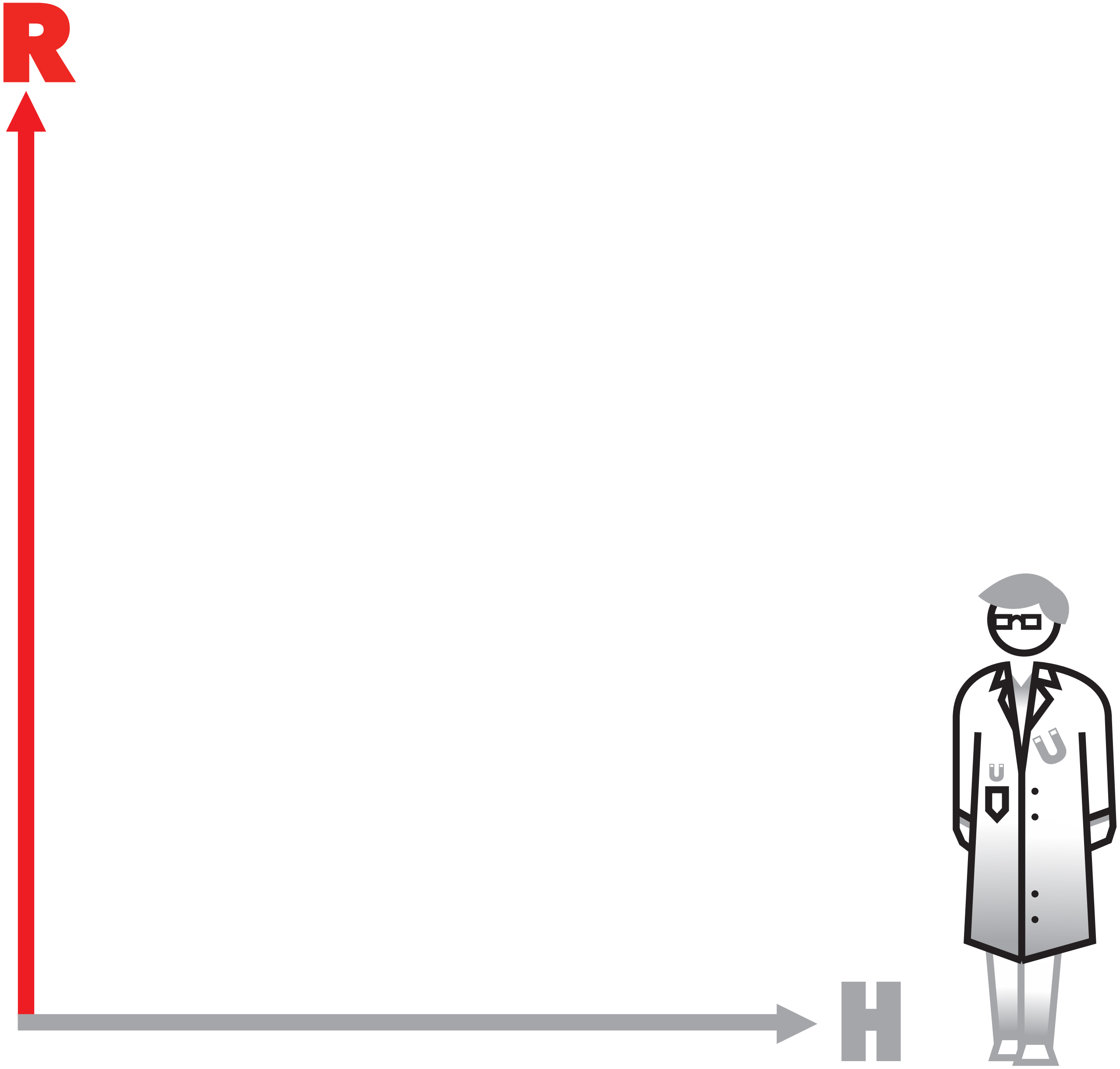
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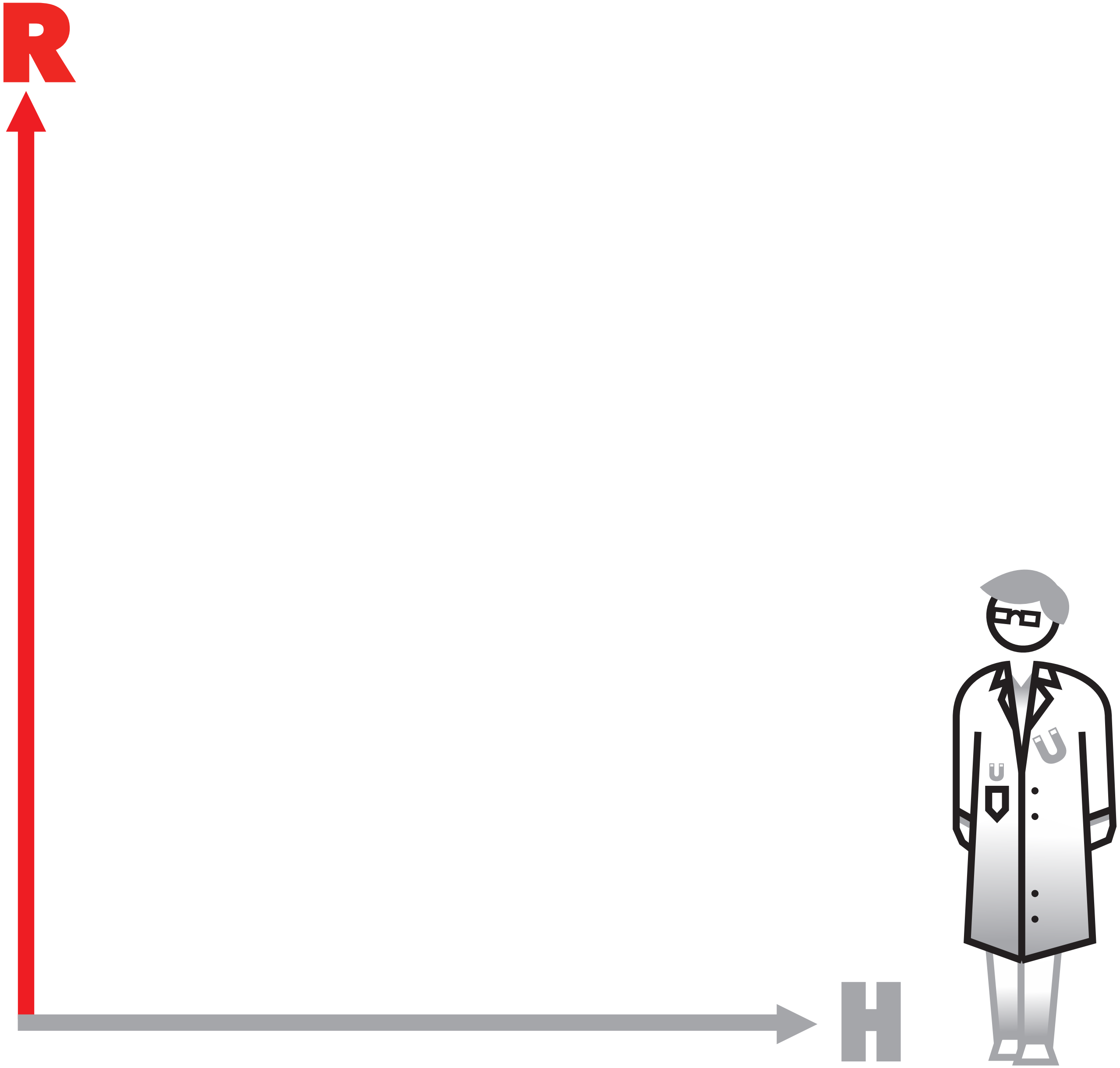
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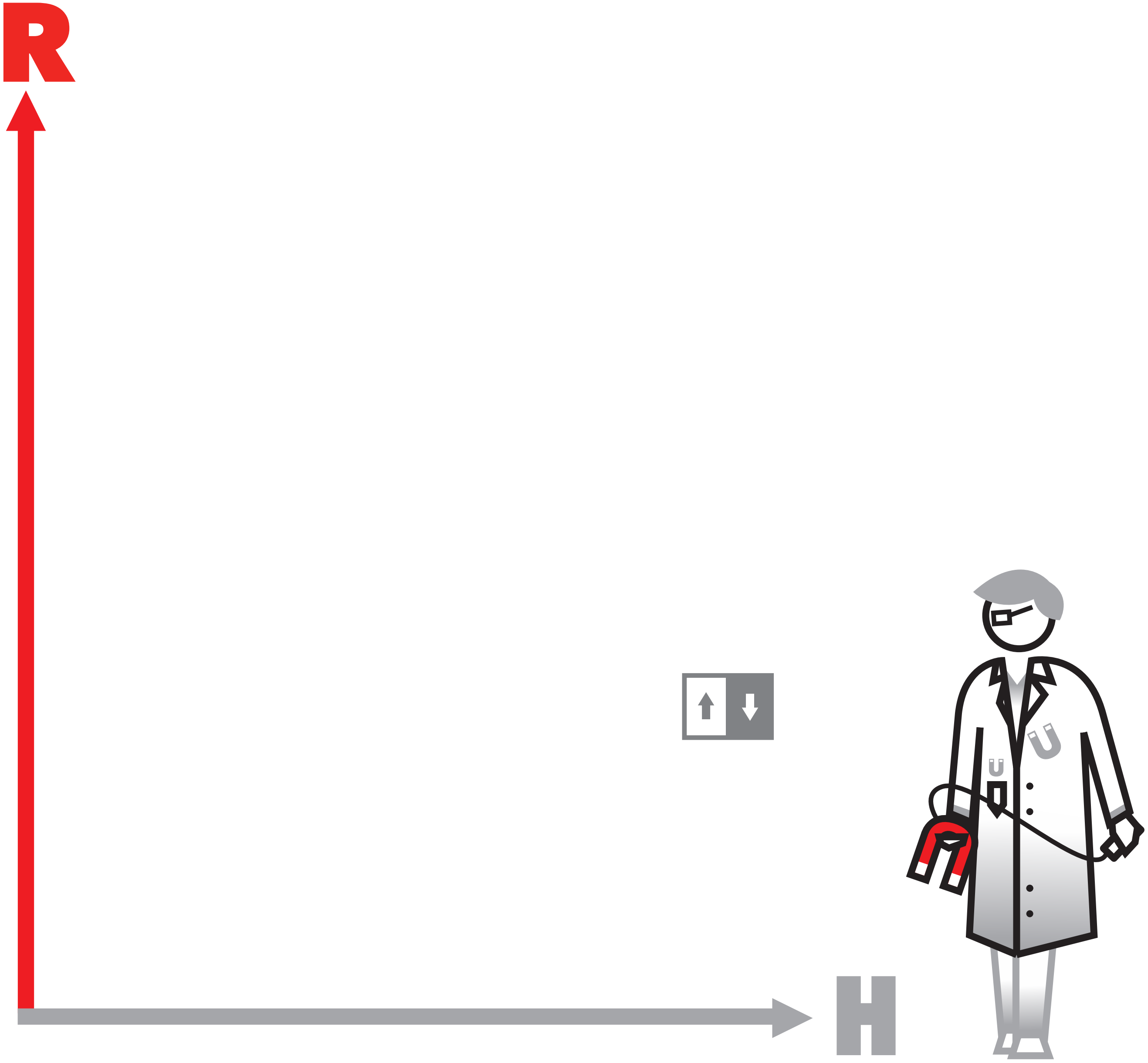
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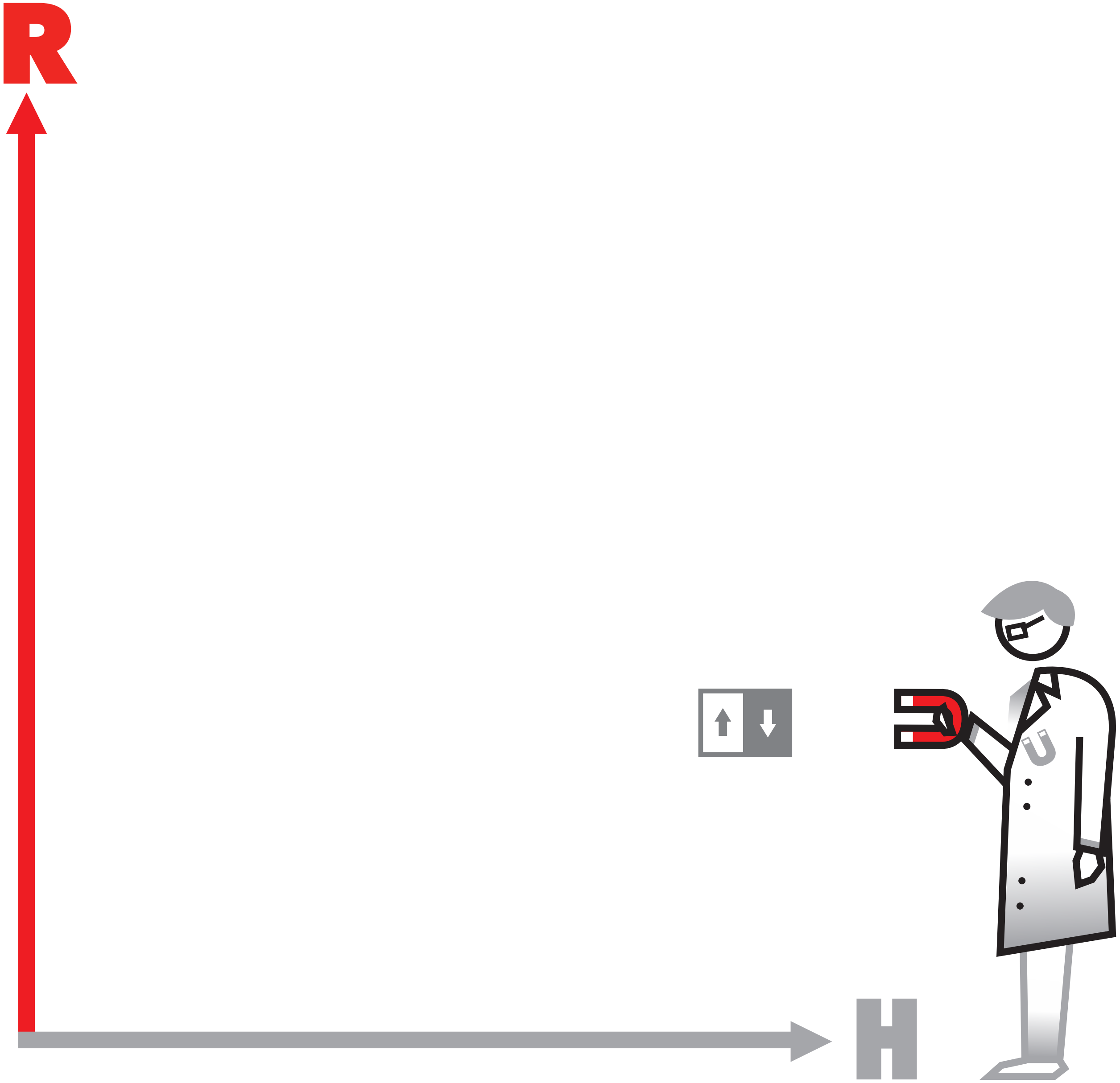
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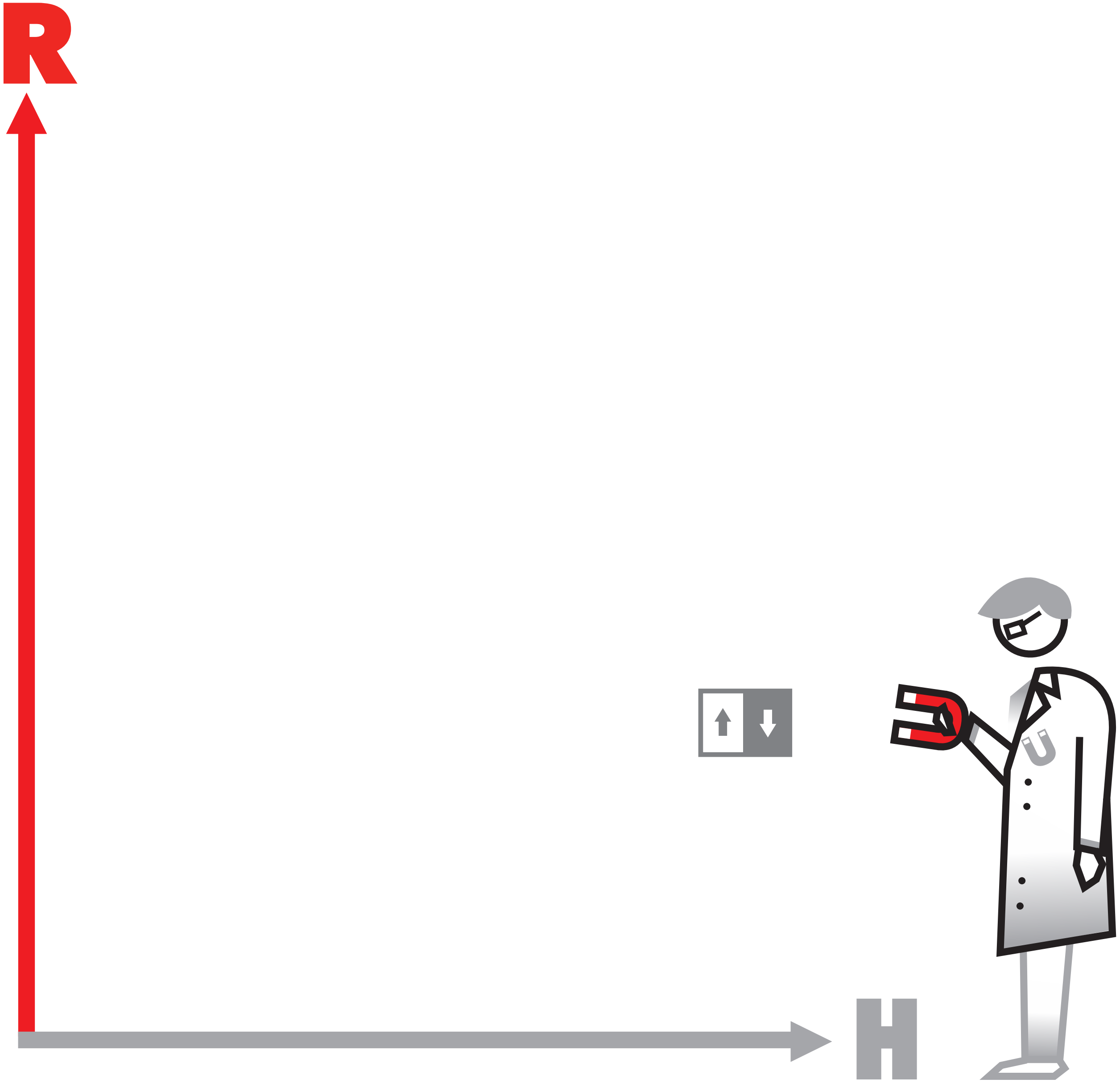
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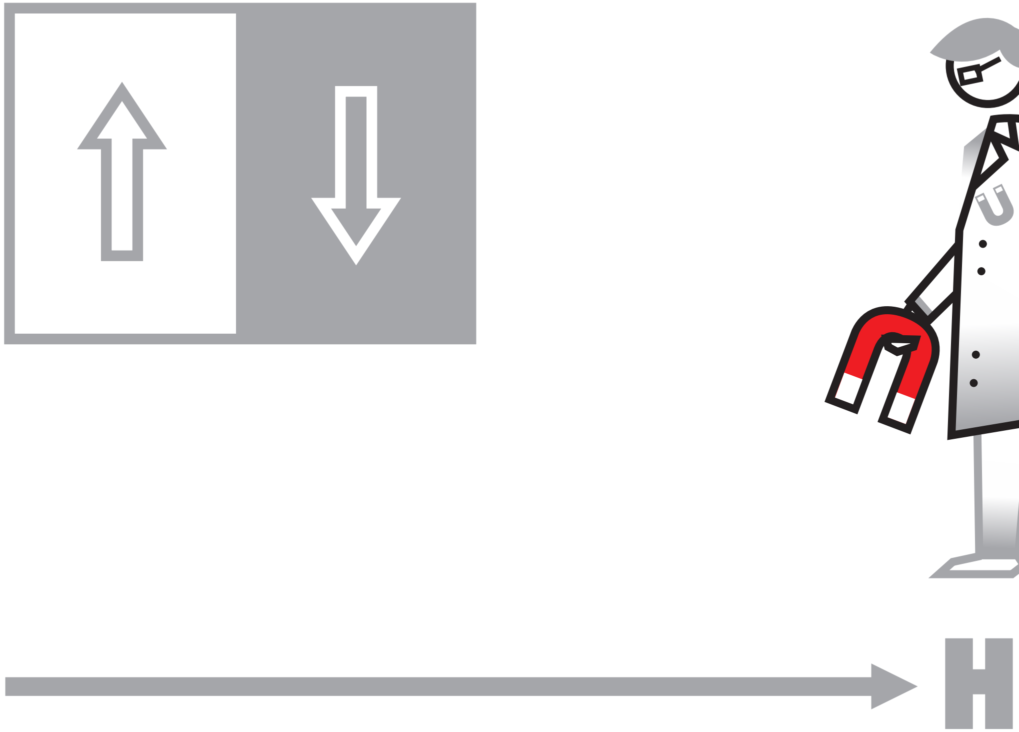
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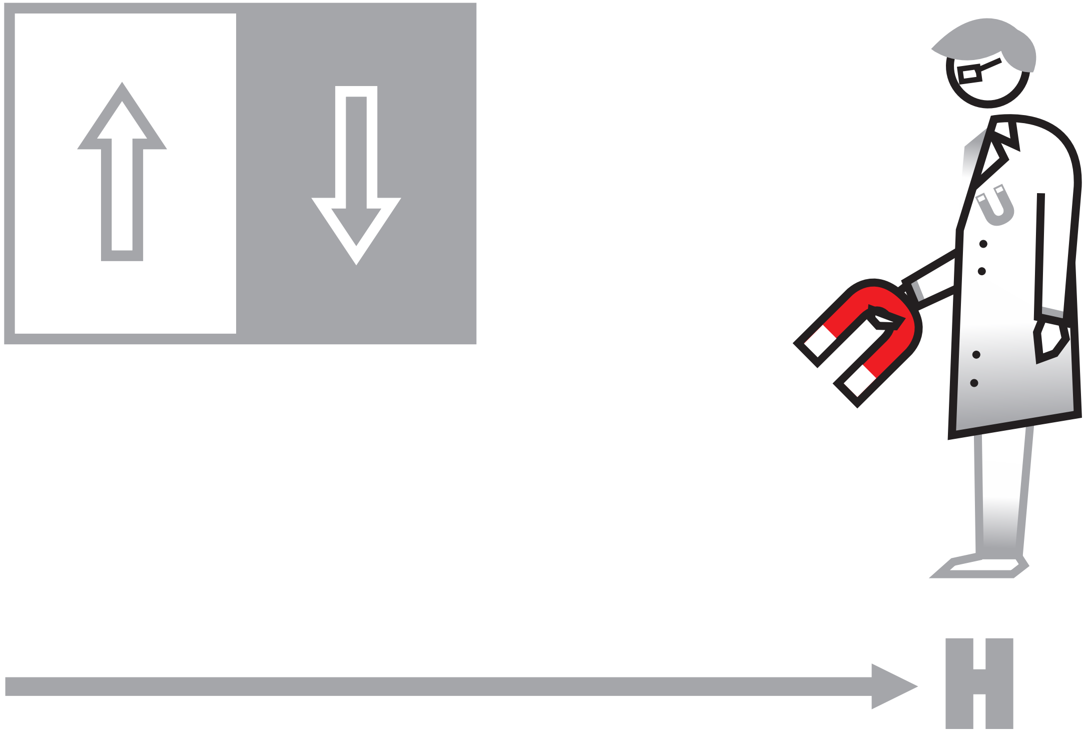
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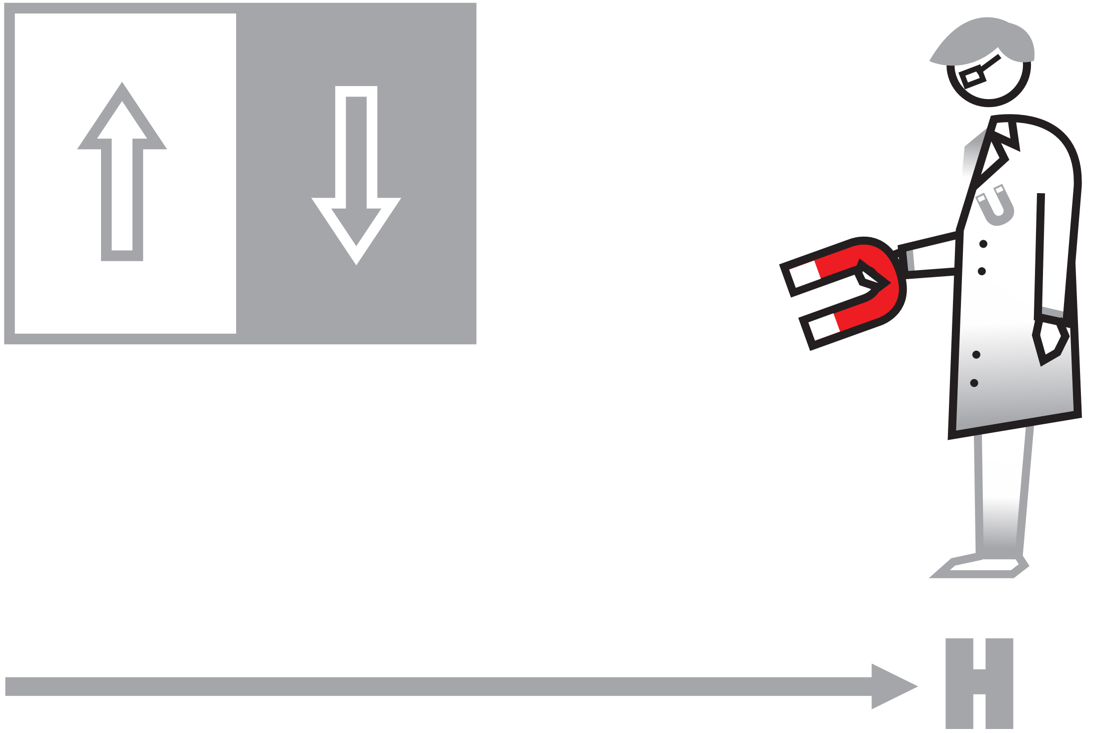
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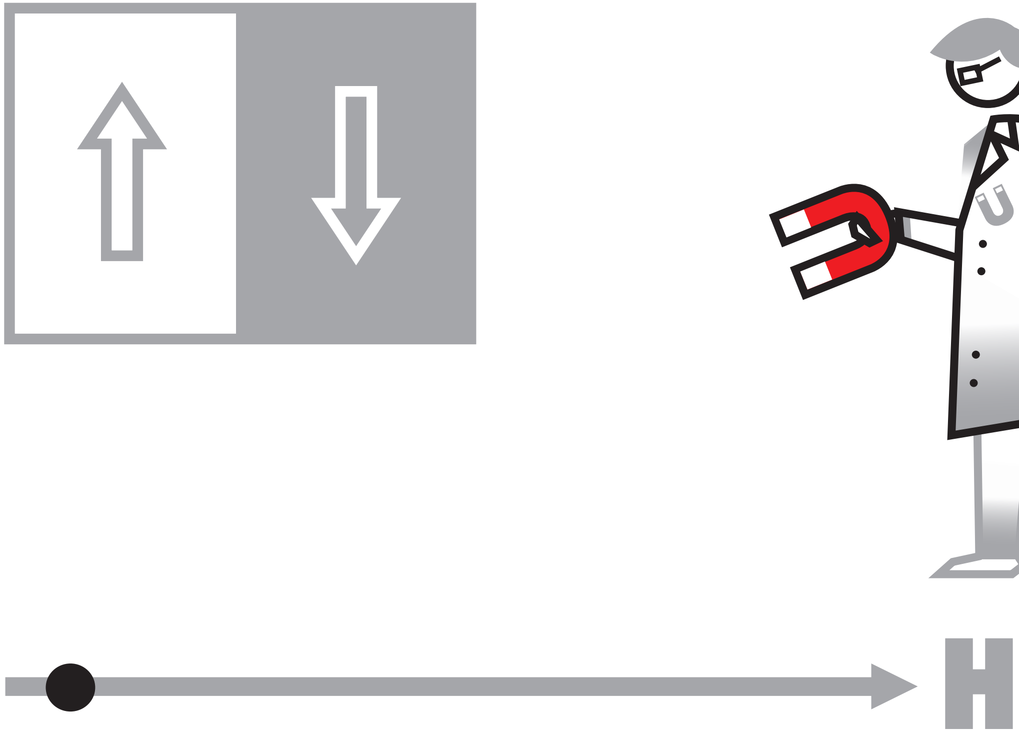
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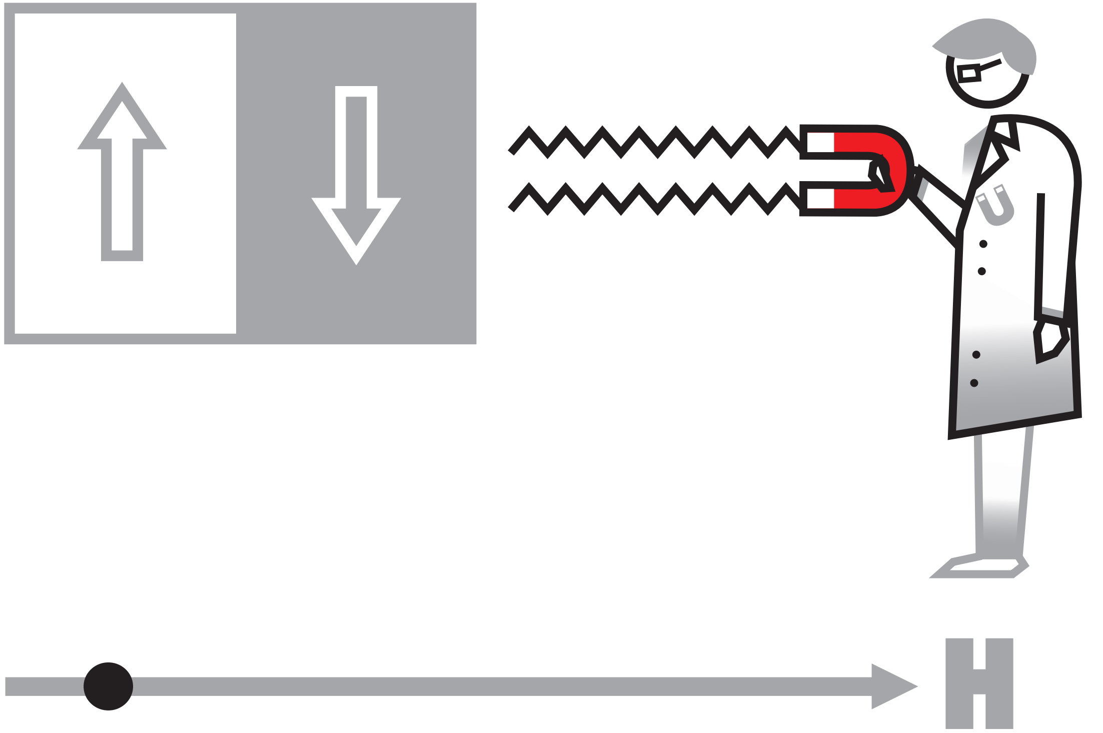
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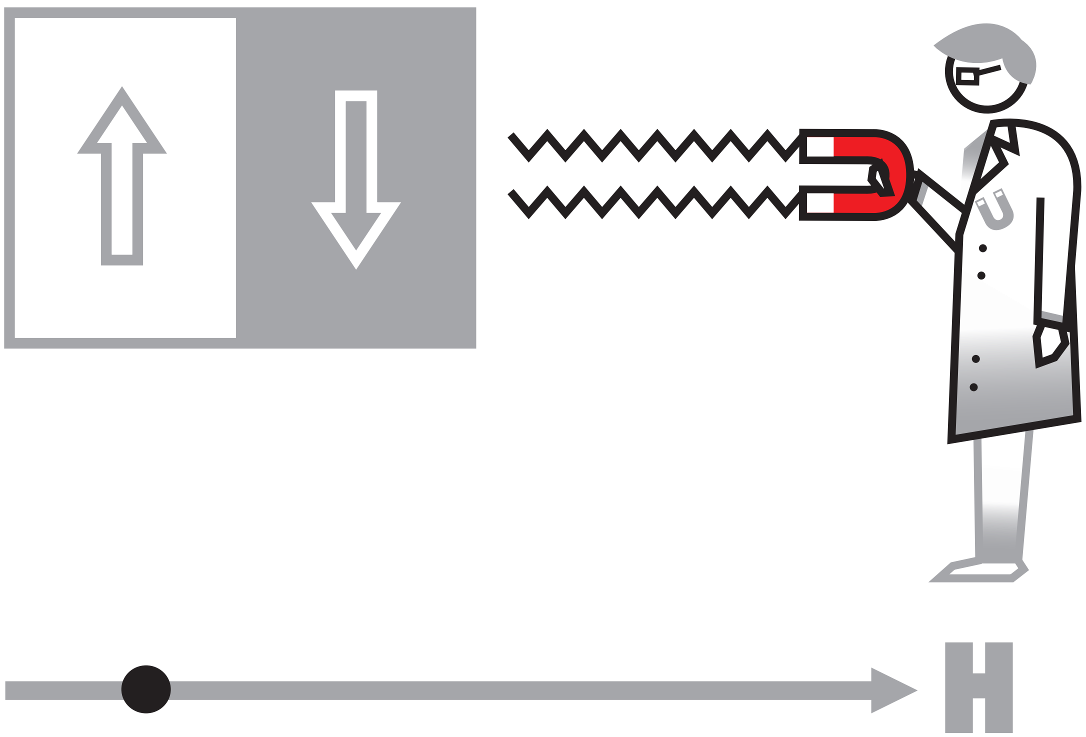
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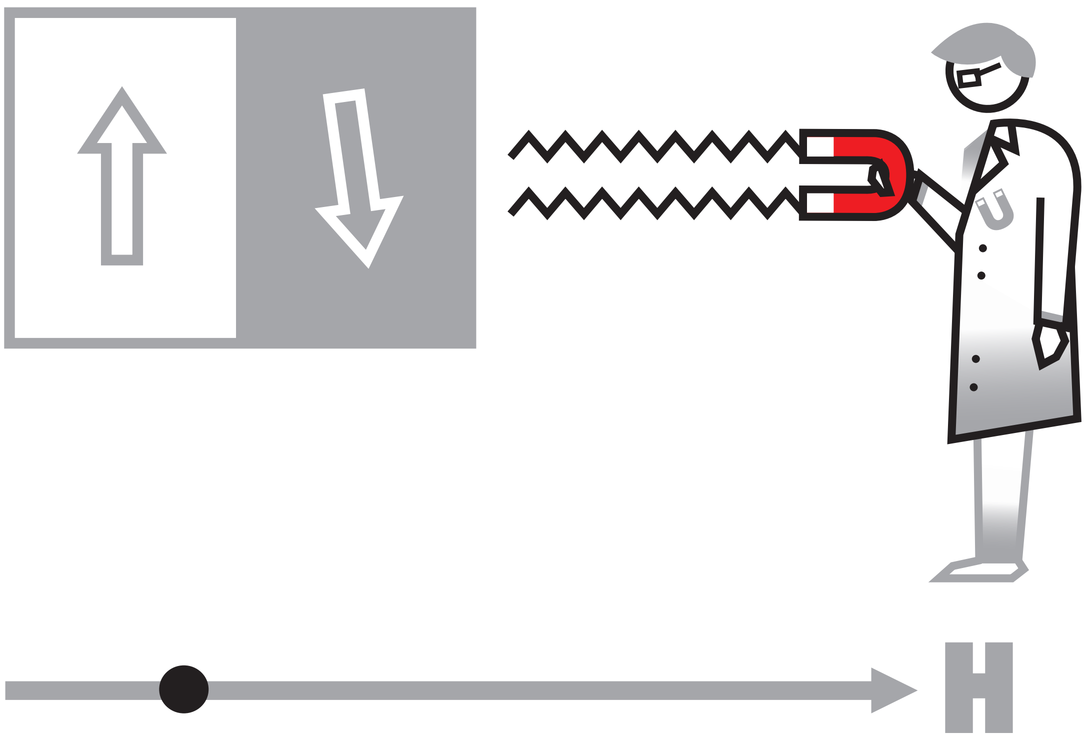
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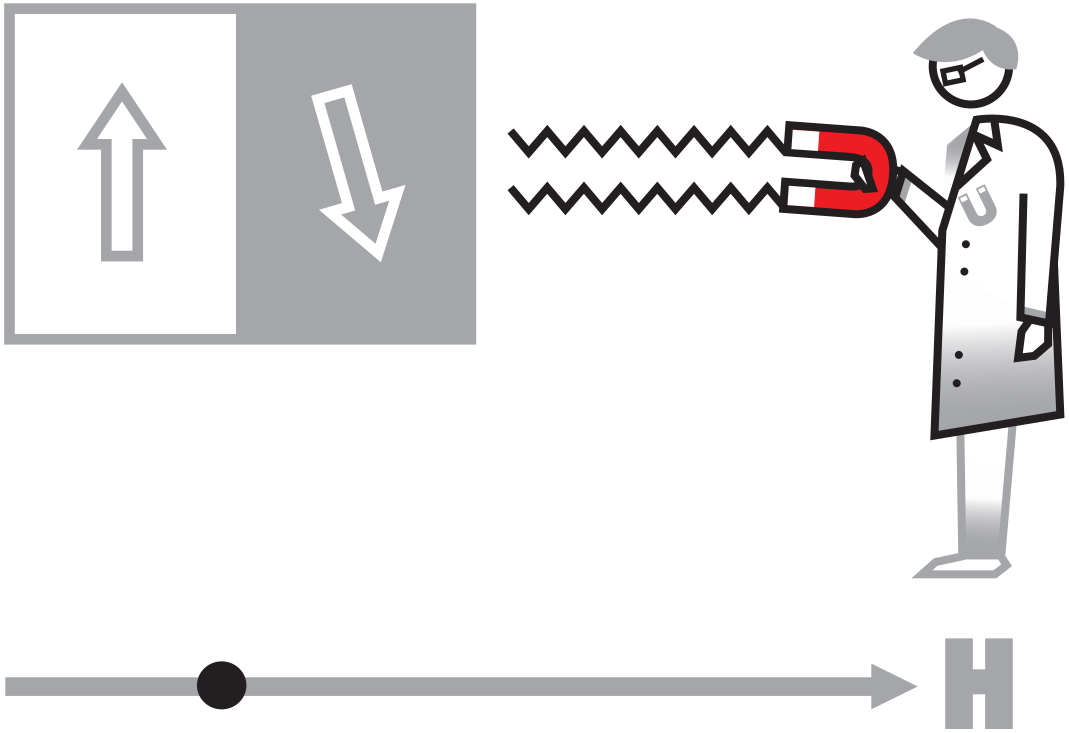
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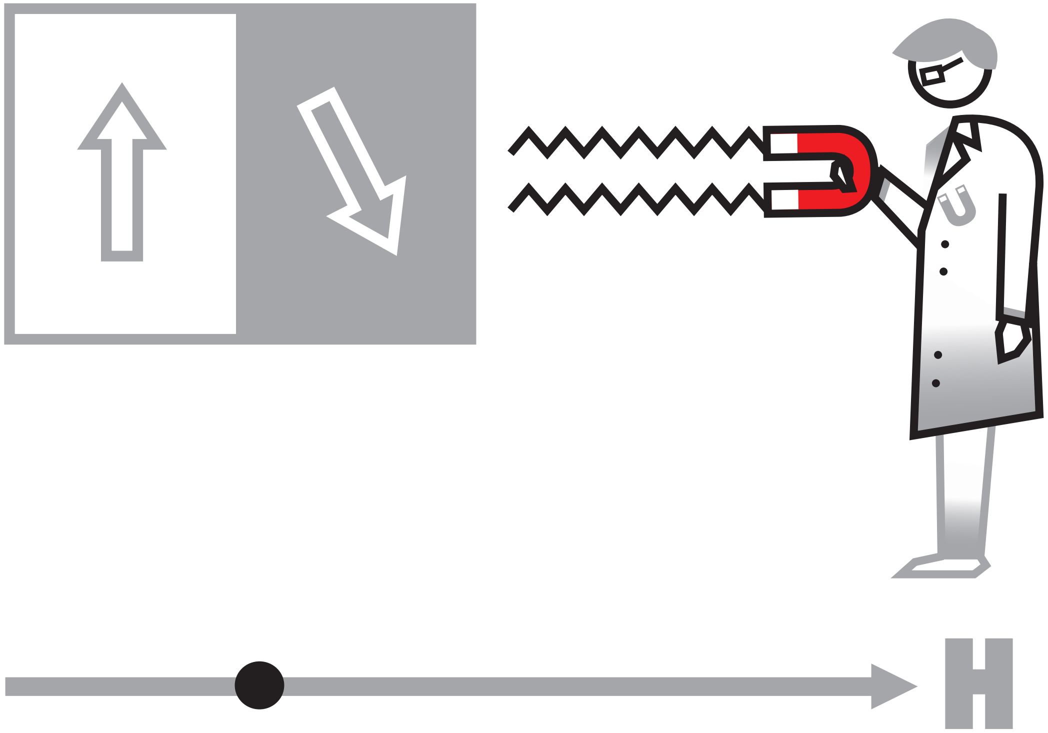
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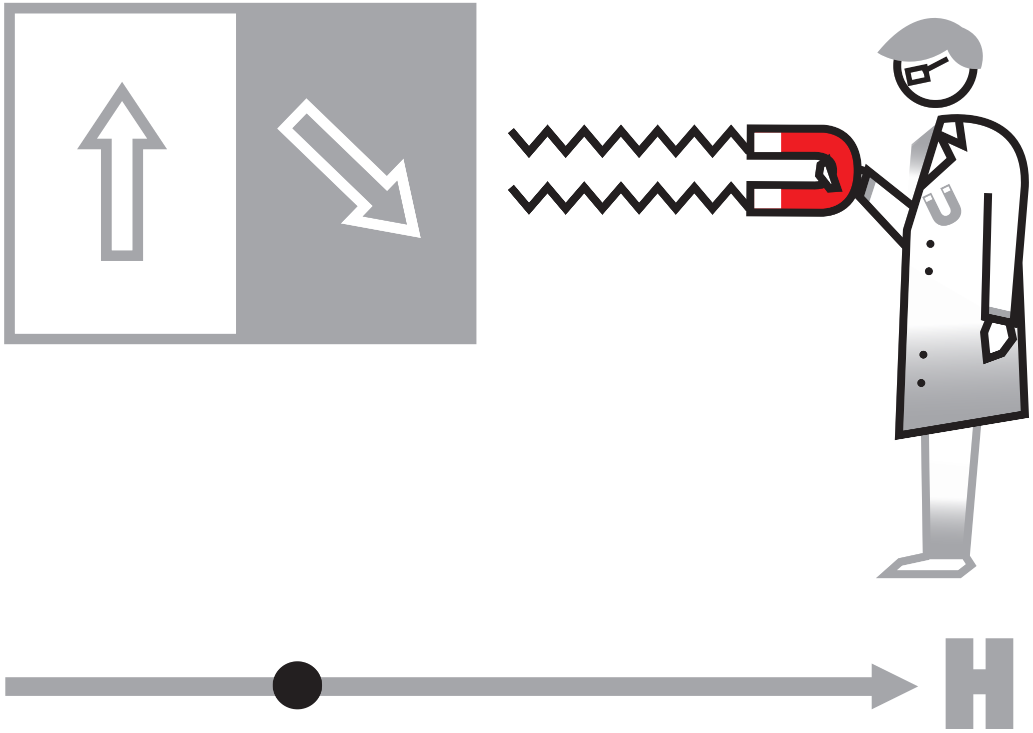
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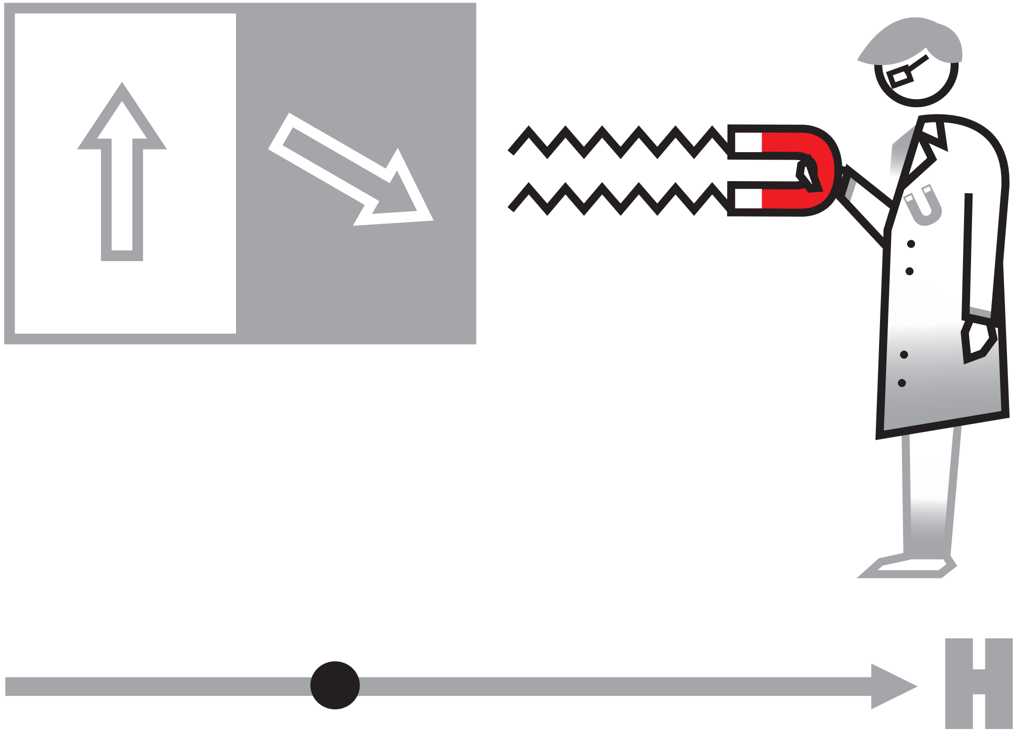
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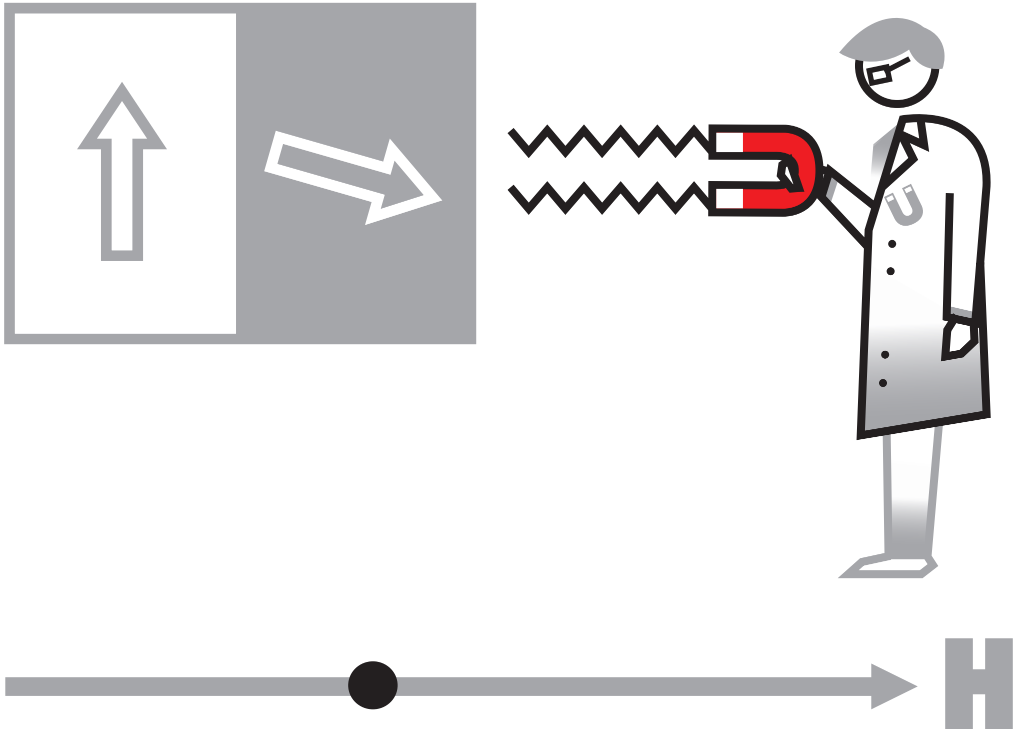
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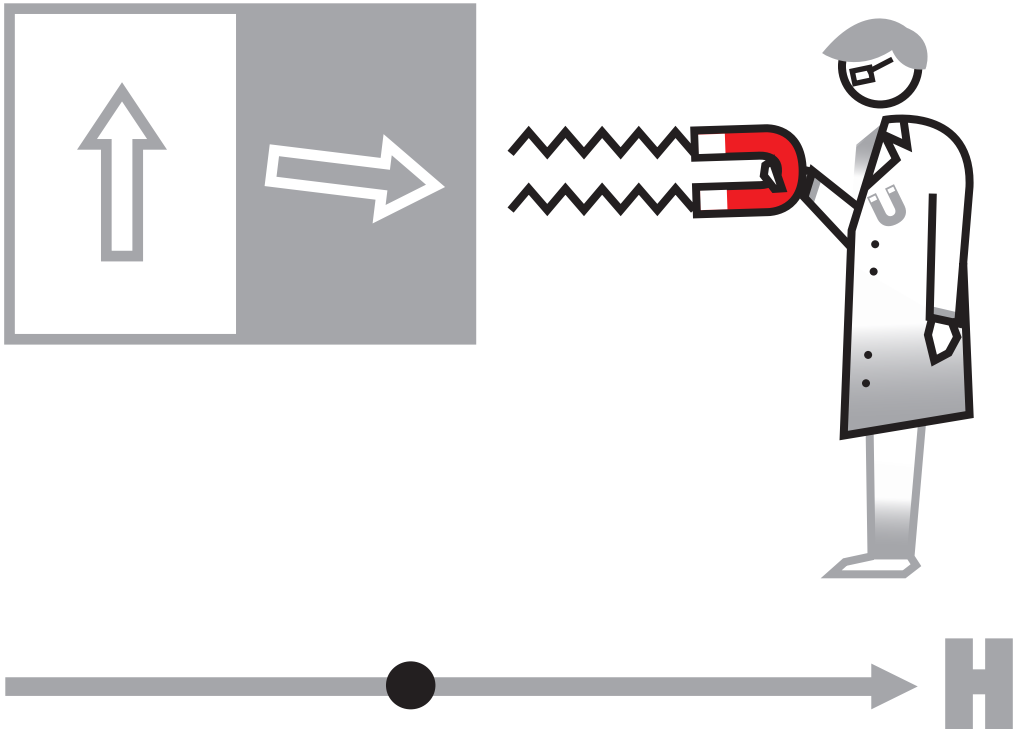
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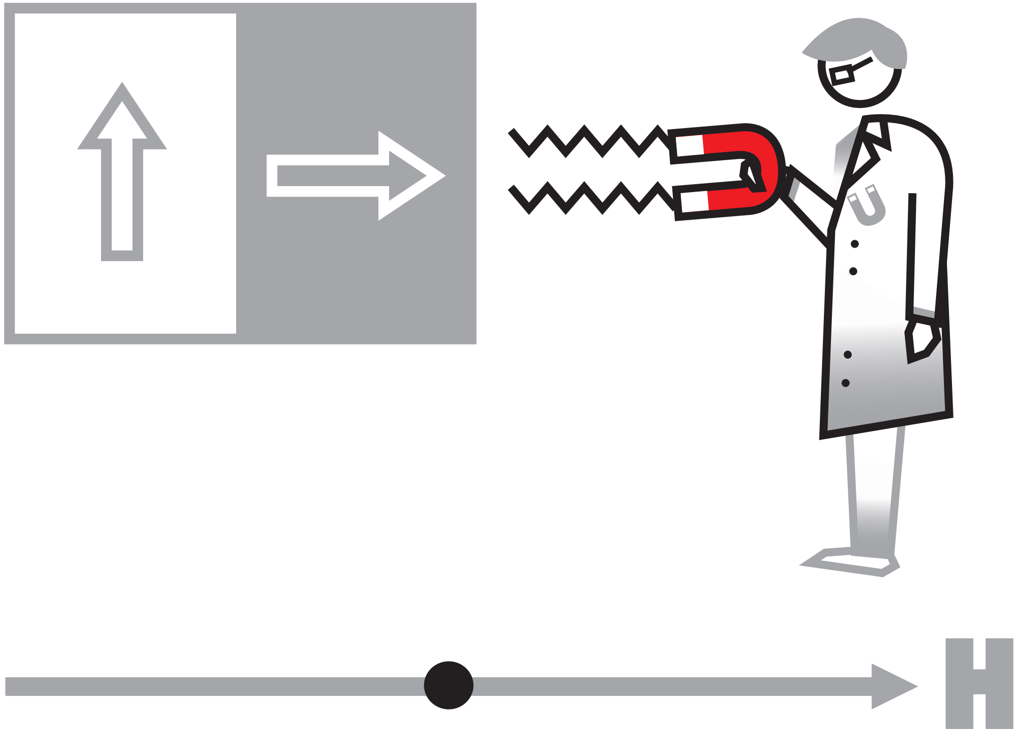
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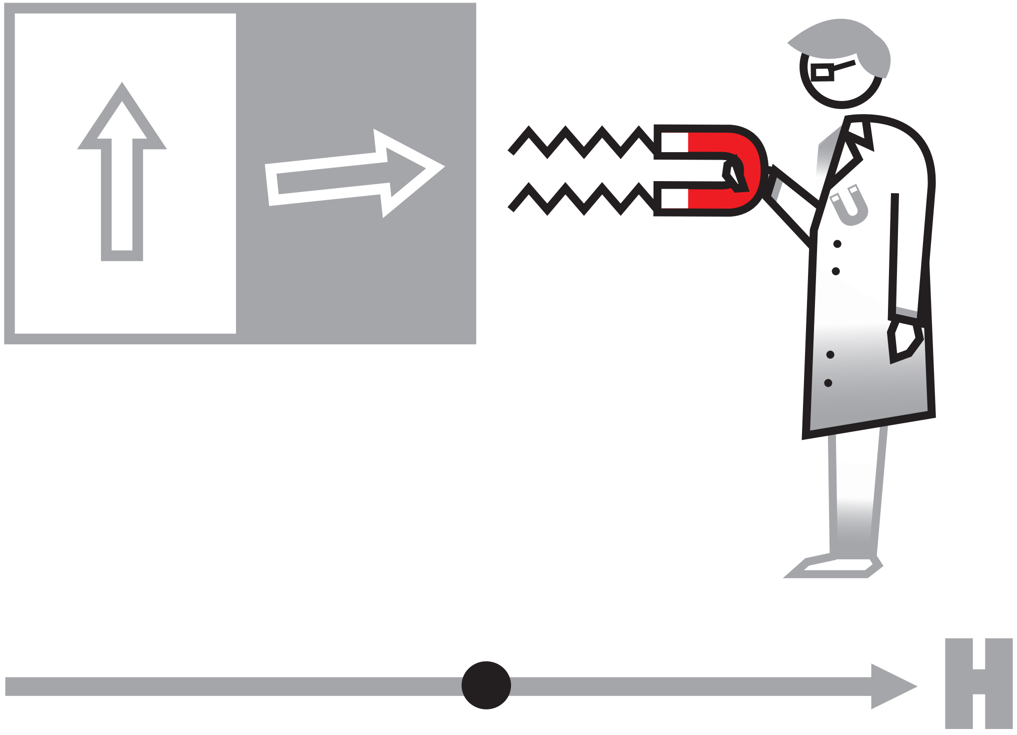
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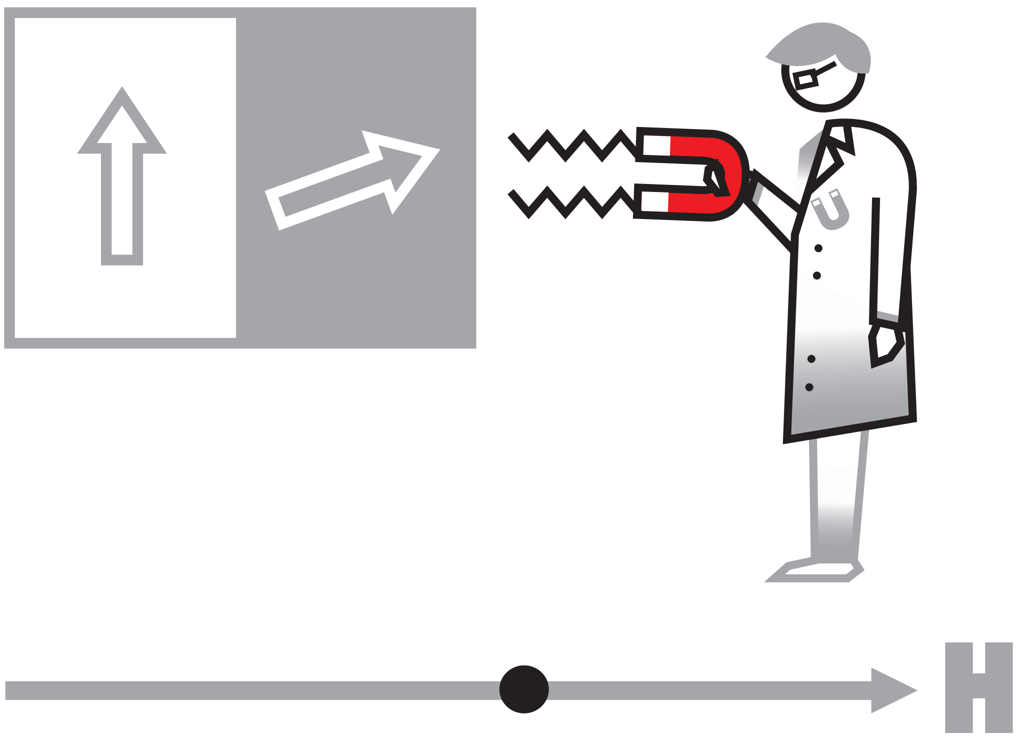
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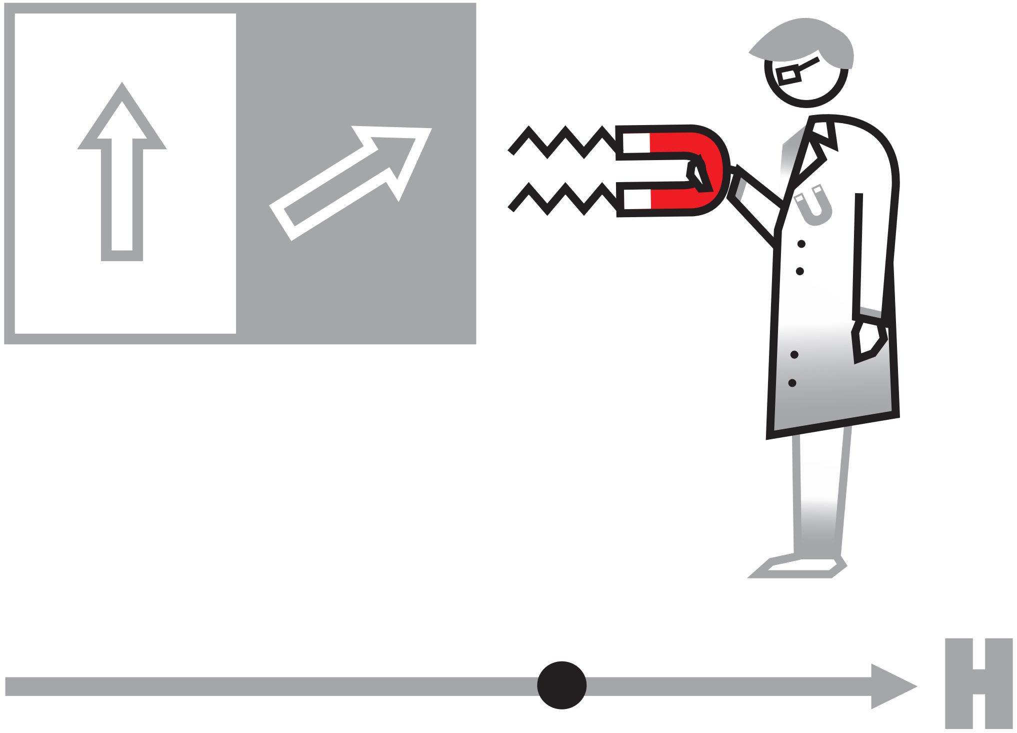
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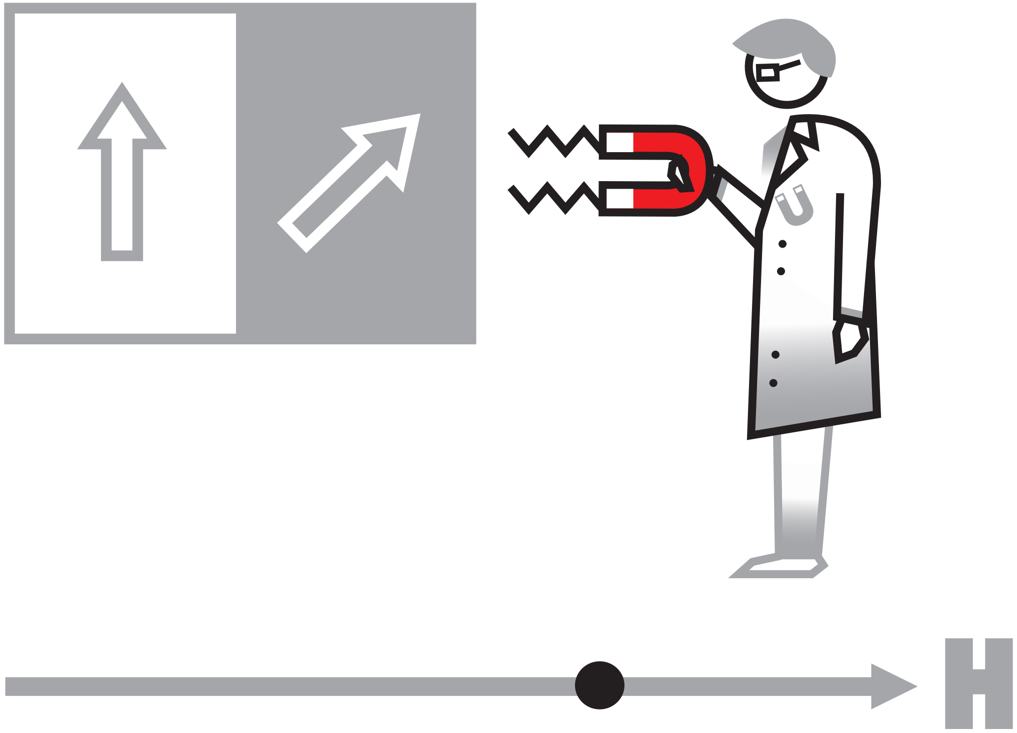

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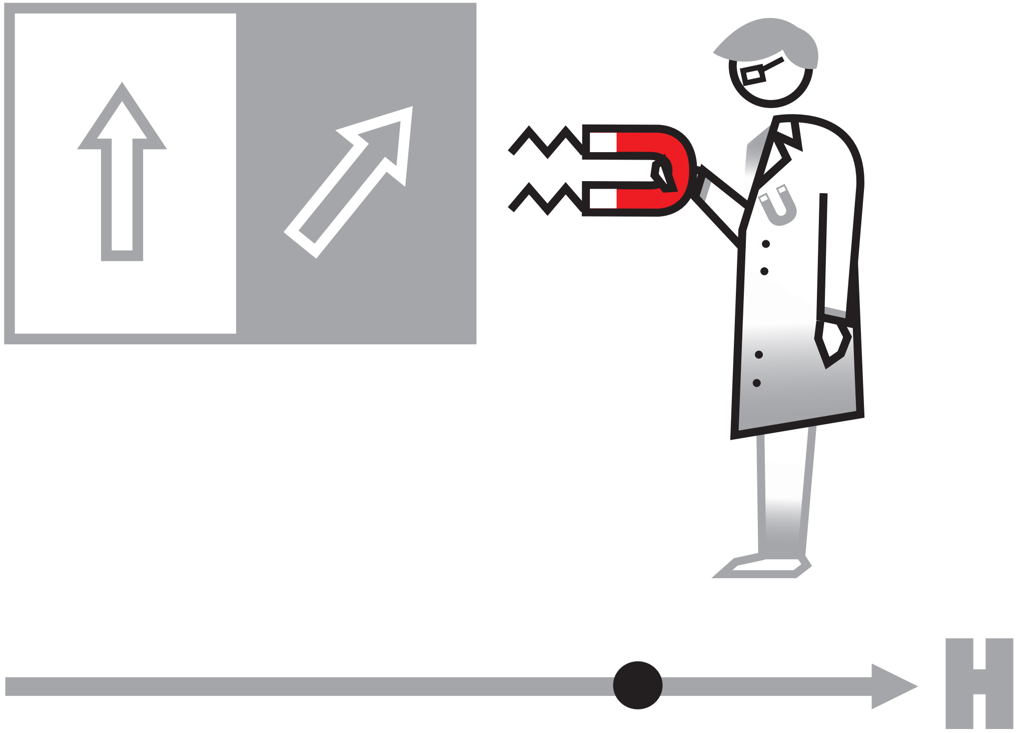
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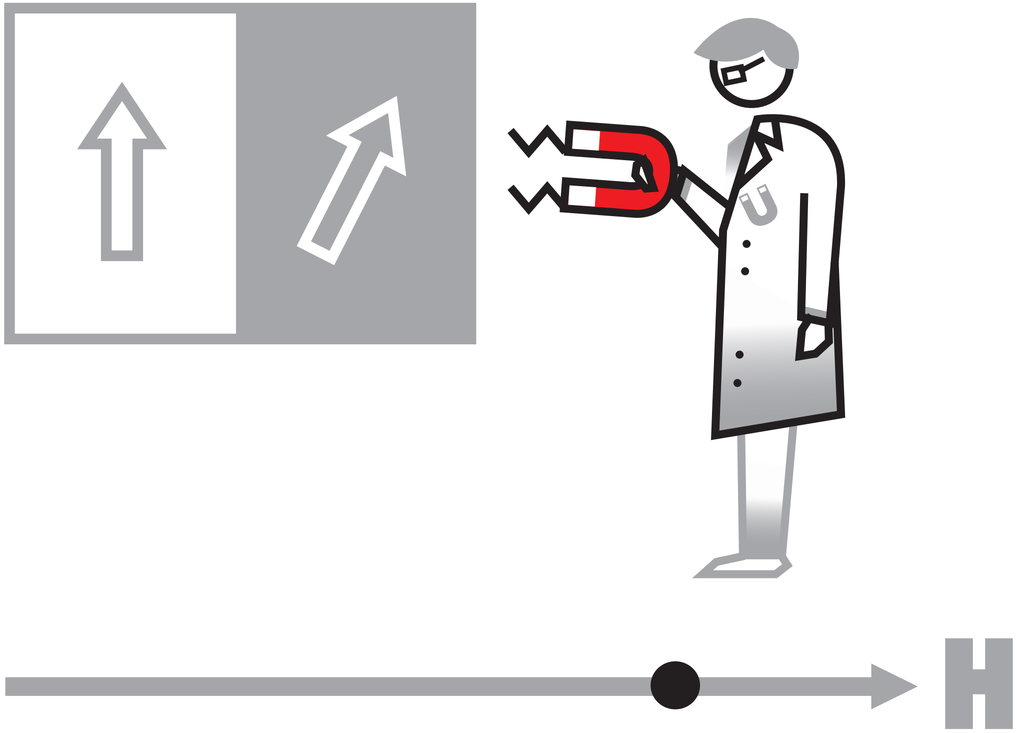
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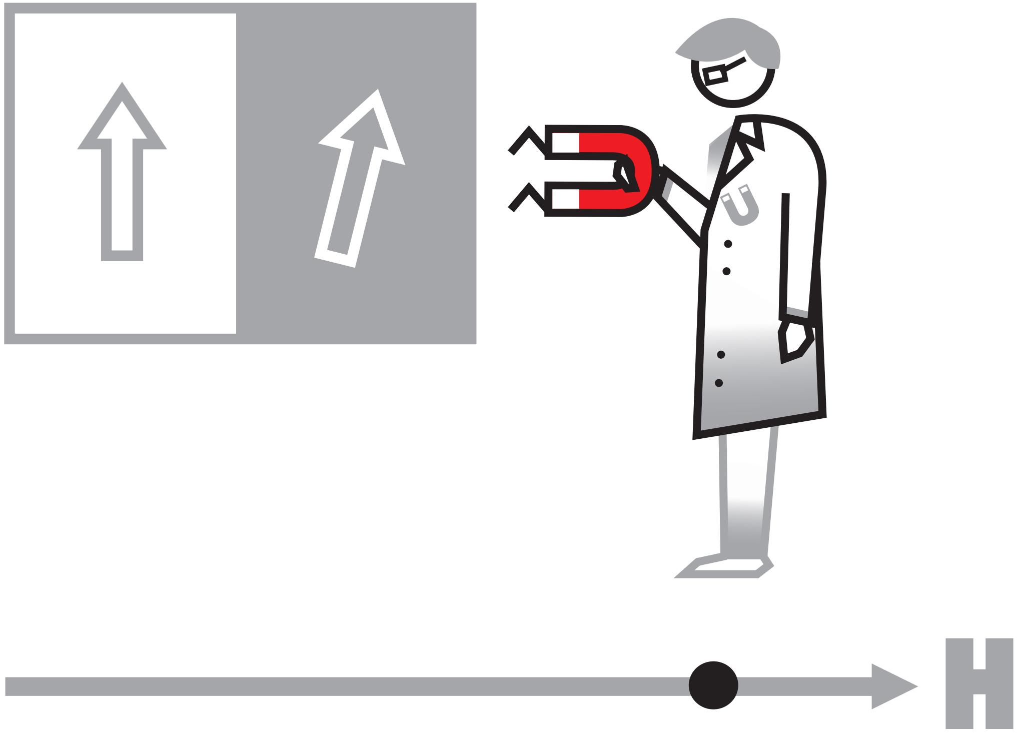
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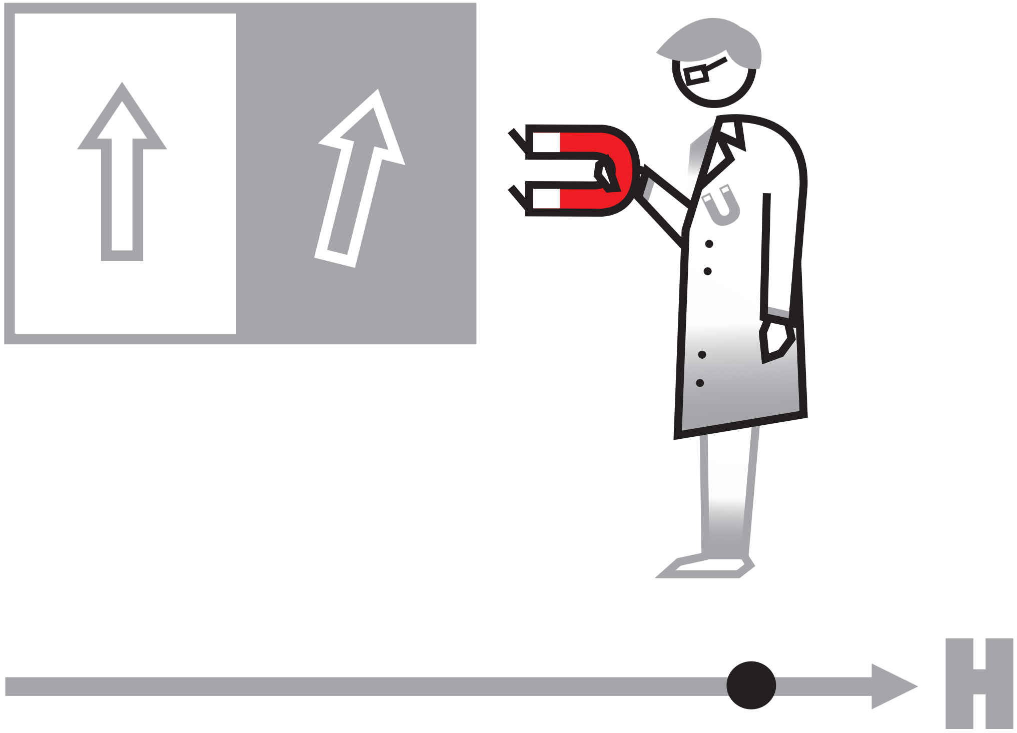
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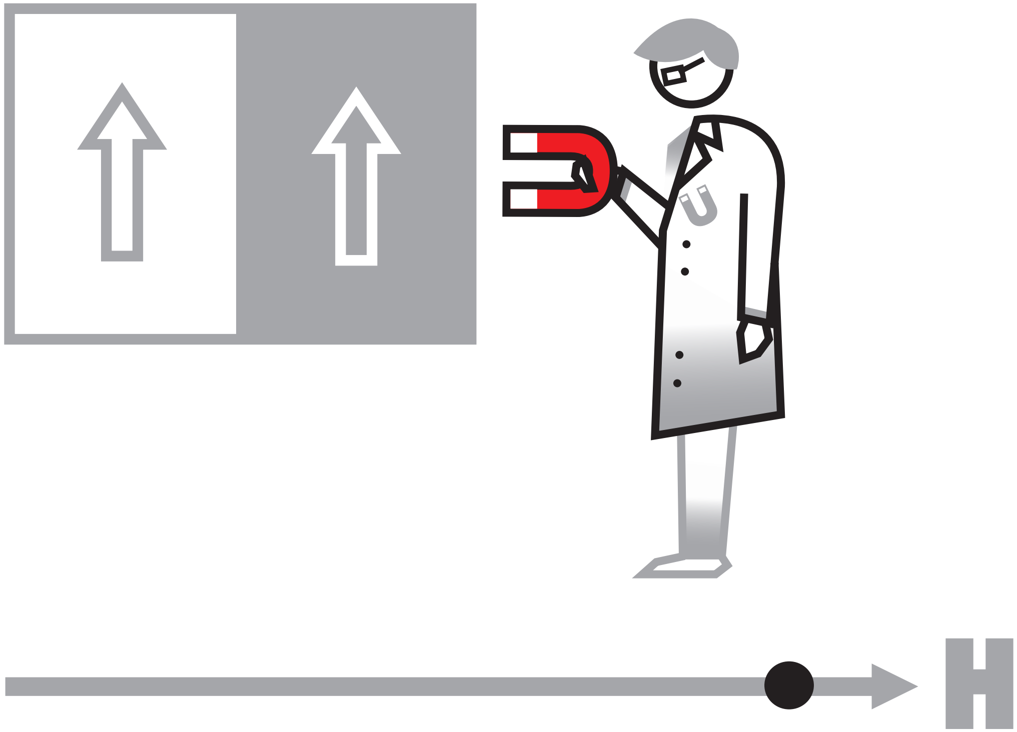
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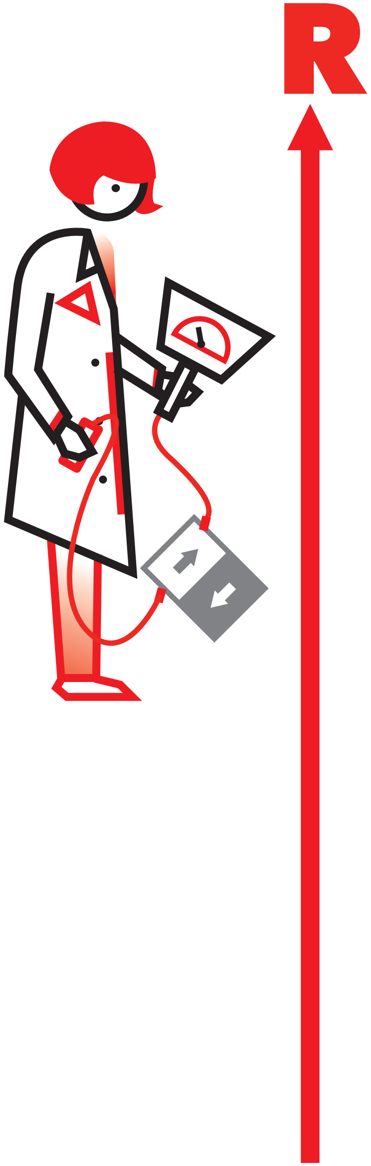
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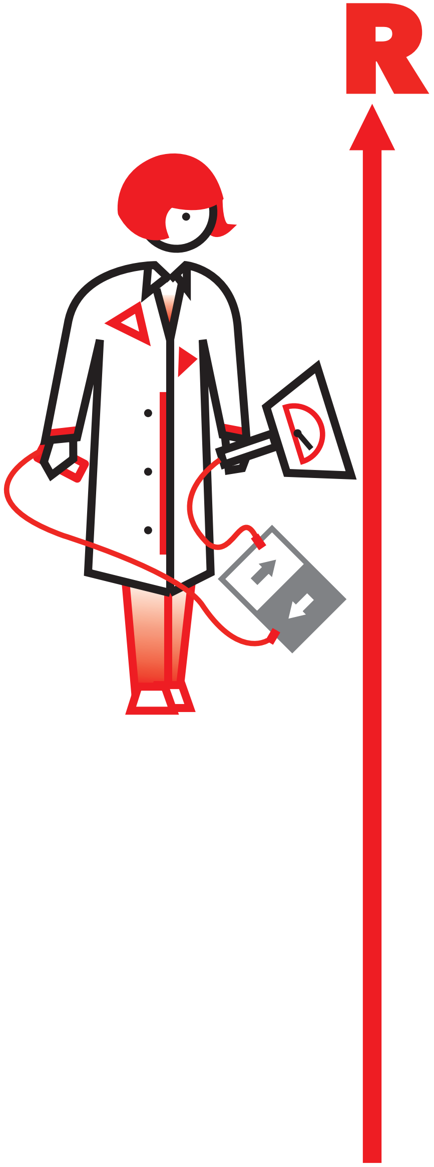
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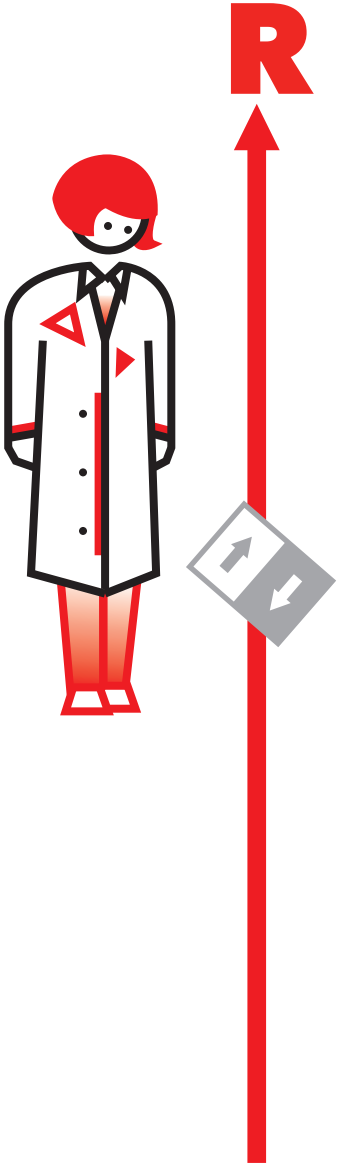
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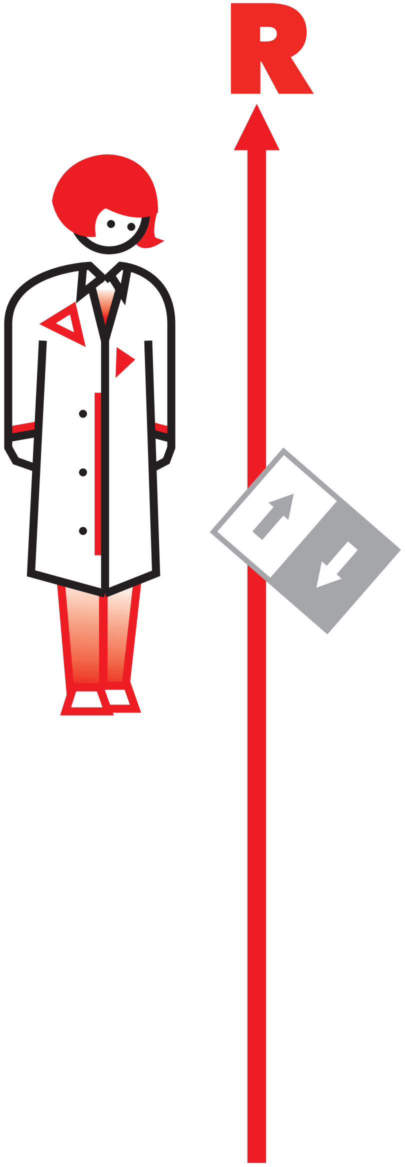
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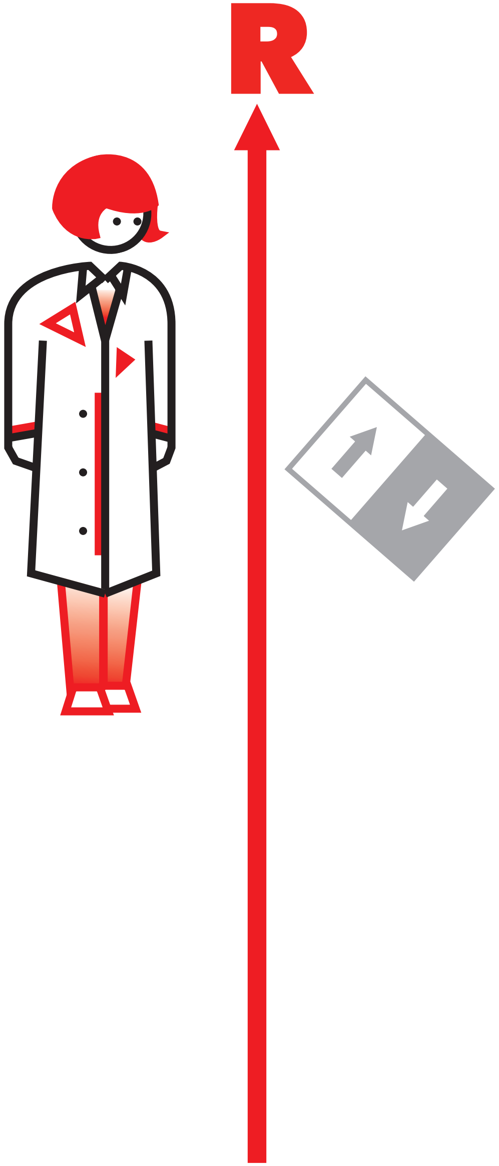
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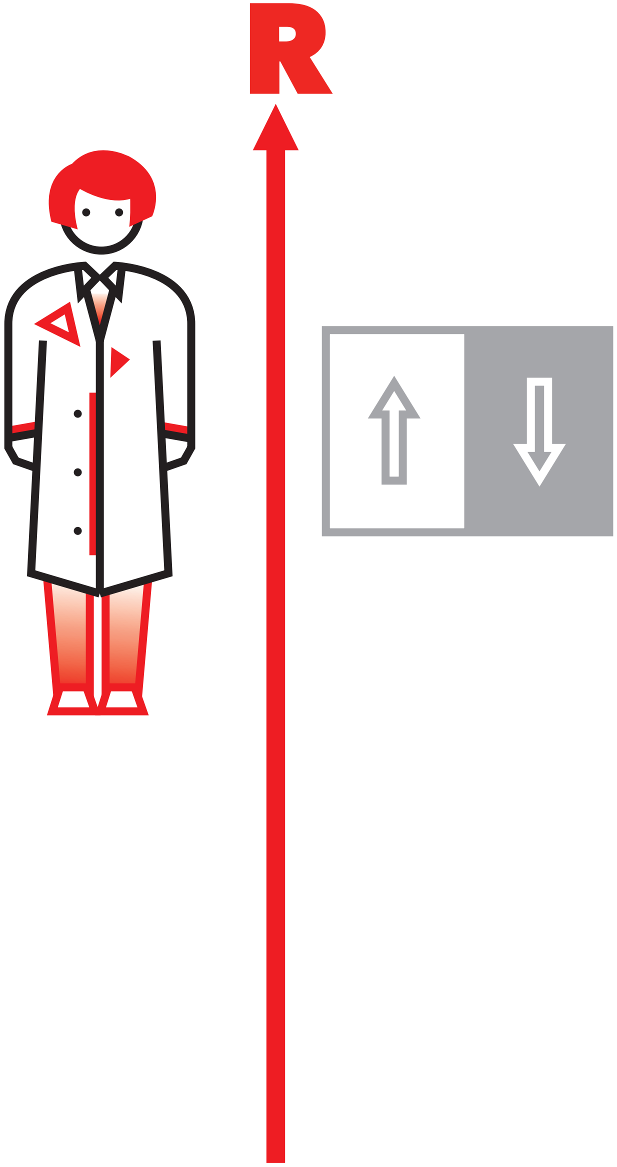
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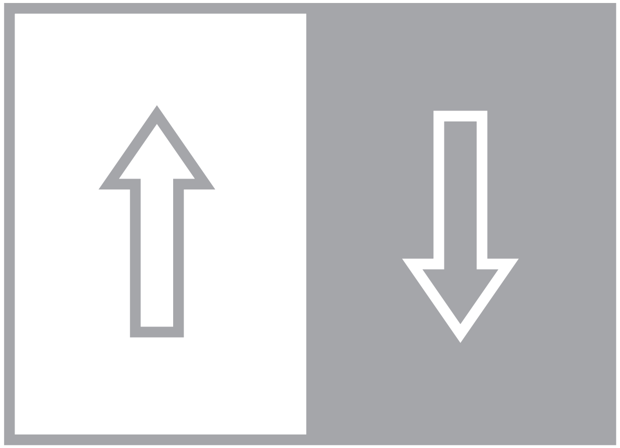

