

TRANSATOMIC – schon wieder ein neuer Reaktortyp?

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Gänzlich anders als in Deutschland, in dem man sich mehr denn je zurück ins Mittelalter träumt, setzt man in USA verstärkt auf die Ausbildung junger Ingenieure und Wissenschaftler und ermutigt sie, eigene Unternehmen zu gründen. Eines der Programme ist das Gateway for Accelerated Innovation in Nuclear (GAIN), des U.S. Department of Energy (DOE). Vereinfacht gesagt, gibt es dort Gutscheine, die die (sonst kostenpflichtige) Nutzung staatlicher Forschungseinrichtungen durch Unternehmensgründungen ermöglicht. Acht solcher "Gutscheine" im Gesamtwert von zwei Millionen Dollar gingen an sog. startups aus der Kerntechnik.

Eines dieser jungen Unternehmen der Kerntechnik ist Transatomic Power Corporation (TPC). Wie so oft in den USA, ist es eine Gründung von Absolventen des MIT. Glückliches Amerika, in dem noch immer tausende junger Menschen bereit sind, sich den Strapazen eines Kerntechnik-Studienganges aussetzen, während man hierzulande lieber "irgendwas mit Medien" studiert. Allerdings kennt man in den USA auch keine Zwangsgebühren zur Schaffung von hoch dotierten Nachrichtenvorlesern und Volksbelehrern. Jeder Staat setzt halt seine eigenen Prioritäten.

Noch etwas ist in den USA völlig anders. Das junge Unternehmen hat bereits mehrere Millionen Dollar privates Risikokapital eingesammelt. Es braucht noch mehr Kapital und hat deshalb ein Papier veröffentlicht, in dem das Konzept seines Reaktors näher beschrieben ist. Sicherlich ein erhebliches wirtschaftliches Risiko. Man vertraut offensichtlich darauf, mangelnde "Geldmacht" durch Schnelligkeit kompensieren zu können. Erklärtes Ziel ist es, möglichst schnell einen kleinen Versuchsreaktor mit 20 MWth zu bauen. Das erste kommerzielle Kraftwerk soll rund 500 MWel (1250 MWth) Leistung haben und rund zwei Milliarden Dollar kosten.

Abgebrannte Brennelemente als Brennstoff

Der Reaktor ist vom Typ "molten salt". Der Brennstoff wird in geschmolzenem Salz gelöst, welches gleichzeitig dem Wärmetransport dient. Populär ist dieser Reaktortyp

im Zusammenhang mit Thorium gemacht worden. Man beschränkt sich hier bewußt auf Uran als Brennstoff, um auf die dafür vorhandene Infrastruktur zurückgreifen zu können. Thorium wird eher als Option in ferner Zukunft gesehen.

Der besondere Charme dieses Konzeptes liegt in der Verwendung abgebrannter Brennelemente aus Leichtwasserreaktoren als Brennstoff. Solche abgebrannten Brennelemente bestehen zu rund 95% aus Uran-238 und etwa je einem Prozent Uran-235 und Plutonium. Der Rest sind Spaltprodukte als Abfall. Das klassische Modell, wie es z.B. in Frankreich praktiziert wird, ist die Wiederaufbereitung nach dem Purex-Verfahren: Man erhält sehr reines Uran, welches als Ersatz für Natururan wieder in den Kreislauf zurückgeführt wird und reines Plutonium, welches als Mischoxid zu

neuen Brennelementen verarbeitet wird. Die Spaltprodukte mit Spuren von Aktinoiden werden verglast und als Atommüll endgelagert. Für diese chemischen Prozeßschritte (Wiederaufbereitungsanlage) geht man von Kosten in Höhe von 1300 bis 3000 US-Dollar pro kg aus. Bei heutigen Preisen für Natururan eine unwirtschaftliche Angelegenheit. Deshalb füllen sich die Lager mit abgebrannten Brennelementen auch weiterhin. Allein in den USA lagern über 70.000 to ausgedienter Brennelemente. Für die "Zwischenlagerung" in Behältern (ähnlich den Castoren in Deutschland) geht man von etwa 100 Dollar pro kg aus. Für die "Entsorgung" haben sich bereits über 31 Milliarden US-Dollar Rücklagen angesammelt – was etwa 400 Dollar pro kg entspricht.

Wem es gelingt, einen Reaktor zu

bauen, der die abgebrannten Brennelemente "frisst", ist in der Rolle einer Müllverbrennungsanlage: Er wird für die Beseitigung des Mülls bezahlt und kann sich mit seinem Preis an den anderen Möglichkeiten (z. B. Müllkippe) orientieren. Die entstehende Wärme ist umsonst. Die elektrische Energie aus der "Müllbeseitigung" ist ein weiteres Zubrot. Es kommt lediglich darauf an, eine besonders günstige "Müllverbrennungsanlage" zu bauen. Genau an diesem Punkt, setzt TPC an.

Das Transatomic Konzept

Die Angst vor dem "Atommüll" wird

**mit seiner
Langlebigkeit
begründet. Es gibt
wahrlich
gefährlichere
Stoffe, als
abgebrannte
Brennelemente.
Solange man sie
nicht aufisst,
sind sie recht
harmlos. Es ist**

**aber die
berechtigte Angst,
ob man diese
Stoffe für
Jahrmillionen
sicher von der
Biosphäre fern
halten kann, die
viele Menschen
umtreibt.**

**Spaltprodukte sind
in diesem Sinne**

**kein Problem, da
sie in wenigen
hundert Jahren
faktisch von
selbst
verschwunden sind.
Jahrhunderte sind
aber durch
technische
Bauwerke
(Kathedralen,
Pyramiden etc.)**

**oder natürliche
Barrieren (einige
hundert Meter
gewachsene
Erdschichten)
sicher
beherrschbar.**

**Man kann aber alle
langlebigen
Aktinoide durch
Spaltung in**

**kurzlebige
Spaltprodukte
umwandeln und
dabei noch riesige
Mengen Energie
erzeugen – am
besten in einem
Kernkraftwerk. Ein
solcher Reaktor
muß besonders
sparsam mit den
bei einer Spaltung**

**freiwerdenden
Neutronen umgehen,
um möglichst viele
andere Kerne
umzuwandeln und
letztendlich zu
spalten.**

**Spaltprodukte
haben teilweise
sehr große
Einfangquerschnitt**

**e. Mit anderen
Worten, sie wirken
parasitär indem
sie wertvolle
Neutronen
“wegfangen”. Die
Konsequenz ist
eine integrierte
Wiederaufbereitung
. Dies läßt sich
nur über eine
Brennstofflösung**

erreichen.

**Es dürfen nur
möglichst wenig
Neutronen das
System verlassen.
Dazu muß man den
Reaktor mit einem
Reflektor
versehen, der die
Neutronen wieder
in den Reaktor
zurück streut.**

**Idealerweise
verwendet man
dafür ebenfalls
Uran, damit nicht
zurück streubare
Neutronen bei
ihrem Einfang
wenigstens neuen
Spaltstoff – hier
Plutonium –
erzeugen.
Bei Reaktoren mit**

**festen
Brennstoffen, kann
man die
Spaltstoffe nicht
kontinuierlich
ersetzen. Man
benötigt deshalb
zu Anfang eine
Überschußreaktivit
ät. So zu sagen,
mehr Spaltstoff
als eigentlich**

zuträglich ist.

Diese

Überschußreaktivität muß durch

Regelstäbe und

abbrennbare Gifte

kompensiert

werden: Wertvolle

Neutronen werden

unnütz weg

gefangen.

Will man mit

**möglichst geringer
Anreicherung
auskommen – was
einem bereits
abgebrannten
Brennelement
entspricht – muß
man zwingend auf
ein thermisches
Neutronenspektrum
übergehen.
Sogenannte**

**“Schnelle Brüter”
erfordern eine
zweistellige
Anreicherung. Also
wesentlich höher,
als sie in einem
frischen
Brennelement für
einen
Leichtwasserreakto
r vorliegen. Man
kann in einem**

**thermischen
Reaktor zwar nicht
brüten – also mehr
Spaltstoff
erzeugen als beim
Betrieb verbraucht
wird – aber fast
genau soviel
erzeugen, wie
verbraucht wird.
Man muß es auch
gar nicht, da ja**

**der “Atommüll”
noch Spaltstoff
enthält.**

**Wieviele
wird nun**

gespart?

Ein

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Leichtwas

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**abgebrannt
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**Brennelemente pro
Jahr.**

Geht man

**von einer
direkten
Endlageru
ng aus,
ist dies
die Menge**

**“Atommüll
” die in
ein
Endlager
muß.
Erzeugt**

**man die
gleiche
elektrisc
he**

Energie

aus eben

solchen

“Atommüll

”, ist

diese

Menge

schon mal

**komplett
eingespar
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**Gleichzei
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aber auch

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“Atommüll

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Die

Energie

wird

durch die

Spaltung

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Atomkerne

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Sie sind

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t. Wird

Uran noch

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Plutonium

für sie

reines

Teufelsze

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diese

**Stoffgruppe
dient
aber bei
diesem
Reaktor
als**

**Brennstof
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Ein

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Die

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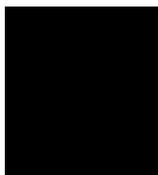
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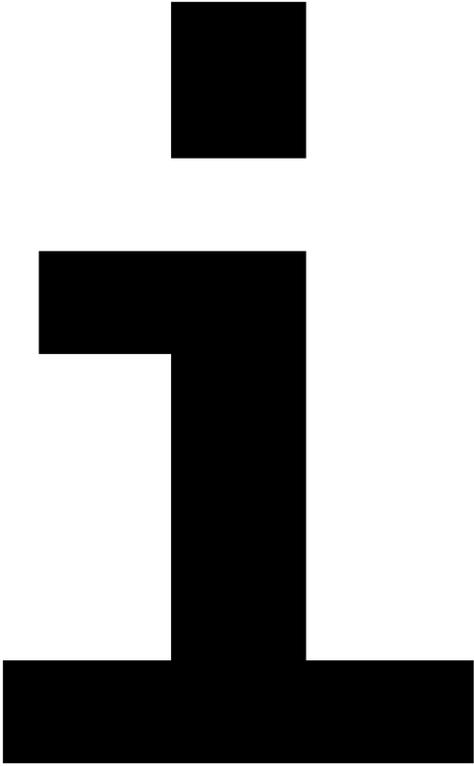
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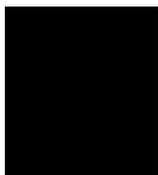
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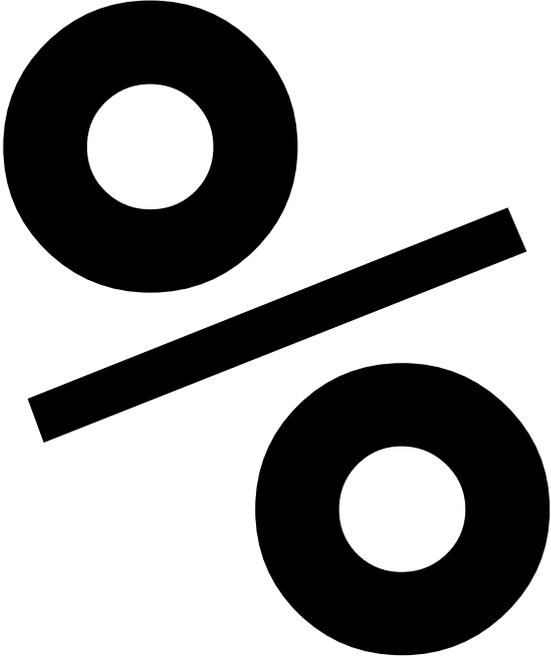


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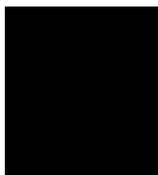
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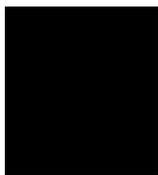
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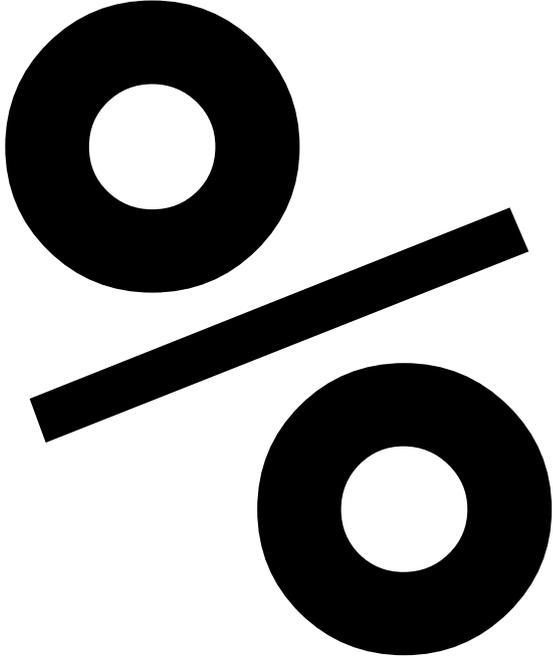
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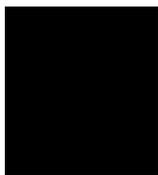
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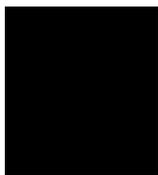
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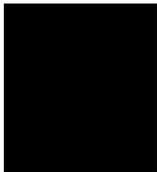
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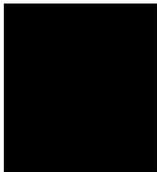
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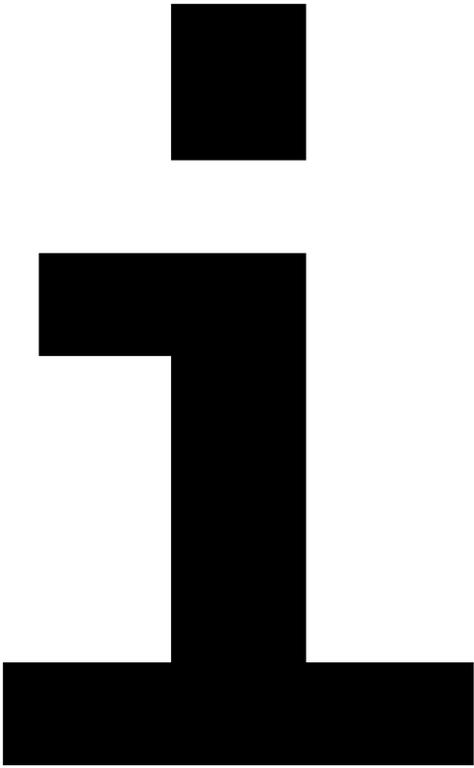
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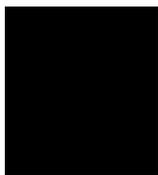
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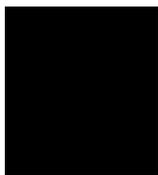
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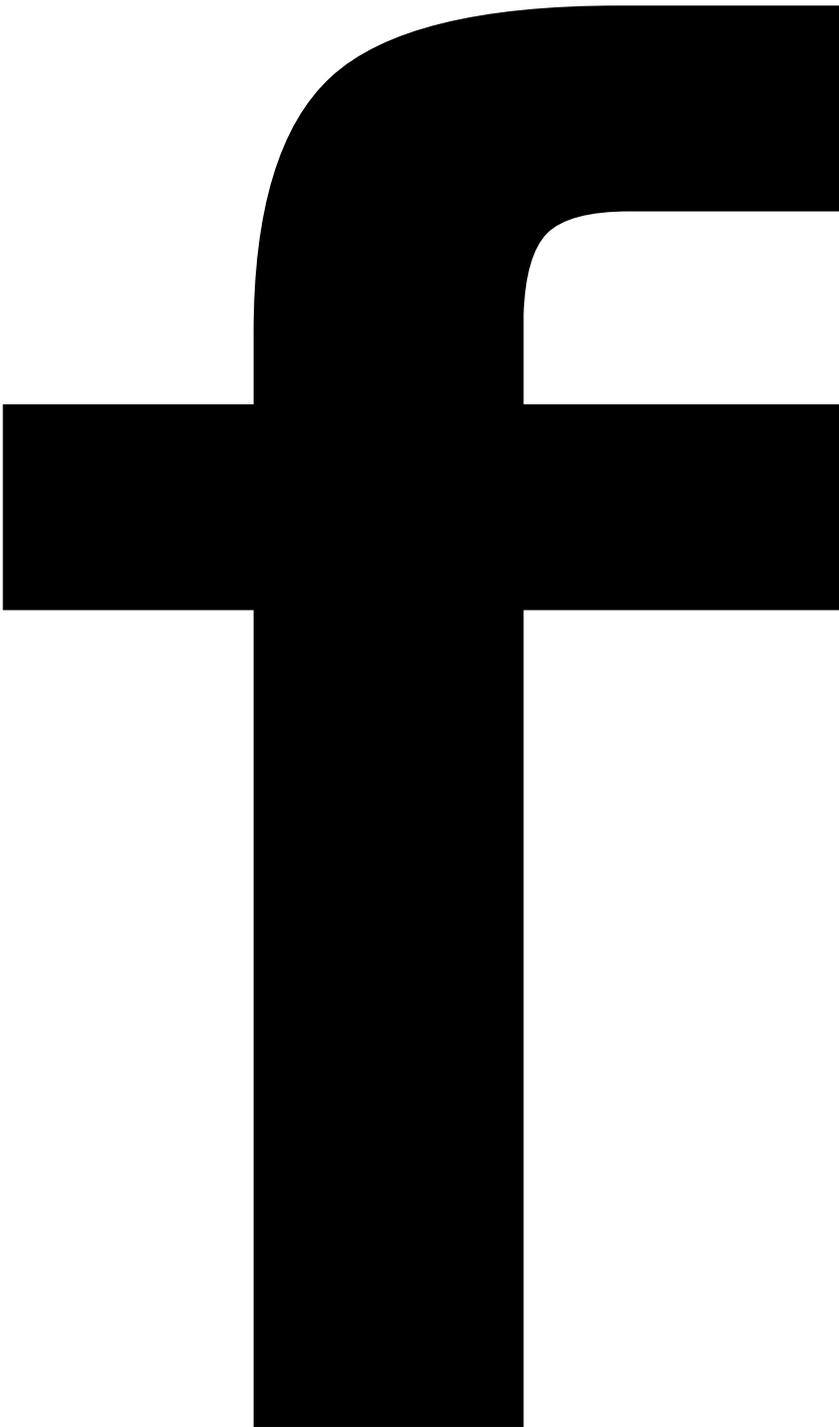
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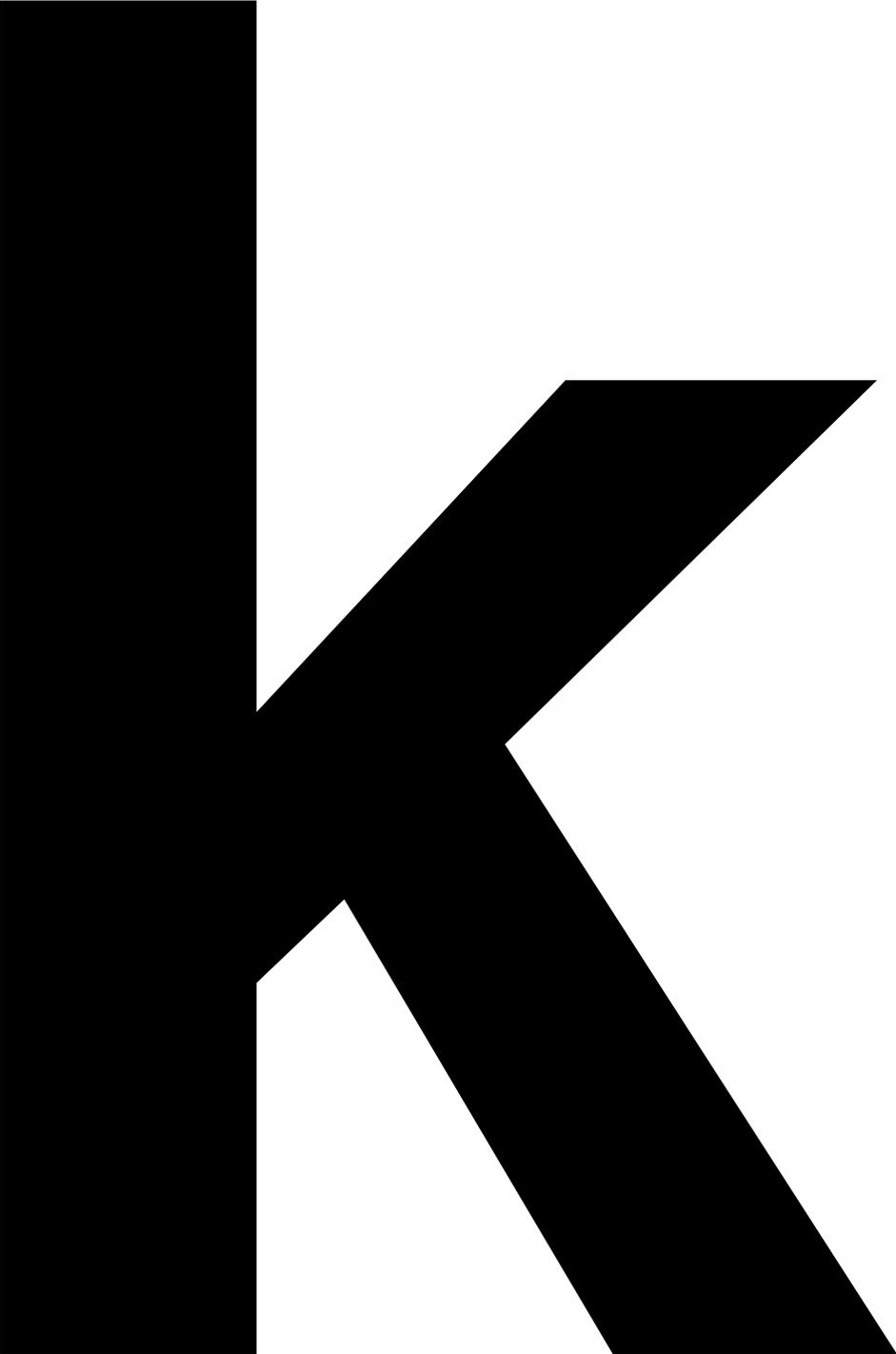
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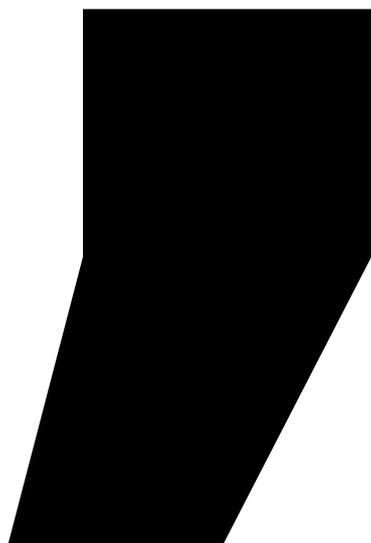
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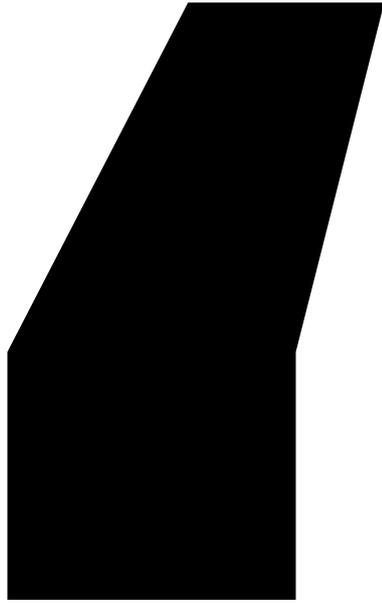
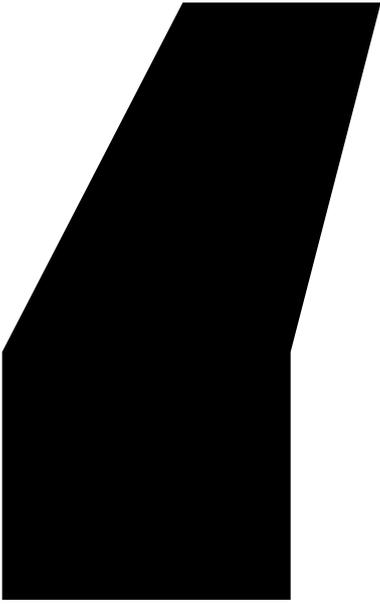
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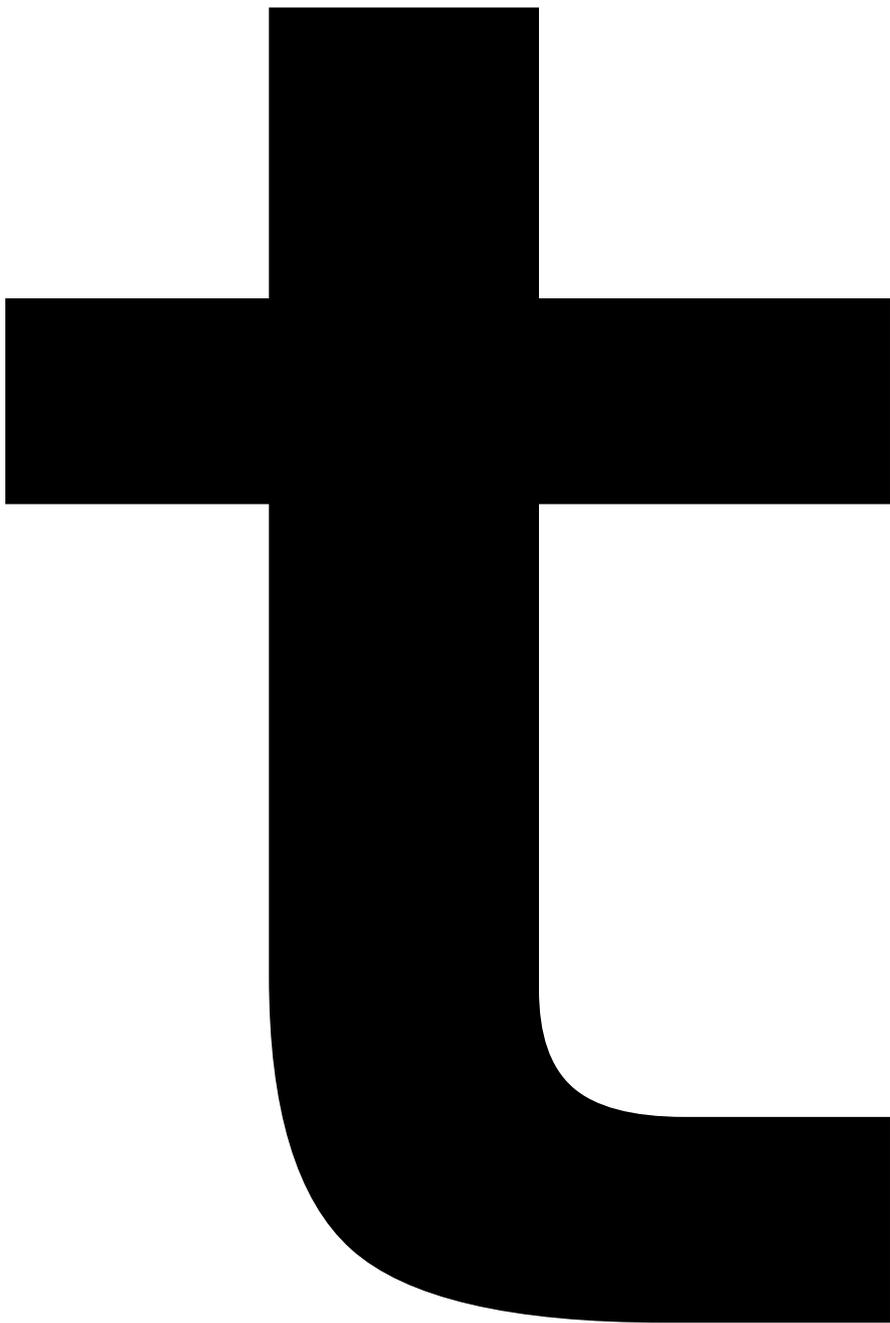