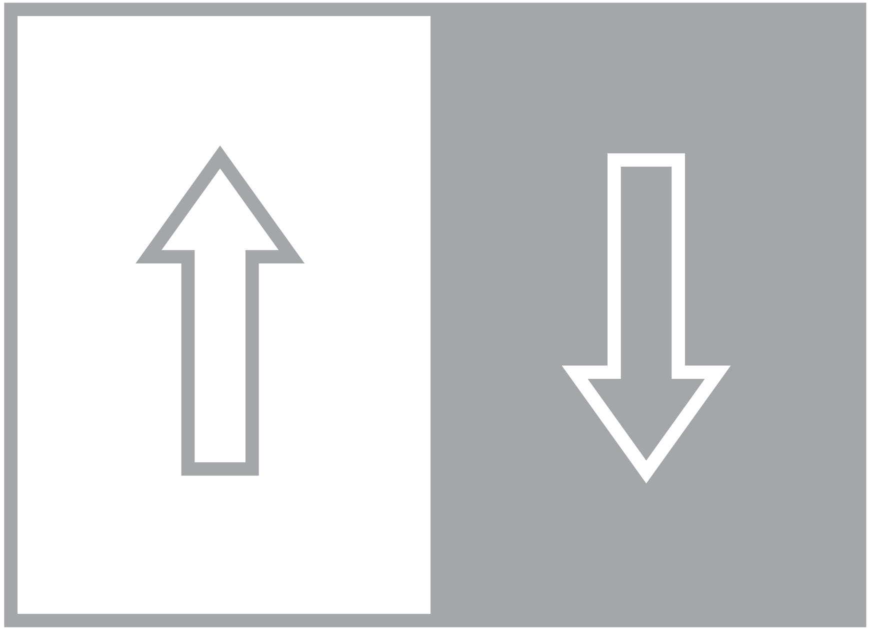

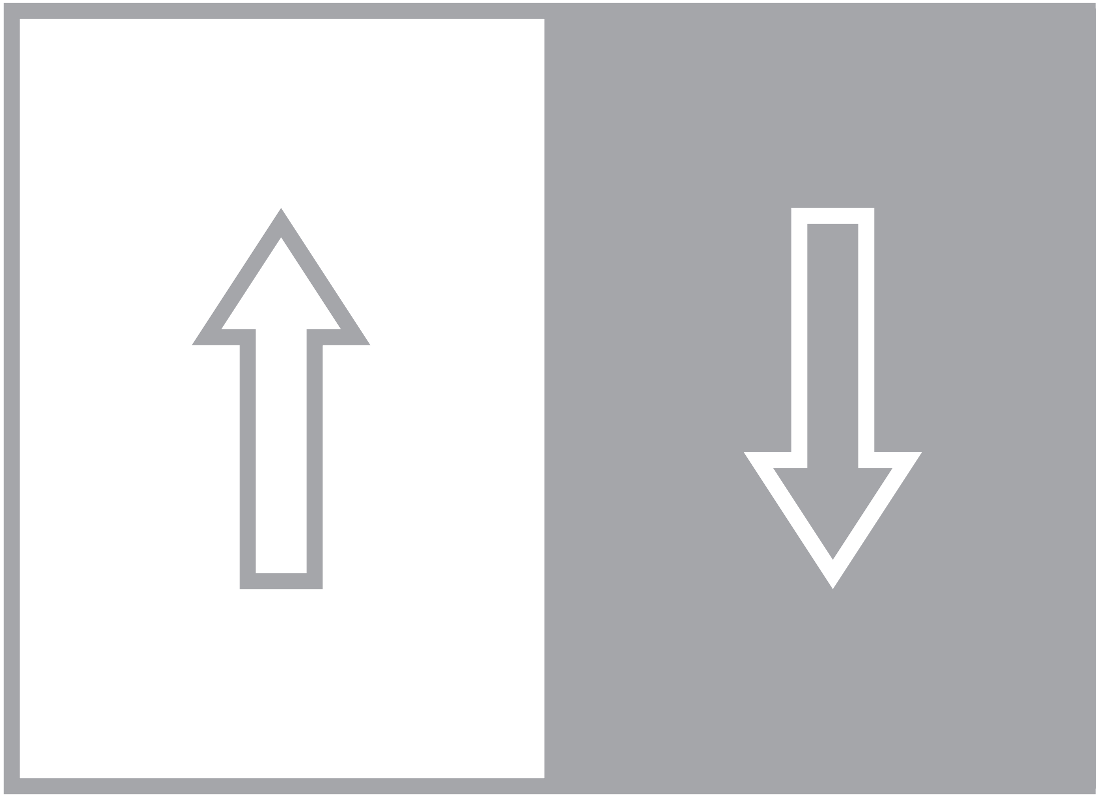

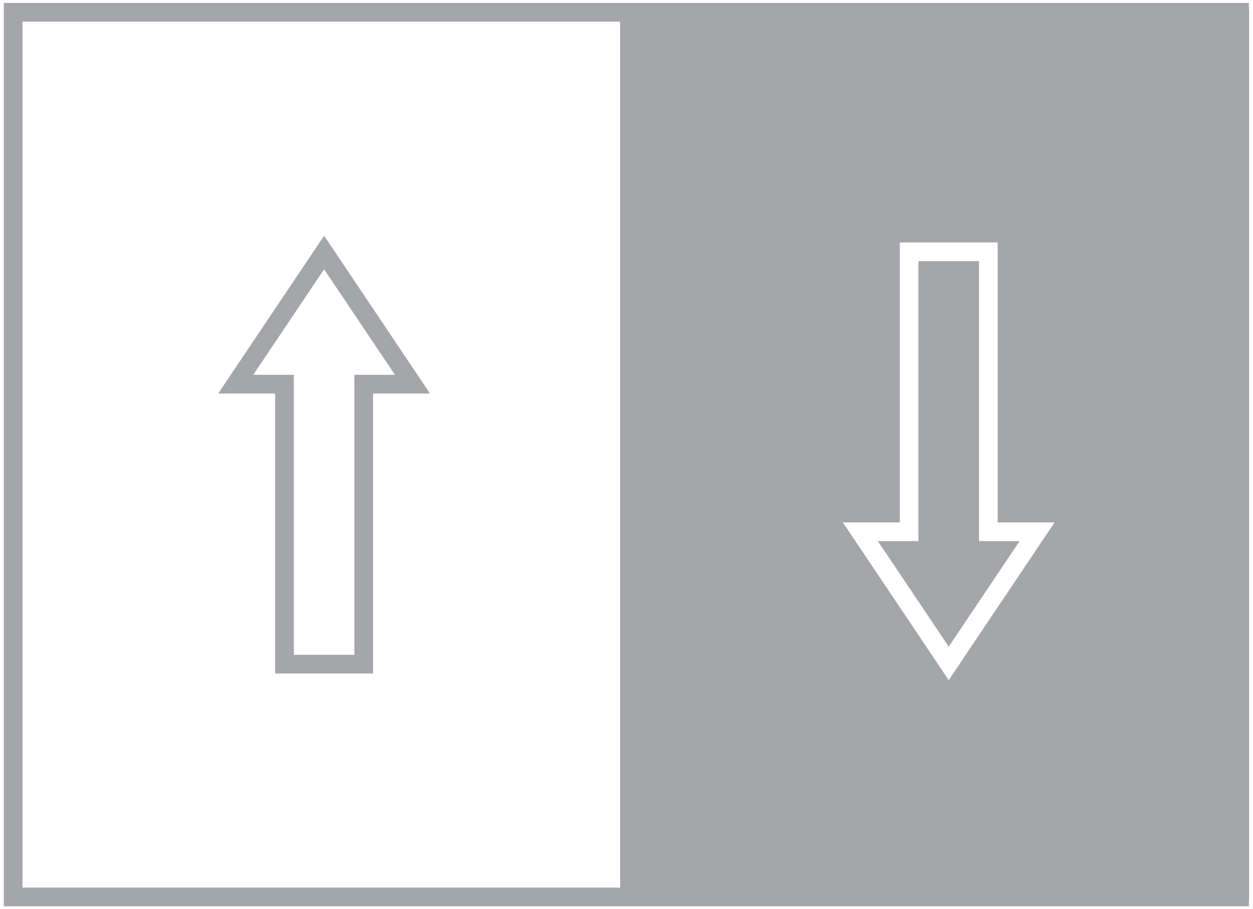

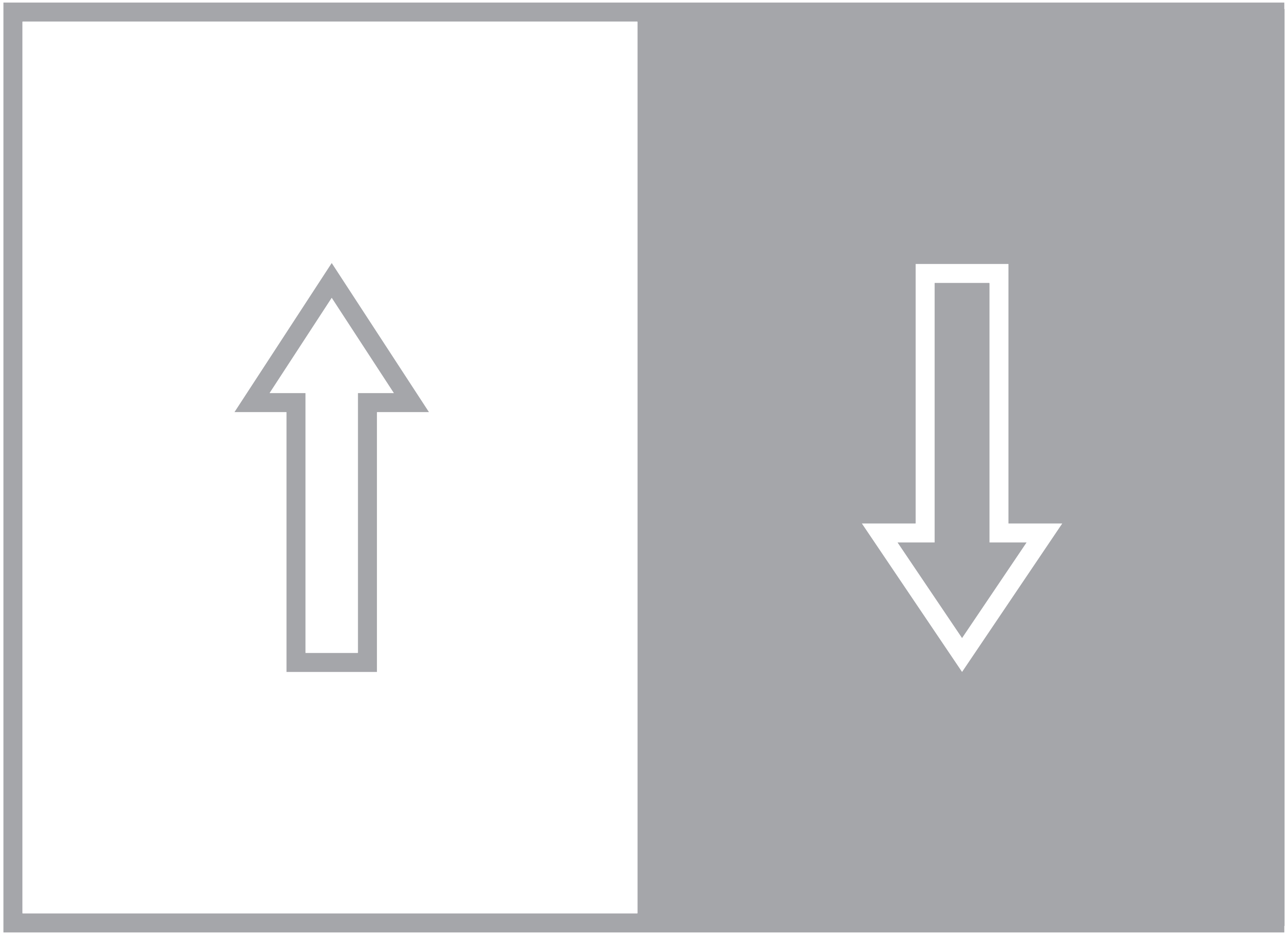

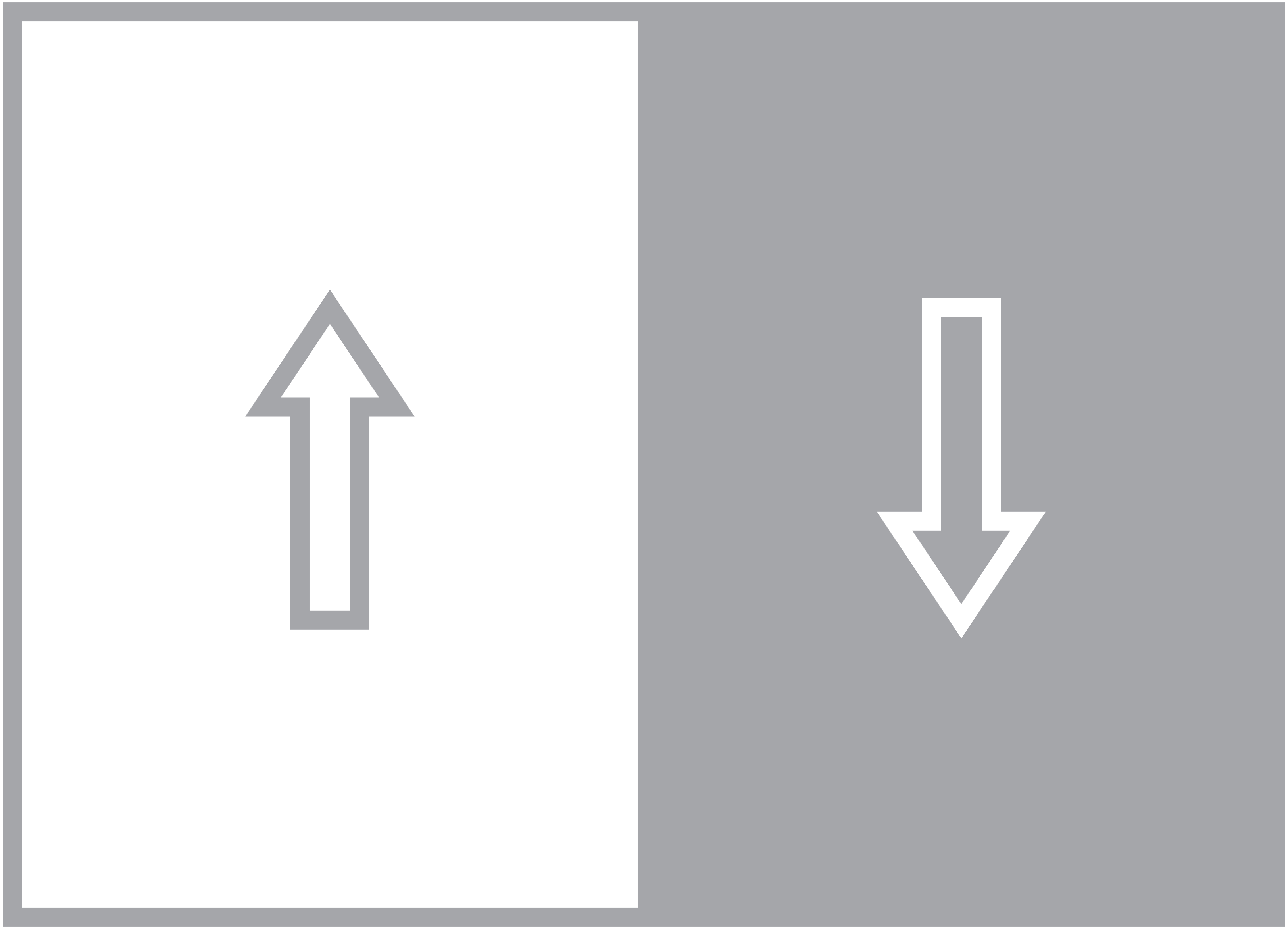

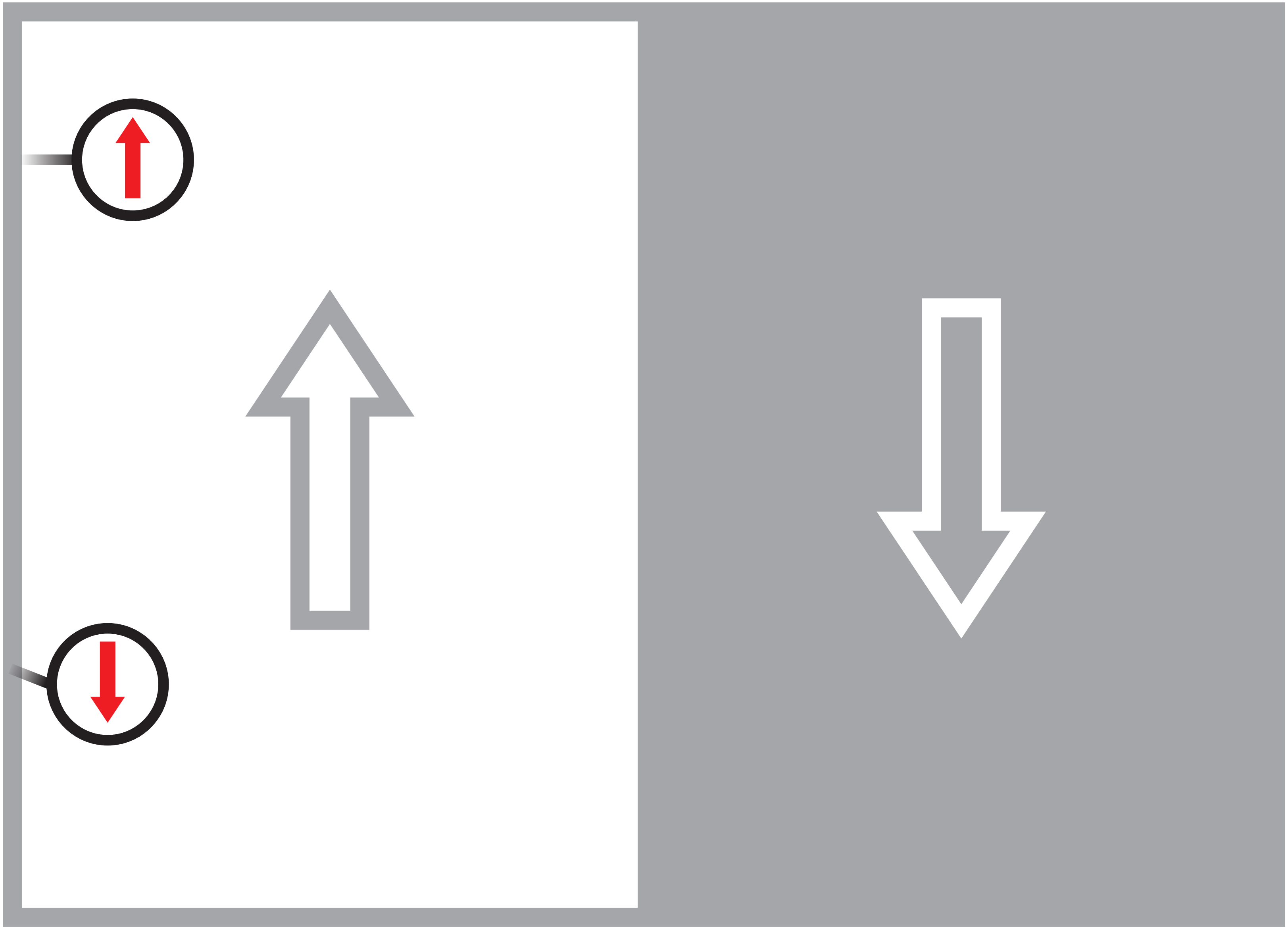

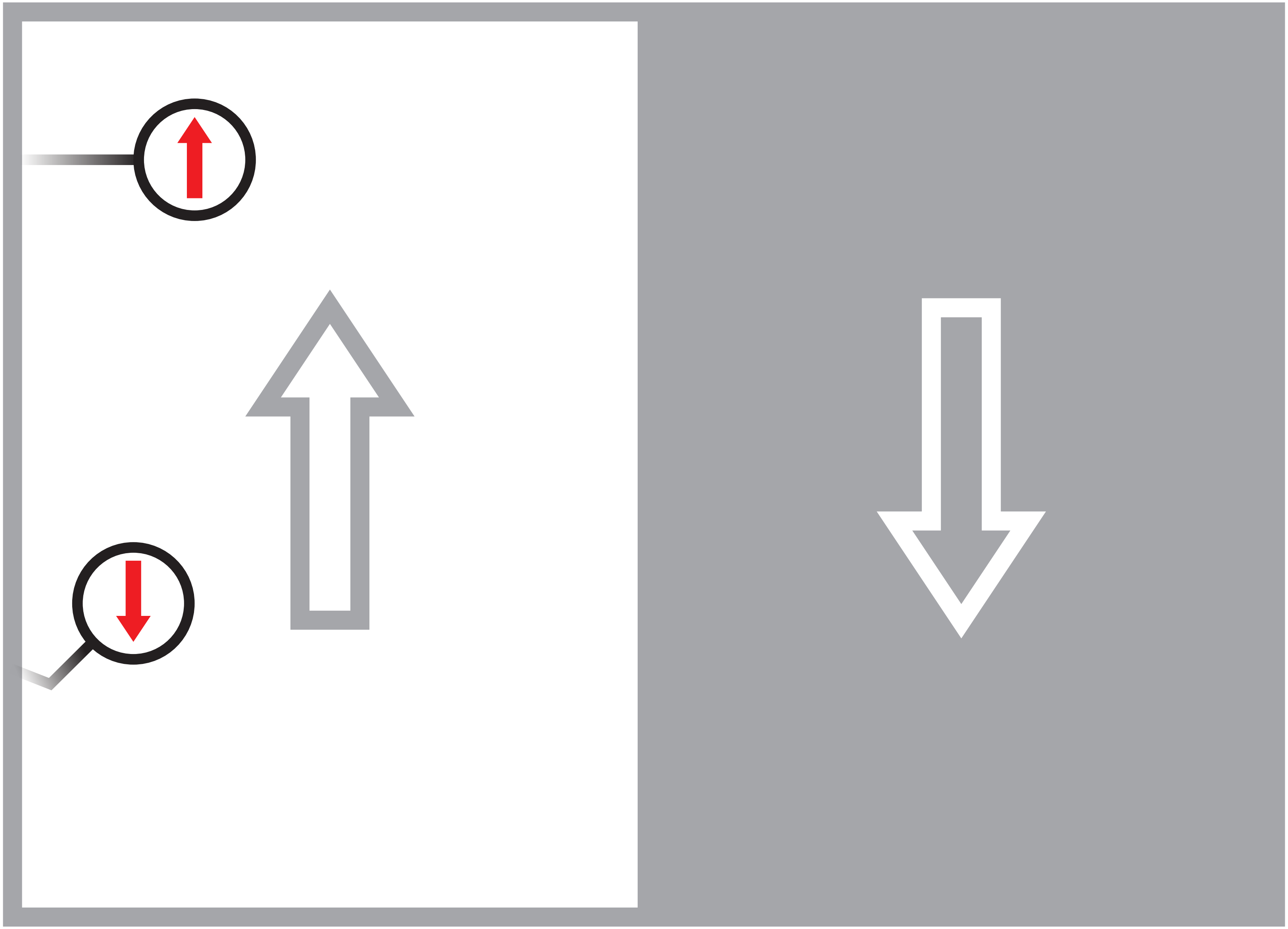

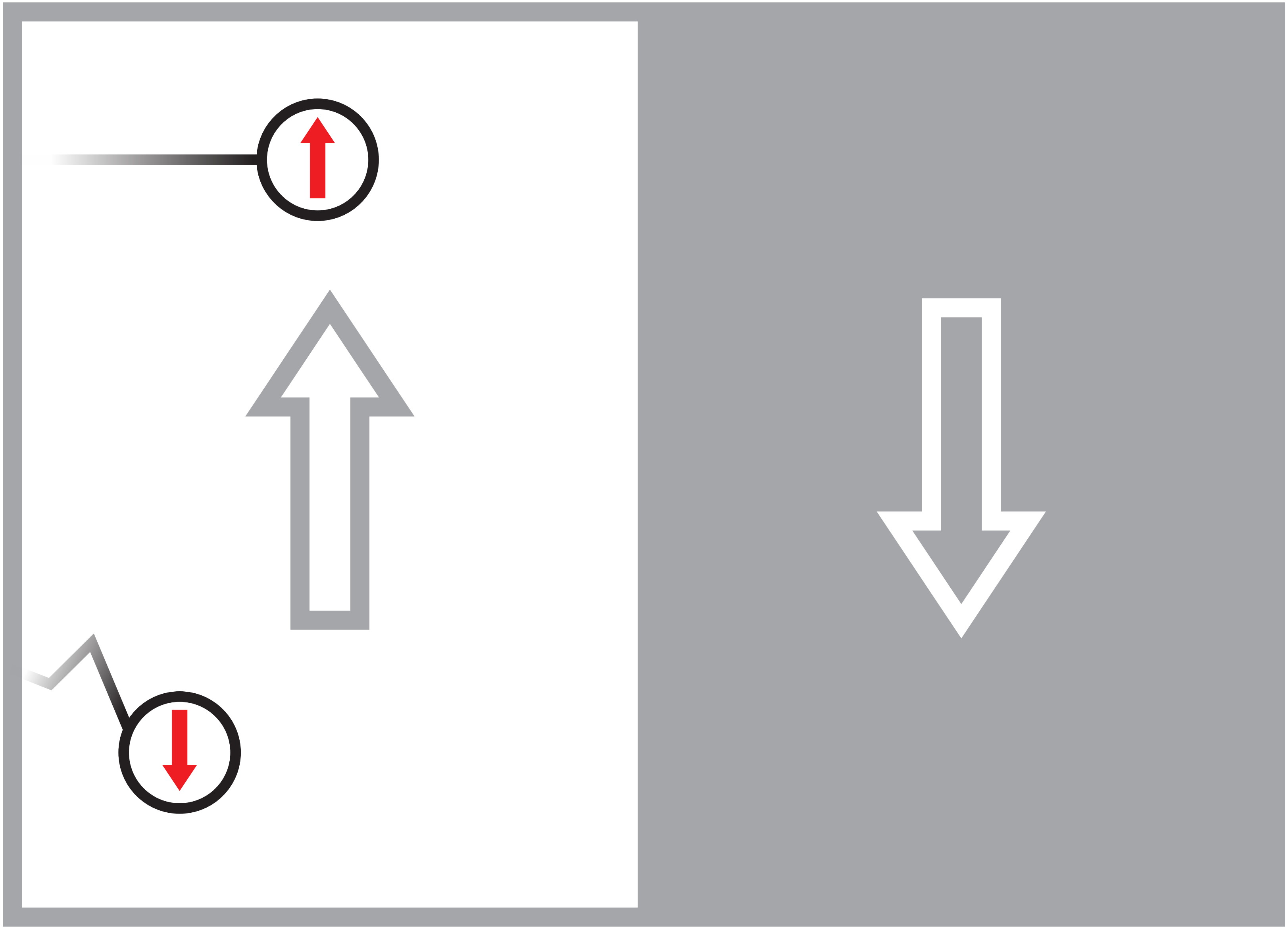

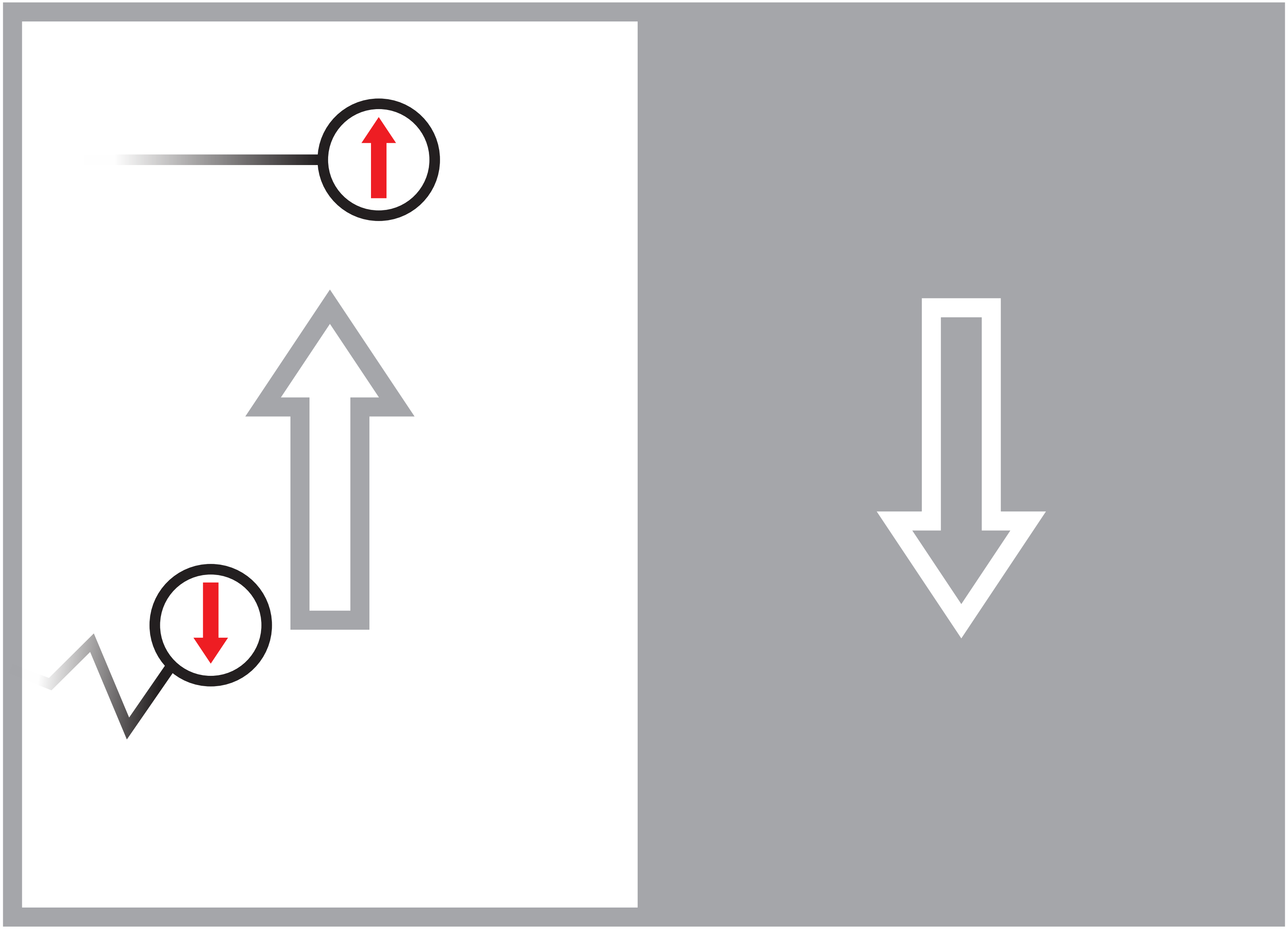

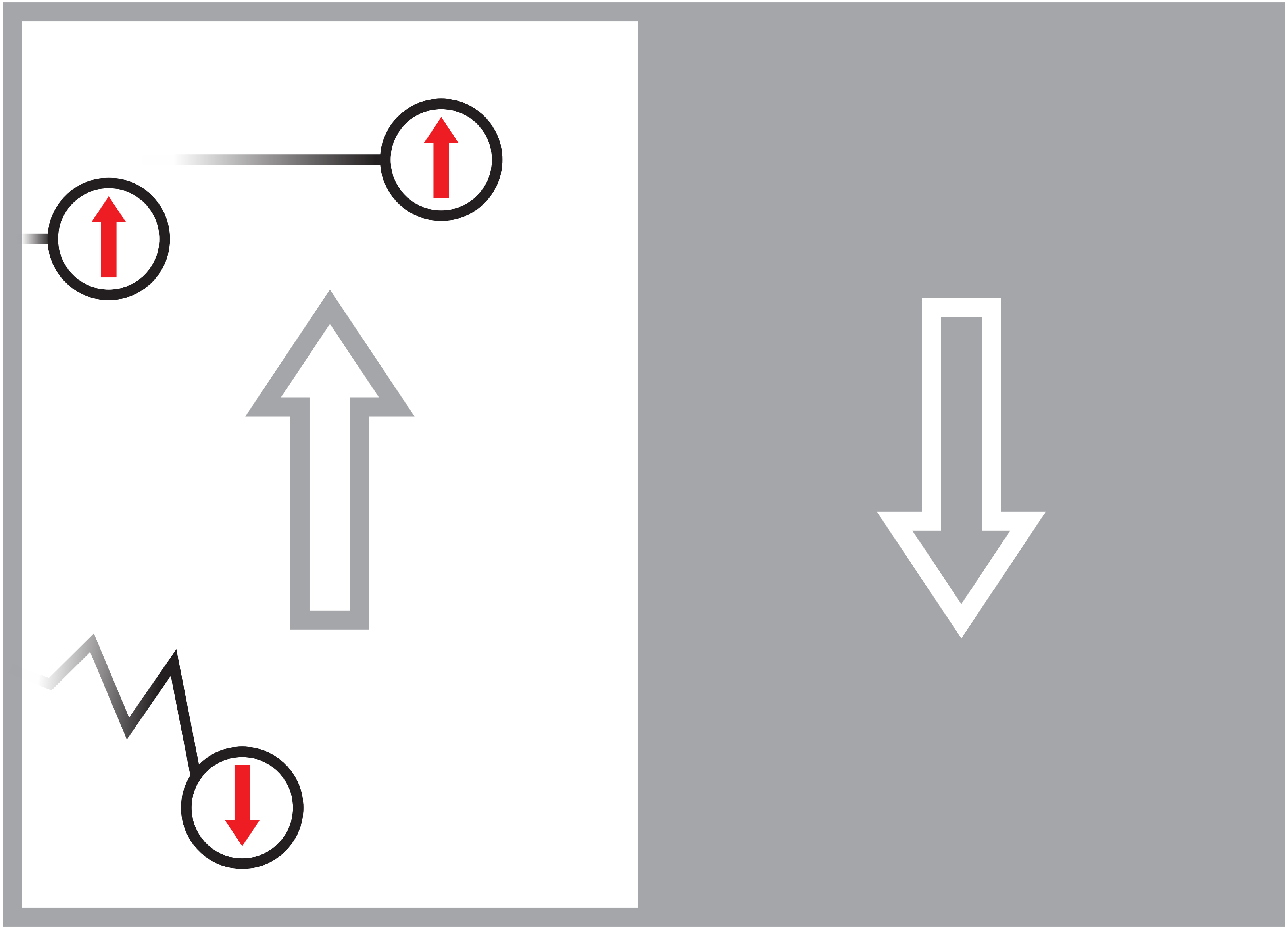

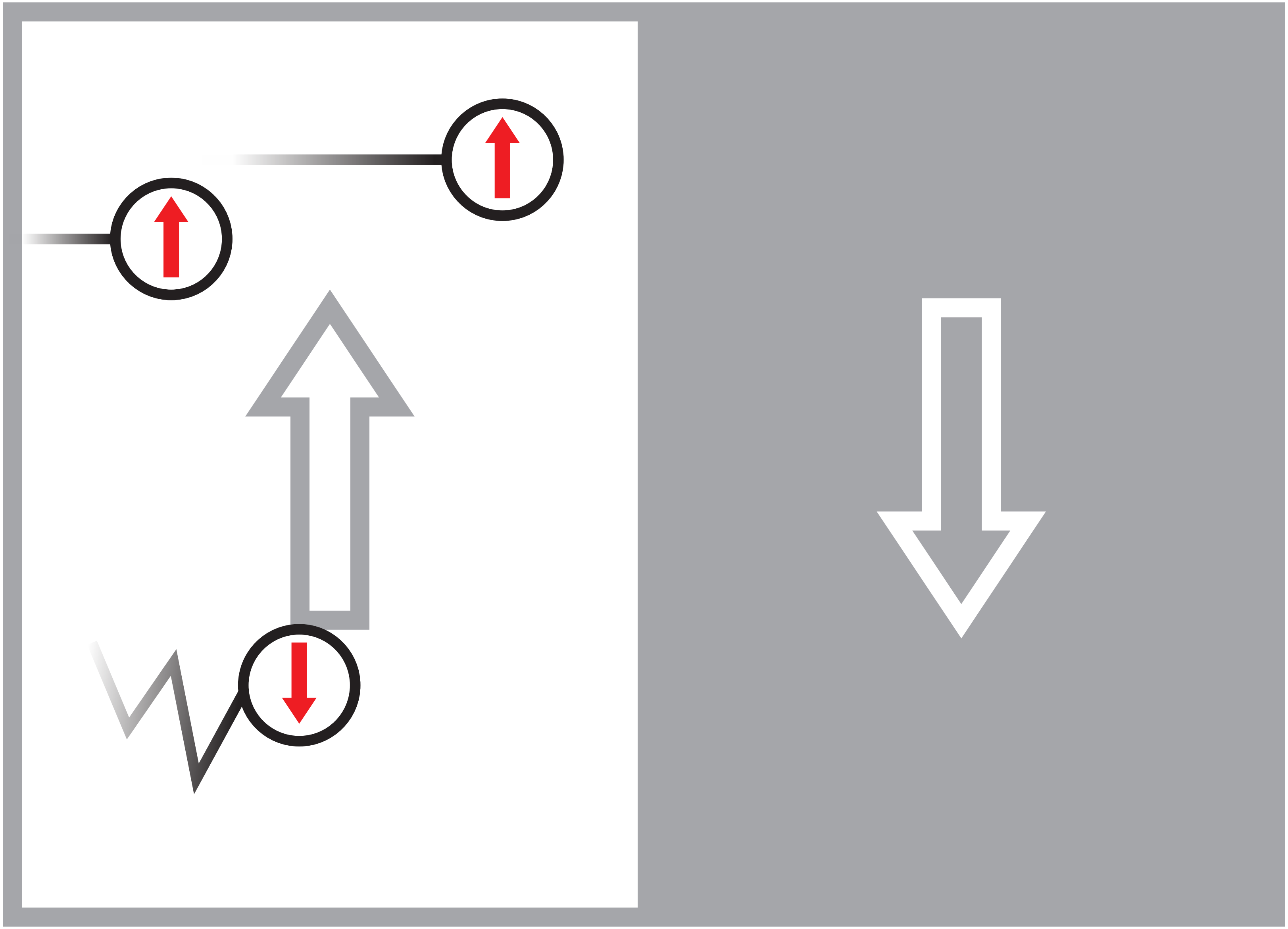

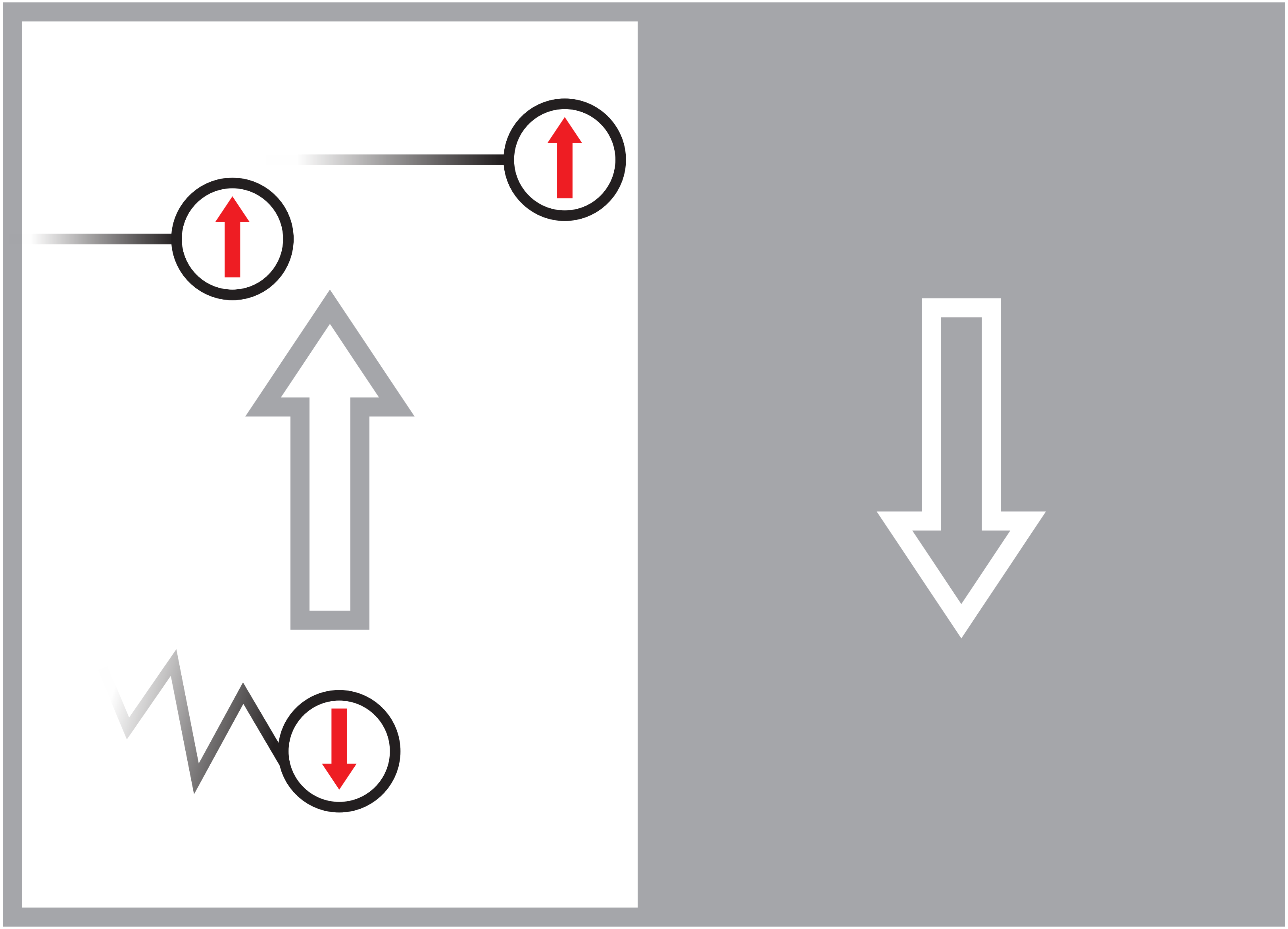

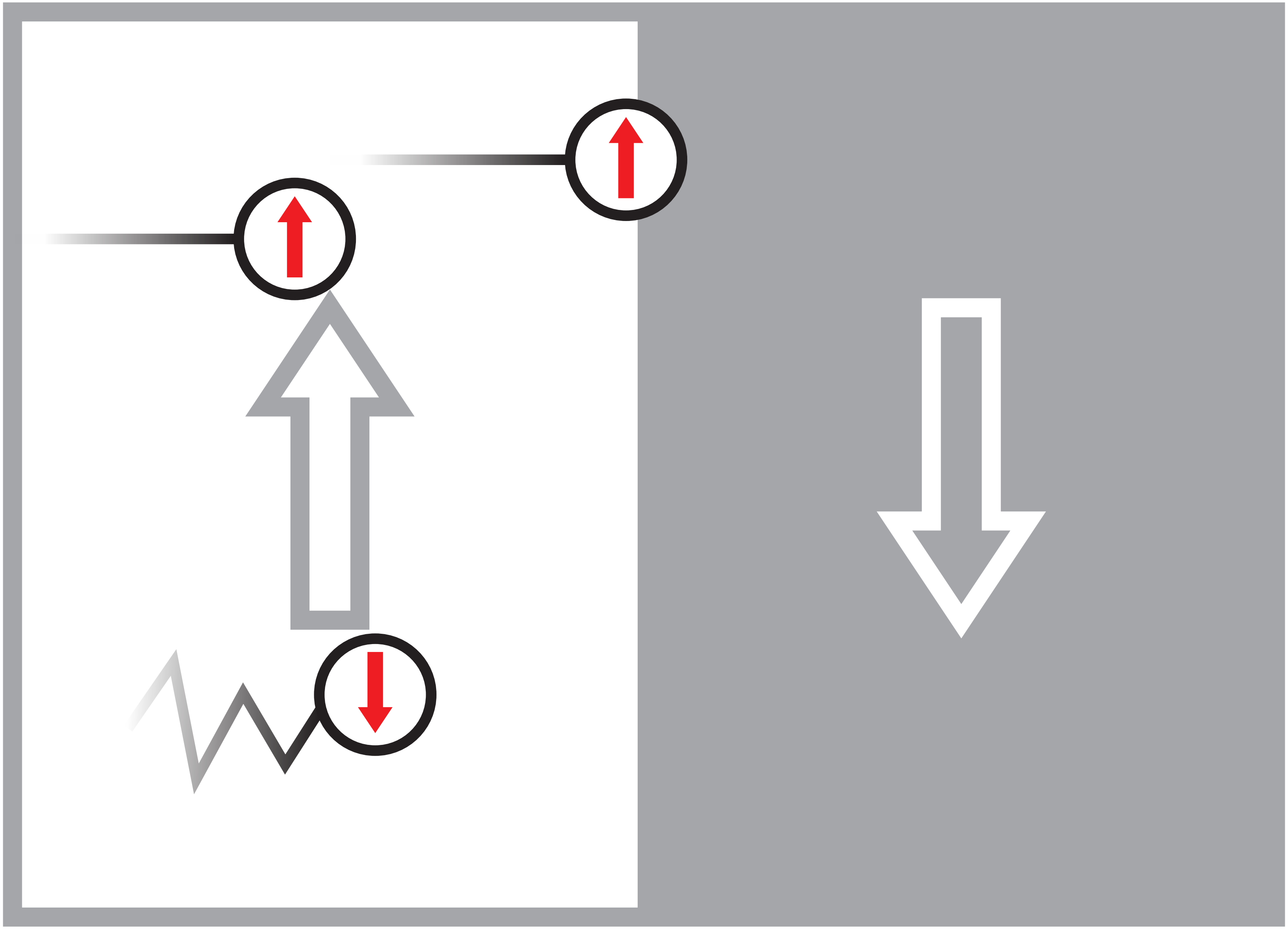

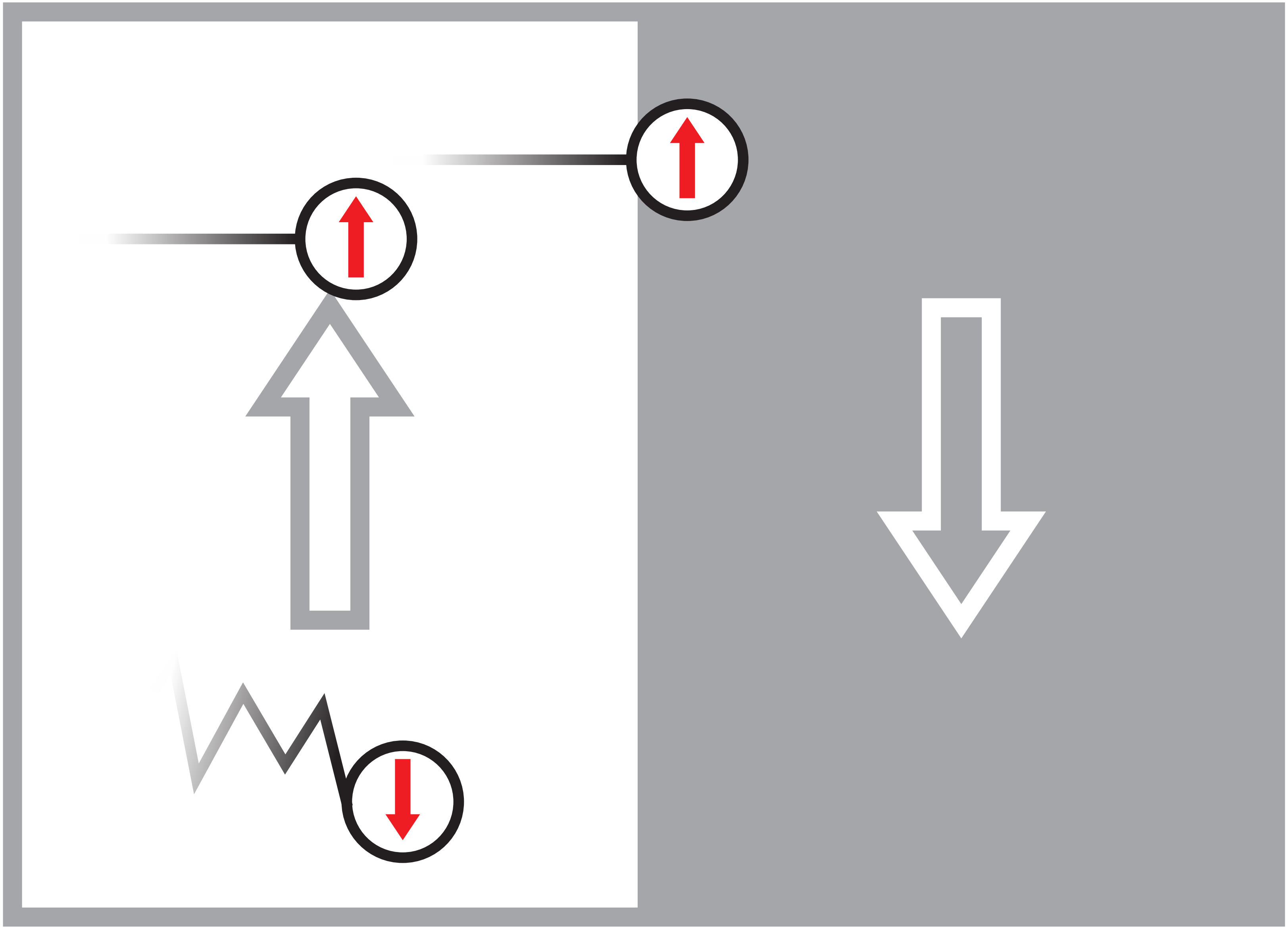

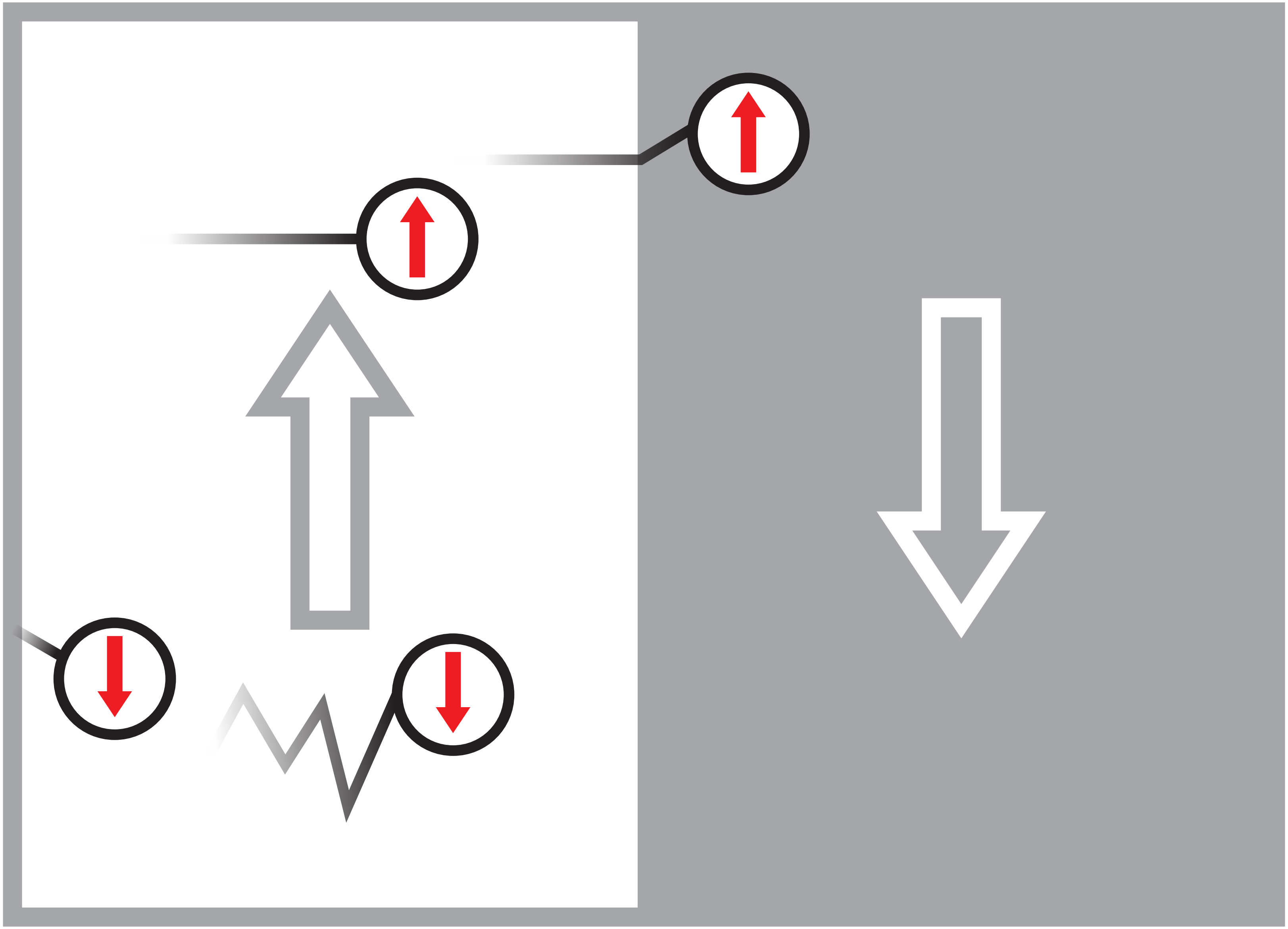

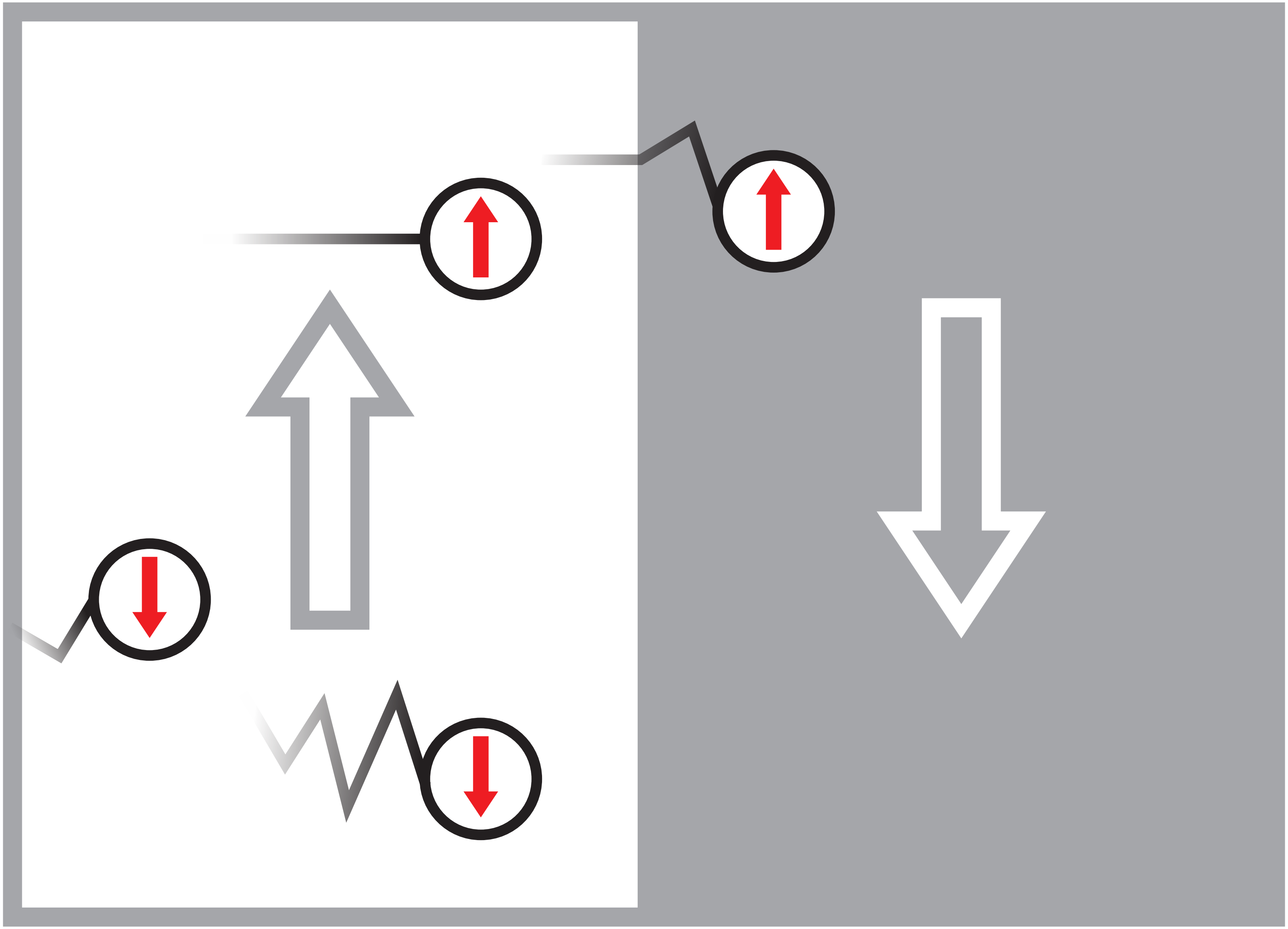

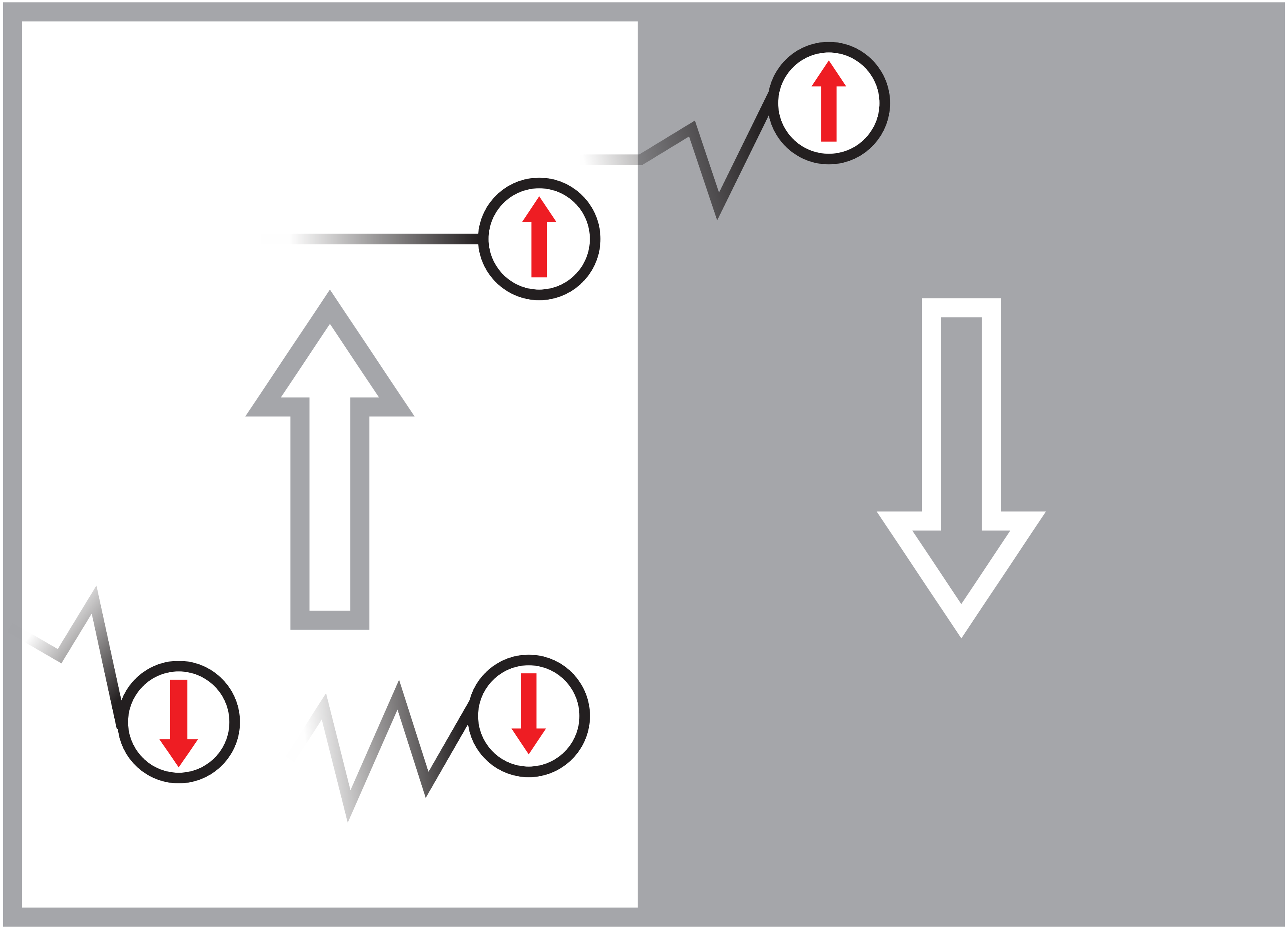

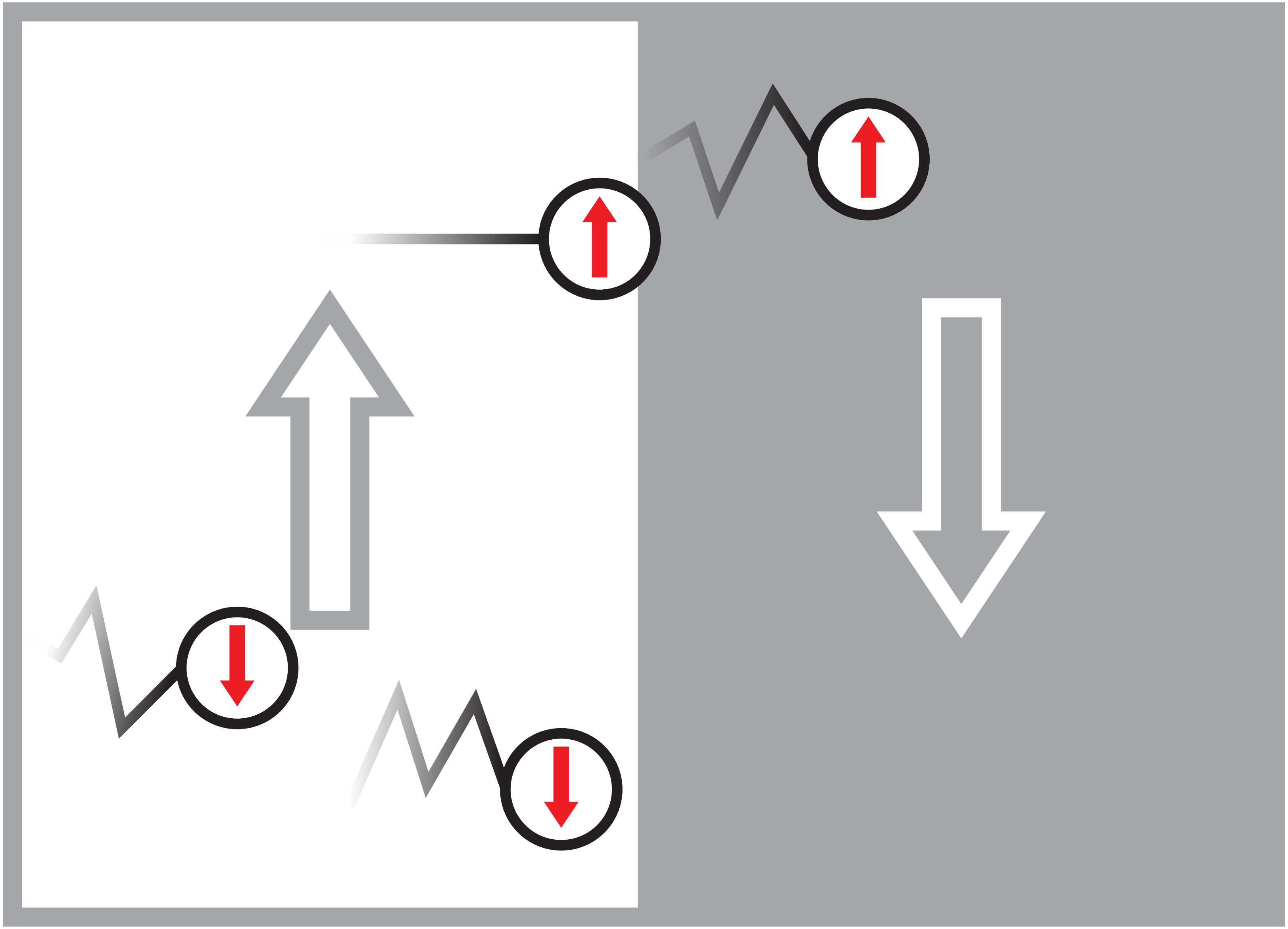

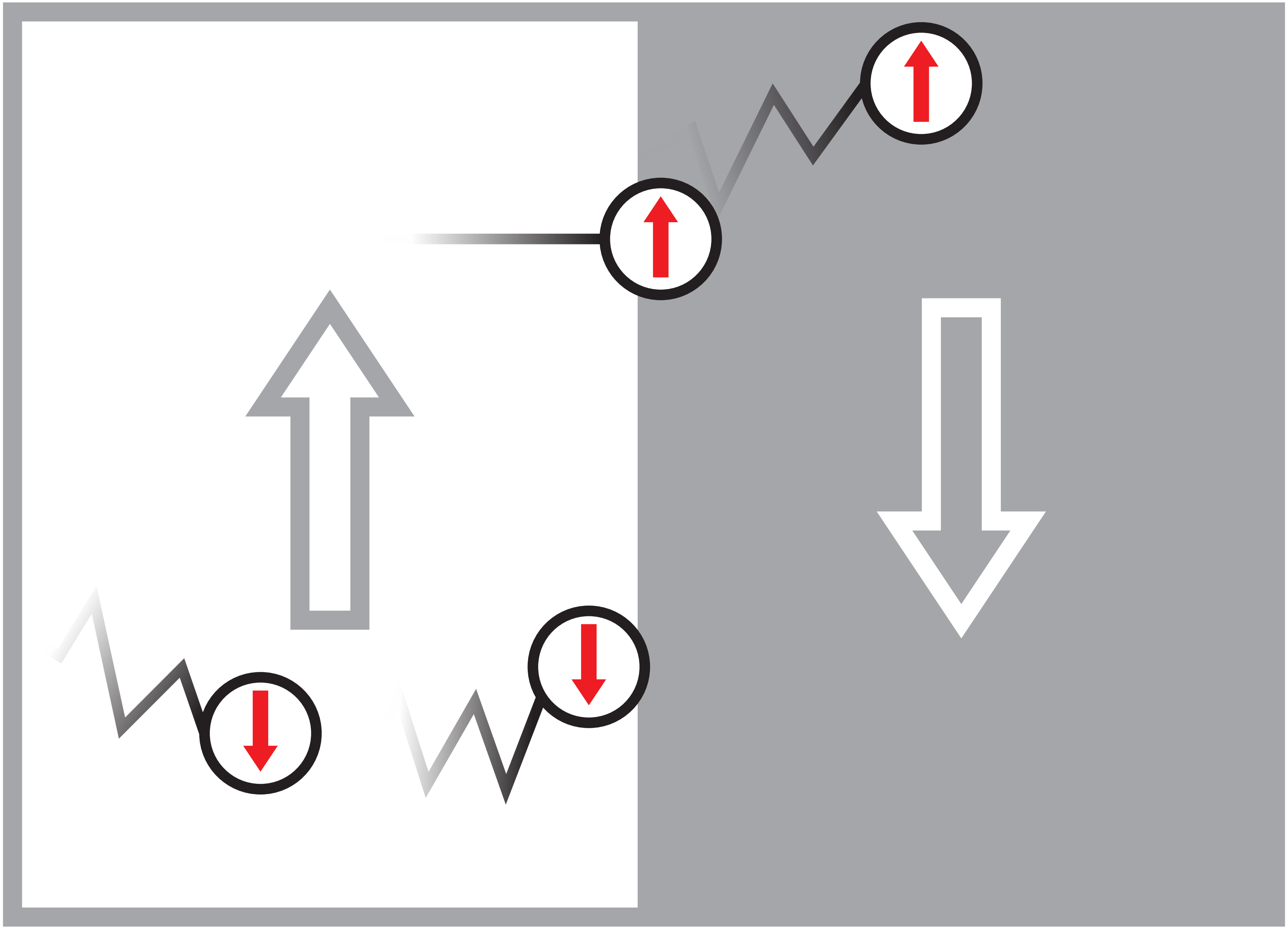

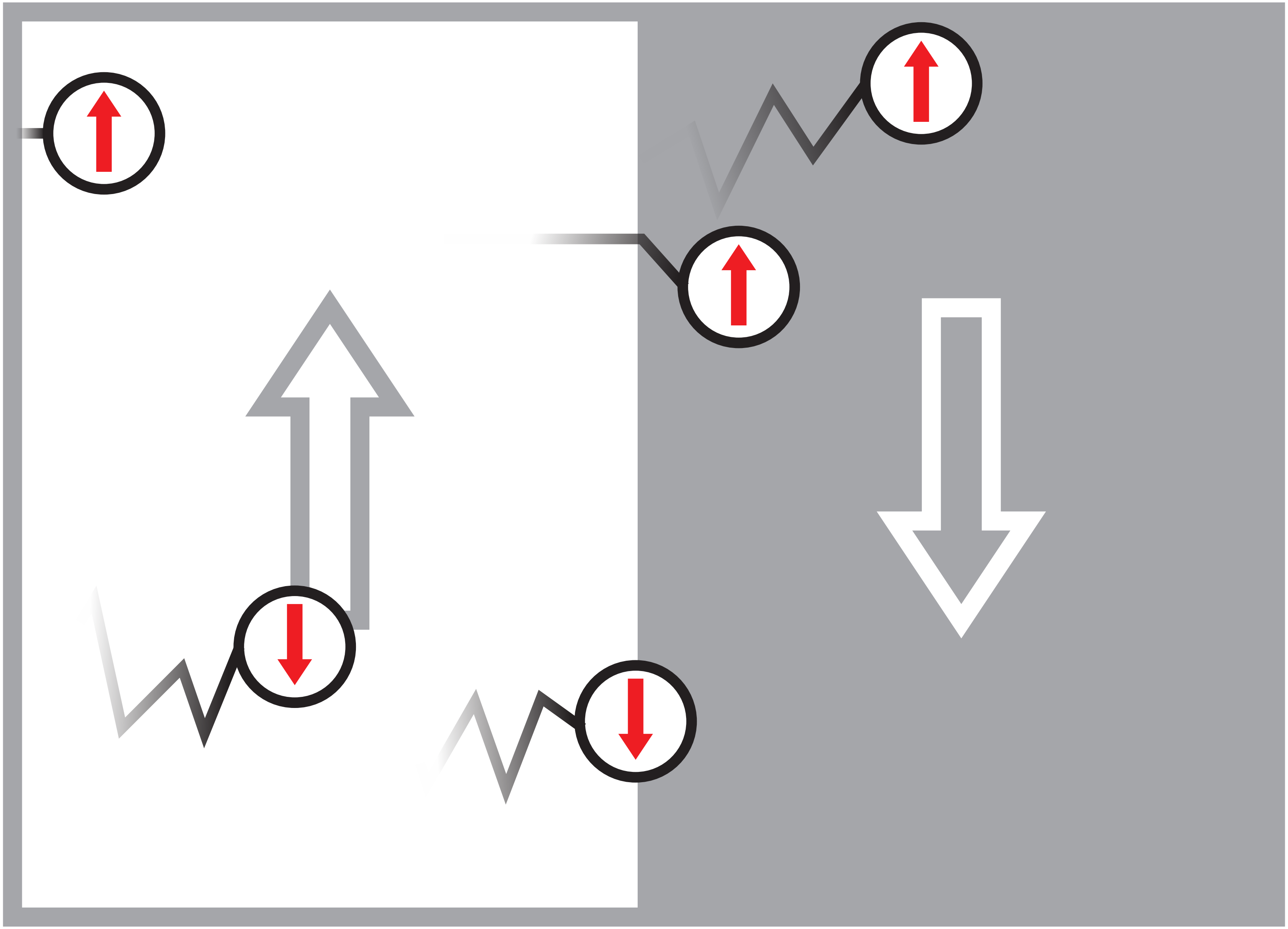

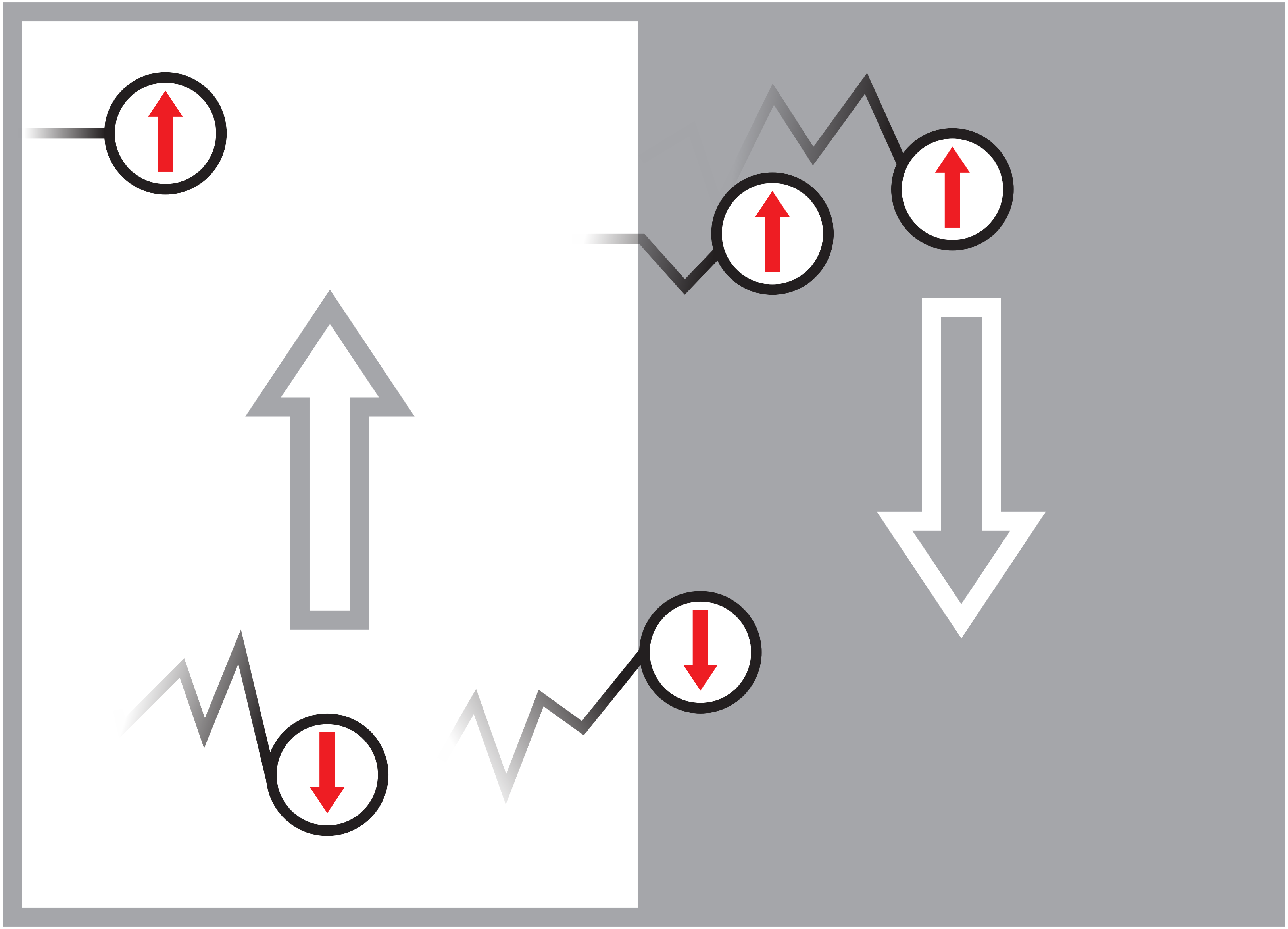

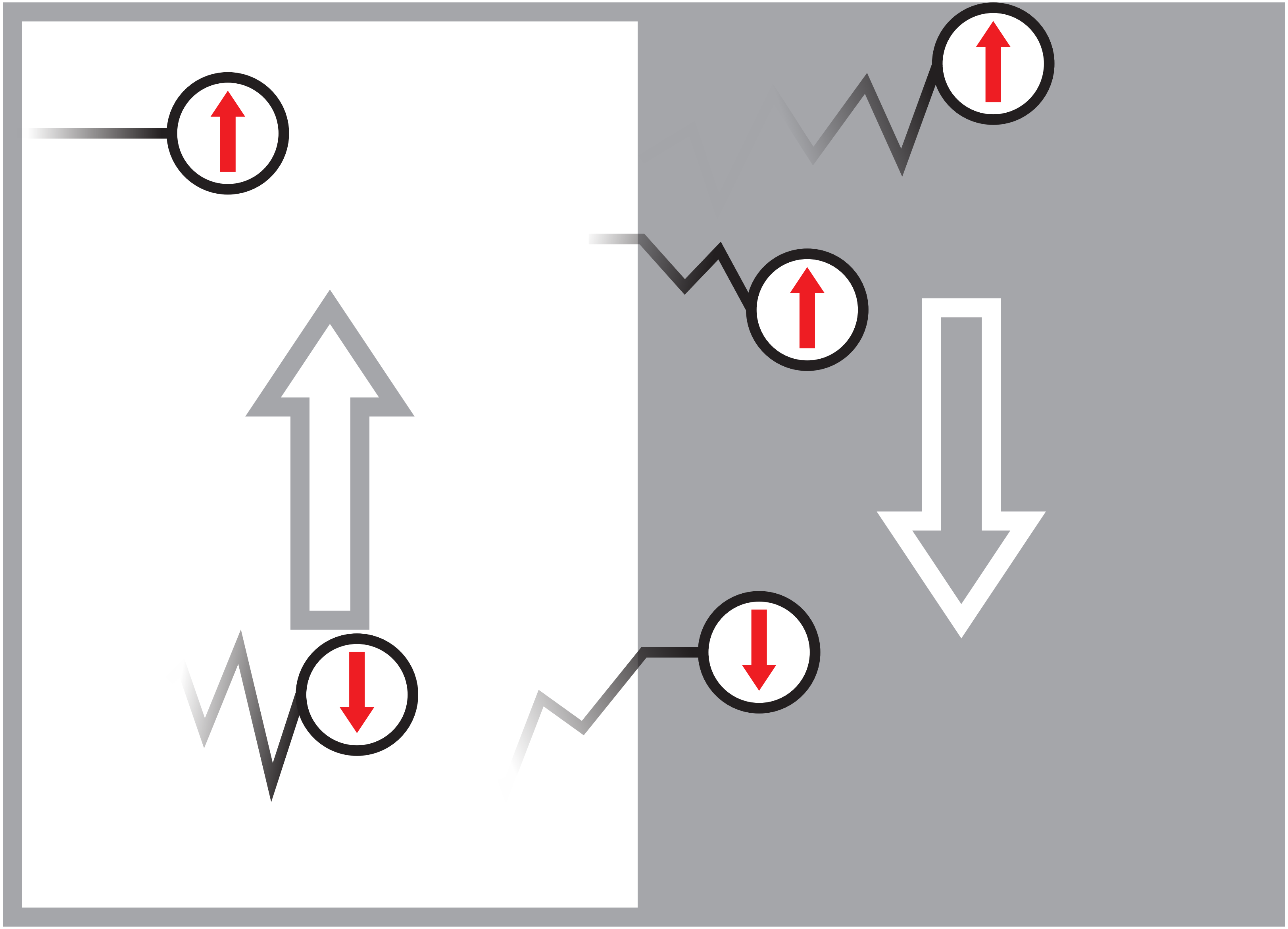

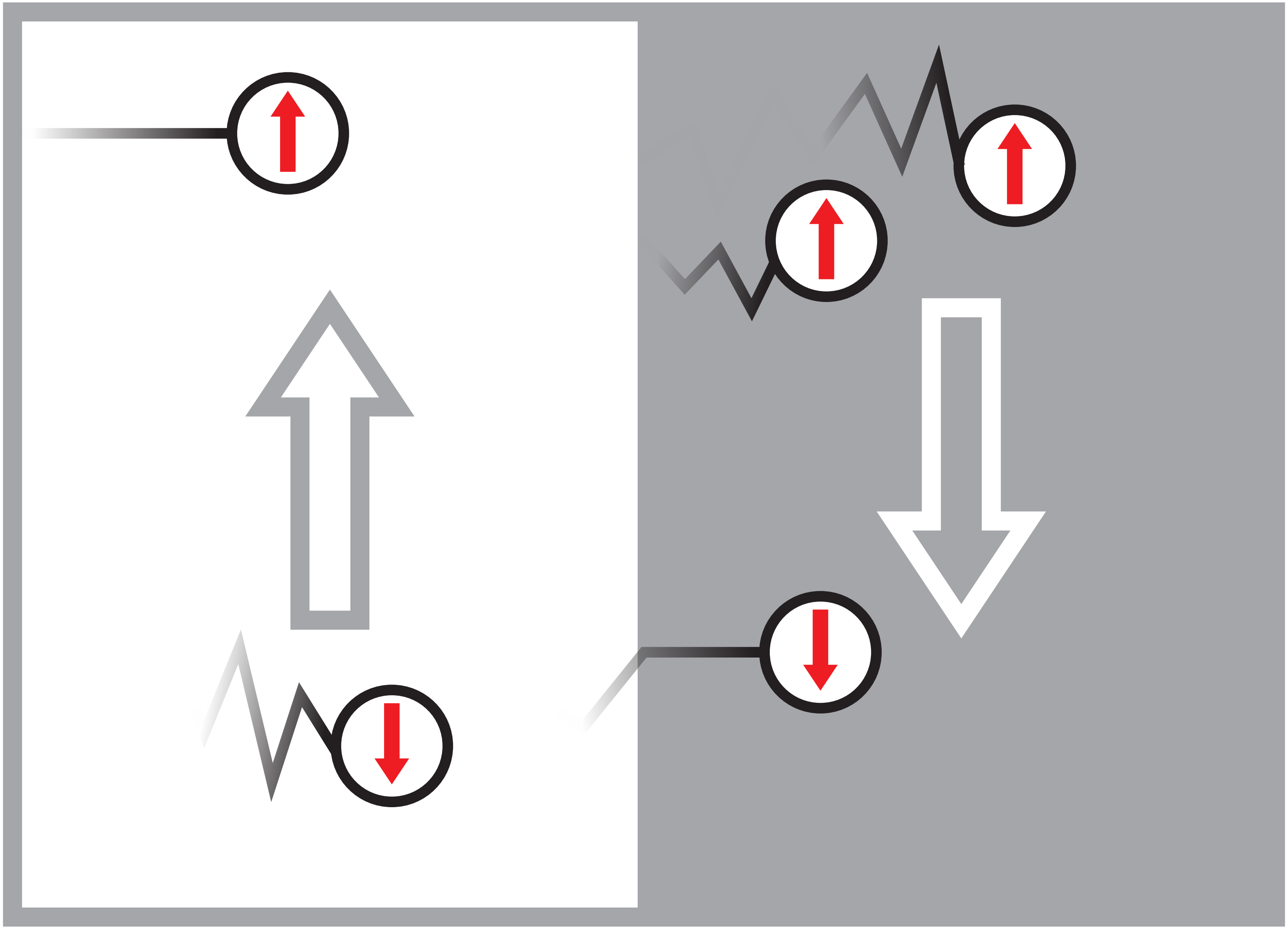

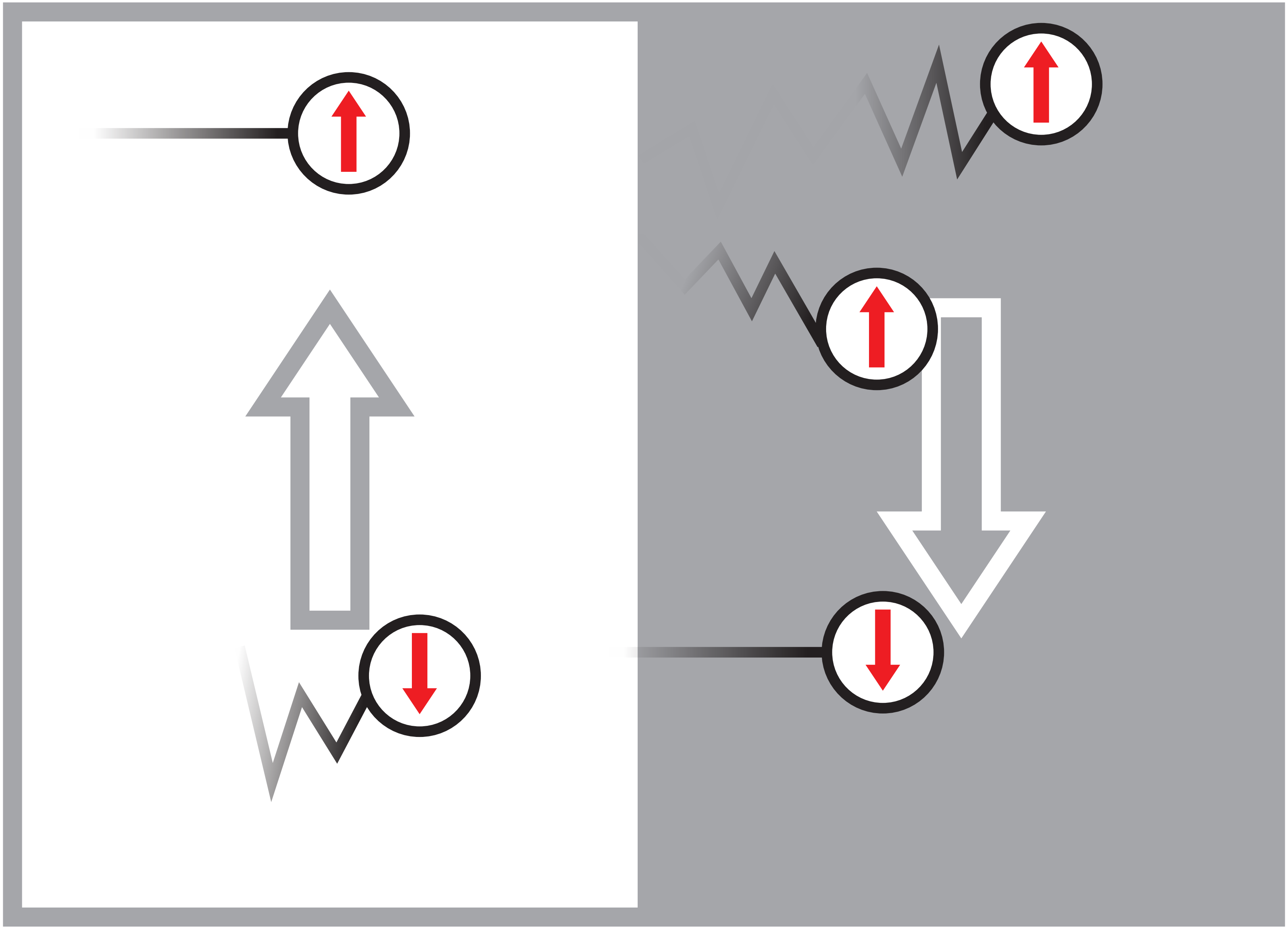

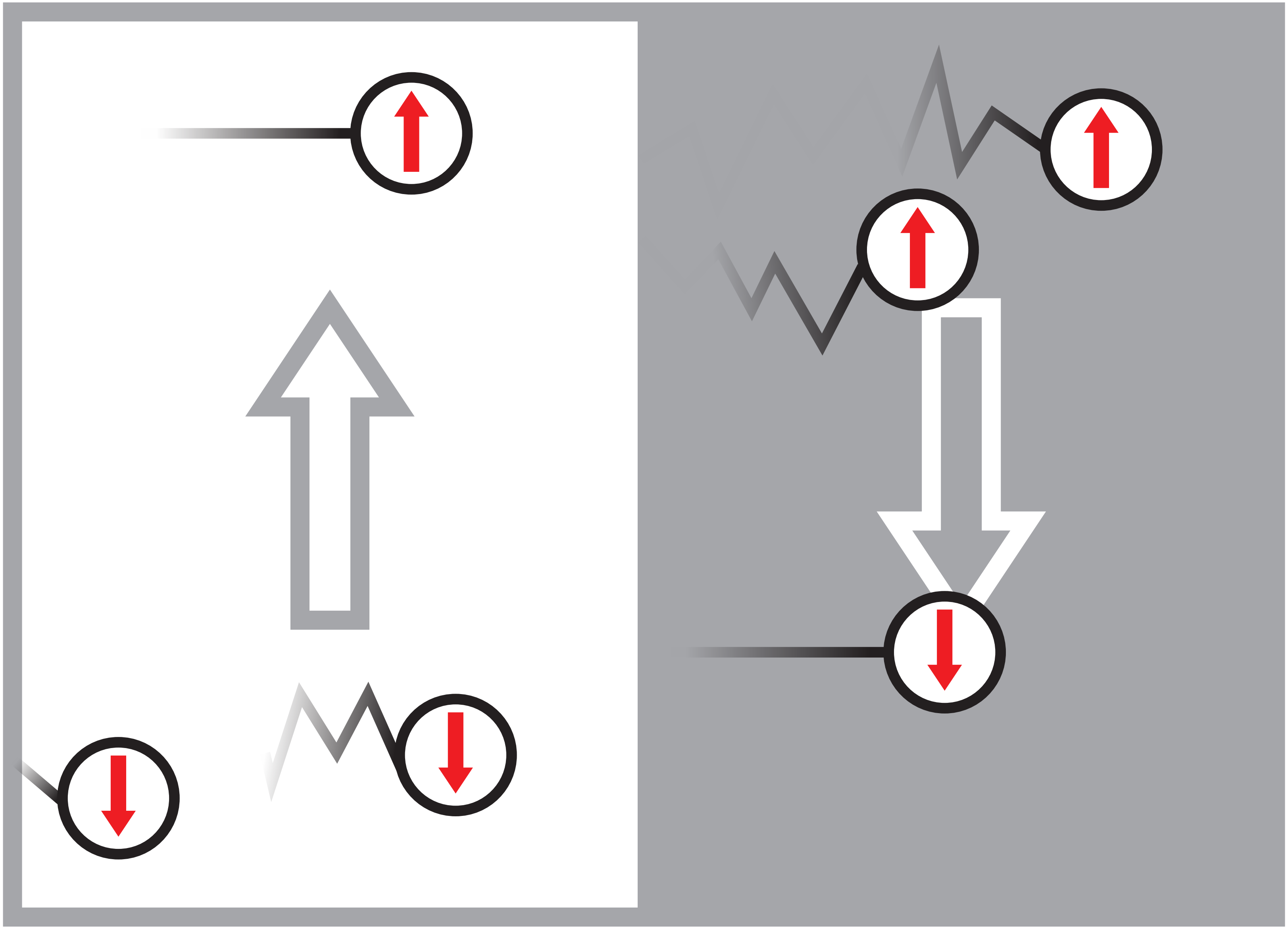

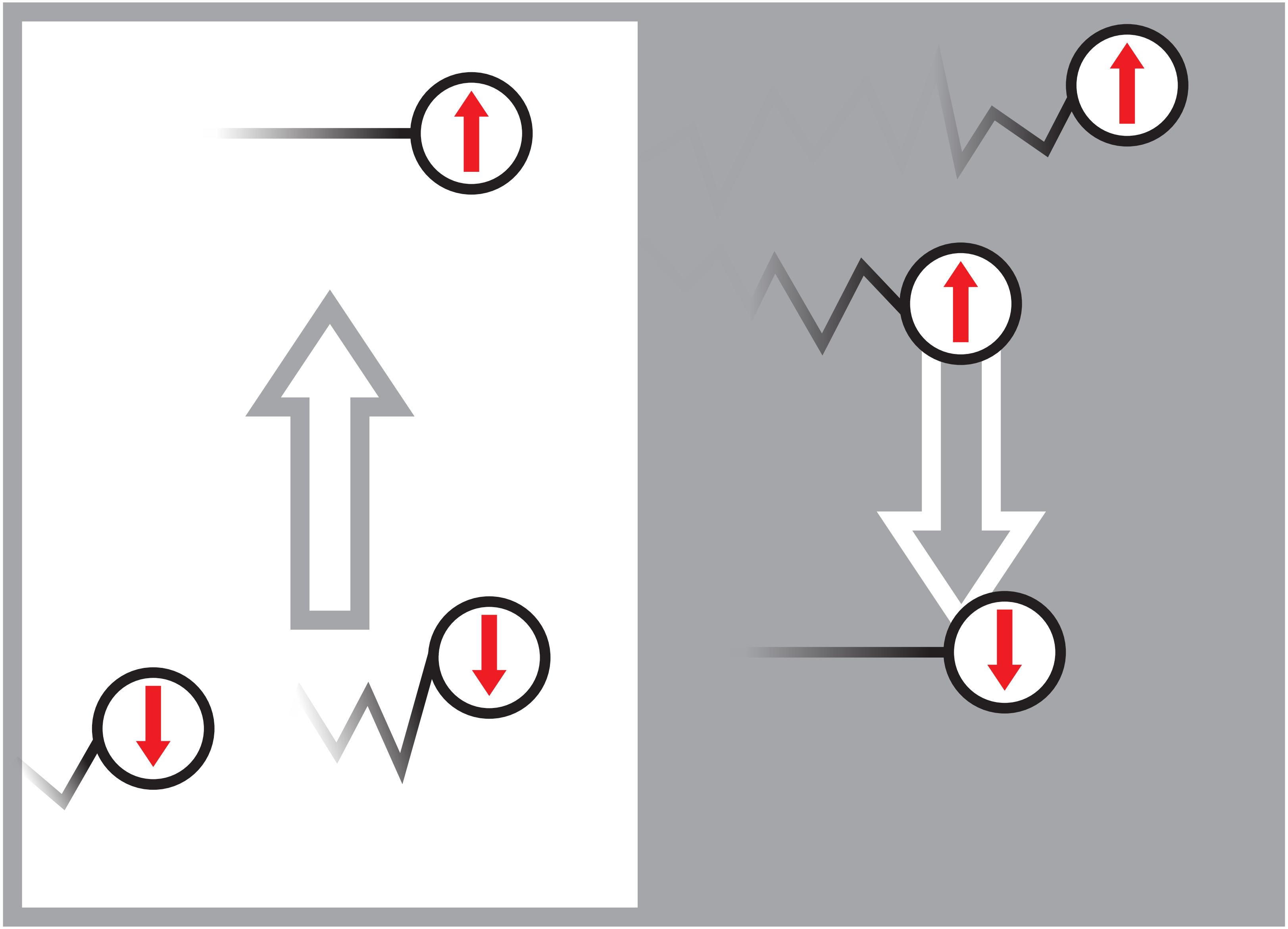

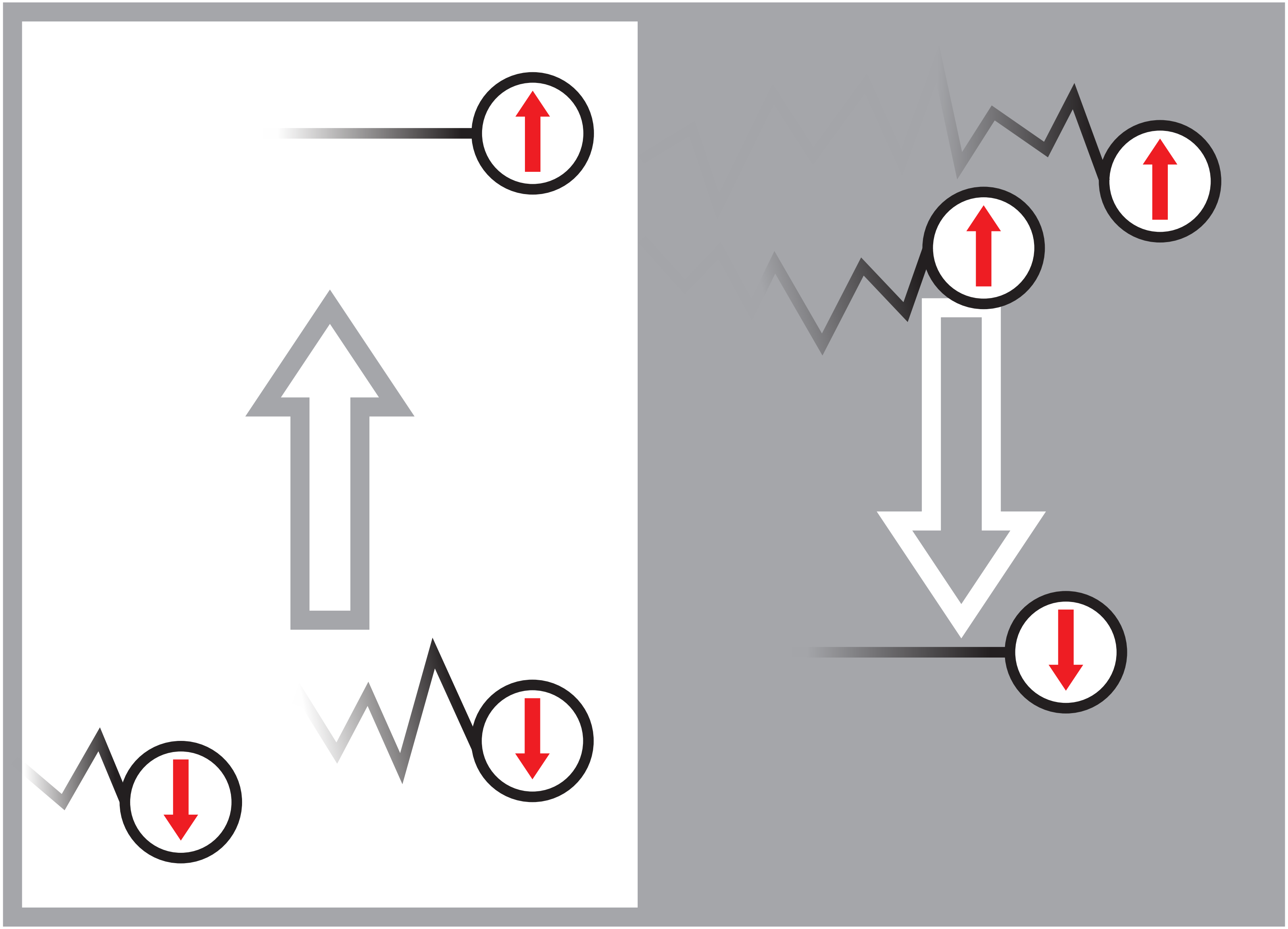

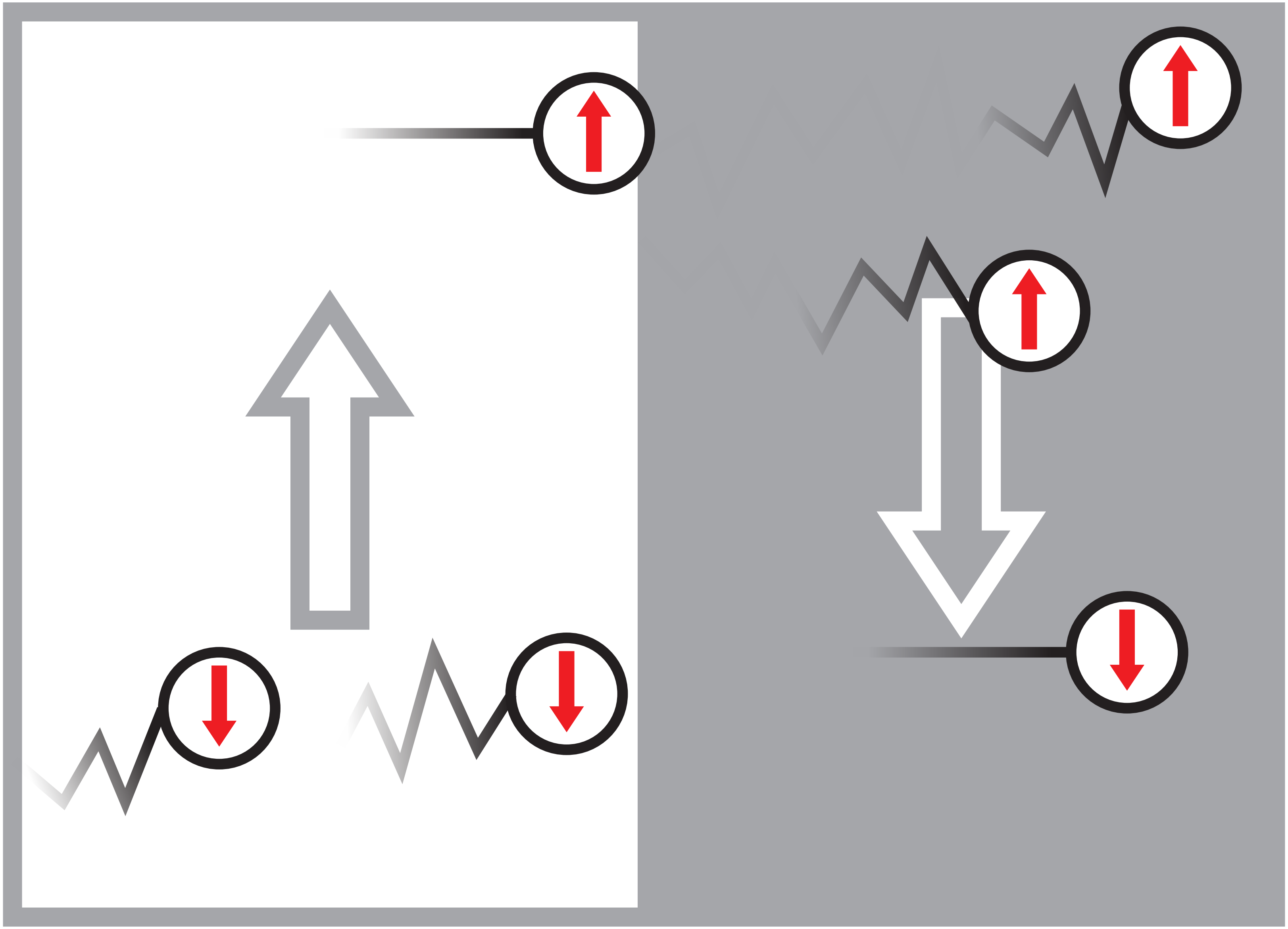

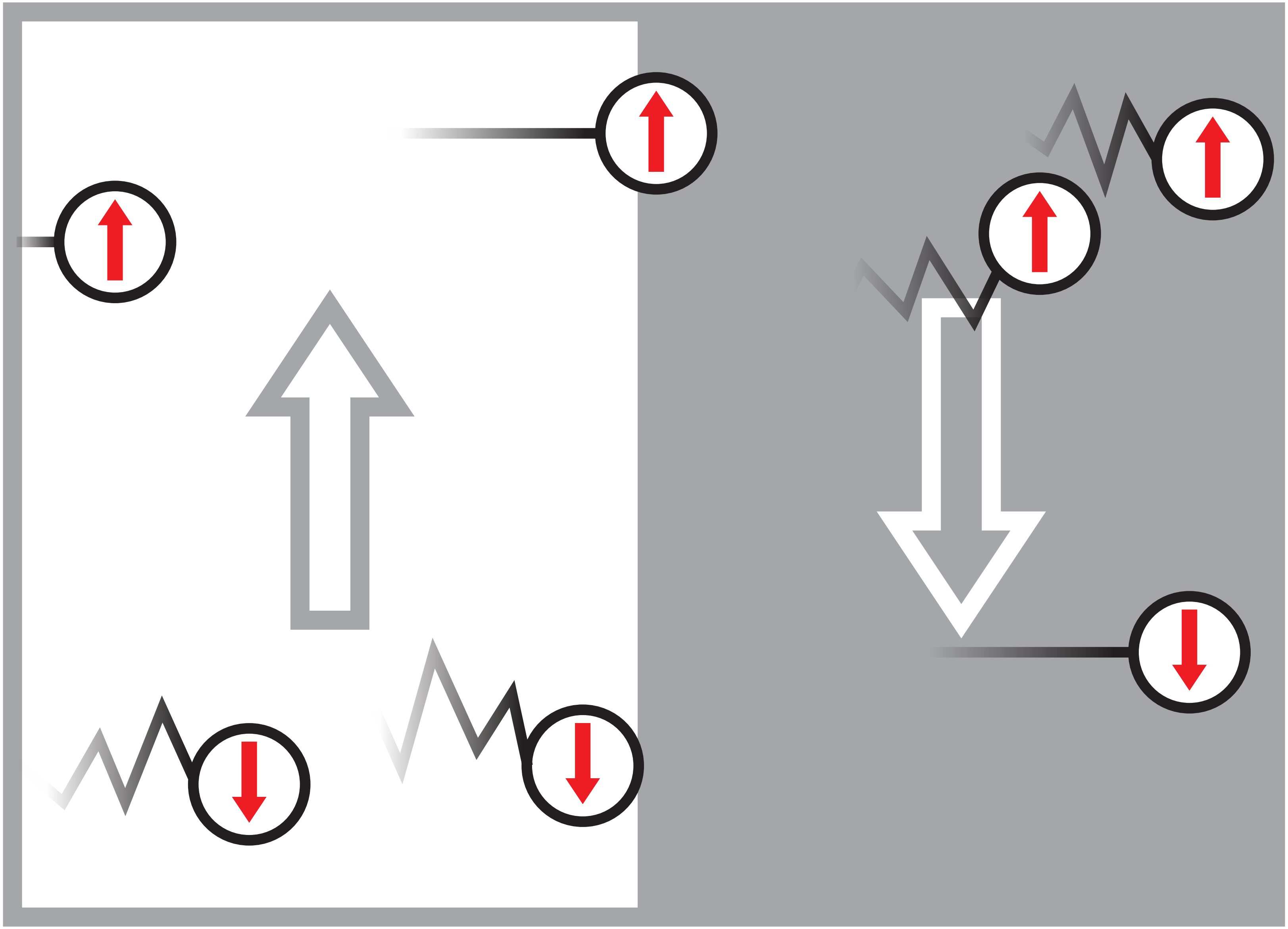

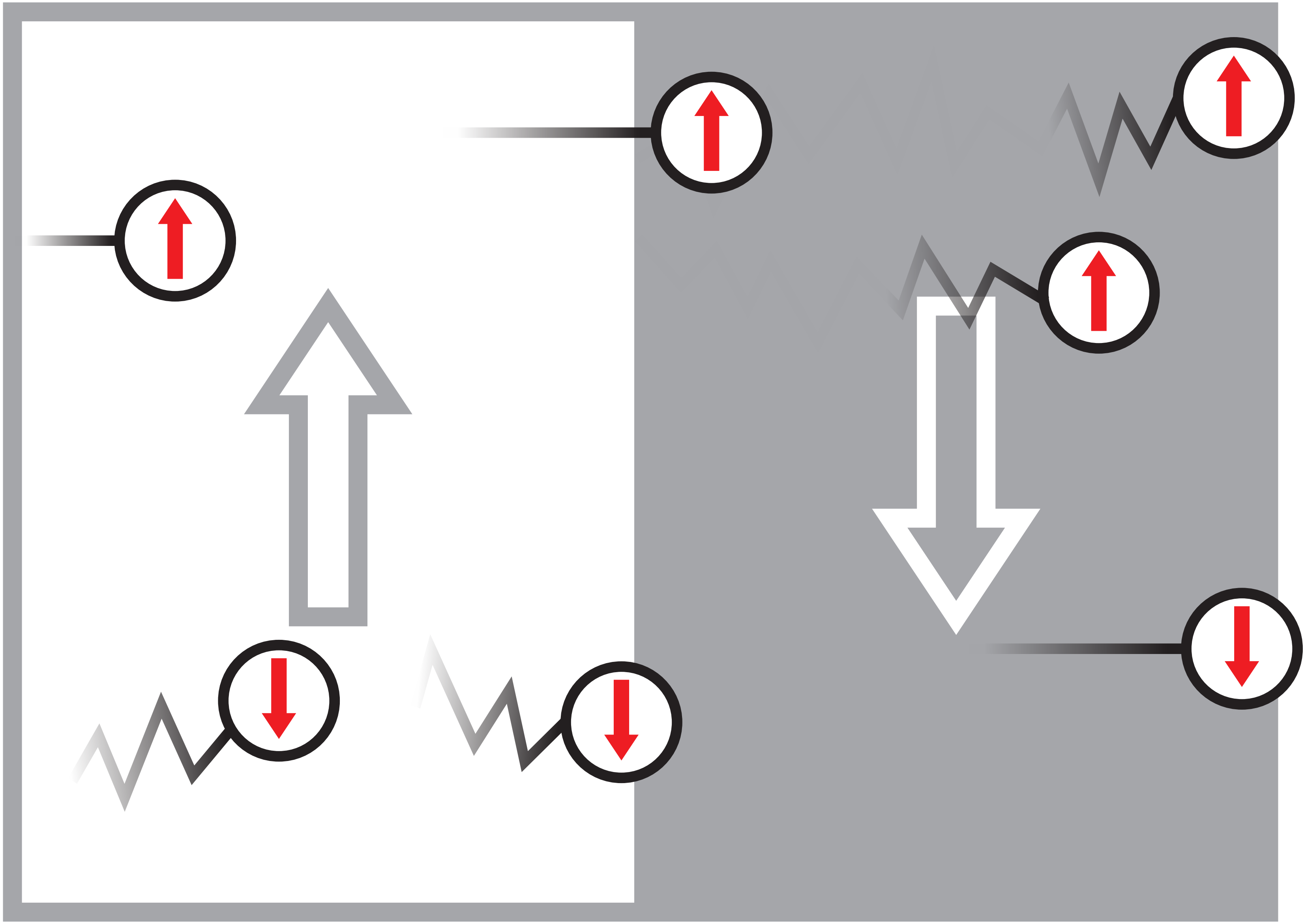

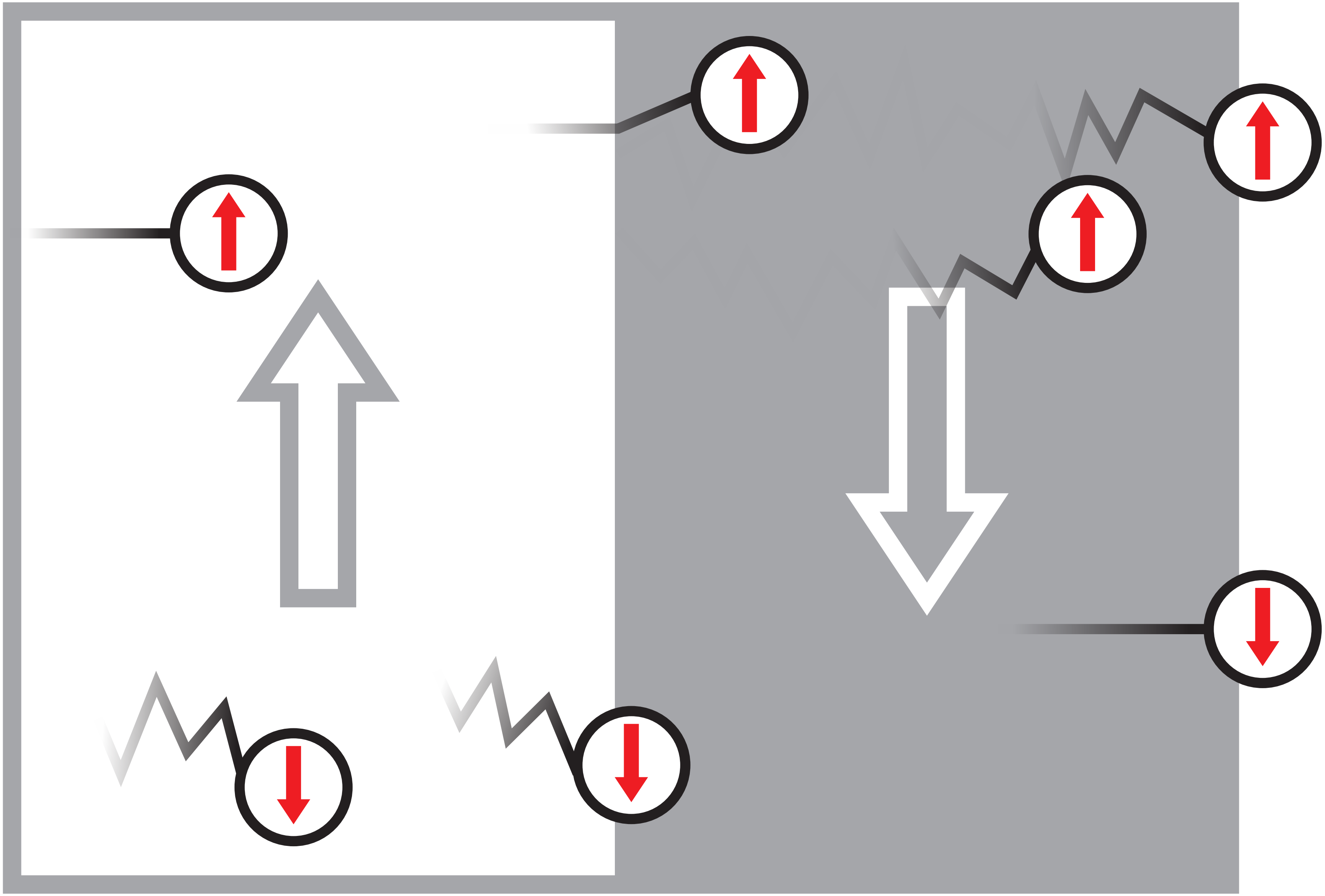

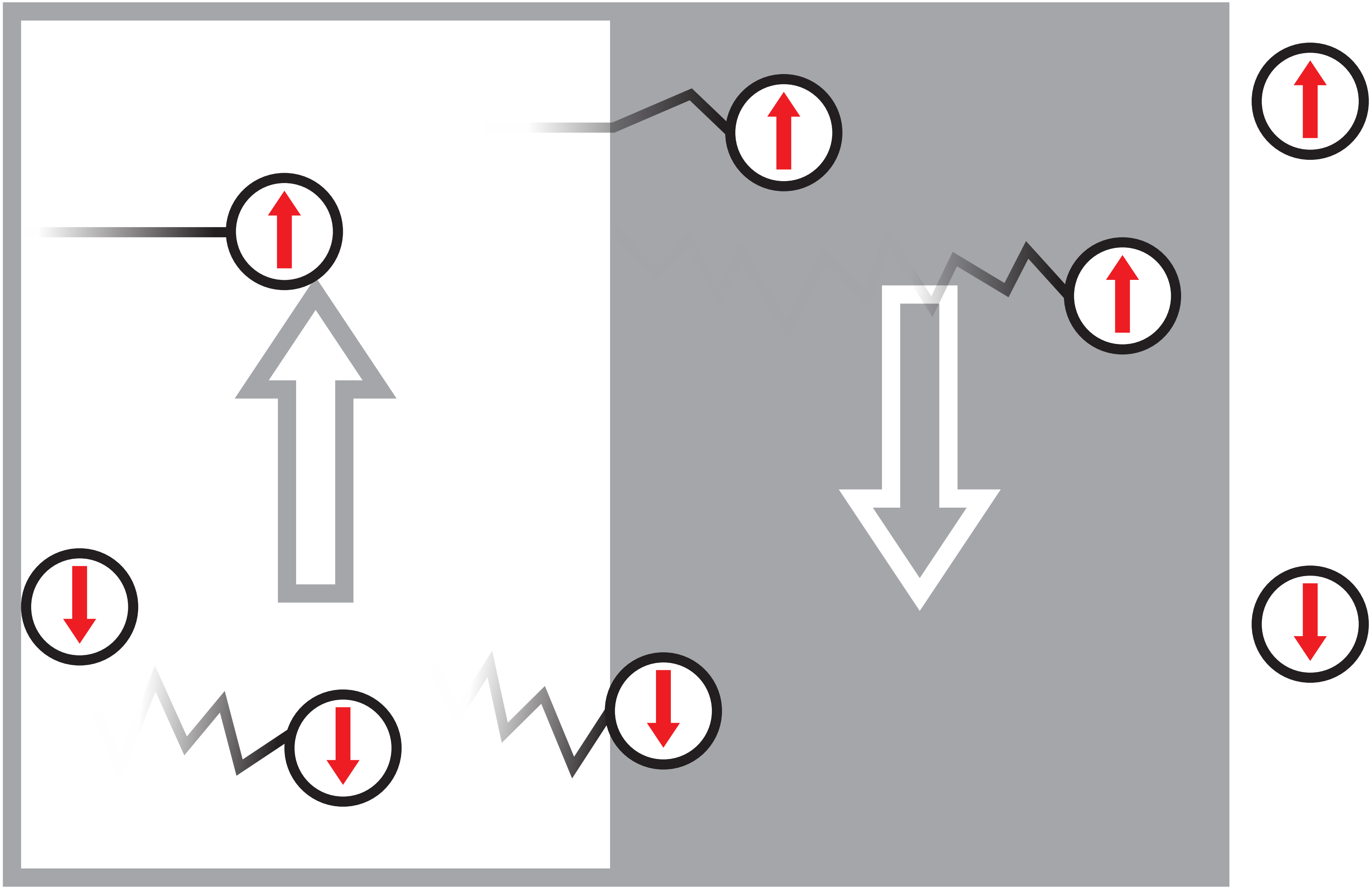

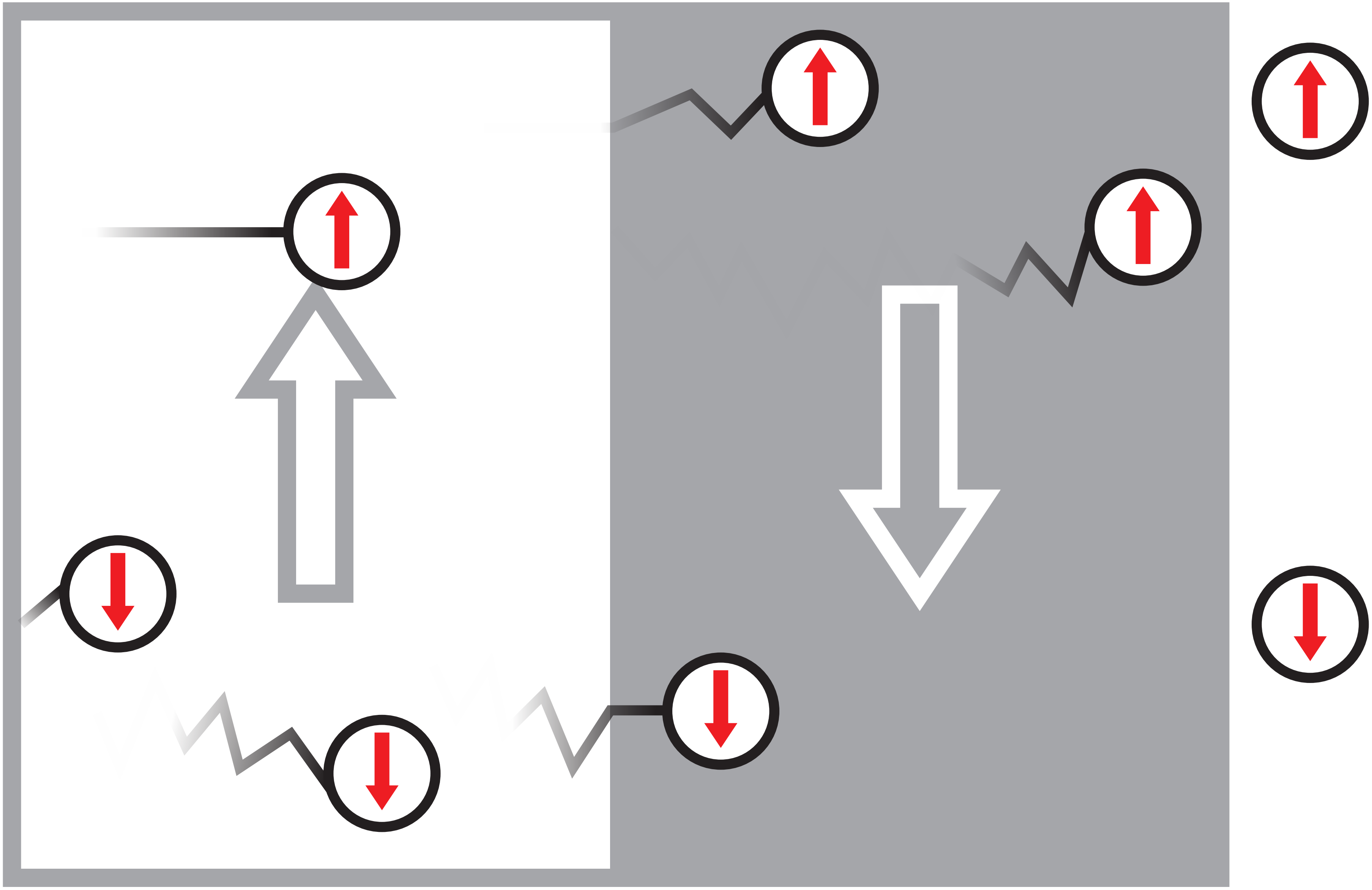

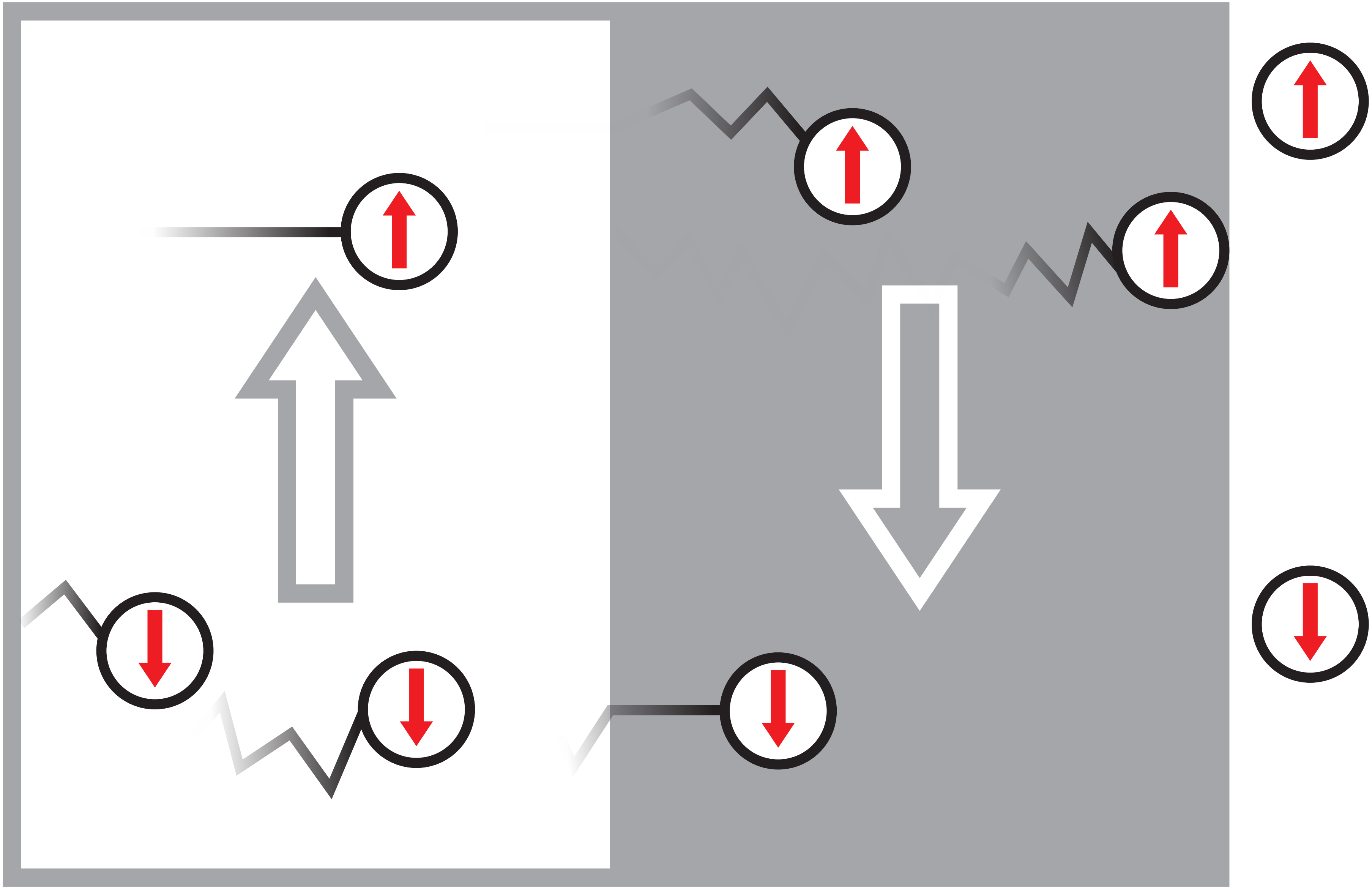

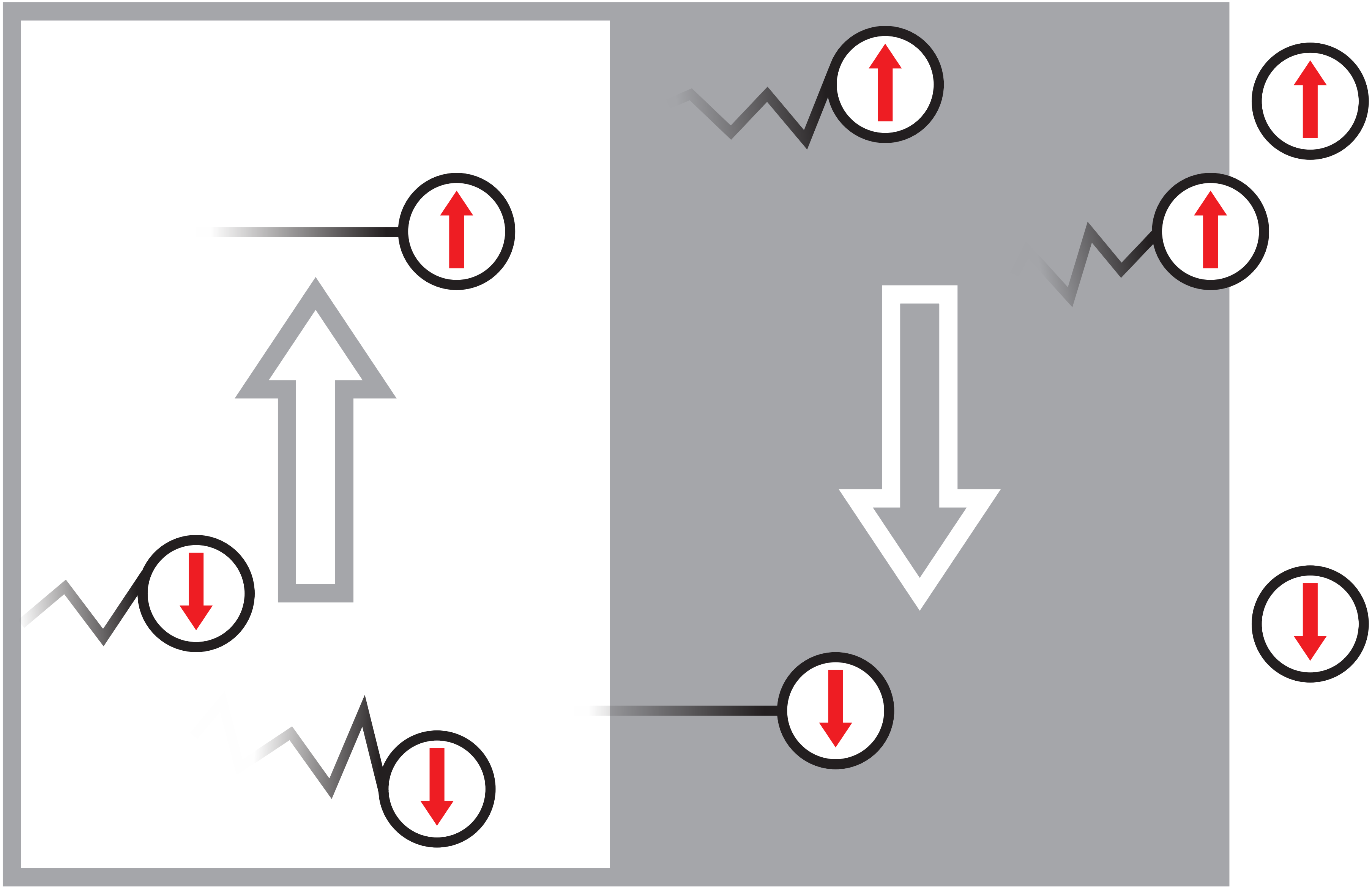