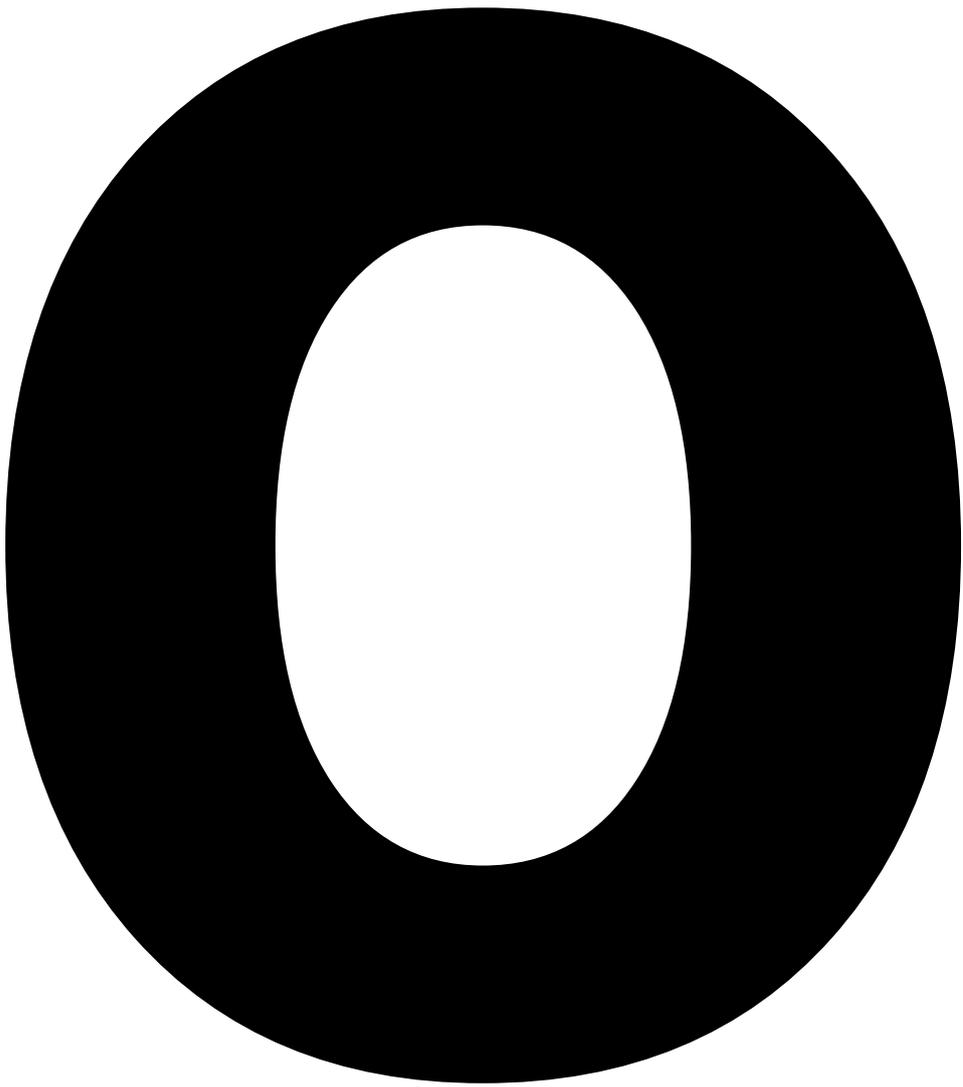
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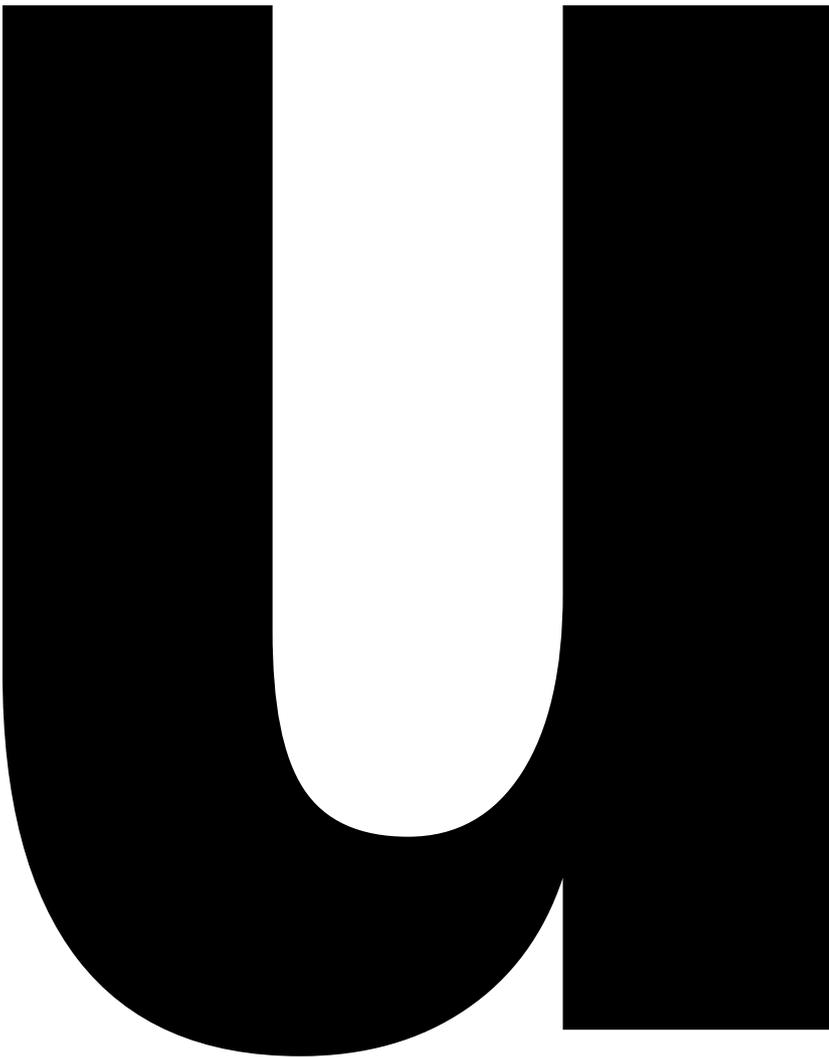
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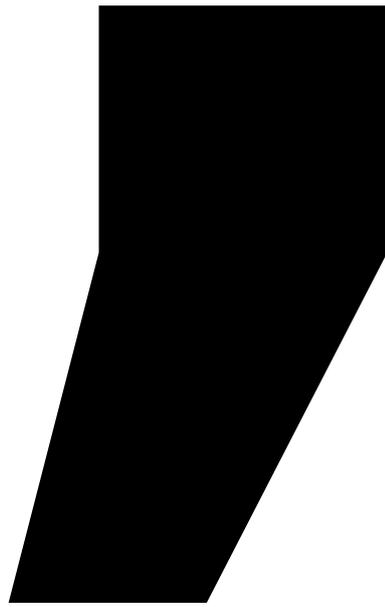
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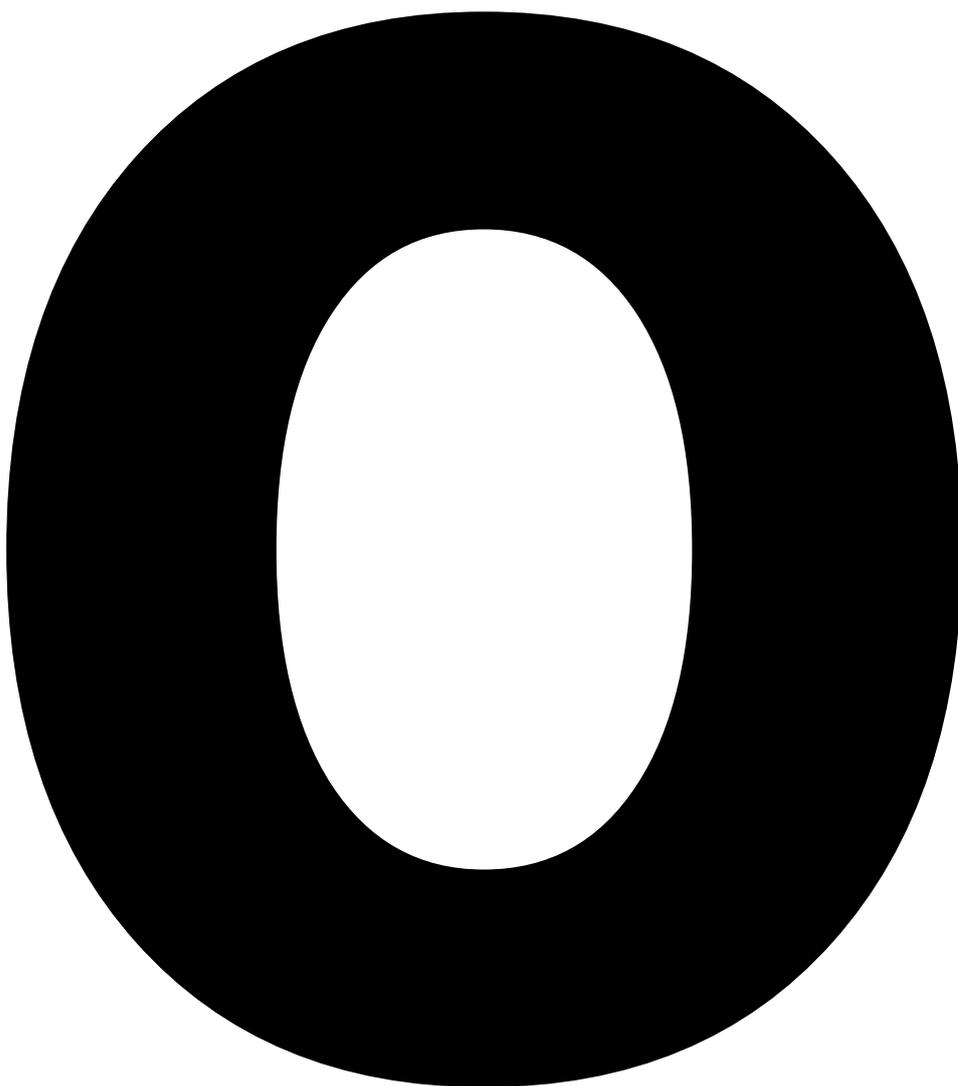


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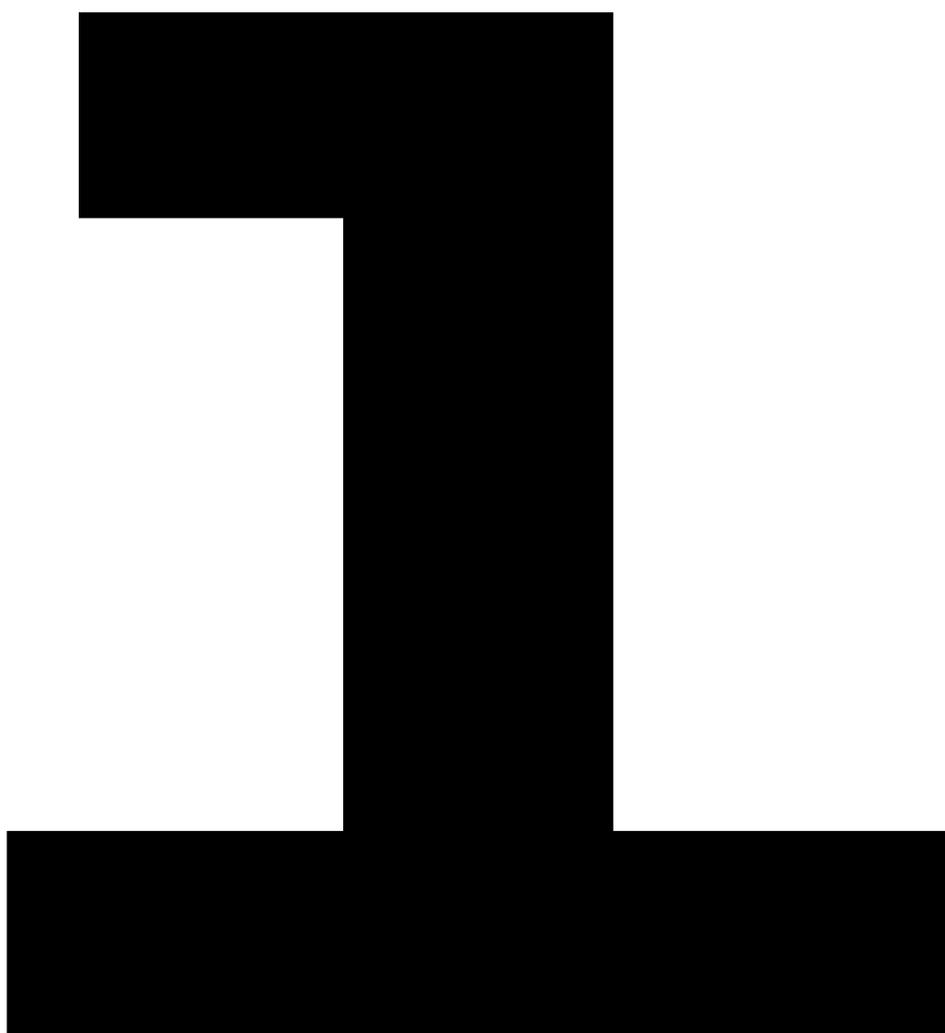
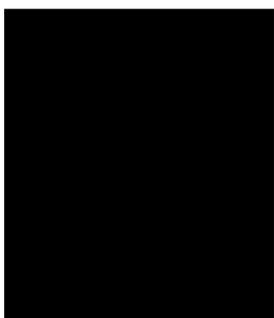


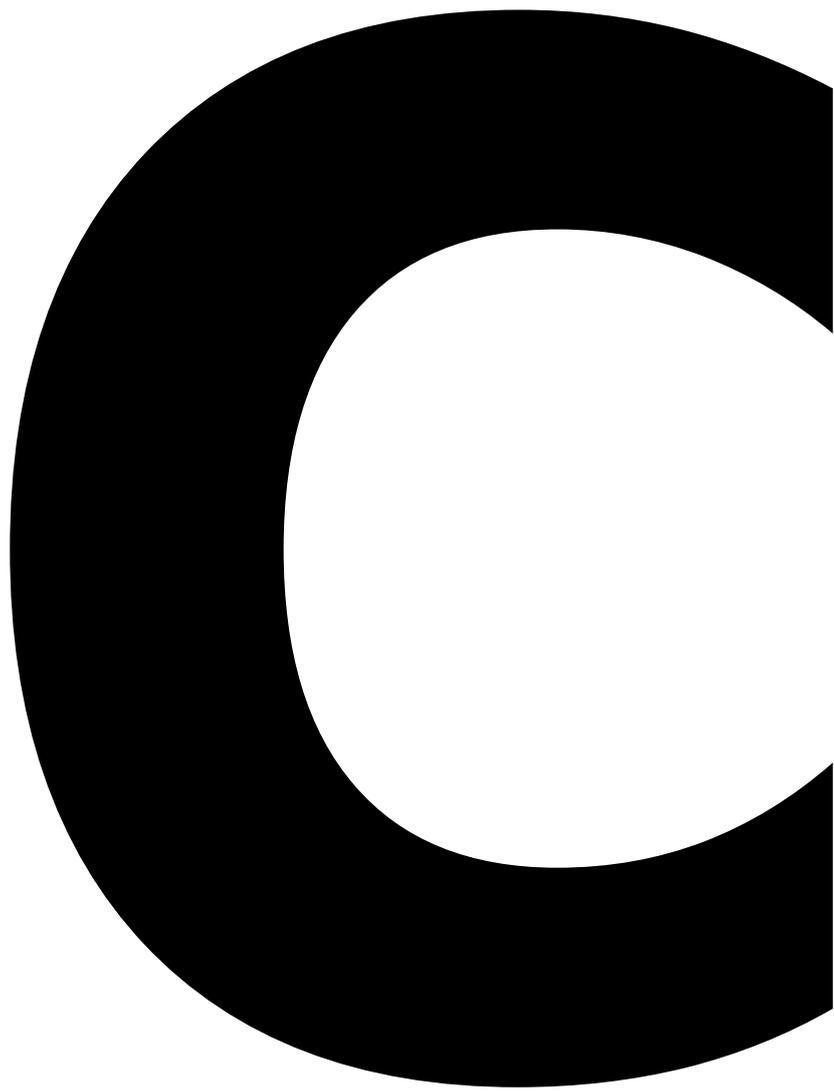
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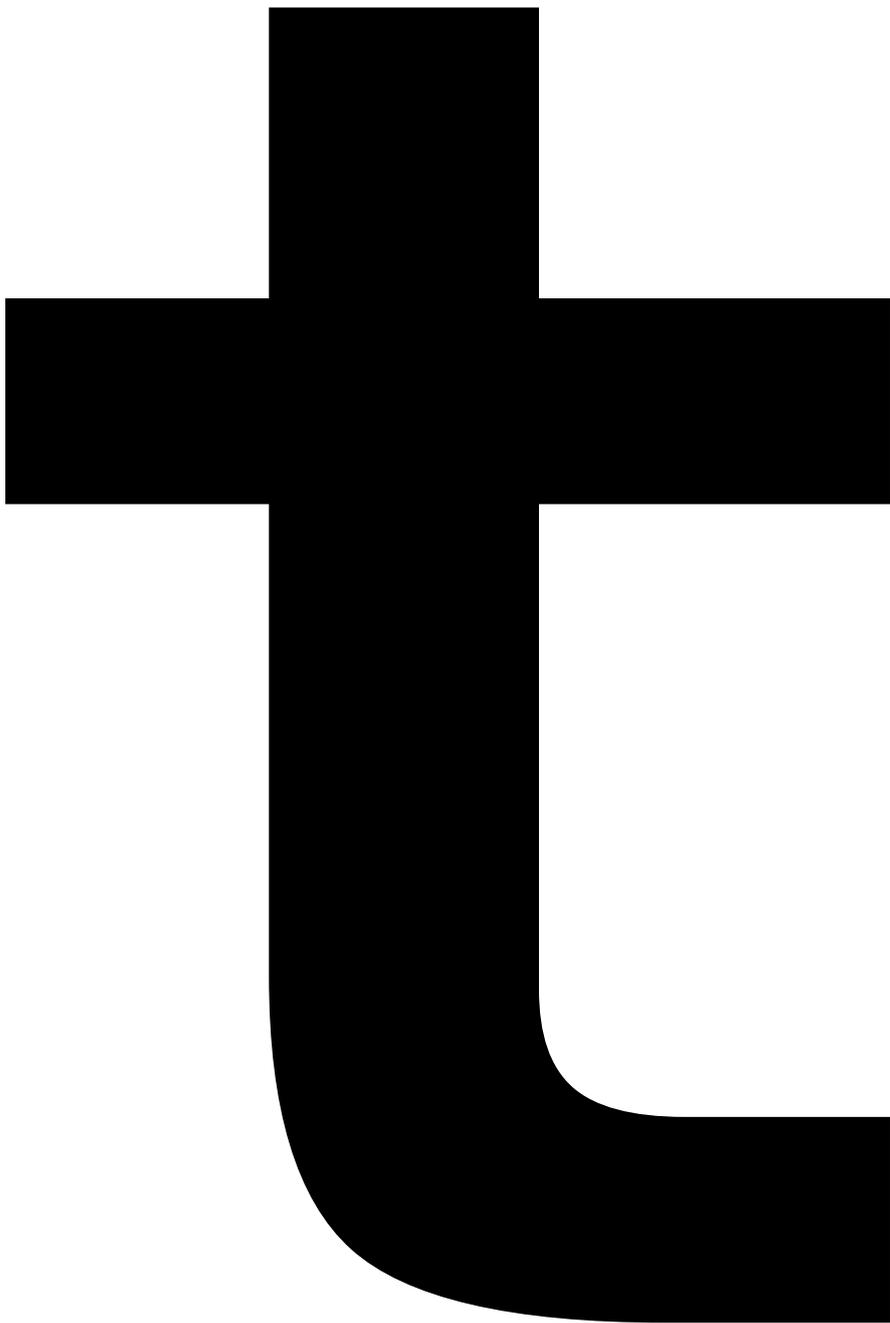
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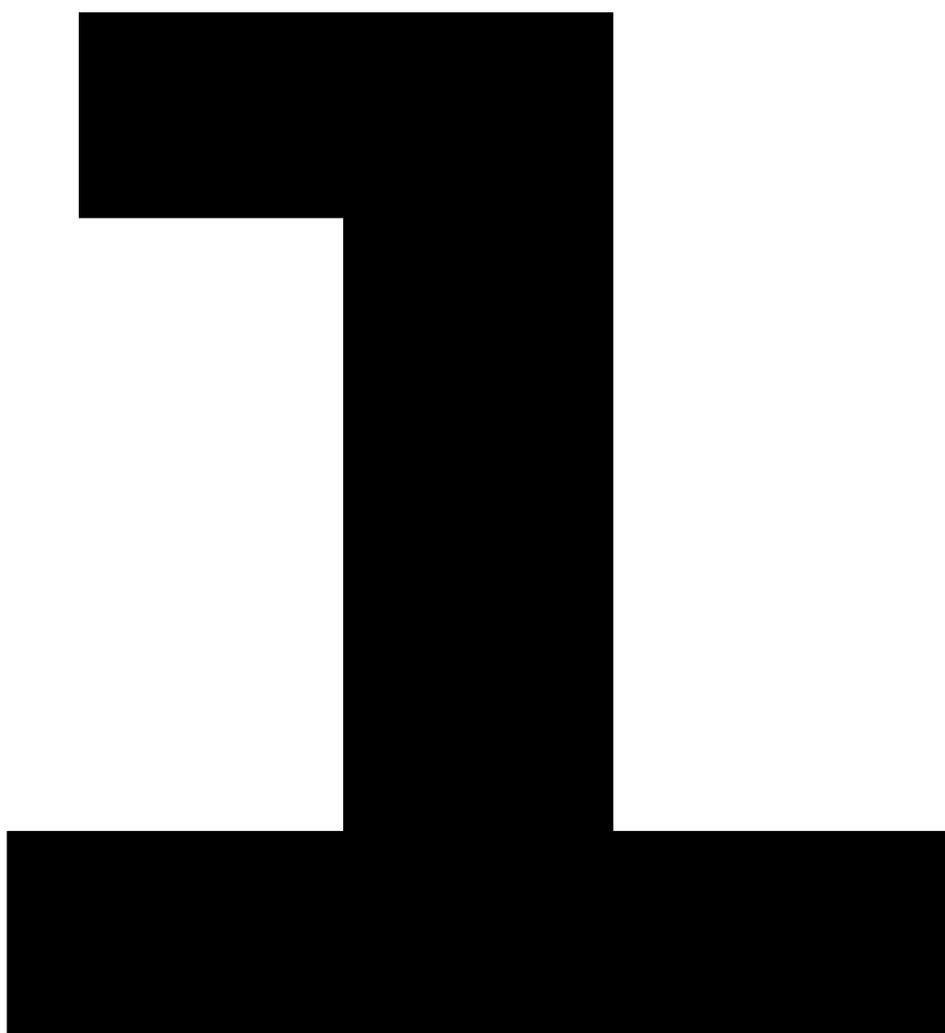
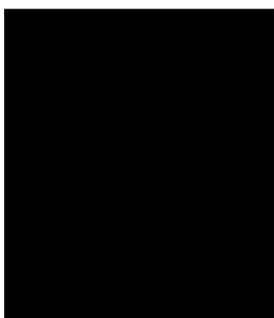


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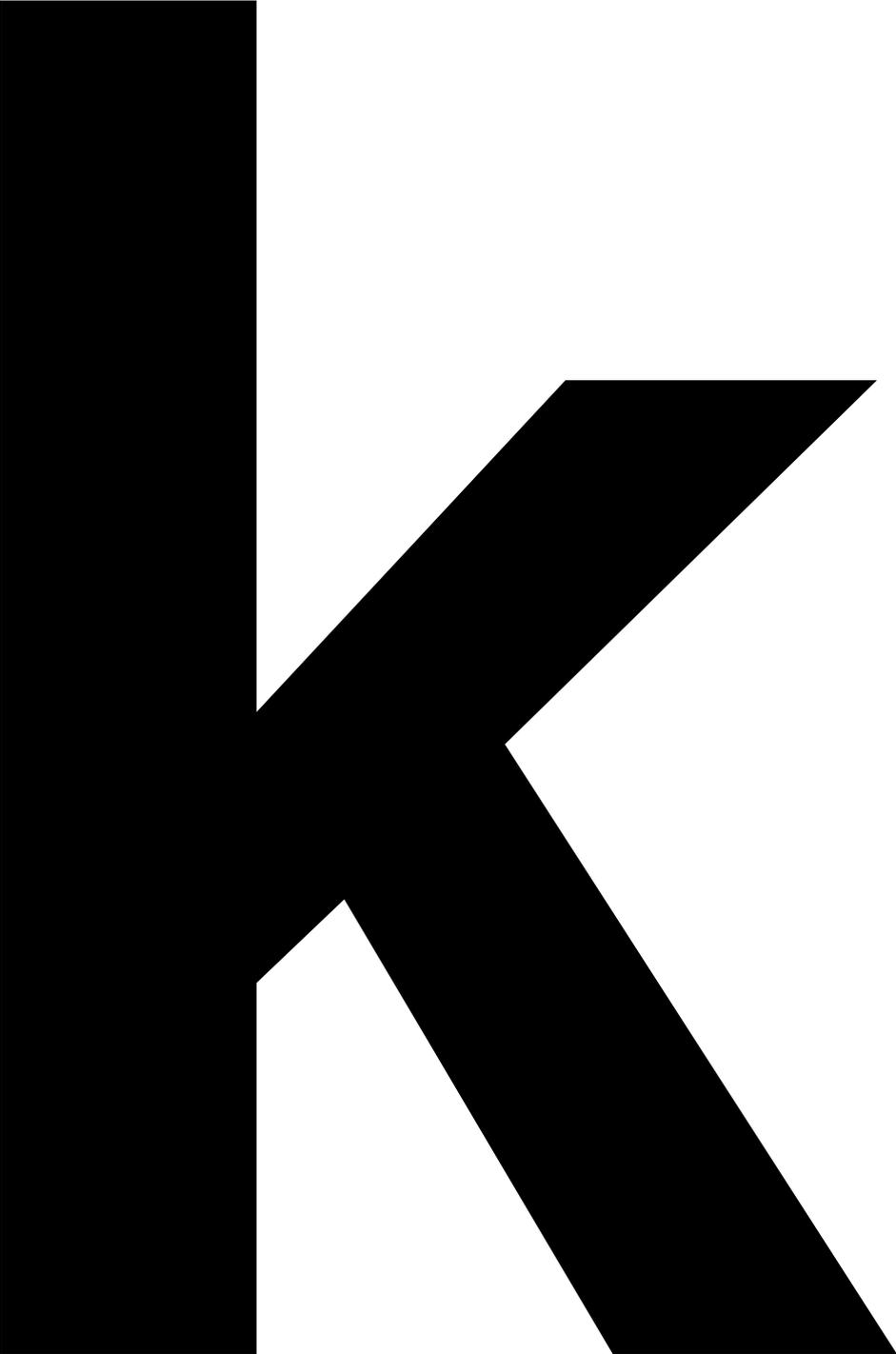


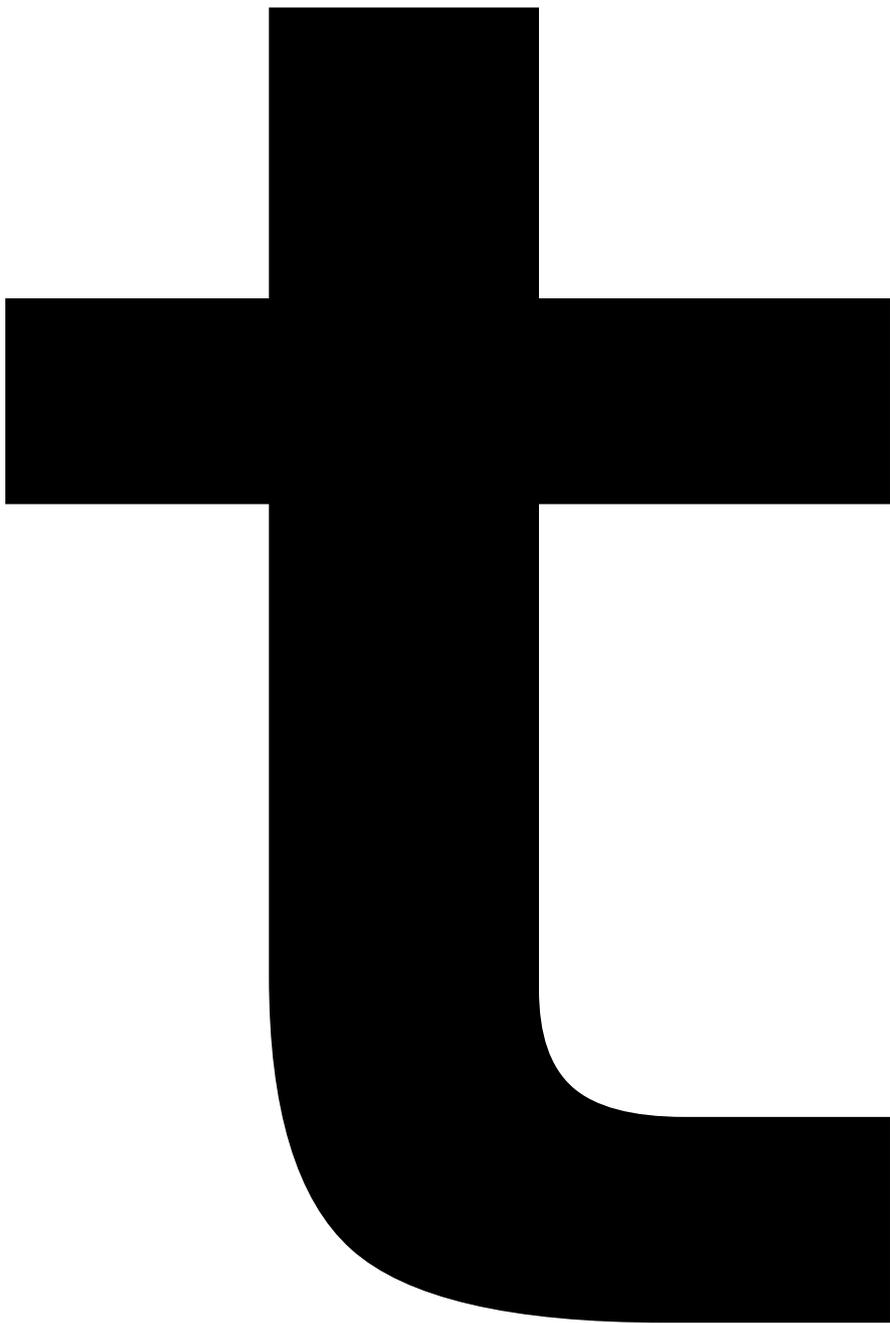
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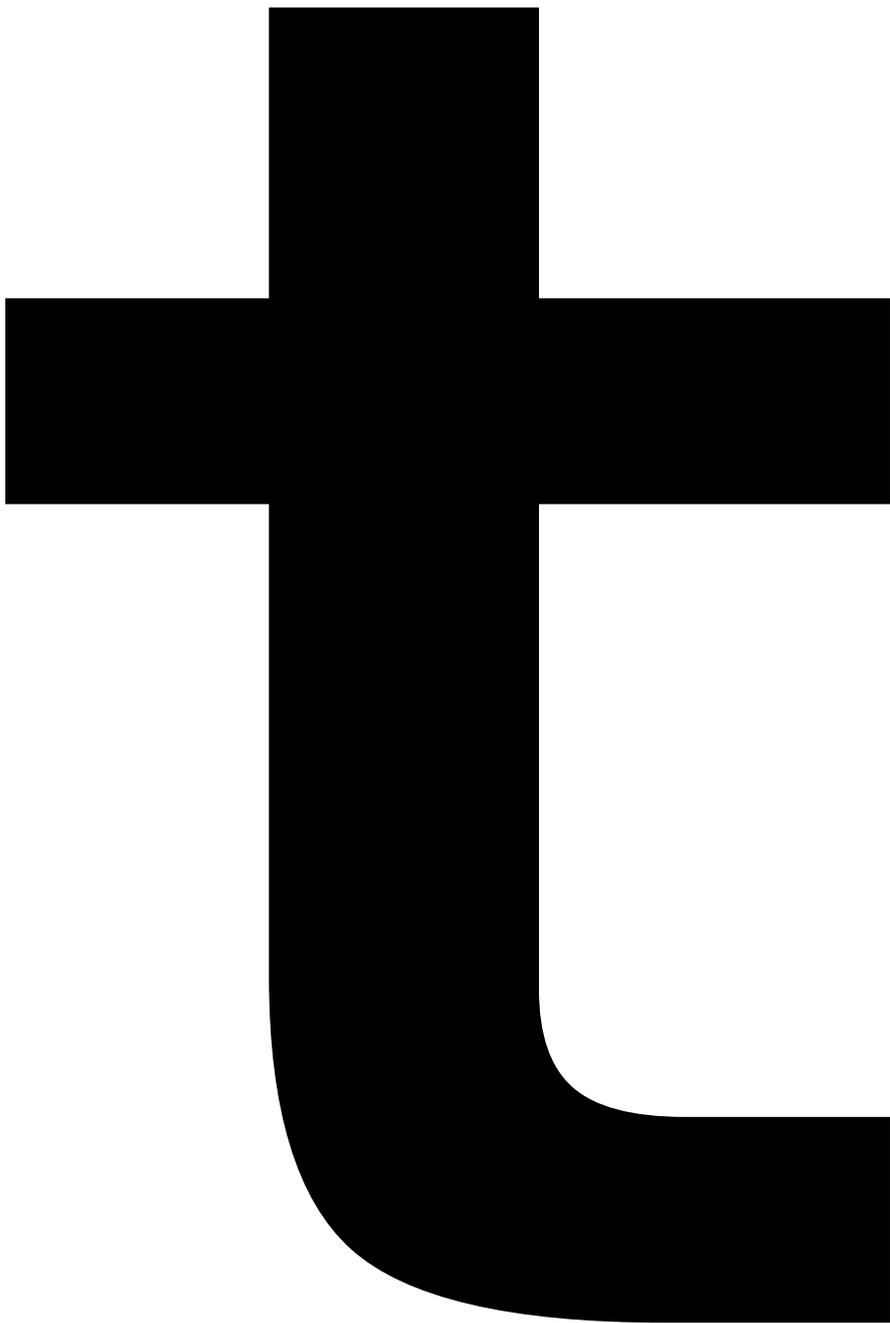
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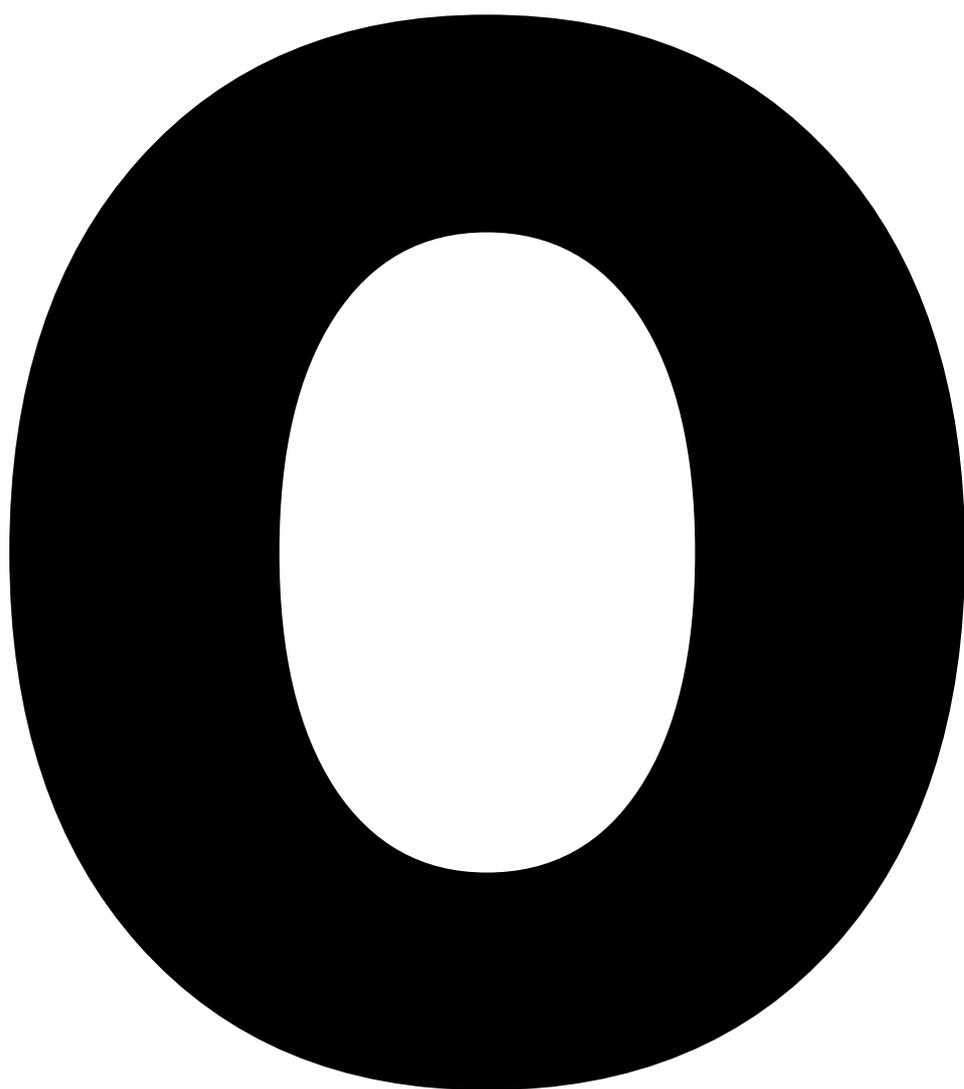
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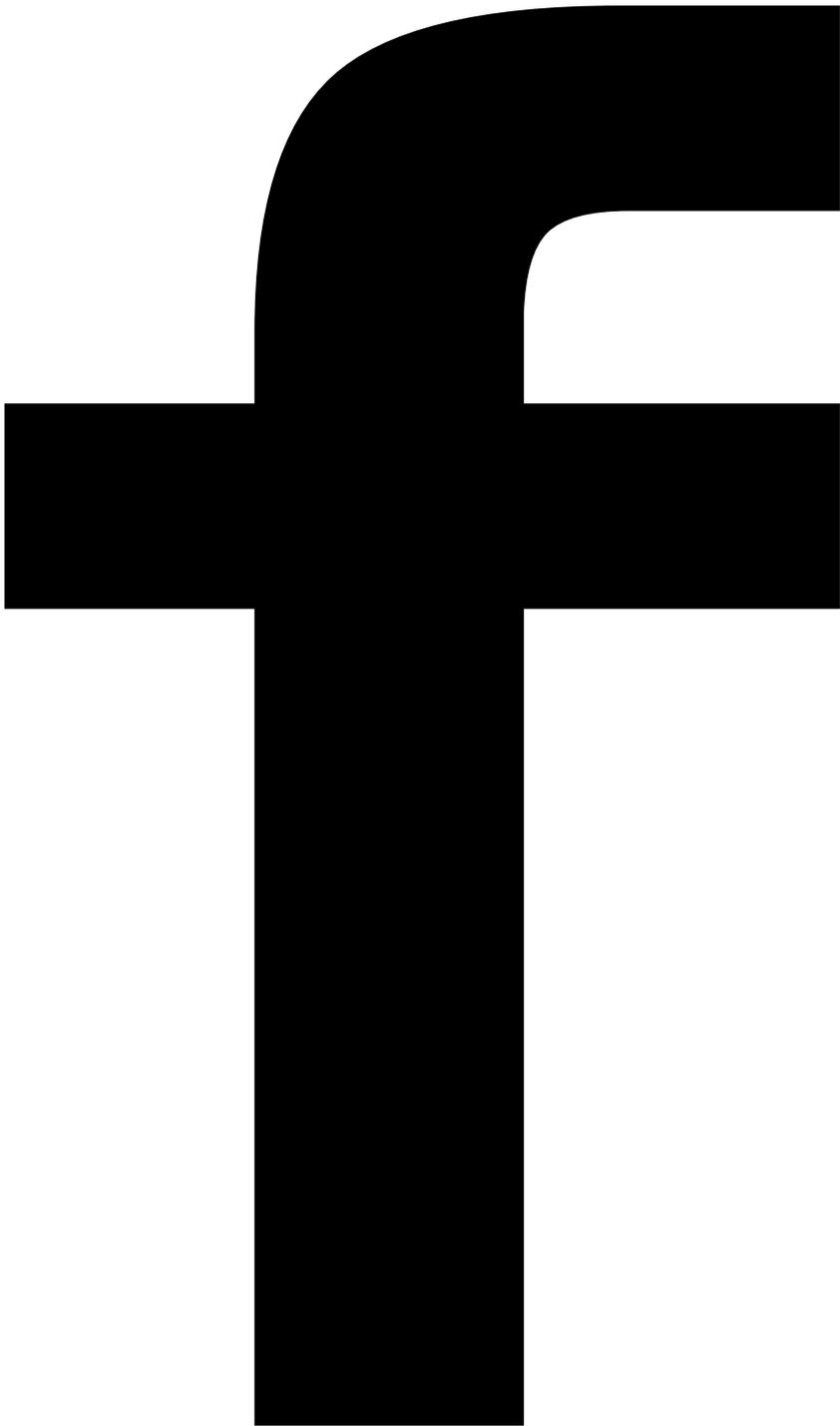
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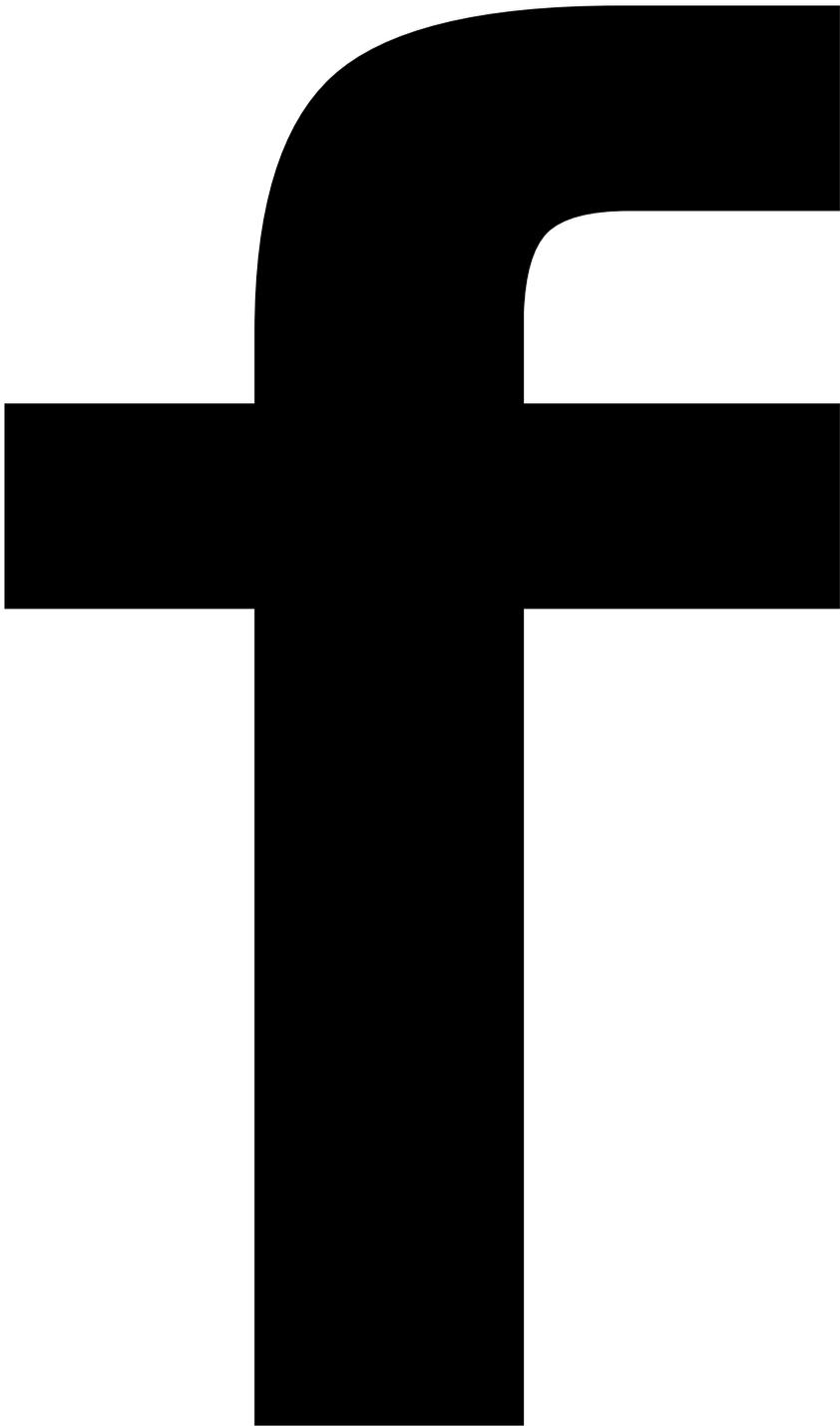
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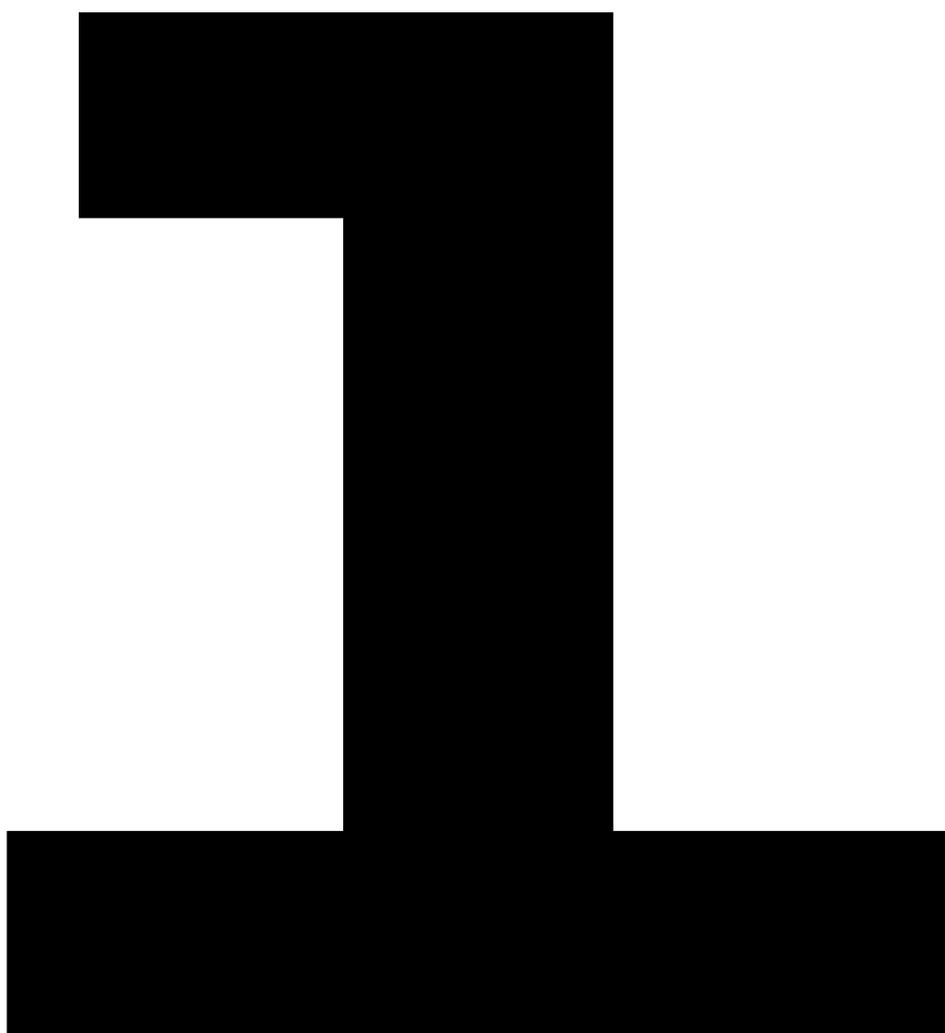
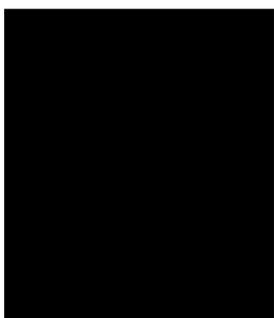




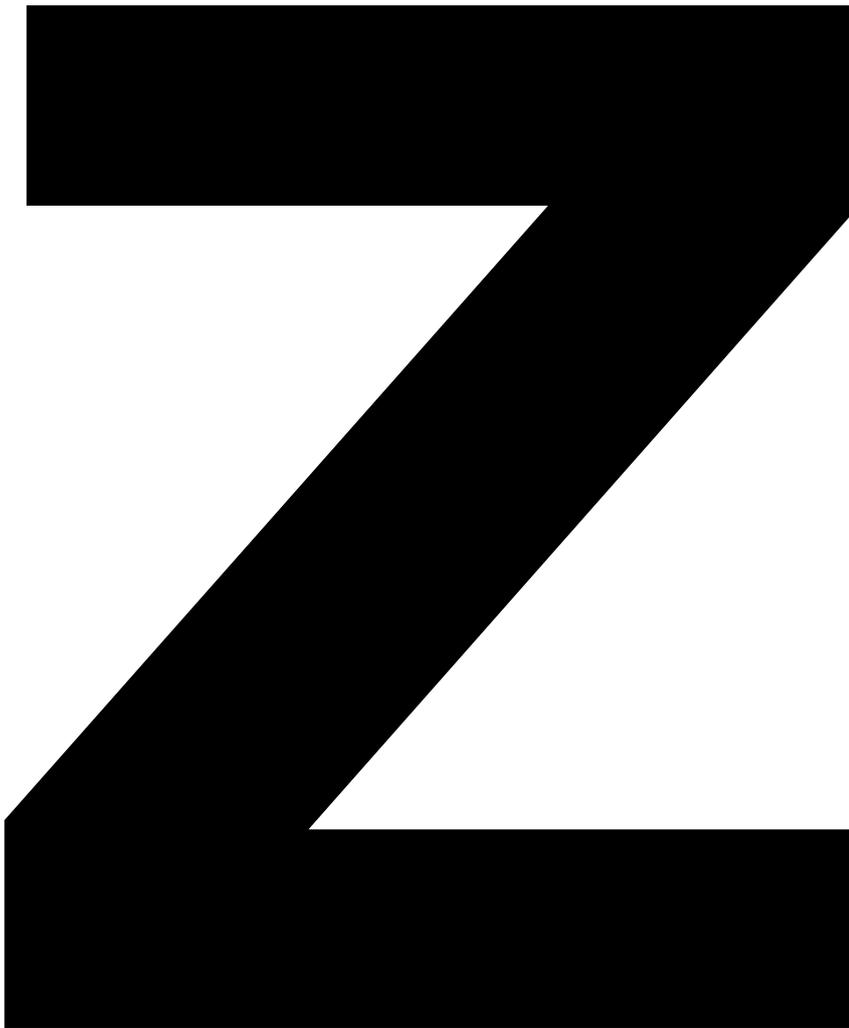




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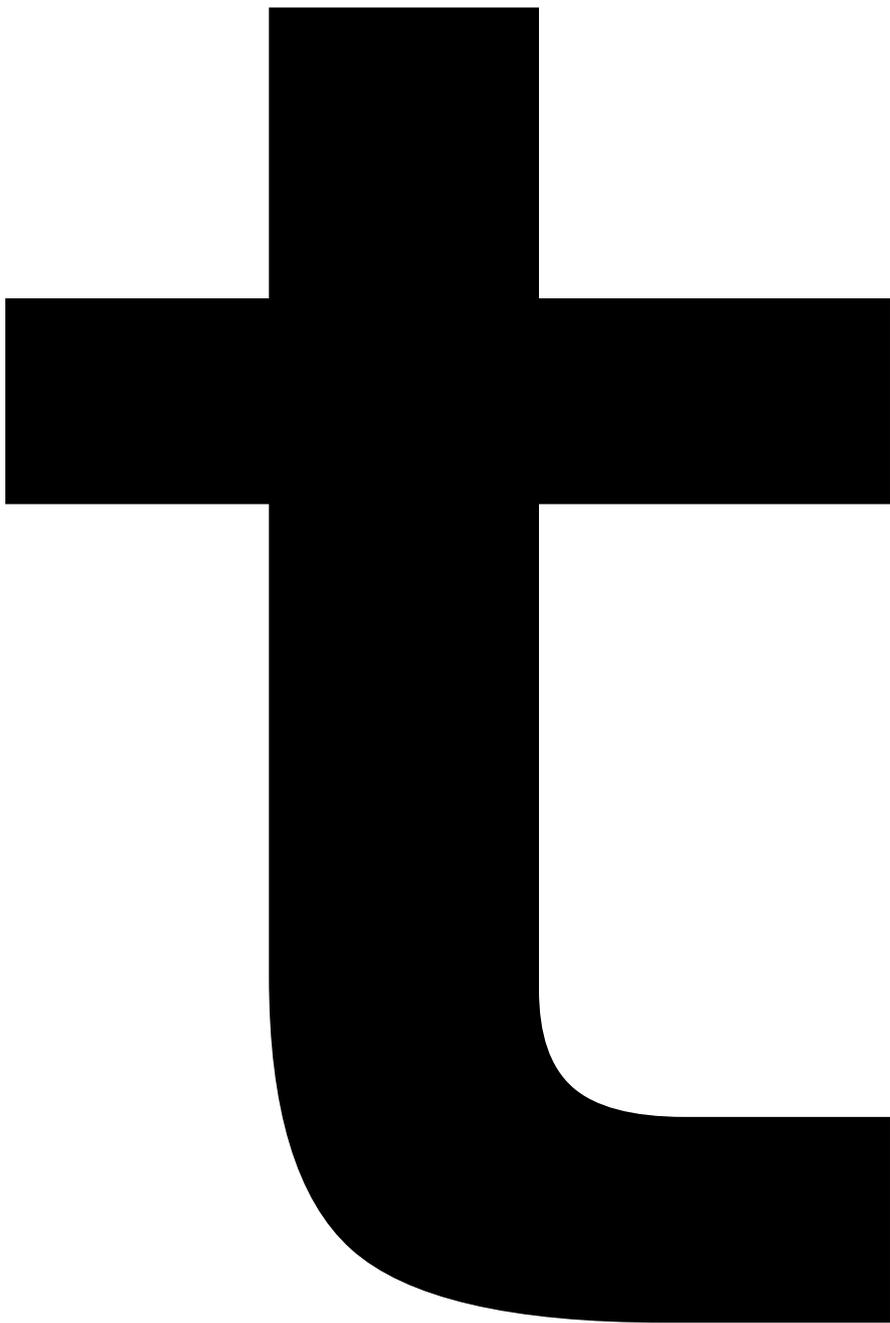
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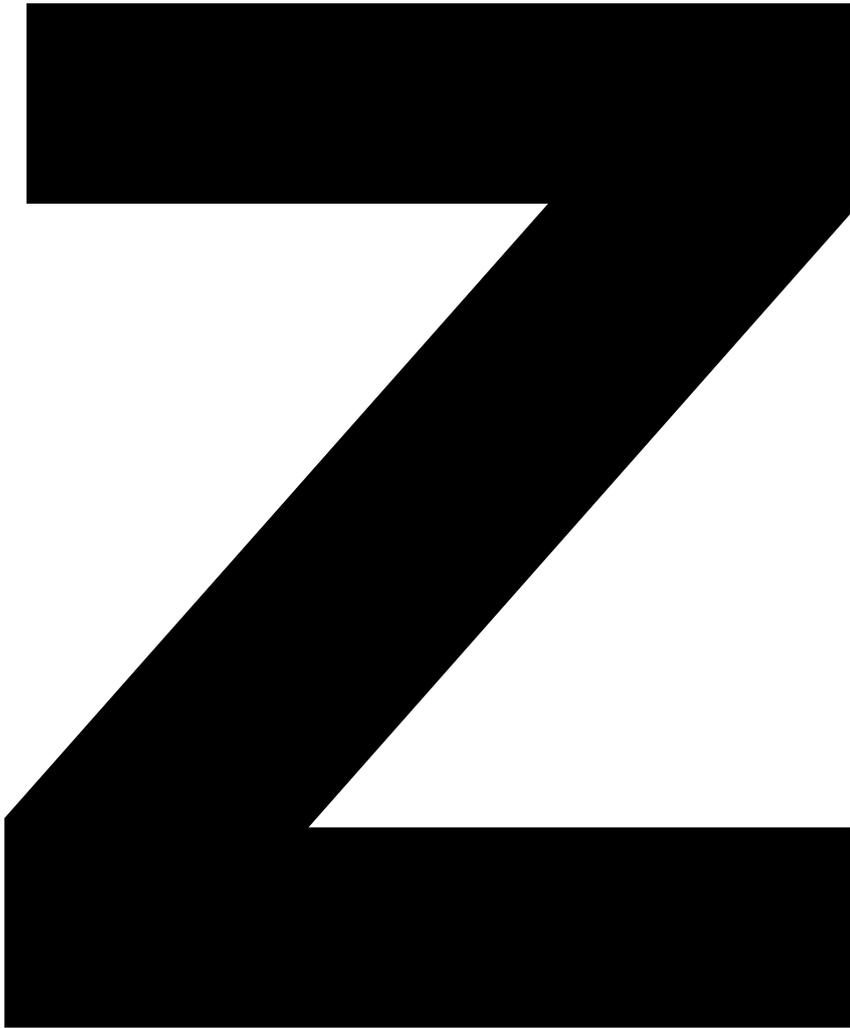