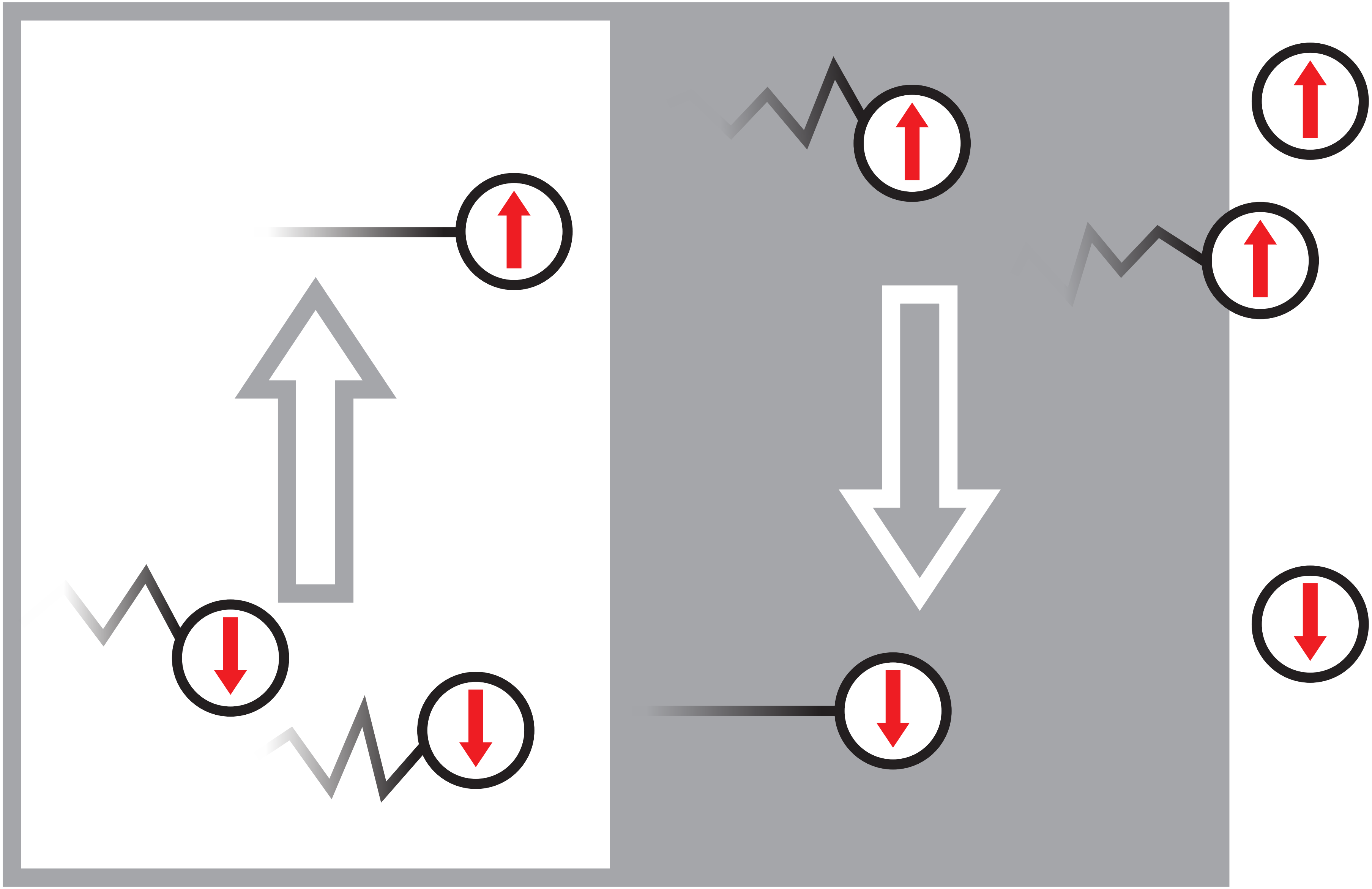

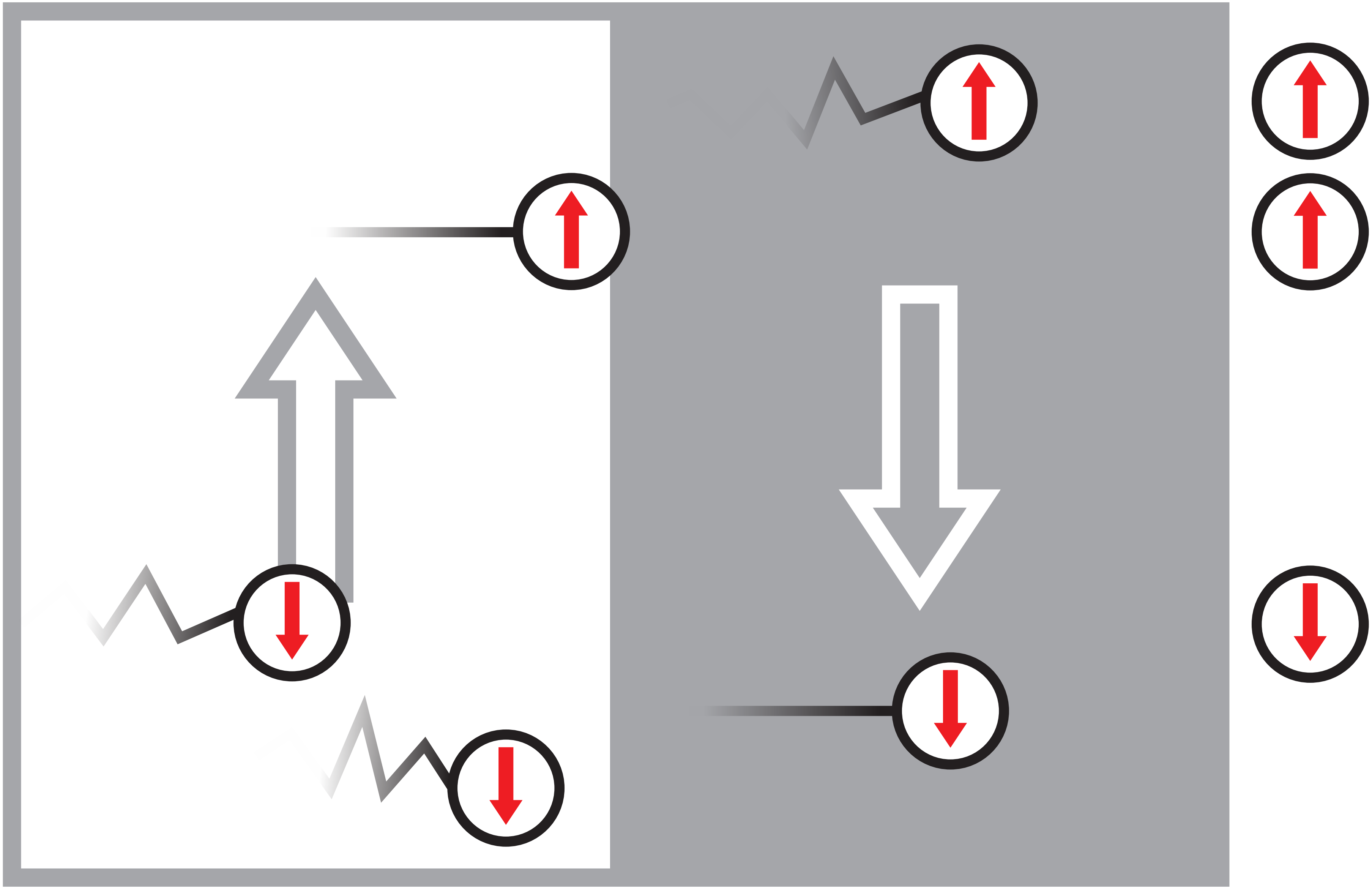

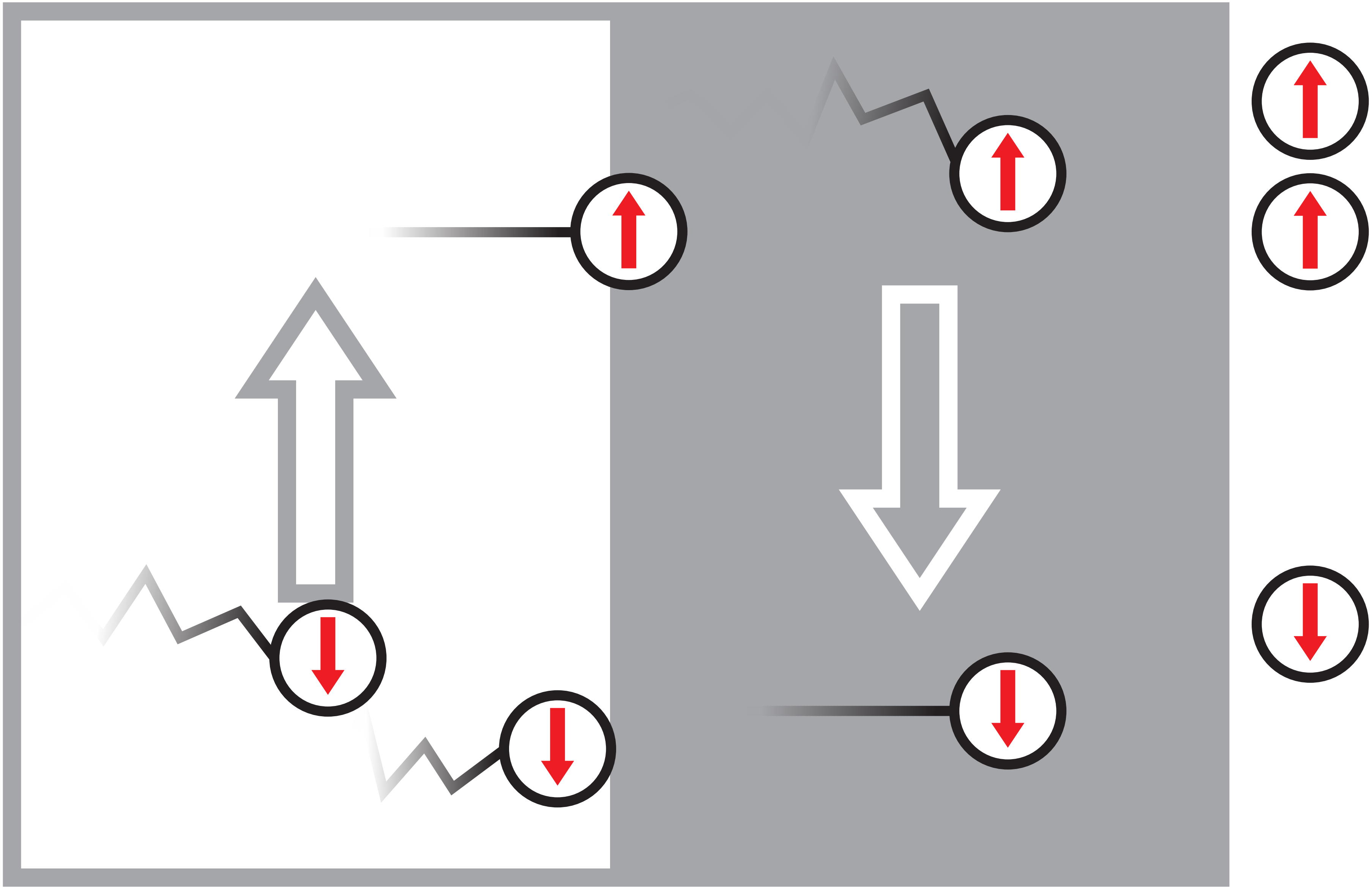

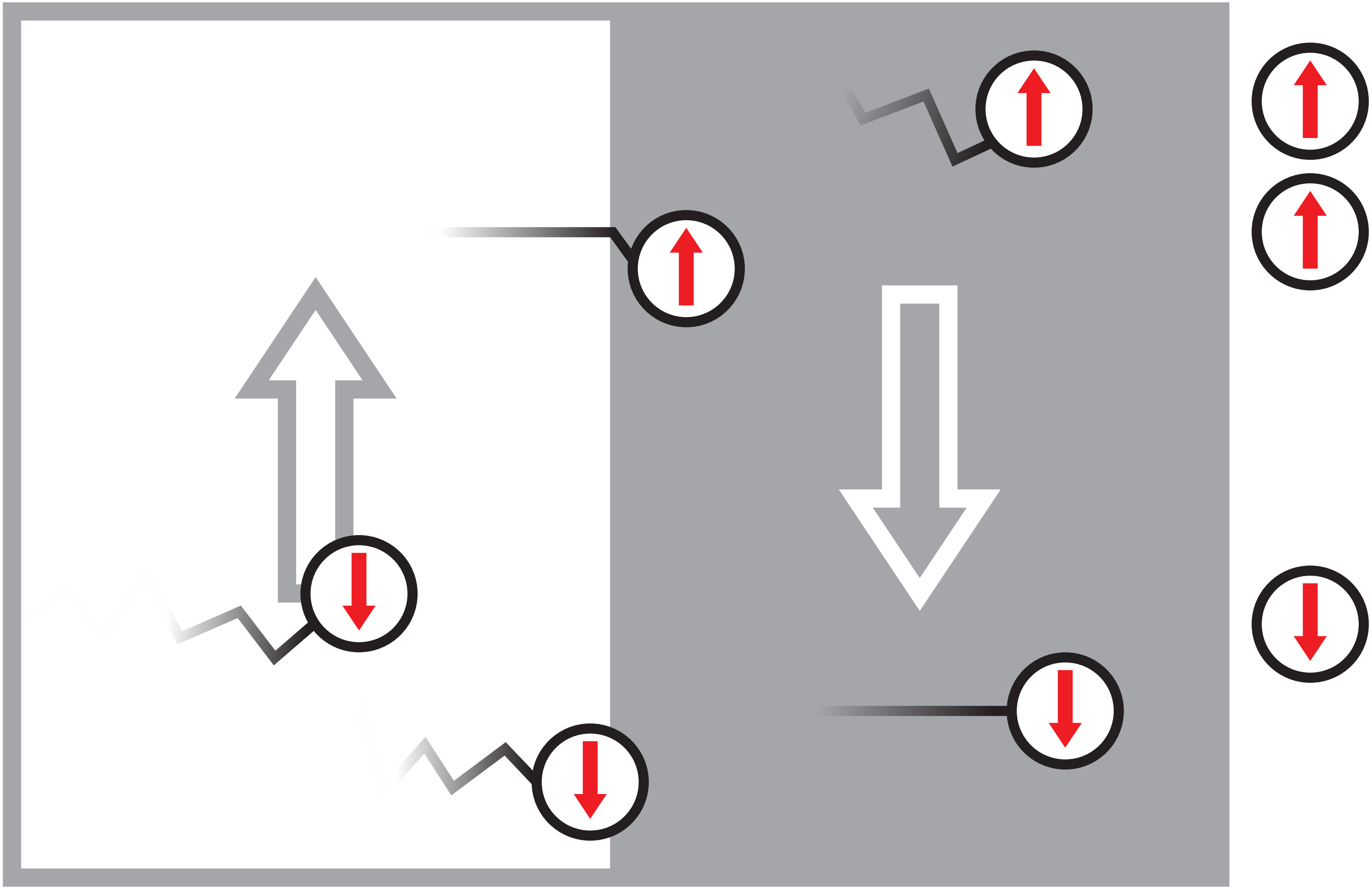

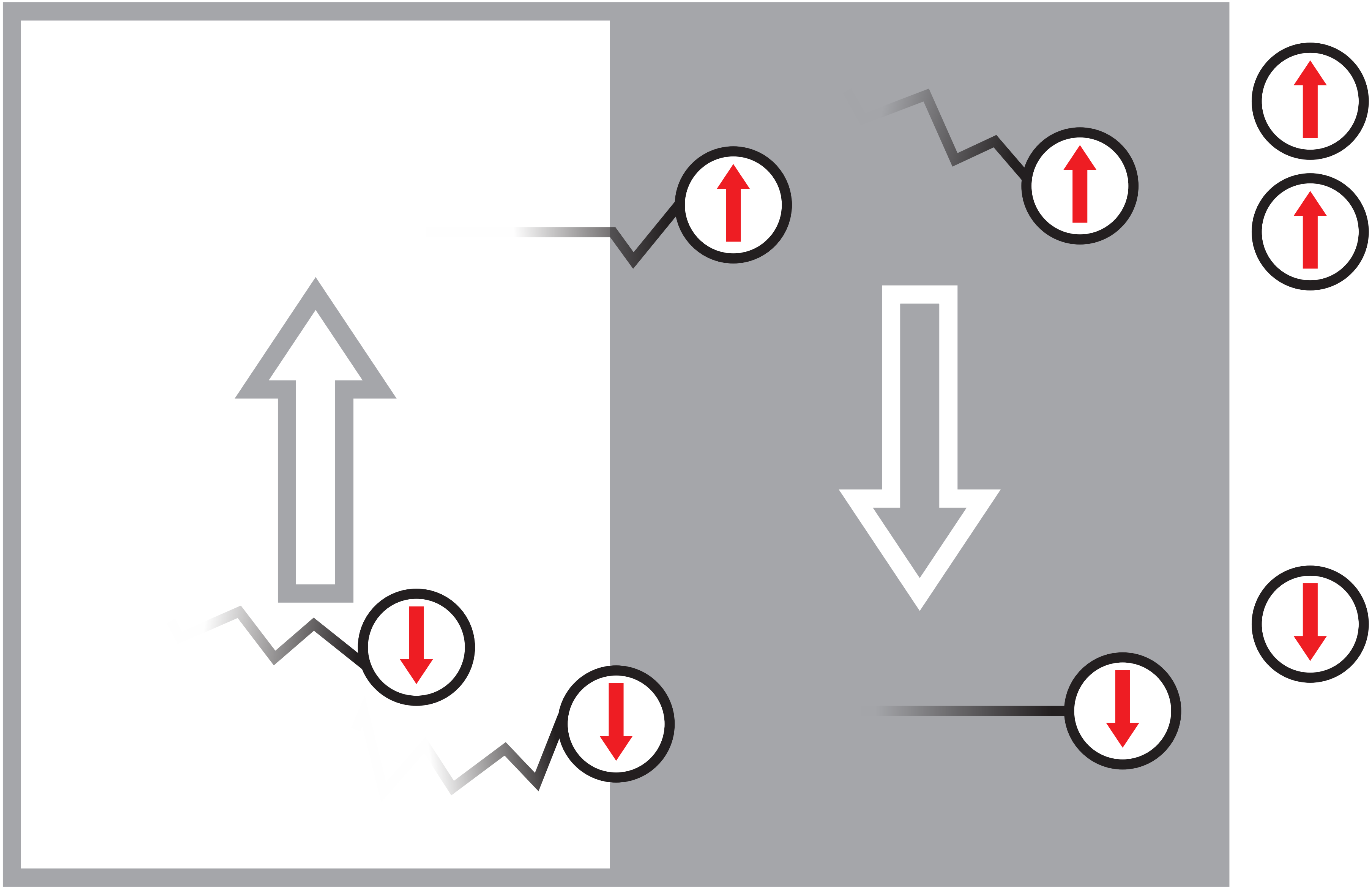

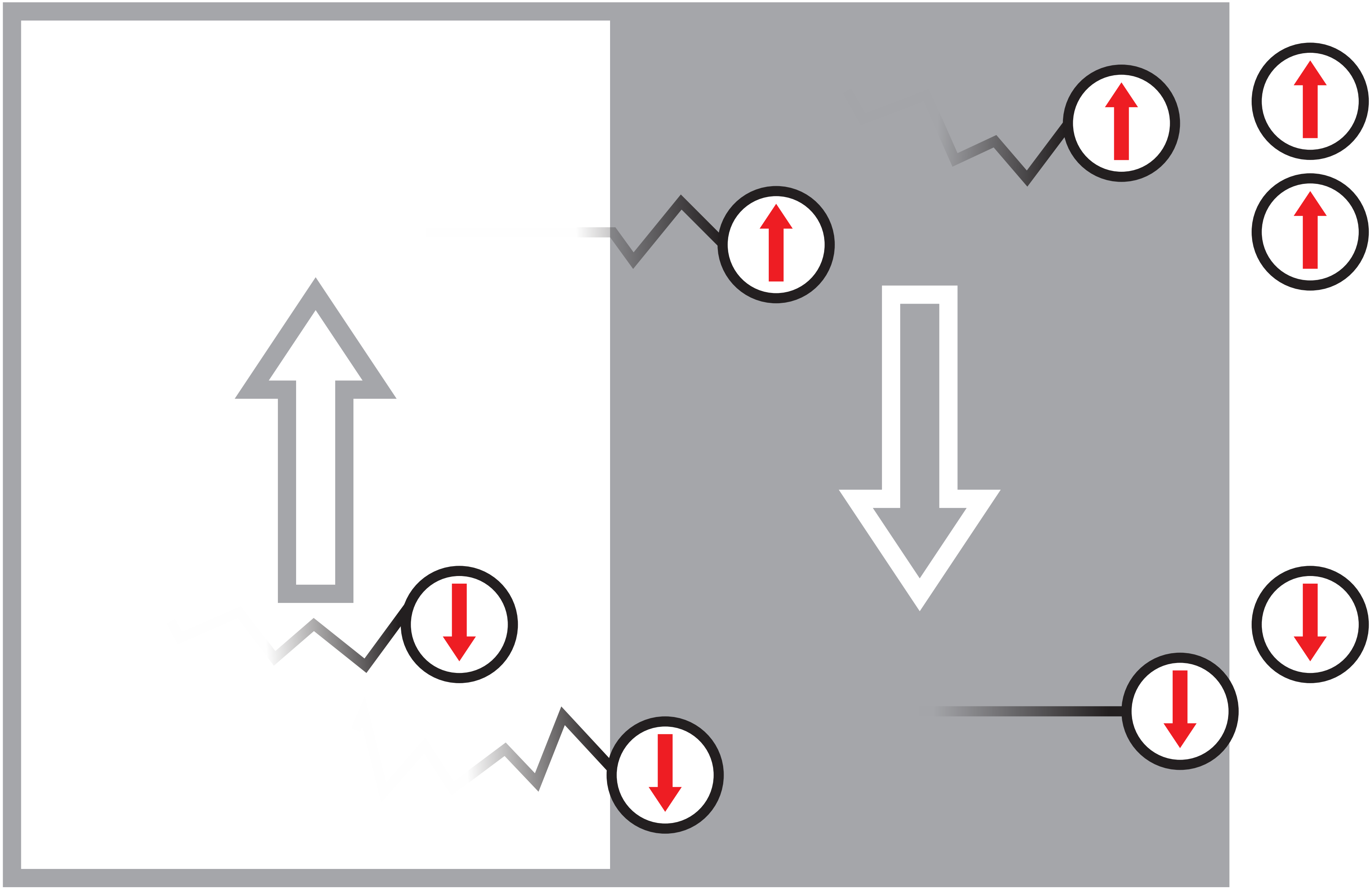

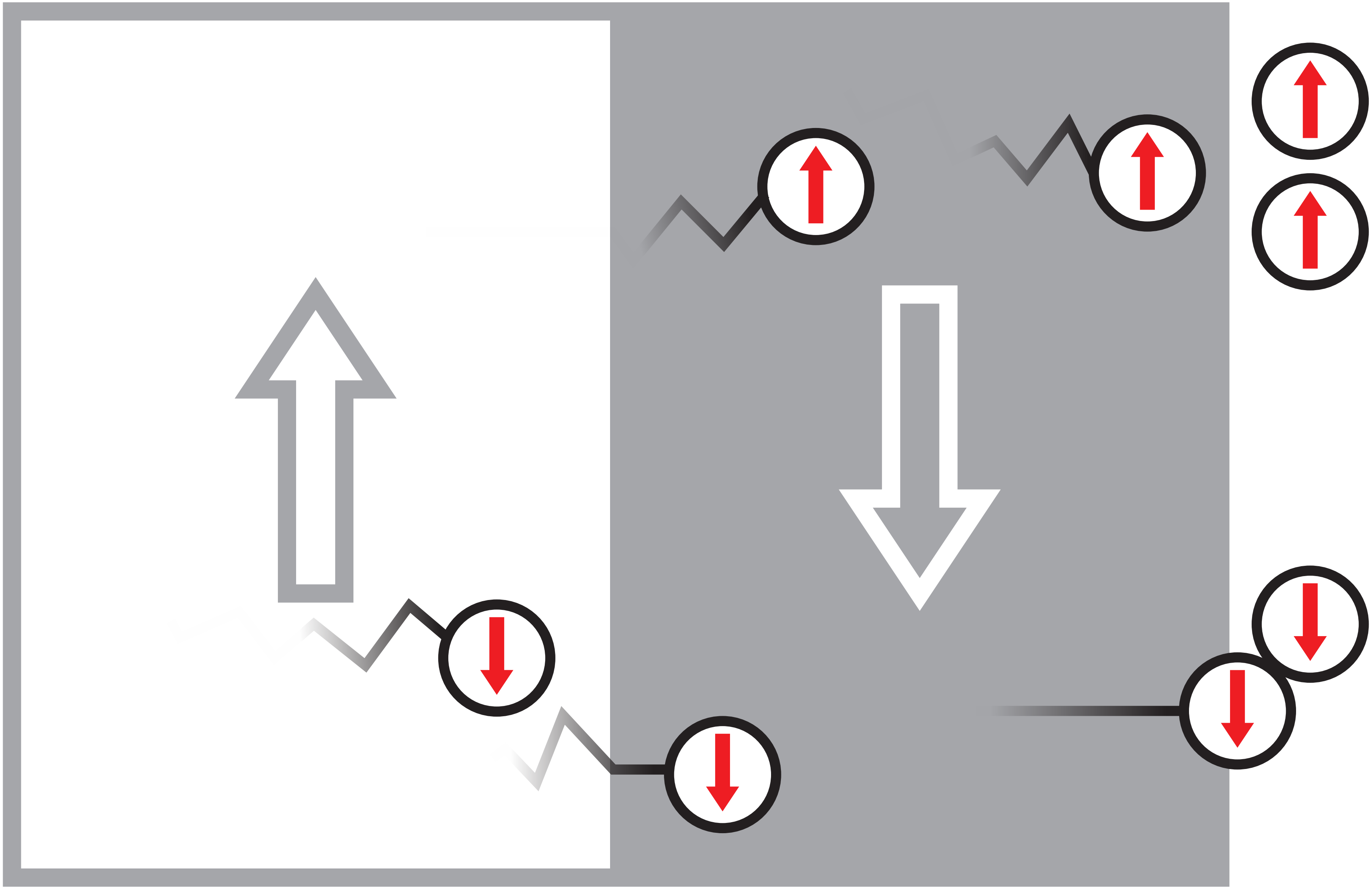

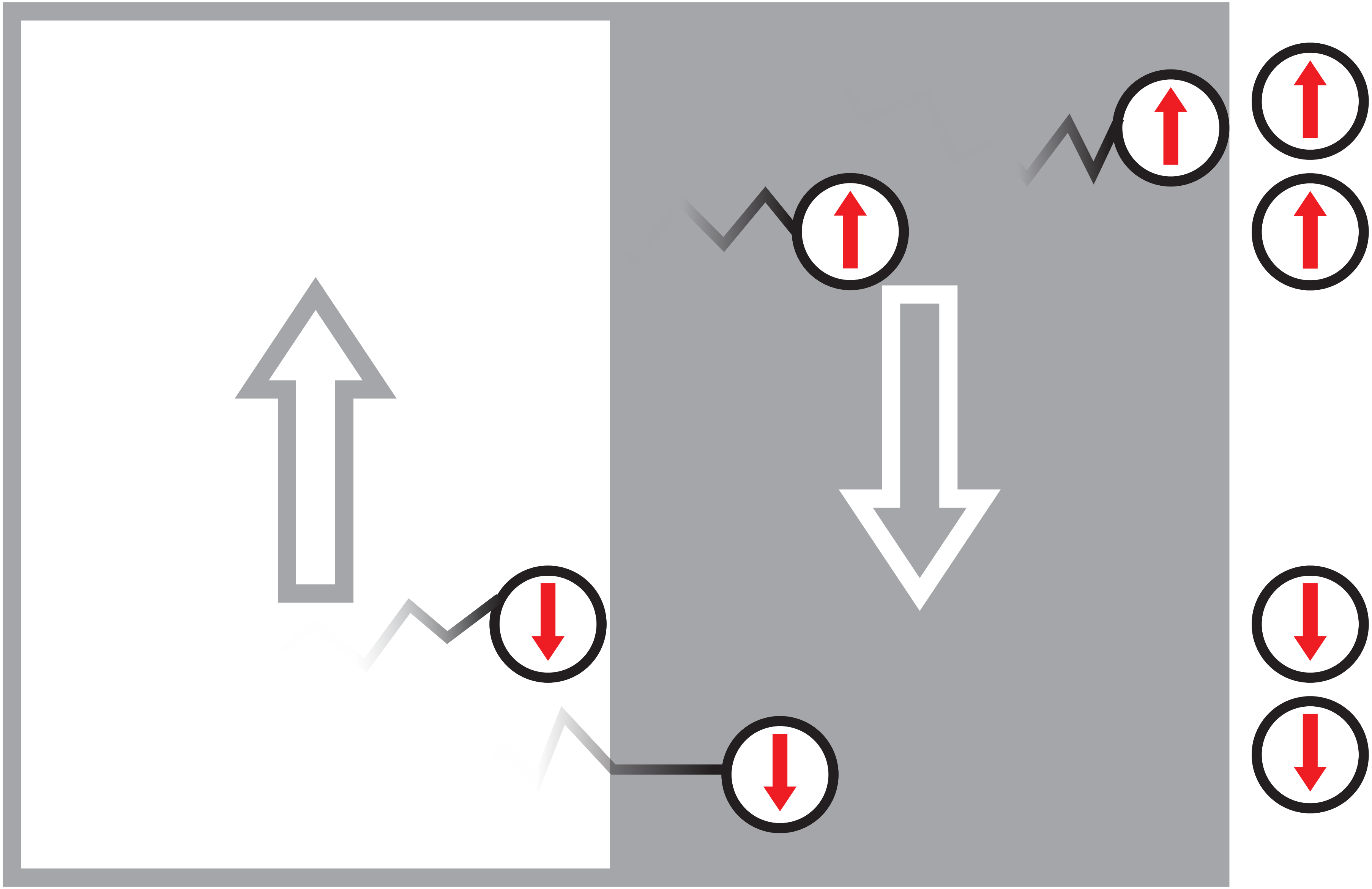

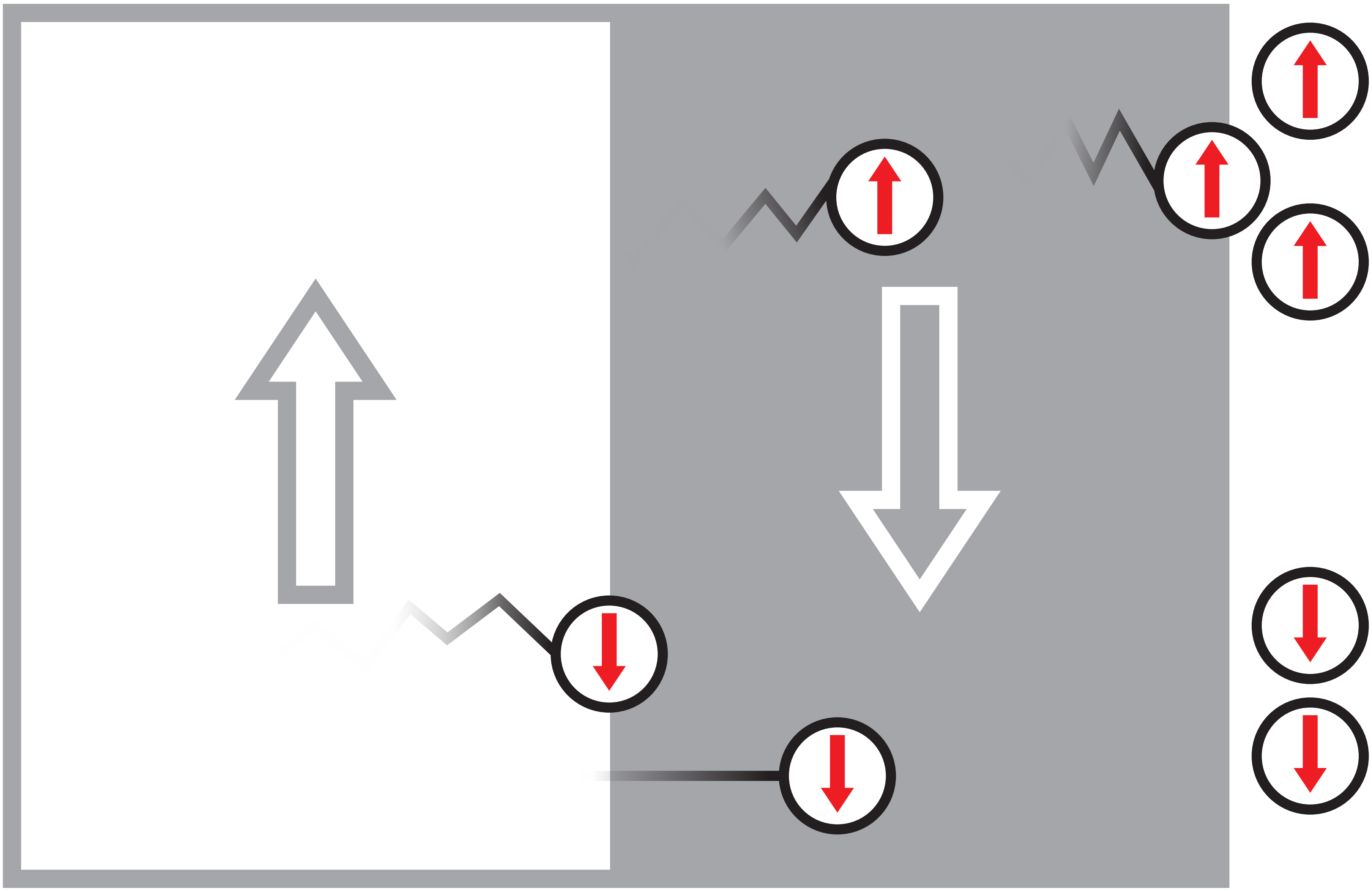

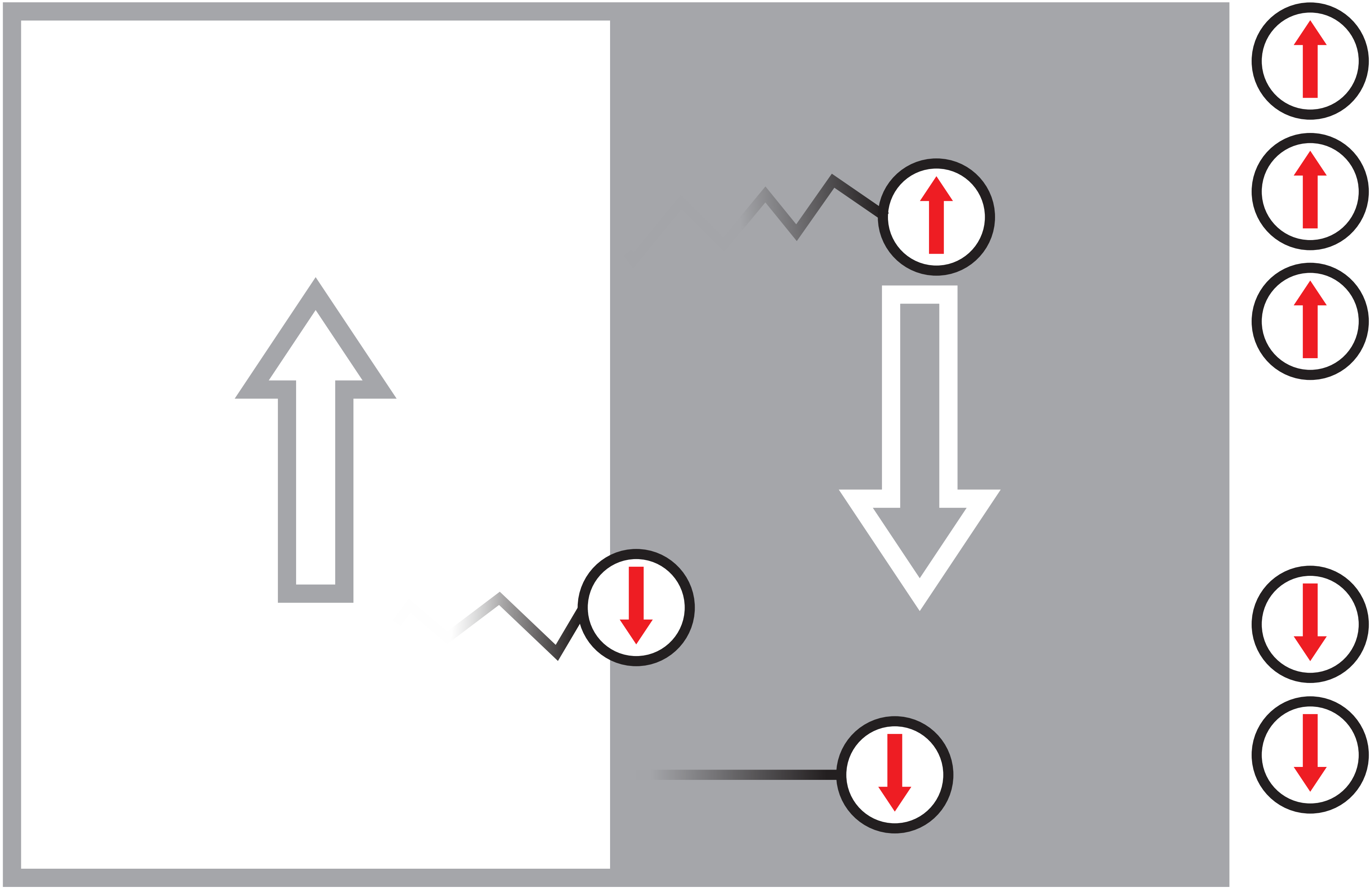

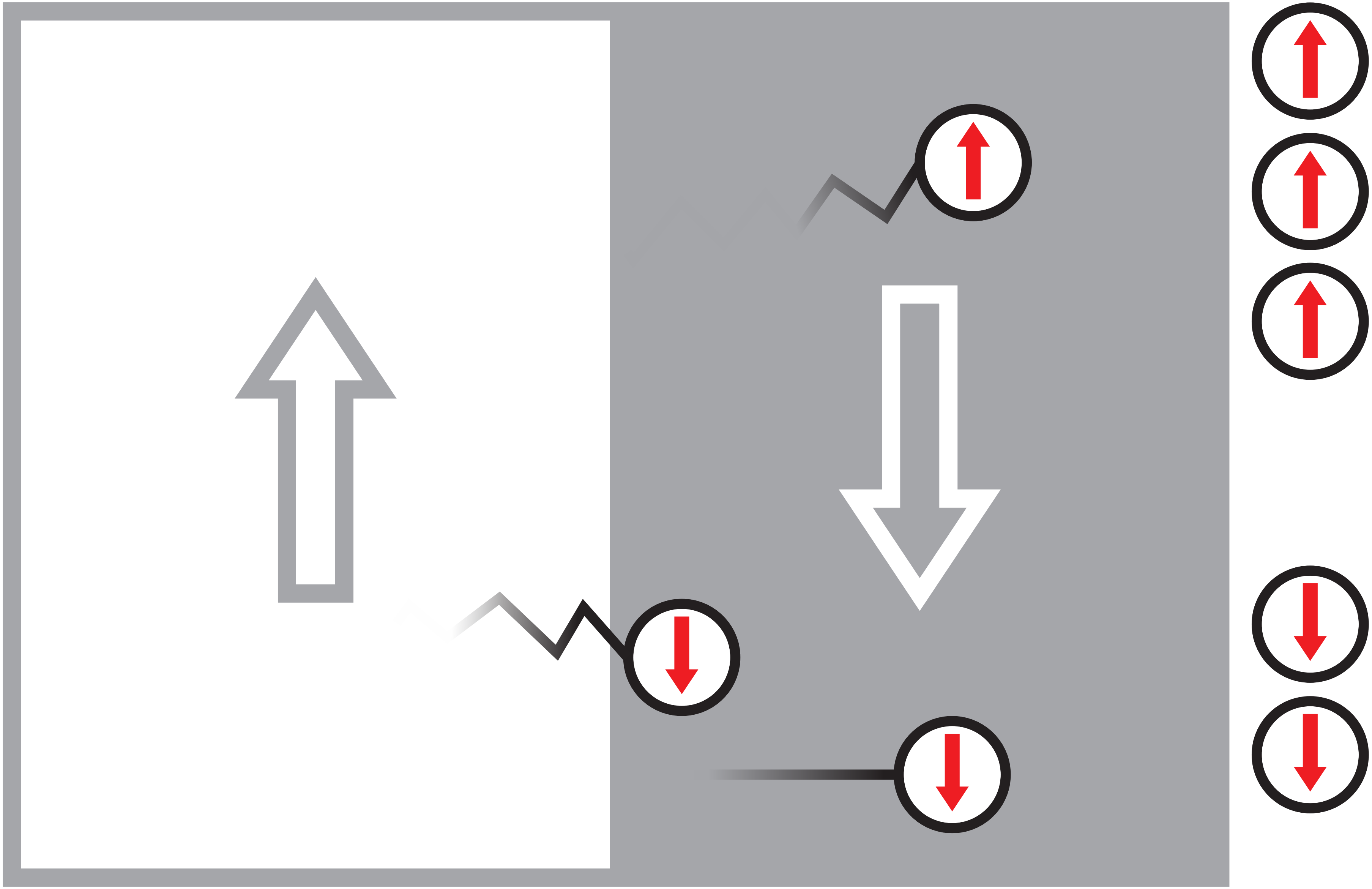

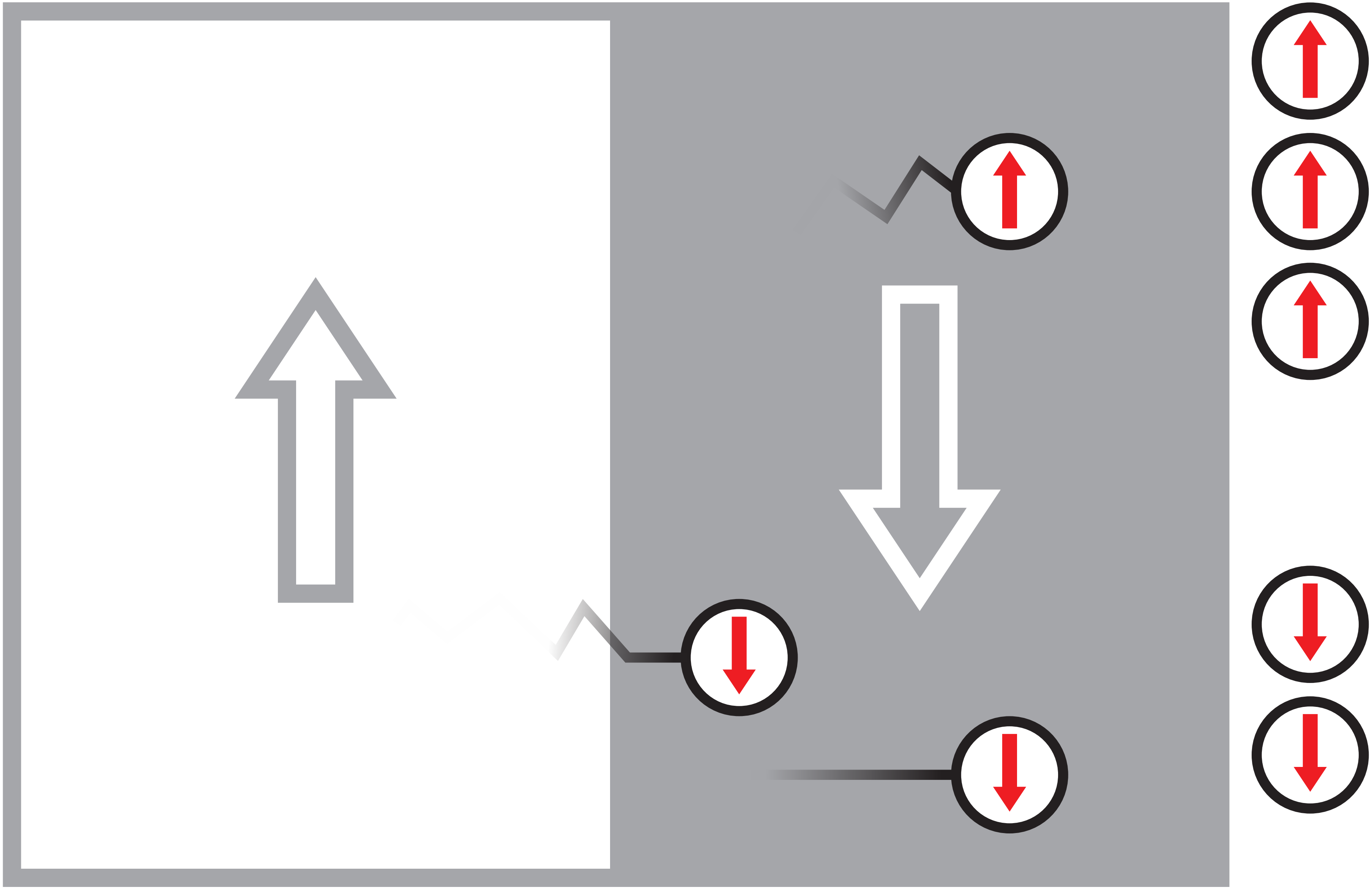

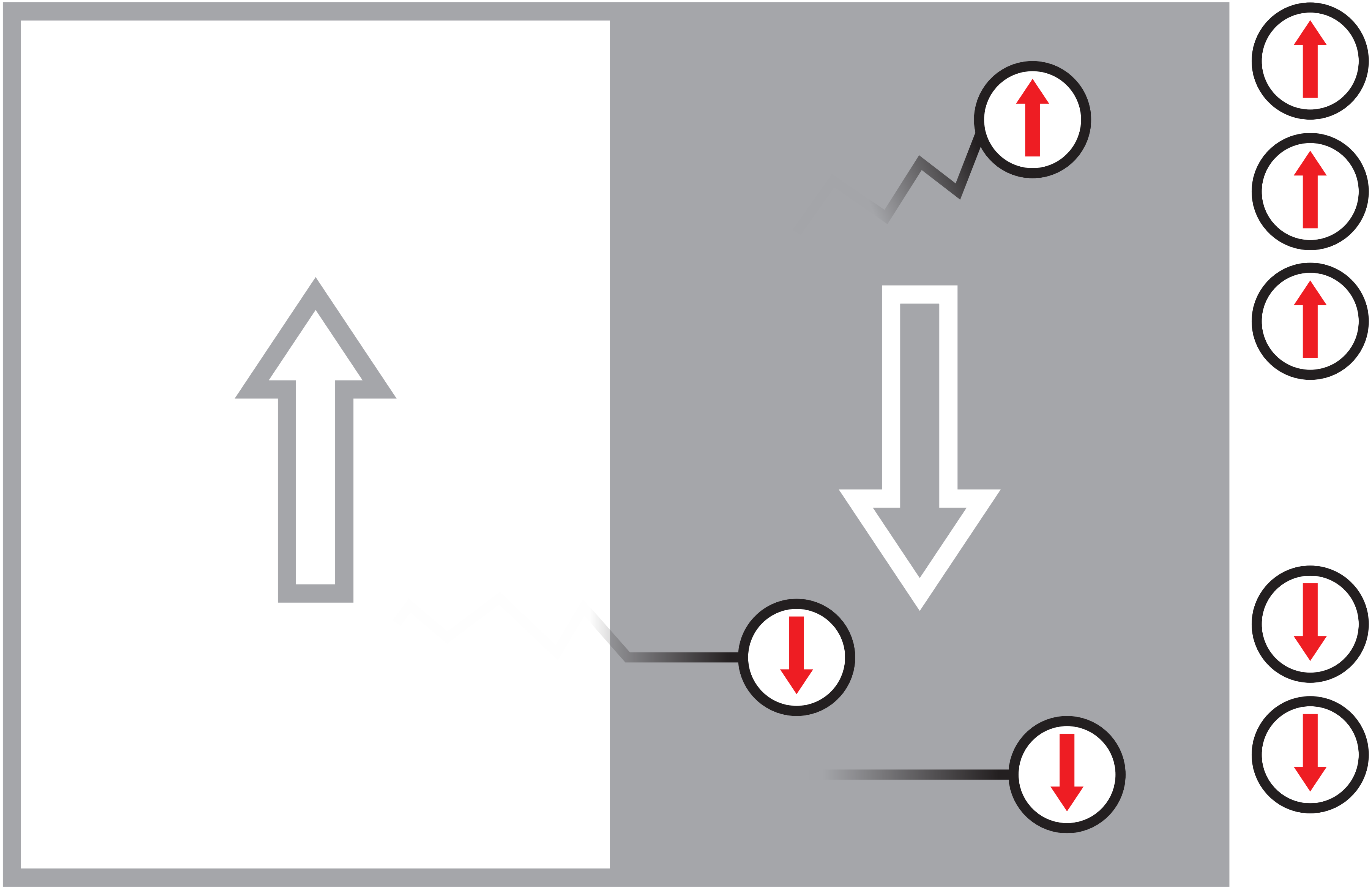

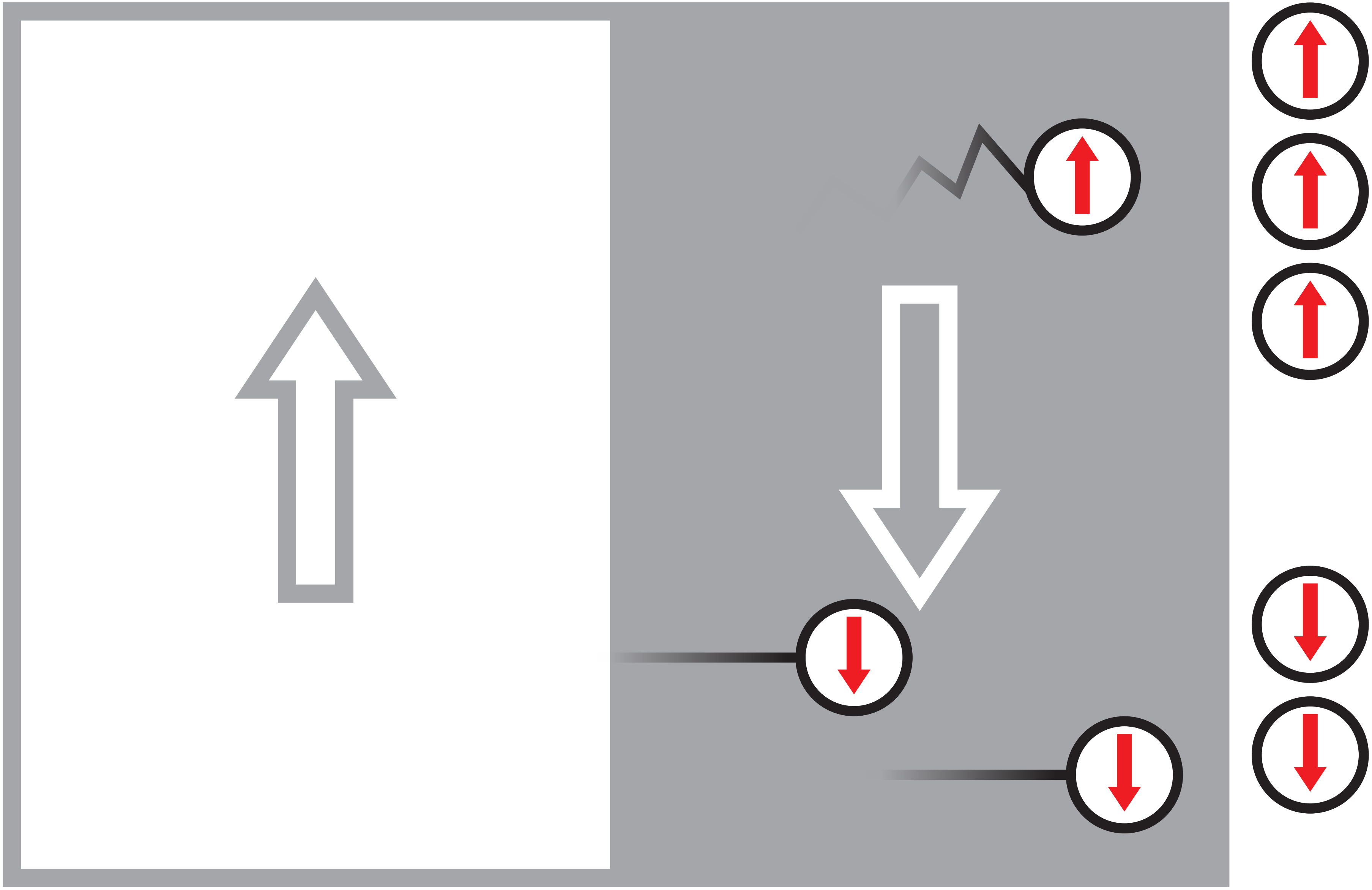

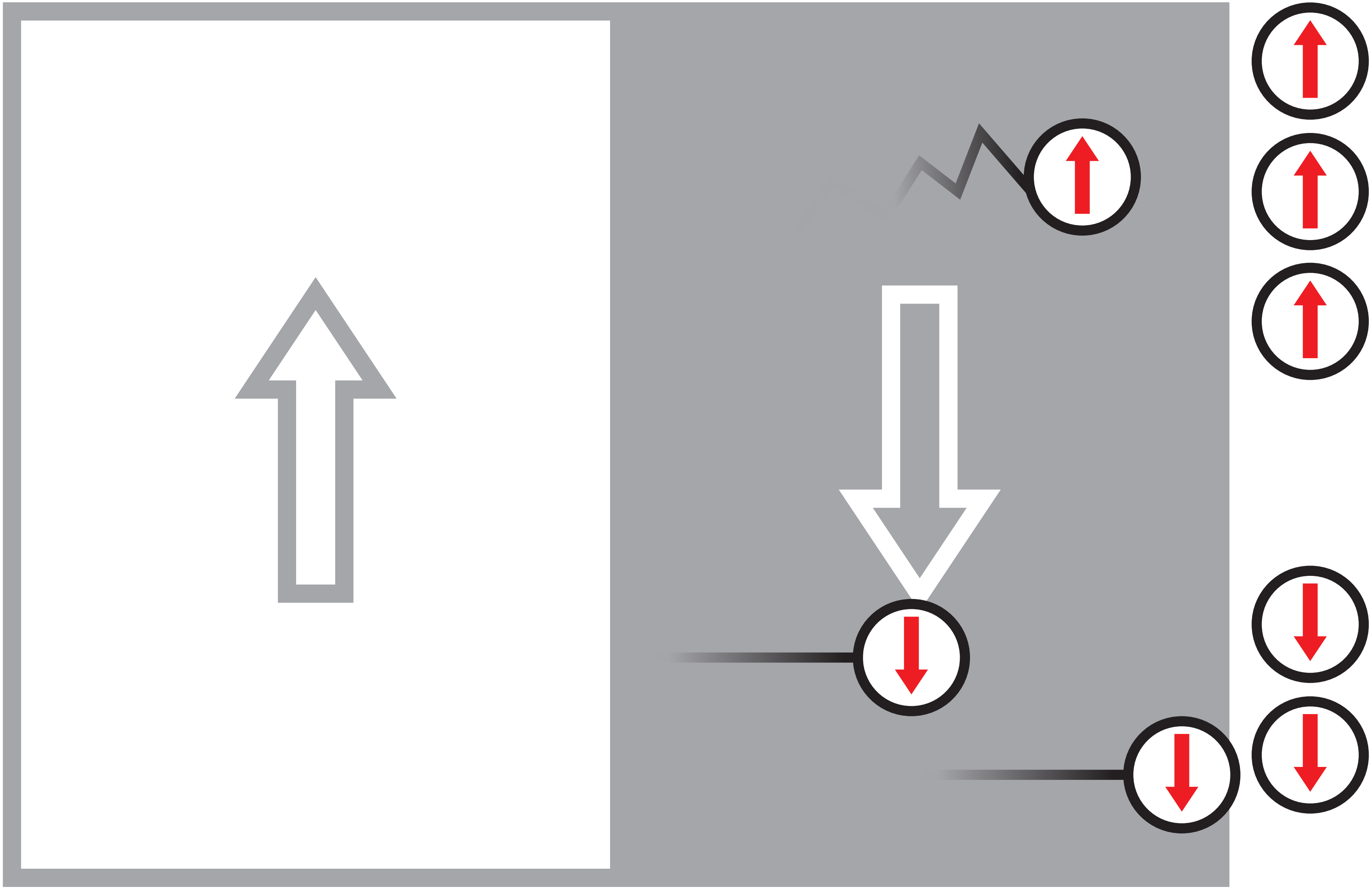

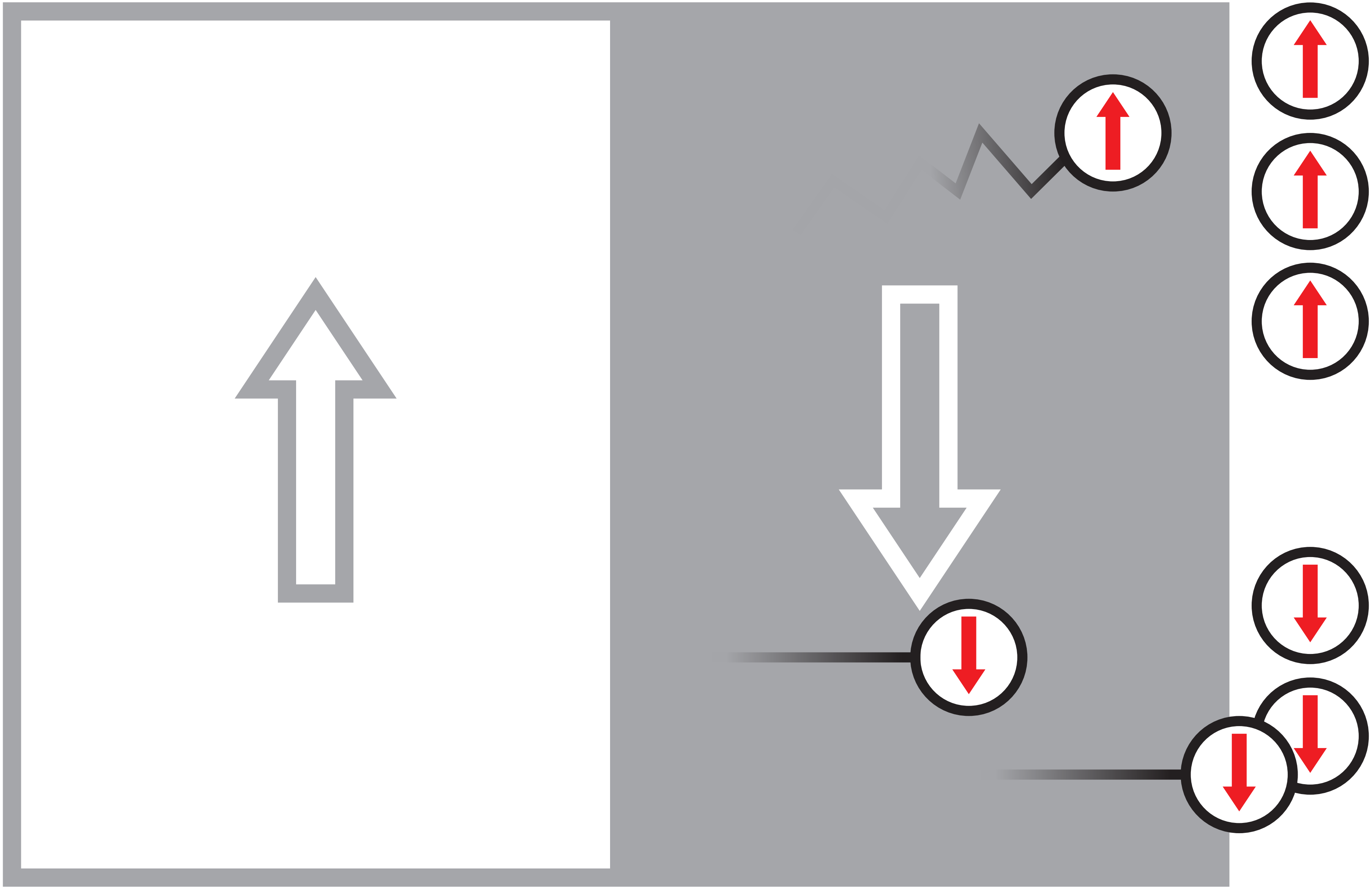

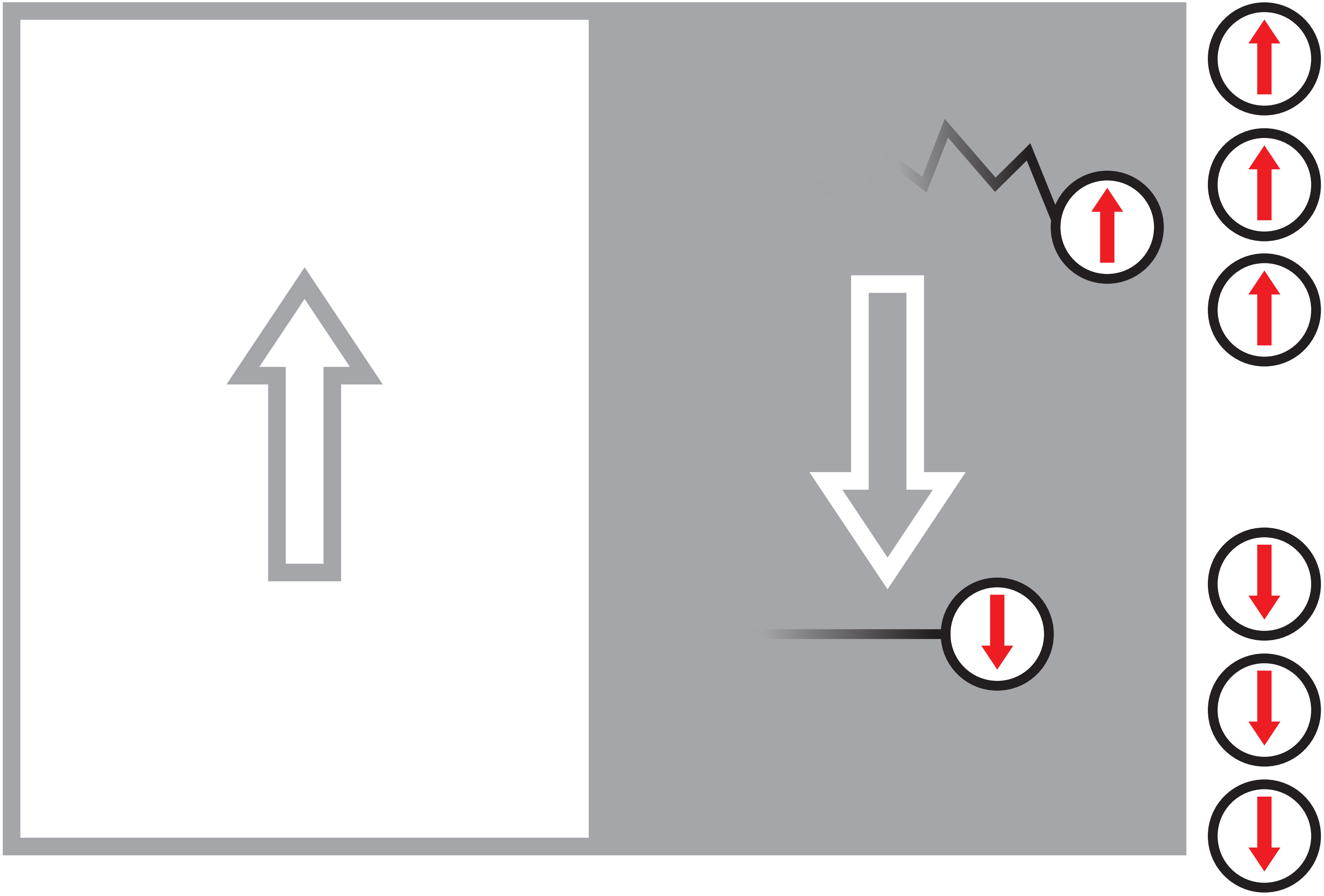

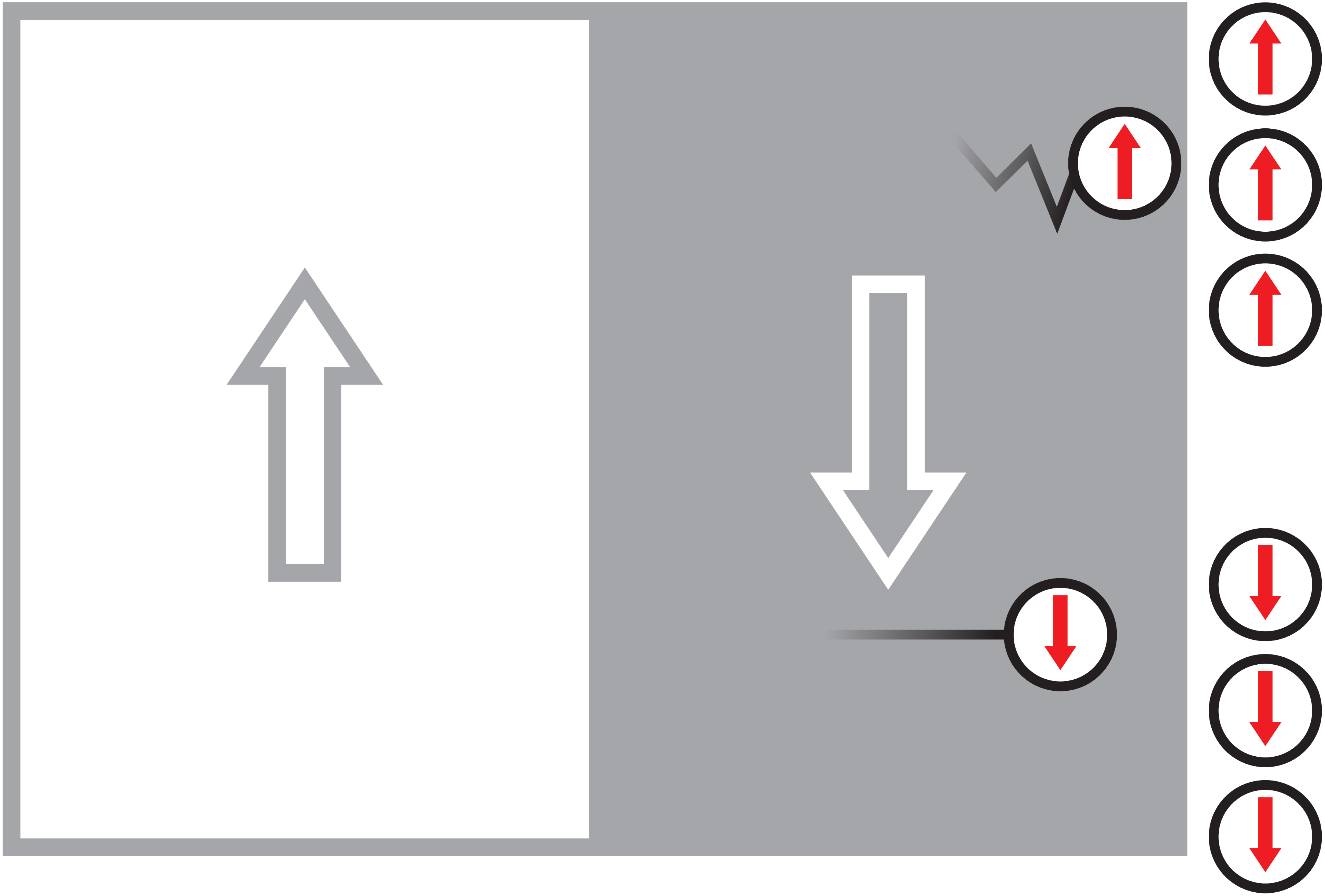

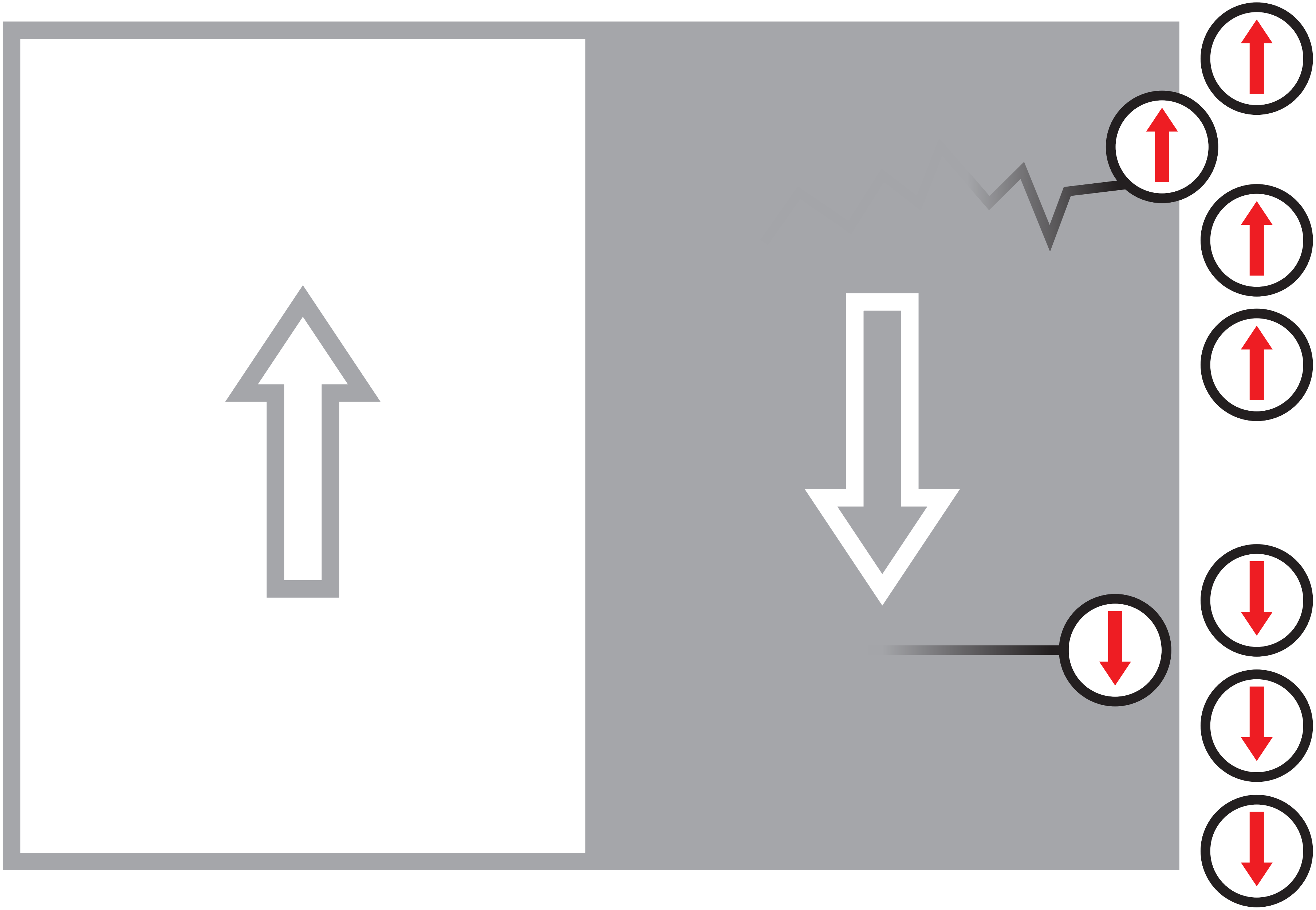

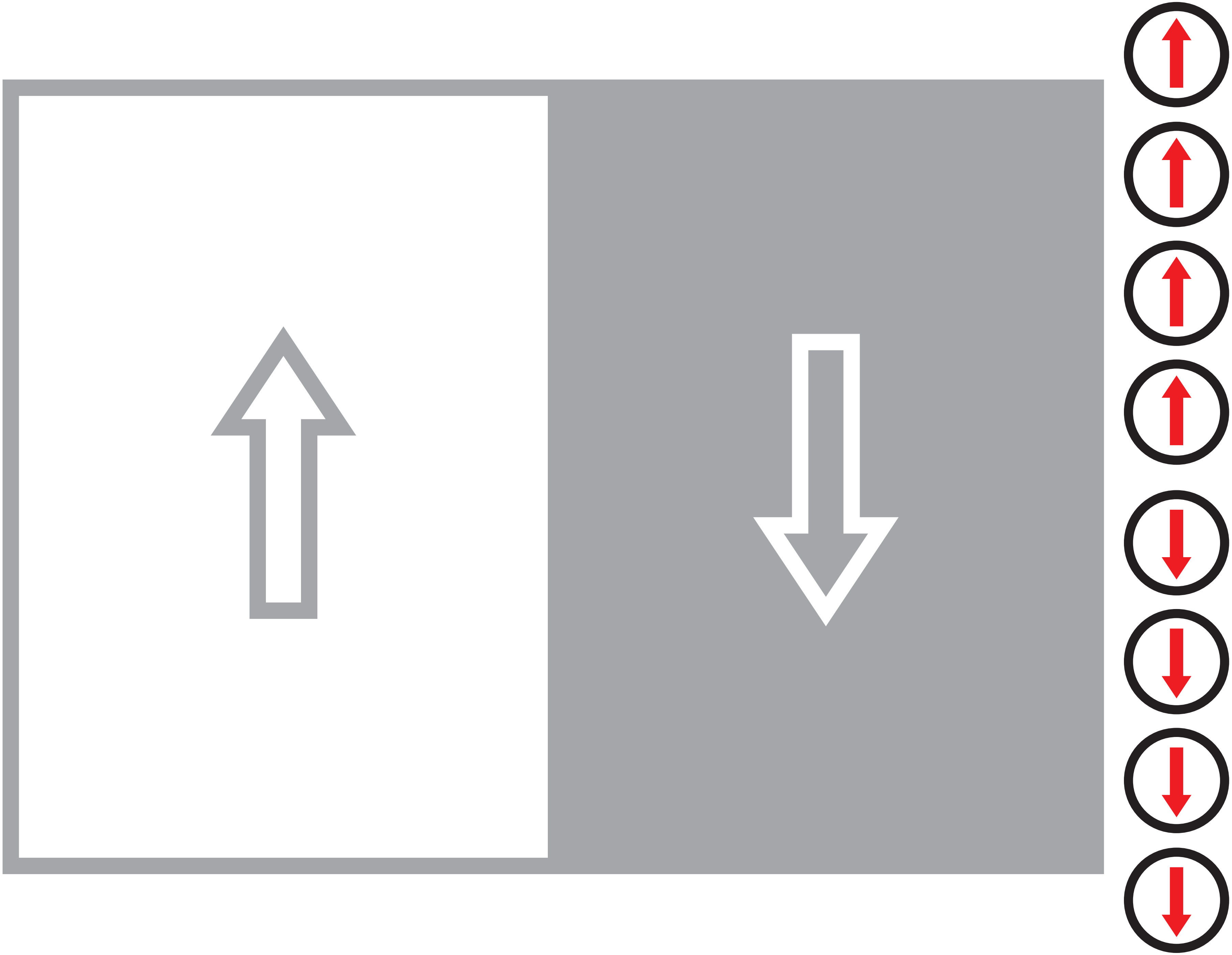

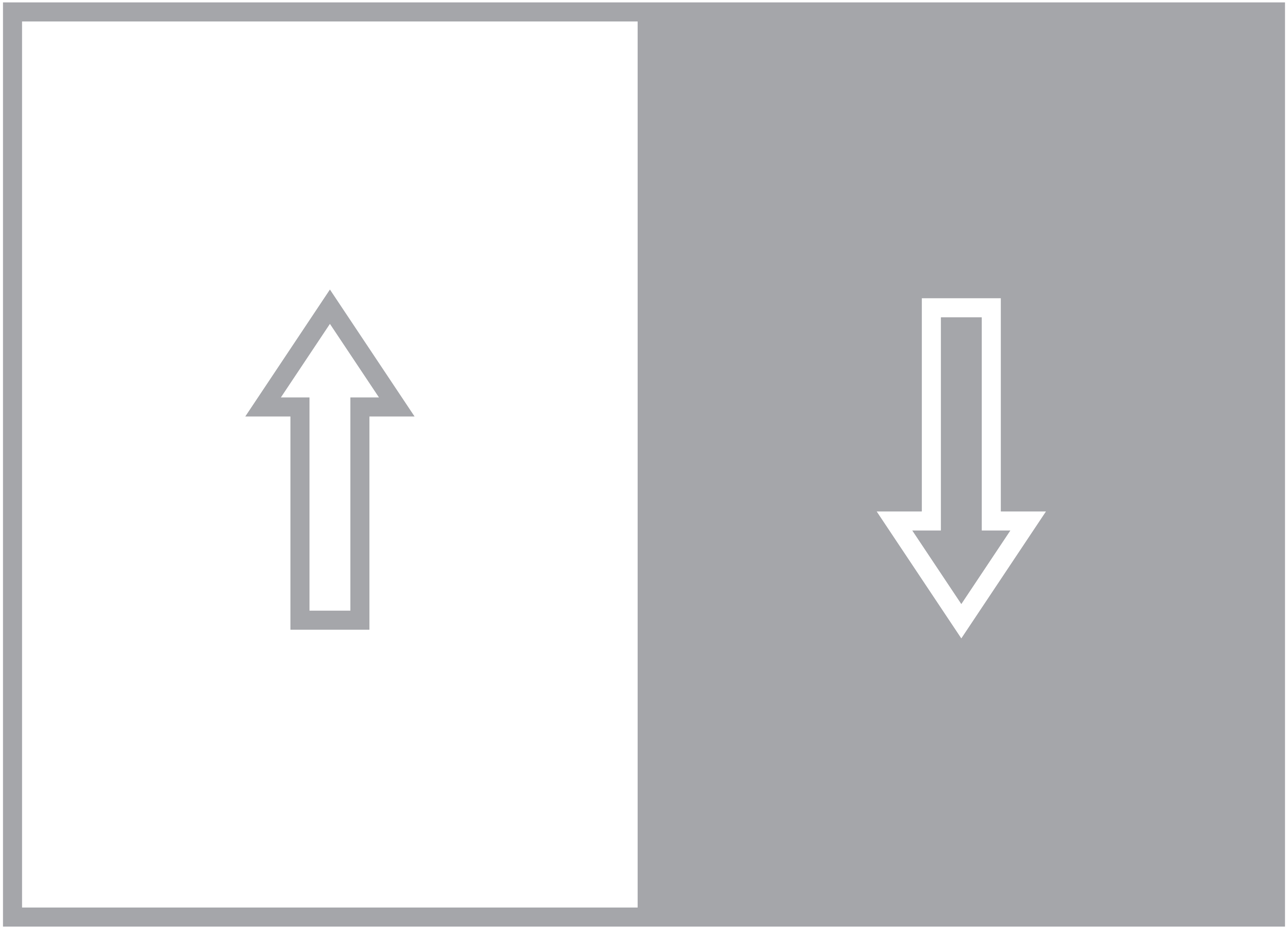

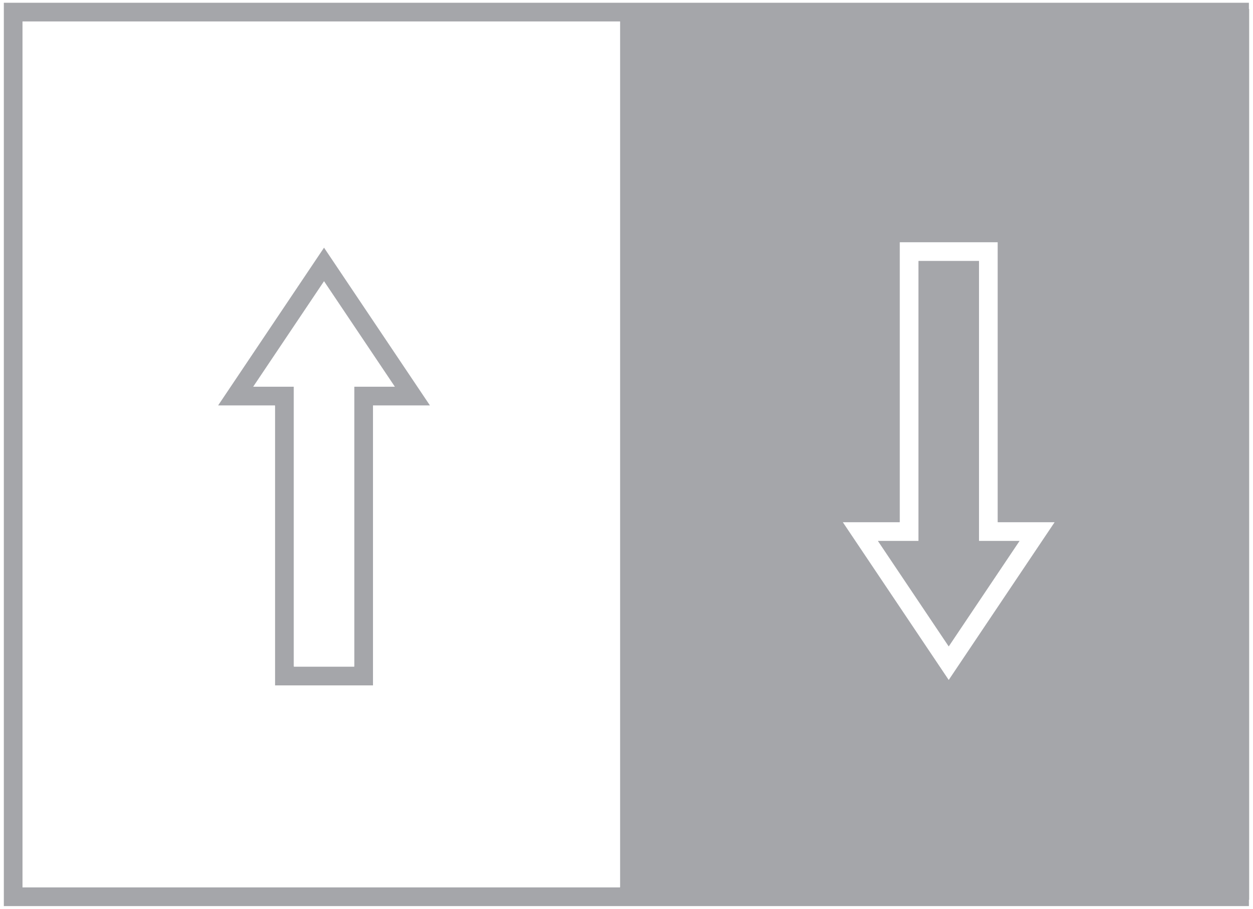

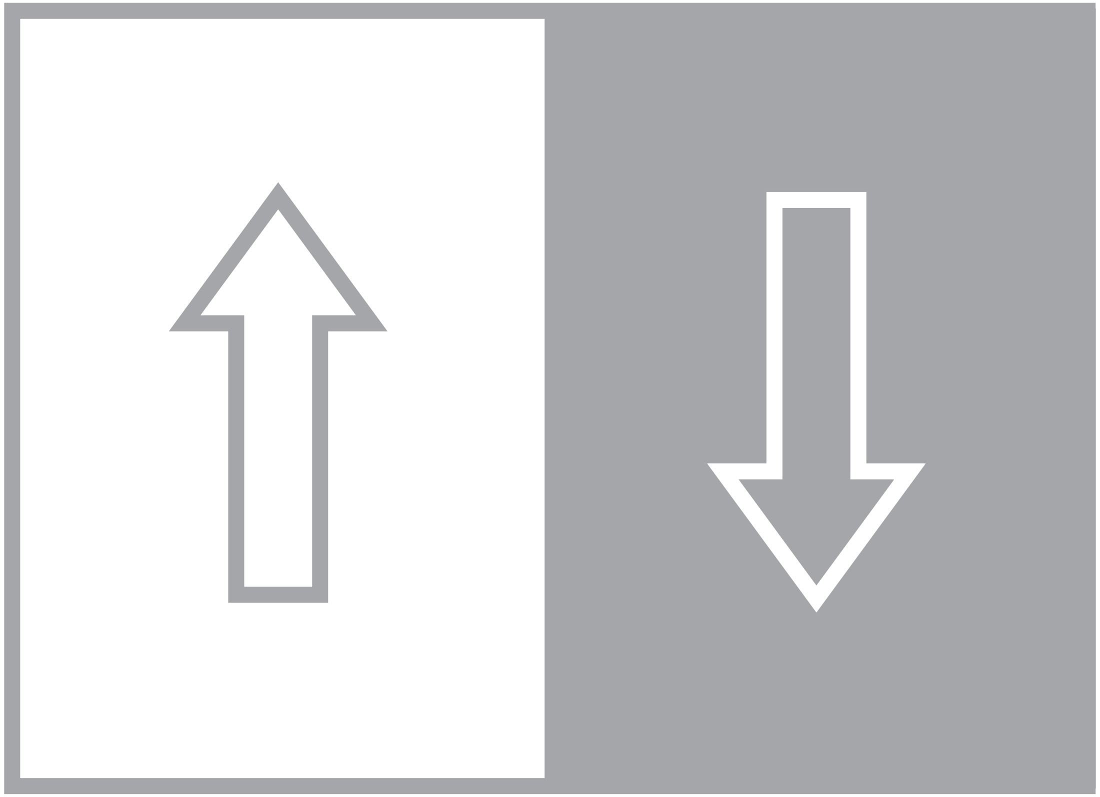

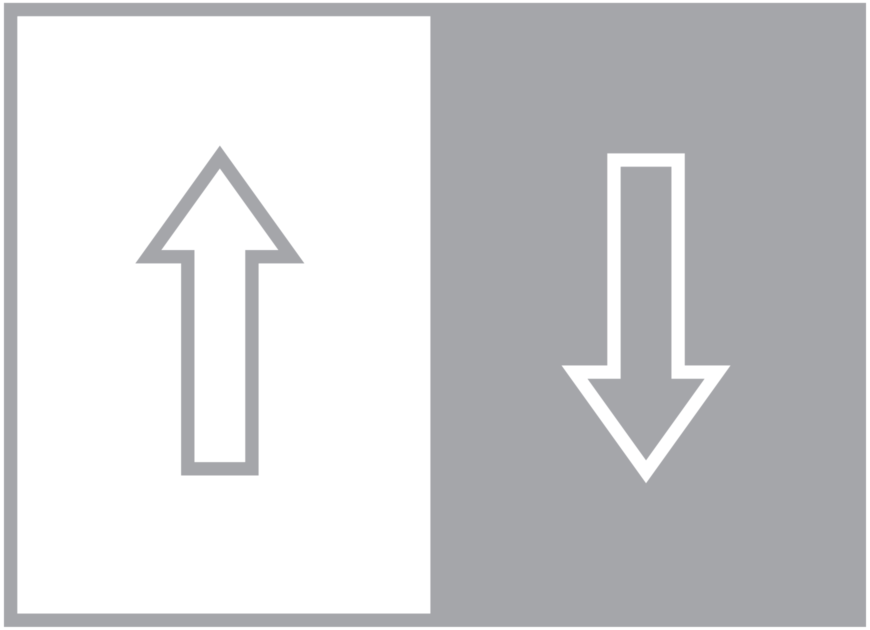

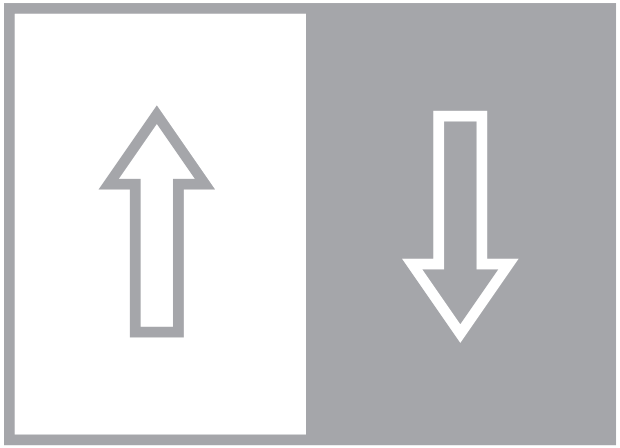

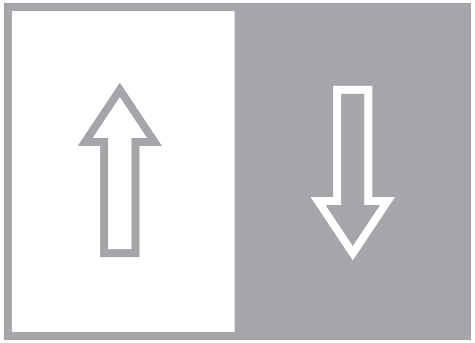

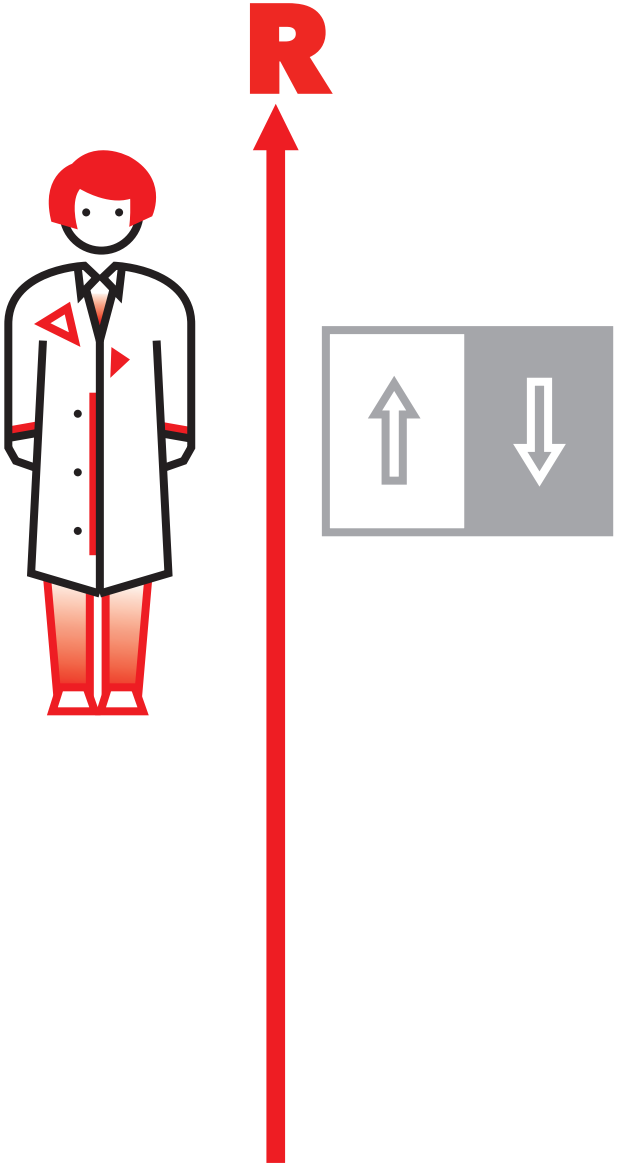
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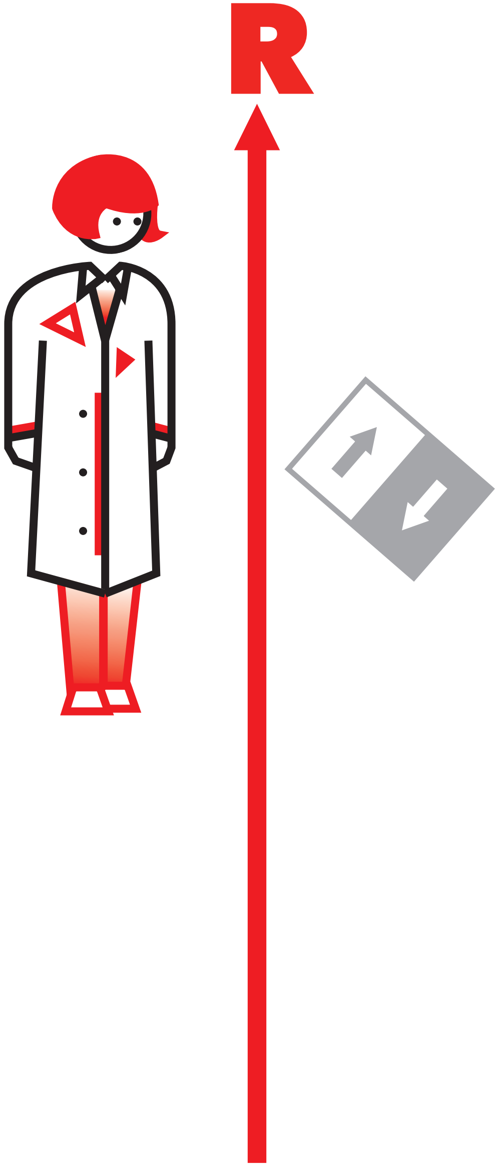
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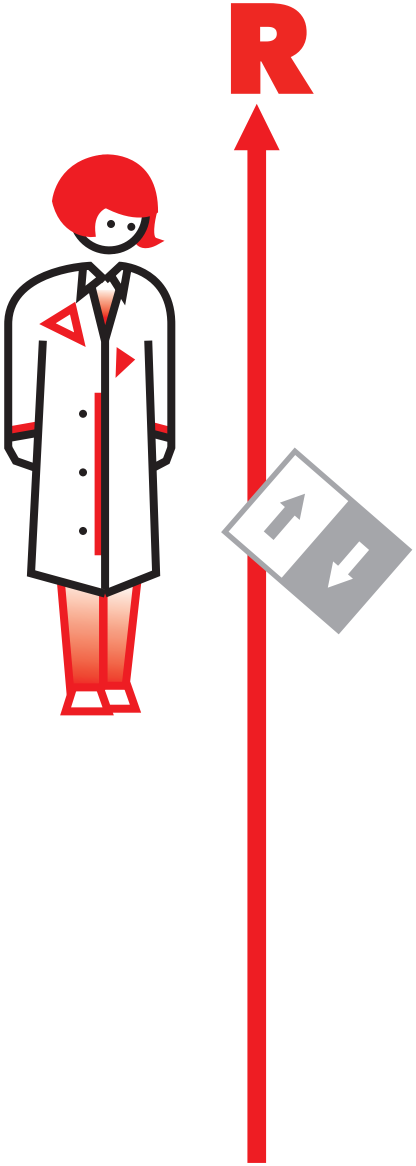
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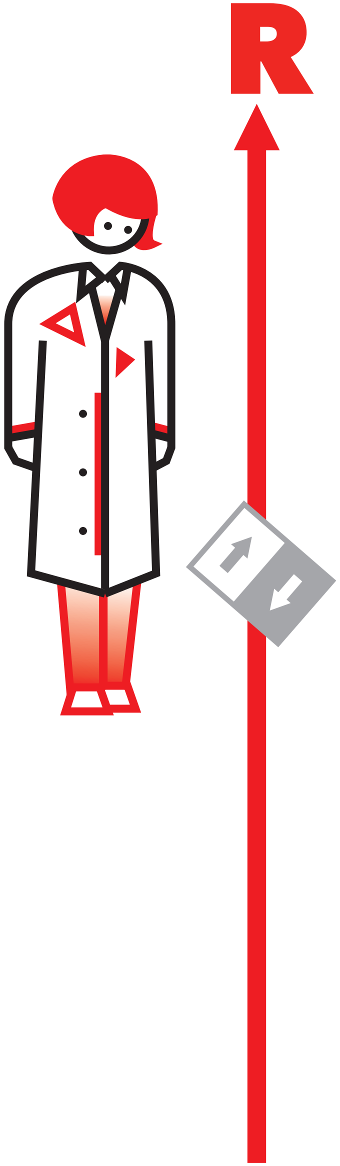