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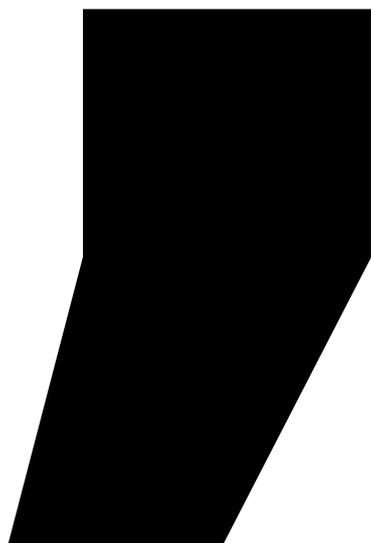
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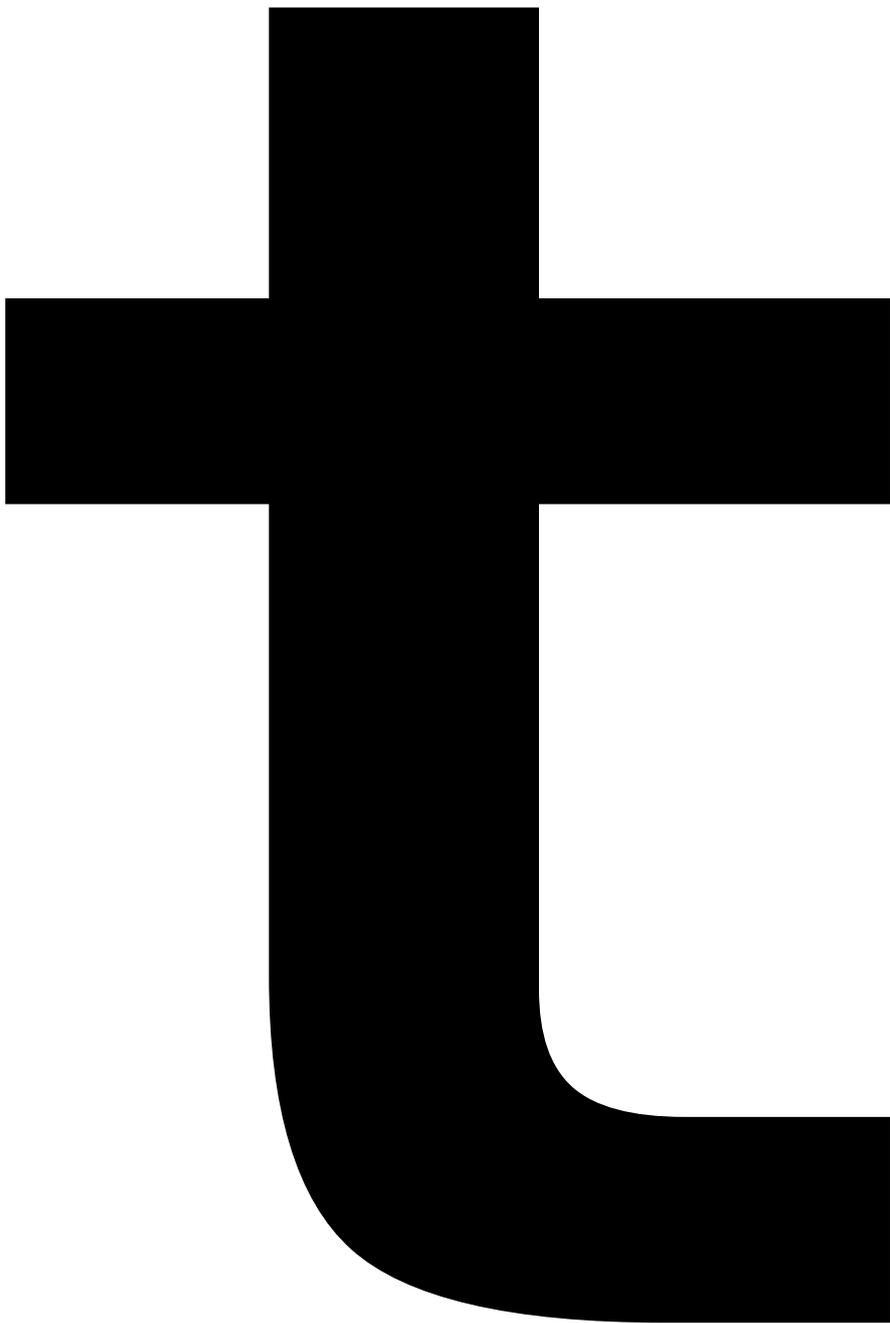
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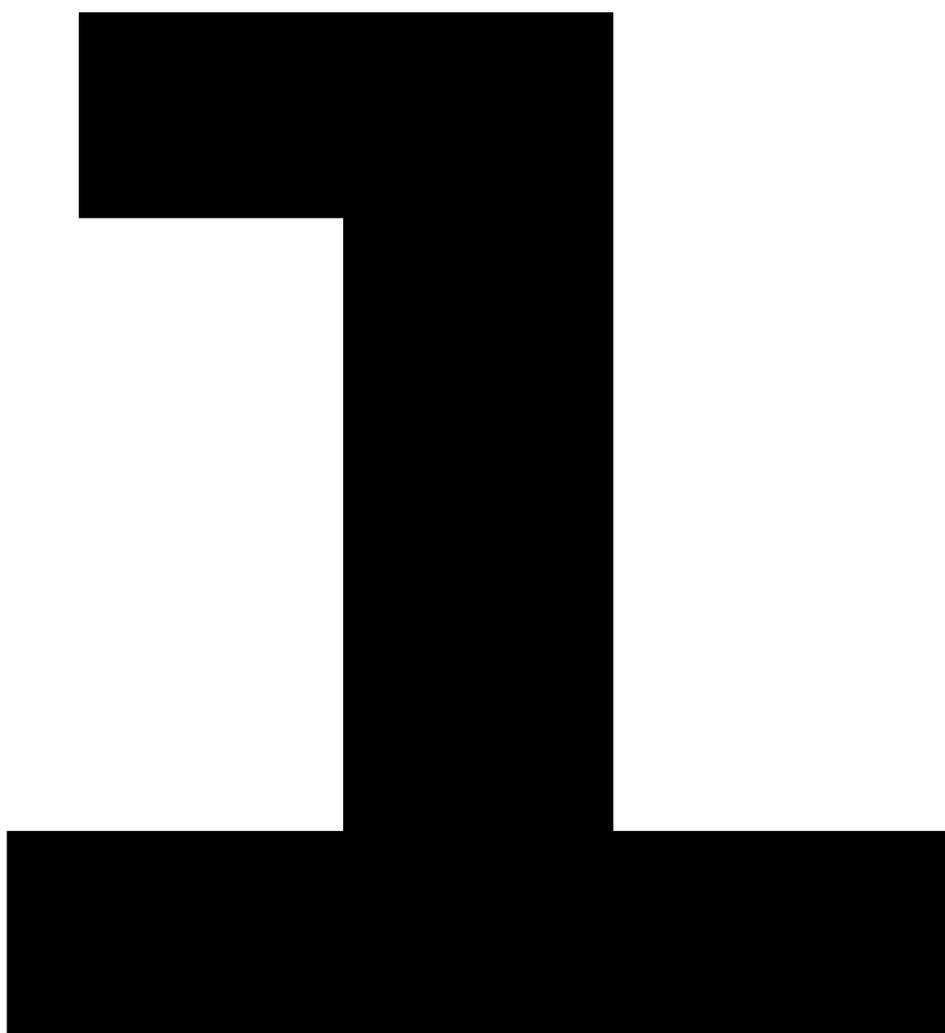
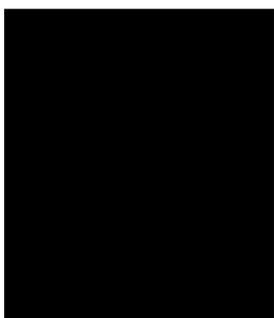
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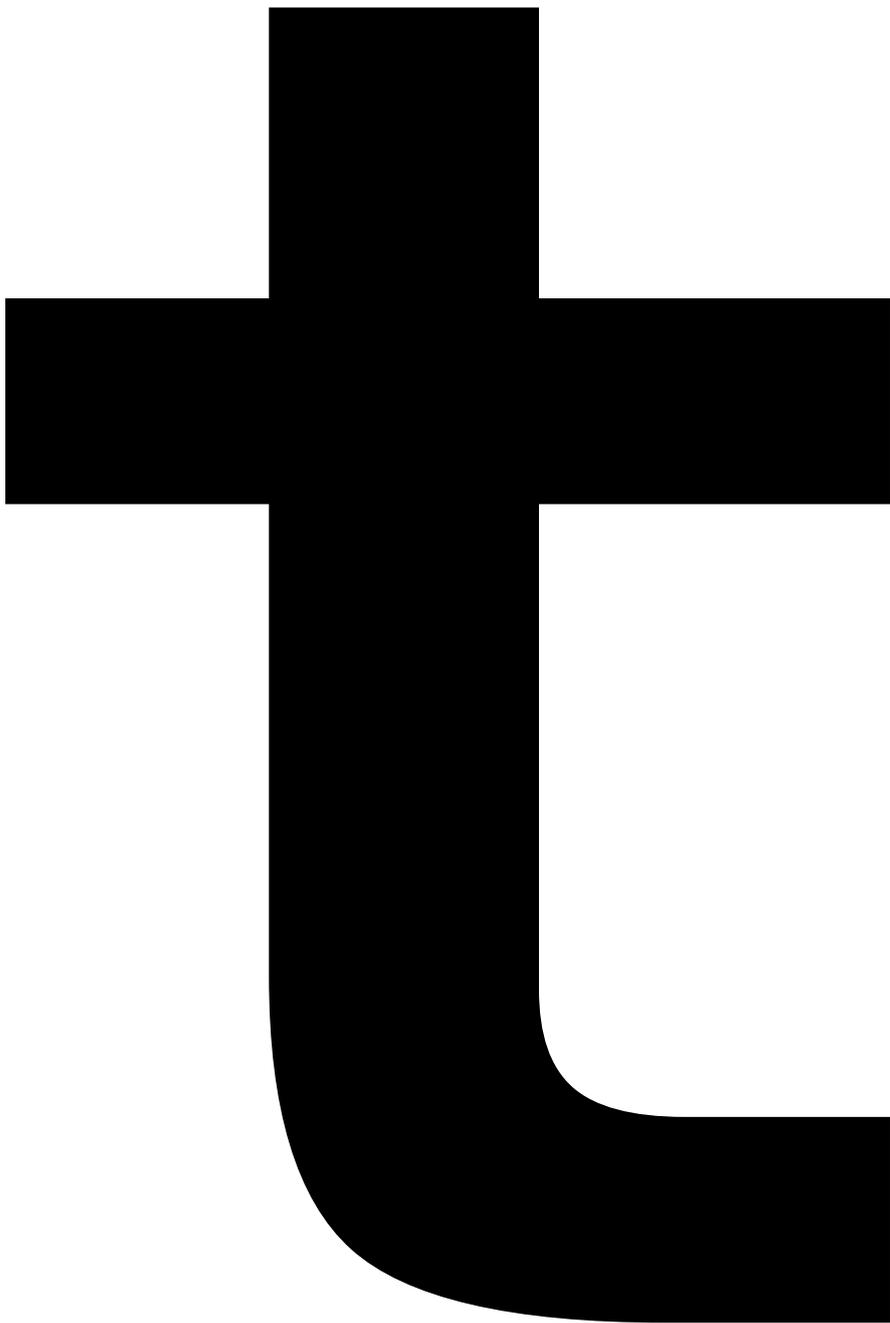
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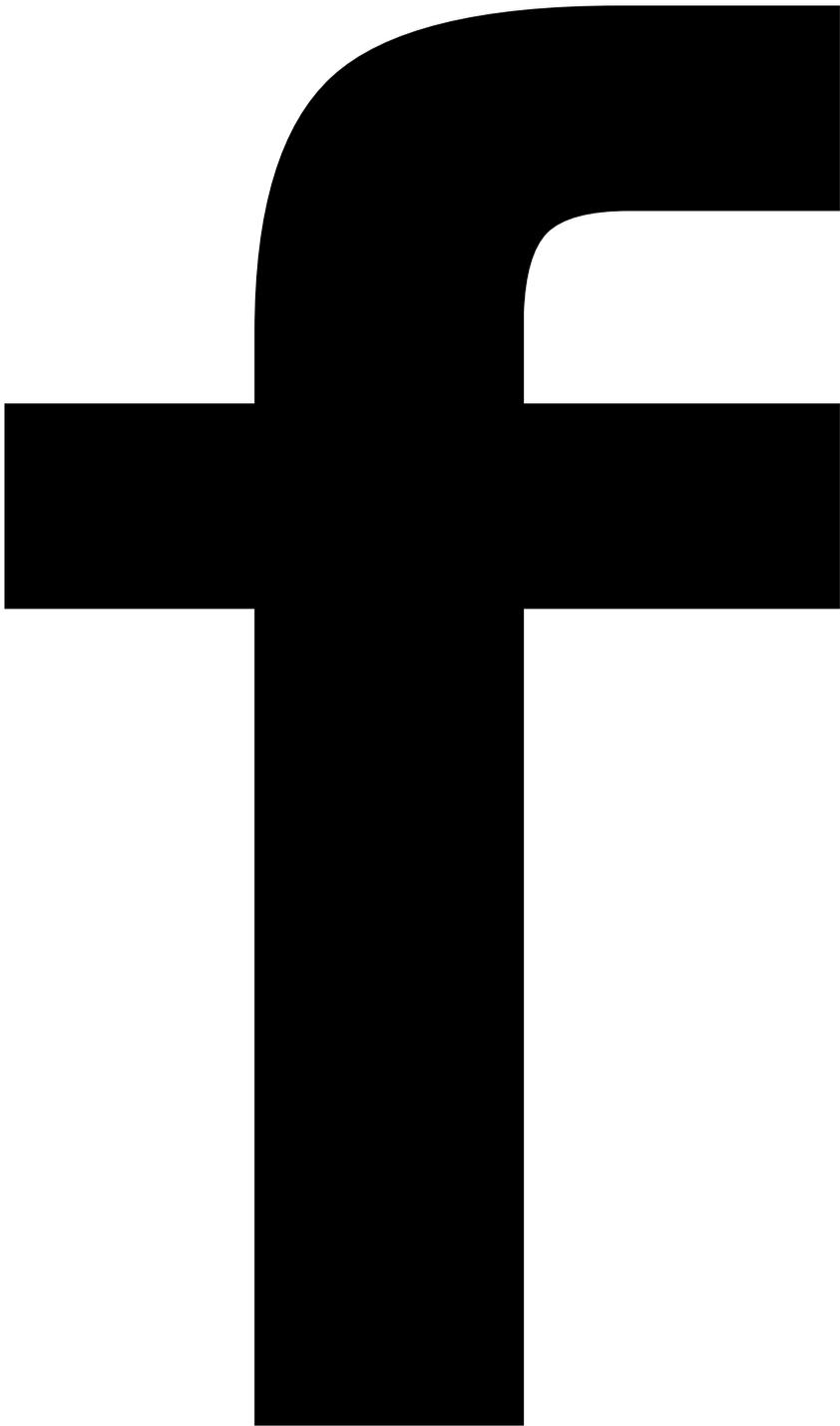


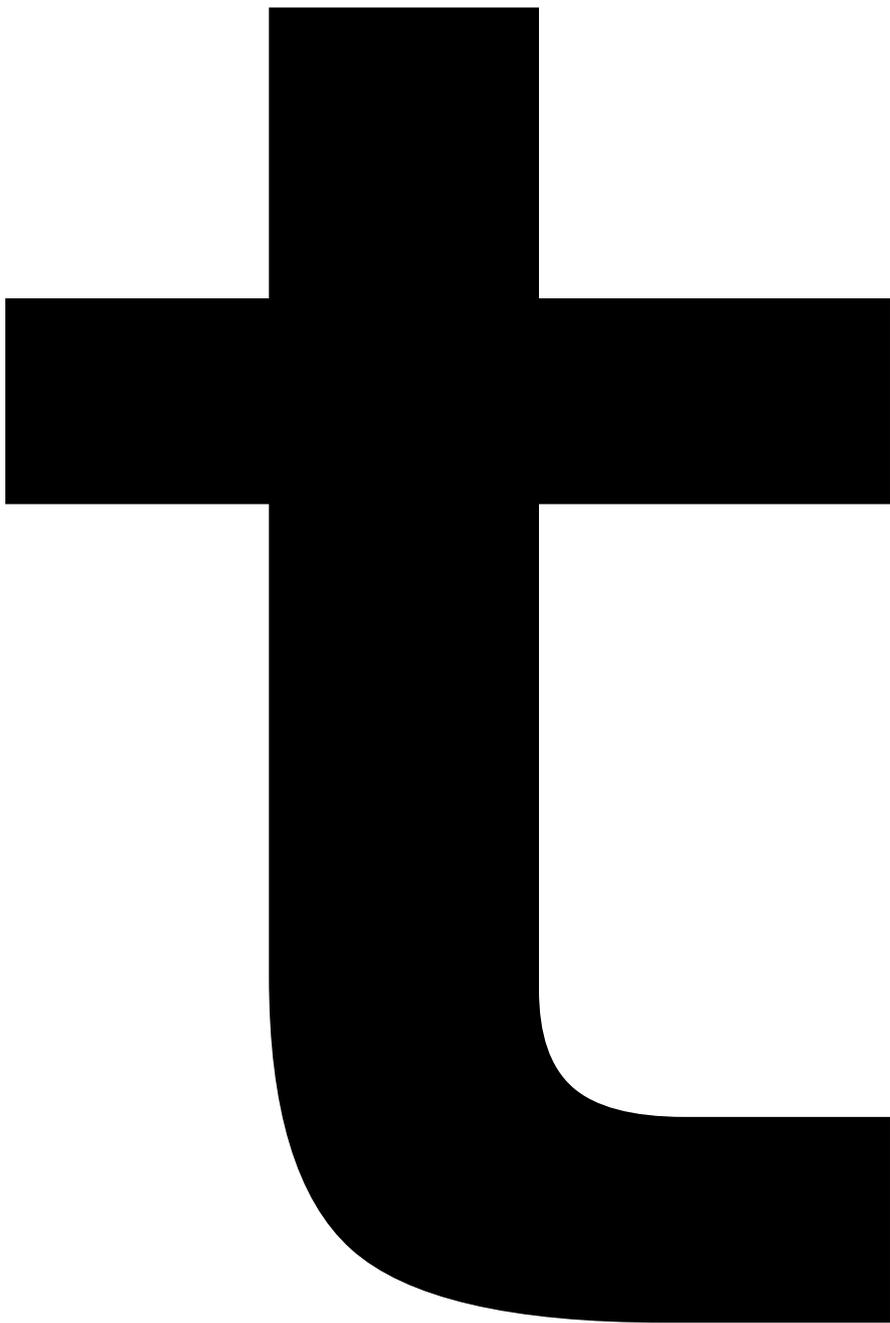
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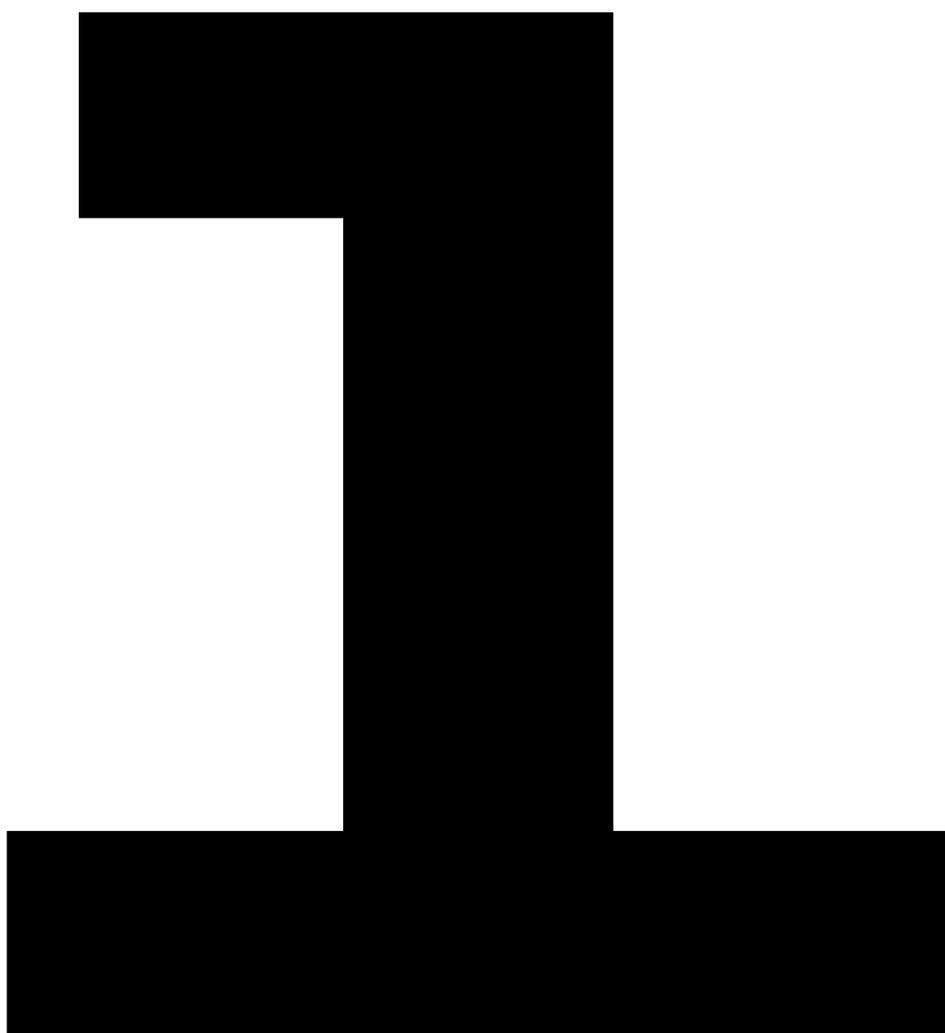
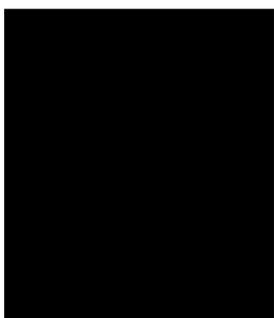
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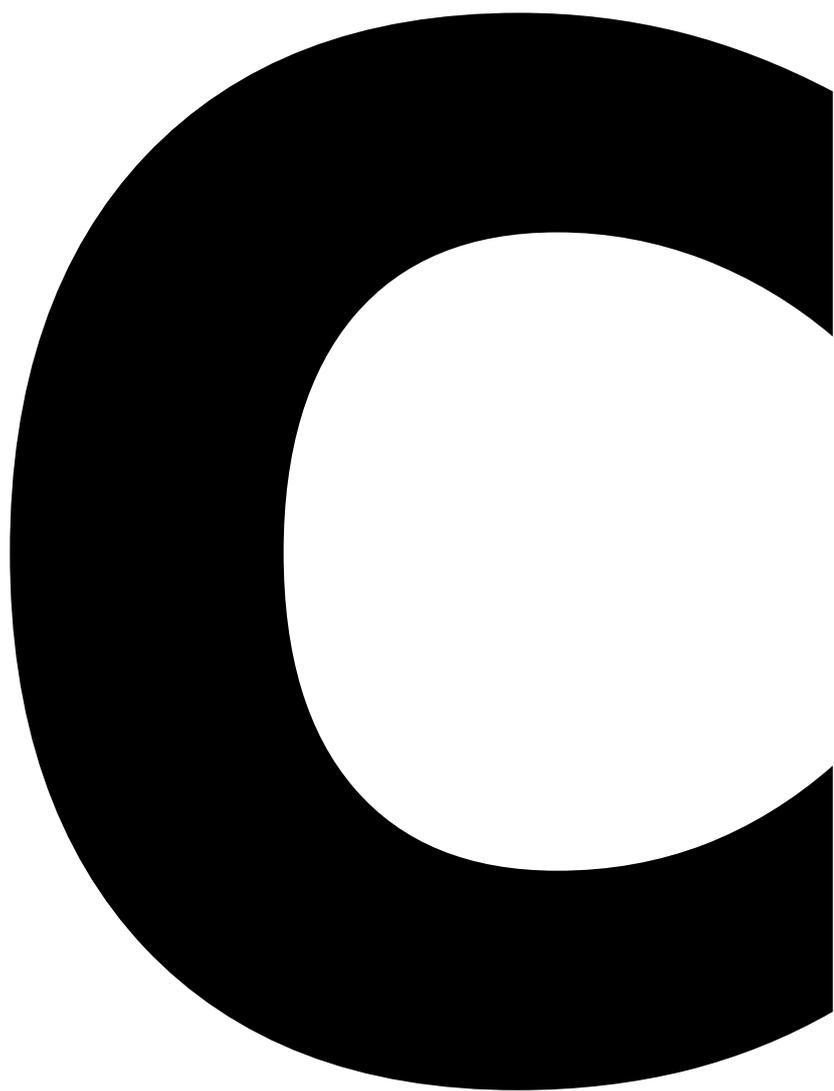
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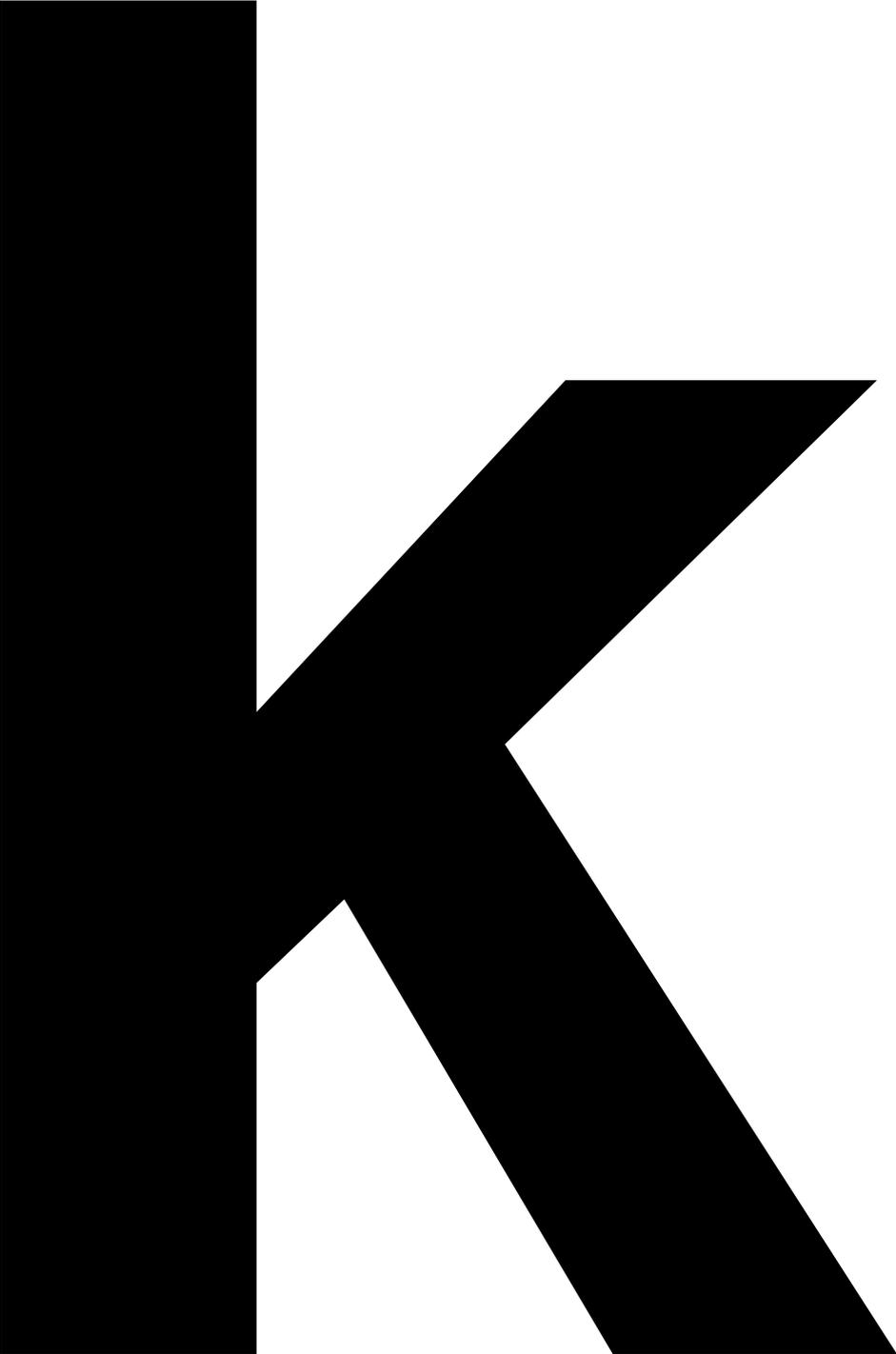


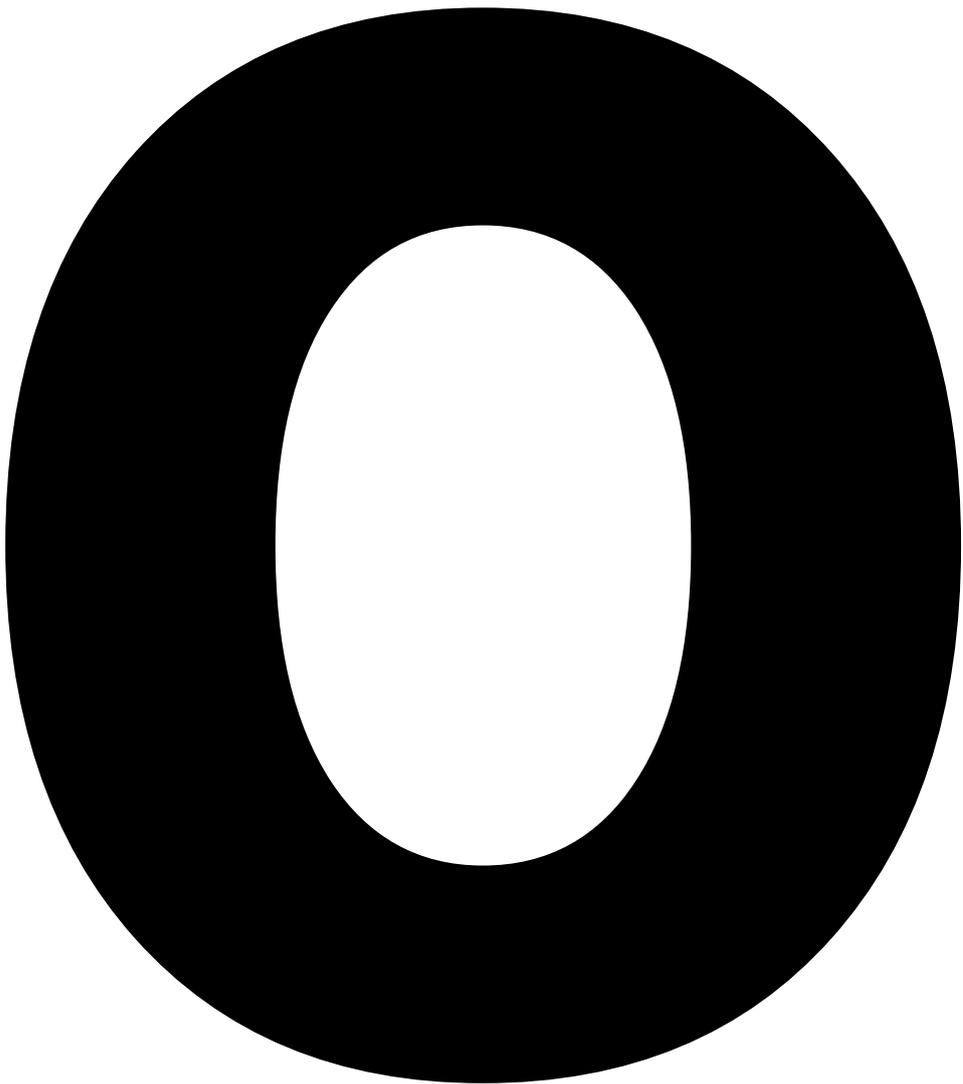
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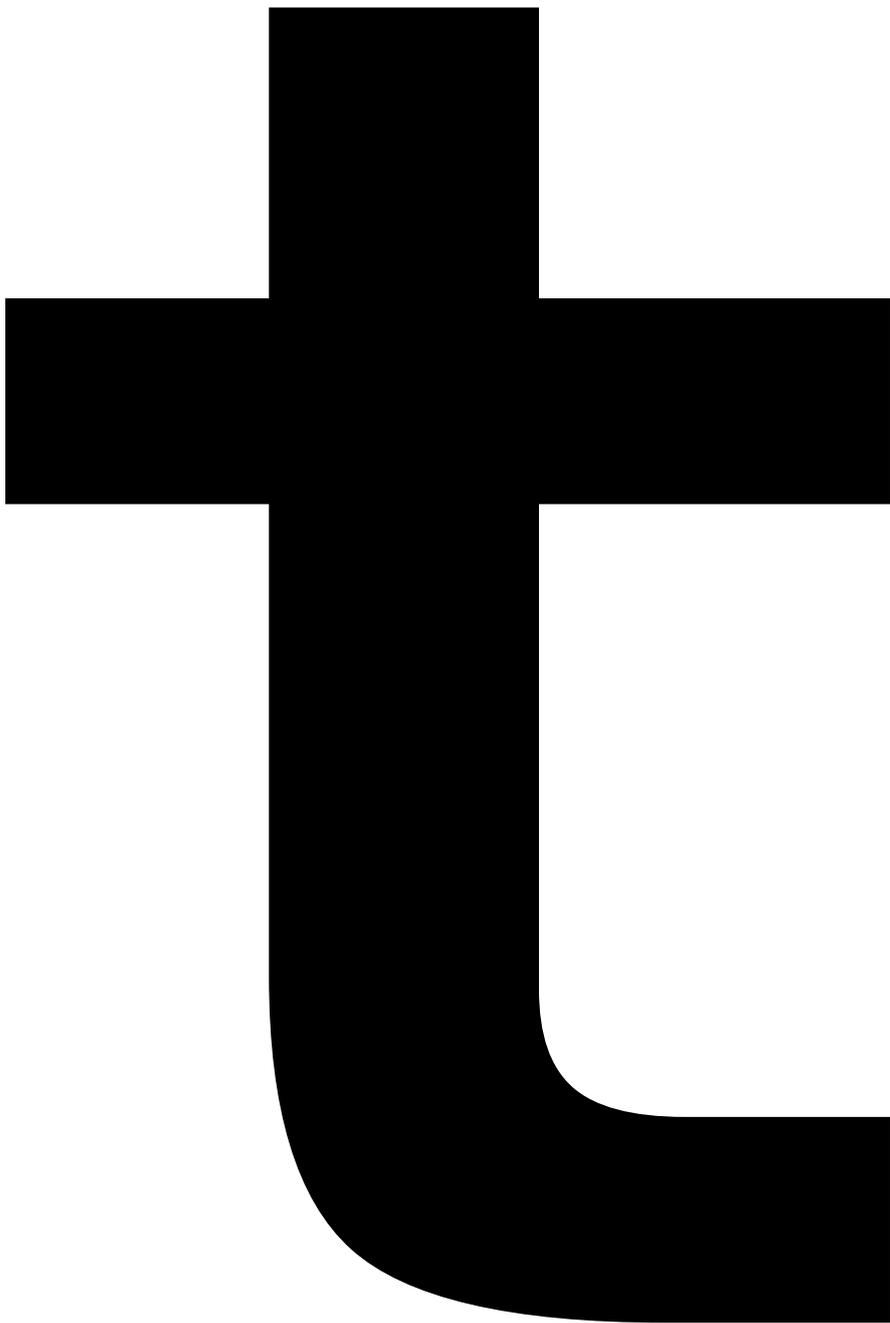
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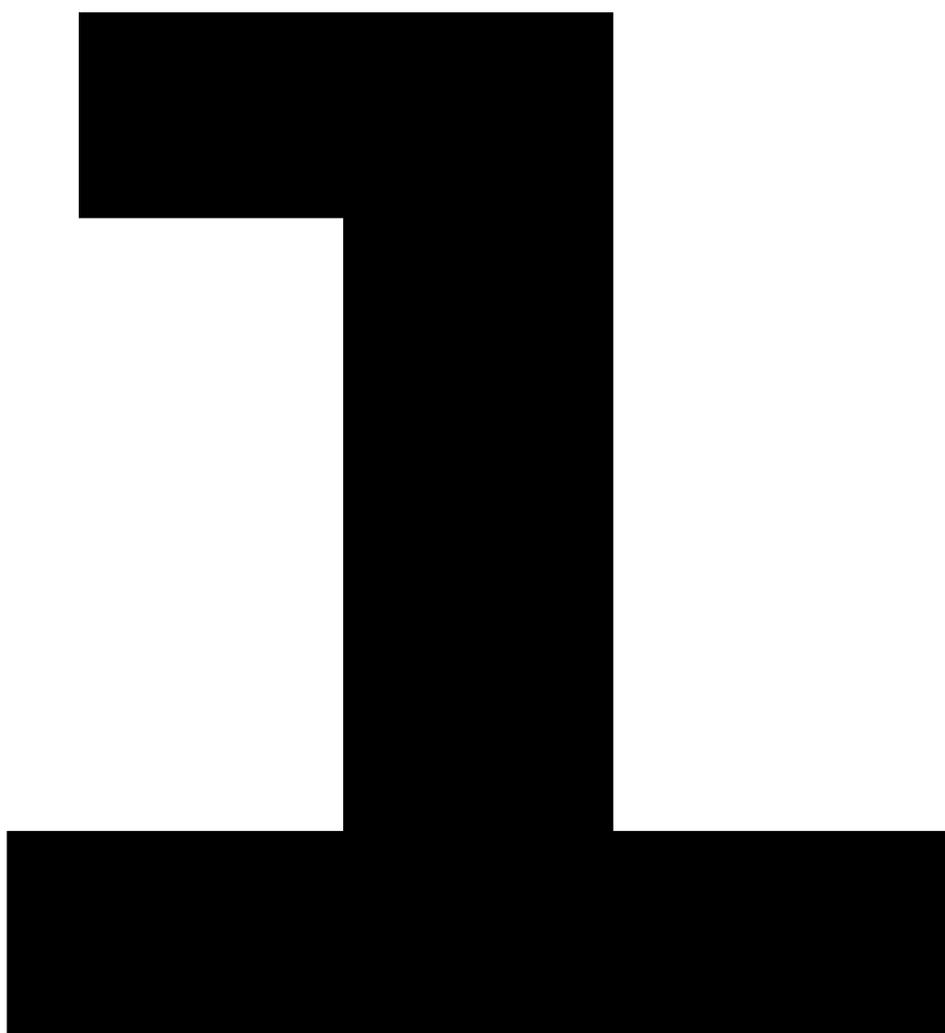
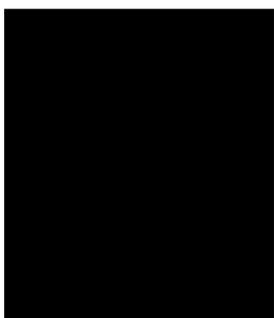
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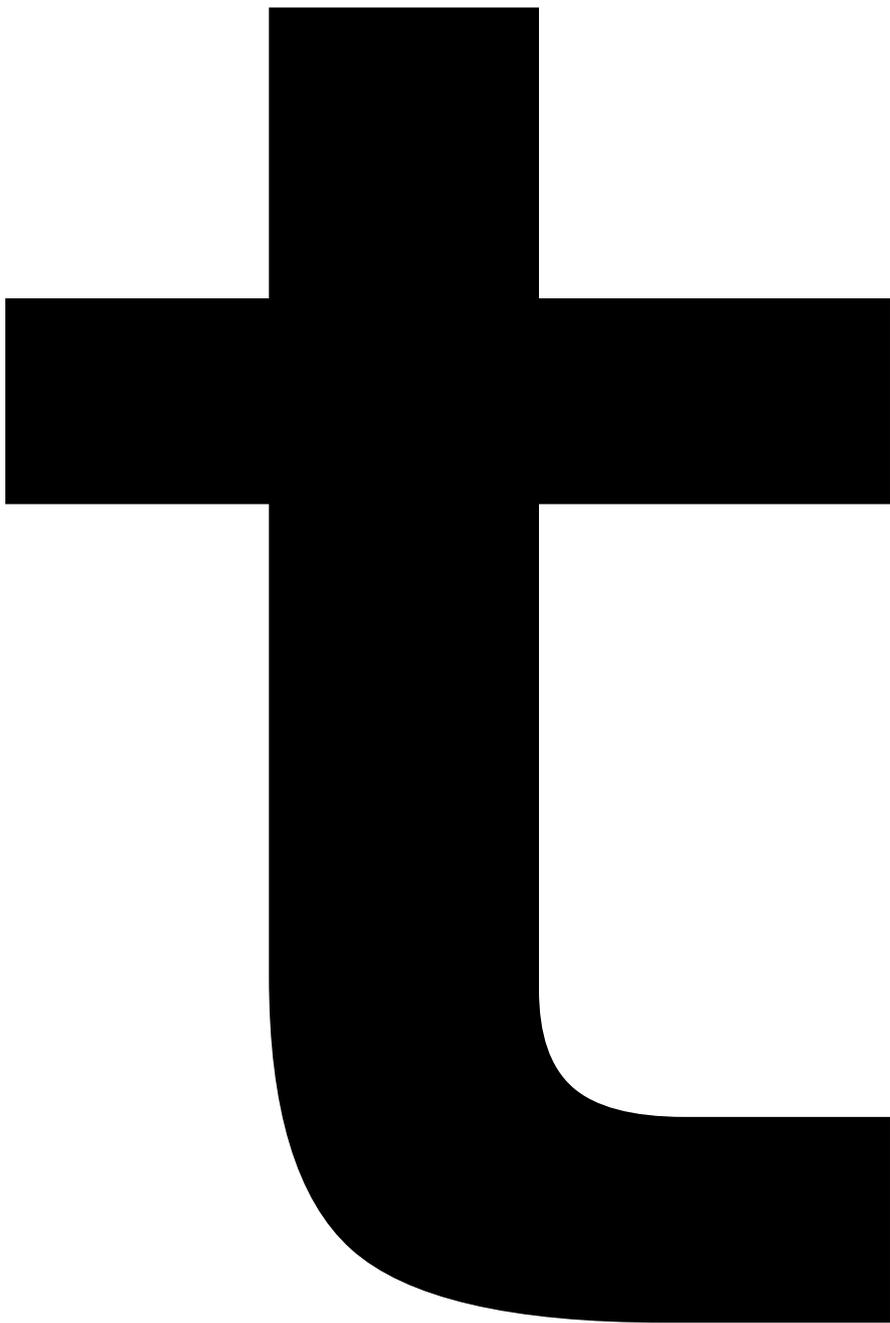
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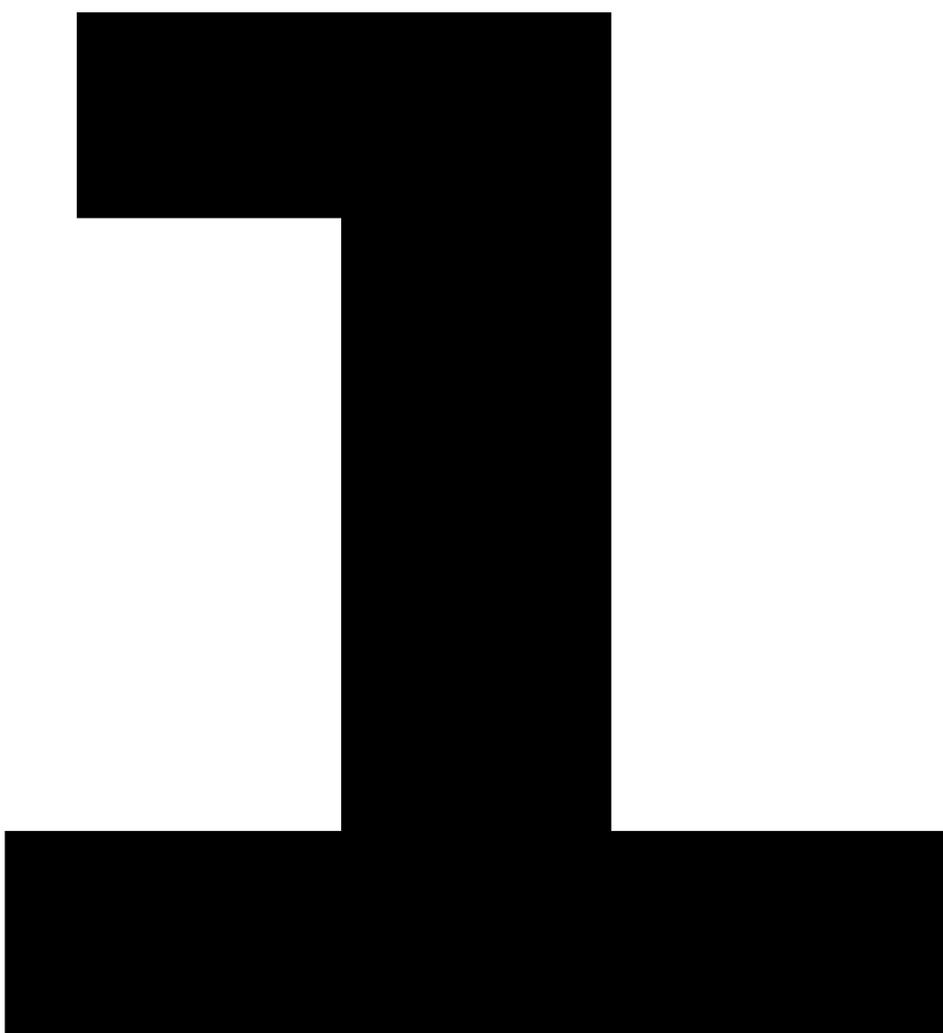
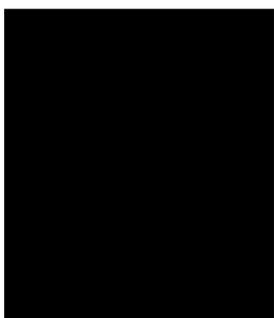
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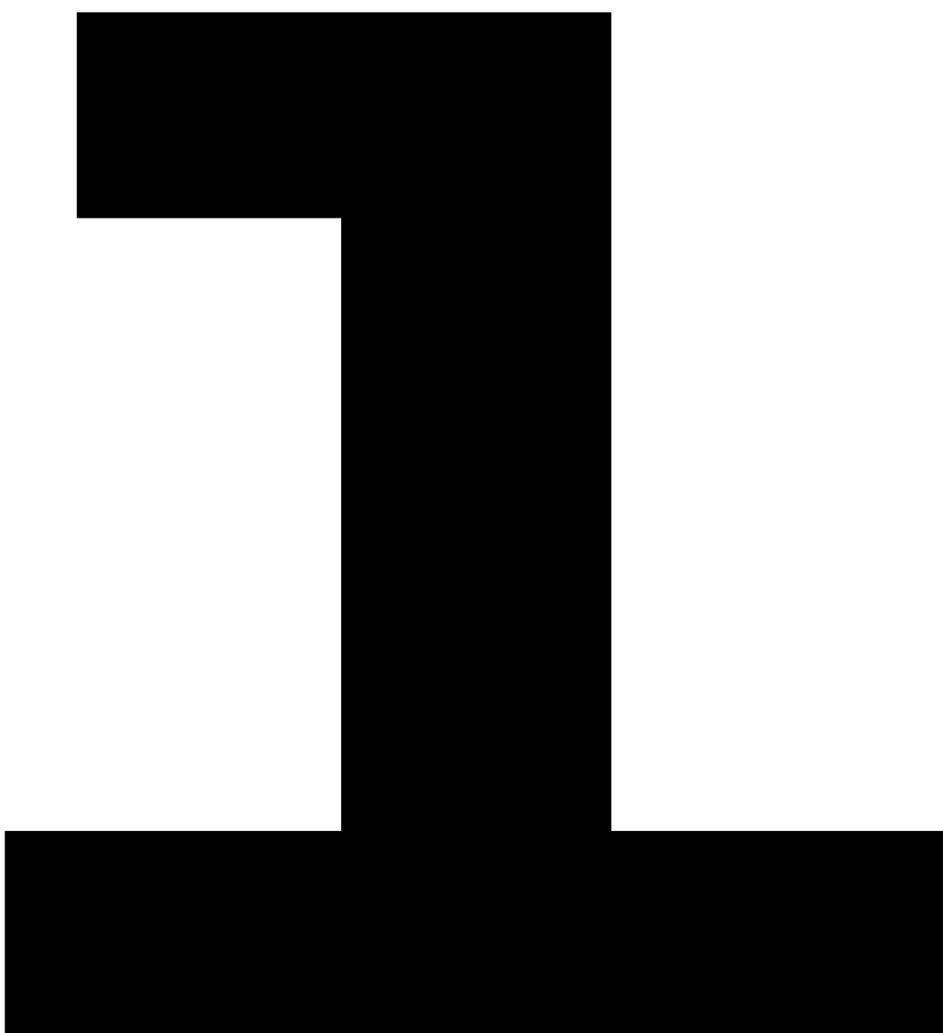
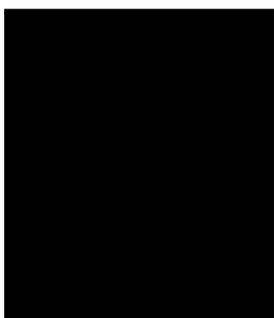






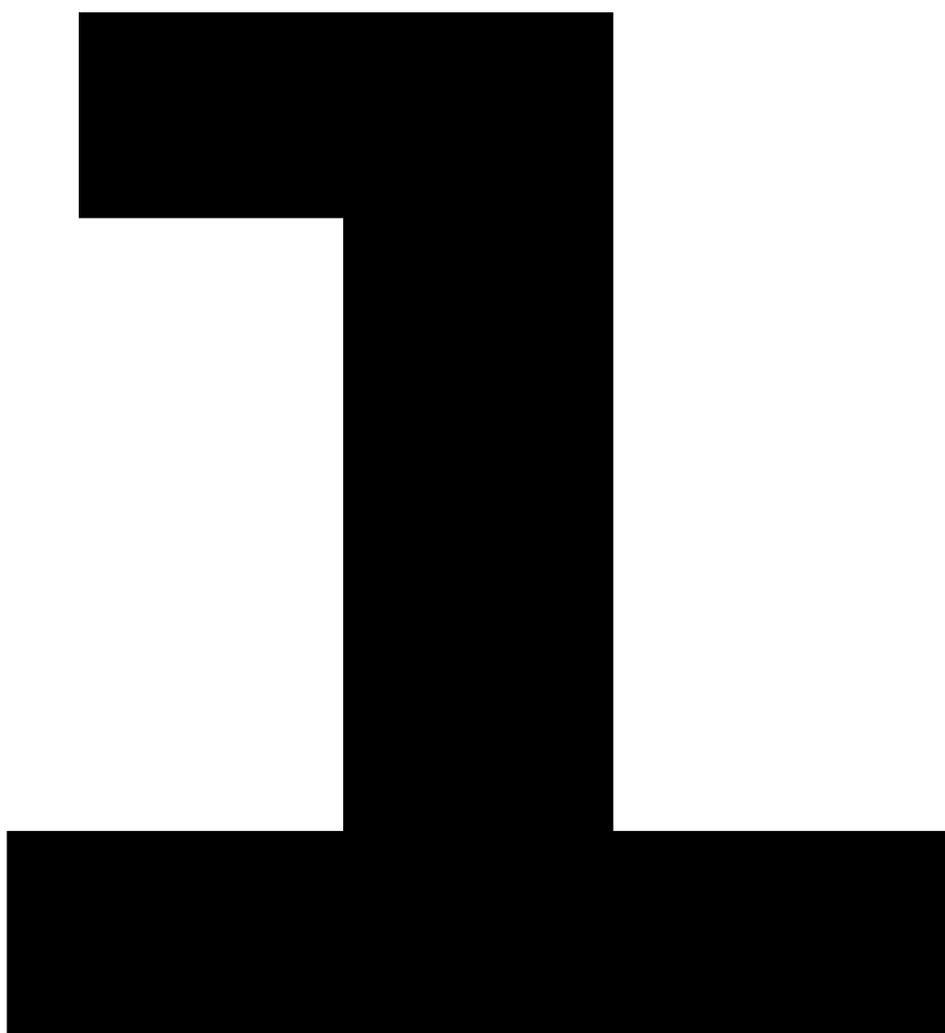
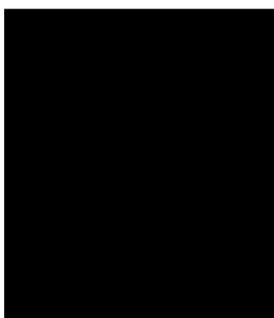
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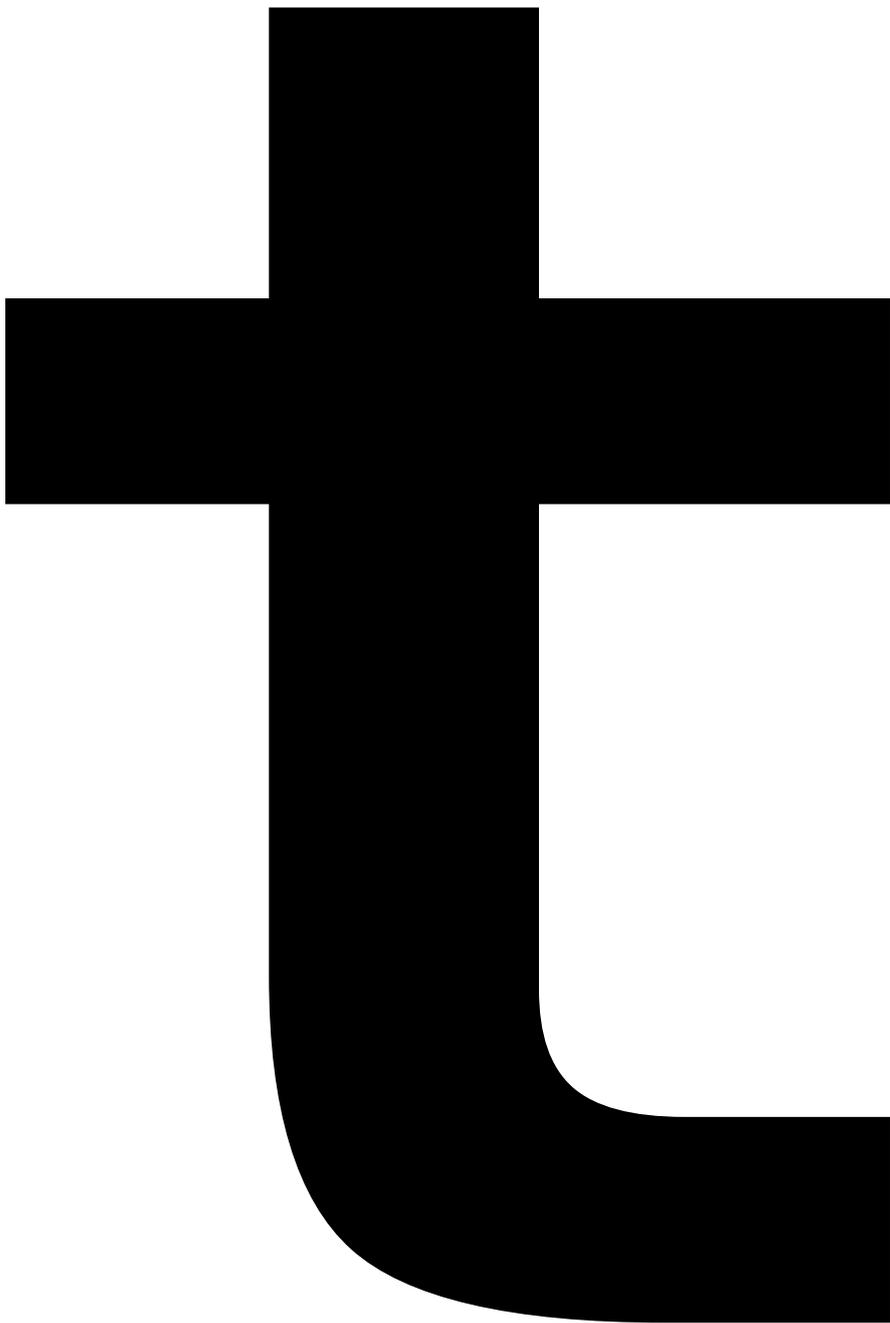
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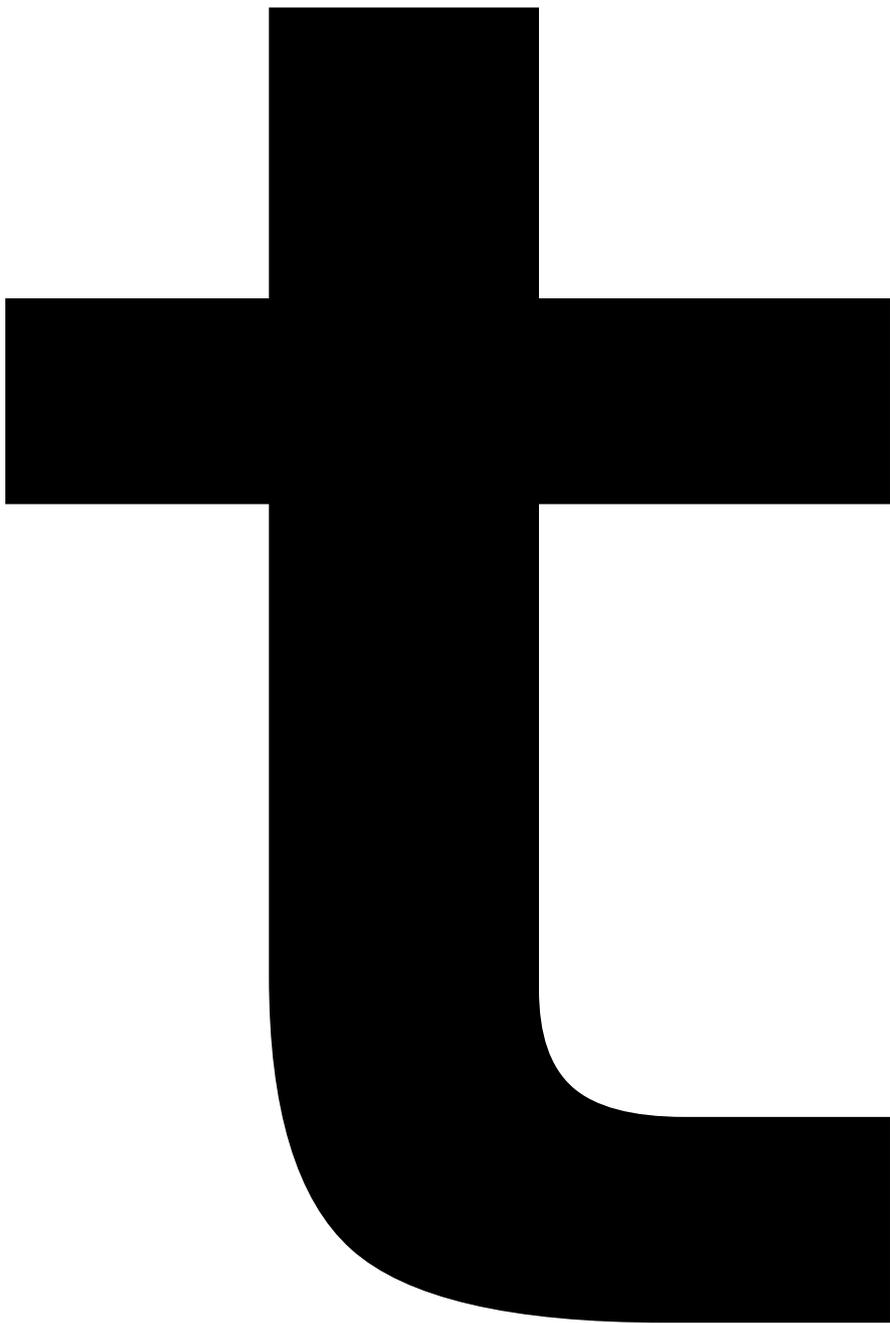
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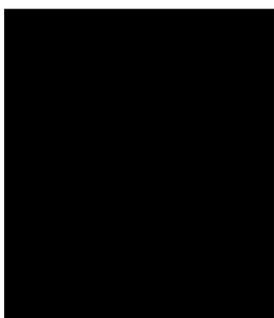