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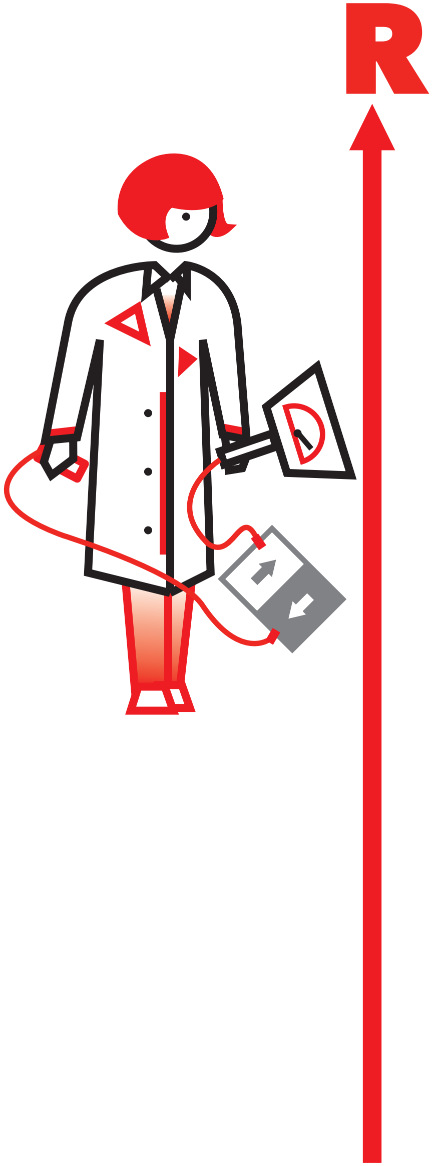
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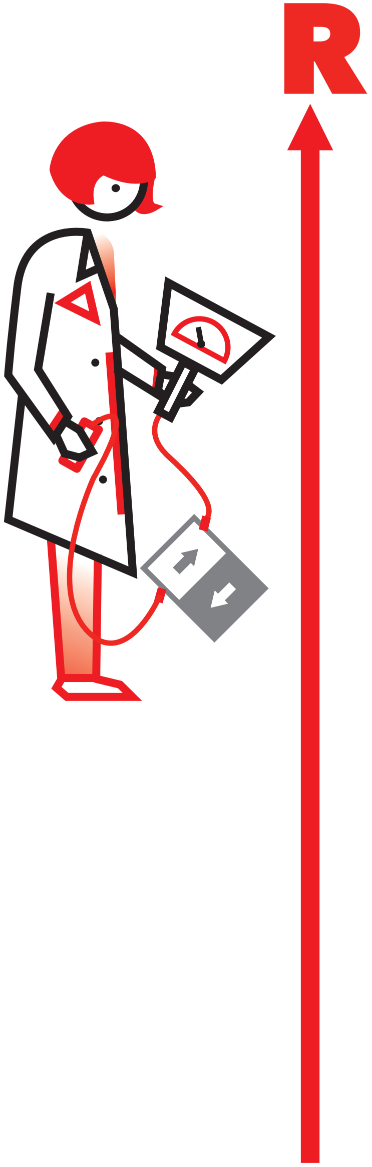
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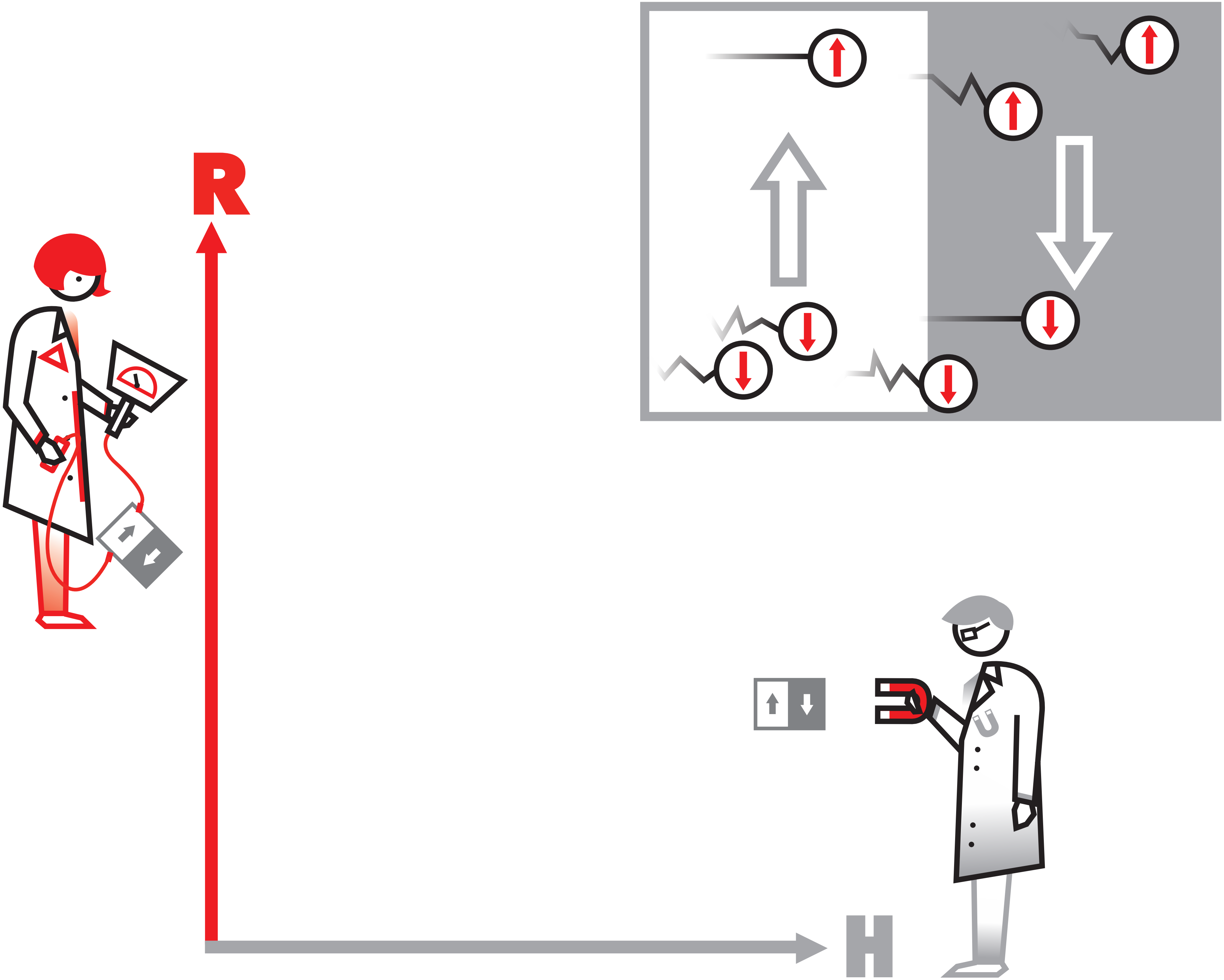
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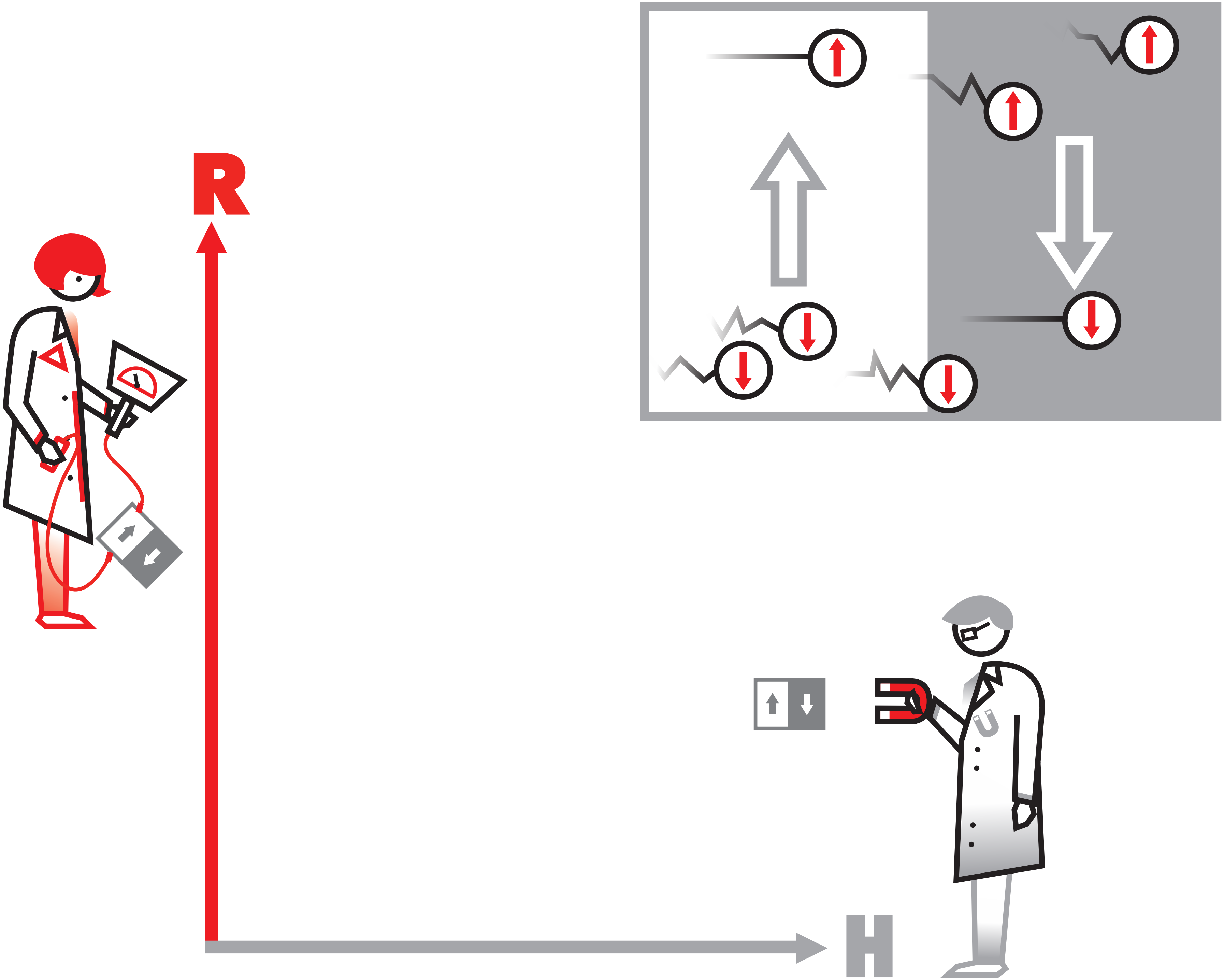
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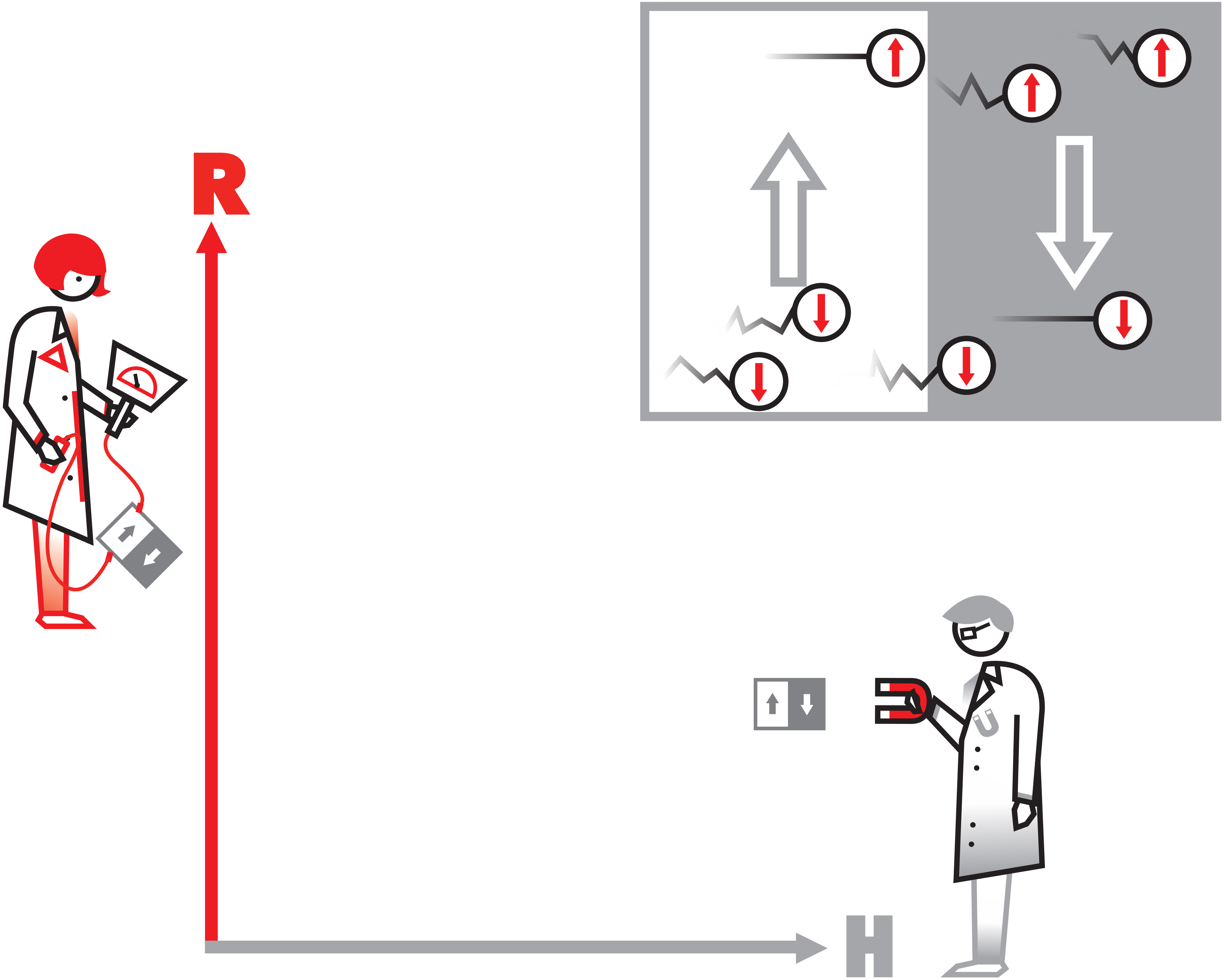
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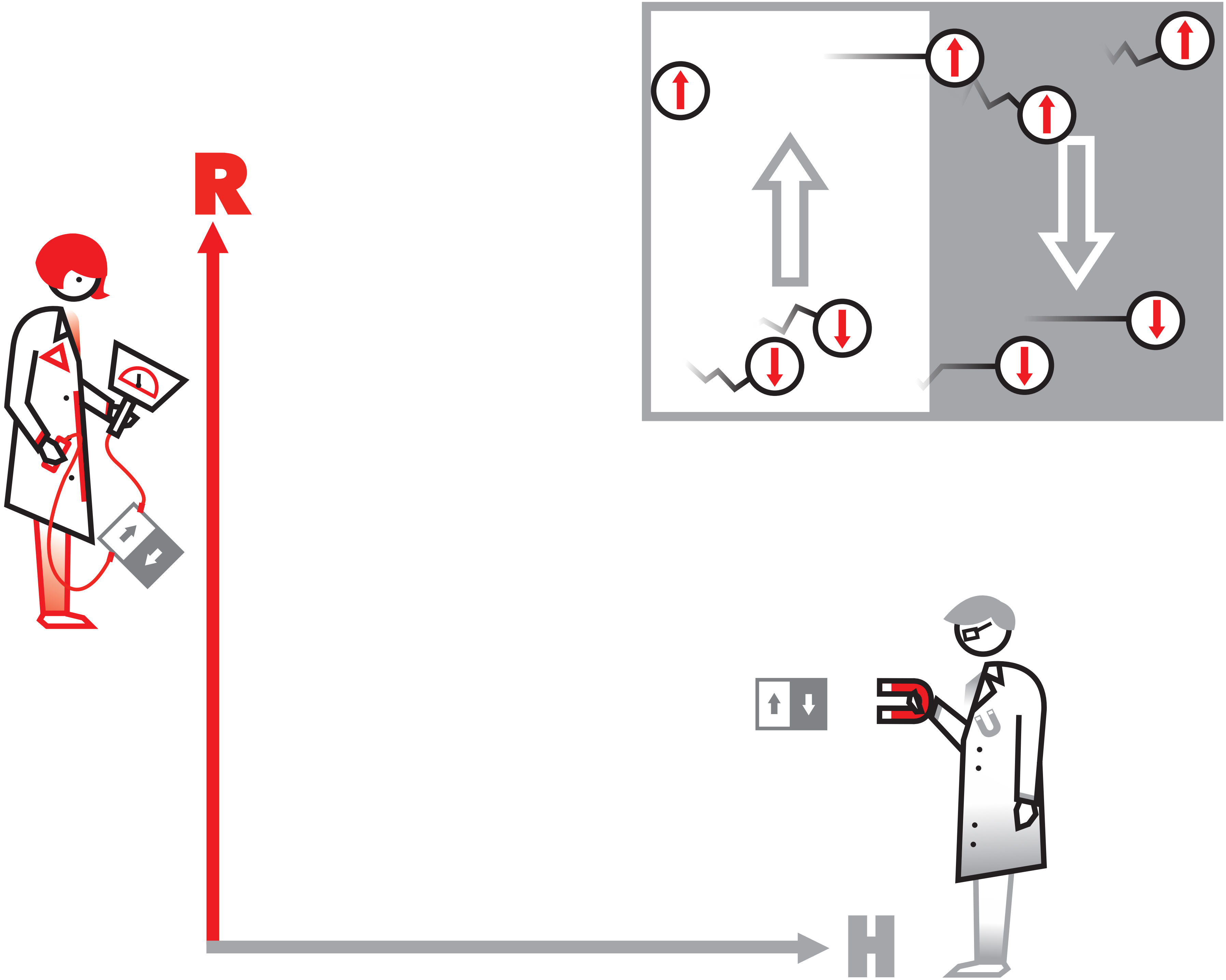
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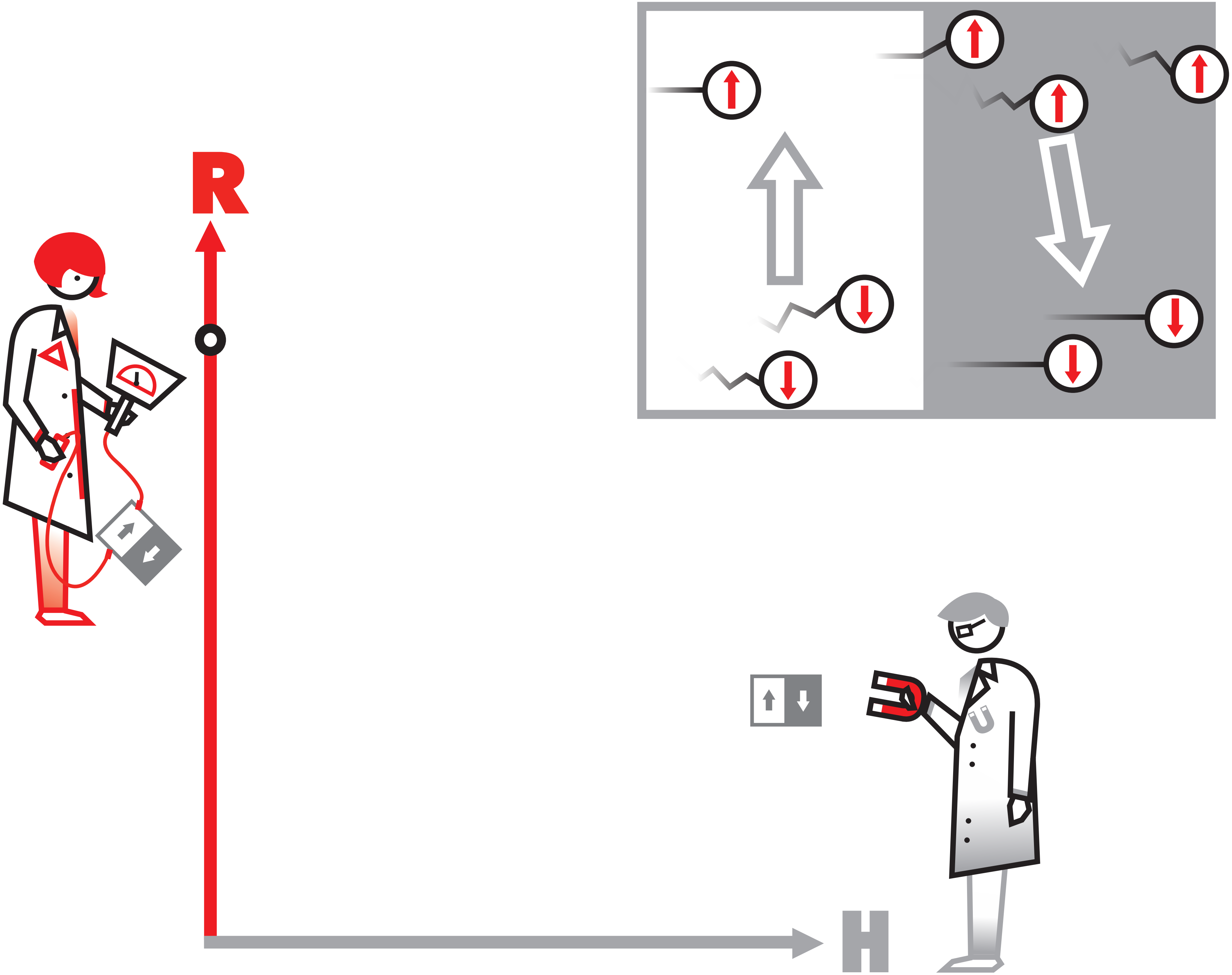
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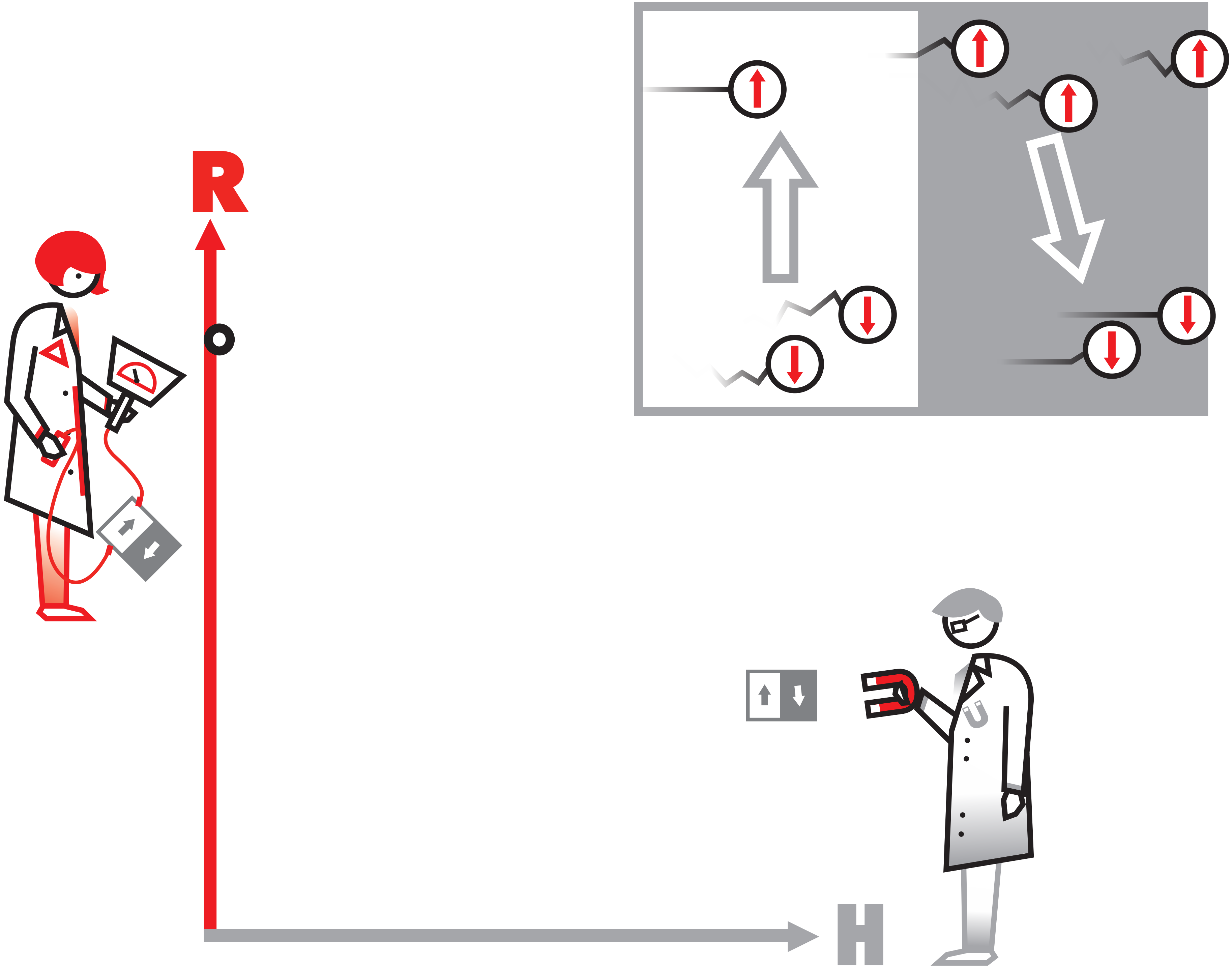
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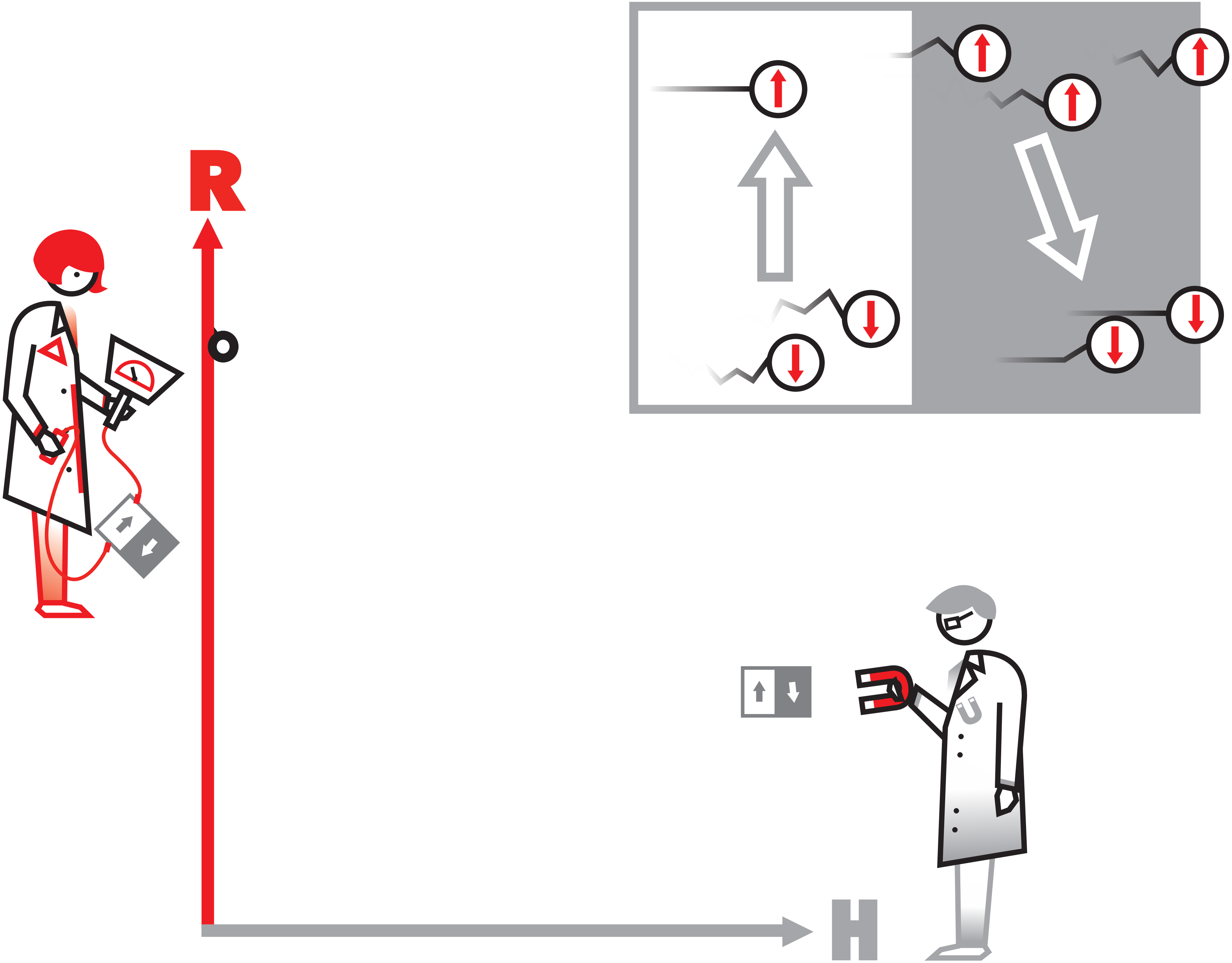
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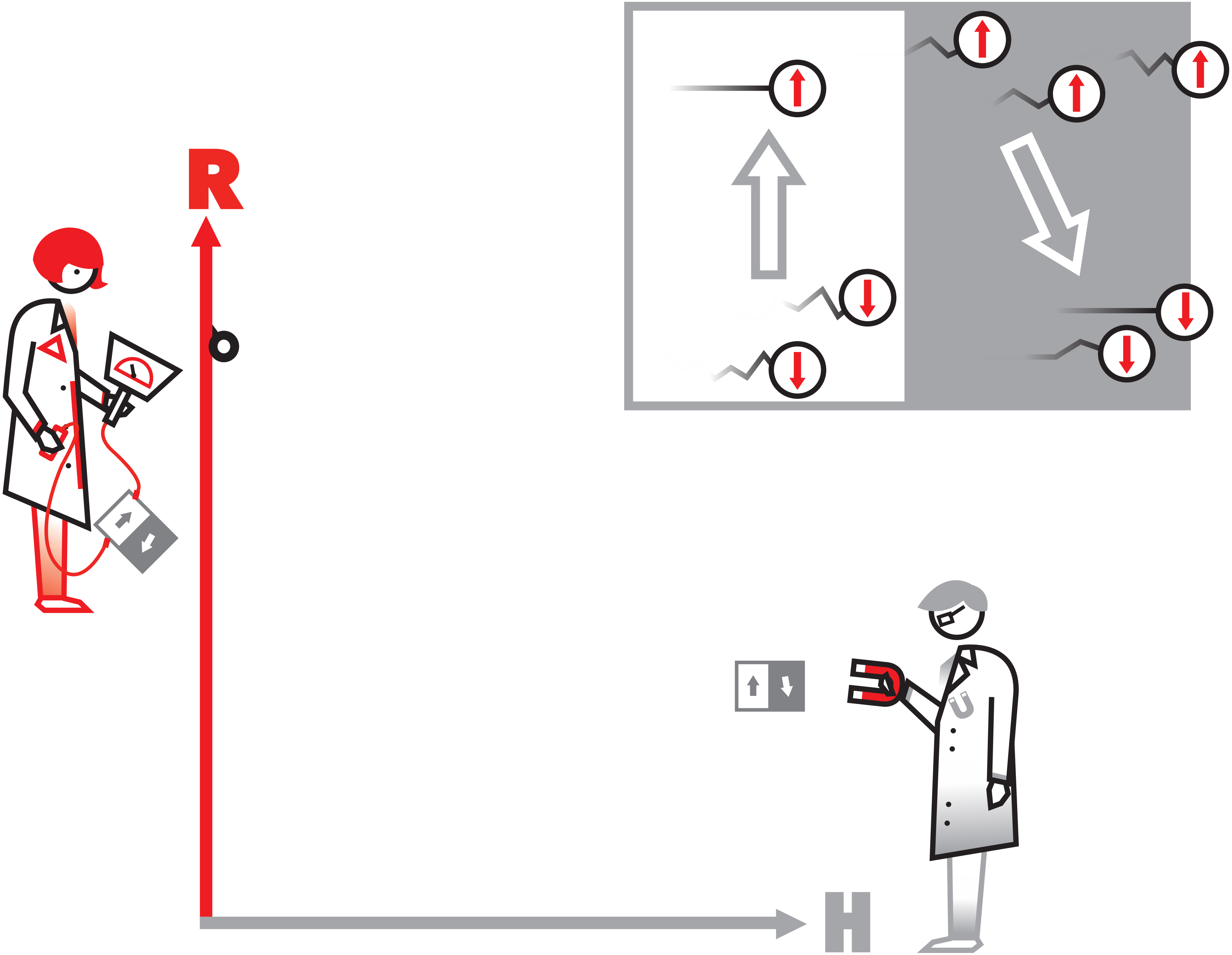
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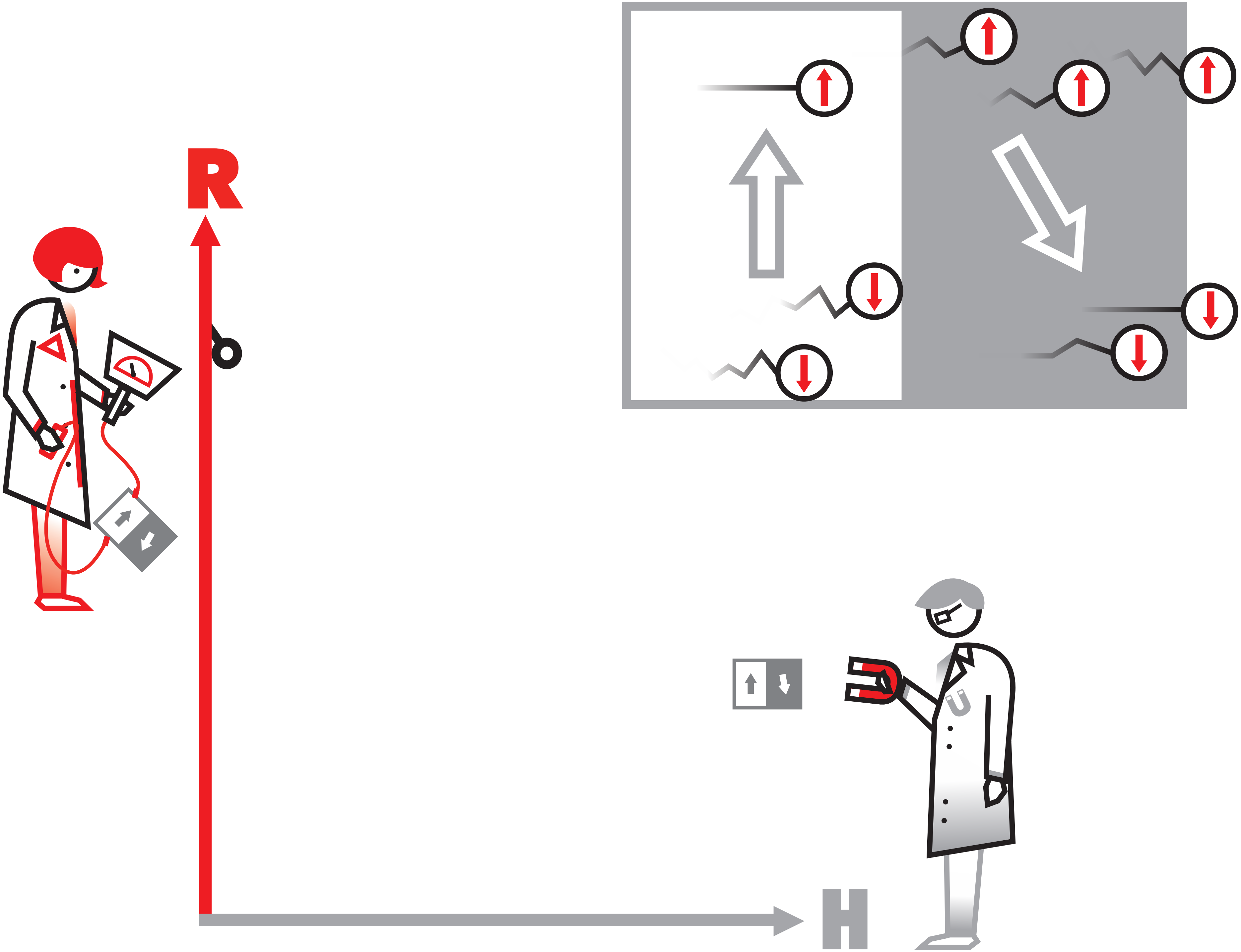
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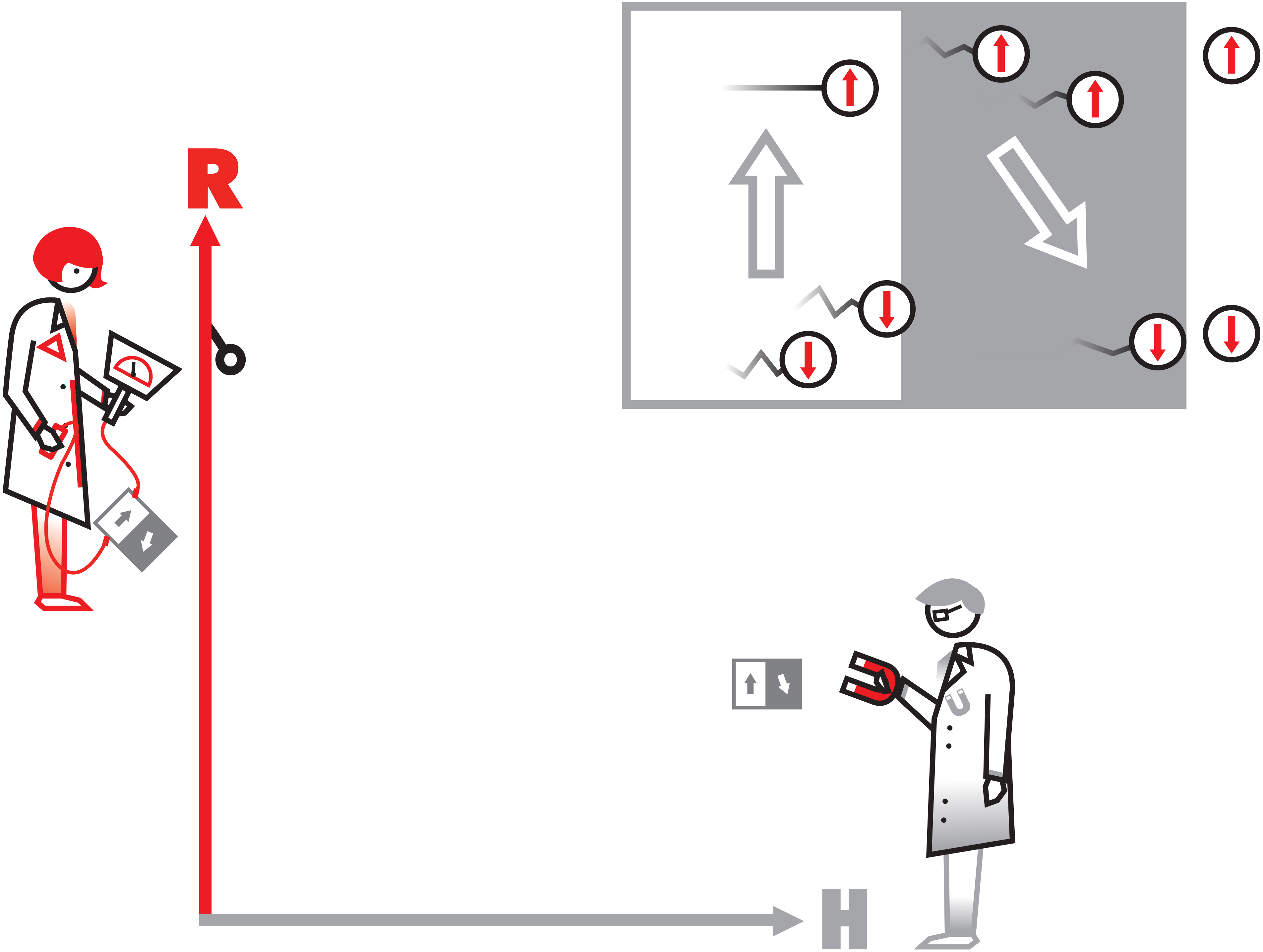
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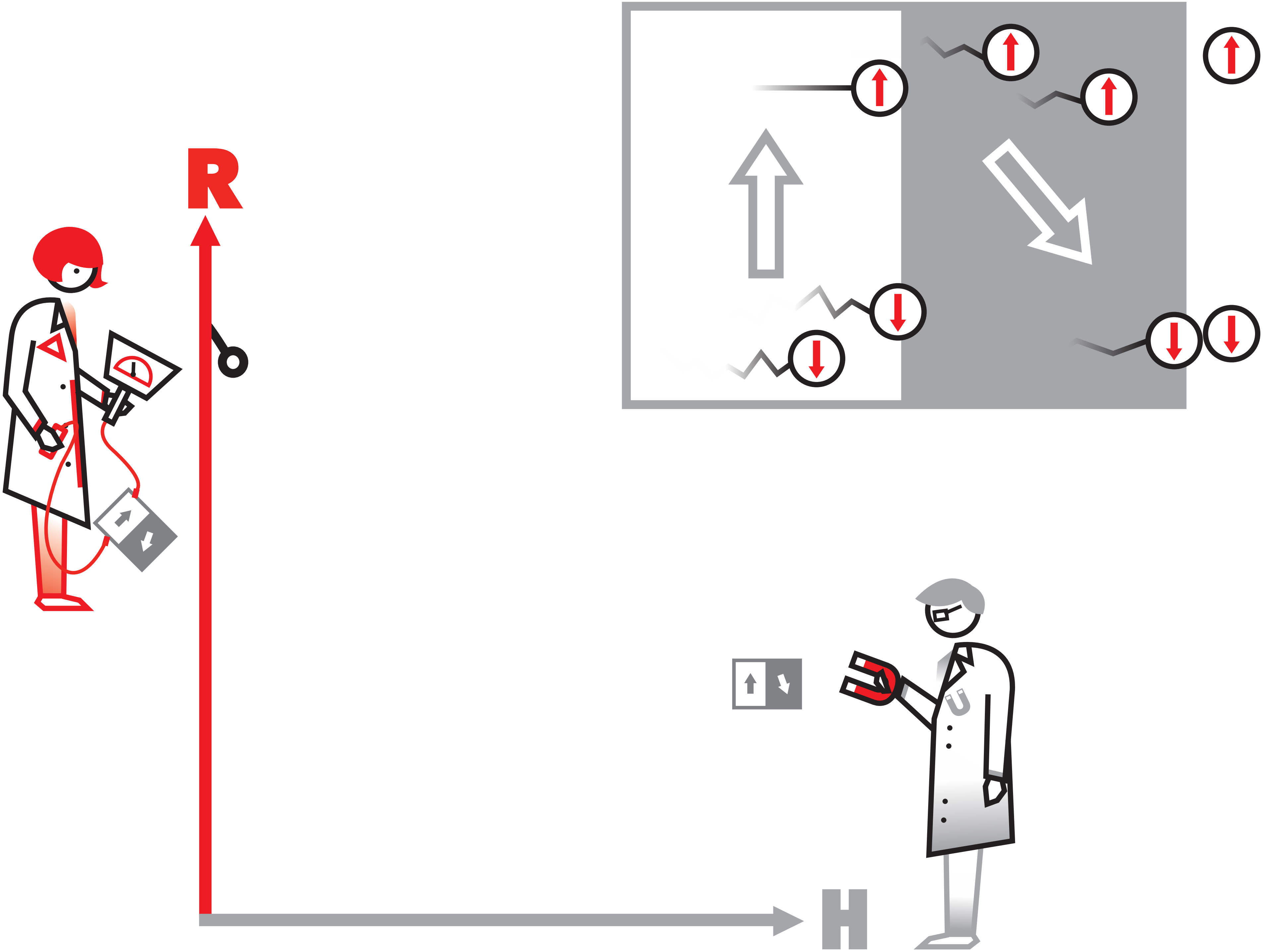
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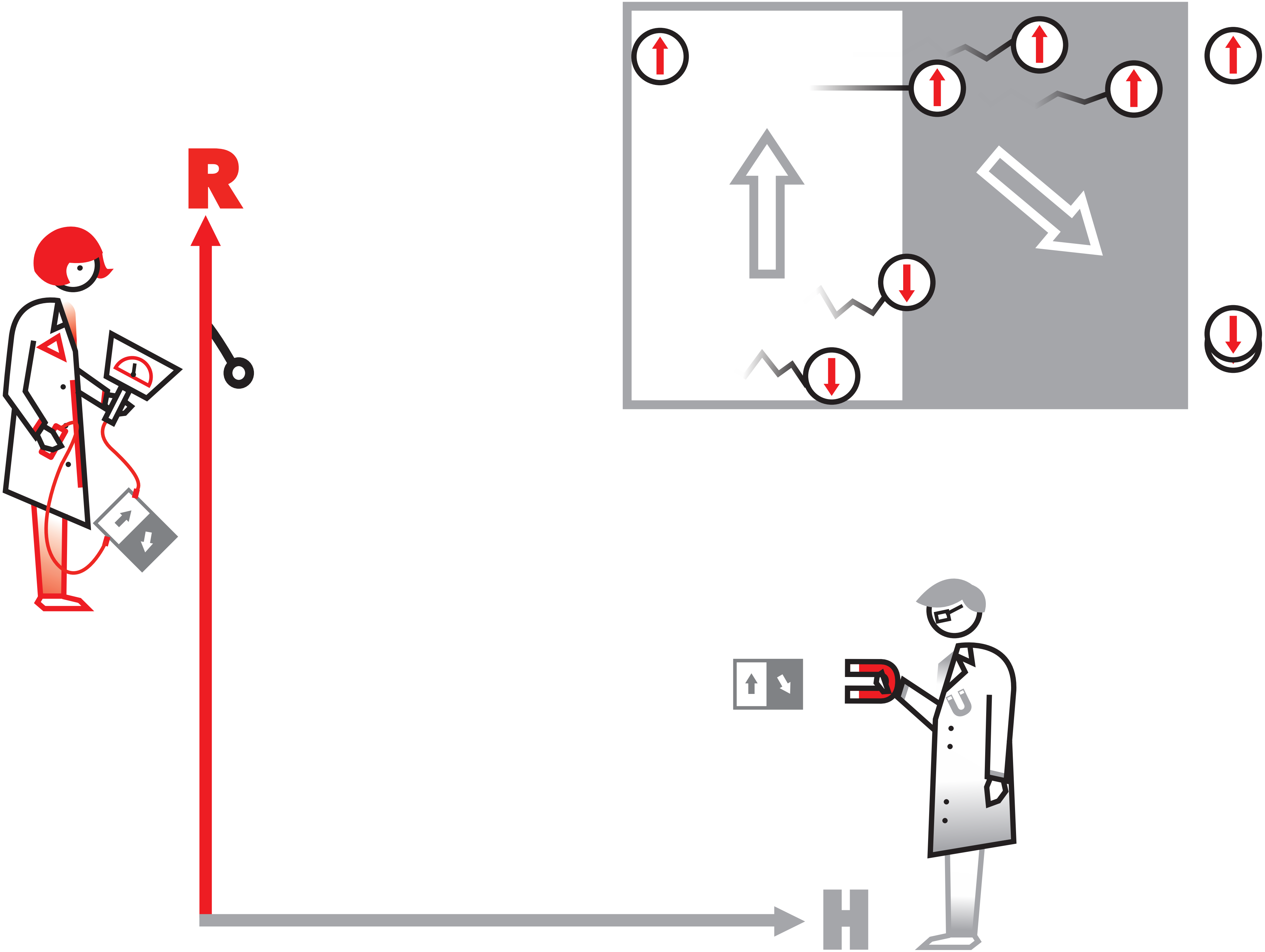
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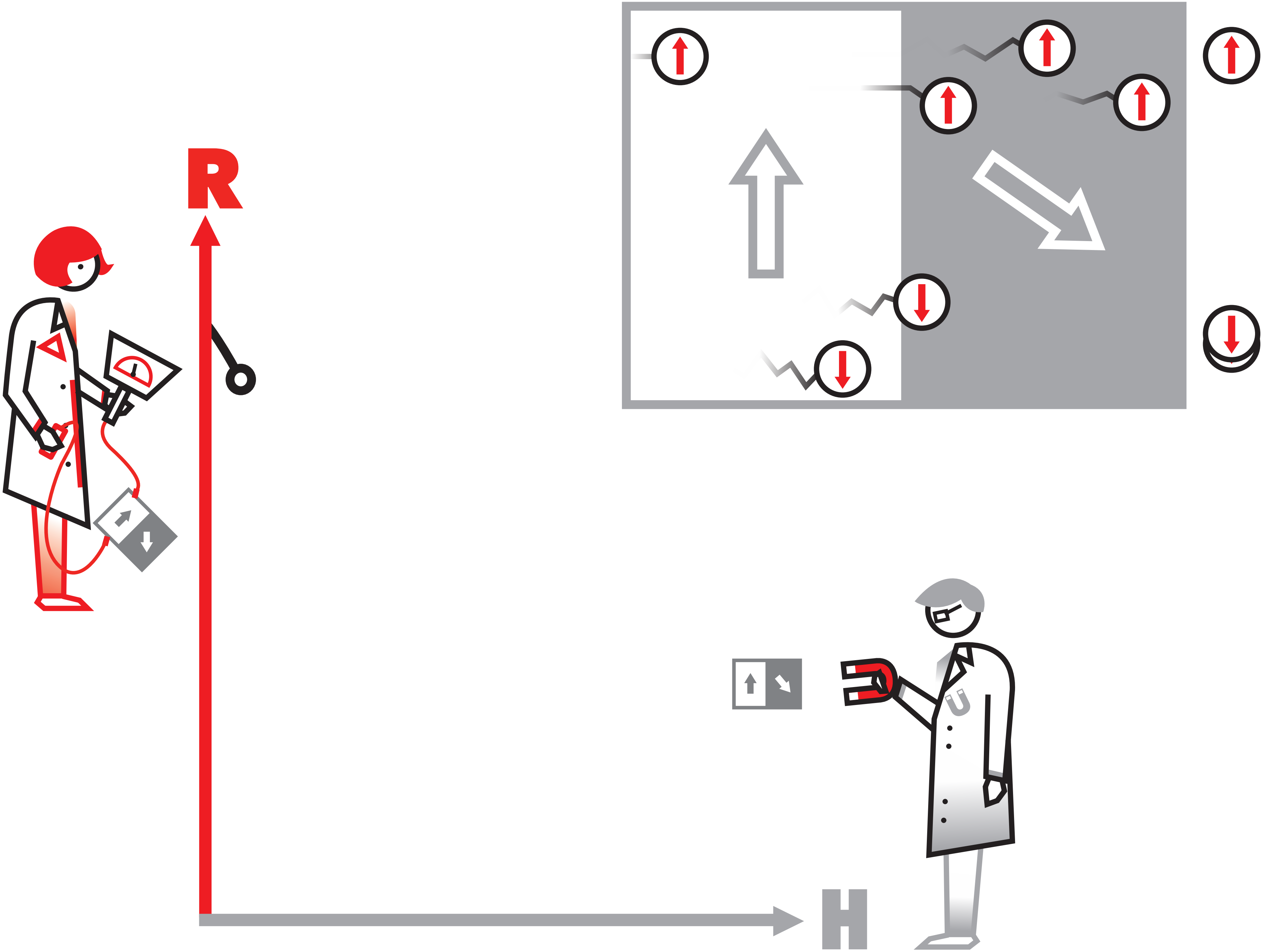
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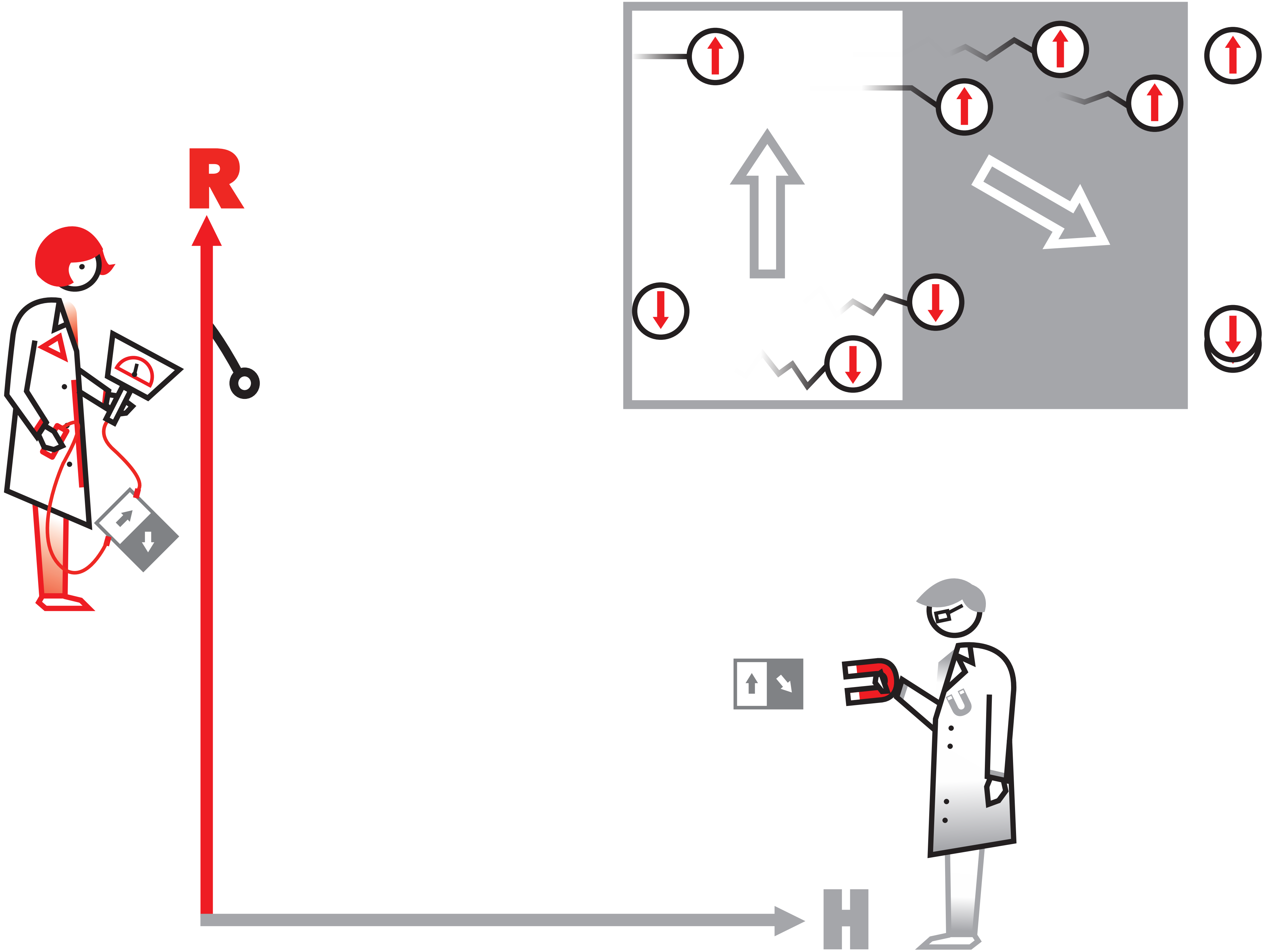