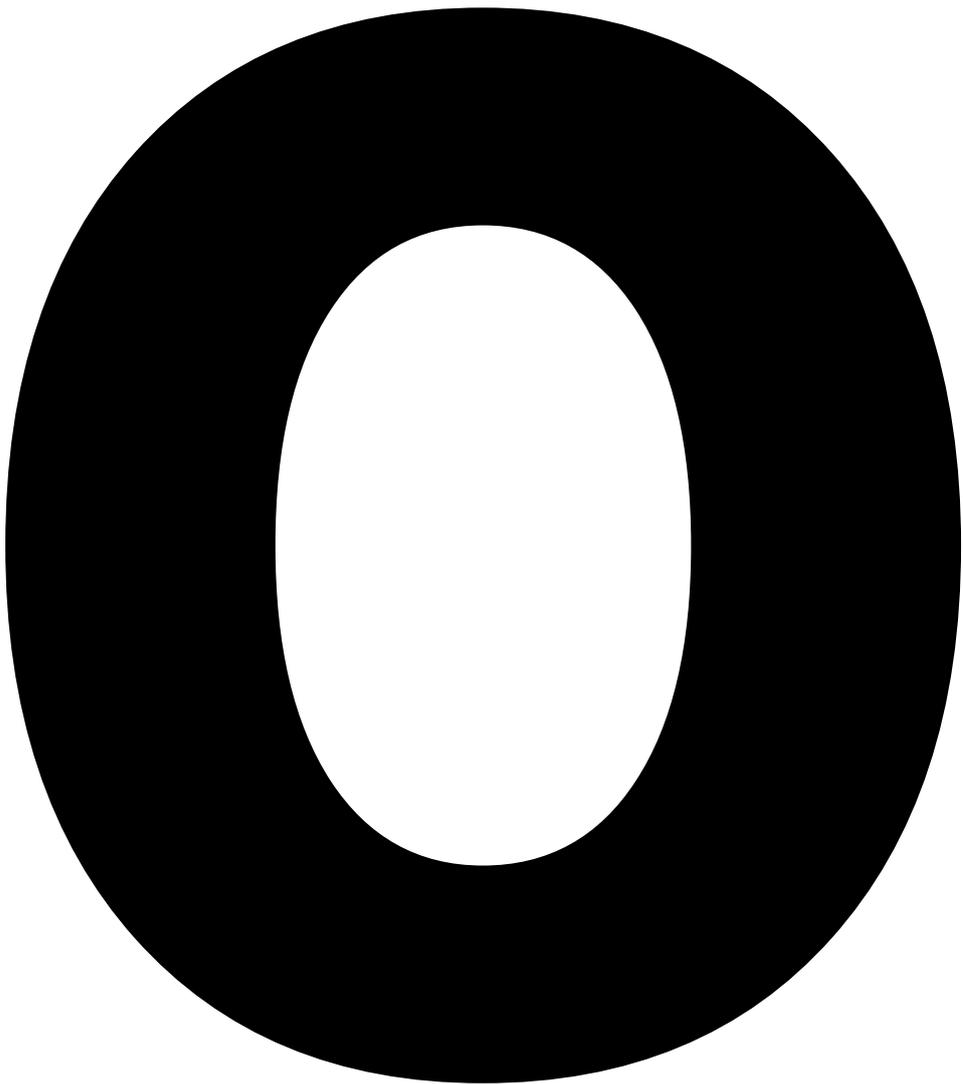


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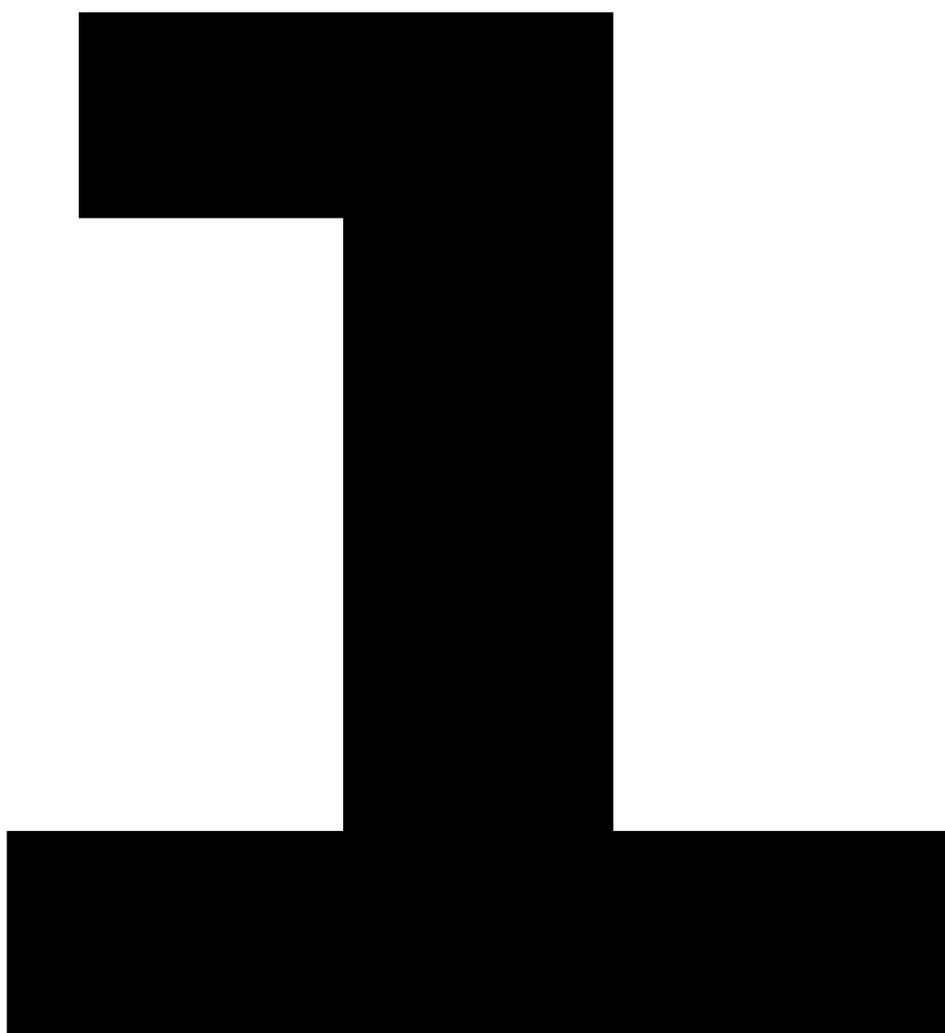
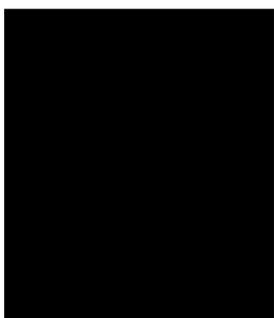






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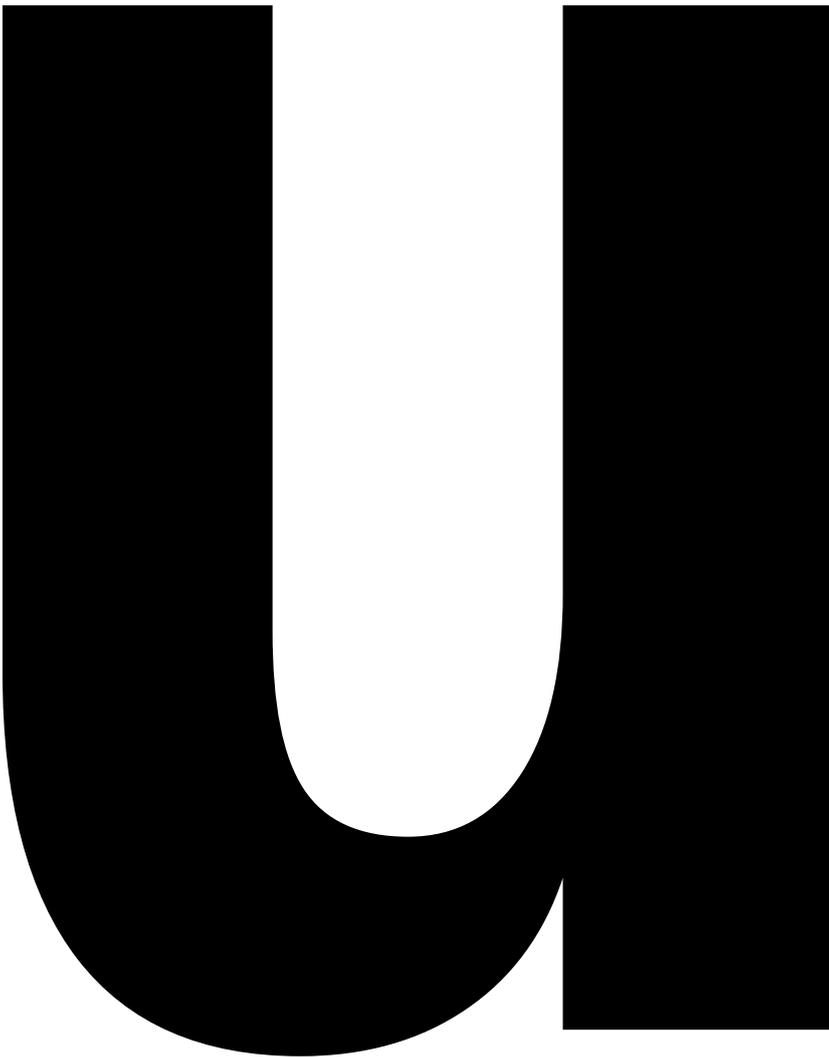


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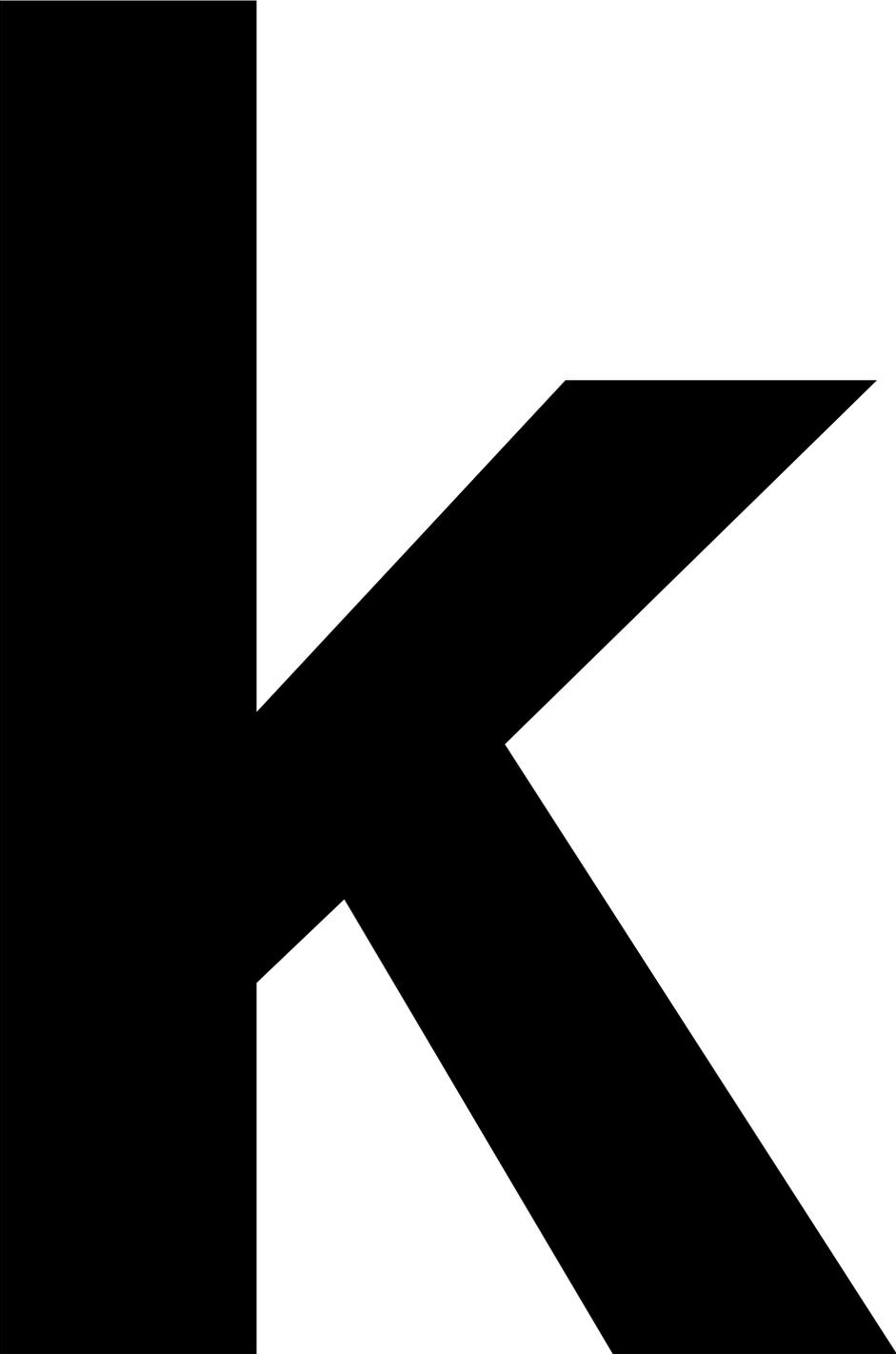
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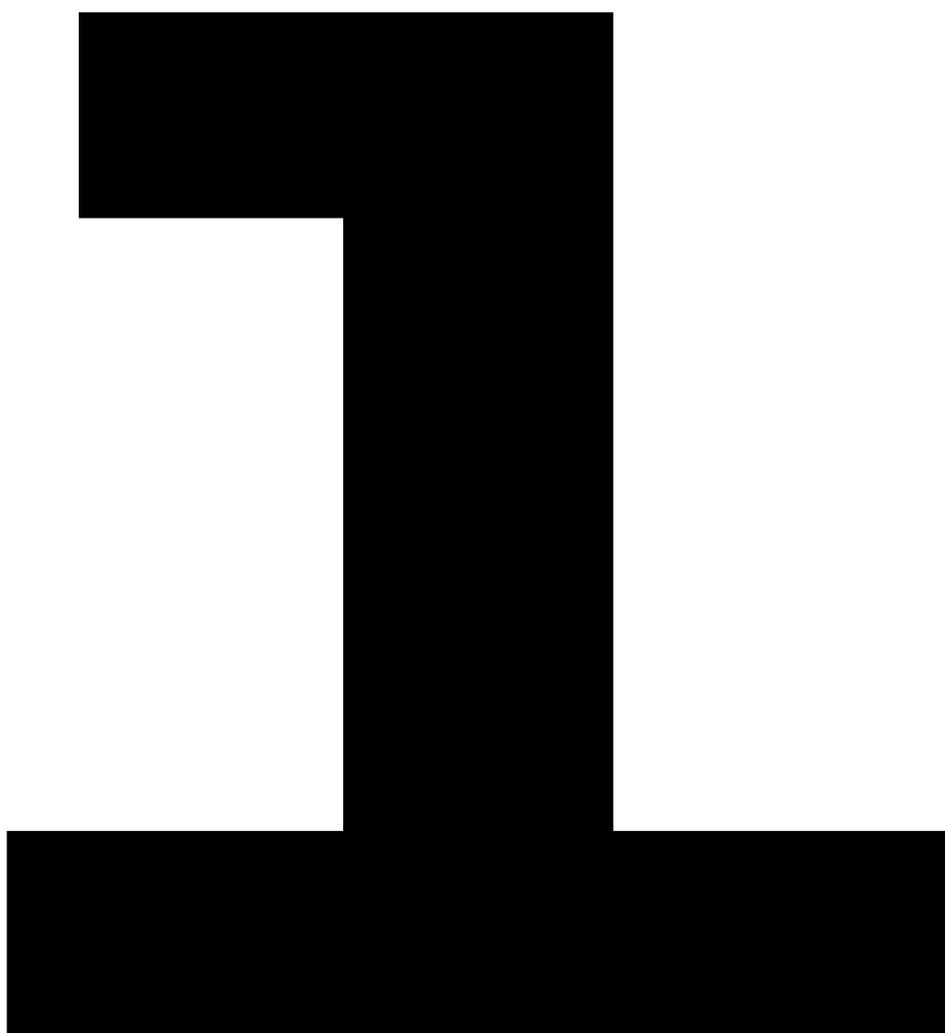
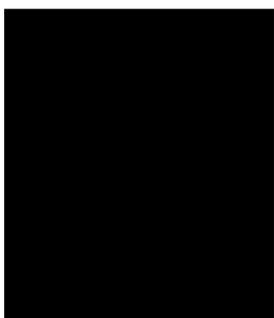


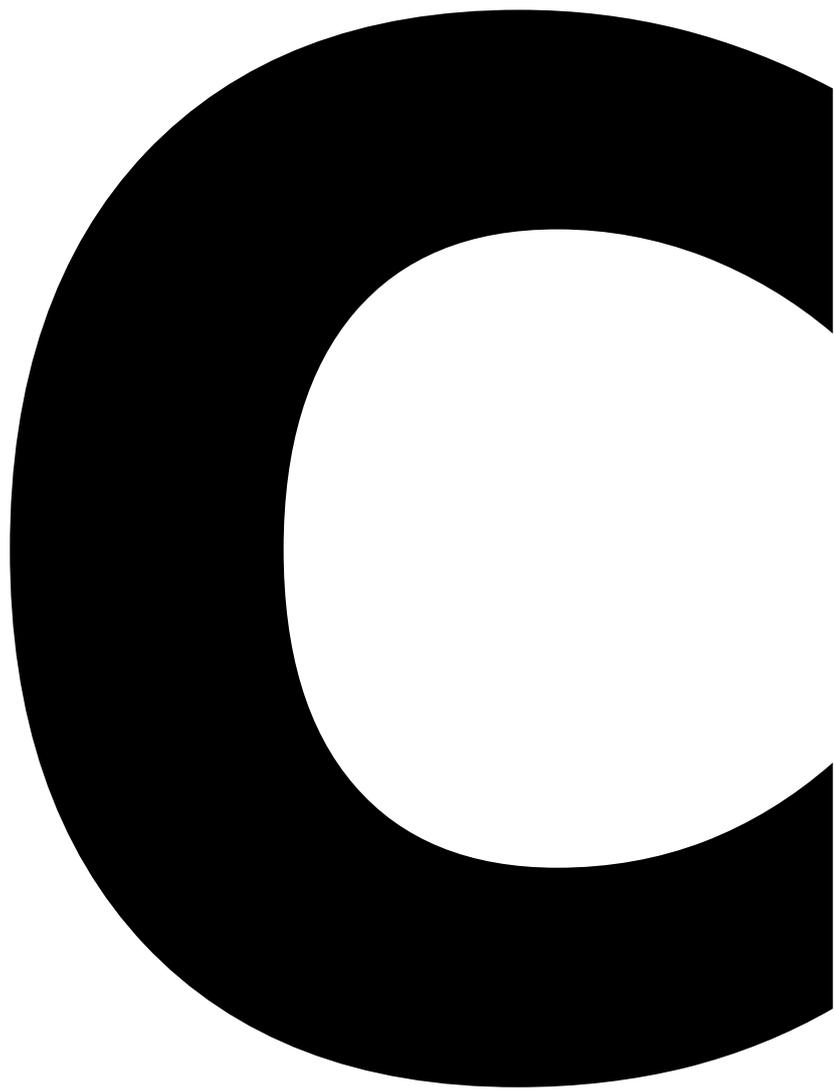
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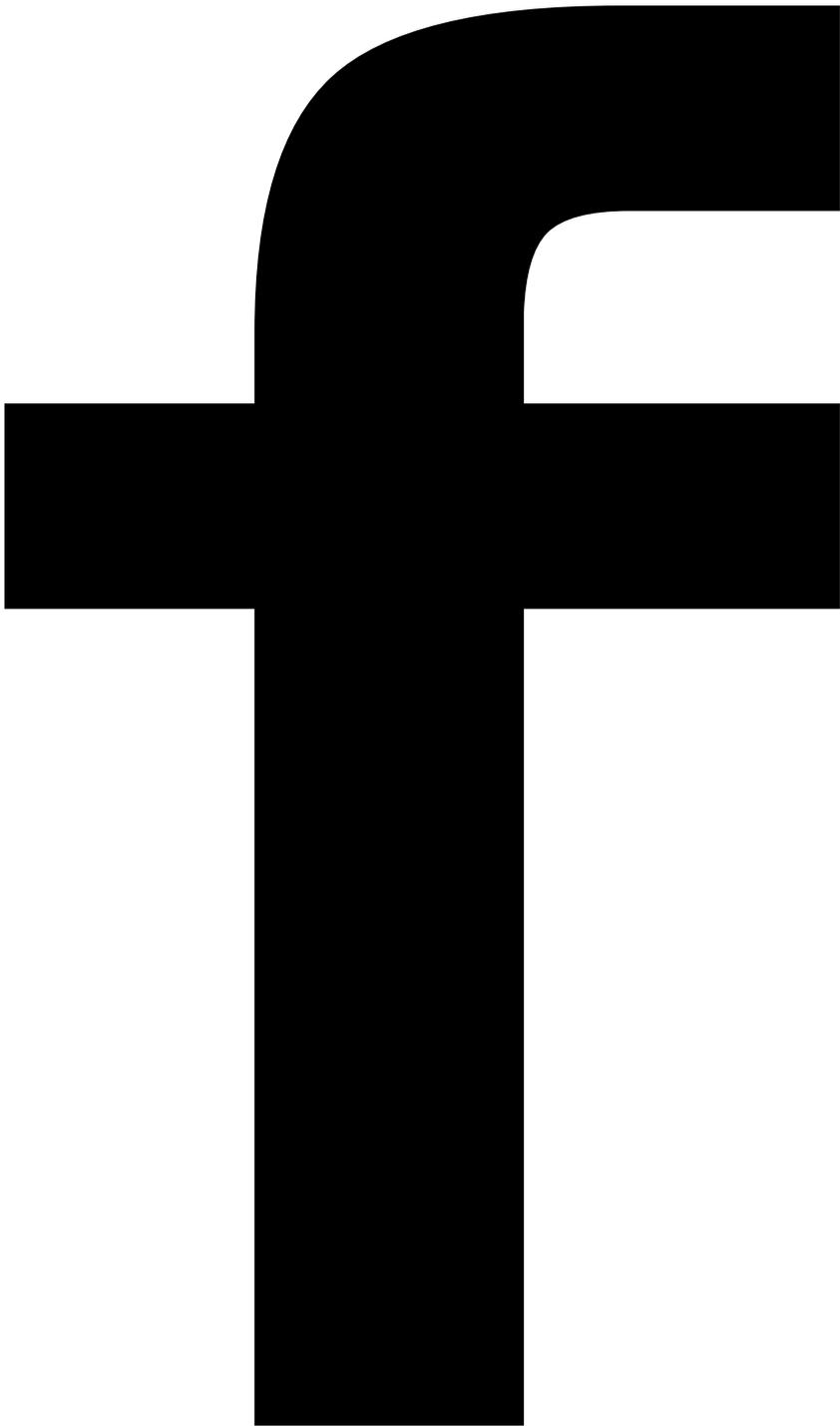
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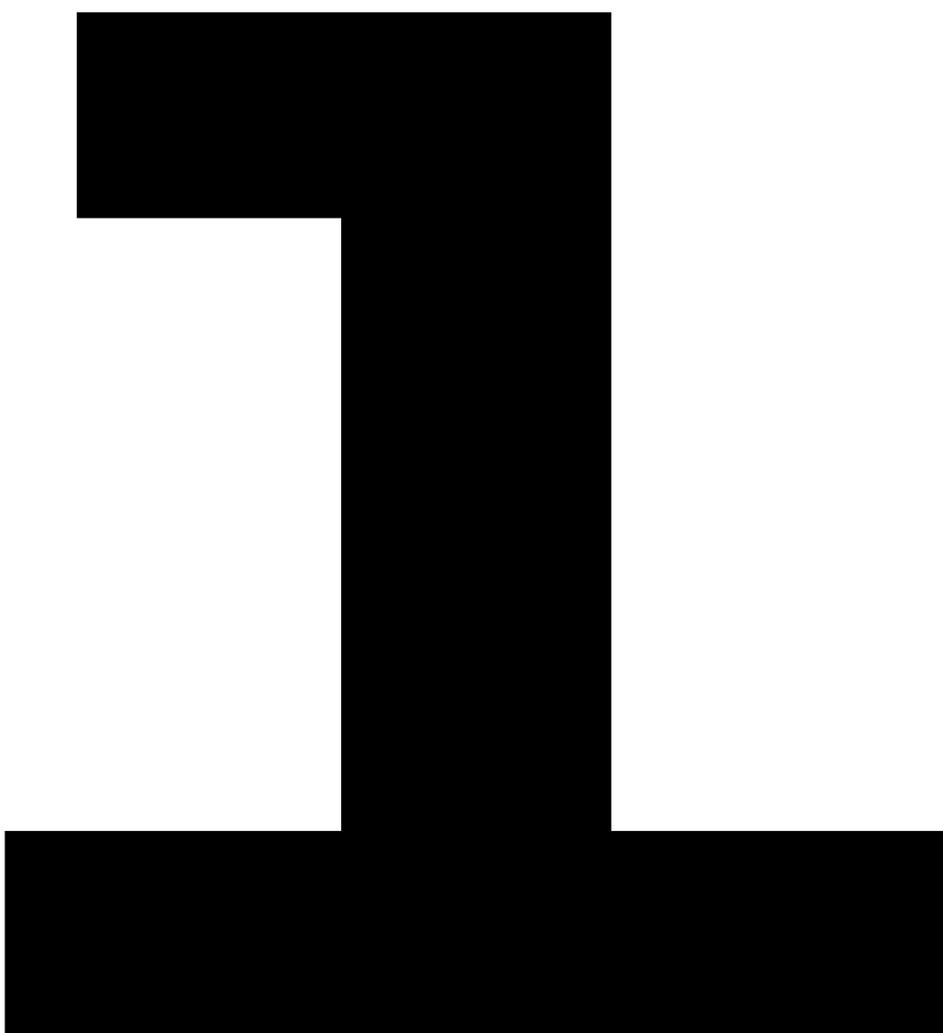
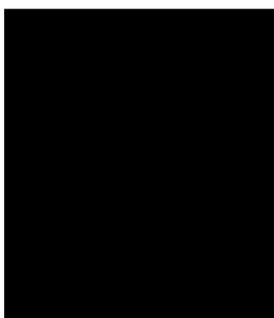