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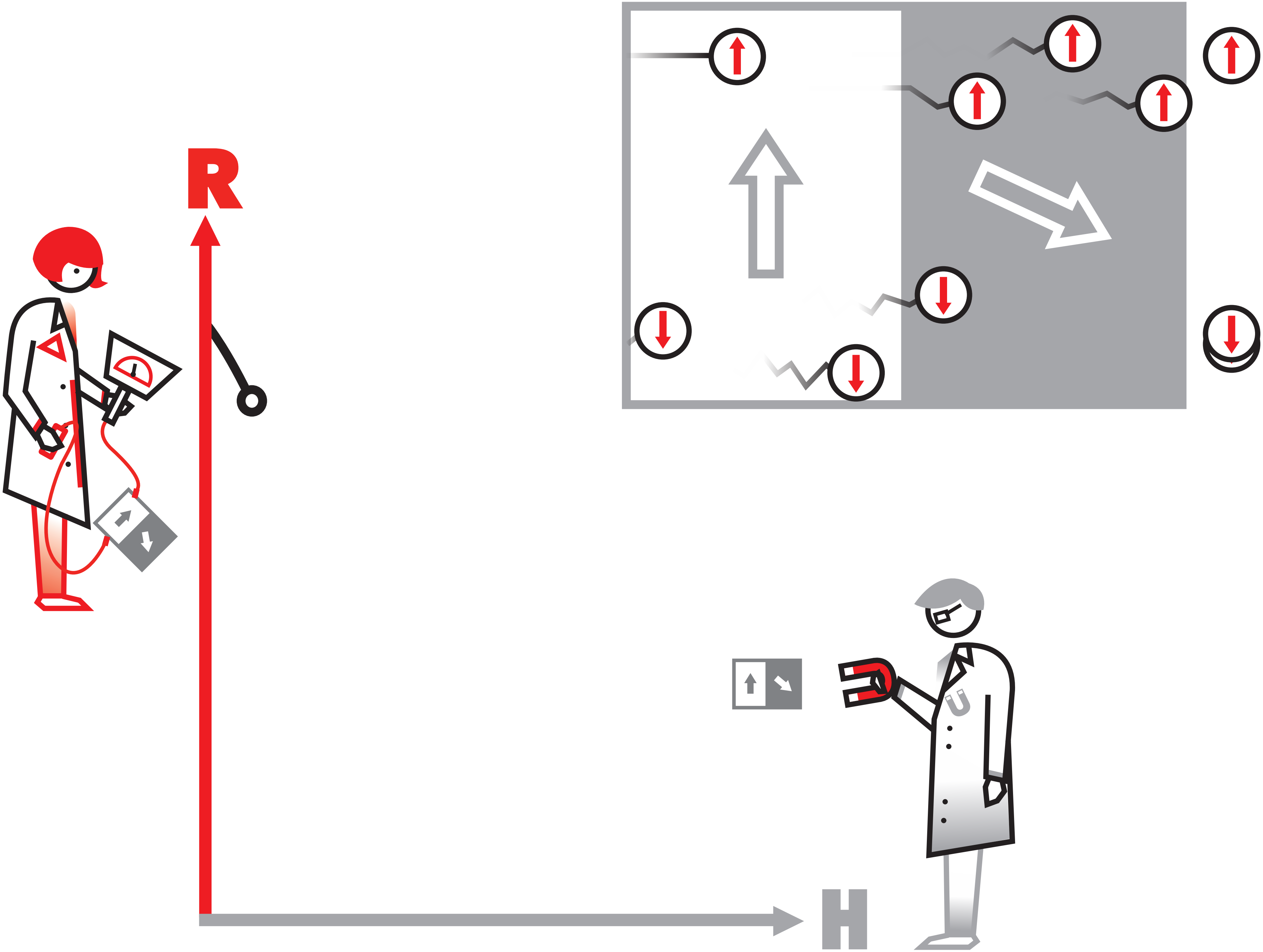
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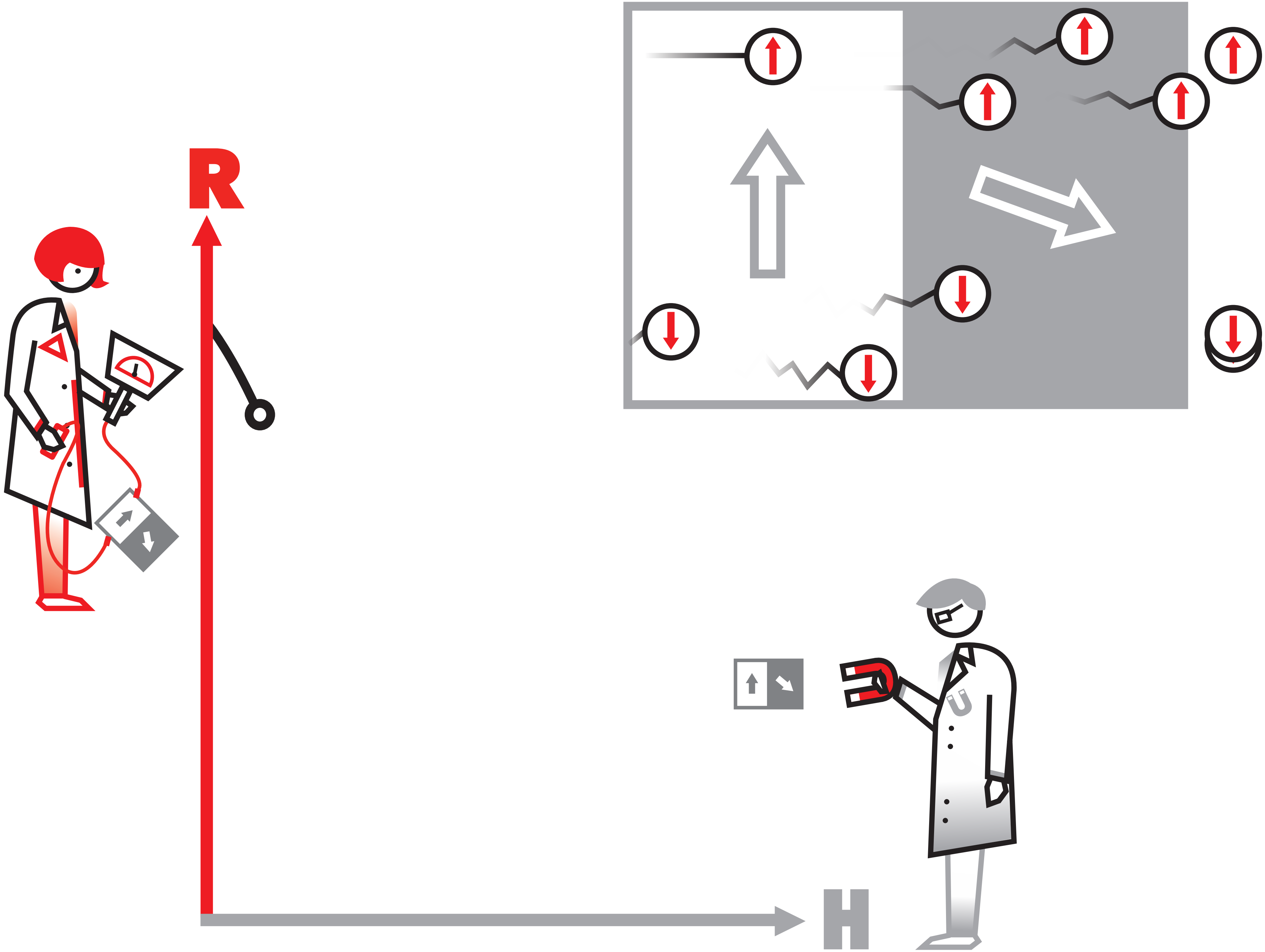
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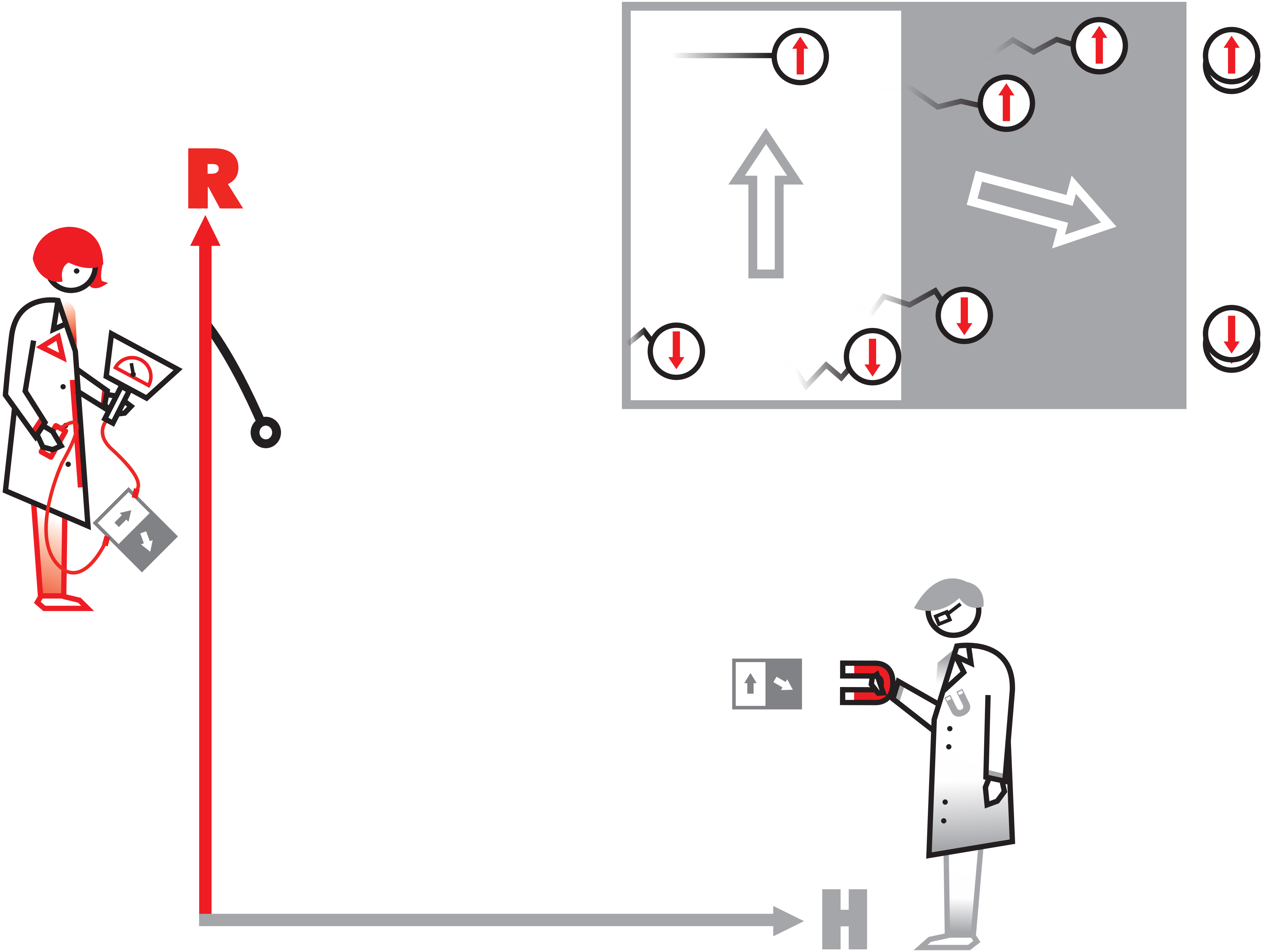
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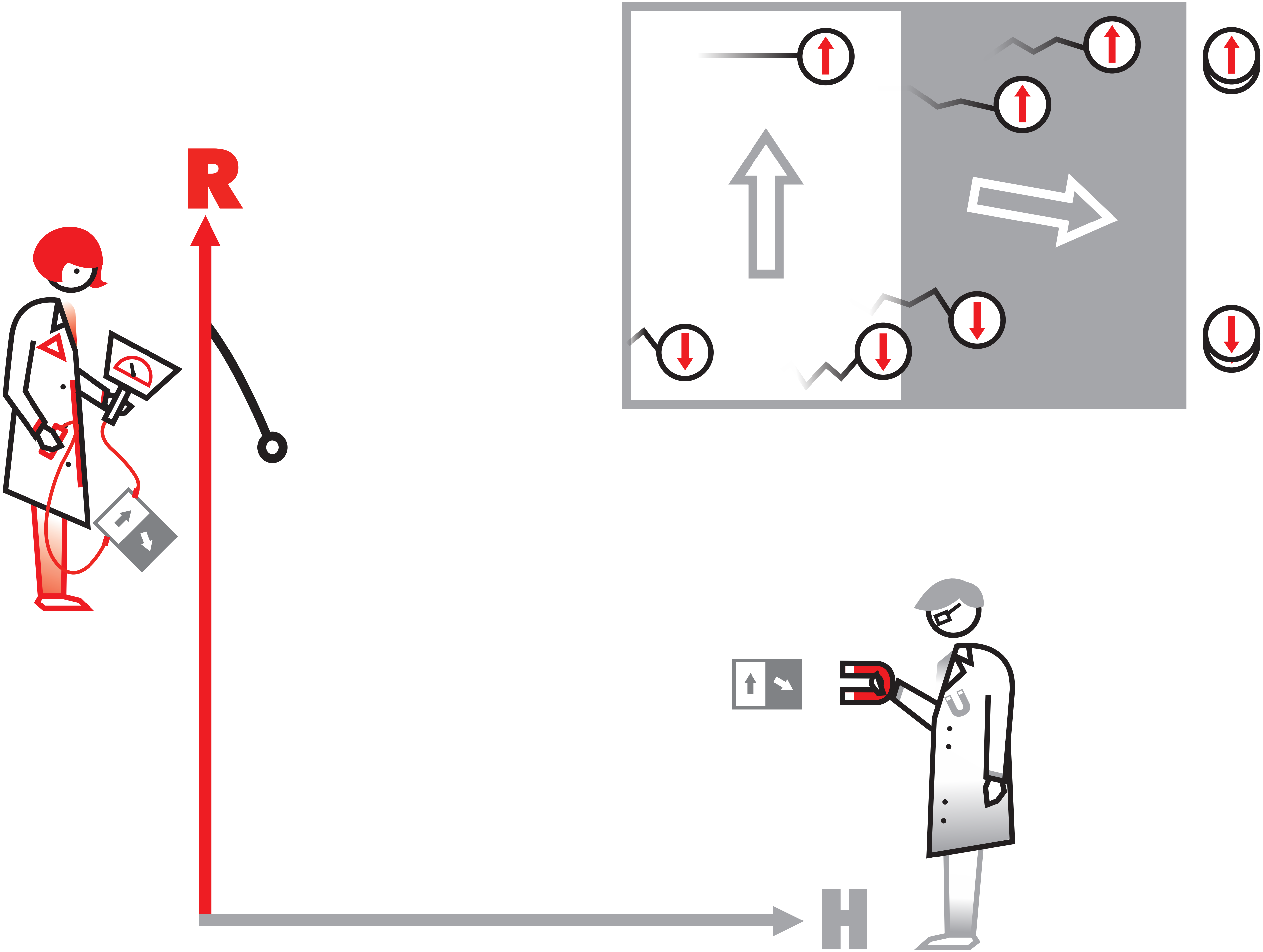
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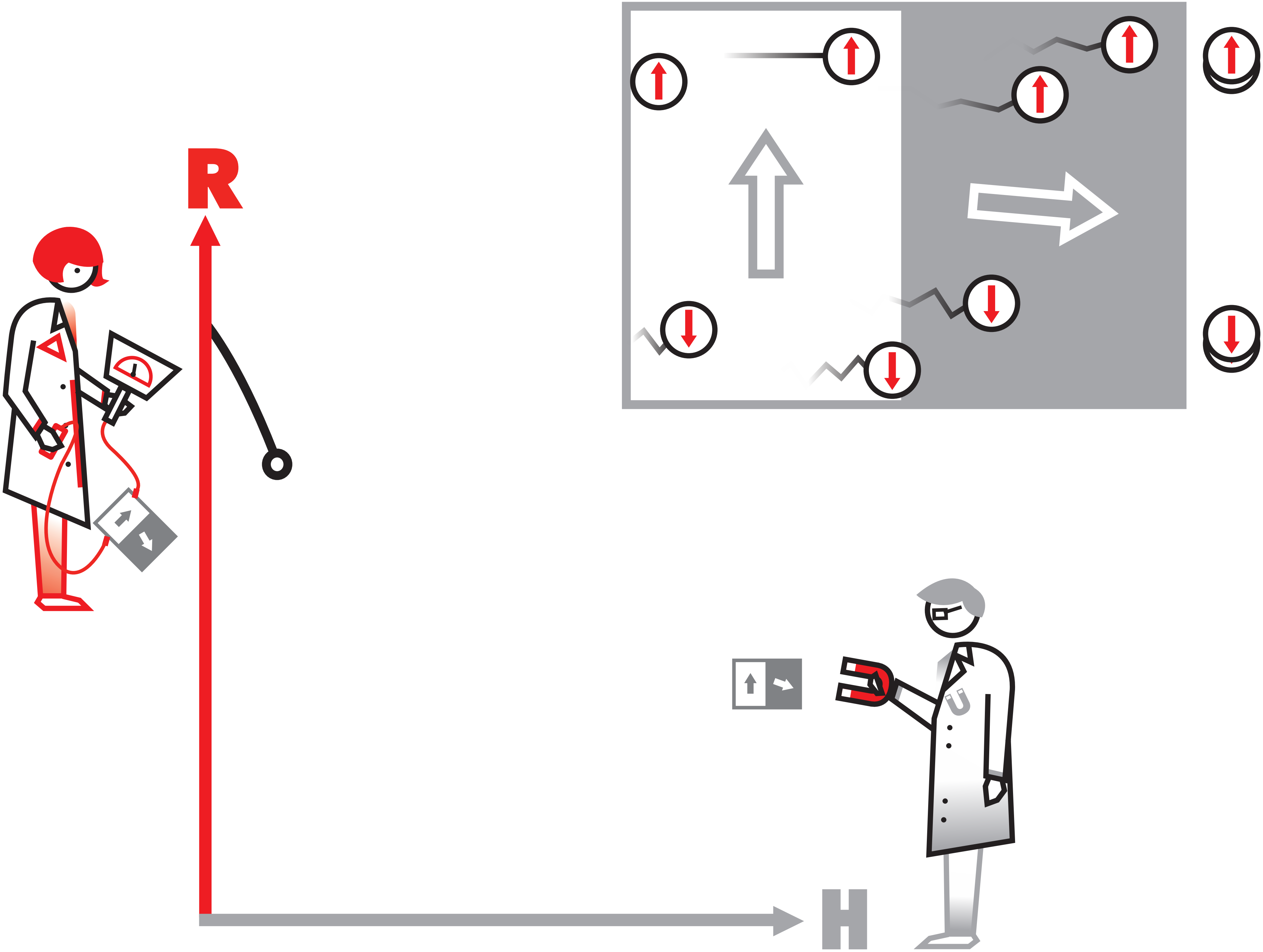
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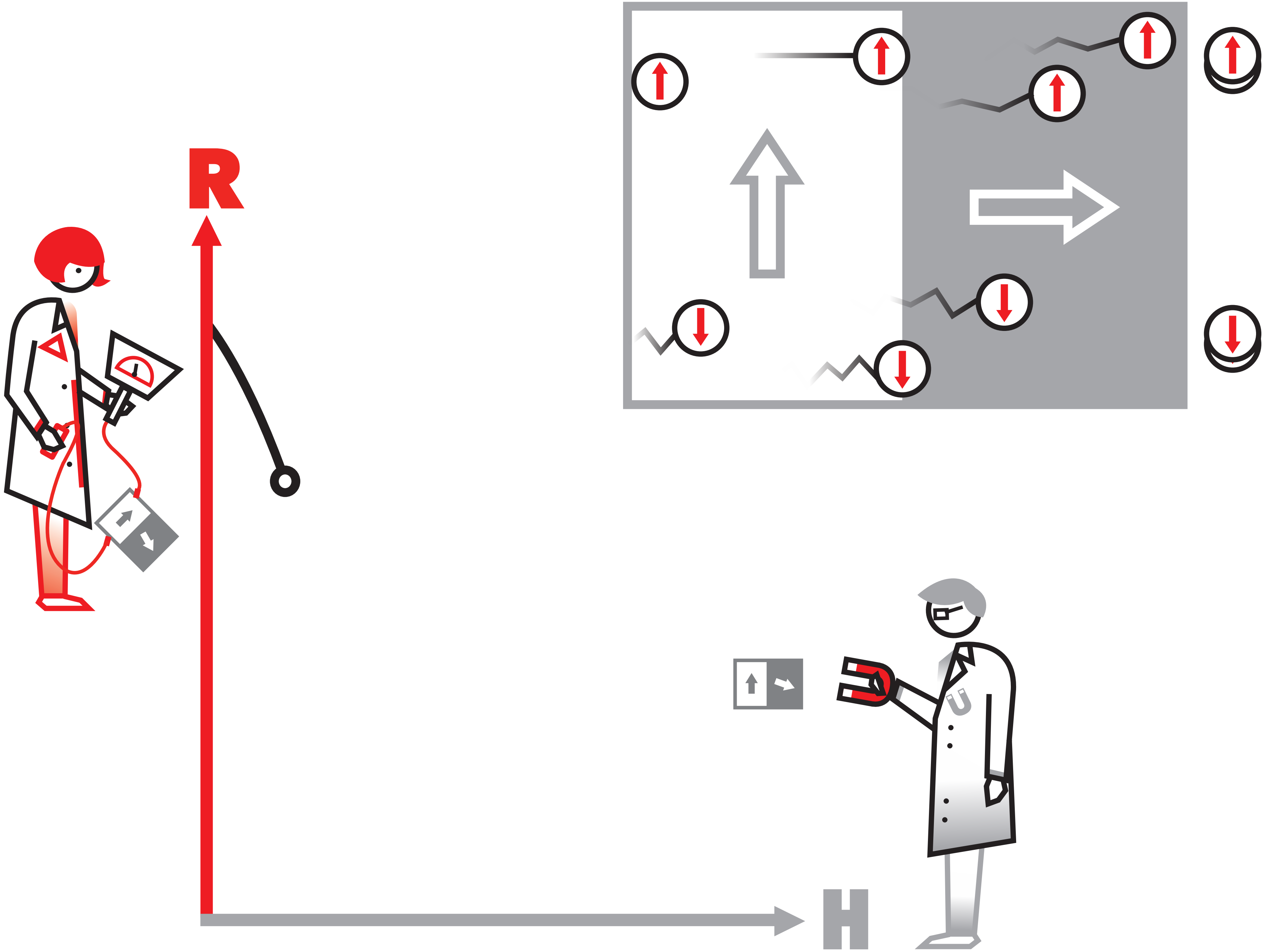
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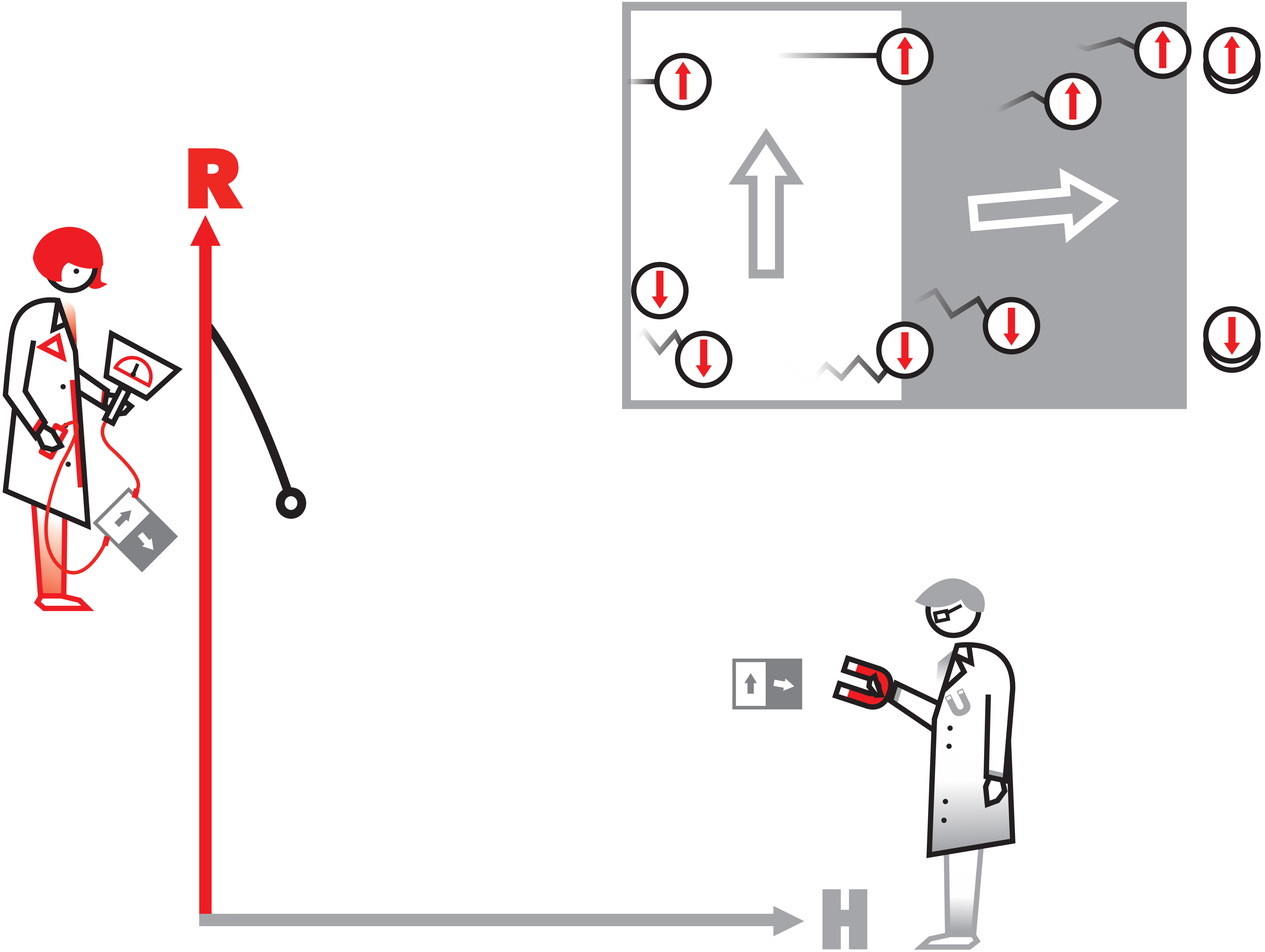
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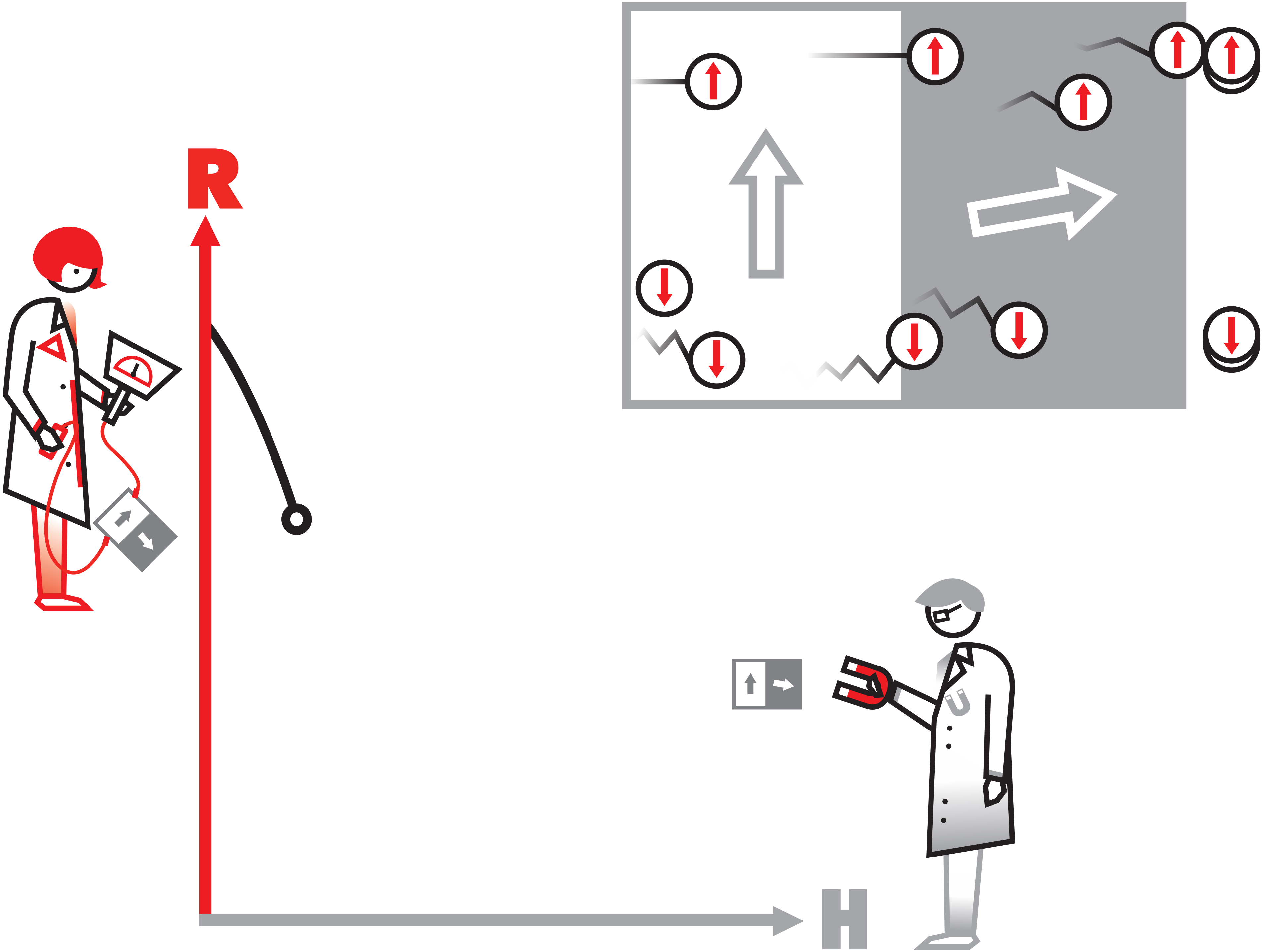
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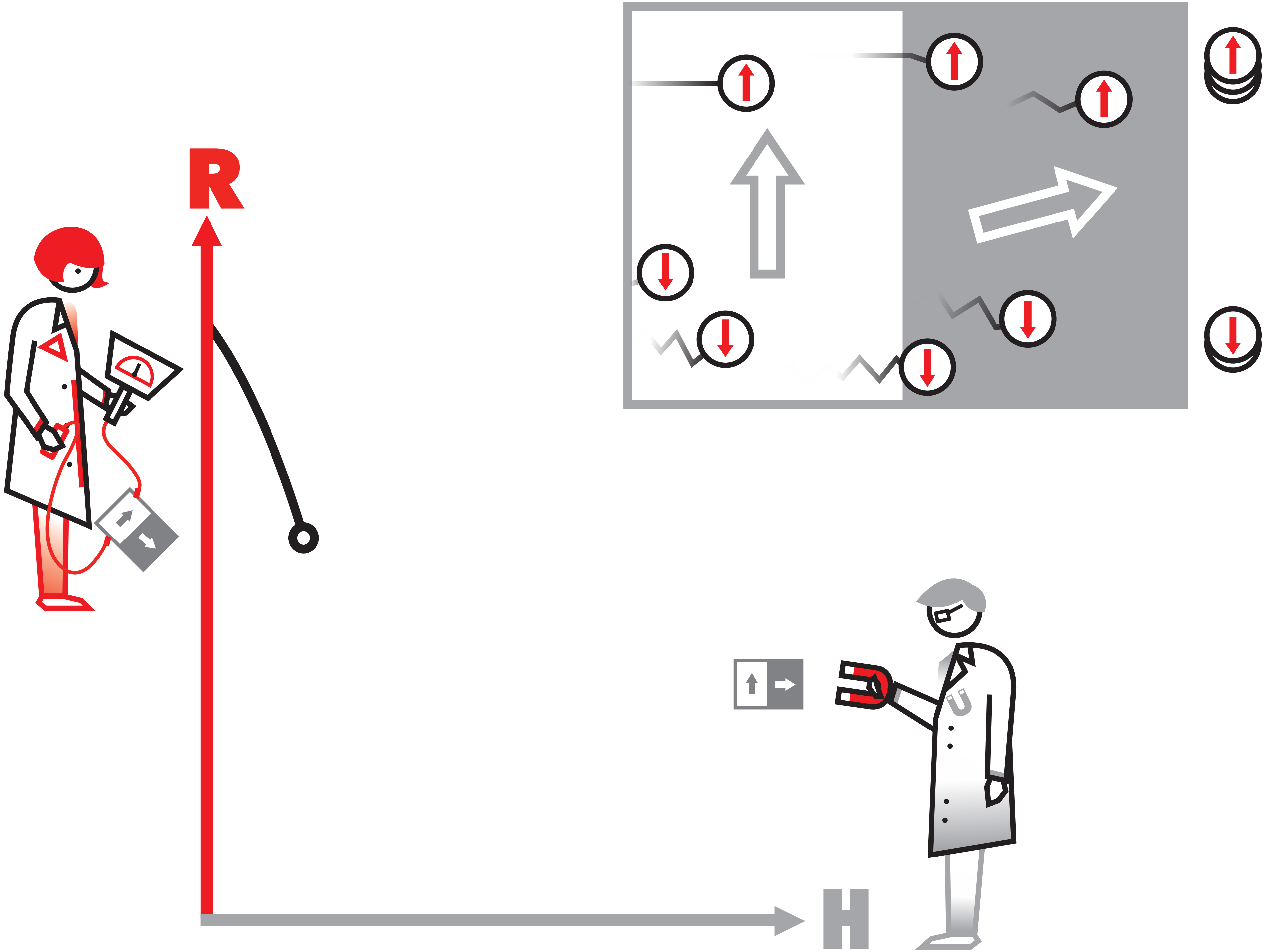
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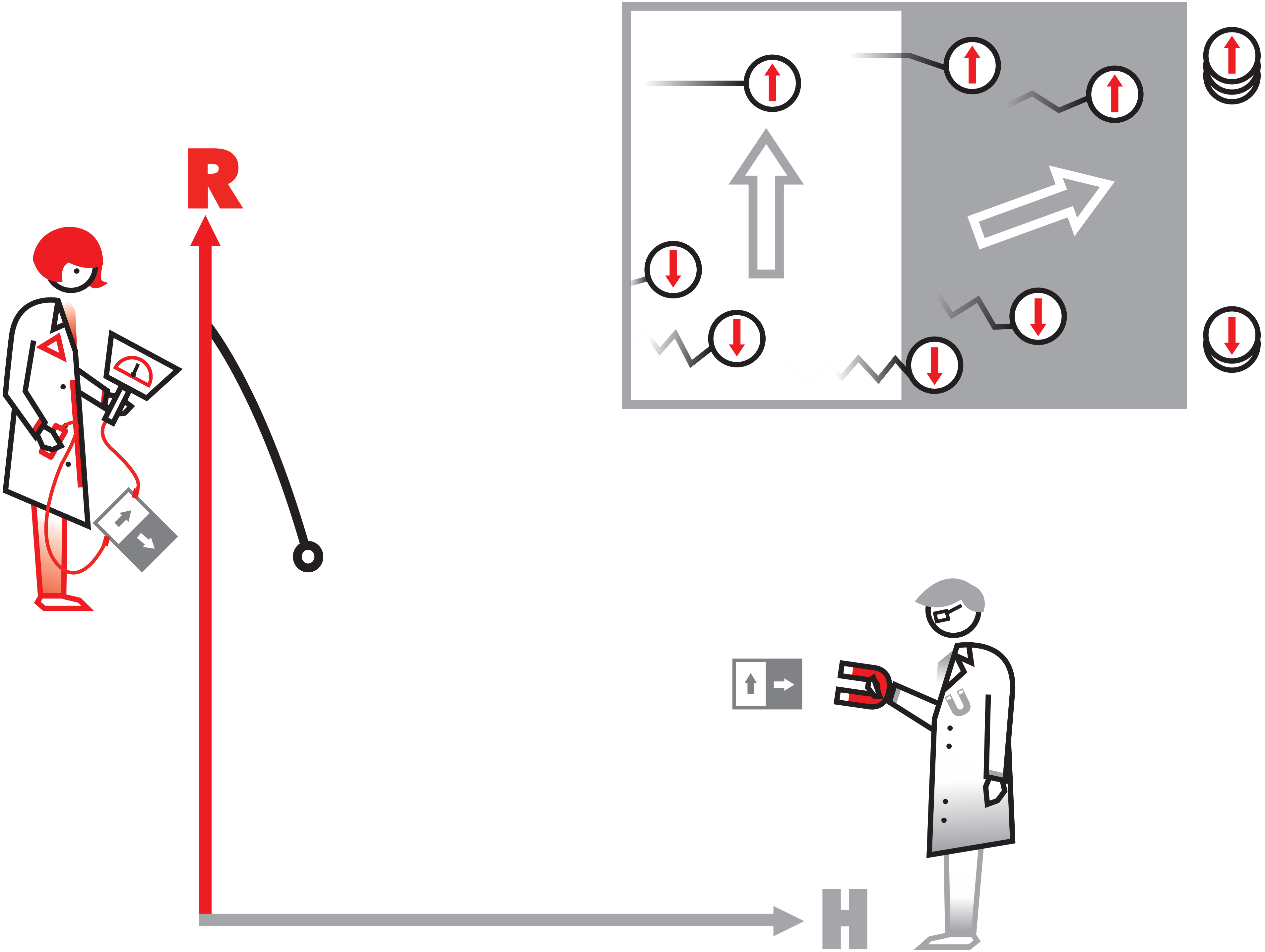
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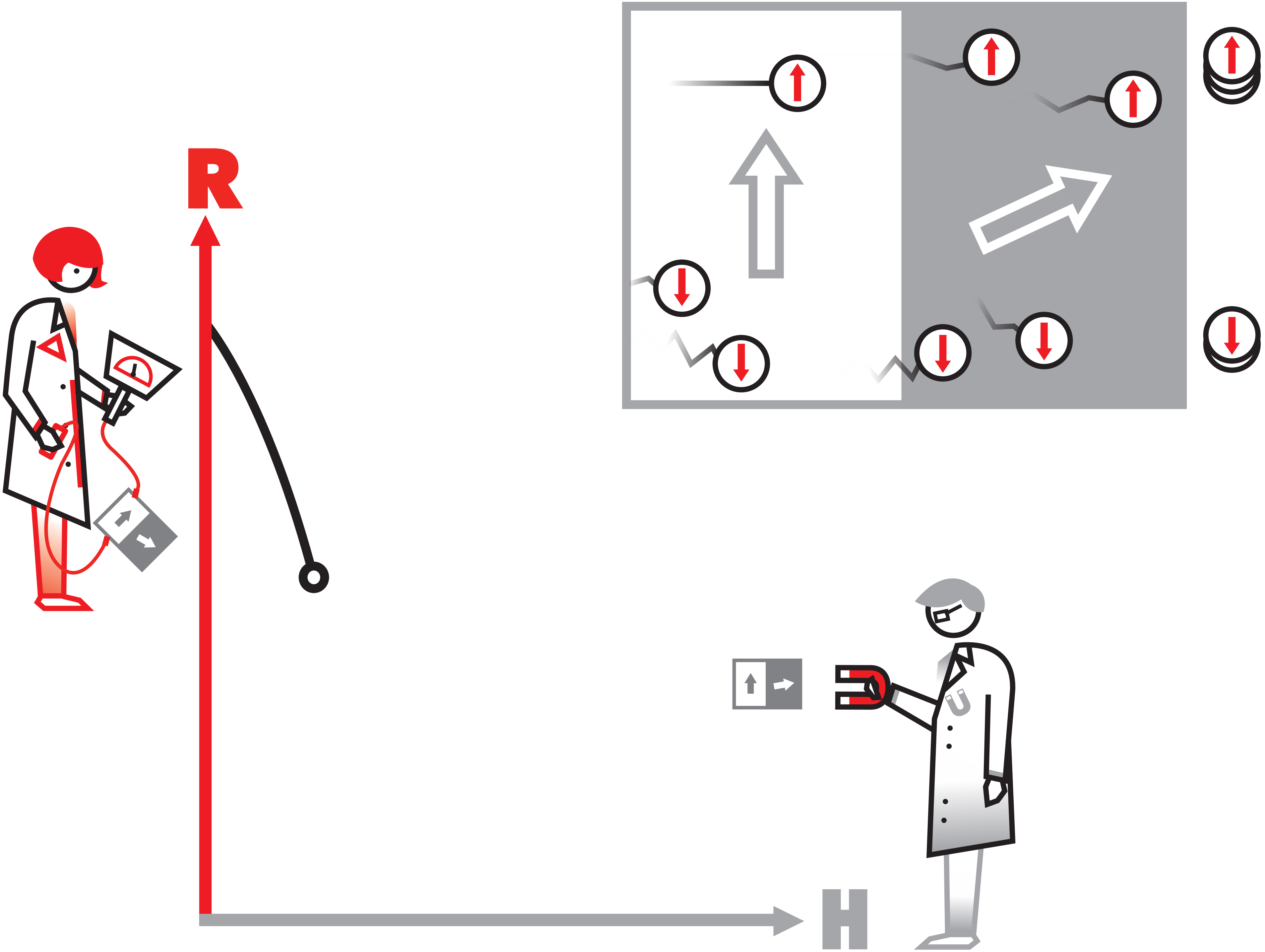
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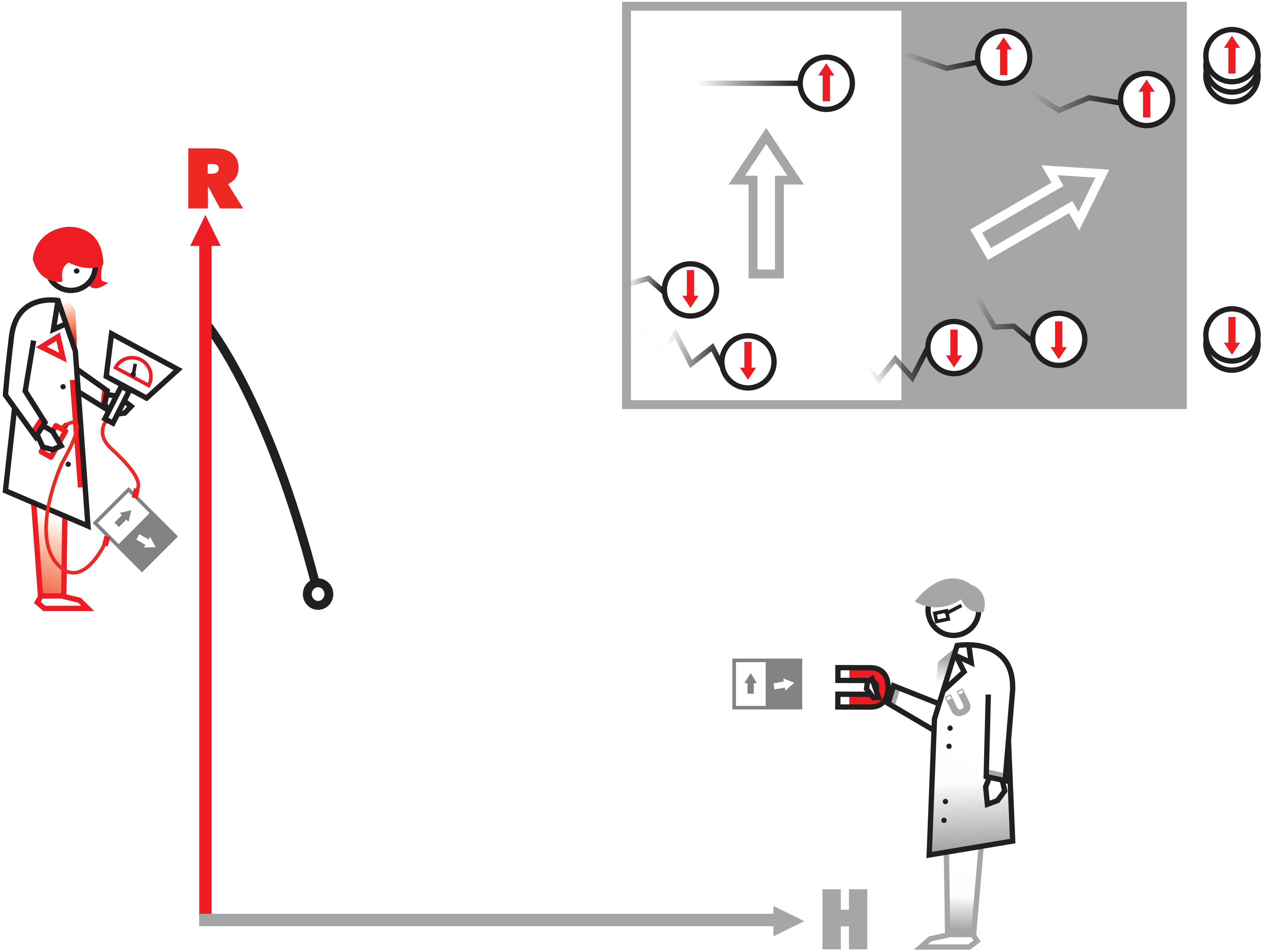
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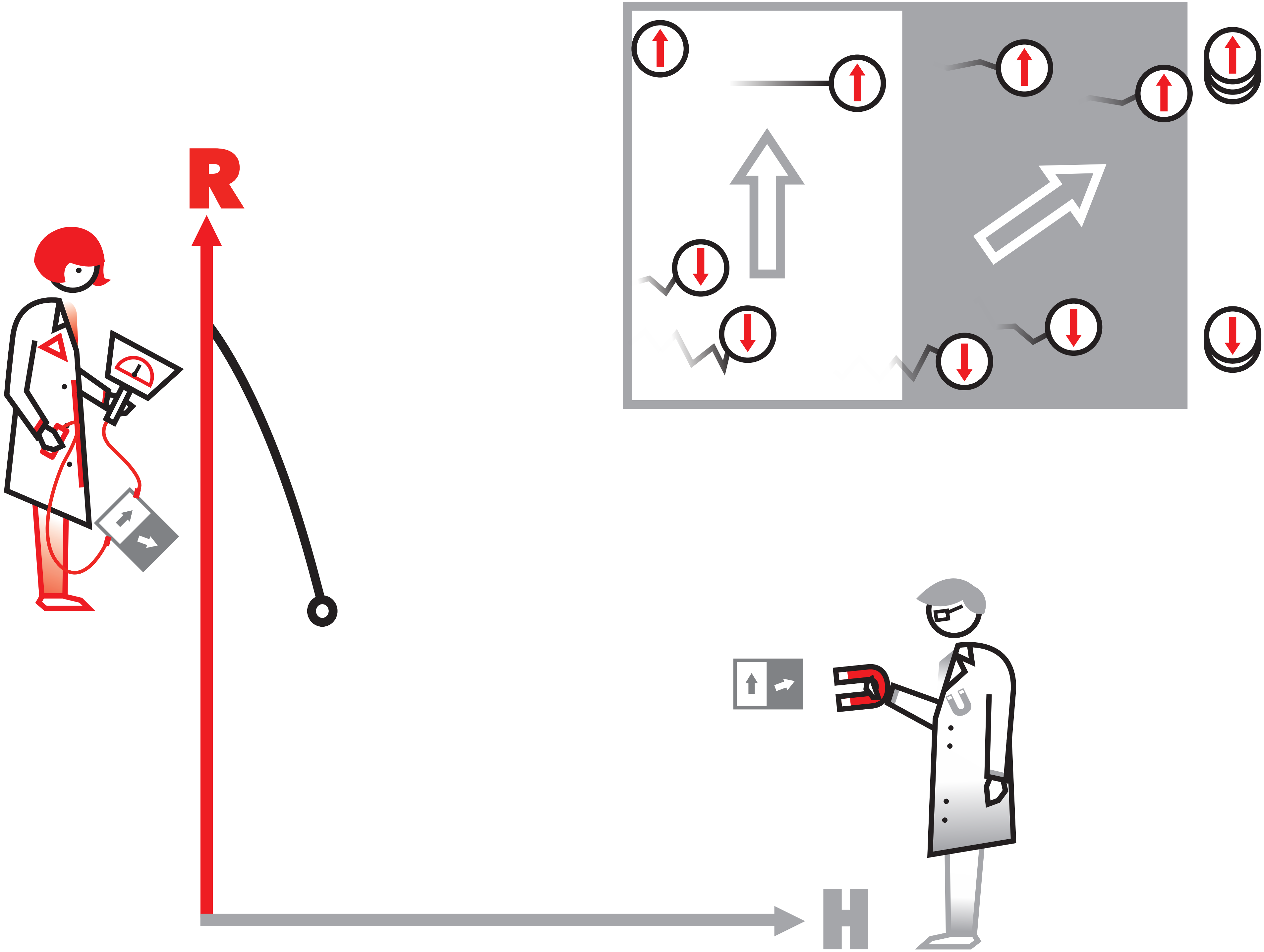
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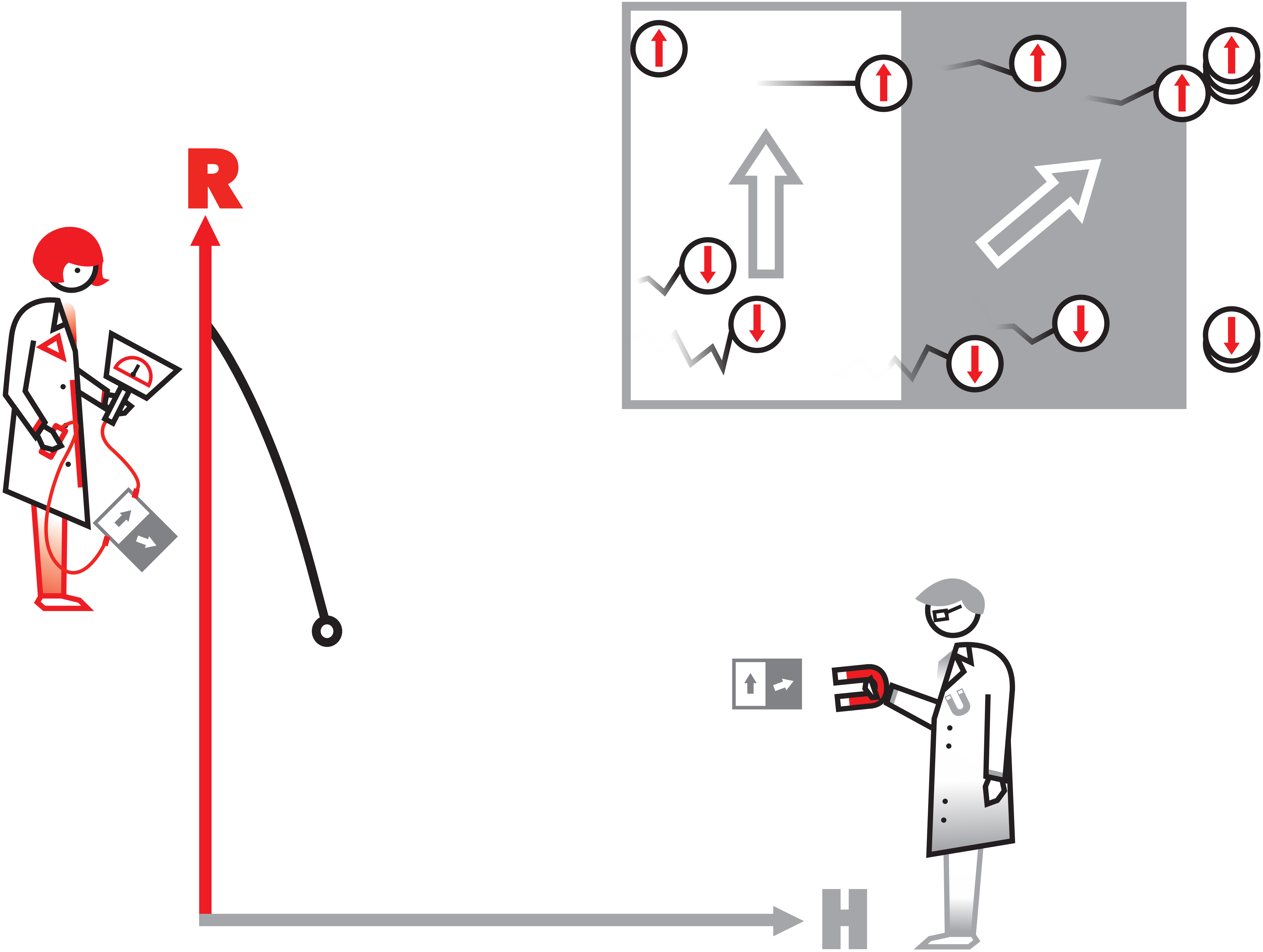
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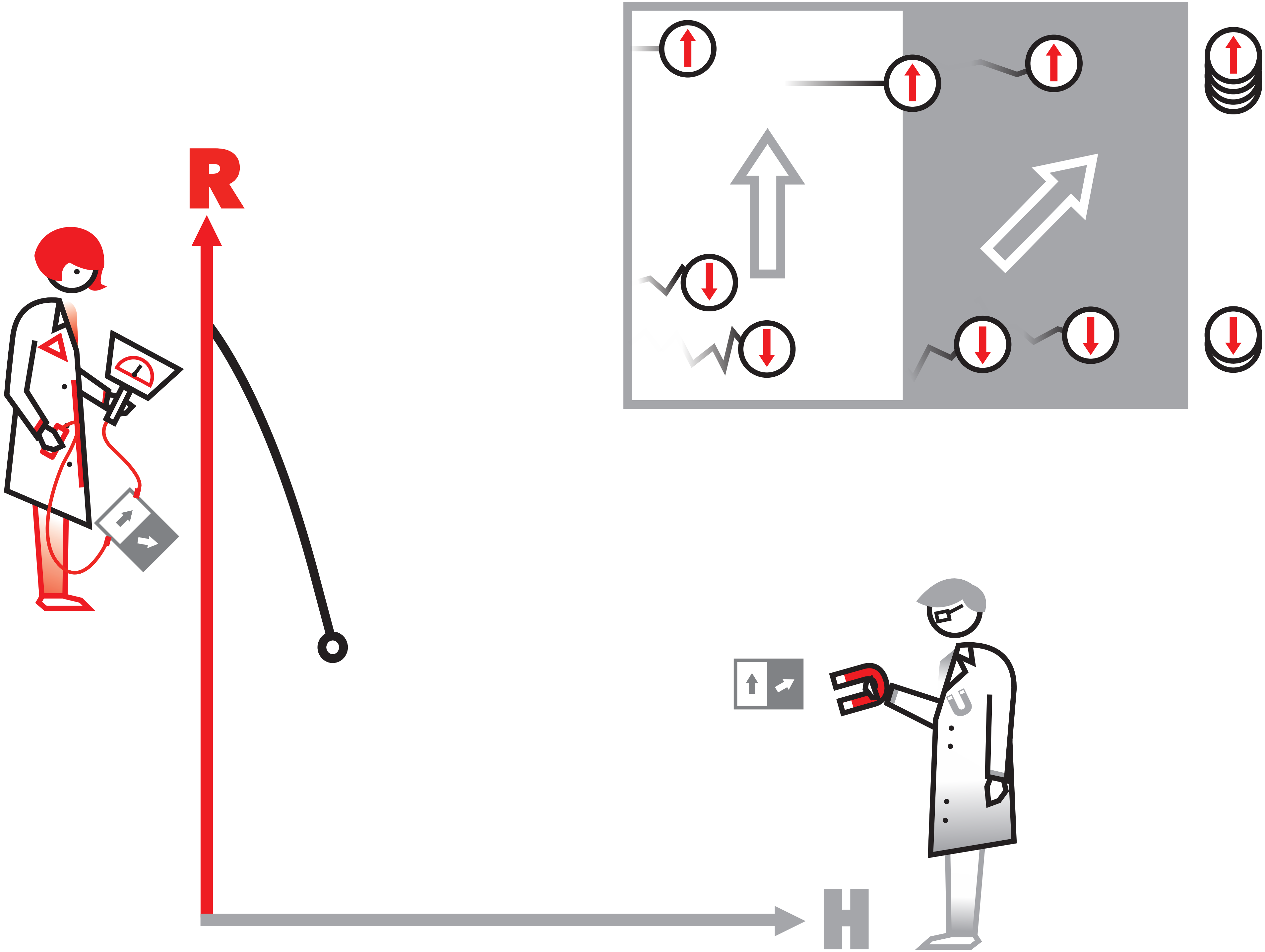
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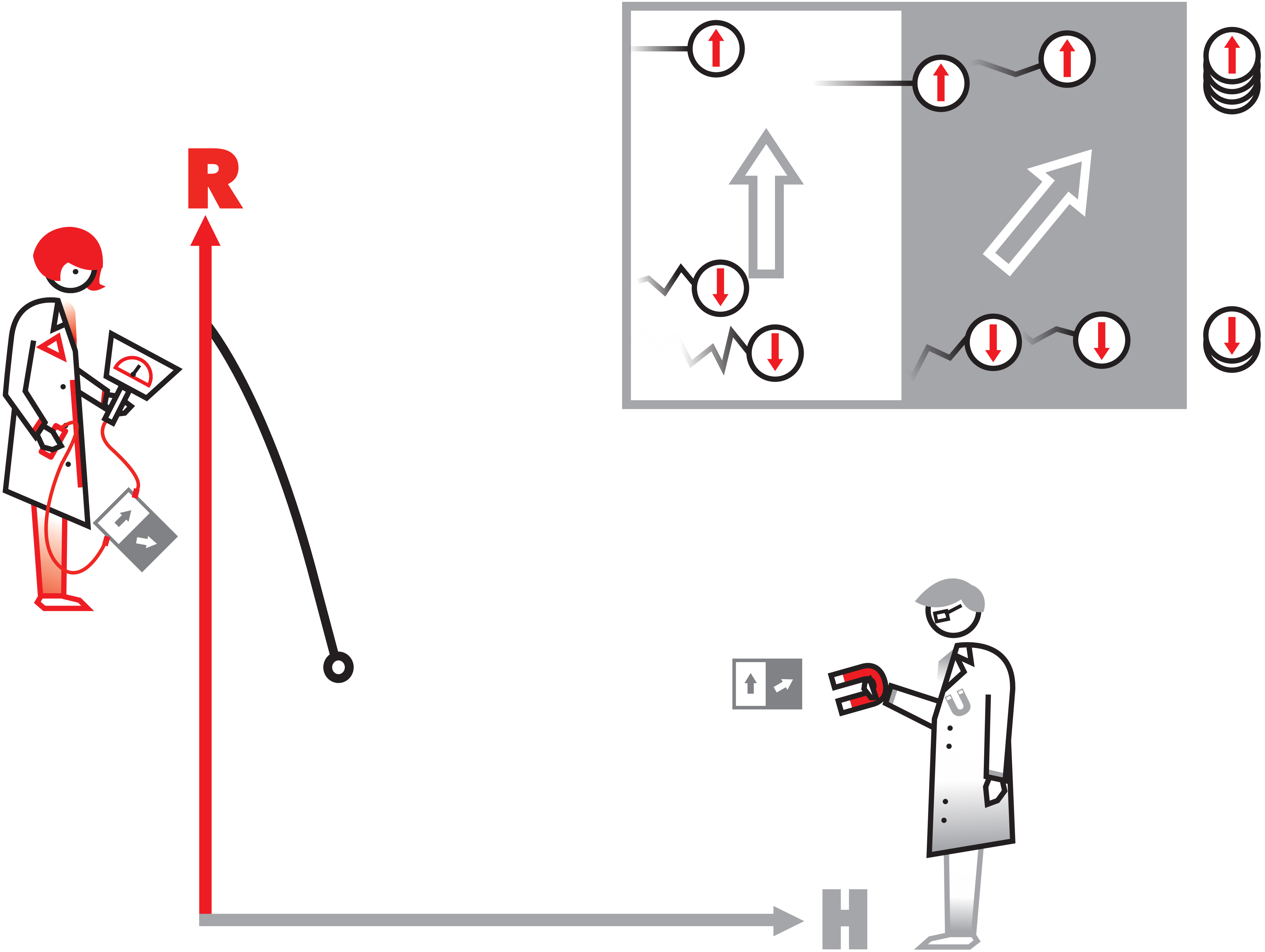
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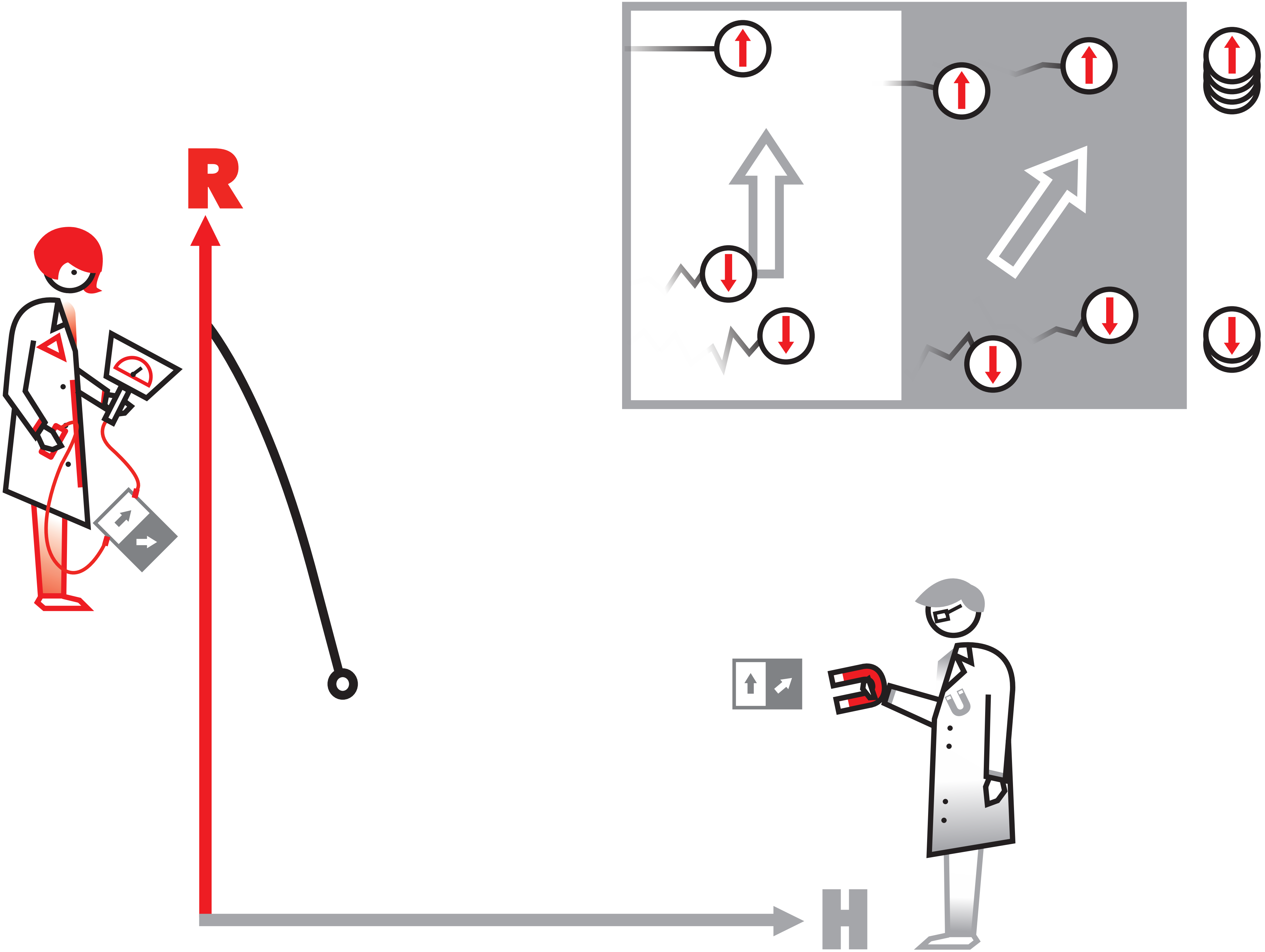
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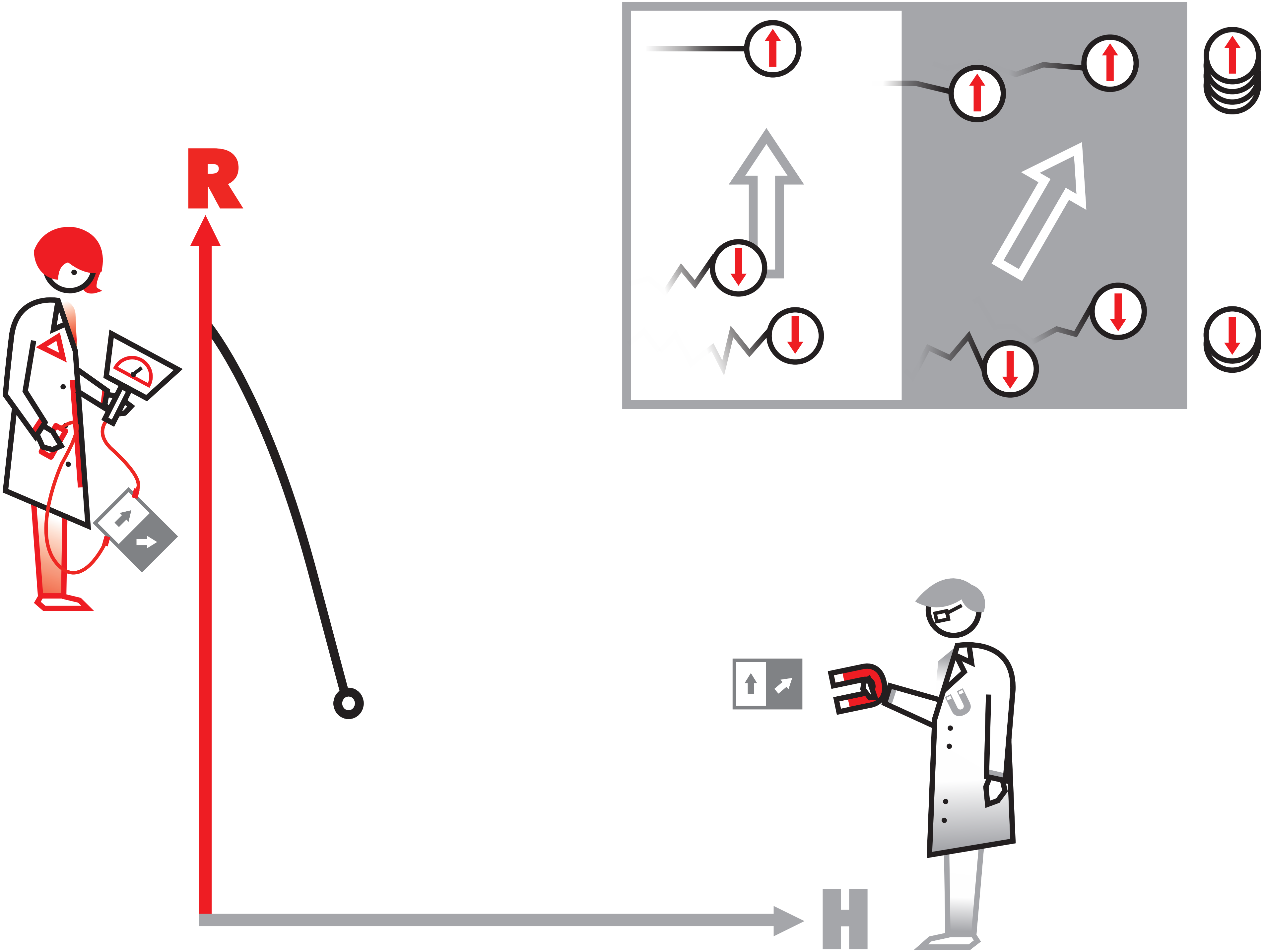
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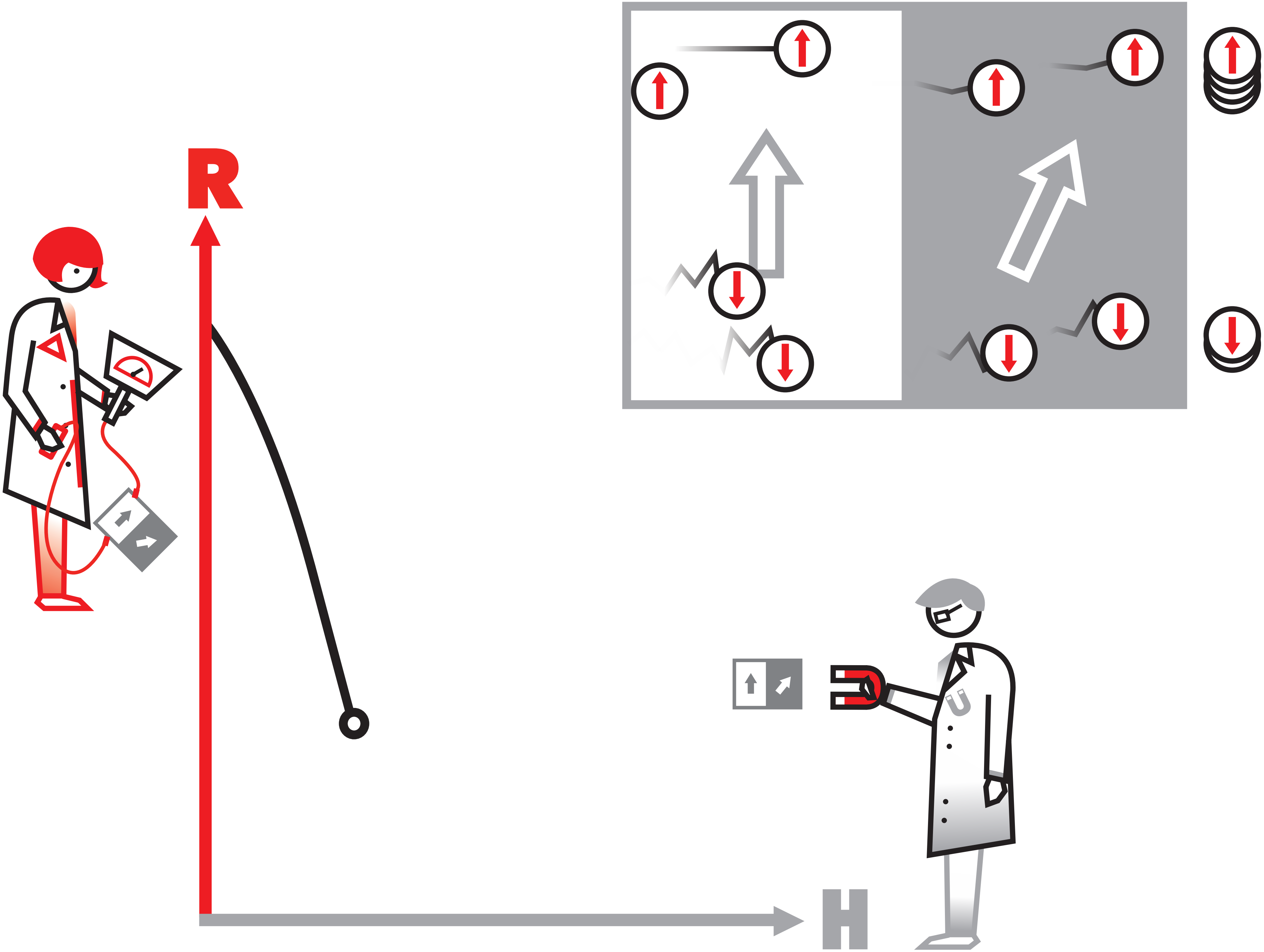
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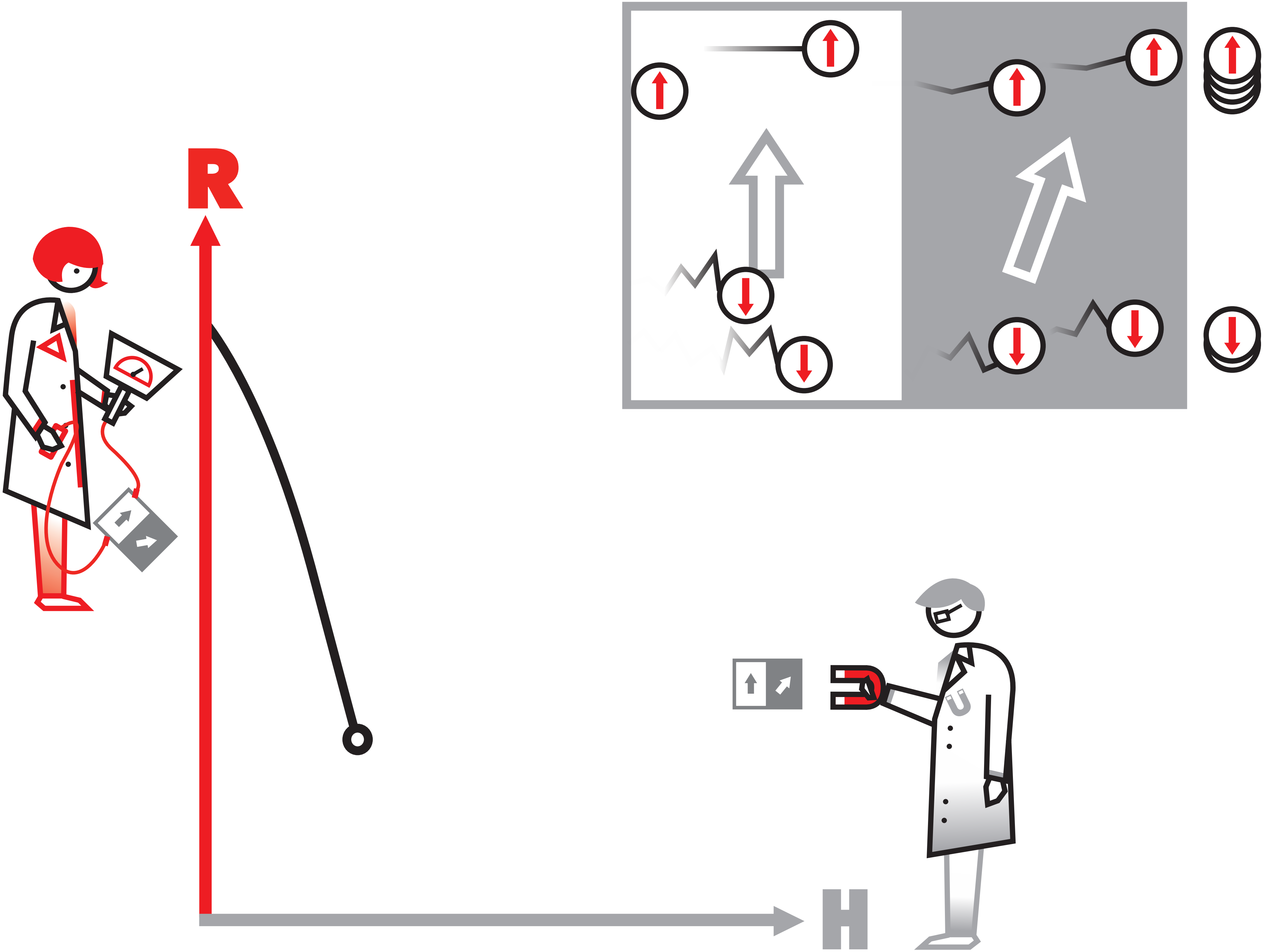
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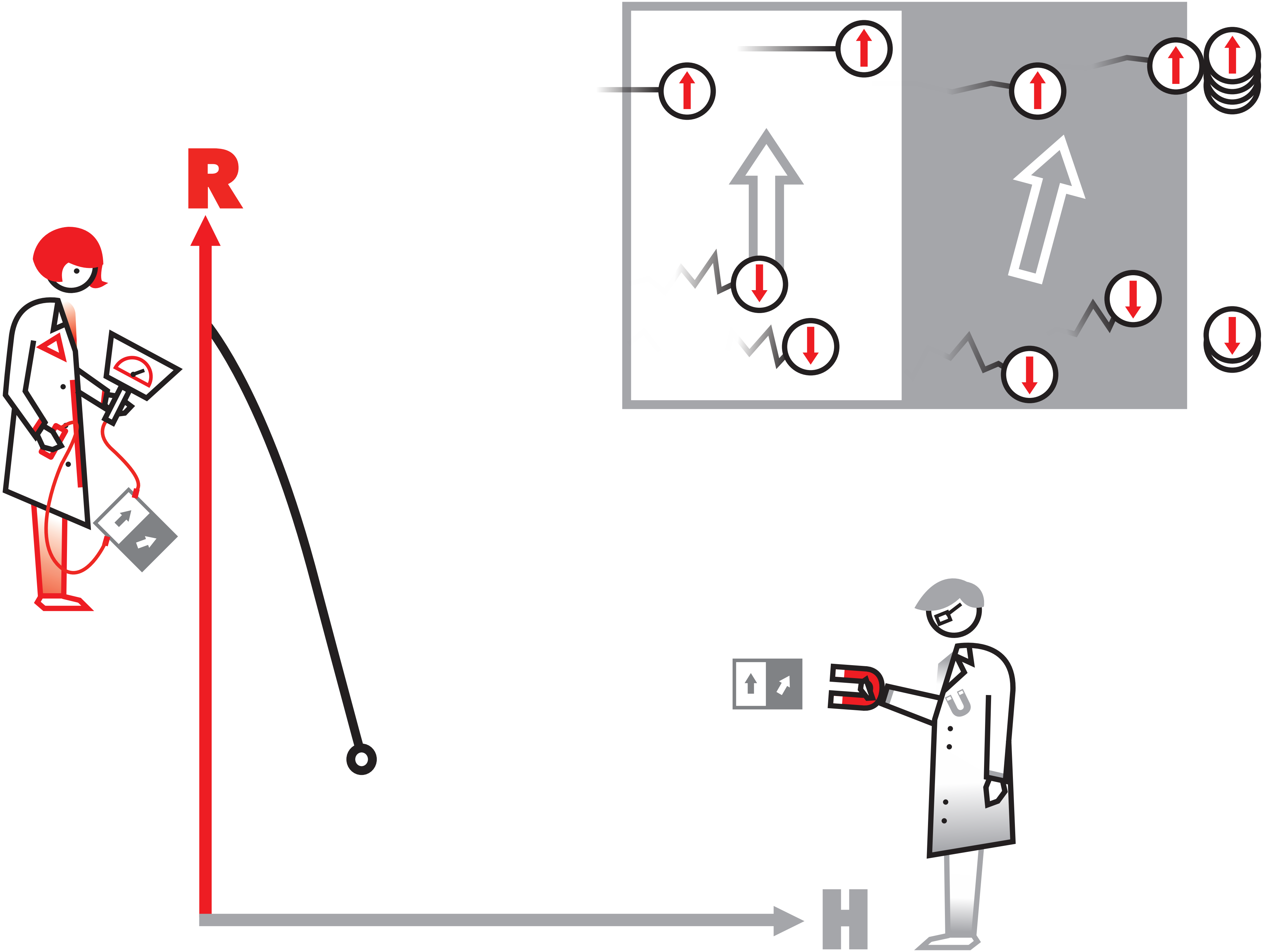
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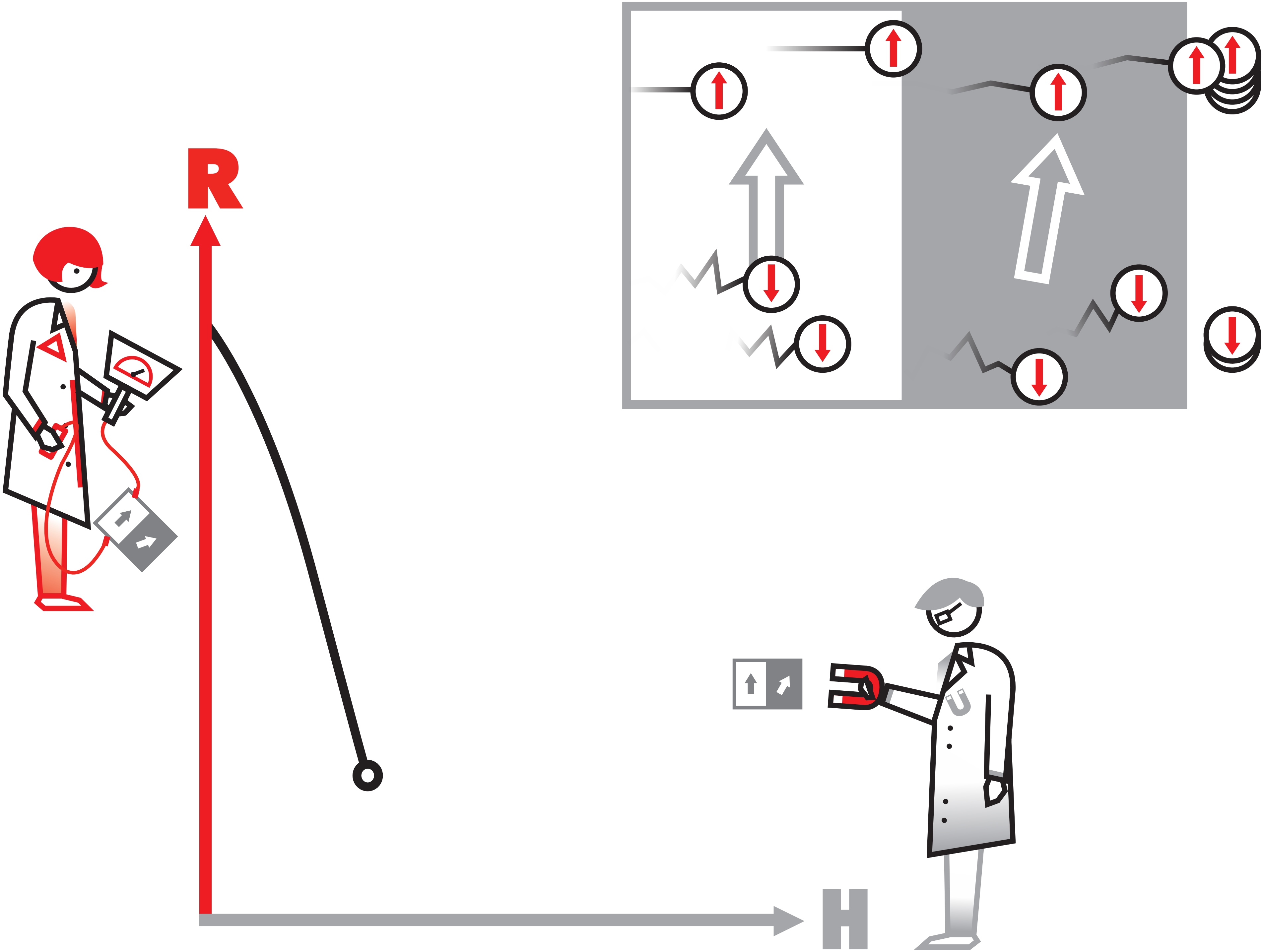
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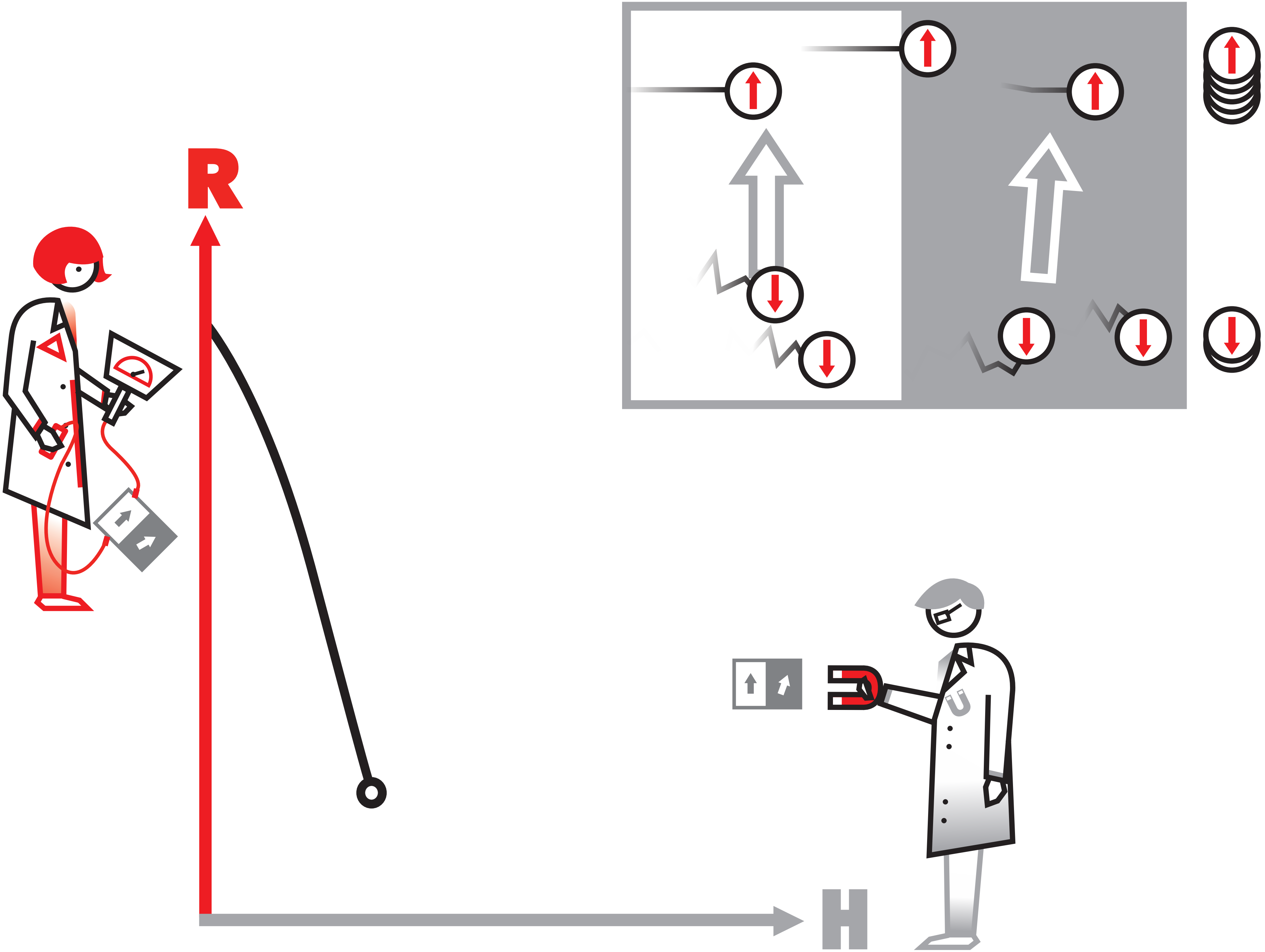
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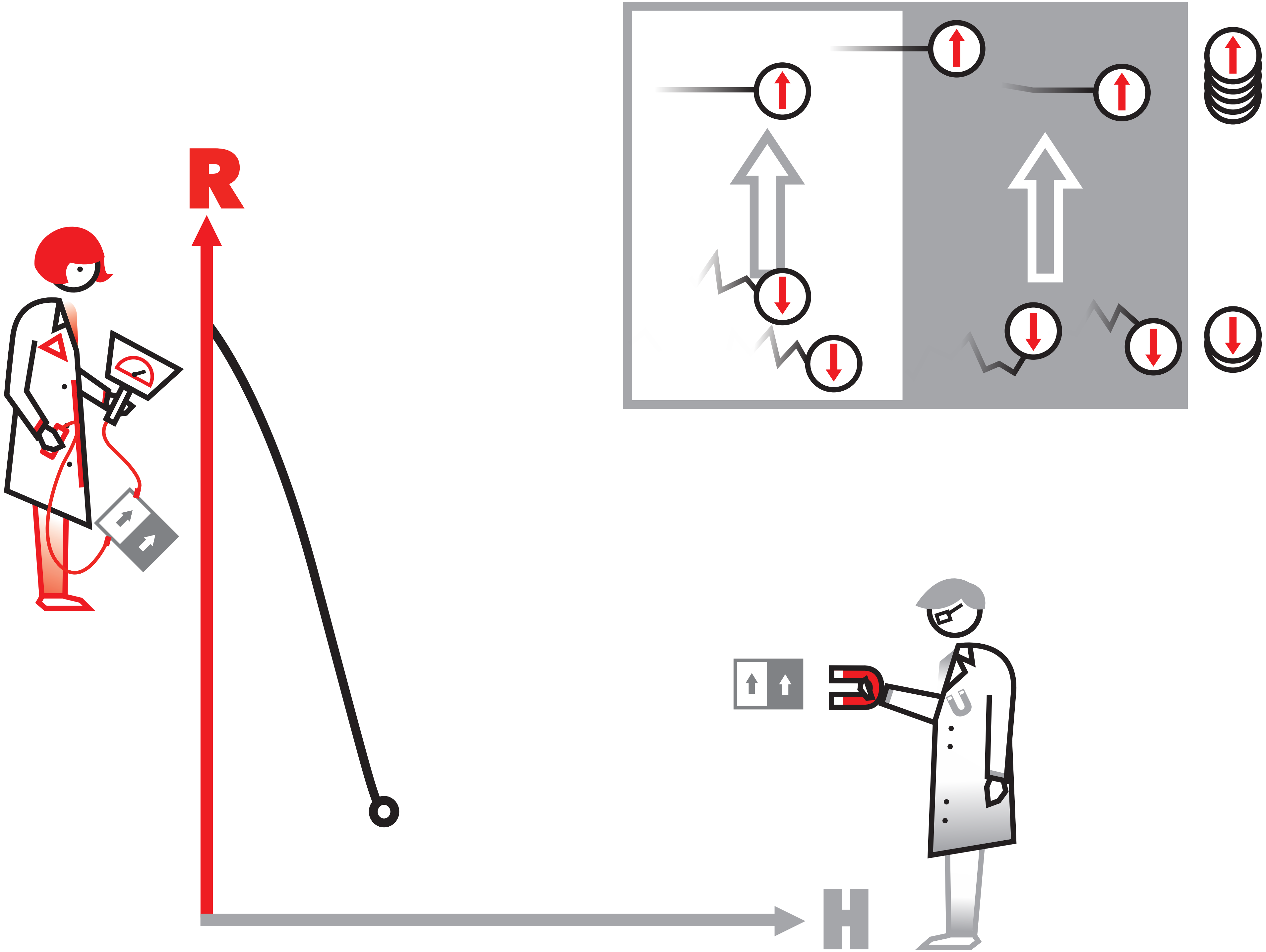
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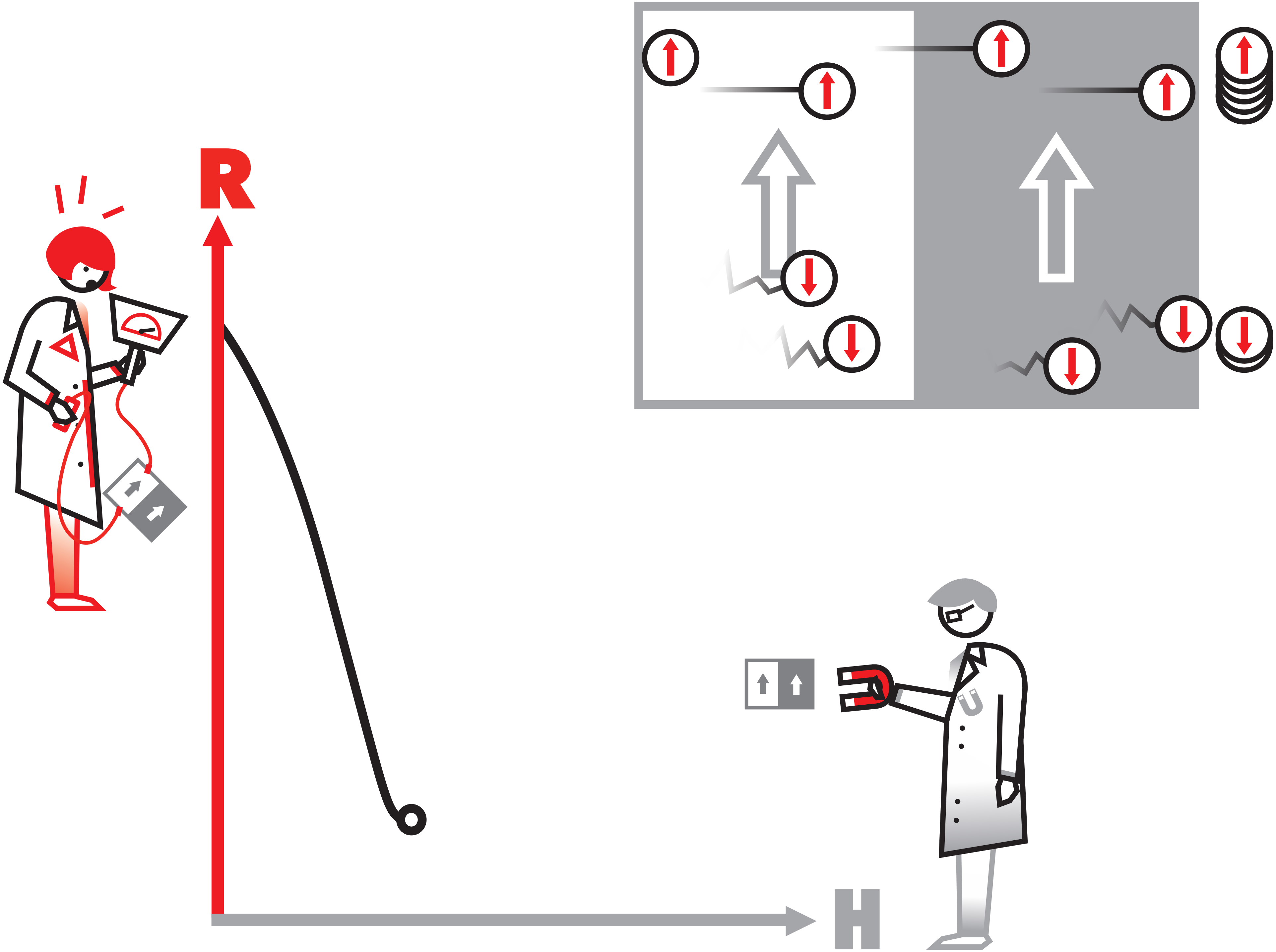
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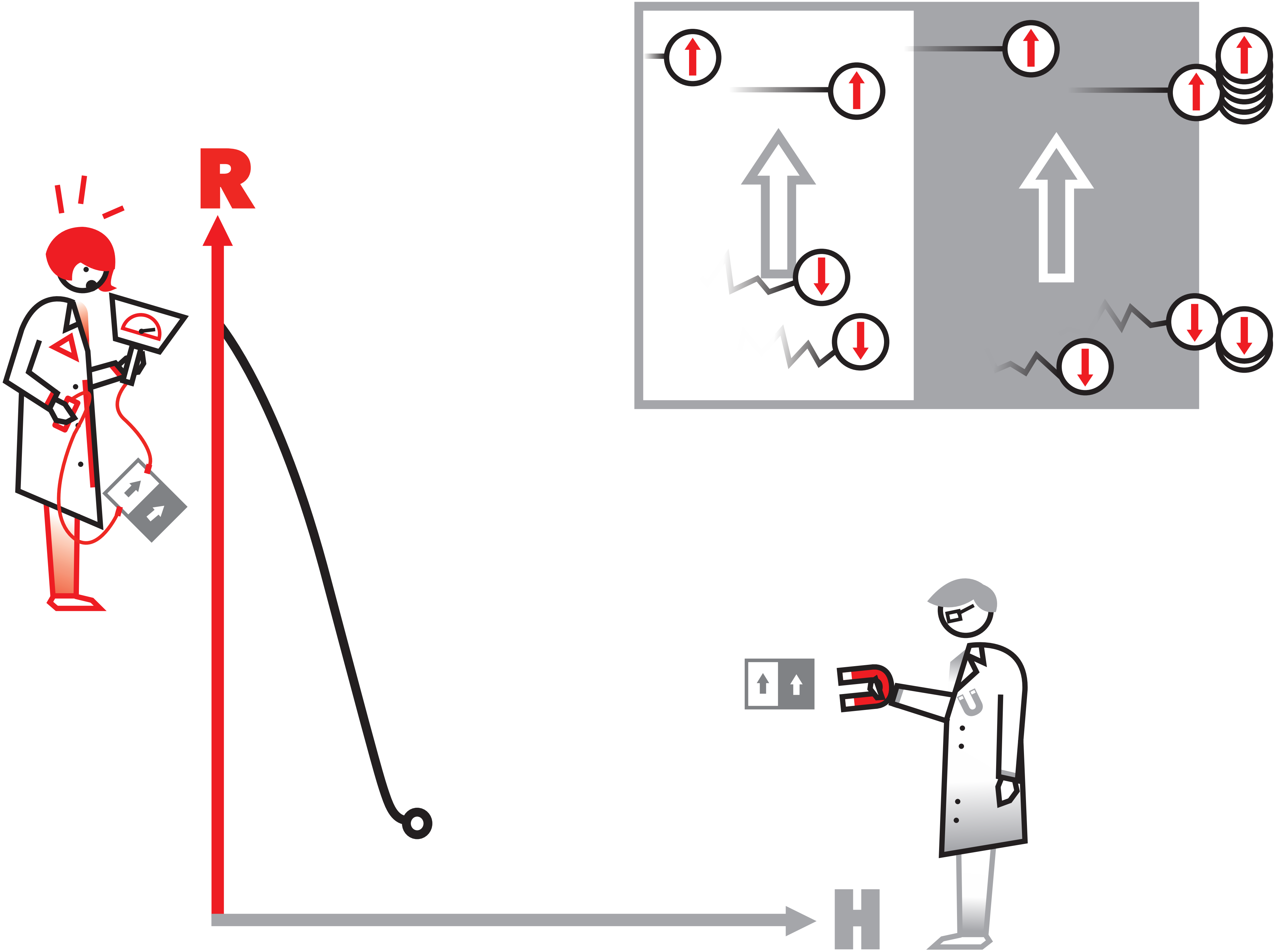
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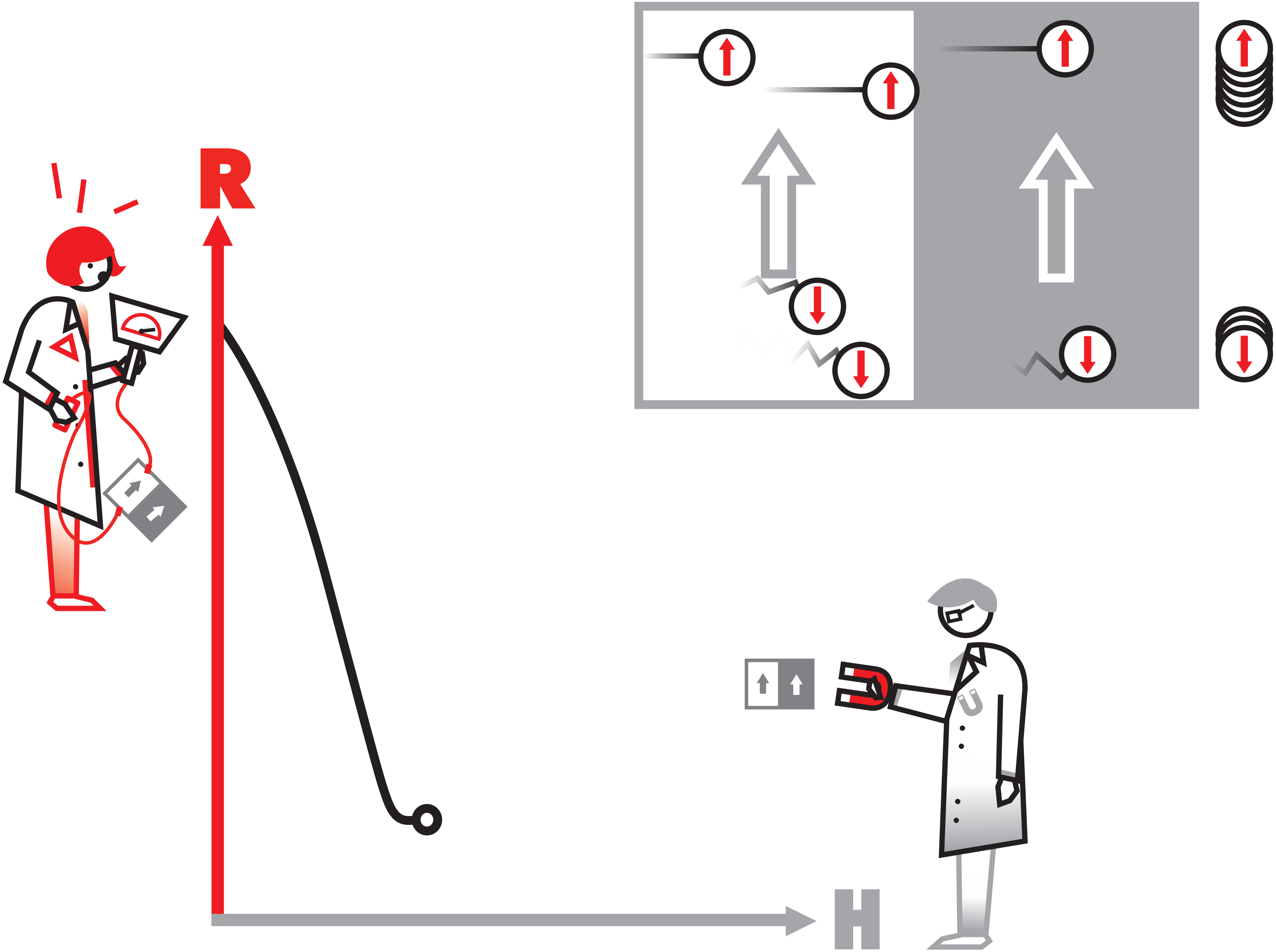
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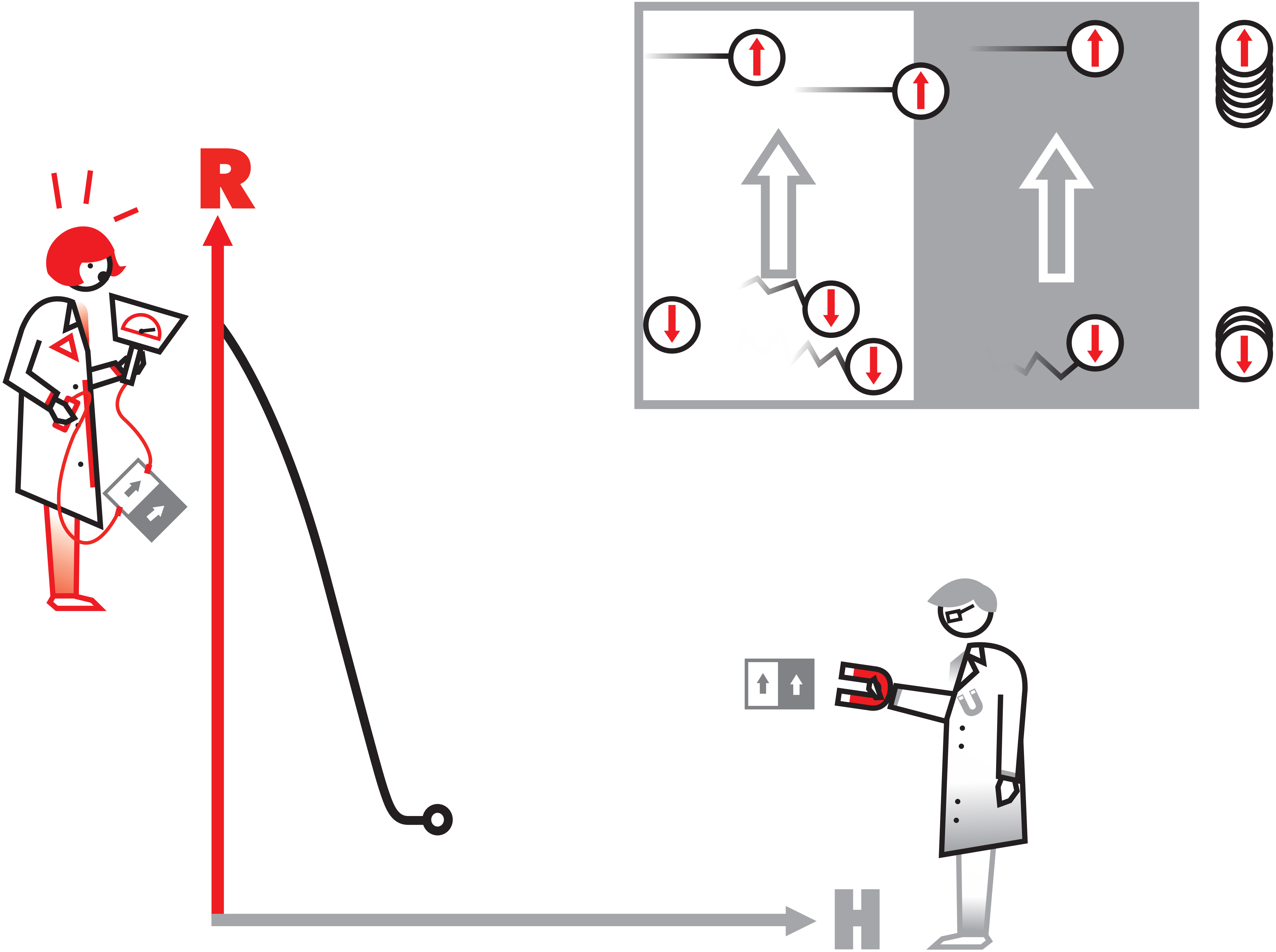
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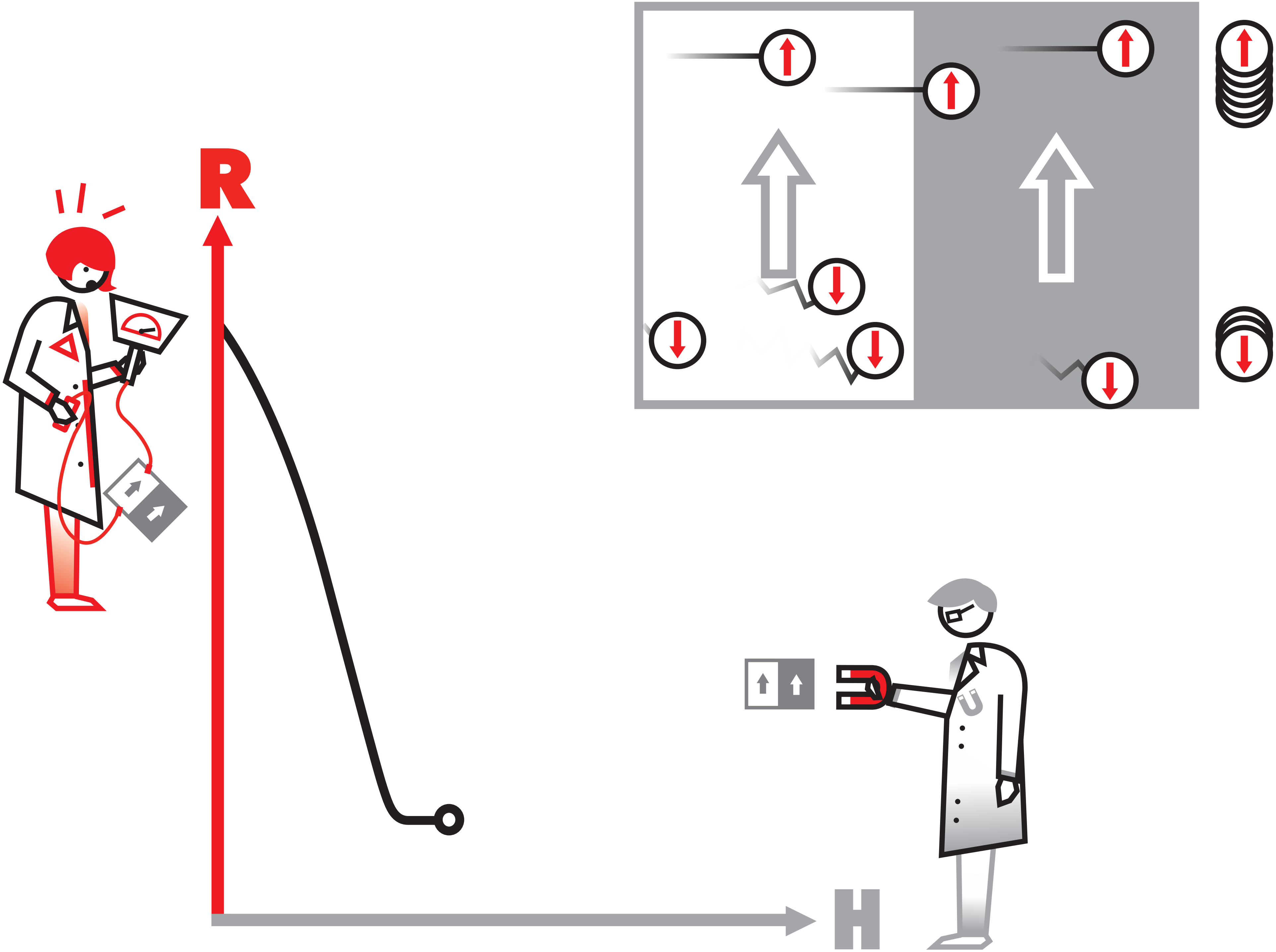
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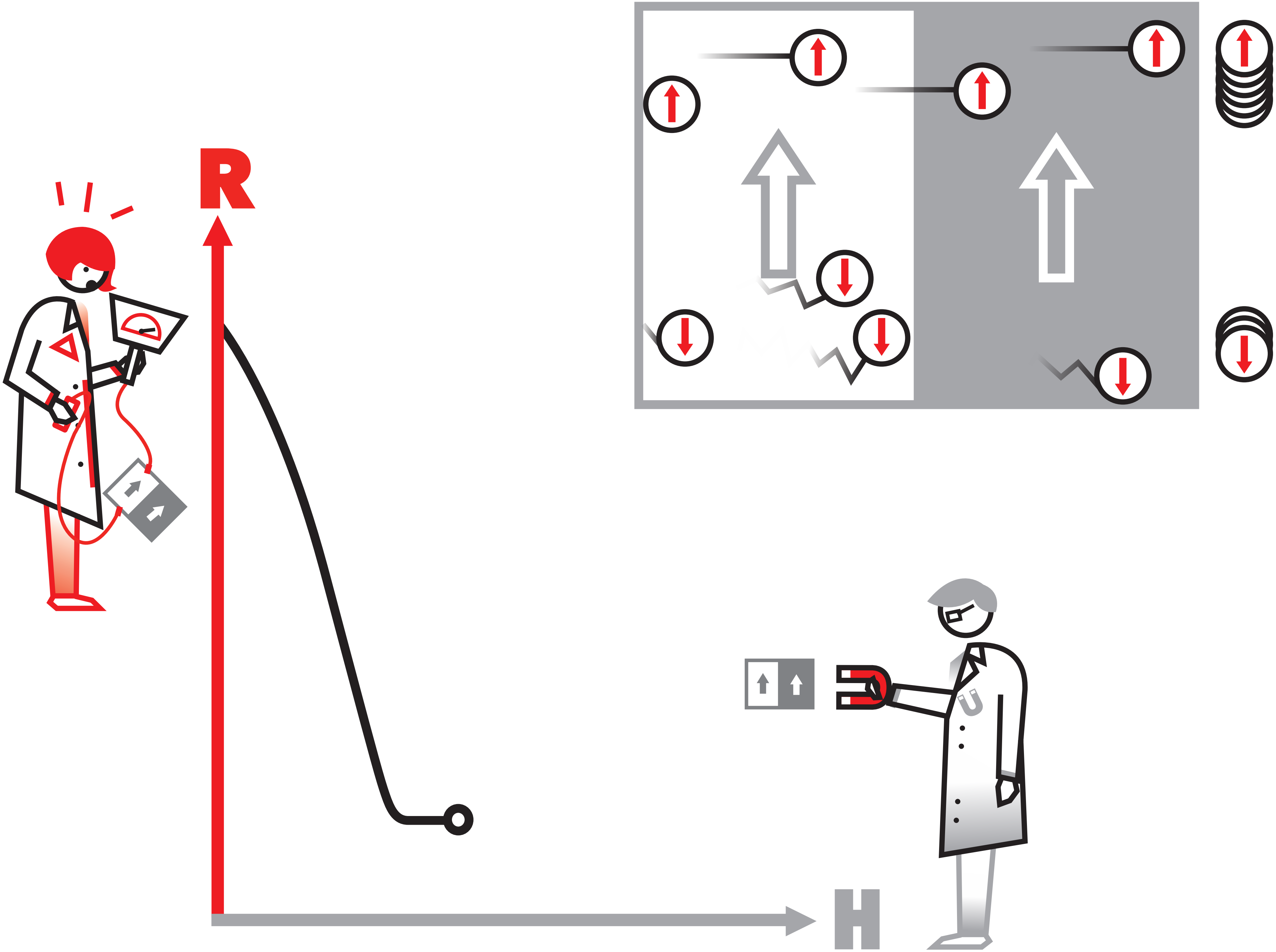
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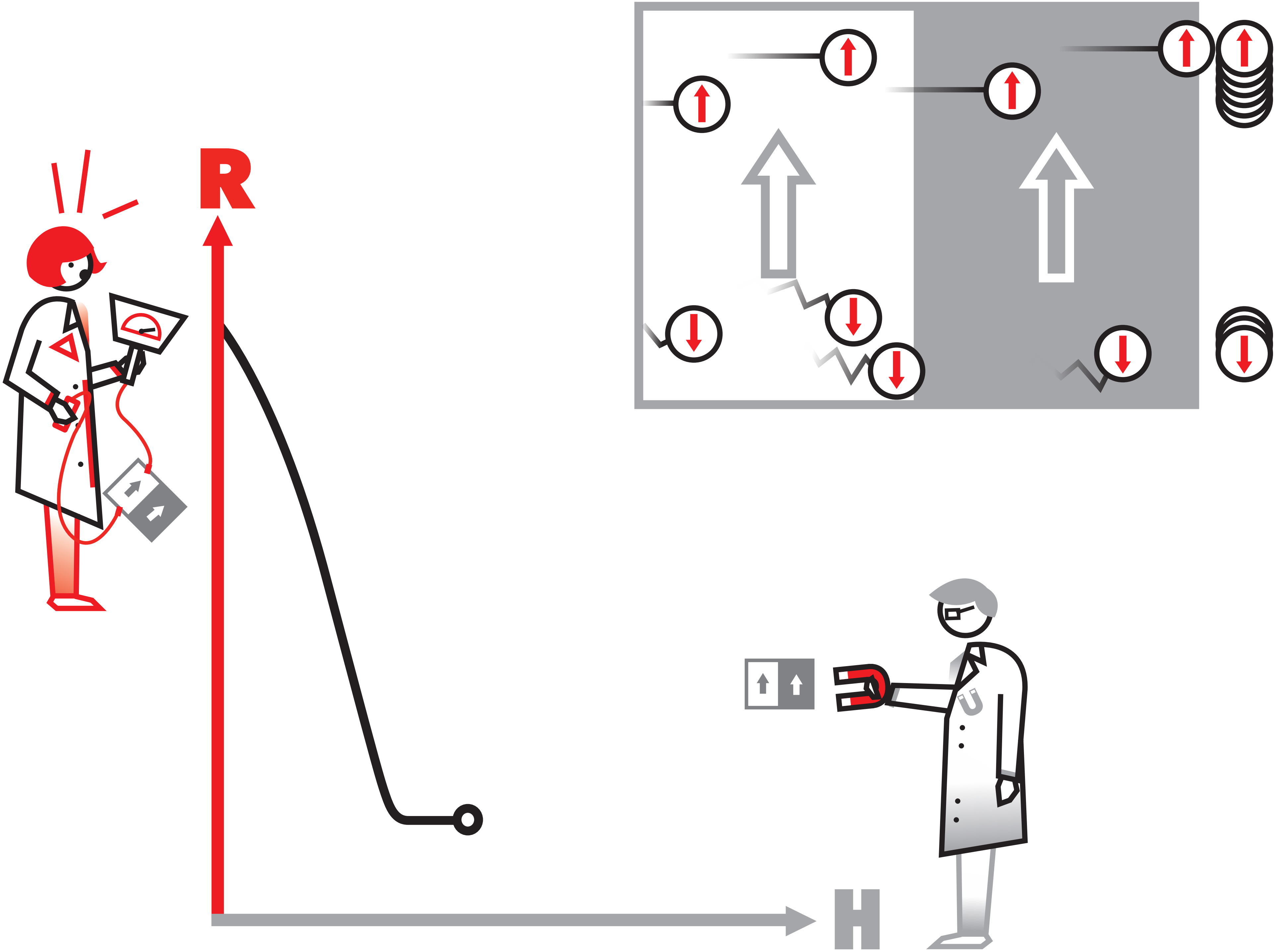