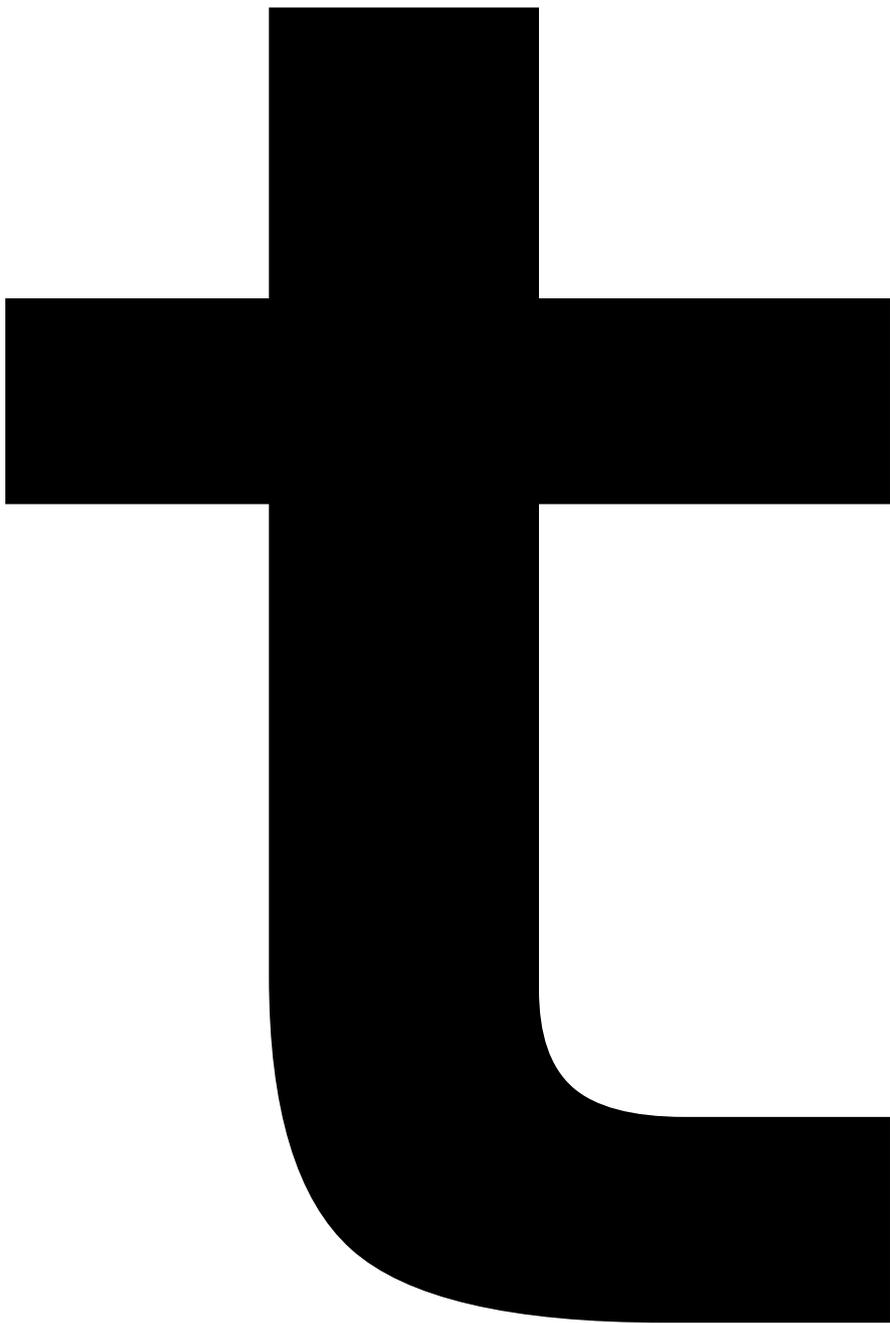
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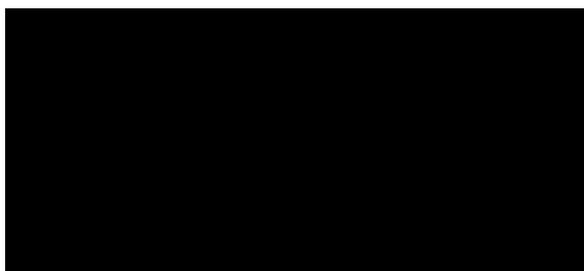


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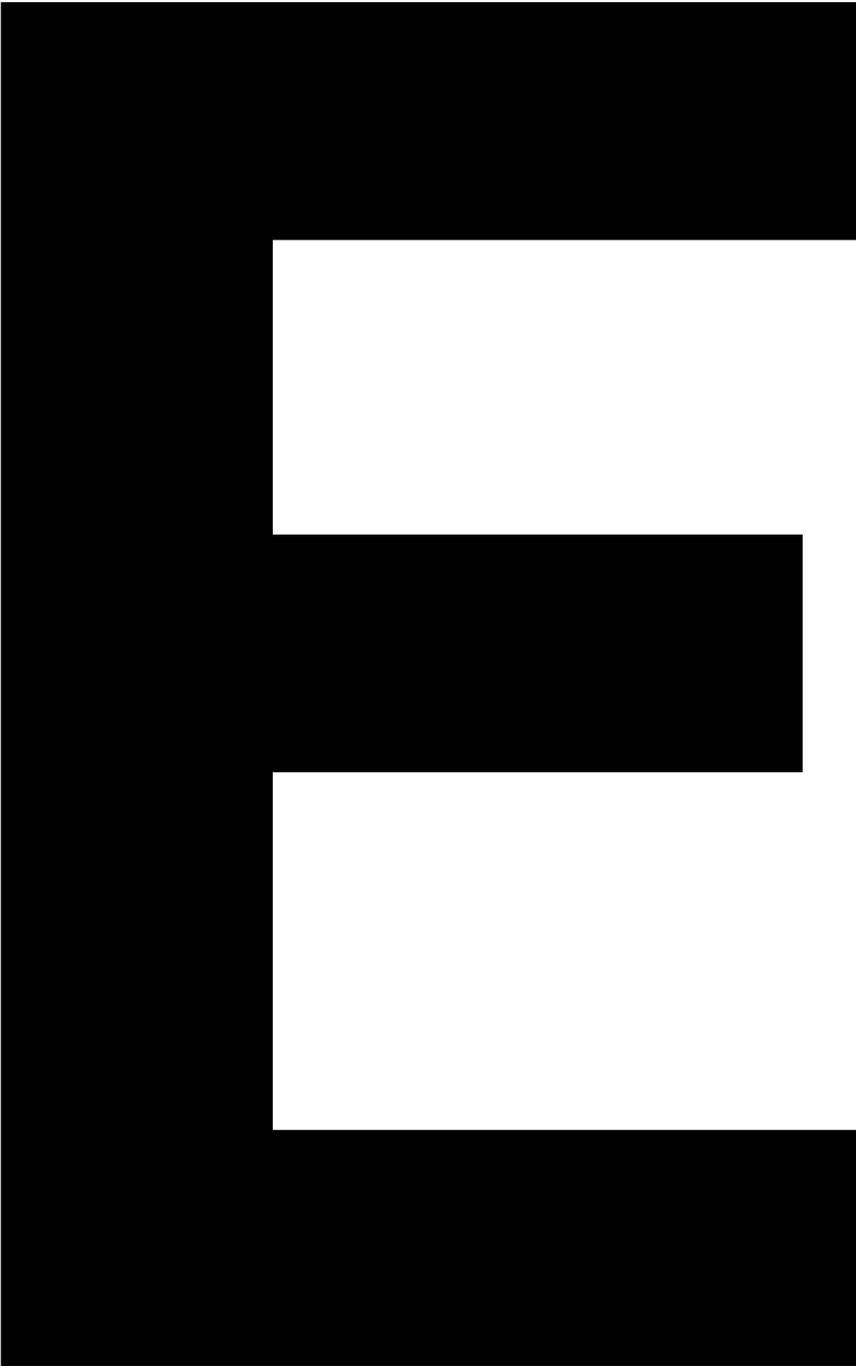
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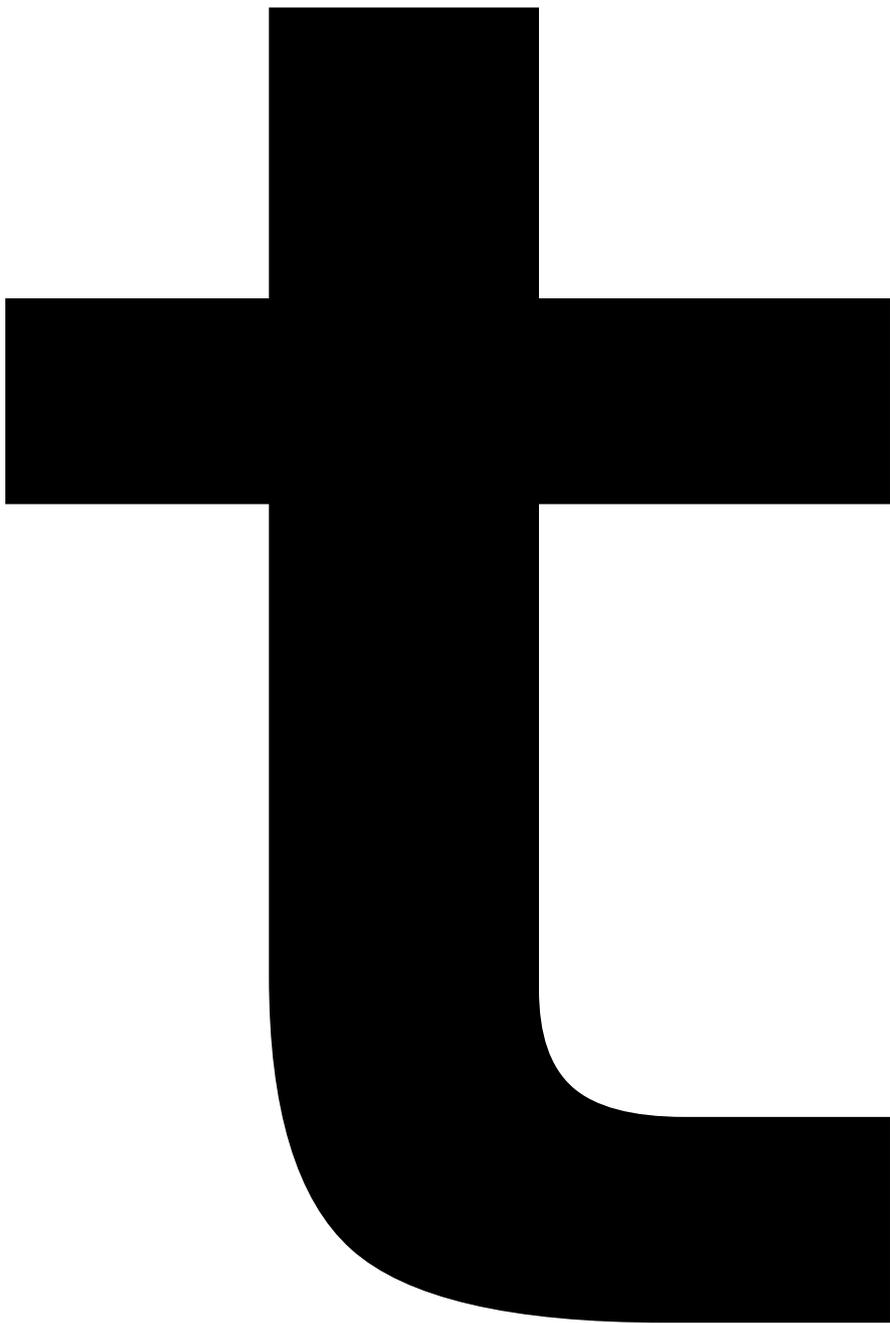
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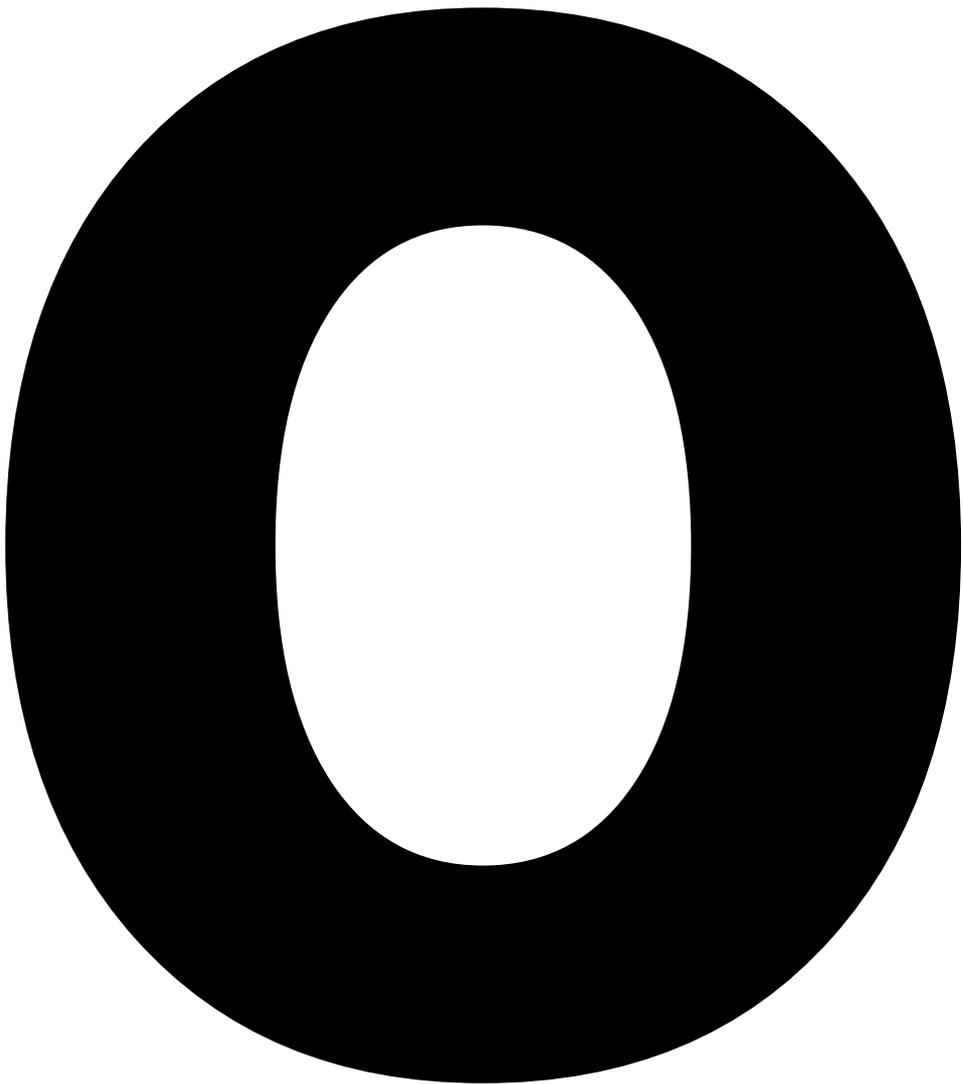
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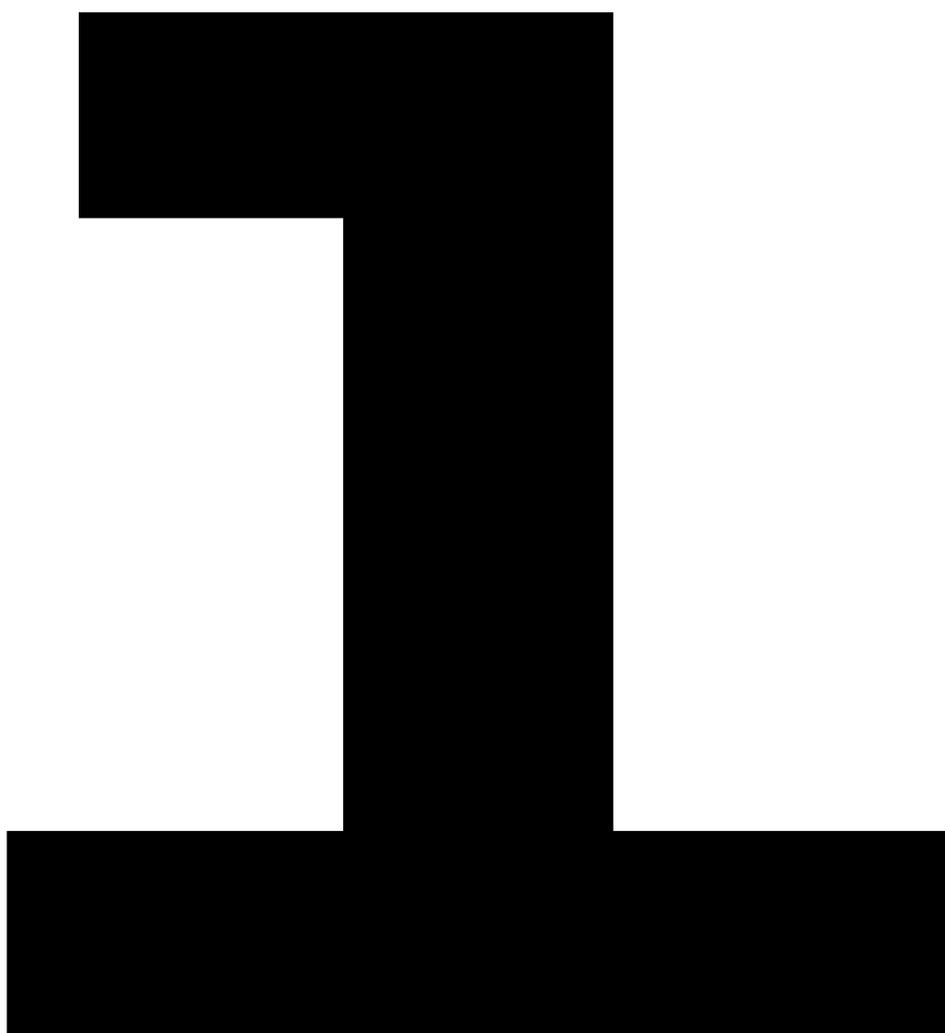
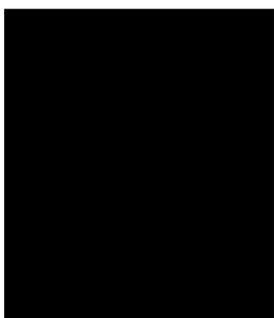
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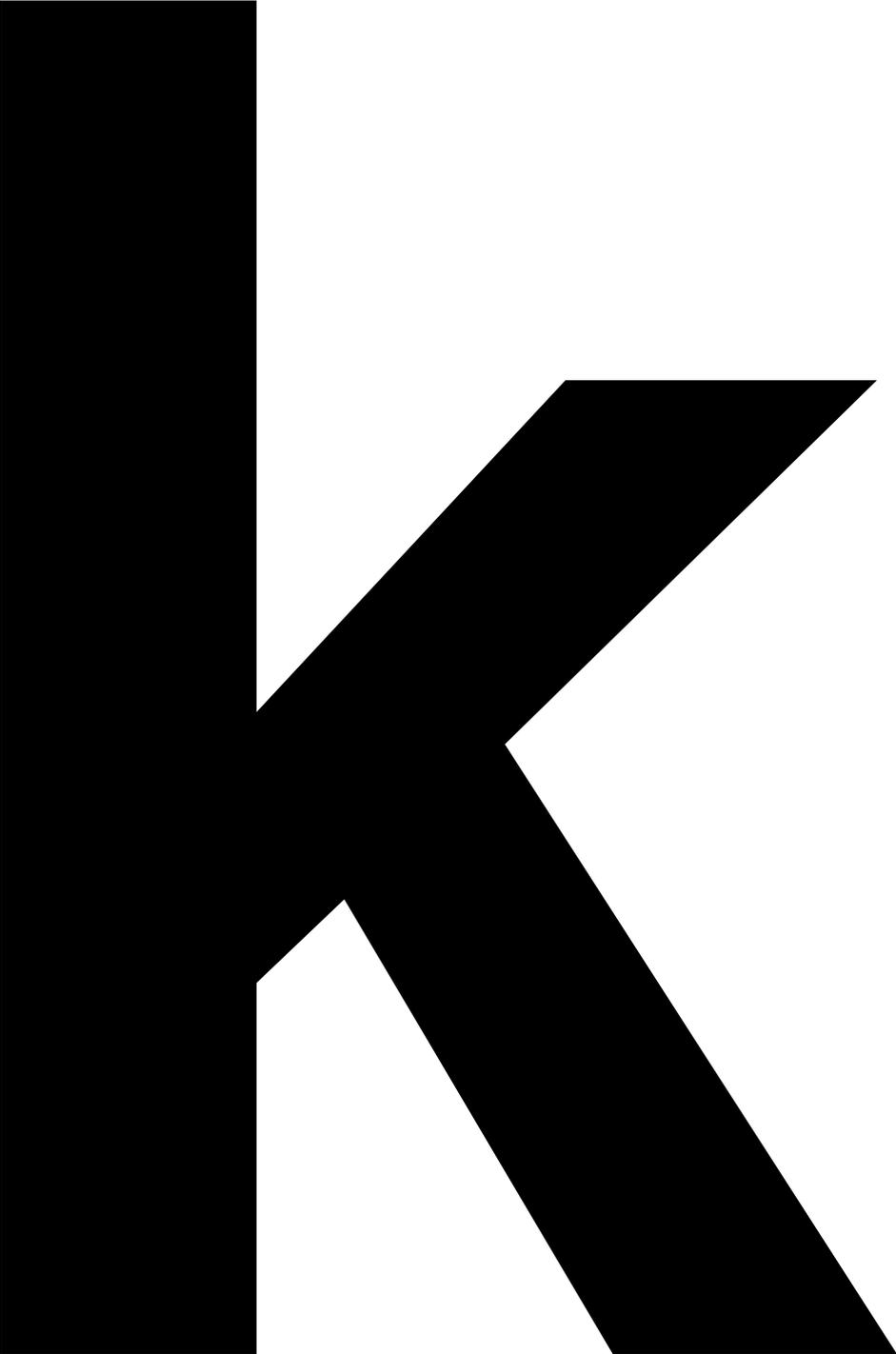
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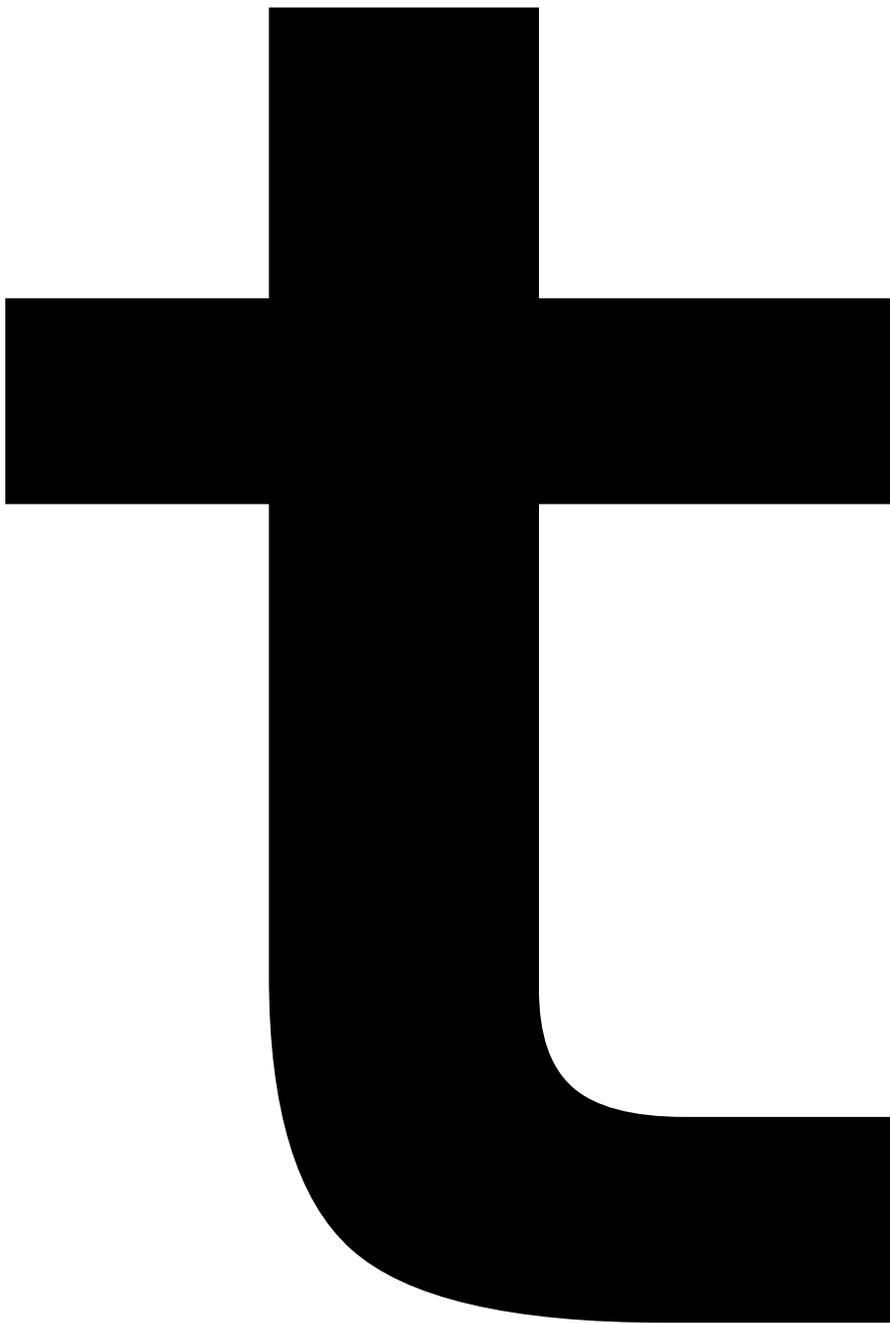
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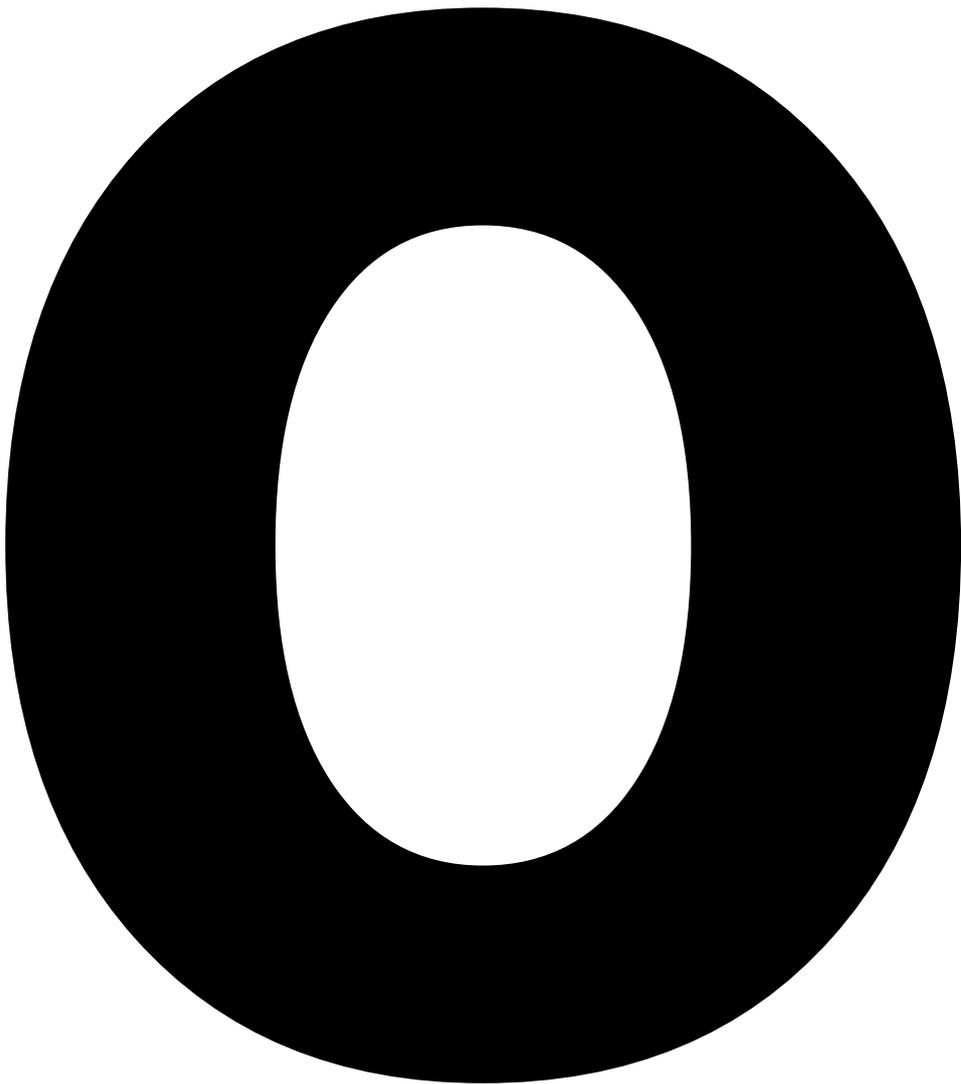
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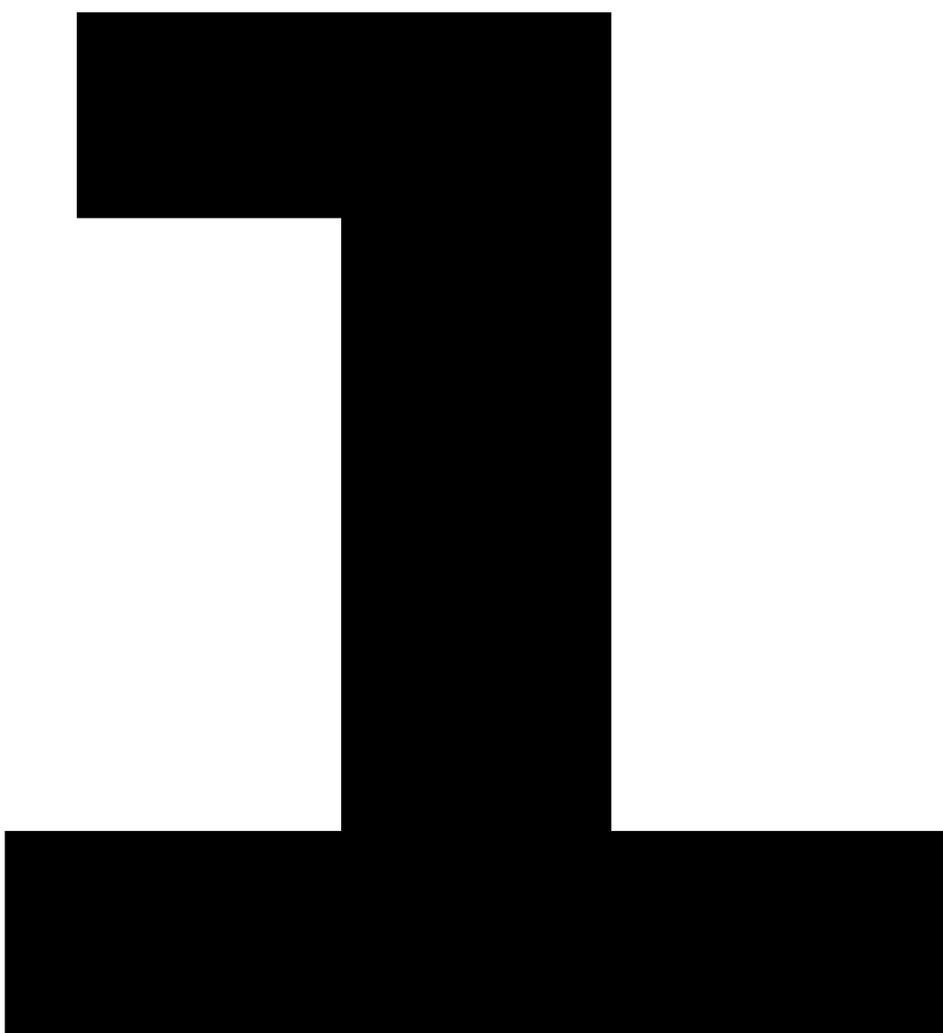
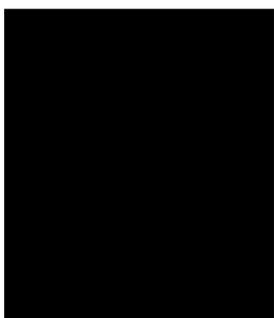