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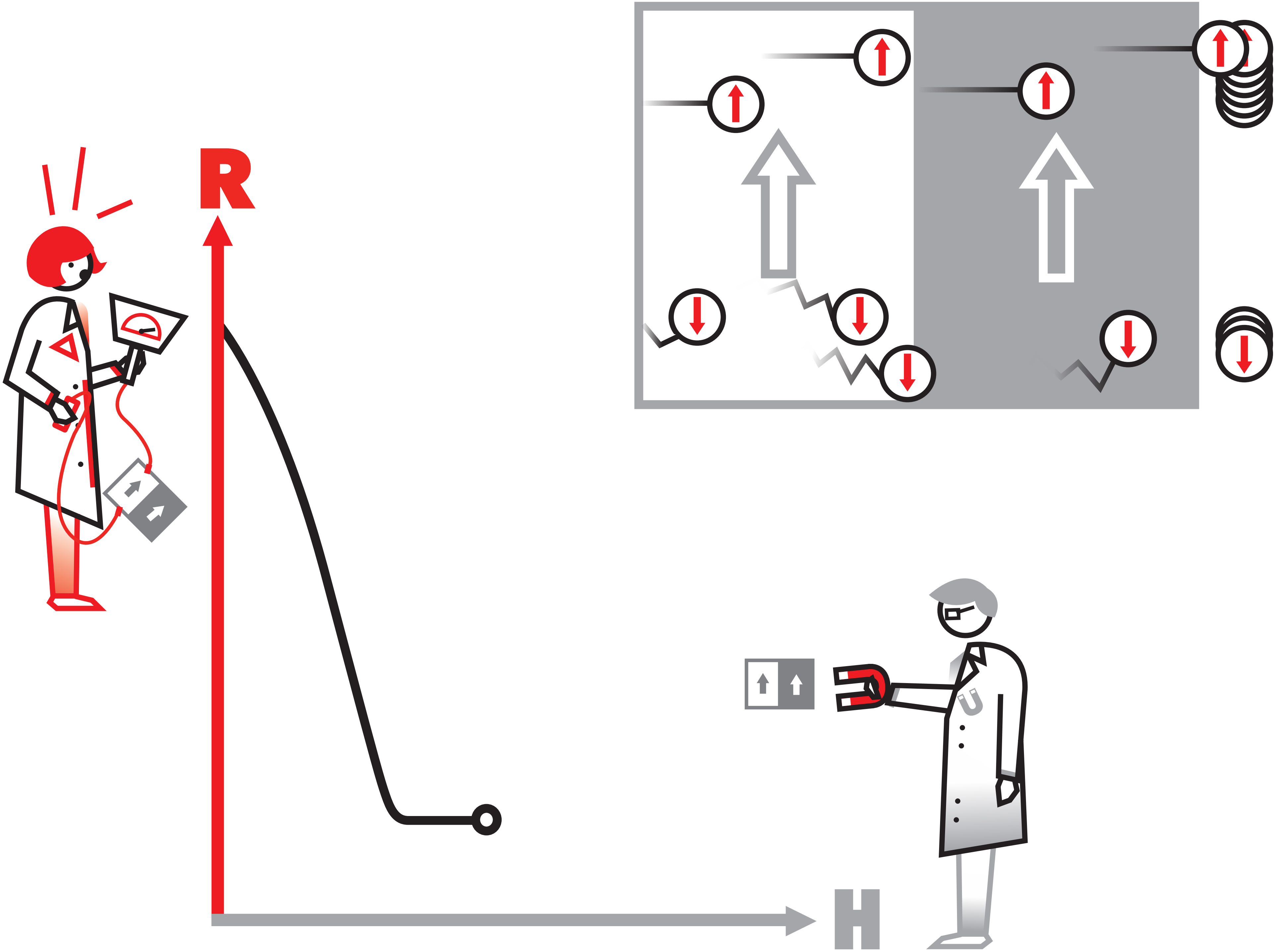
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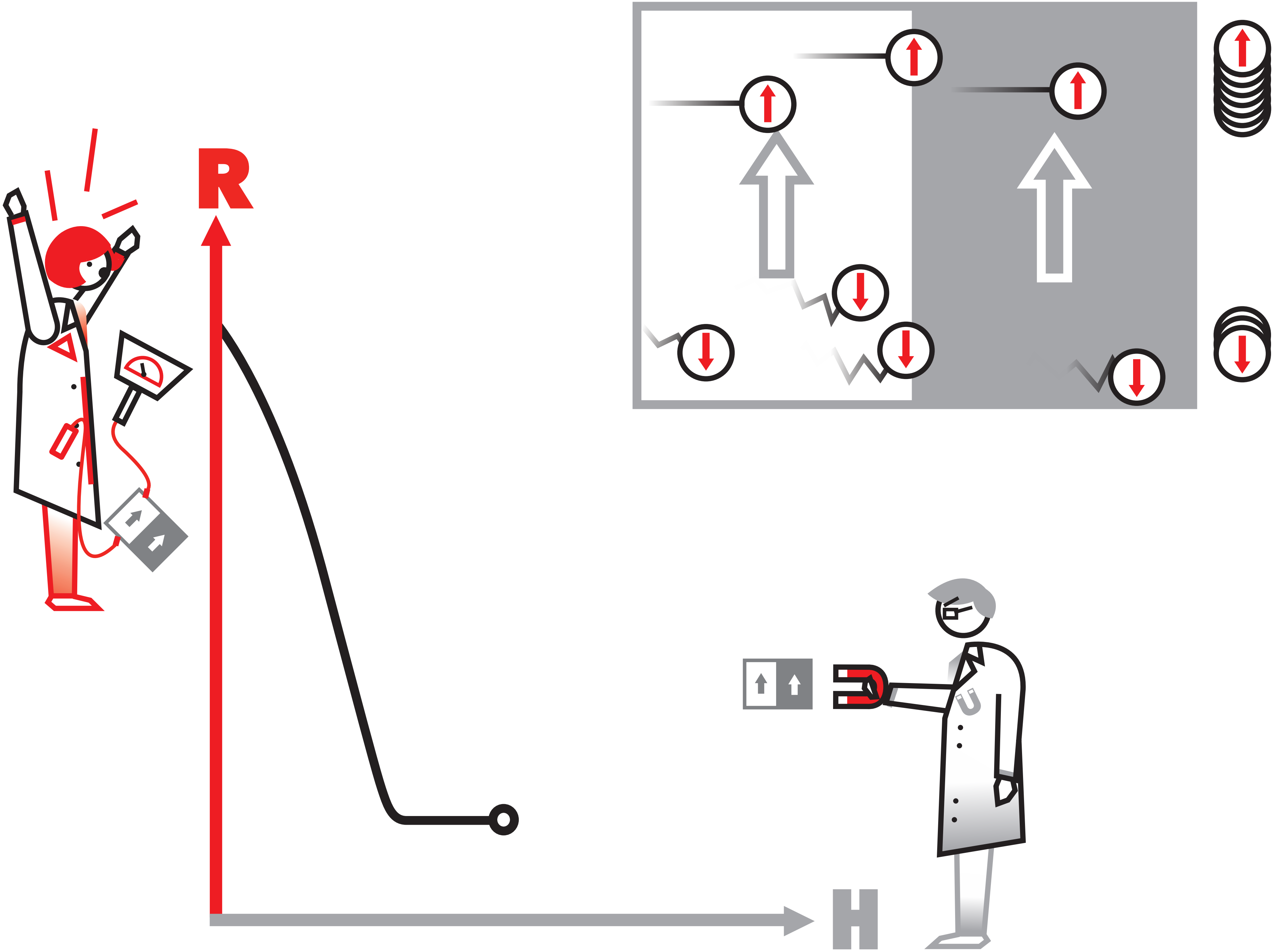
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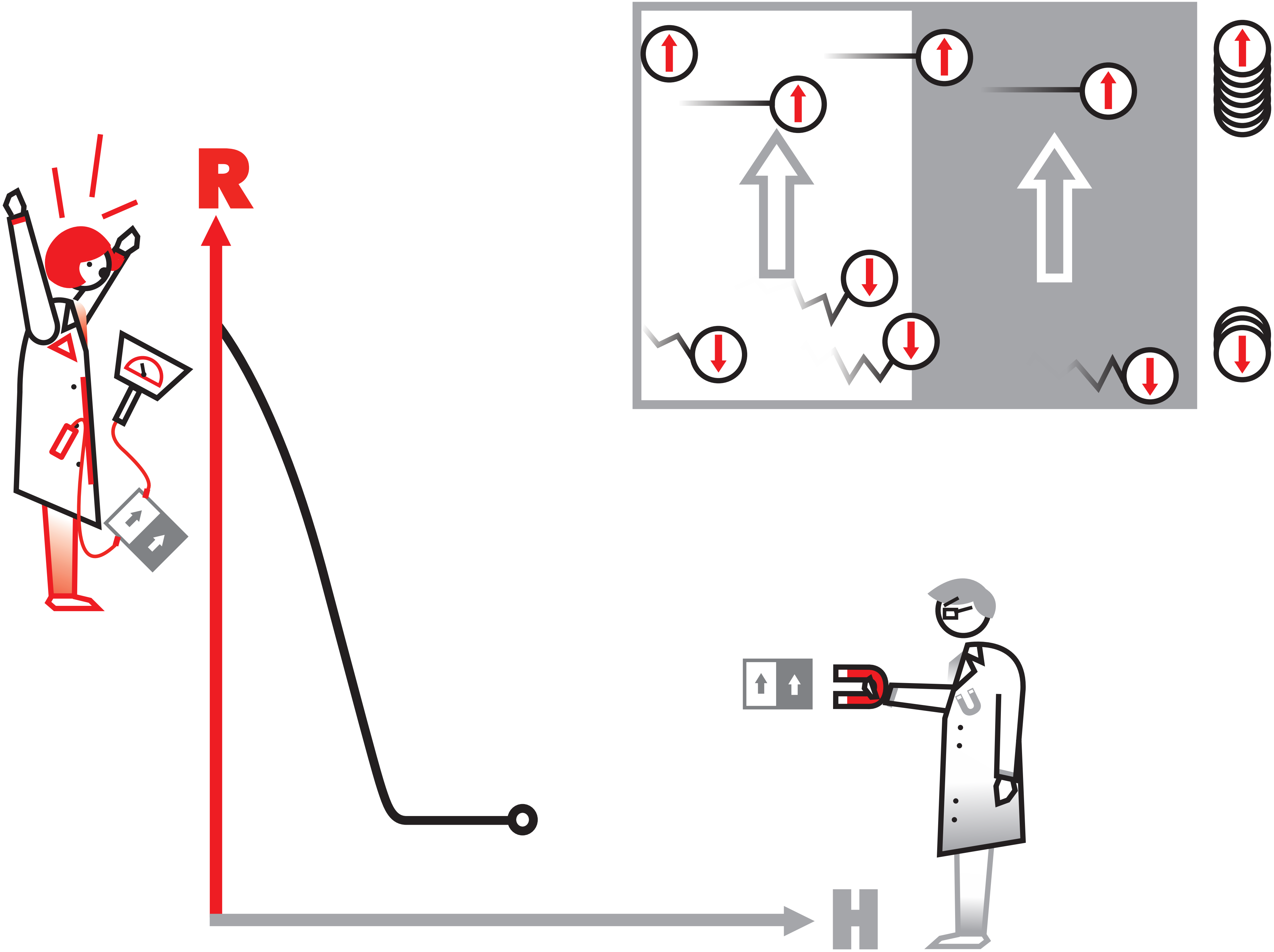
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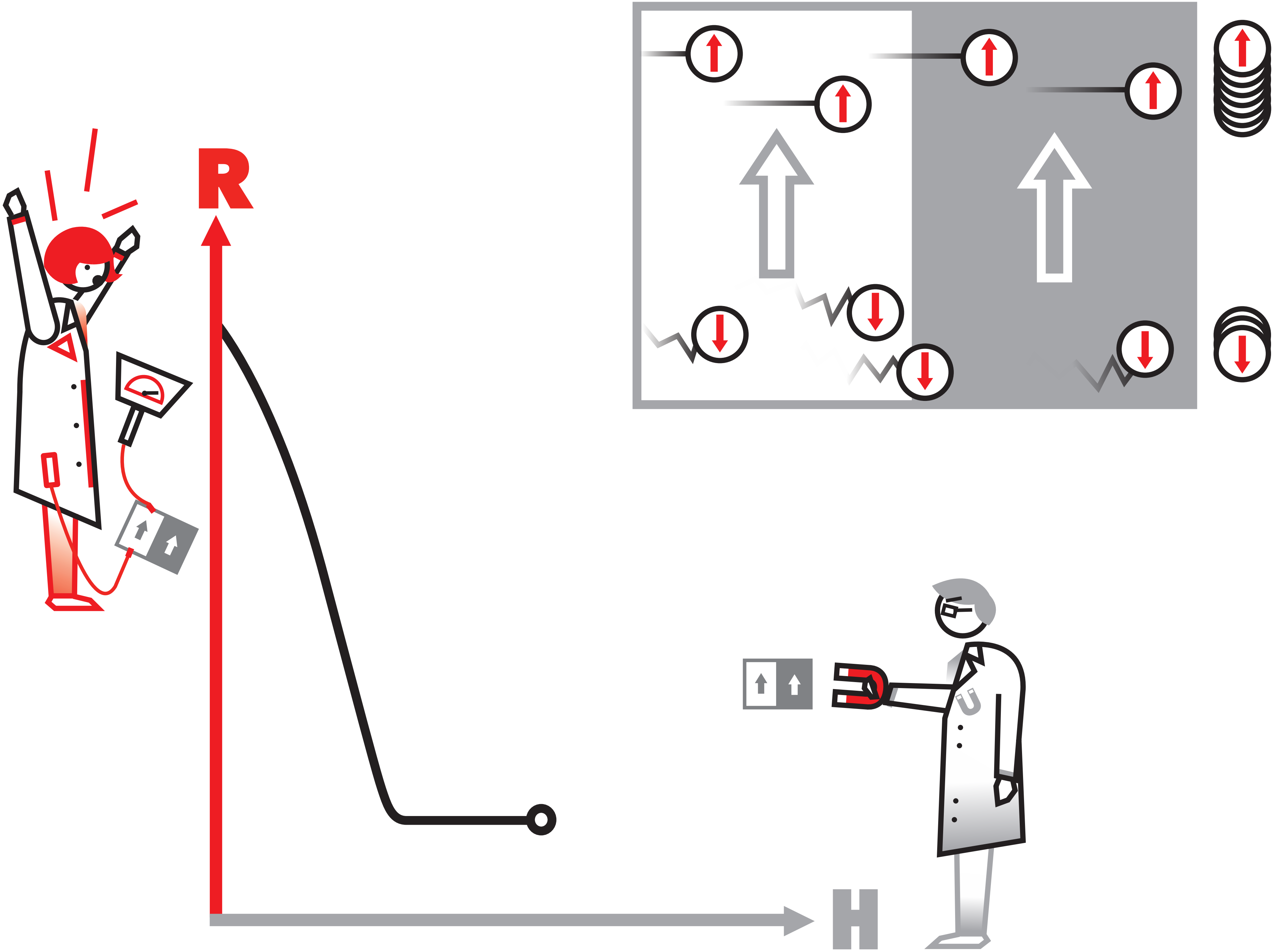
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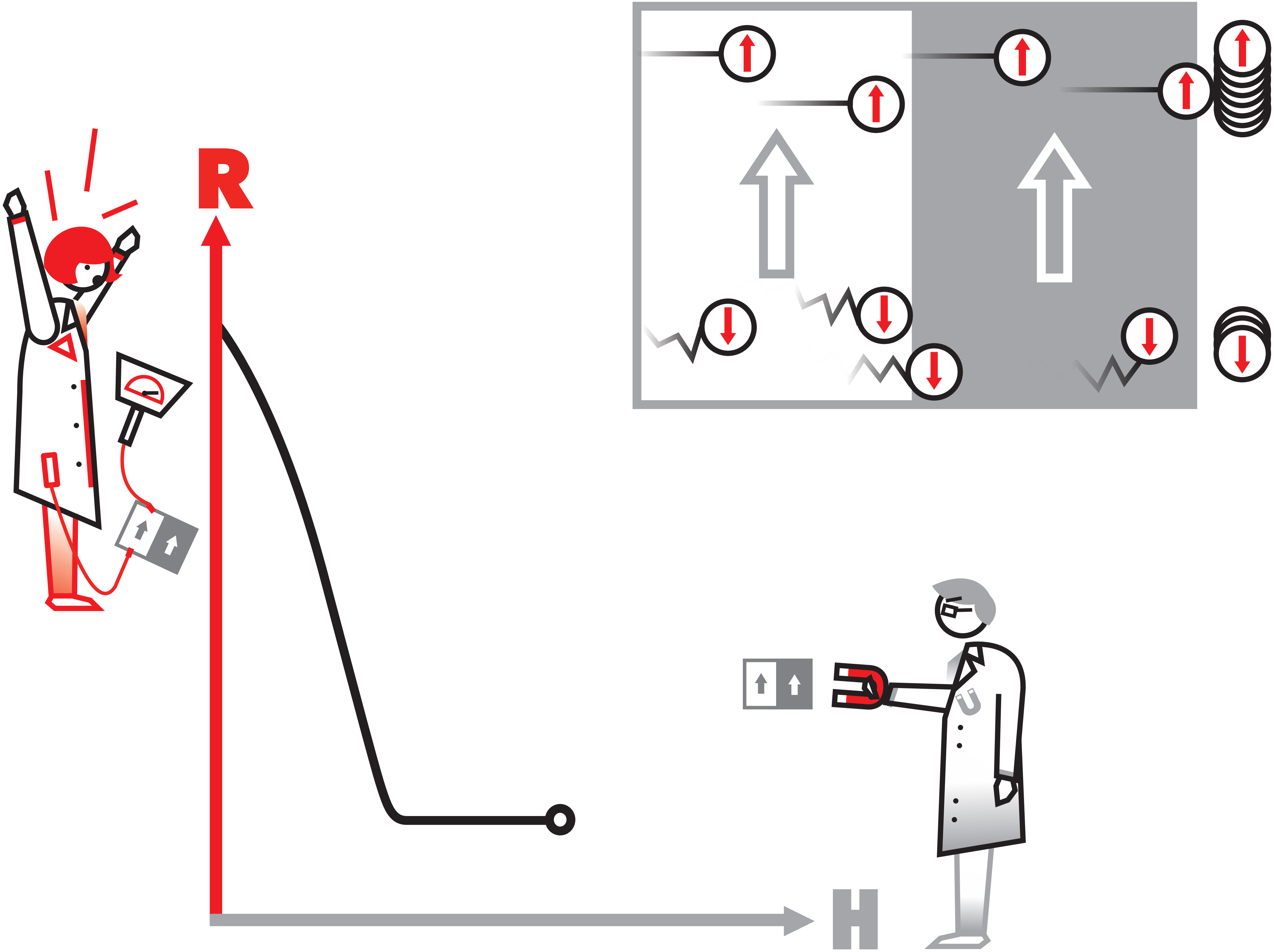
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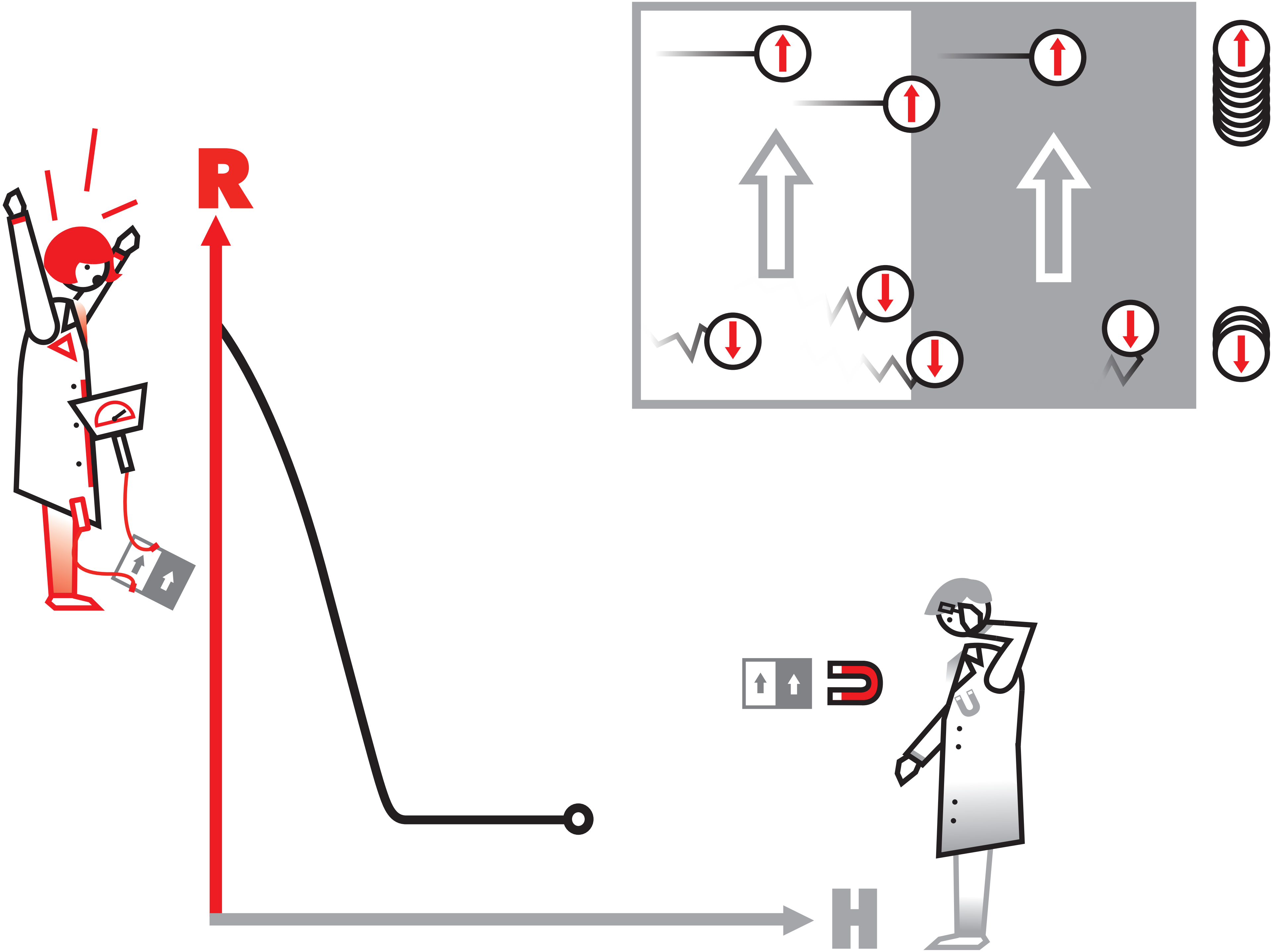
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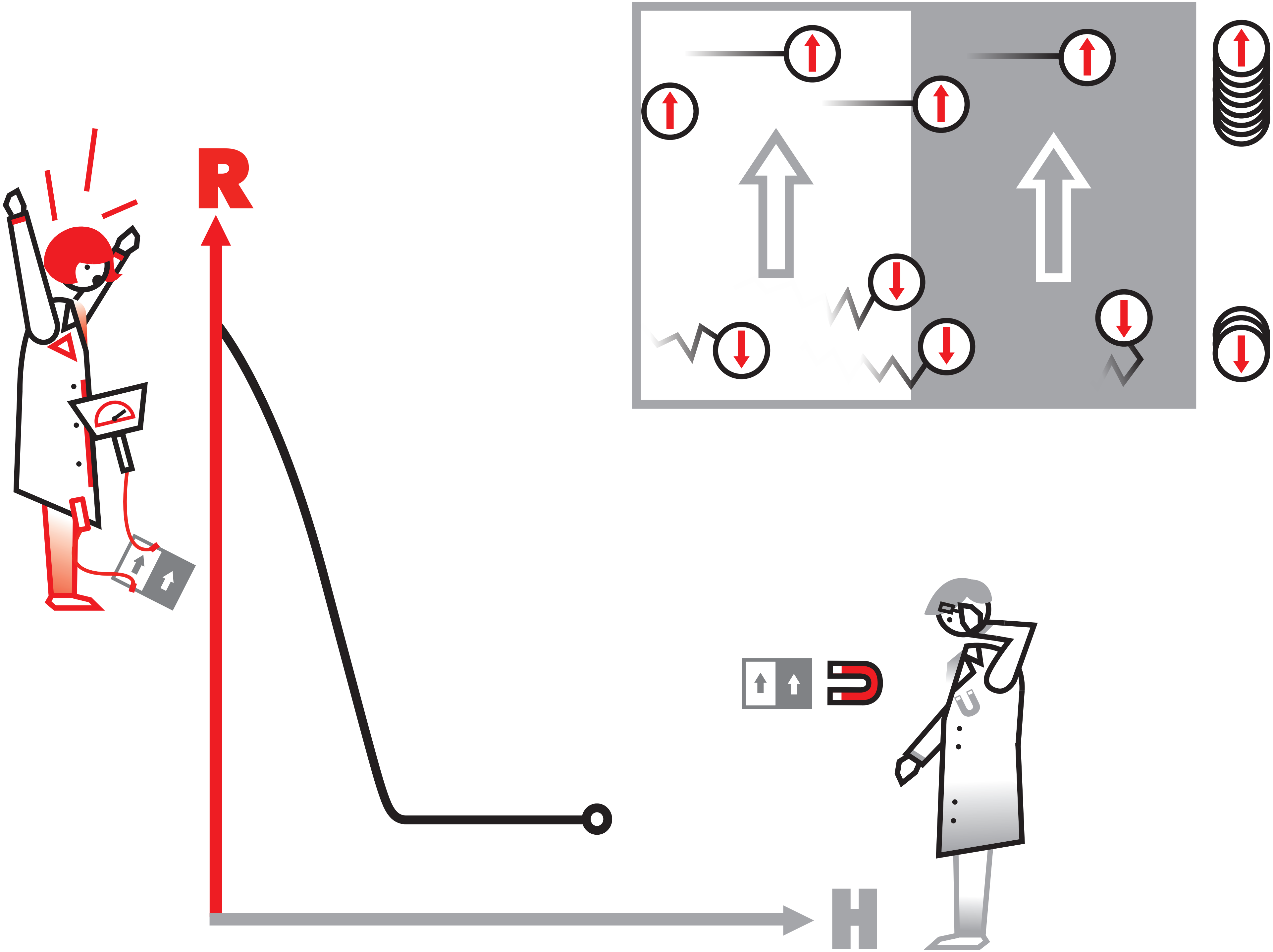
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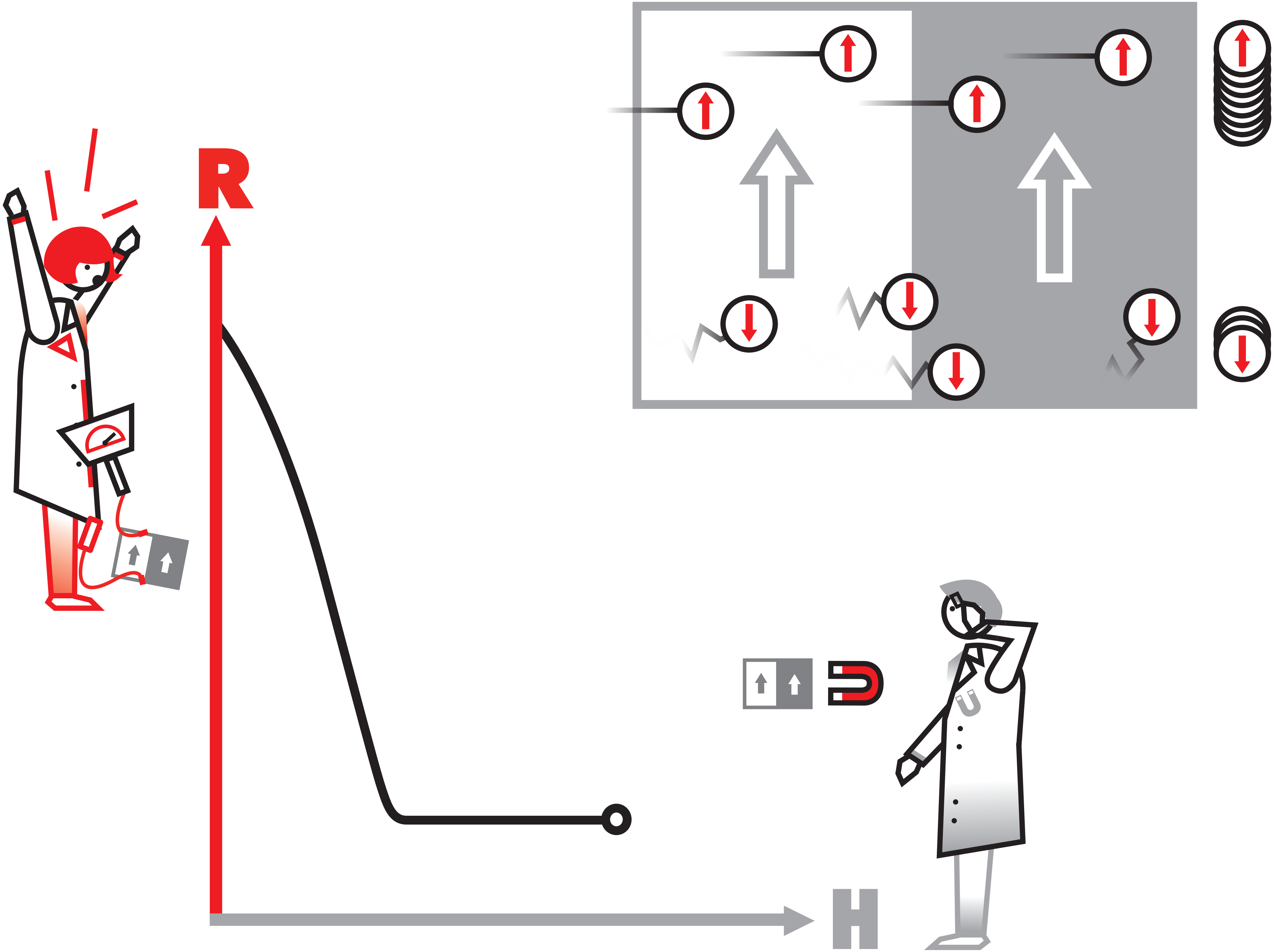
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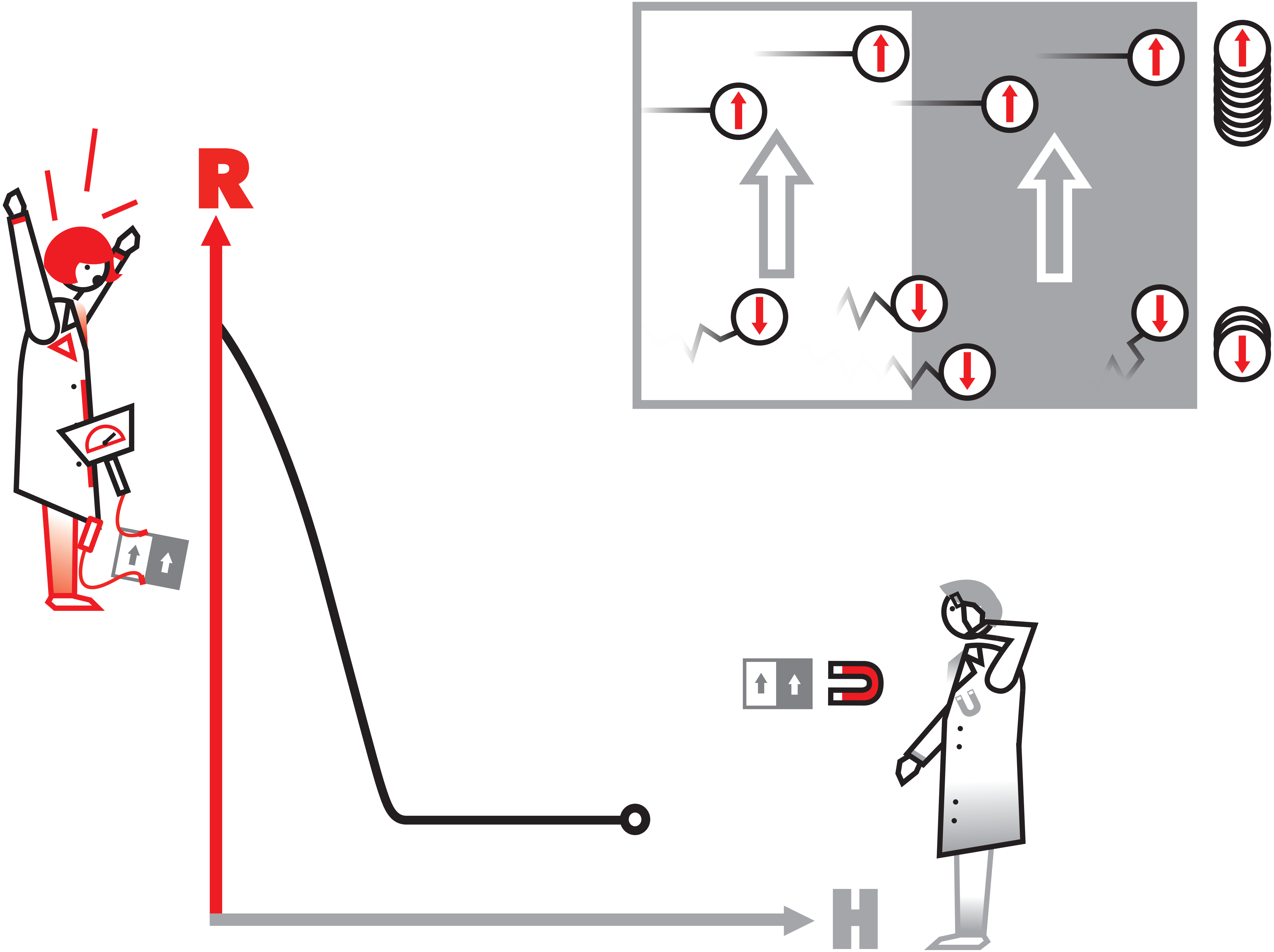
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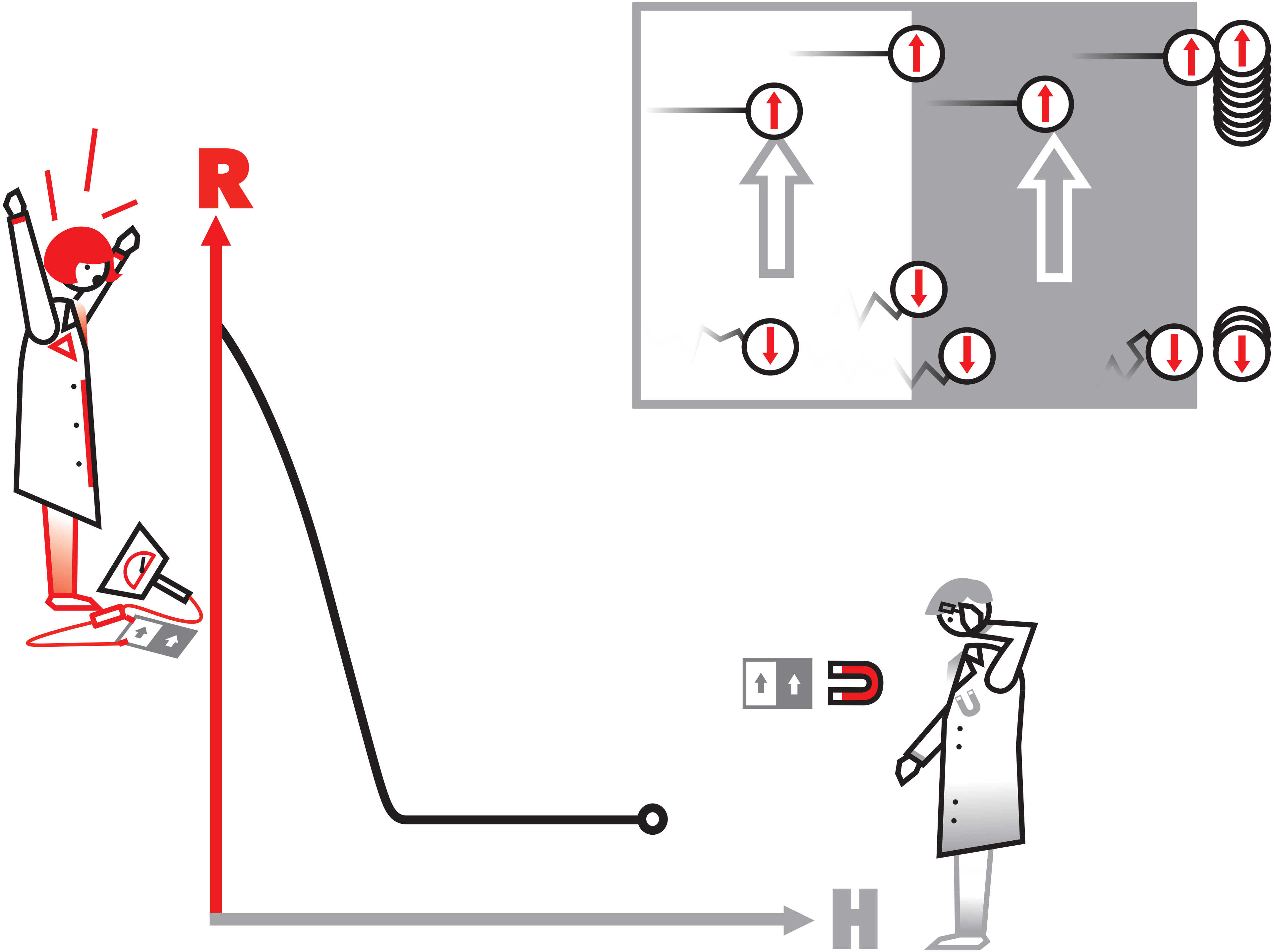
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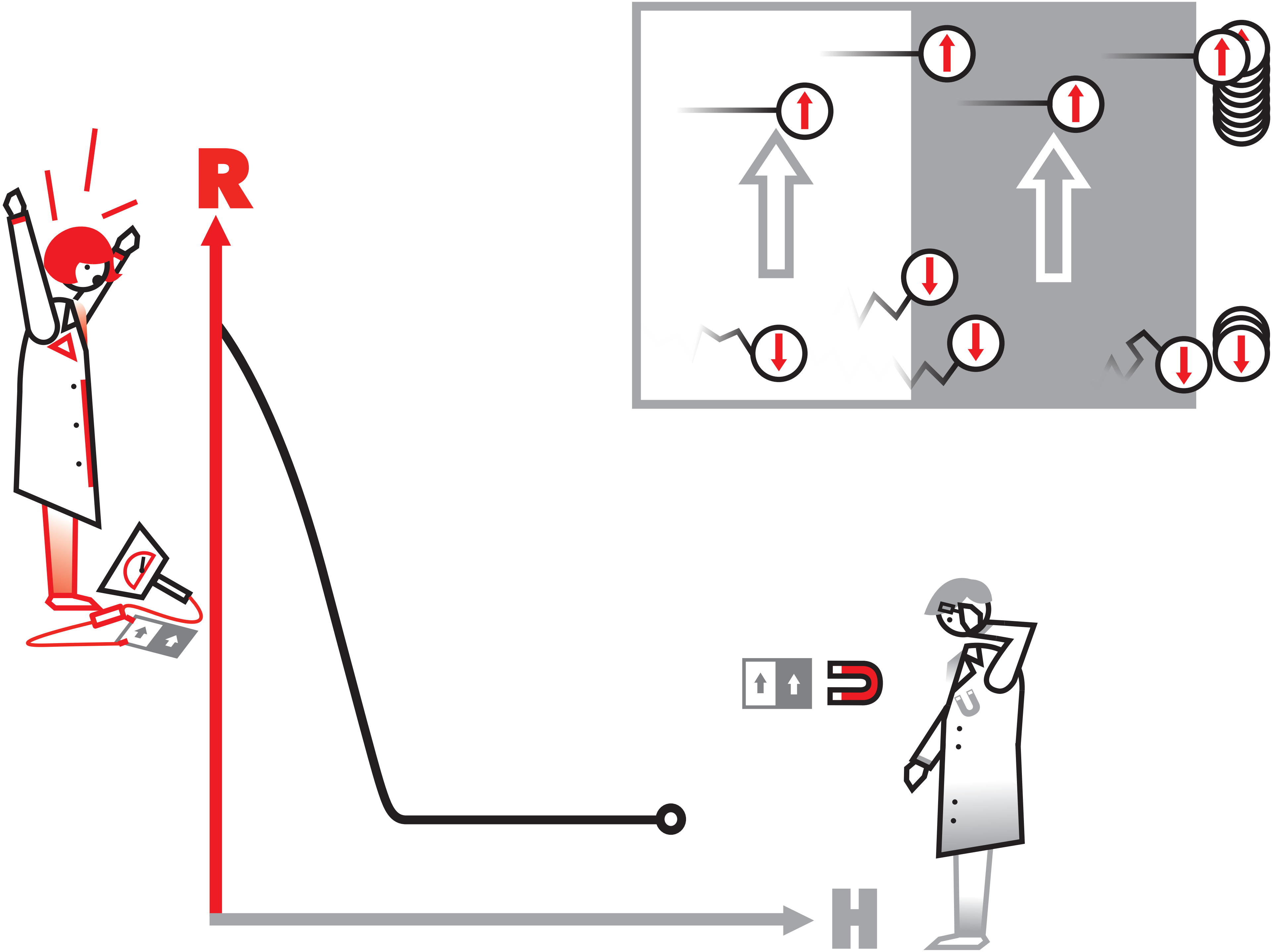
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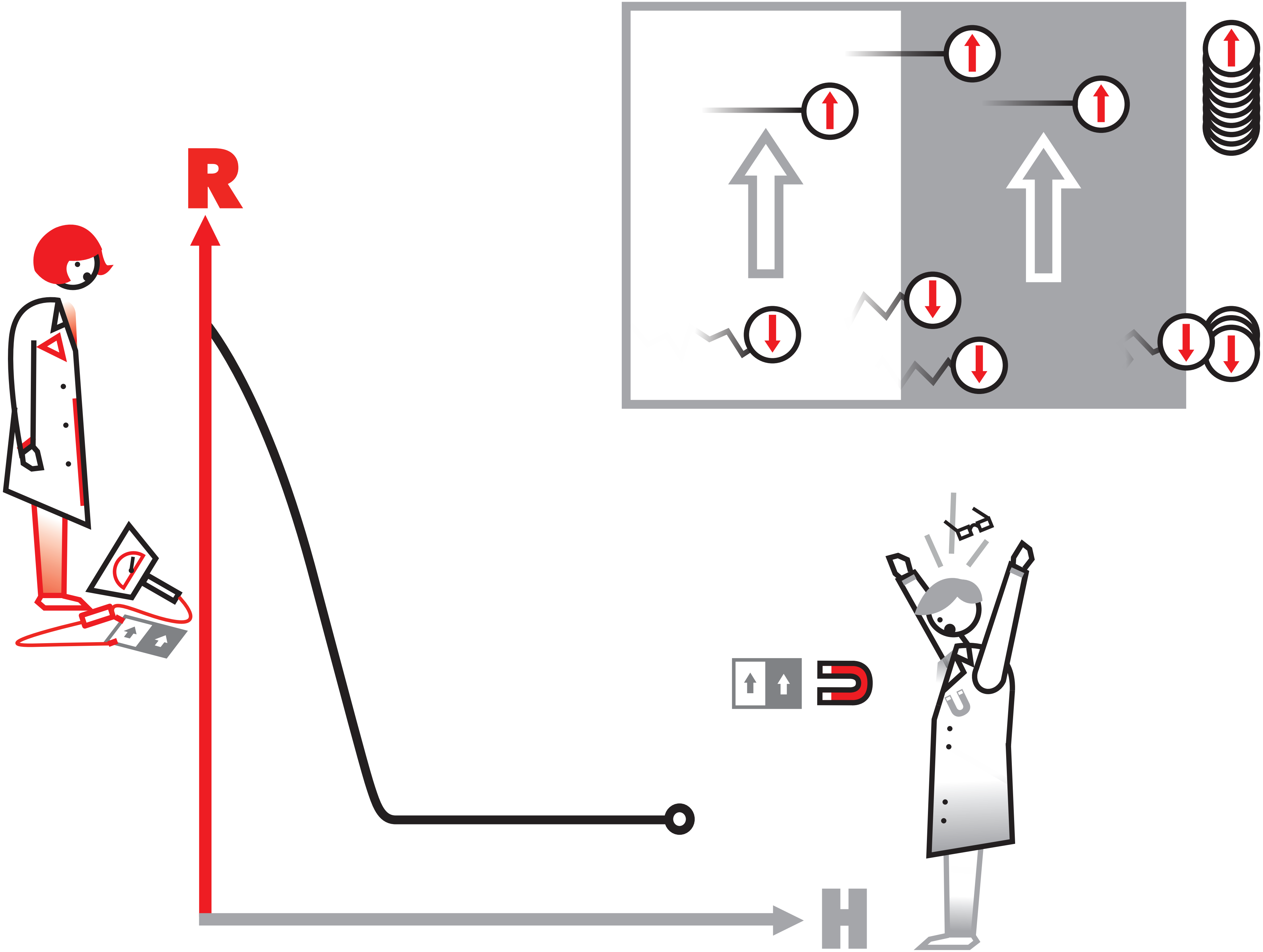
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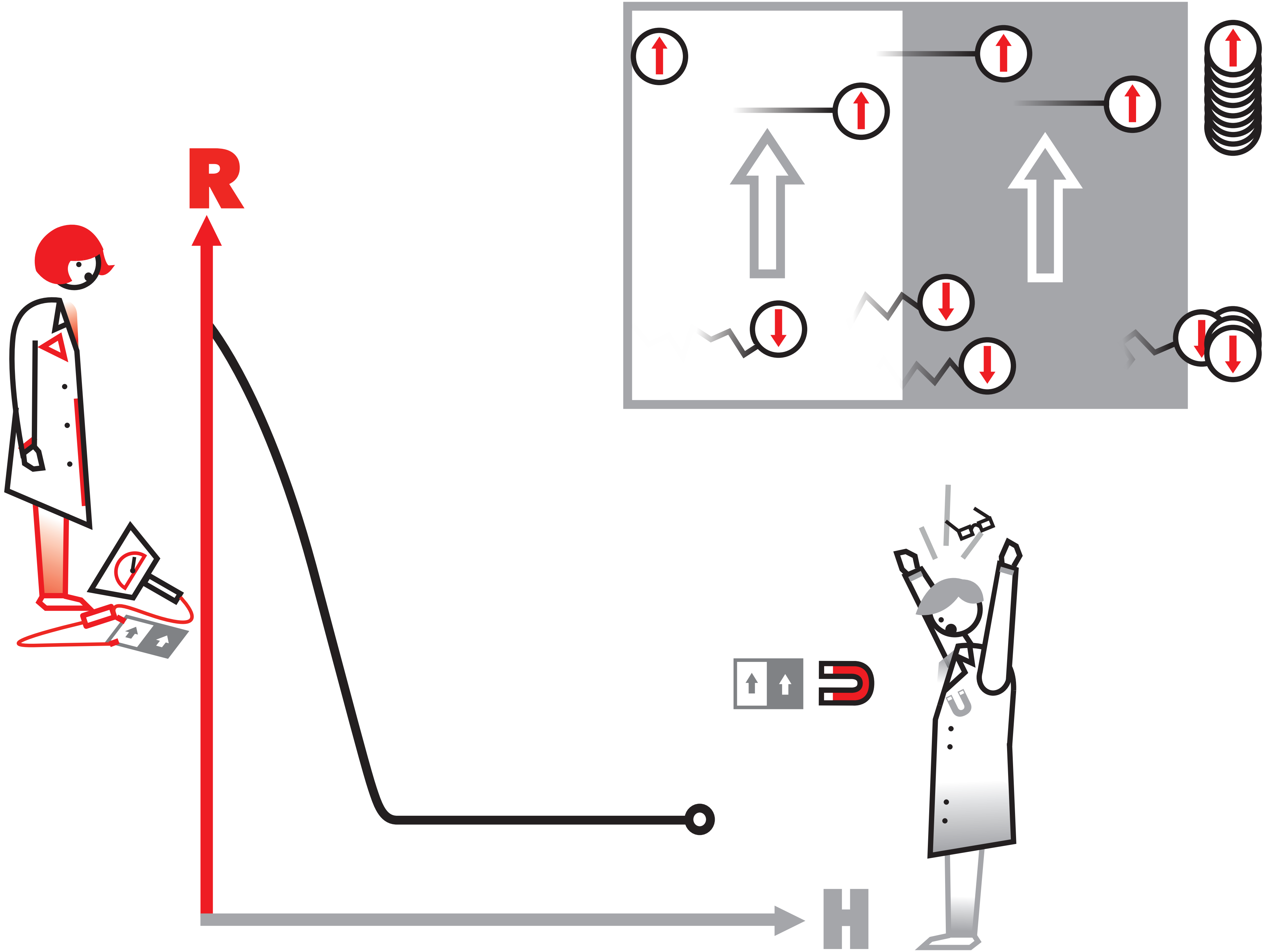
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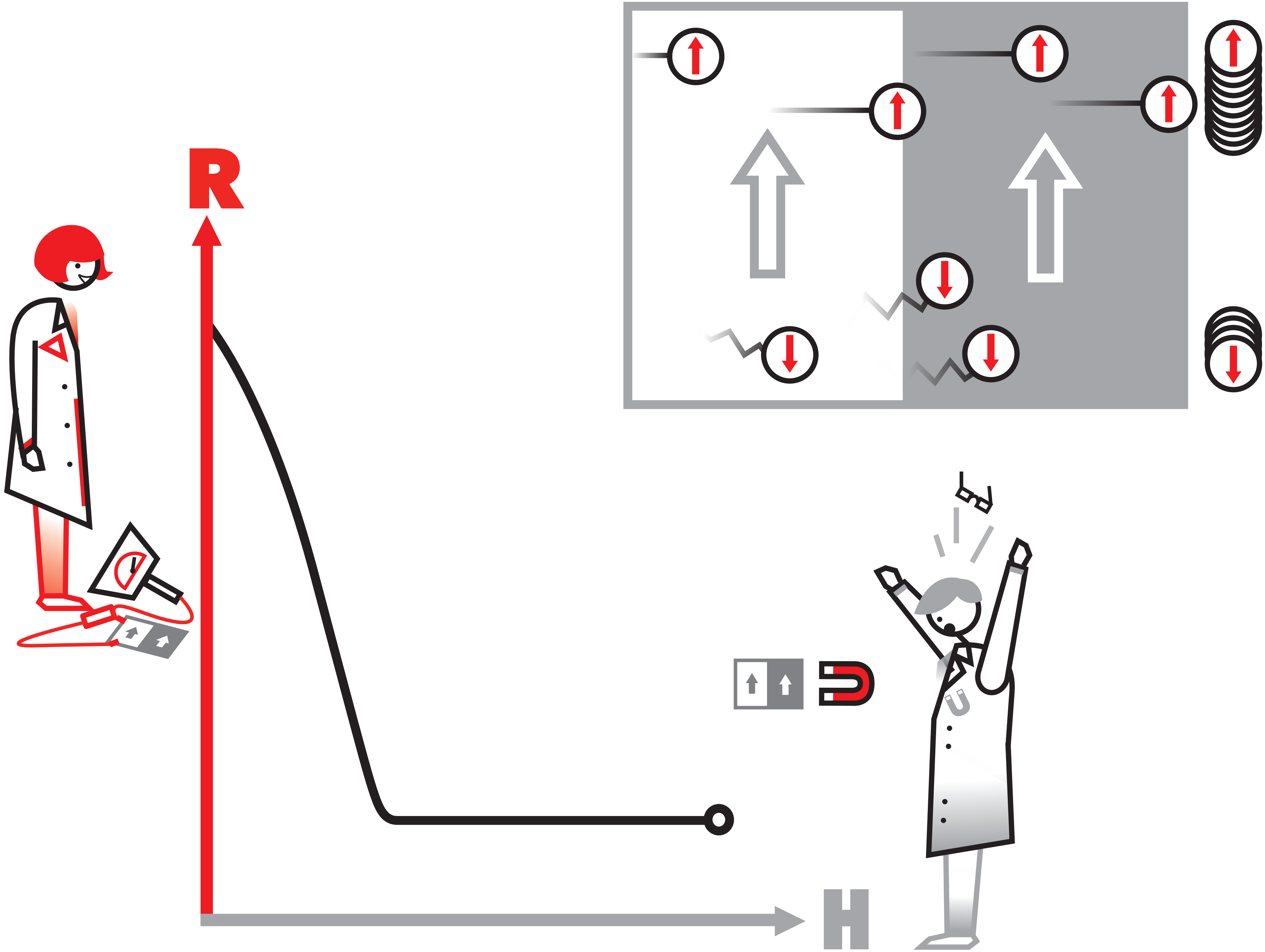
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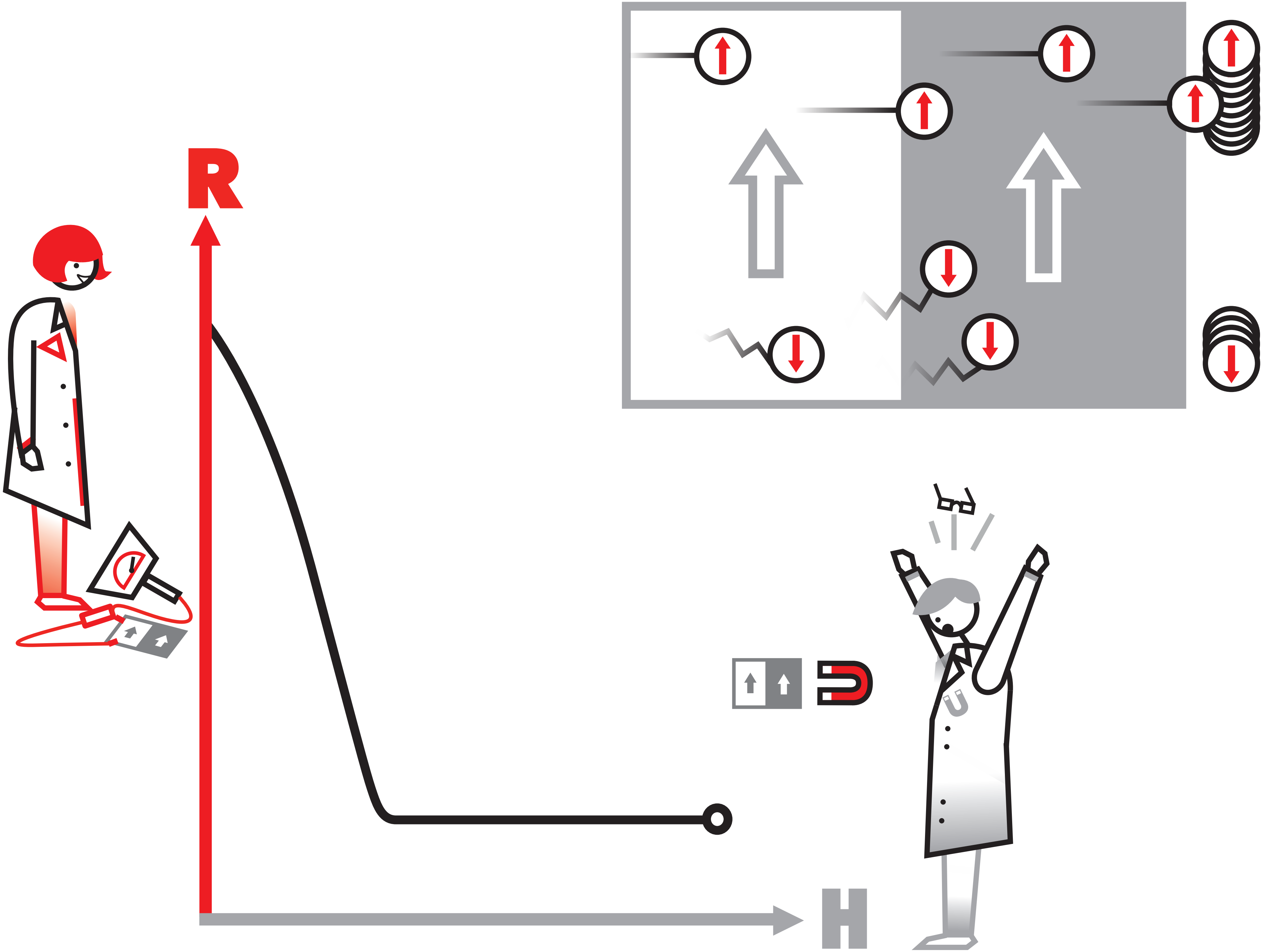
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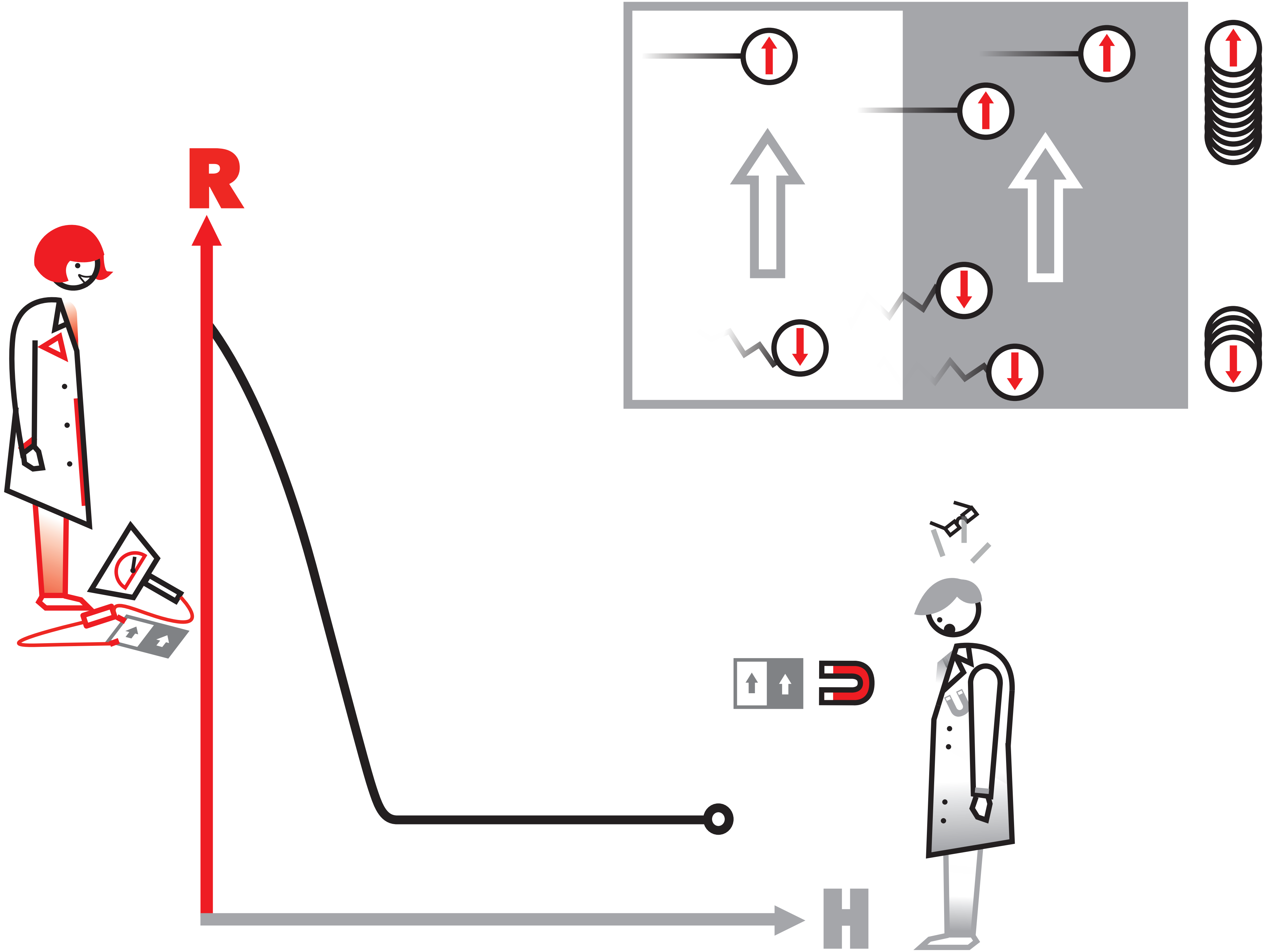
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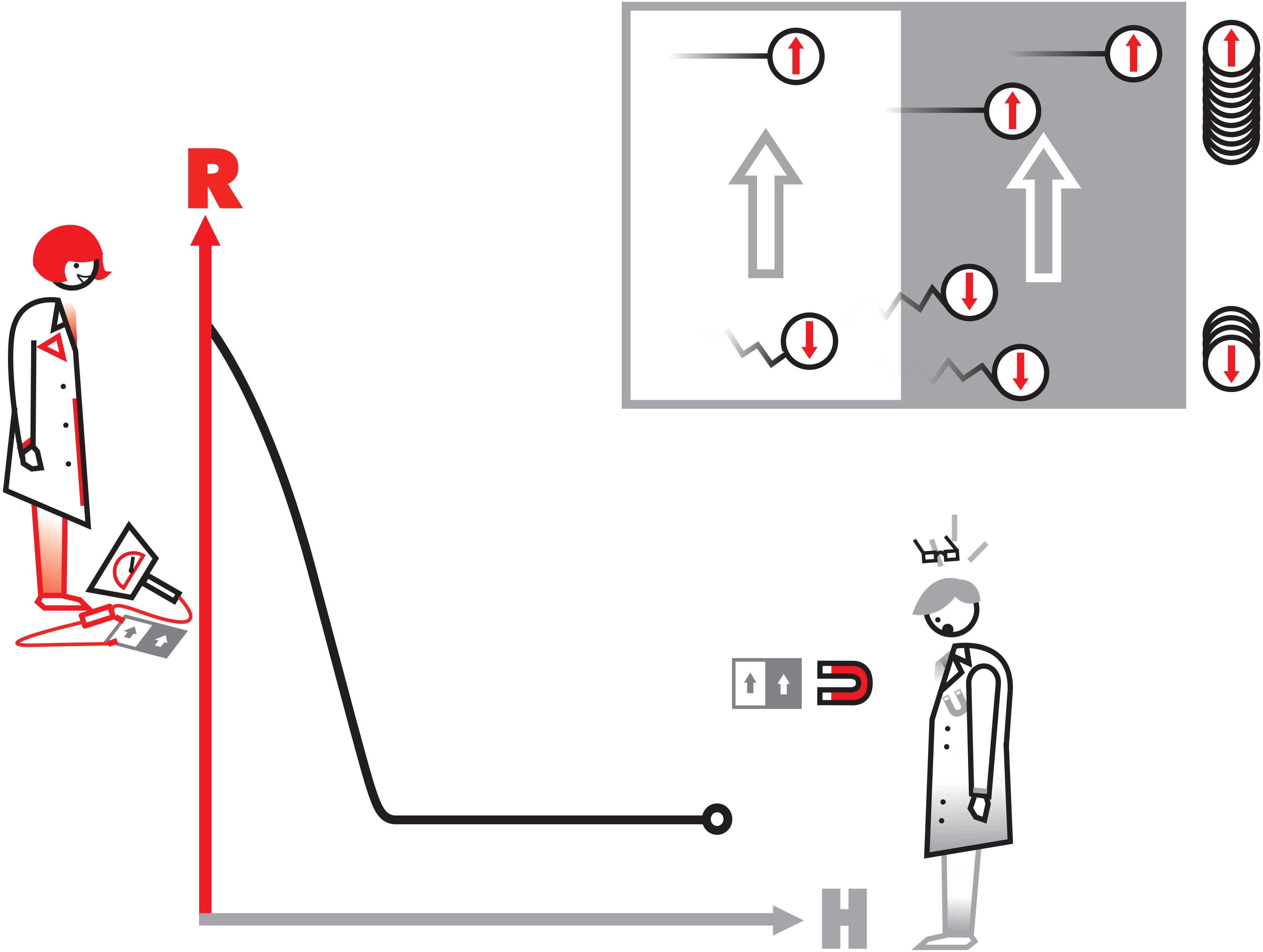
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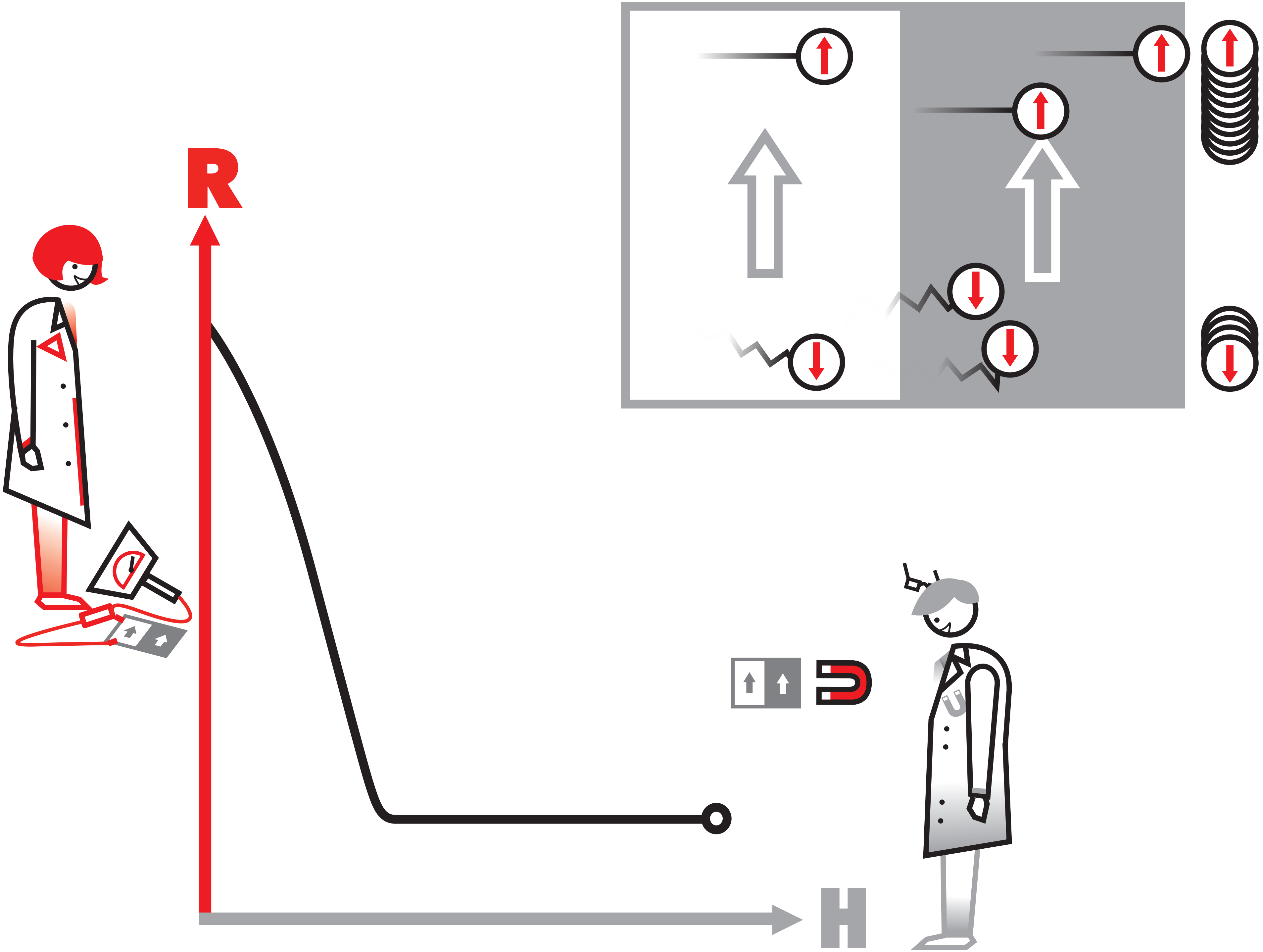
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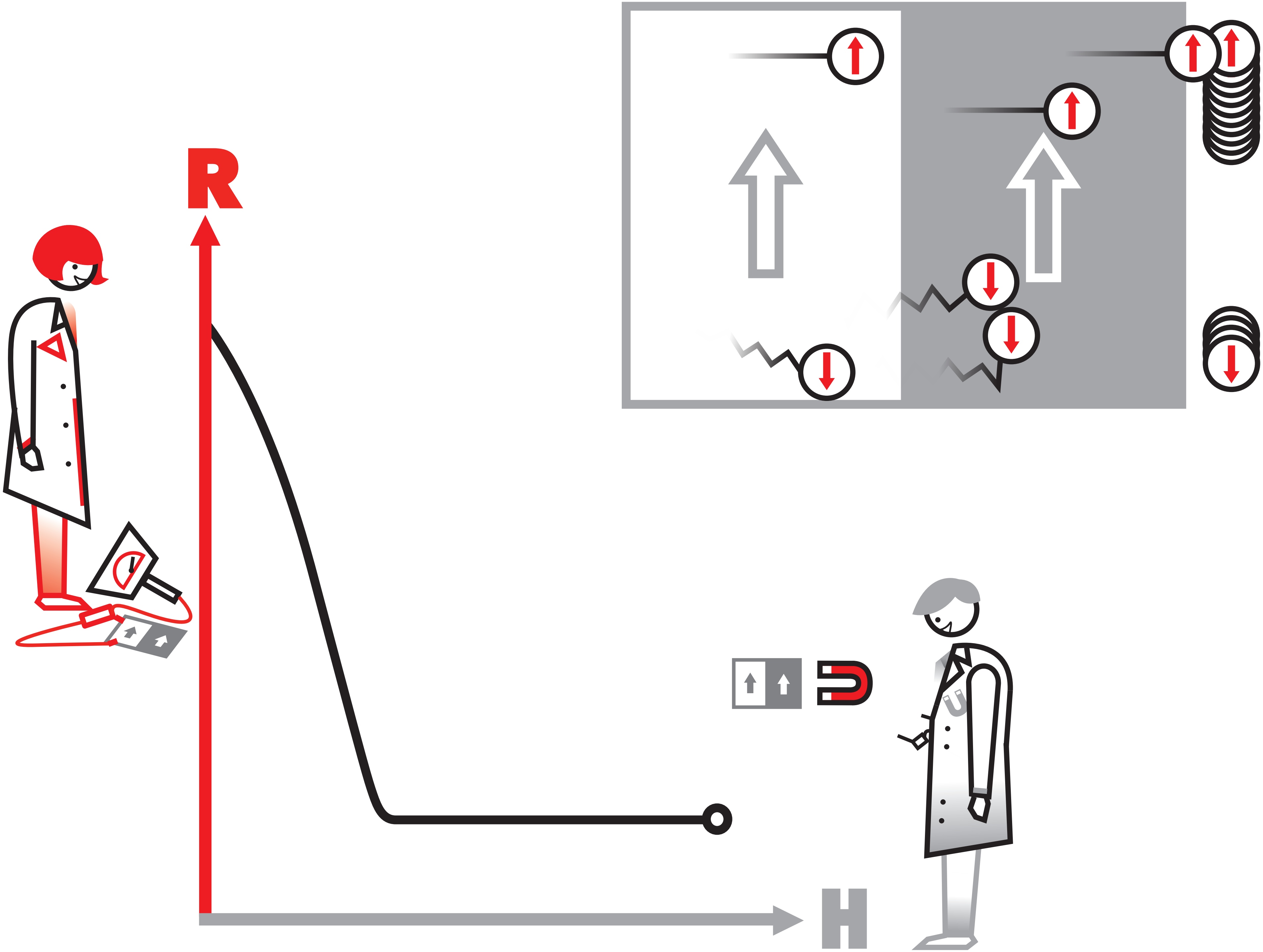
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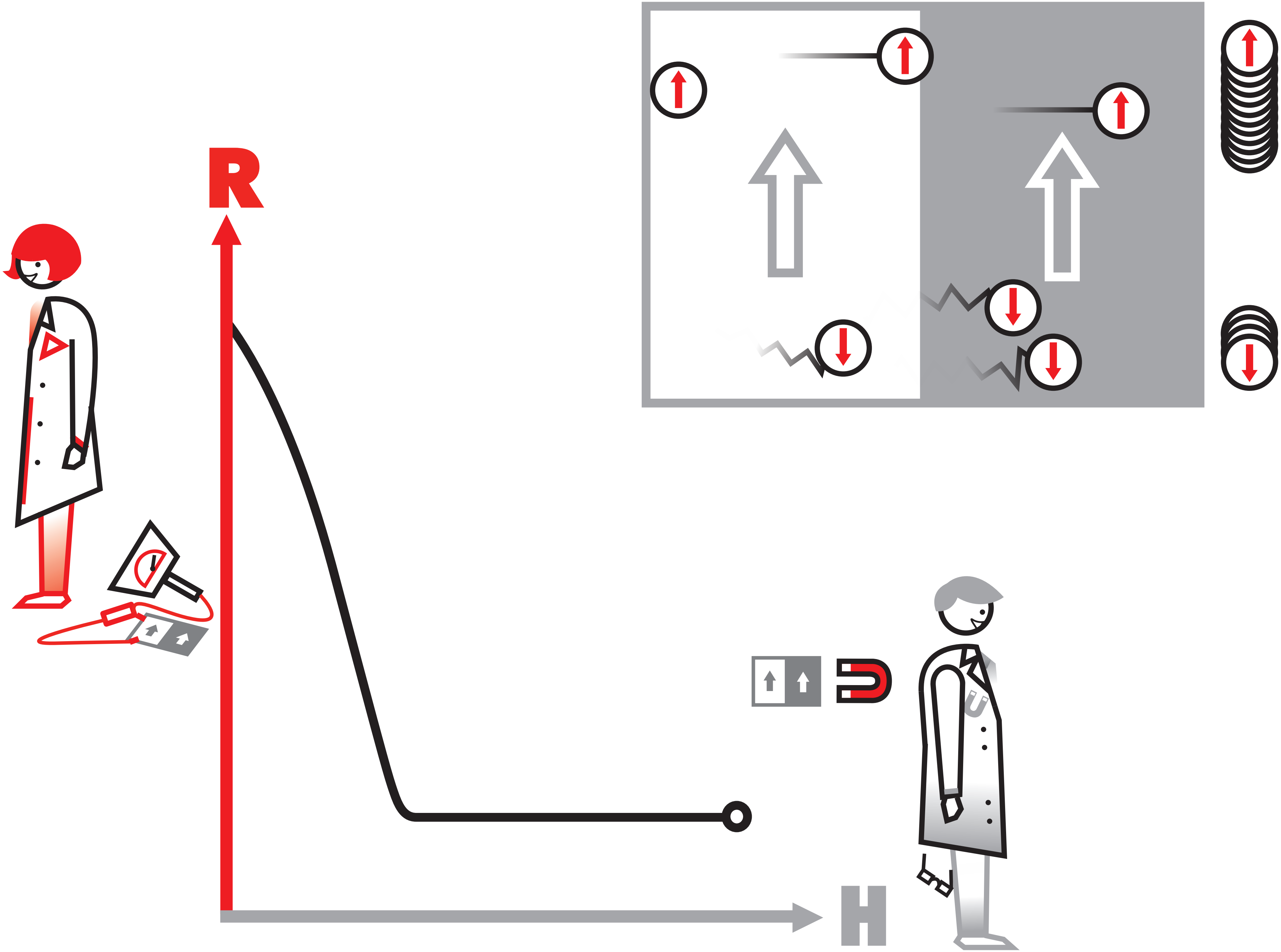
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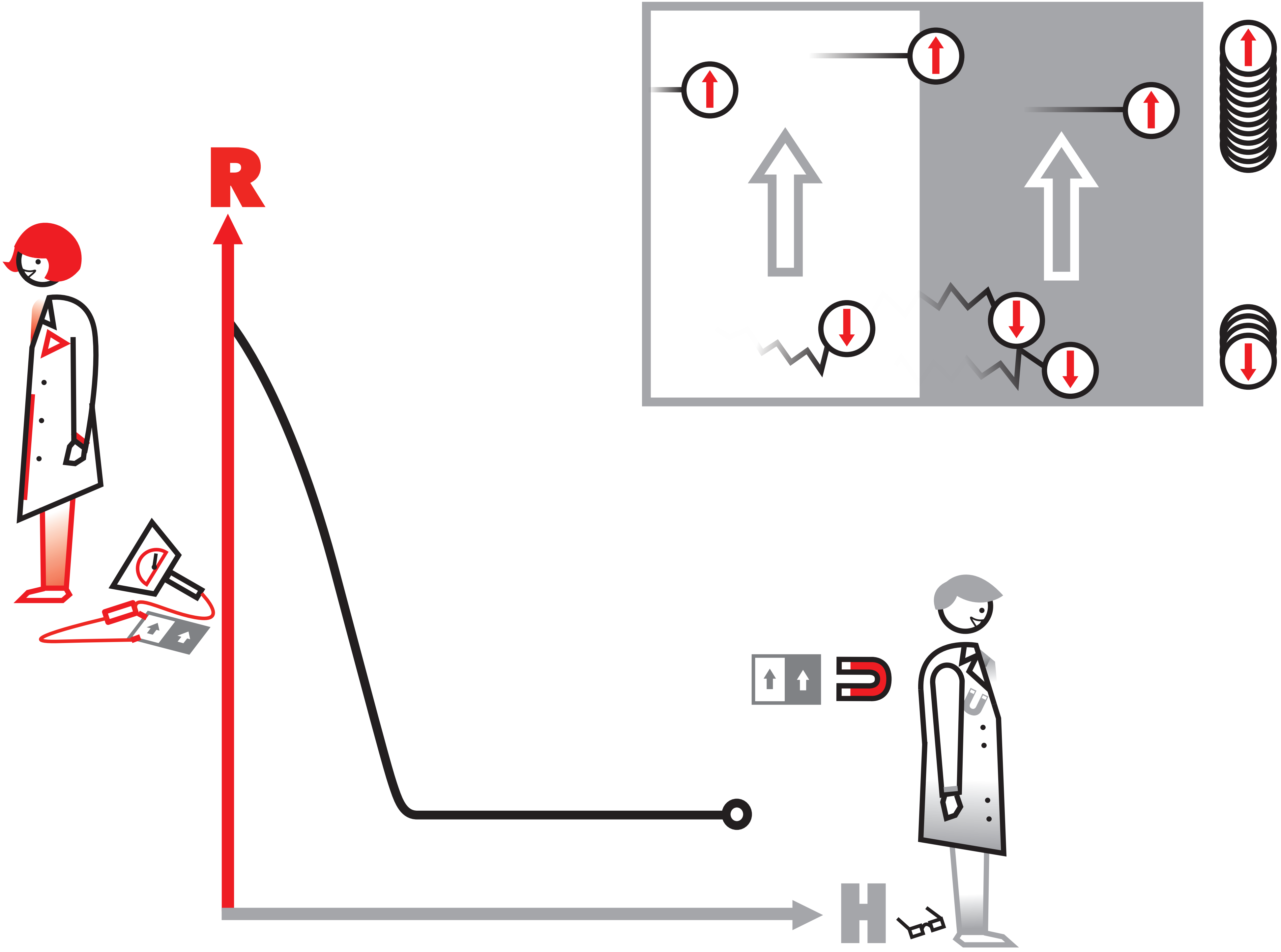
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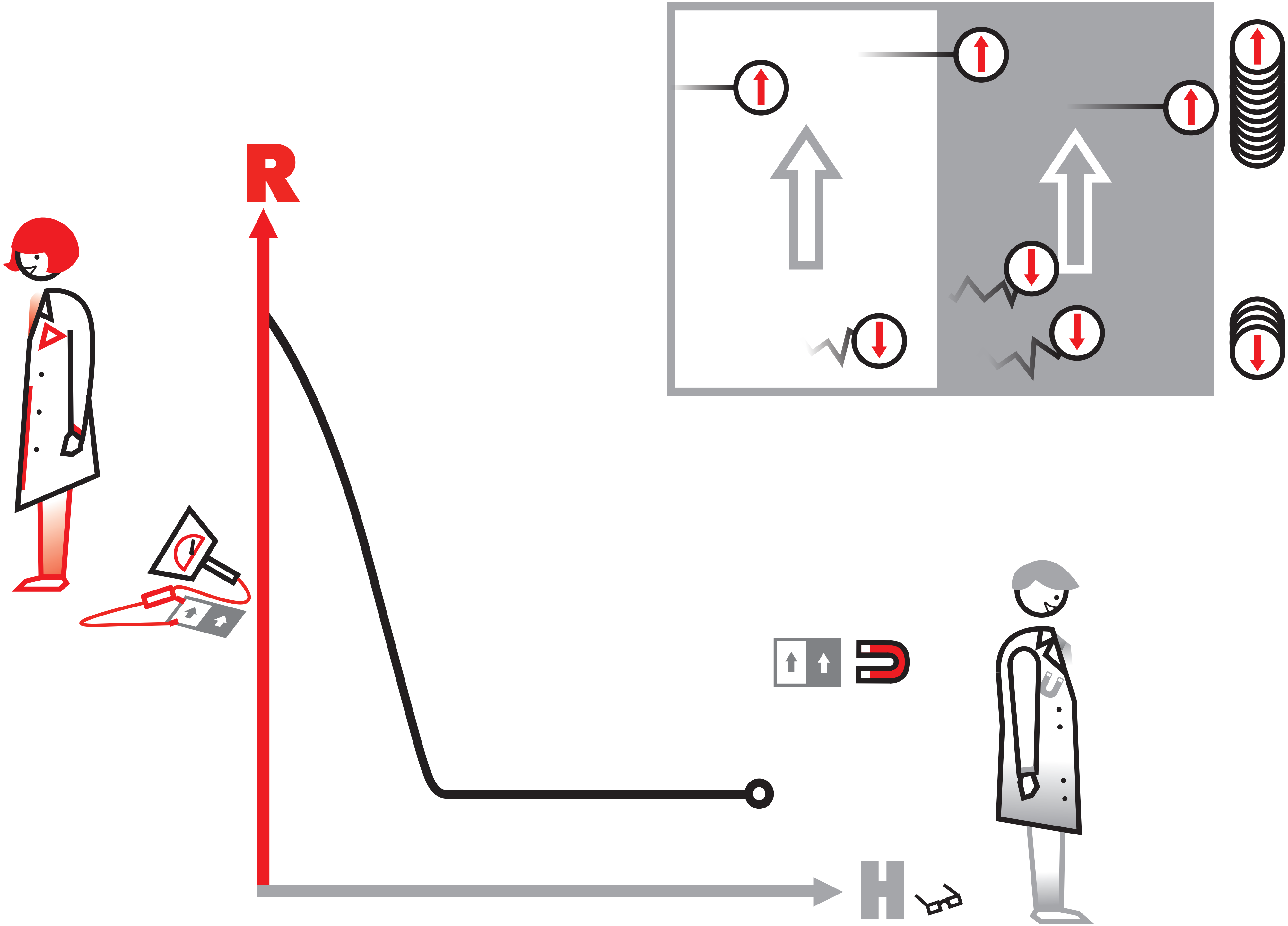
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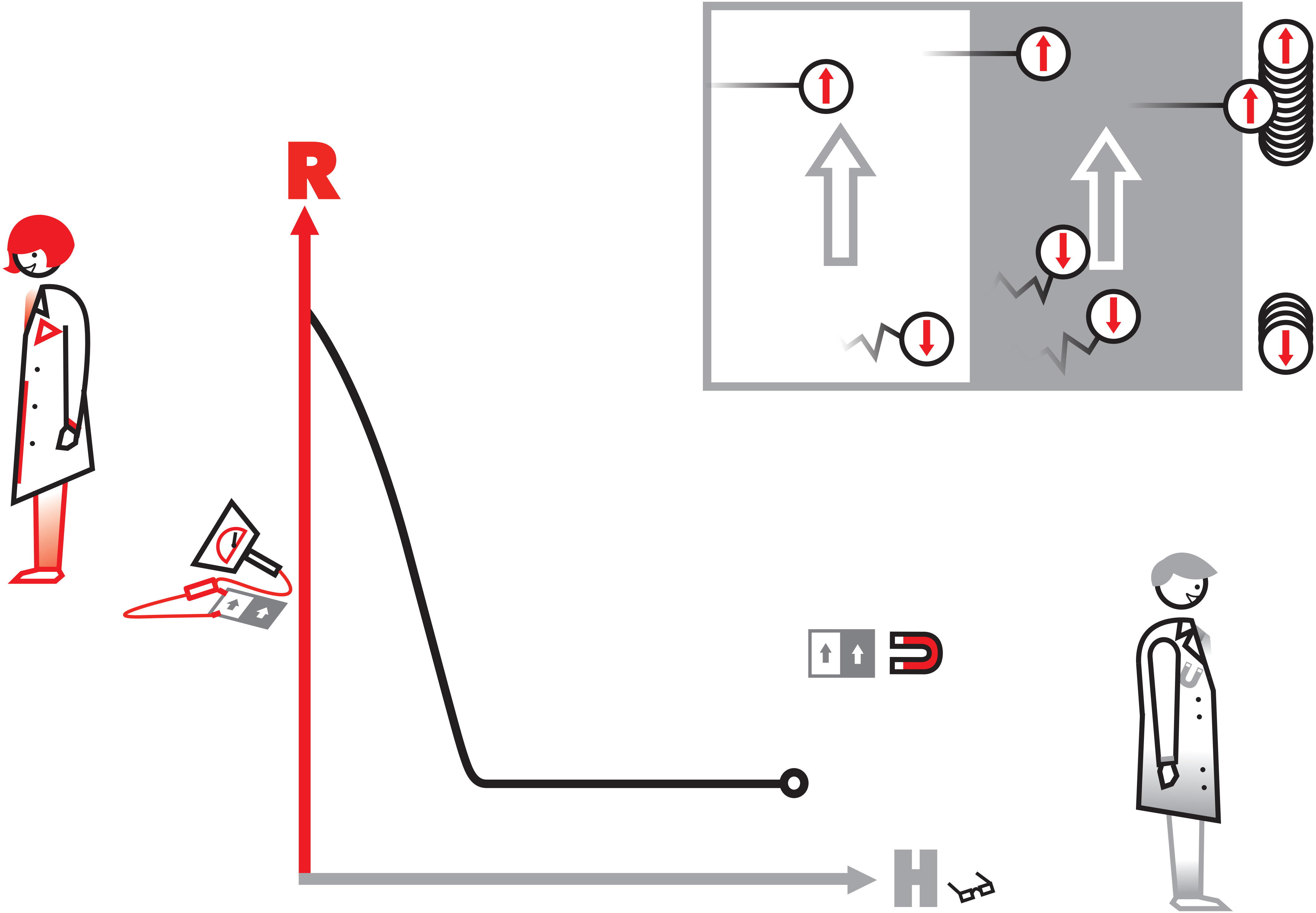
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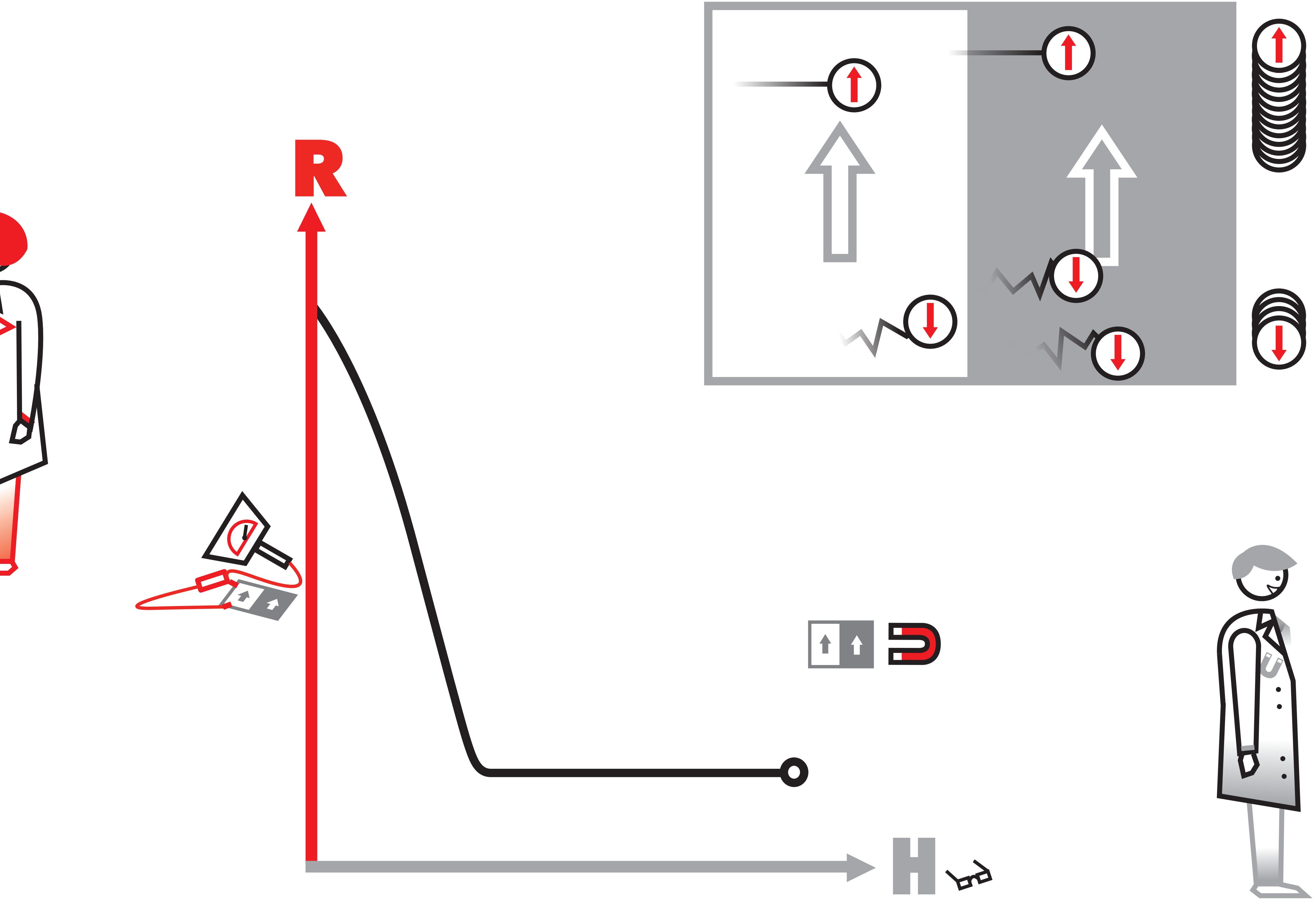
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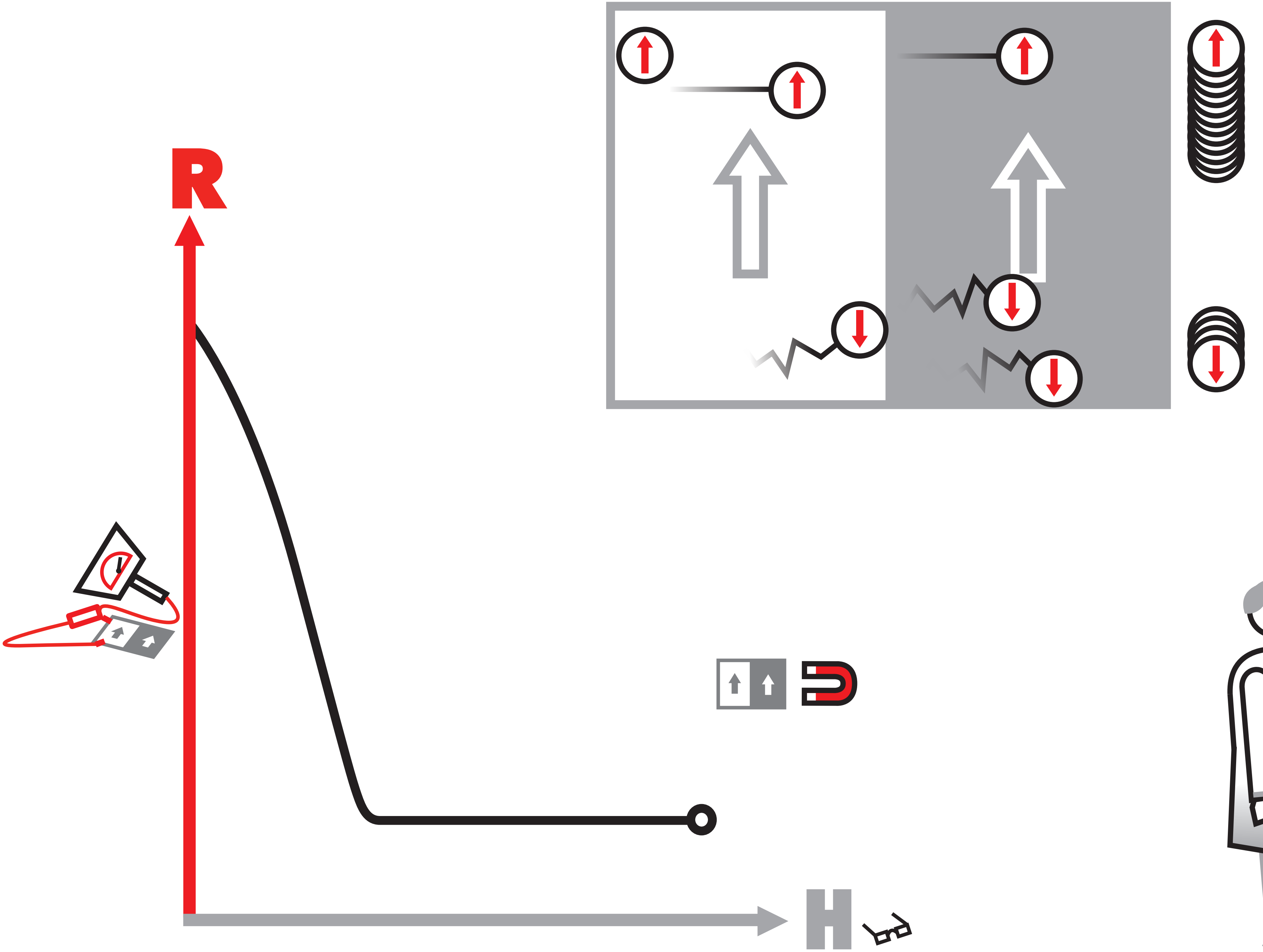
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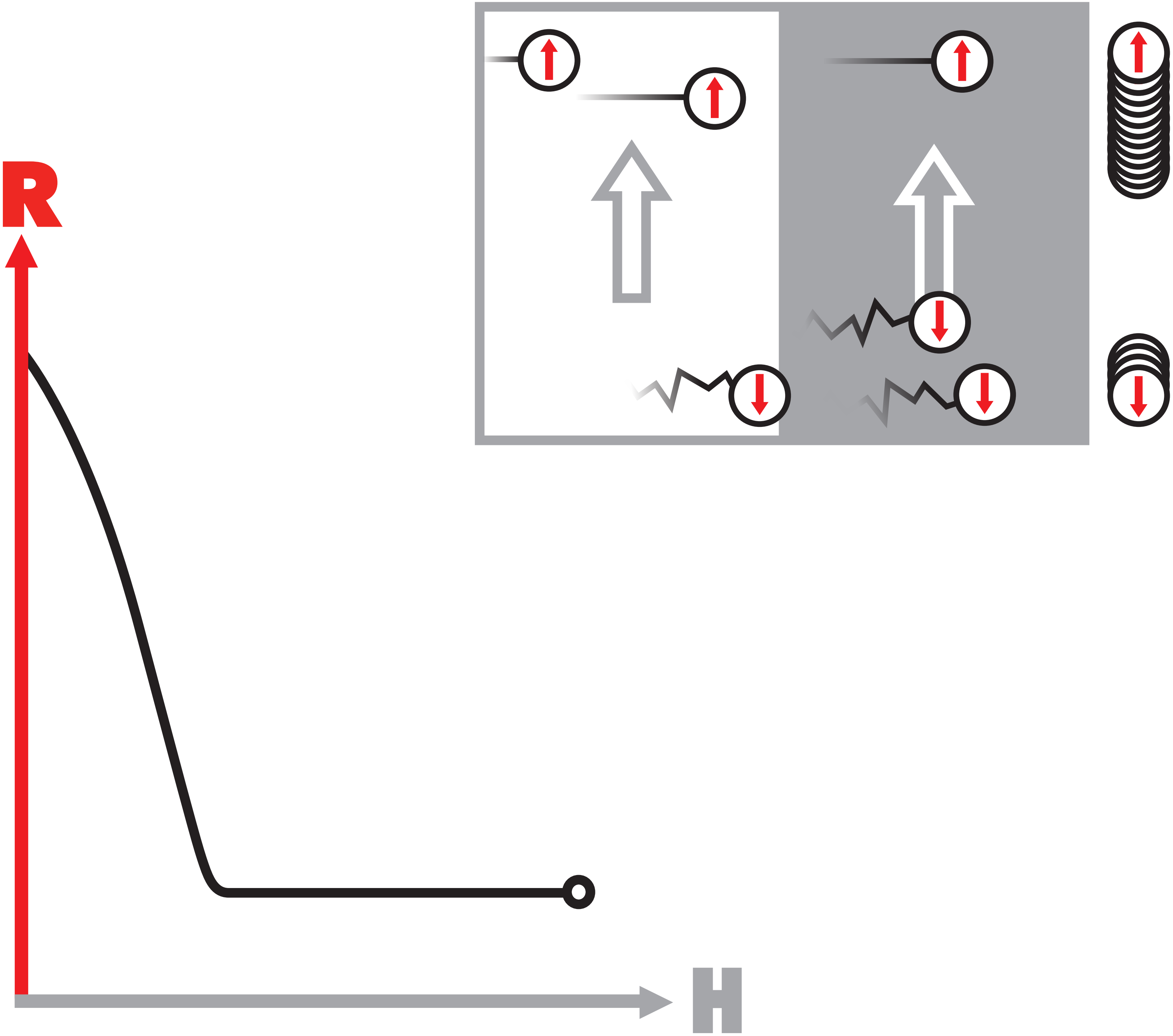
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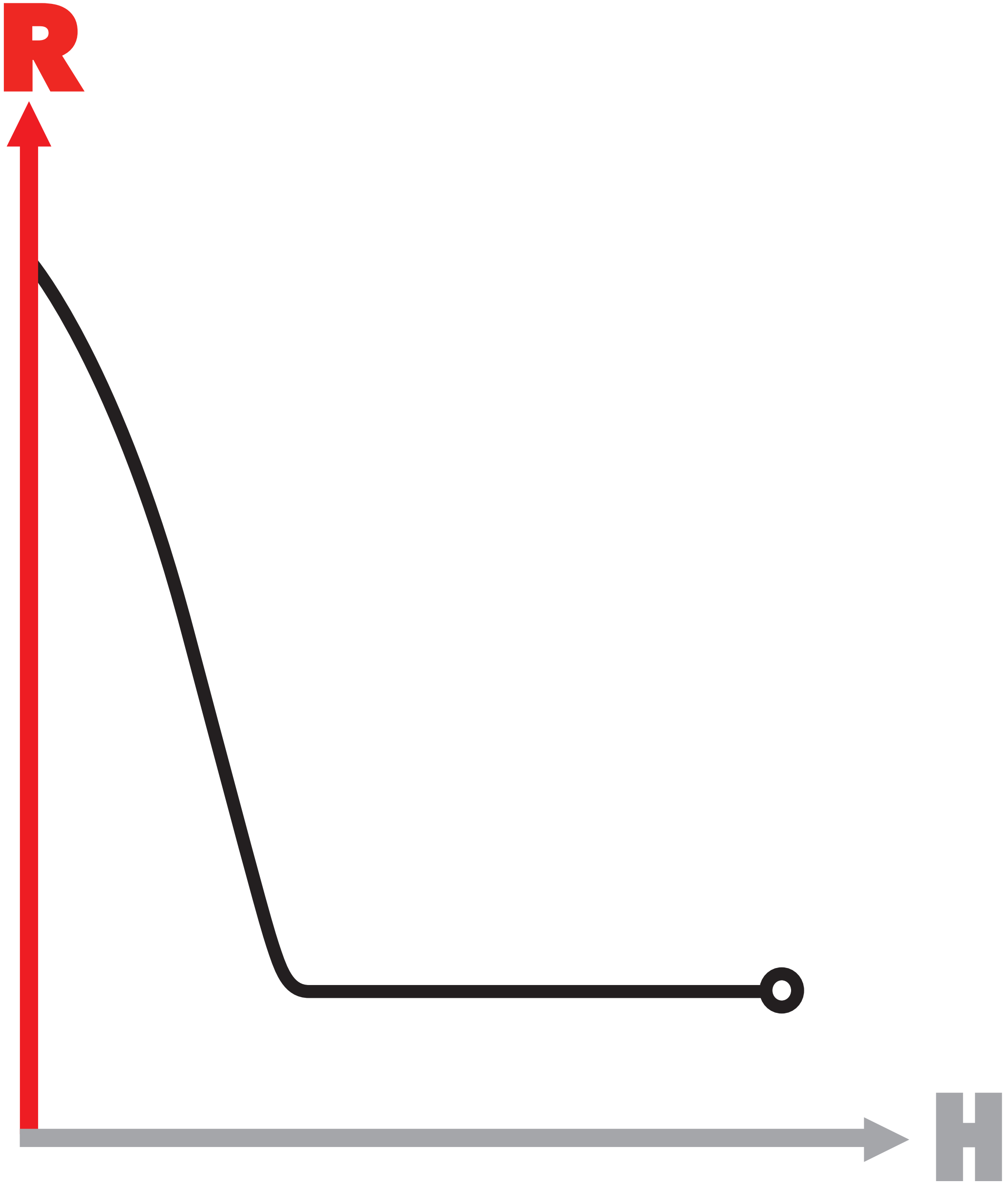
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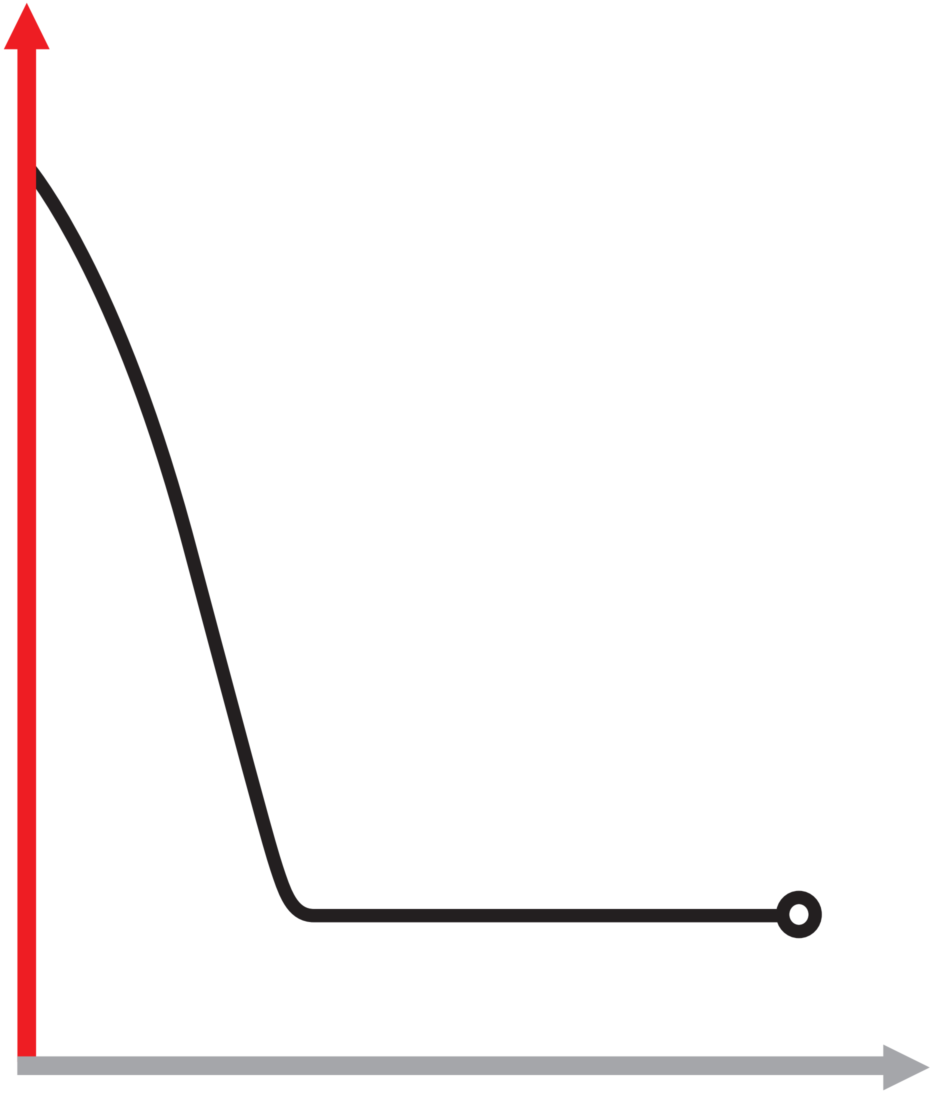

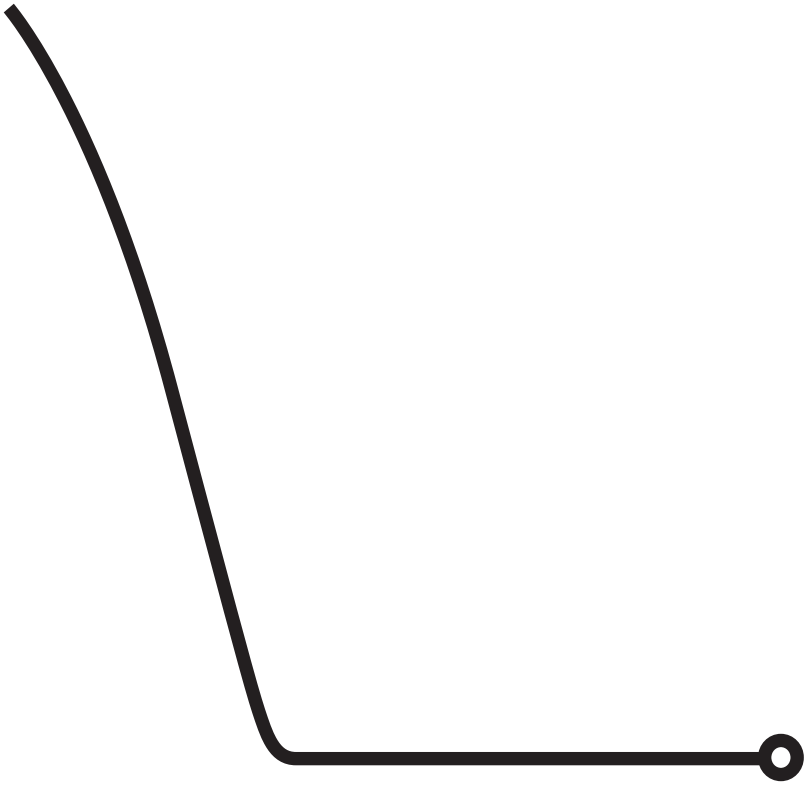

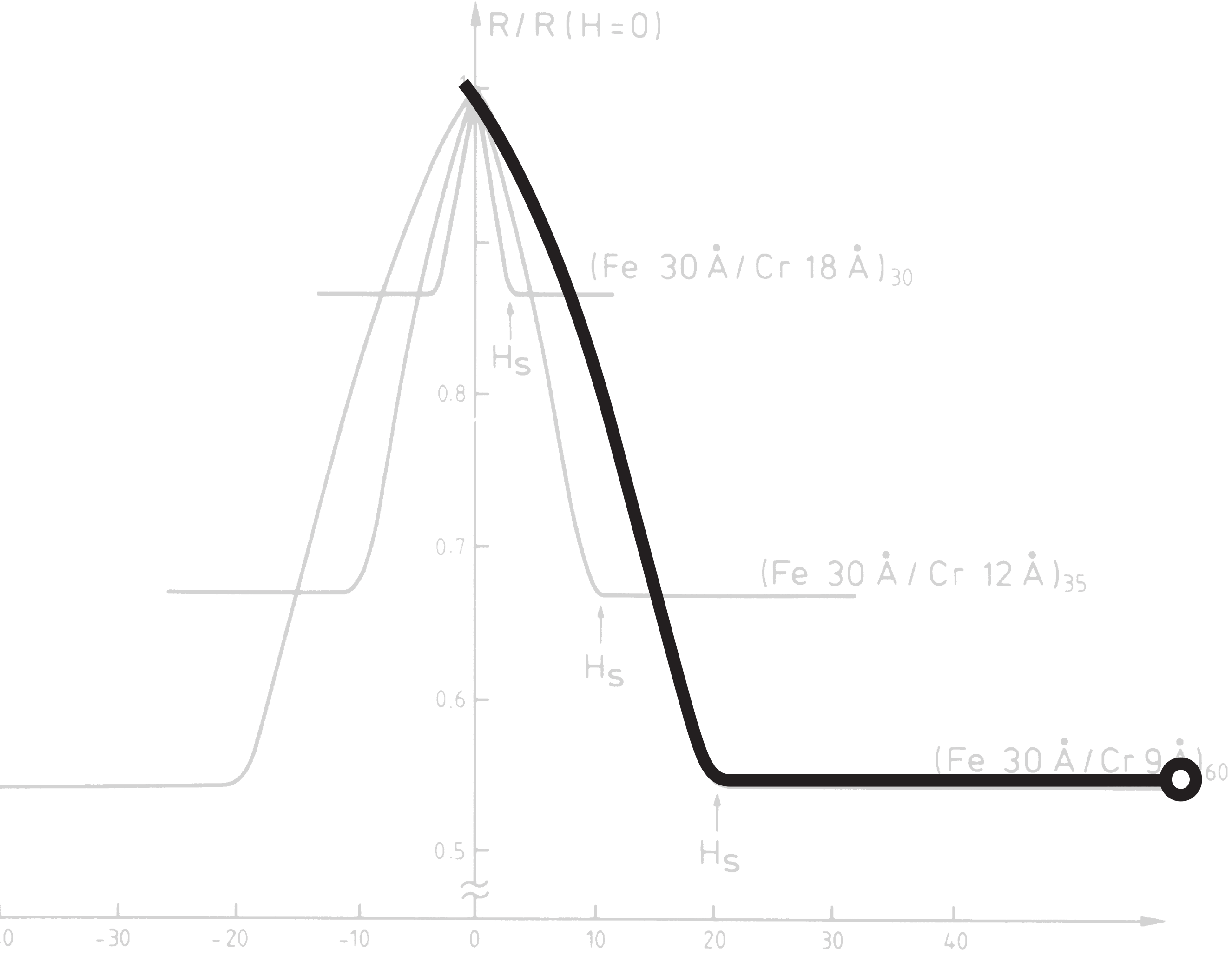
R / R (H = 0)
(Fe 30 Å / Cr 18 Å)$_{30}$
(Fe 30 Å / Cr 12 Å)$_{35}$
(Fe 30 Å / Cr 9 Å)$_{60}$
H_s
H_s
H_s
0.8
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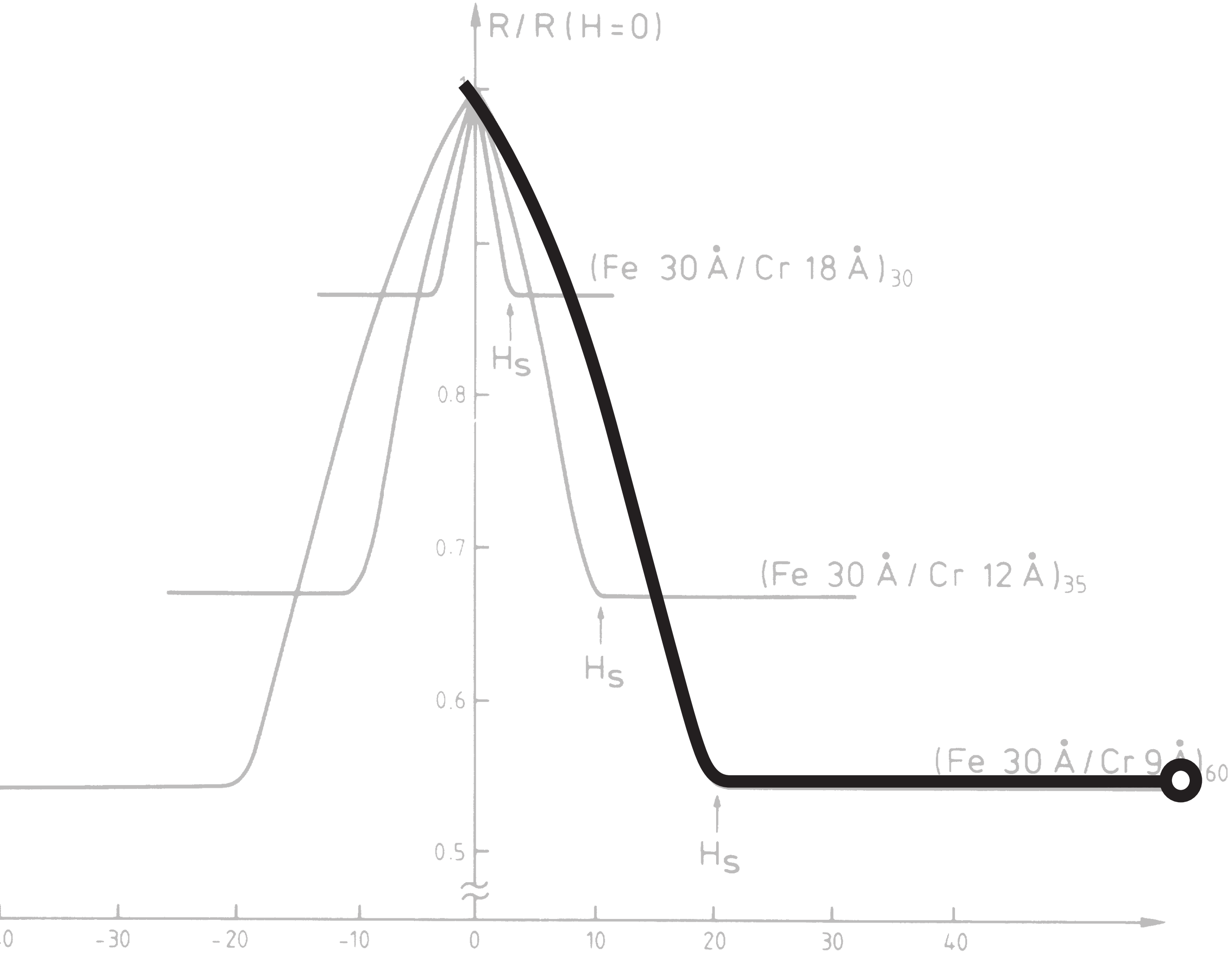
R / R (H = 0)
(Fe 30 Å / Cr 18 Å)₃₀
(Fe 30 Å / Cr 12 Å)₃₅
(Fe 30 Å / Cr 9 Å)₆₀
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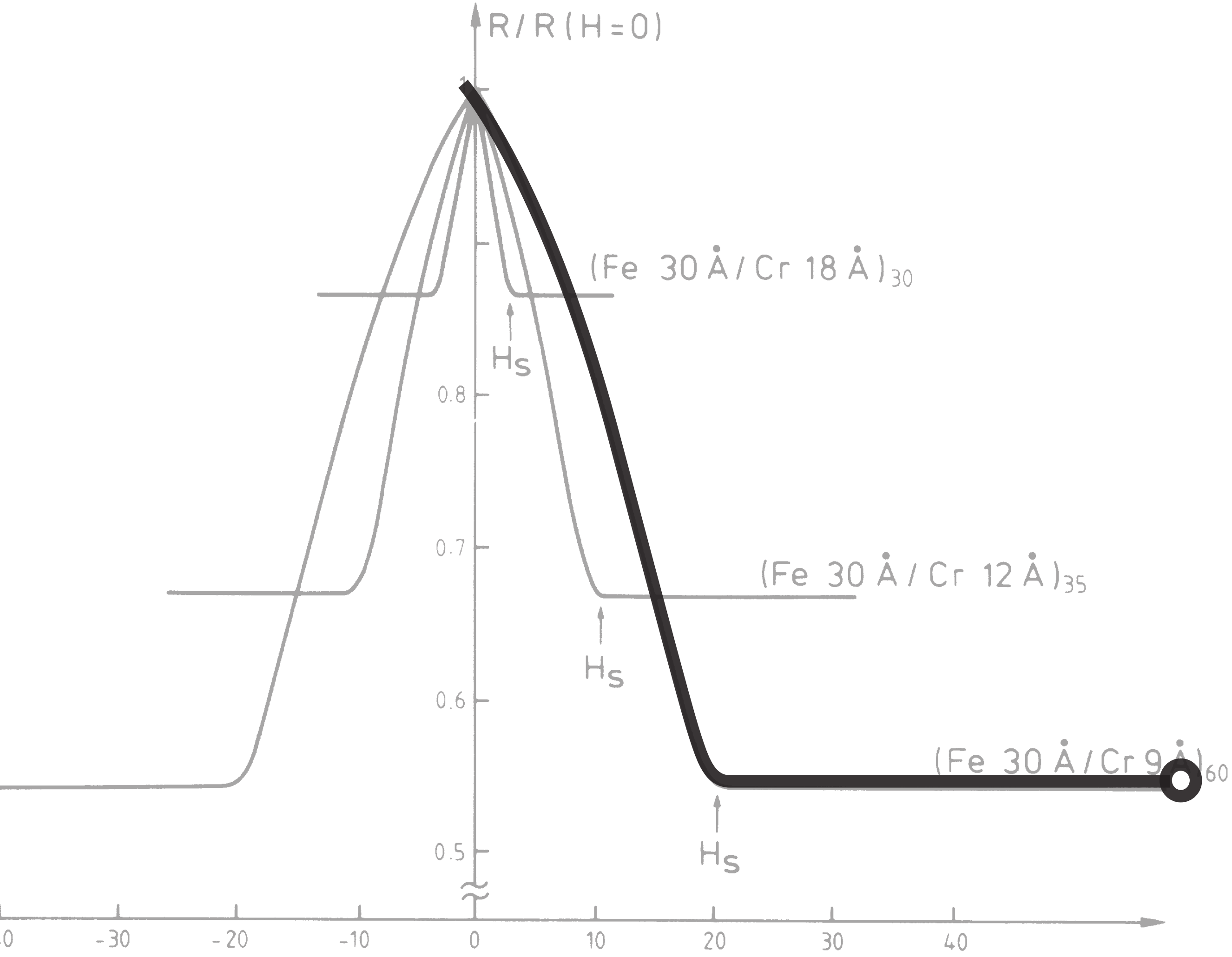
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H$_S$
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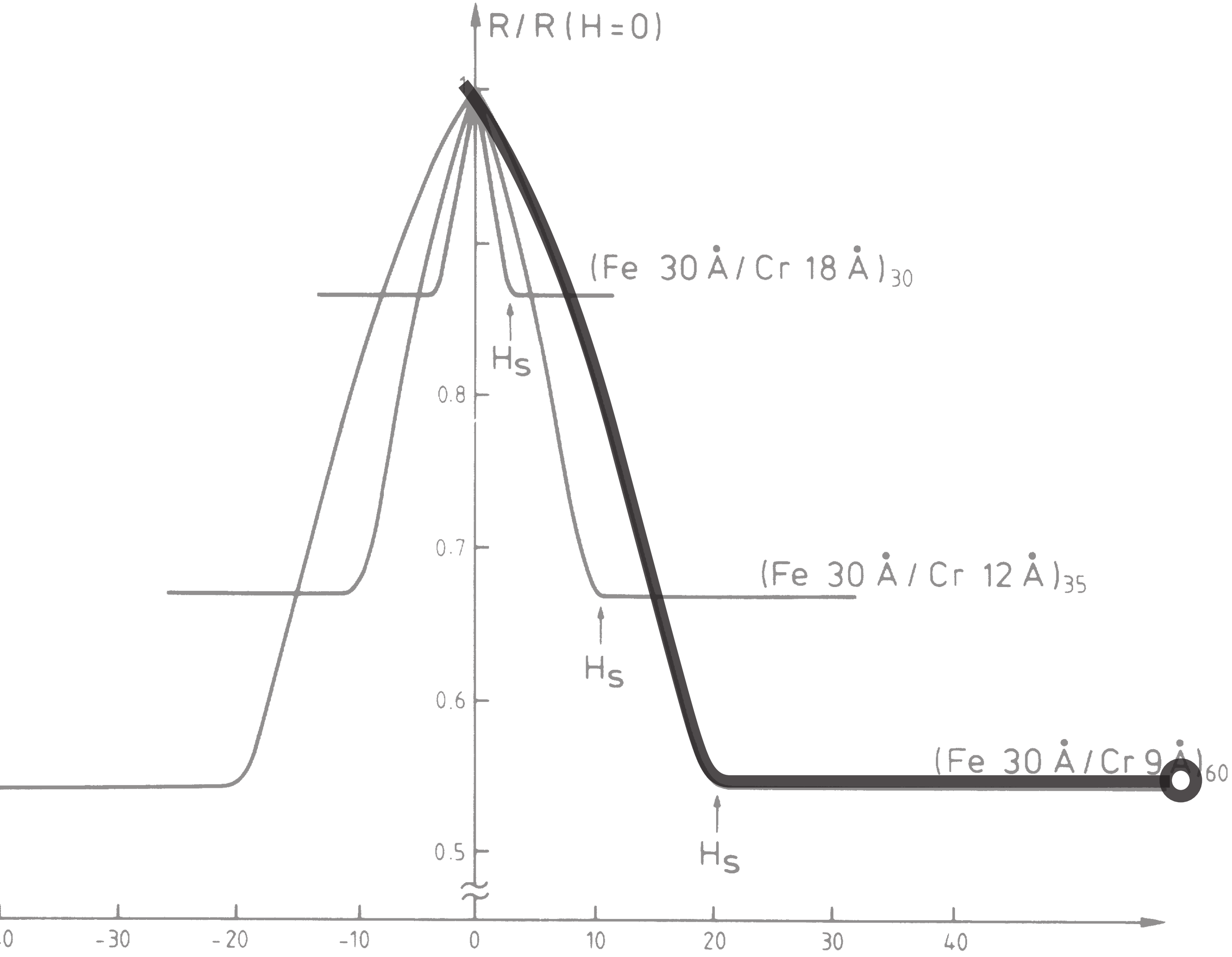
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(Fe 30 Å / Cr 18 Å)$_{30}$
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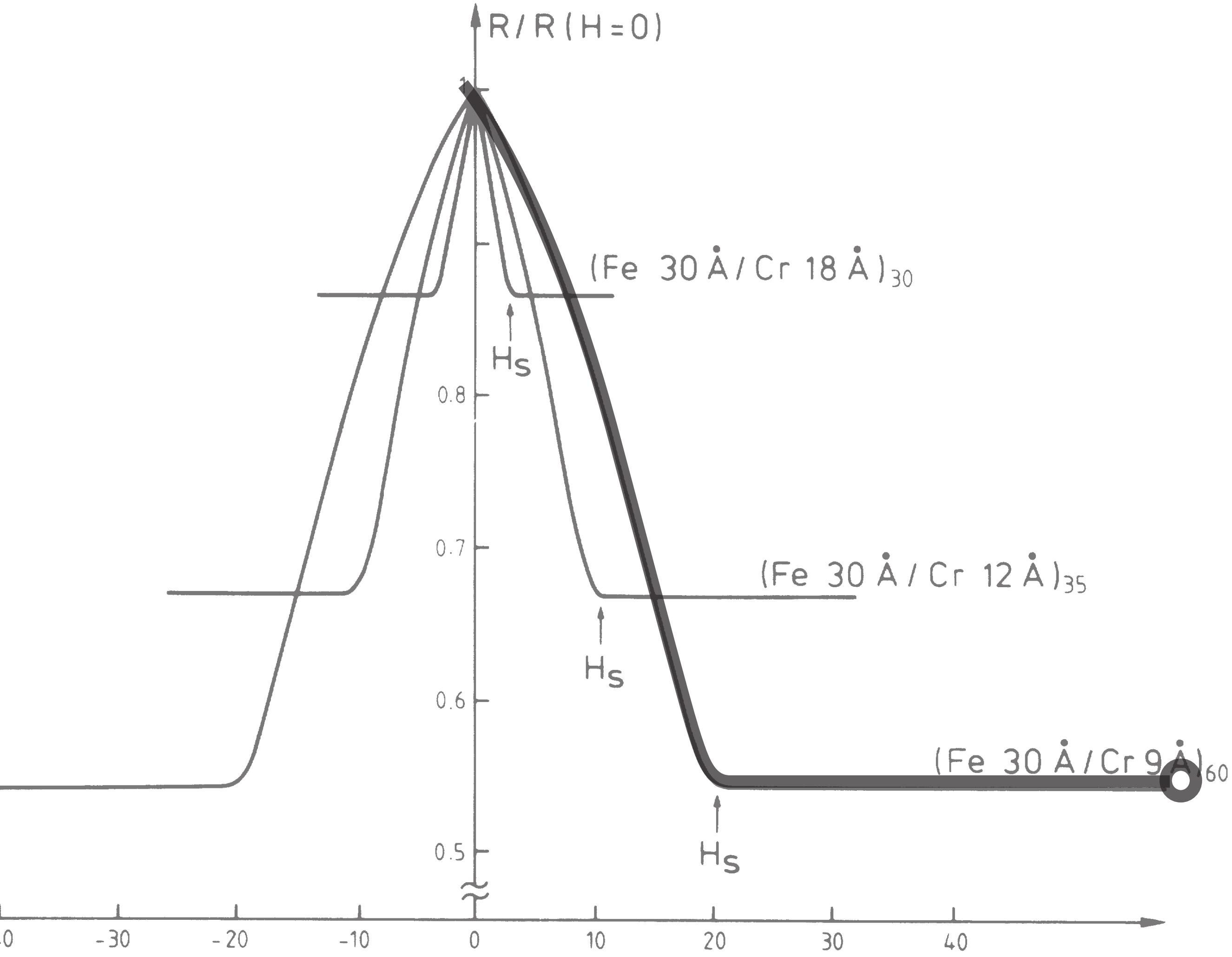
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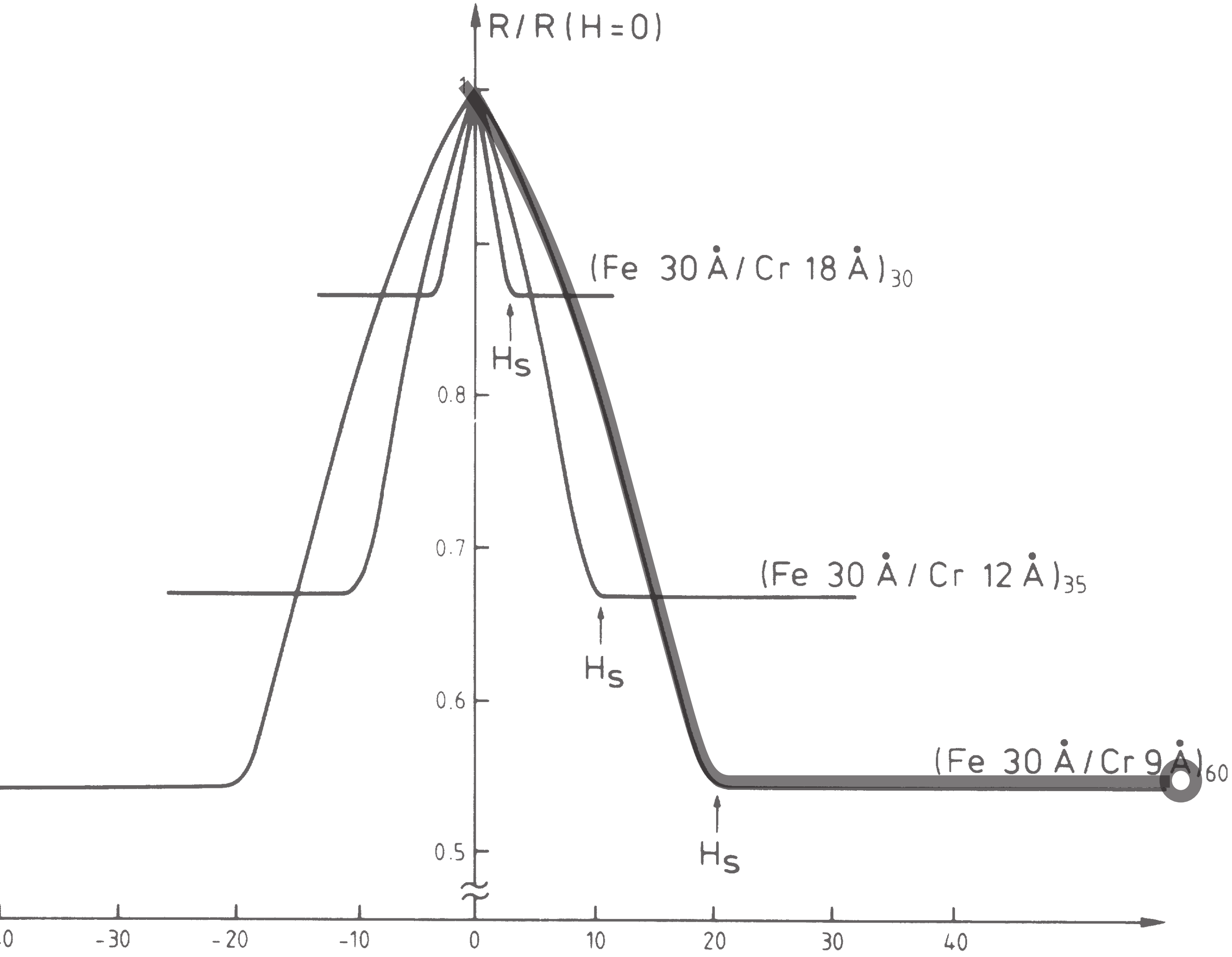

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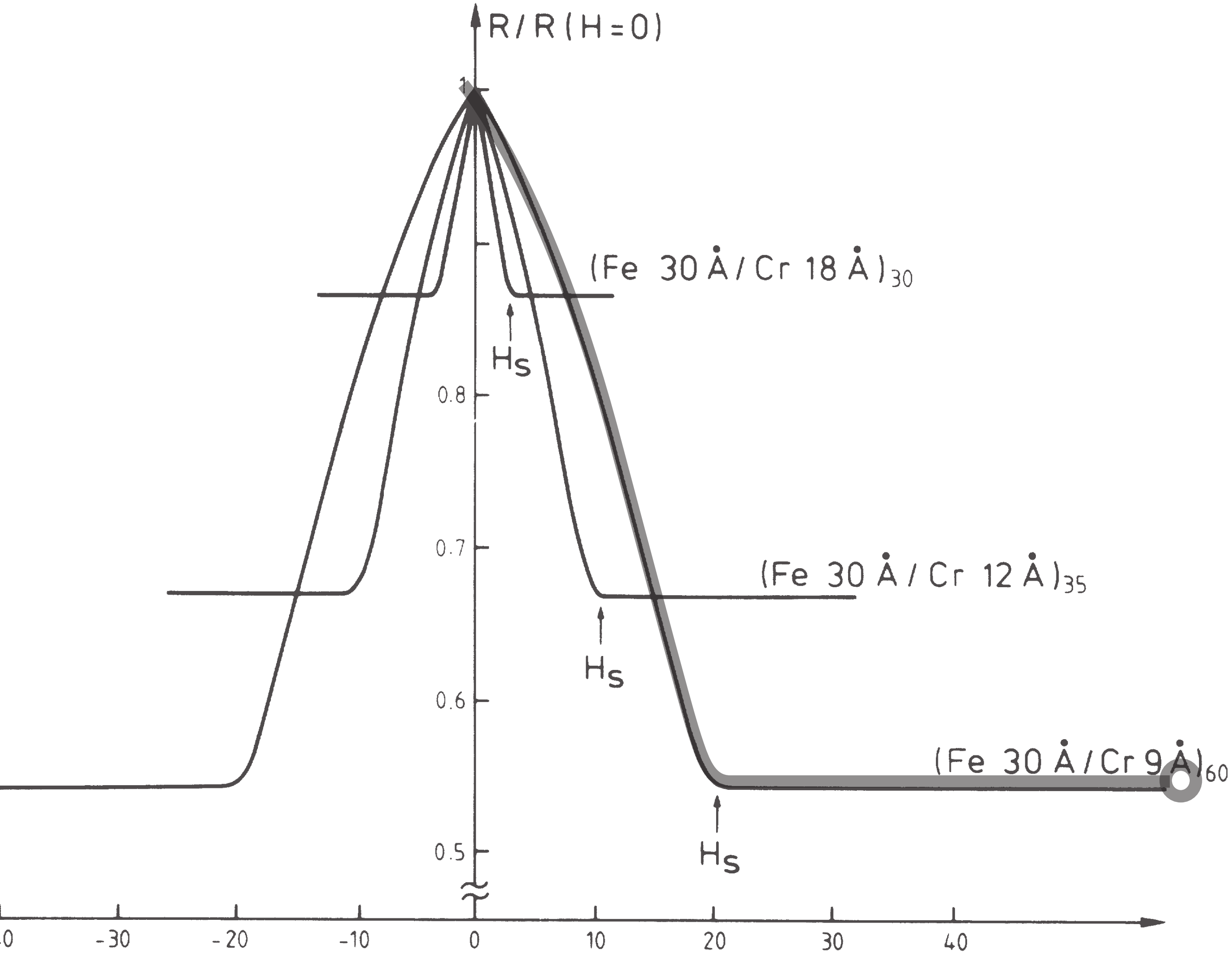
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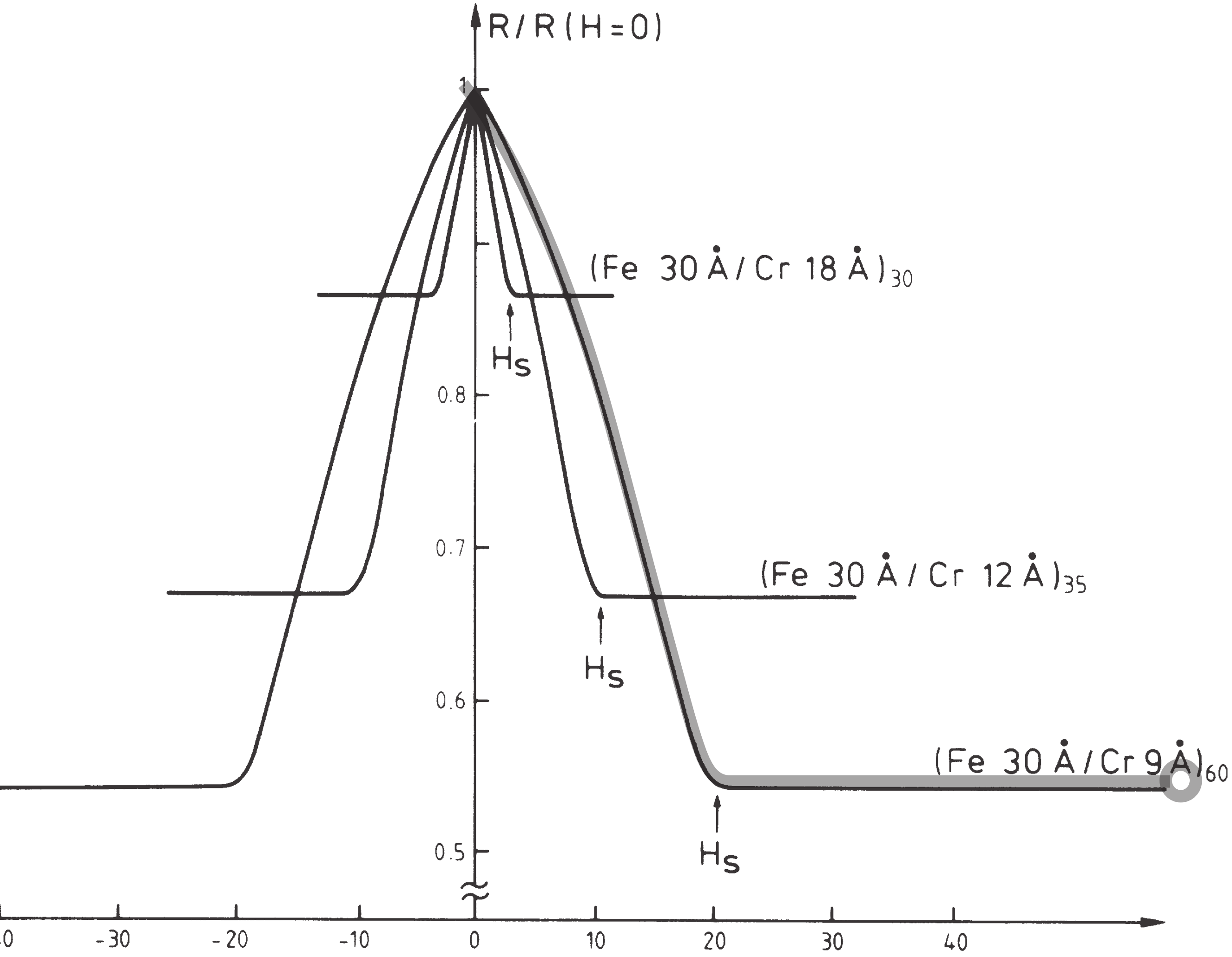
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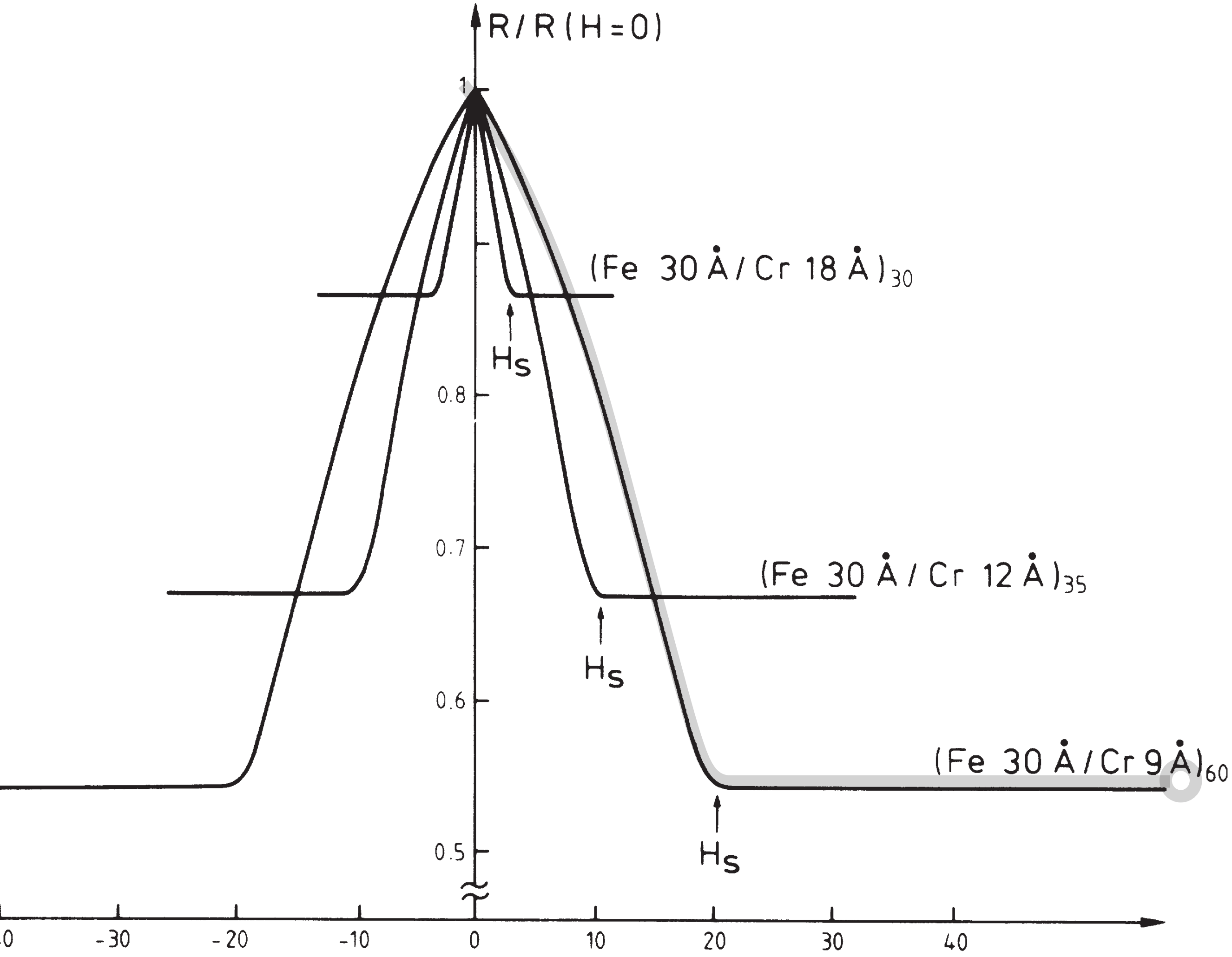
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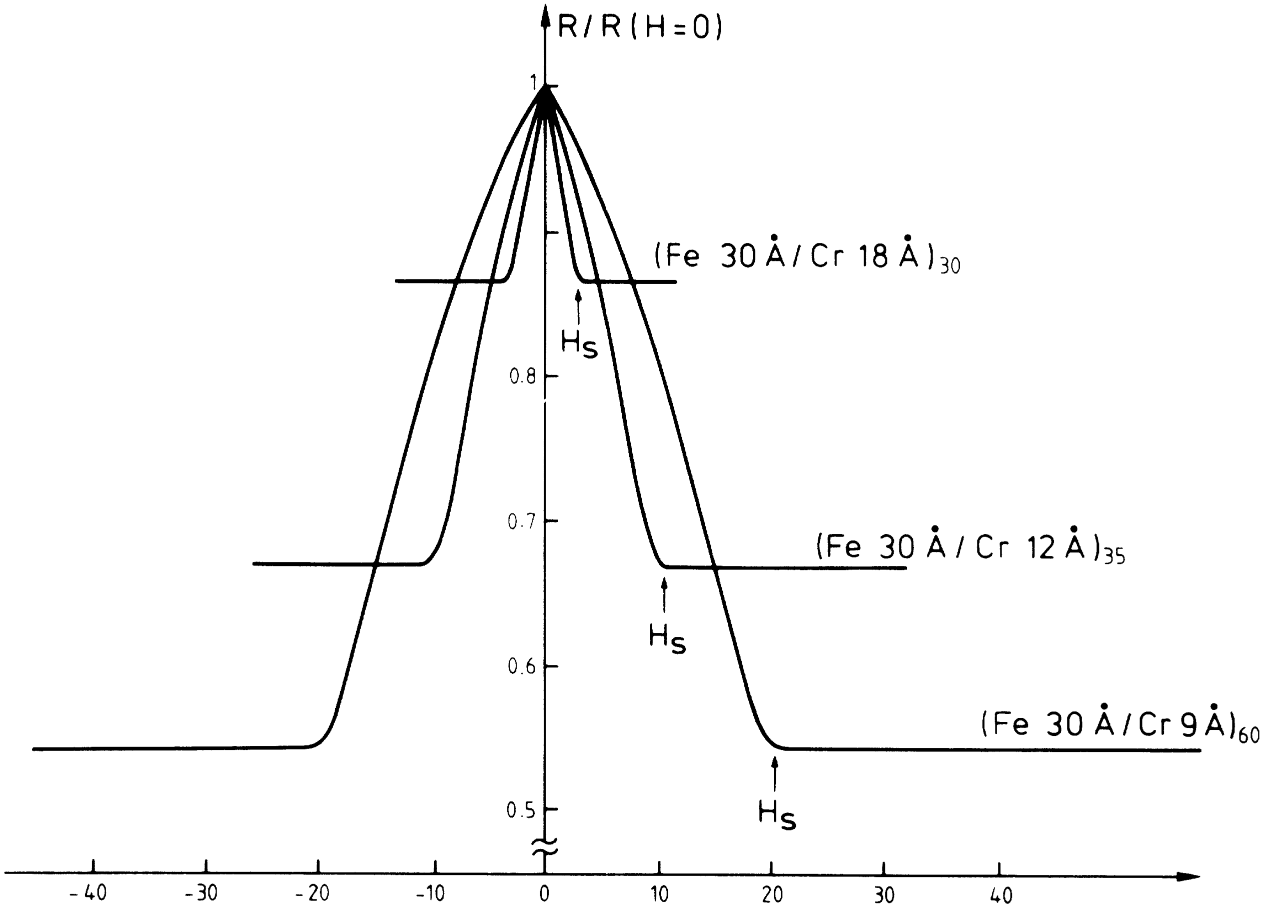
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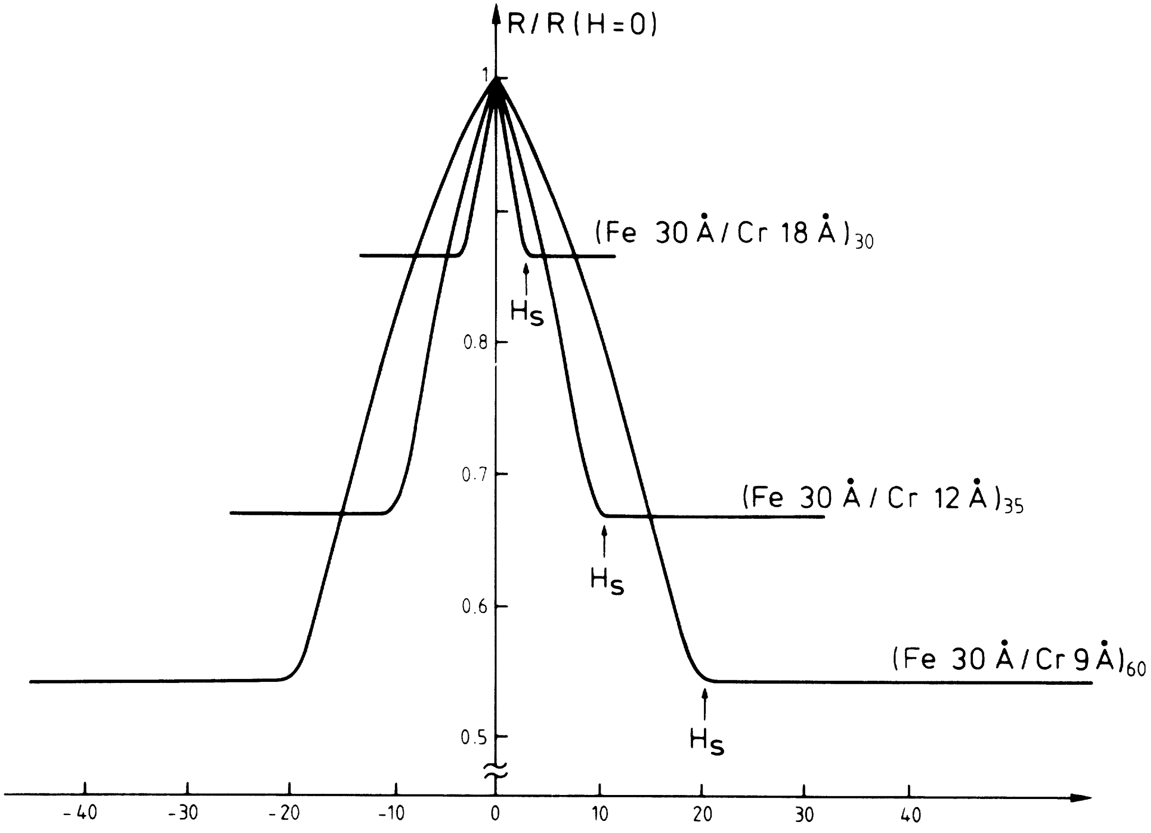
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H_S
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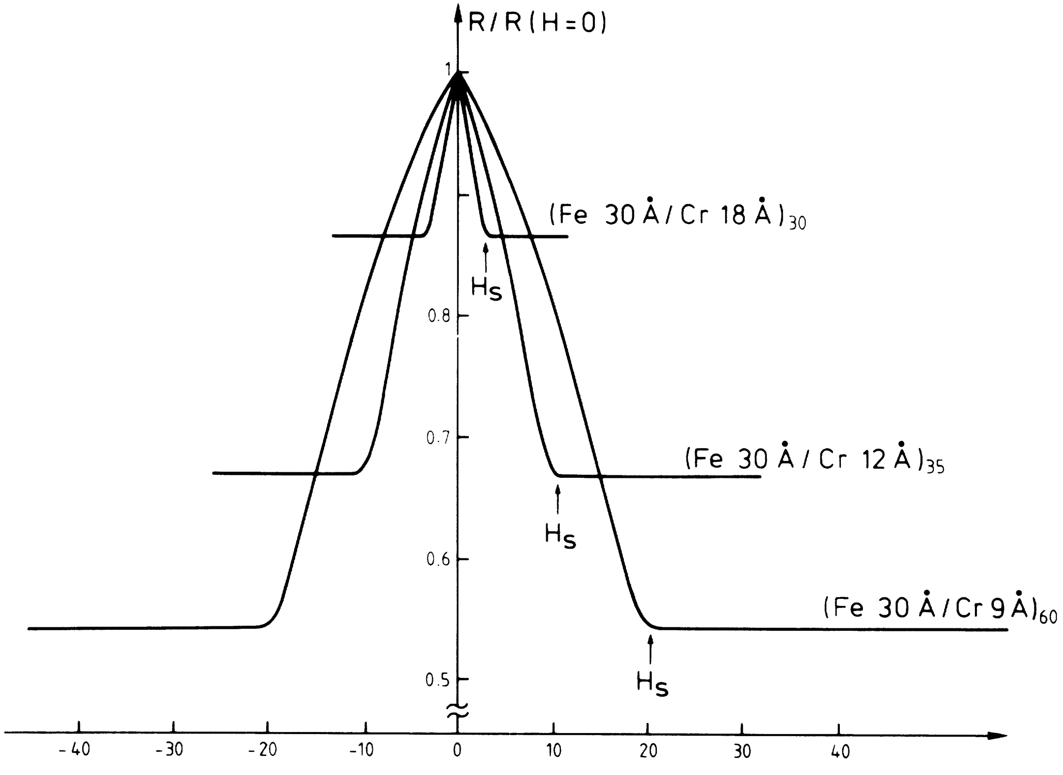
H_S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H$_s$
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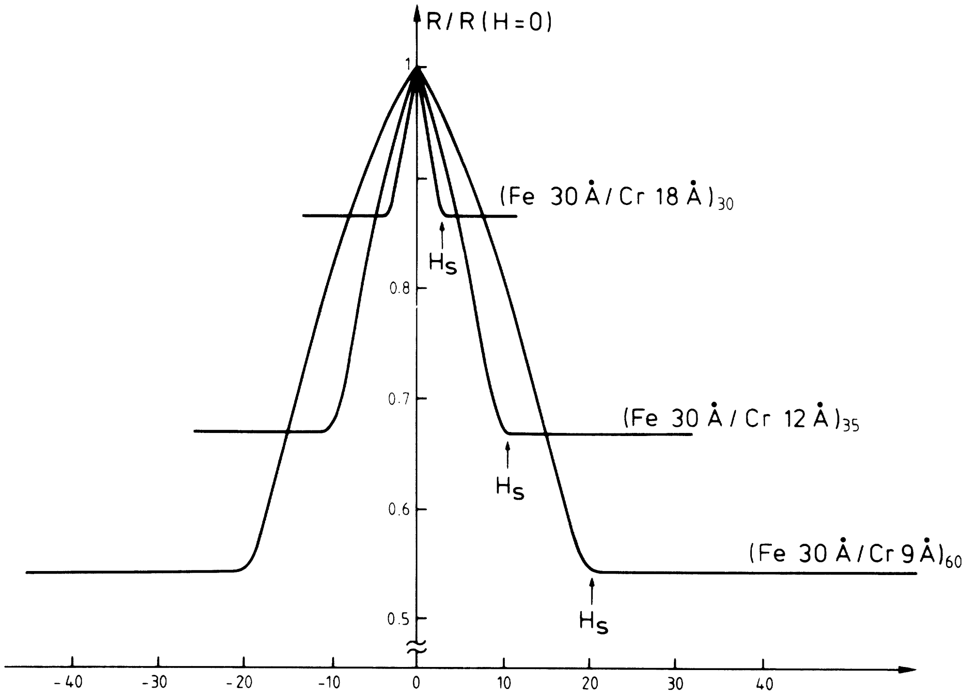
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H$_s$
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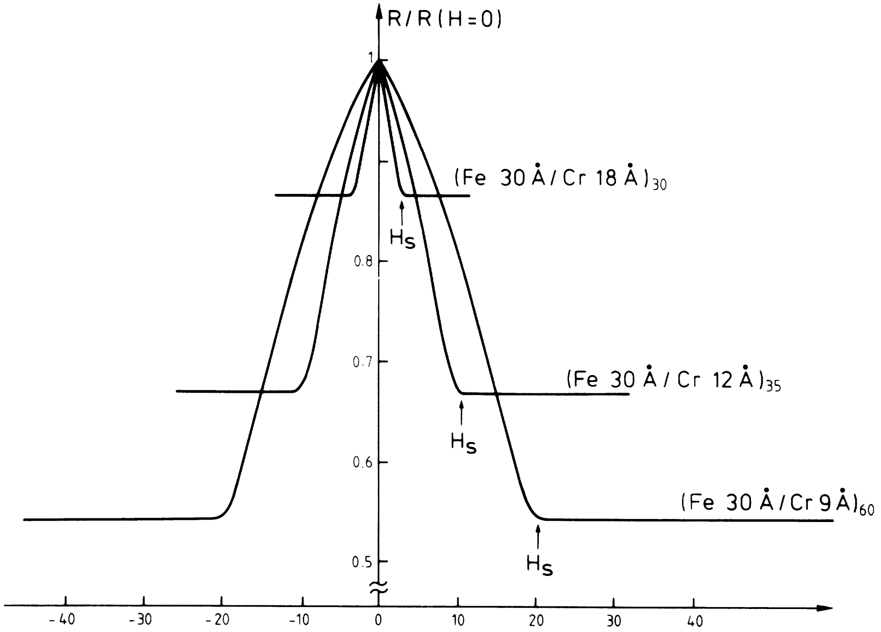
R / R (H = 0)
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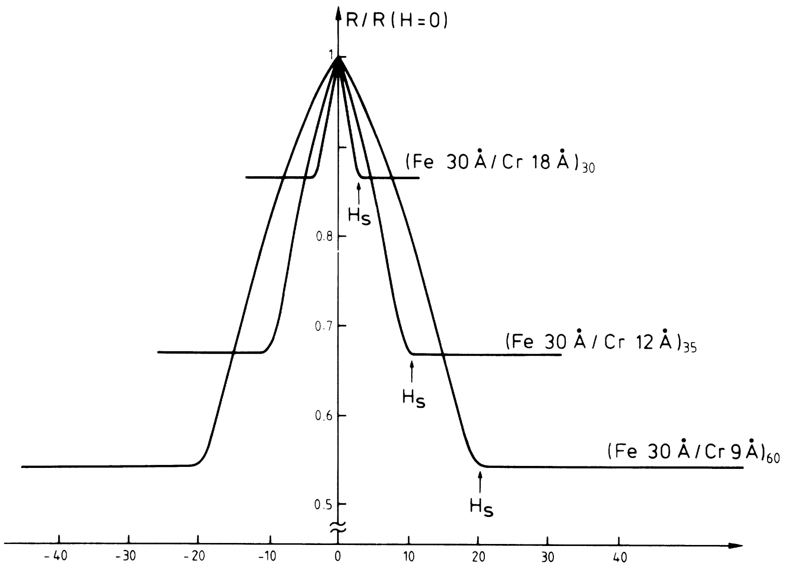
R / R (H = 0)
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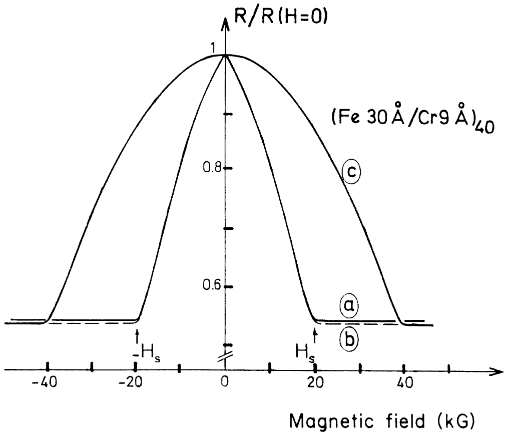

FIG. 2. Magnetoresistance of a [(Fe 30 Å)/(Cr 9 Å)]$_{40}$ superlattice of 4.2 K. The current is along [110] and the field is in the layer plane along the current direction (curve *a*), in the layer plane perpendicular to the current (curve *b*), or perpendicular to the layer plane (curve *c*). The resistivity at zero field is 54 $\mu\Omega$ cm. There is a small difference between the curves in increasing and decreasing field (hysteresis) that we have not represented in the figure. The superlattice is covered by a 100-Å Ag protection layer. This means that the magnetoresistance of the superlattice alone should be slightly higher.

of Grünberg *et al.*[4] and by the spin-polarized low-energy electron-diffraction experiments of Carbone and Alvarado.[10] The AF coupling between the Fe layers has been ascribed to indirect exchange interactions through the Cr layers, but a theoretical model of these interactions is still lacking.[4,9]

The magnetoresistance of the Fe/Cr superlattices has been studied by a classical ac technique on small rectangular samples. Examples of magnetoresistance curves at 4.2 K are shown in Figs. 2 and 3. The resistance decreases during the magnetization process and becomes practically constant when the magnetization is saturated. The curves *a* and *b* in Fig. 2 are obtained for applied fields in the plane of layers in the longitudinal and transverse directions, respectively. The field H_S is the field needed to overcome the AF couplings and to saturate the magnetization (compare with Fig. 1). In contrast, fields applied perpendicularly to the layers (curve *c*) have to overcome not only the AF coupling but also the magnetic anisotropy, so that the magnetoresistance is saturated at a field higher than H_S.

The most remarkable result exhibited in Figs. 2 and 3 is the huge value of the magnetoresistance. For $t_{\mathrm{Cr}}=9$ Å and $T=4.2$ K, see Fig. 2, there is almost a factor of 2 between the resistivities at zero field and in the saturated state, respectively (in absolute value, the resistivity change is about 23 $\mu\Omega$ cm). By comparison of the results for three different samples in Fig. 3, it can be seen

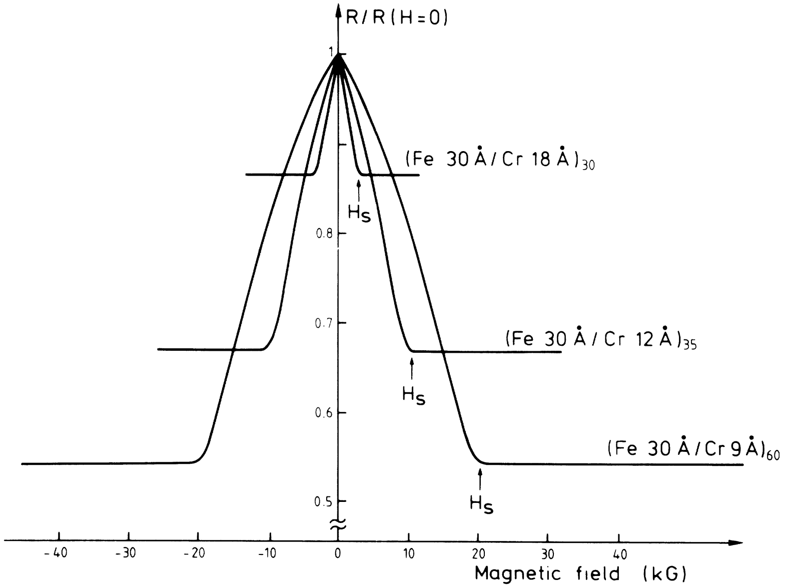

FIG. 3 Magnetoresistance of three Fe/Cr superlattices at 4.2 K. The current and the applied field are along the same [110] axis in the plane of the layers.

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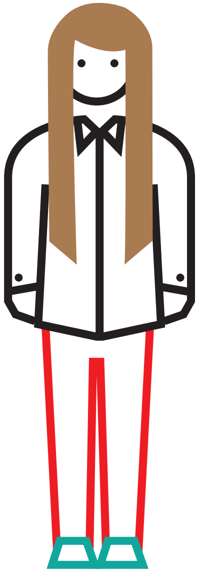

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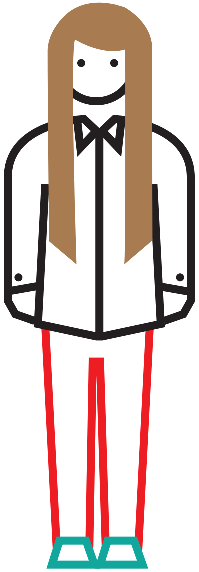

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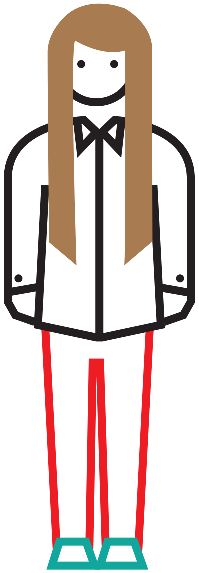

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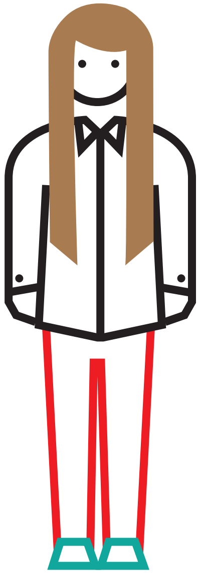

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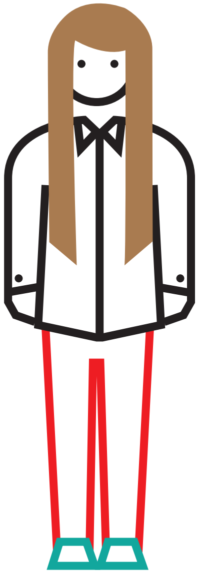

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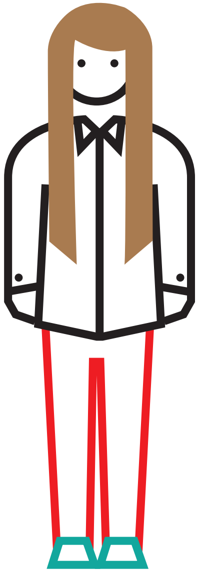

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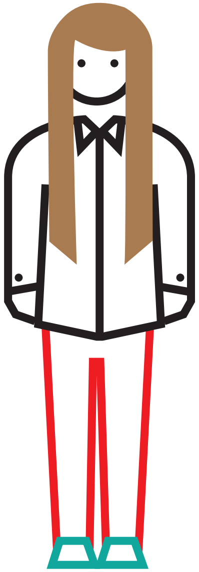

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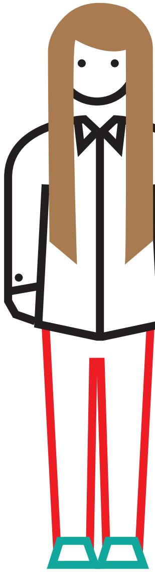

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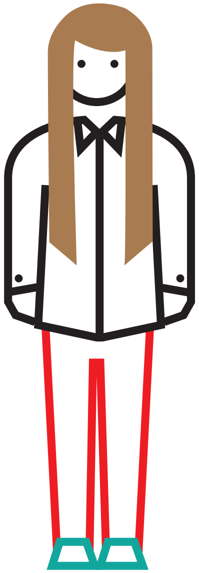

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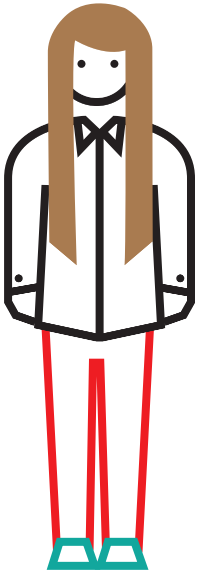

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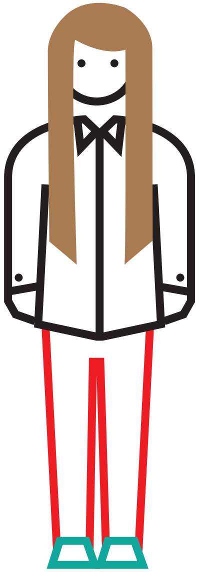

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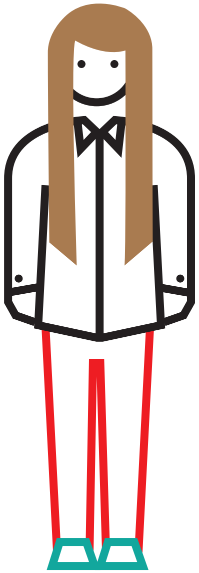

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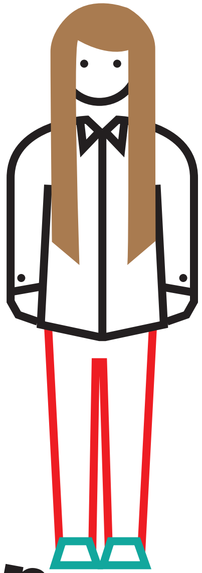

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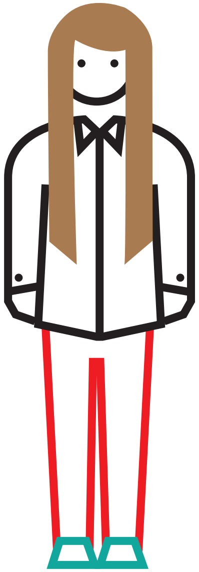

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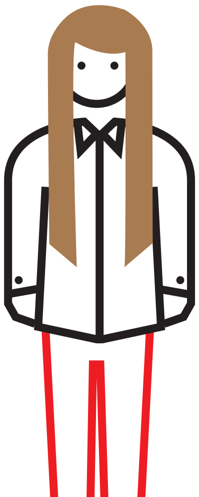

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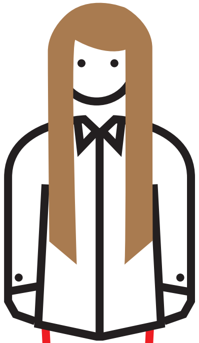

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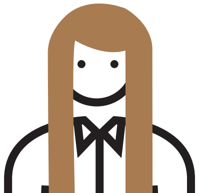

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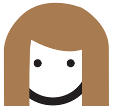

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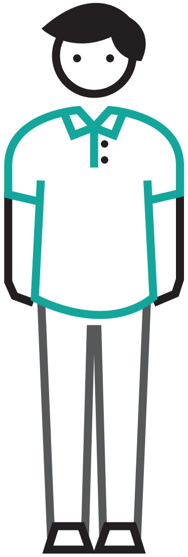

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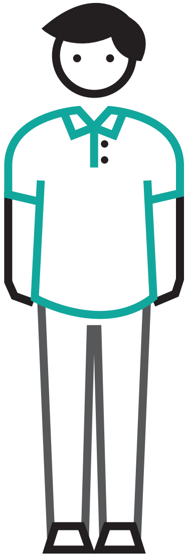

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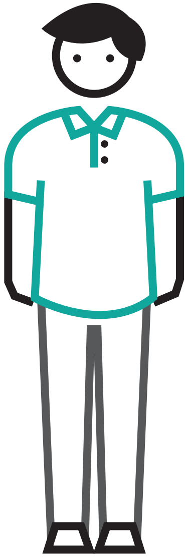

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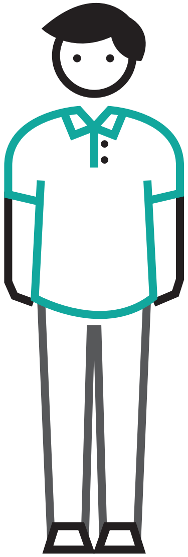

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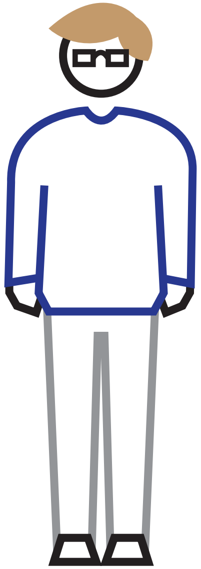

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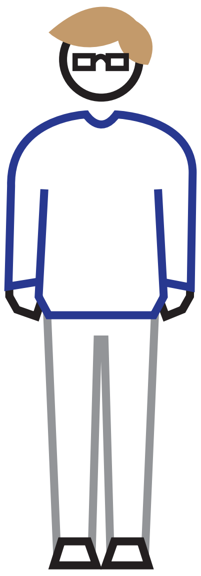

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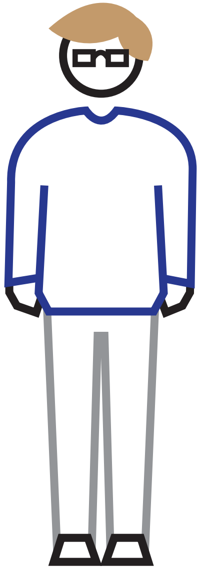

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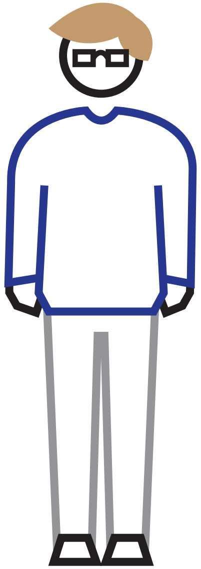

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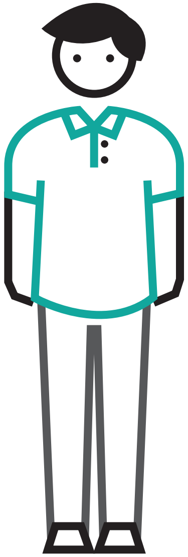

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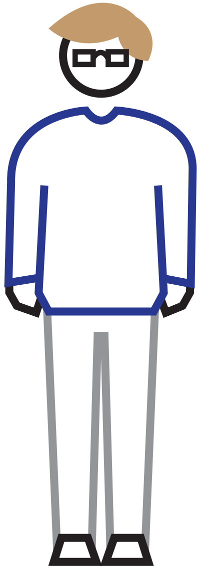

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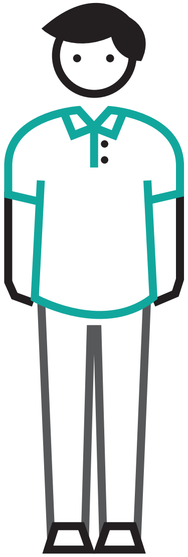

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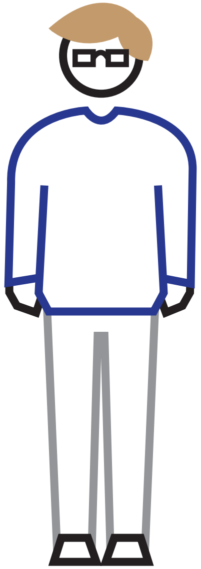

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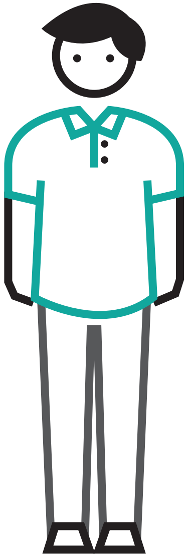

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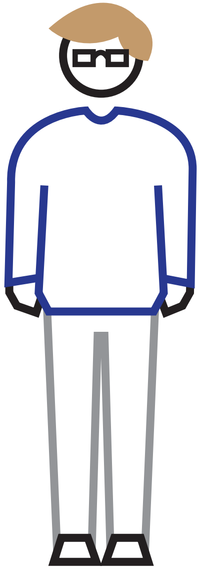

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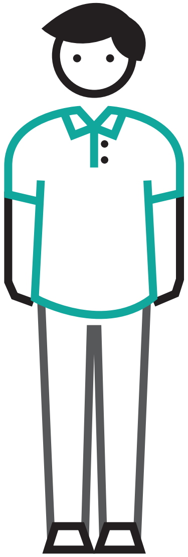

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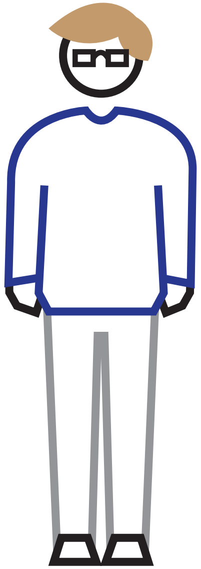

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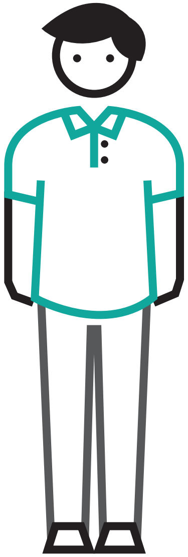

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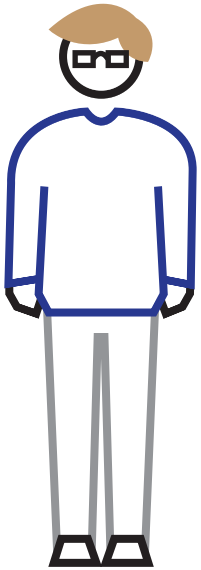

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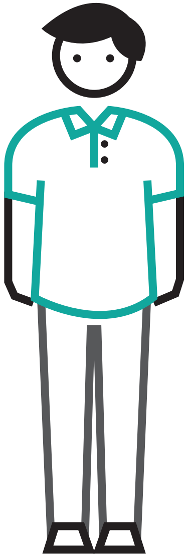

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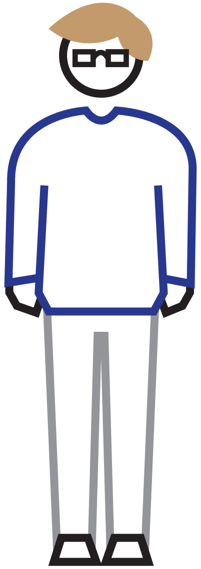

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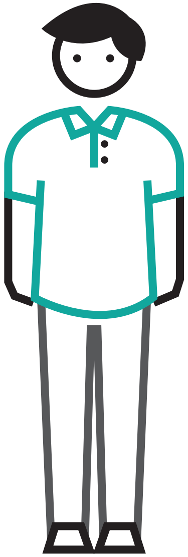

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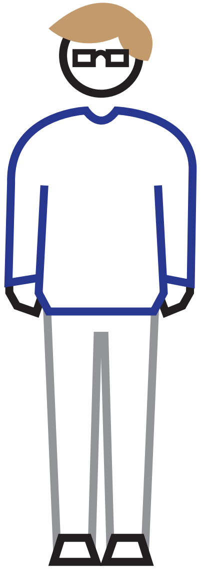

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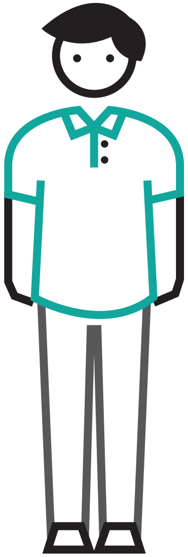

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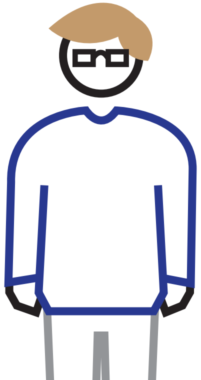

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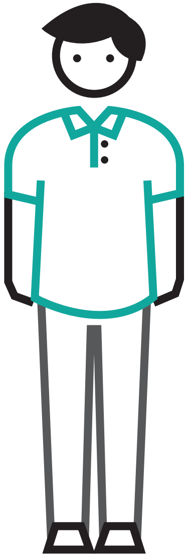

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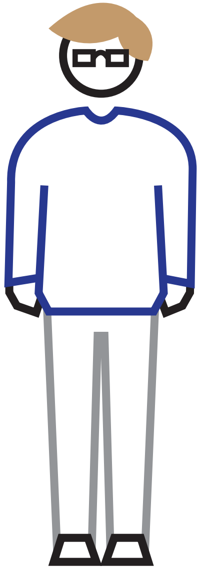

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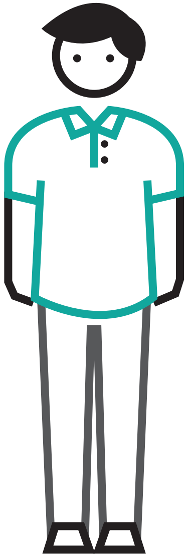

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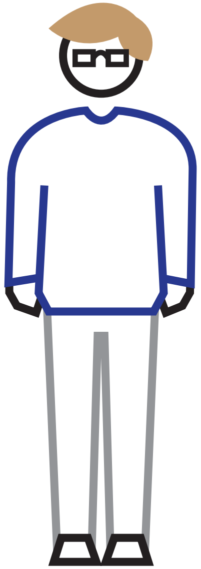

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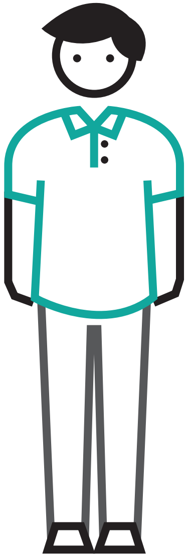

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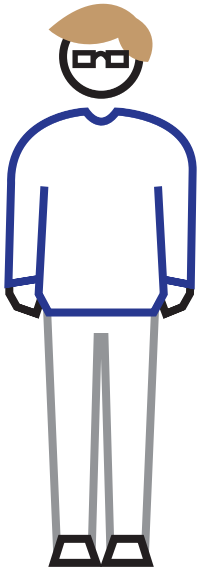

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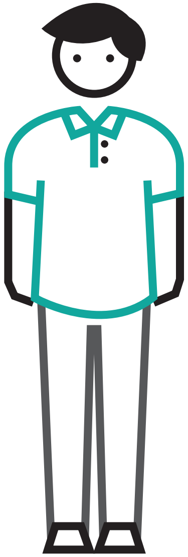

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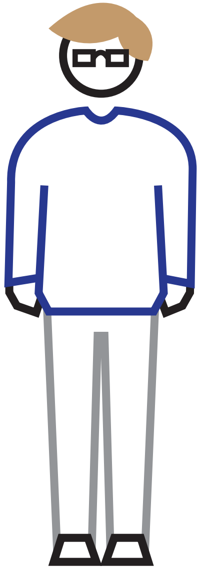

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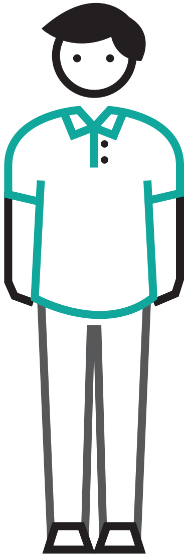

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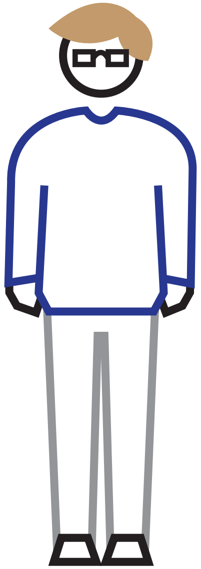

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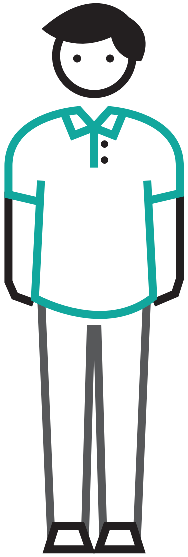

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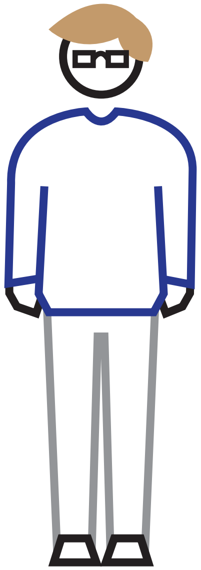

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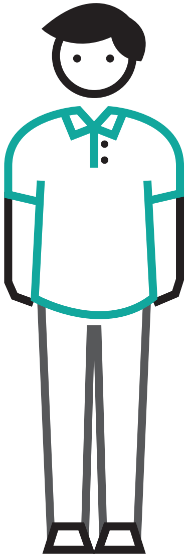

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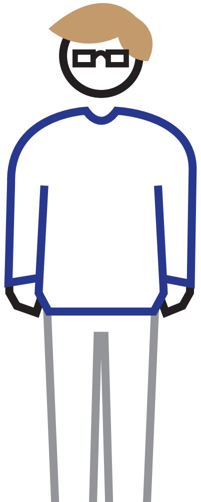

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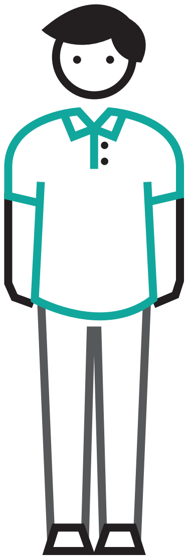

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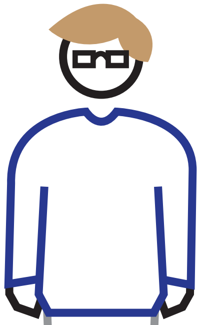

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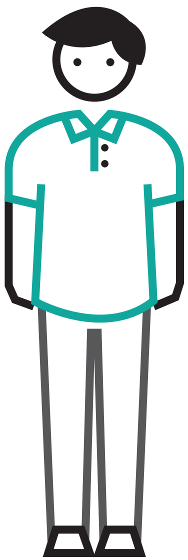

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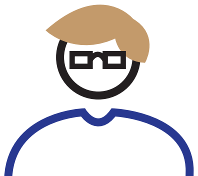

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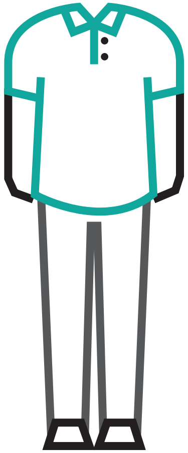

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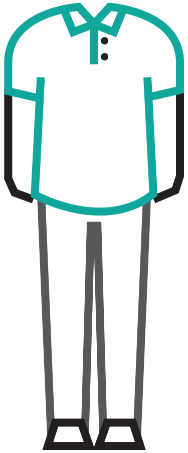

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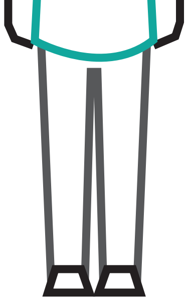

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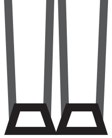

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