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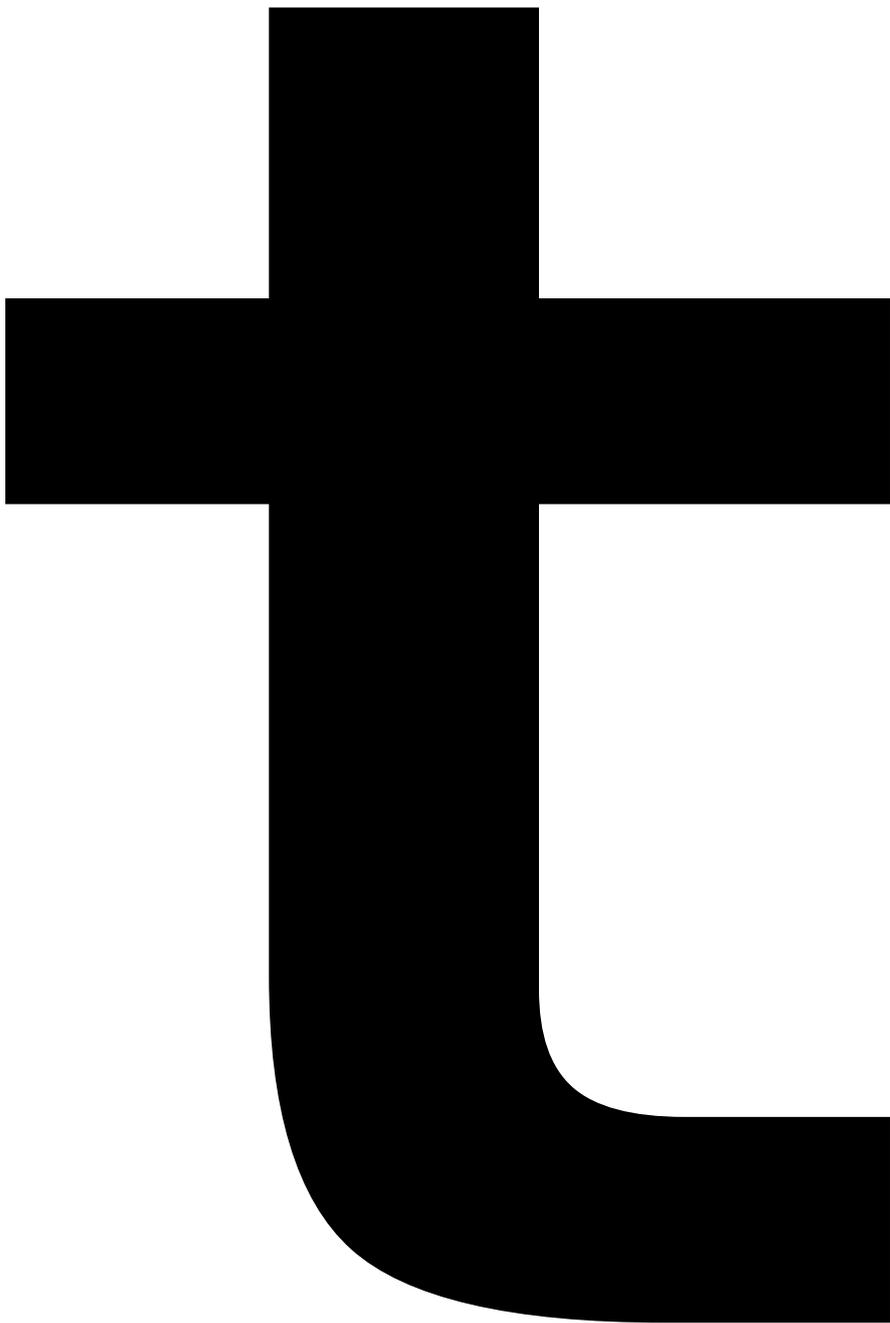


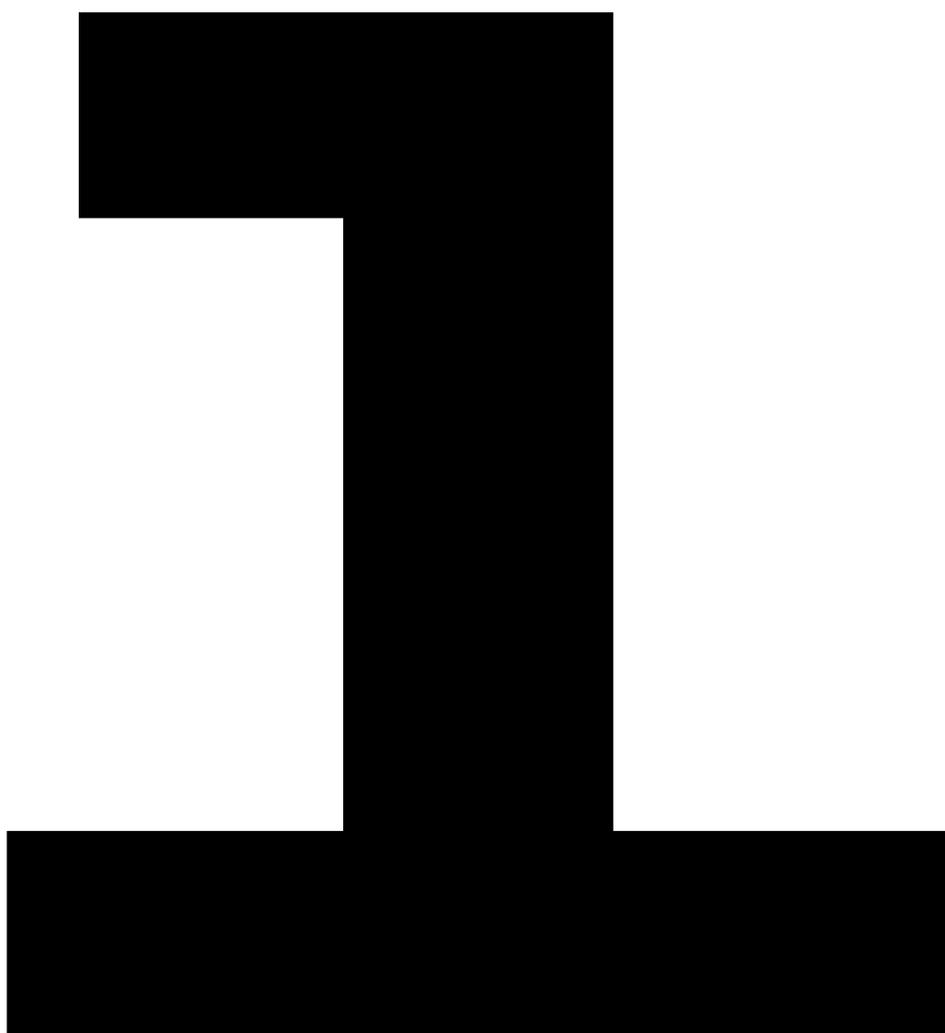
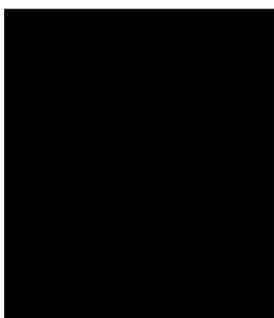
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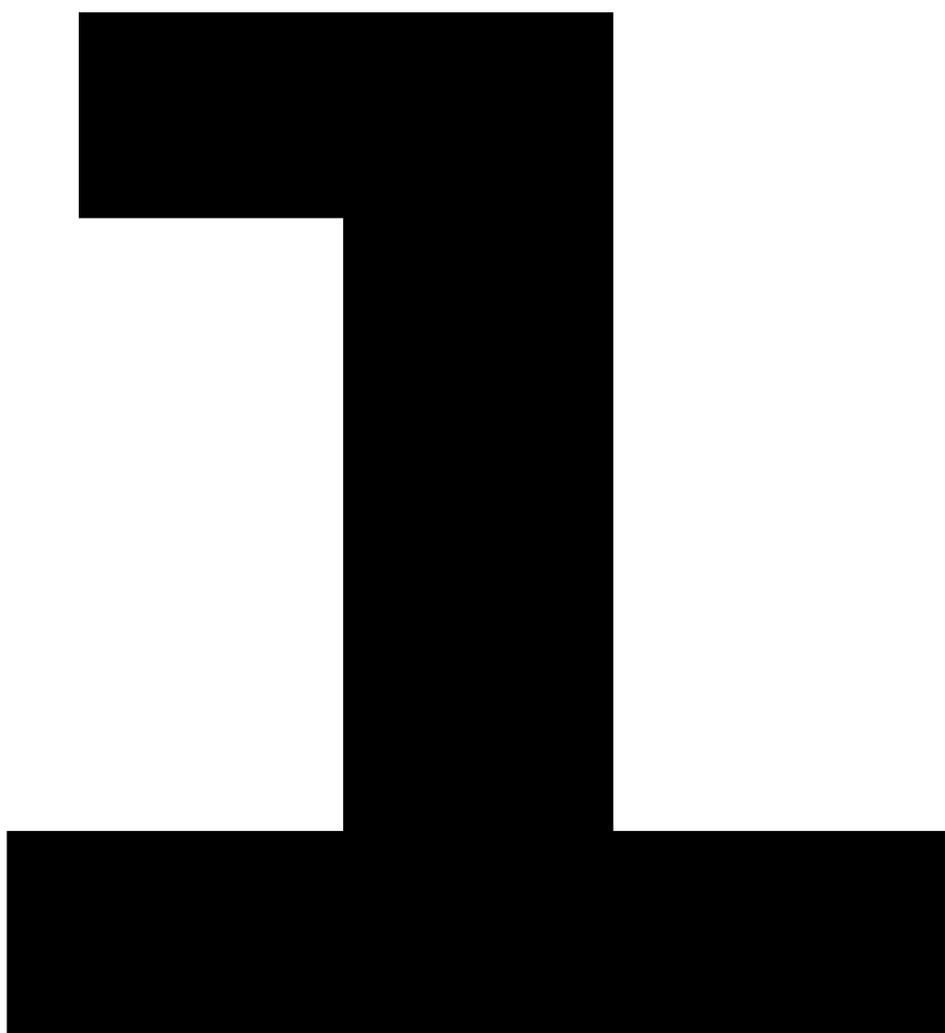
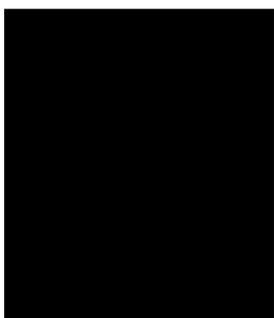
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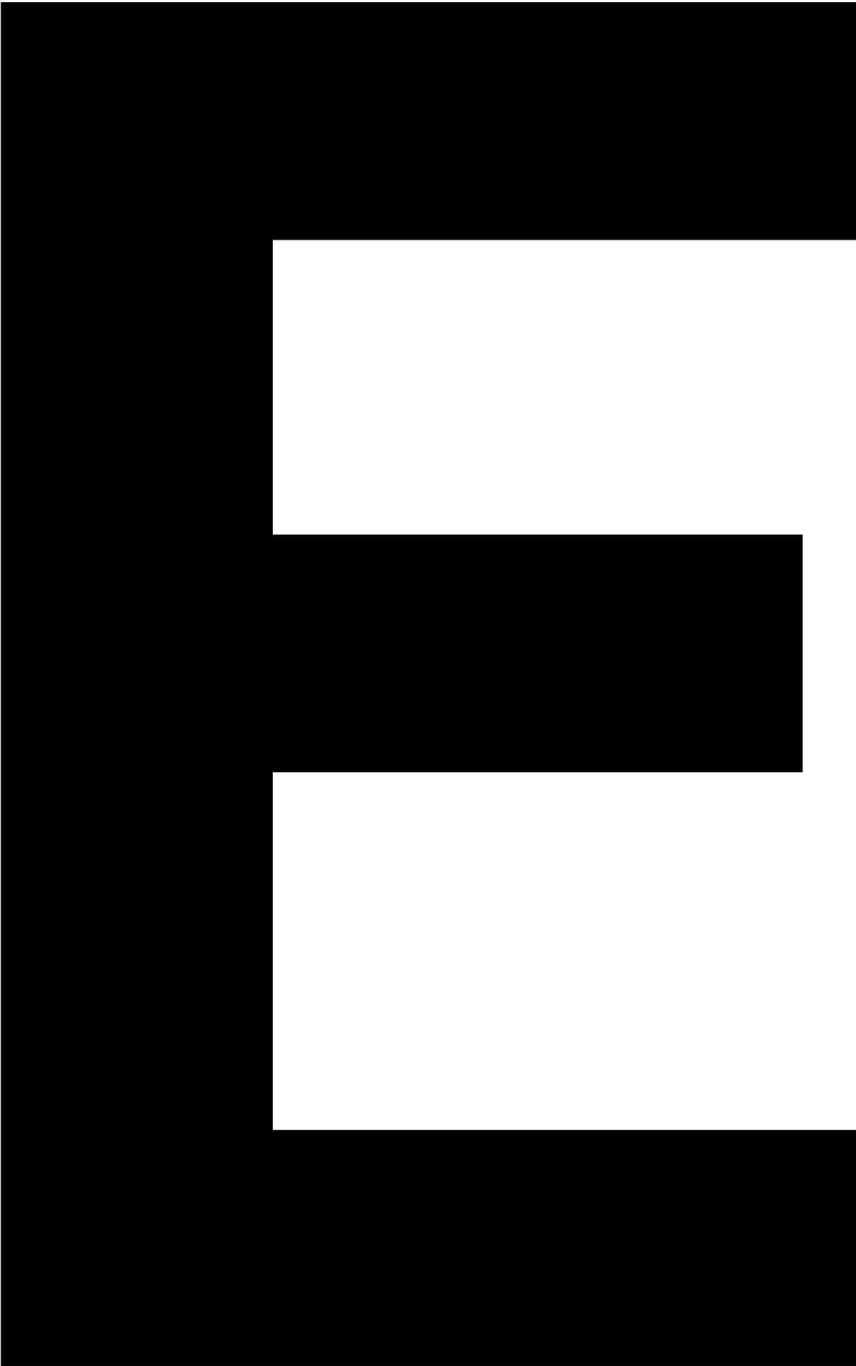
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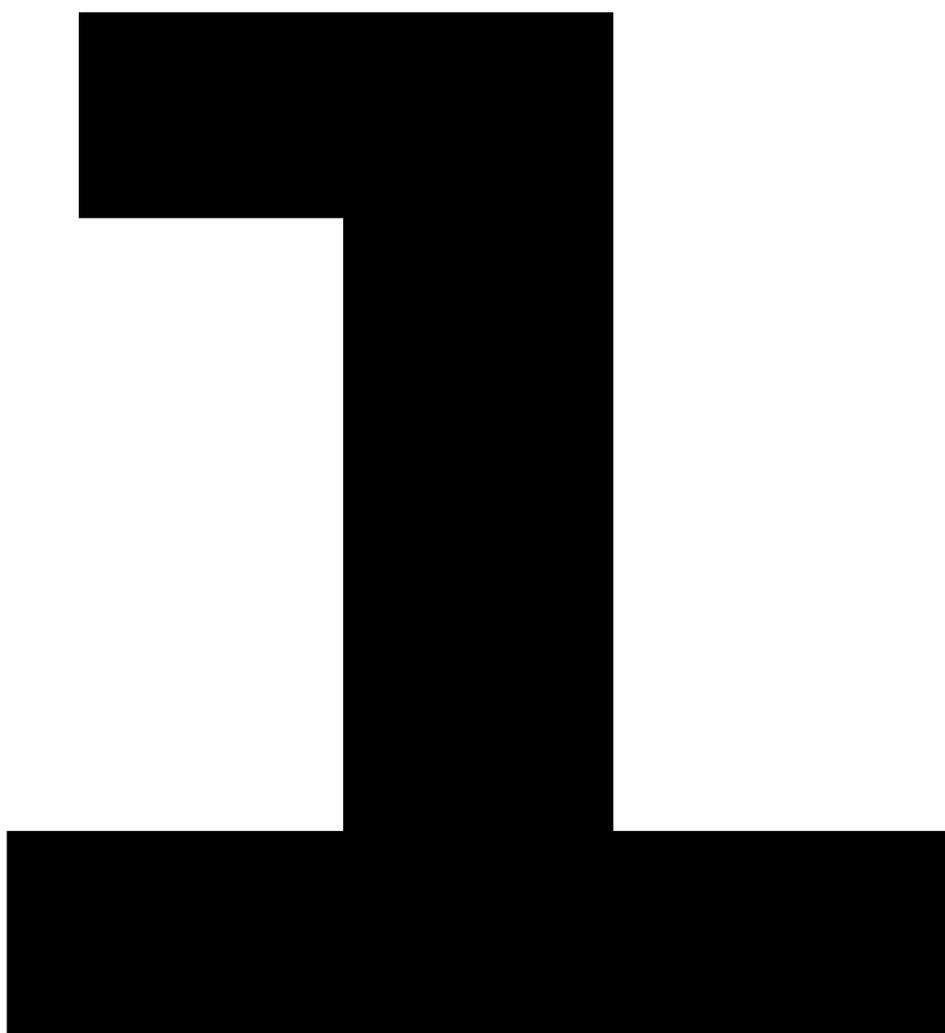
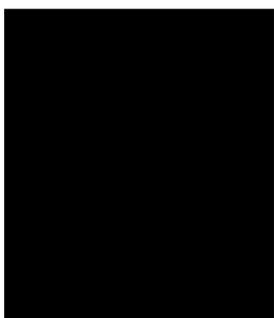


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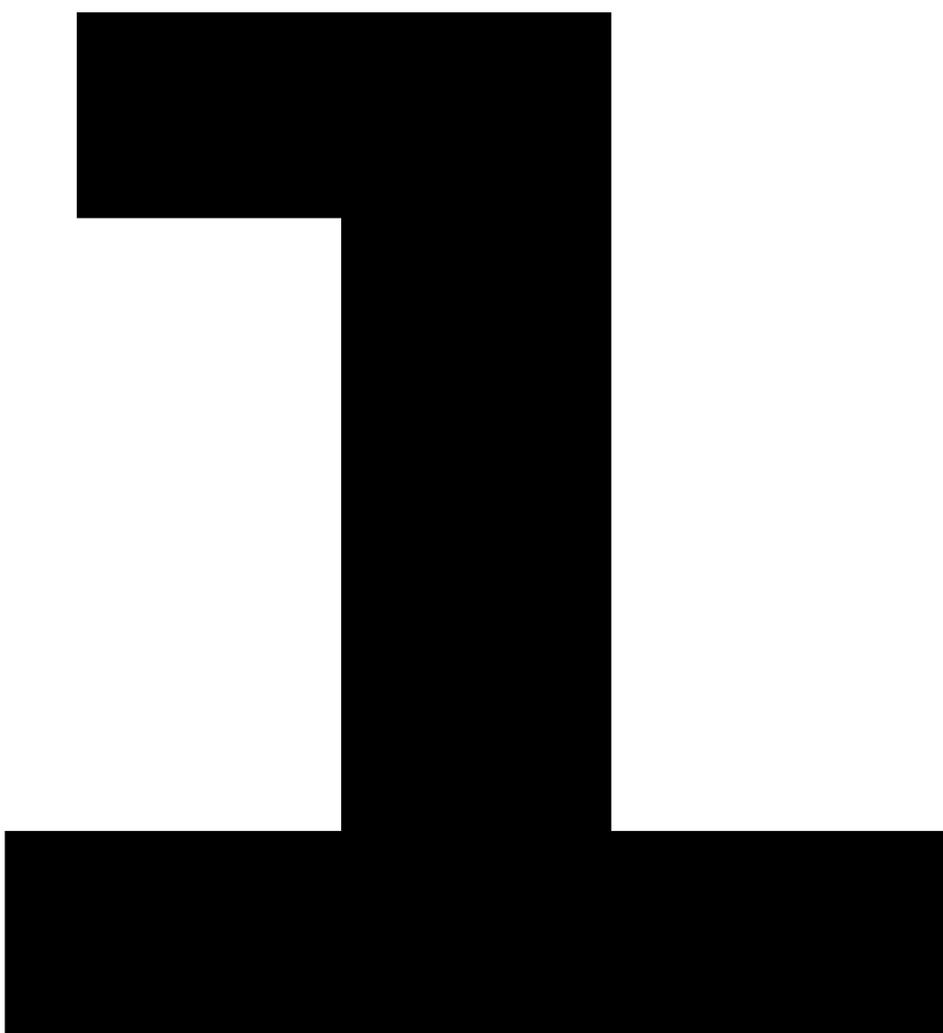
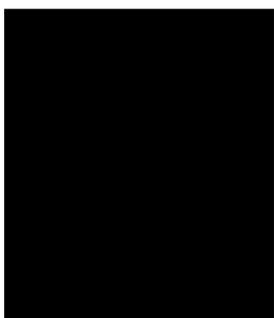
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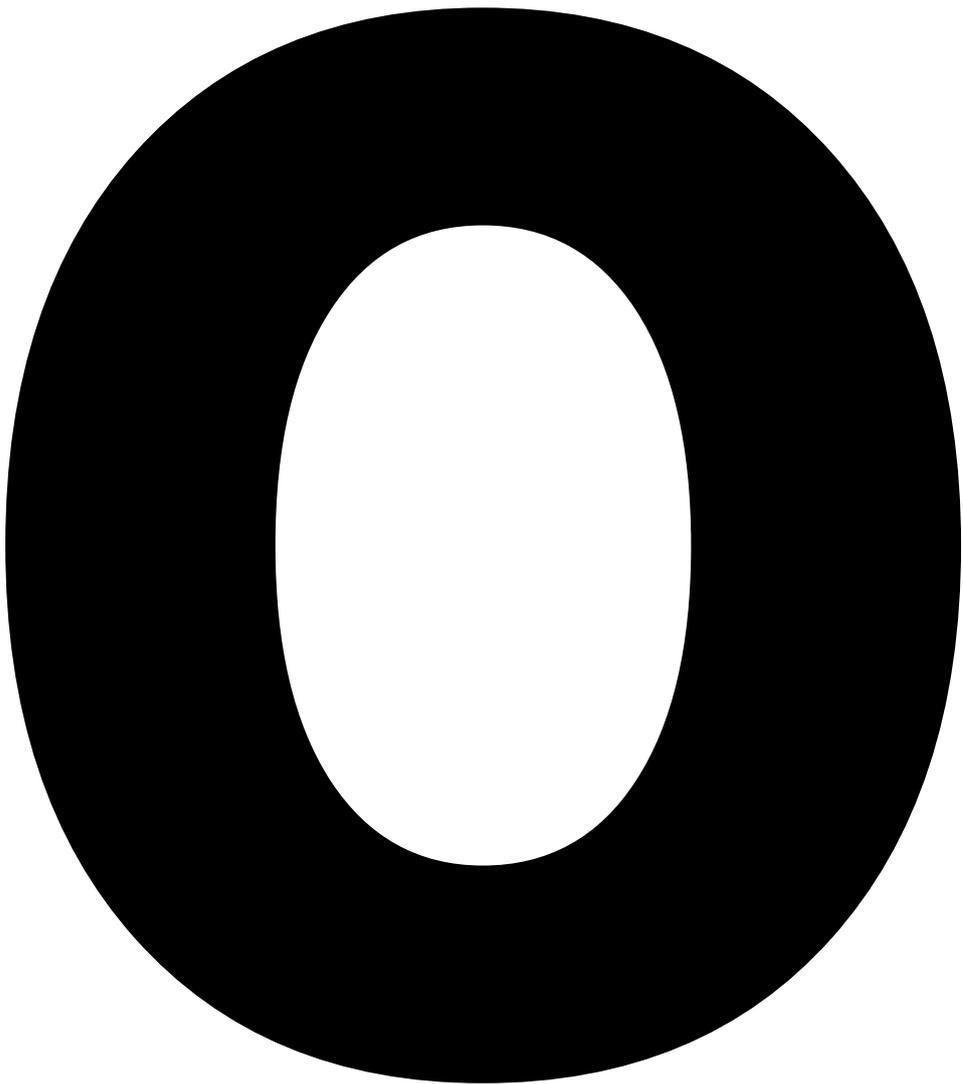
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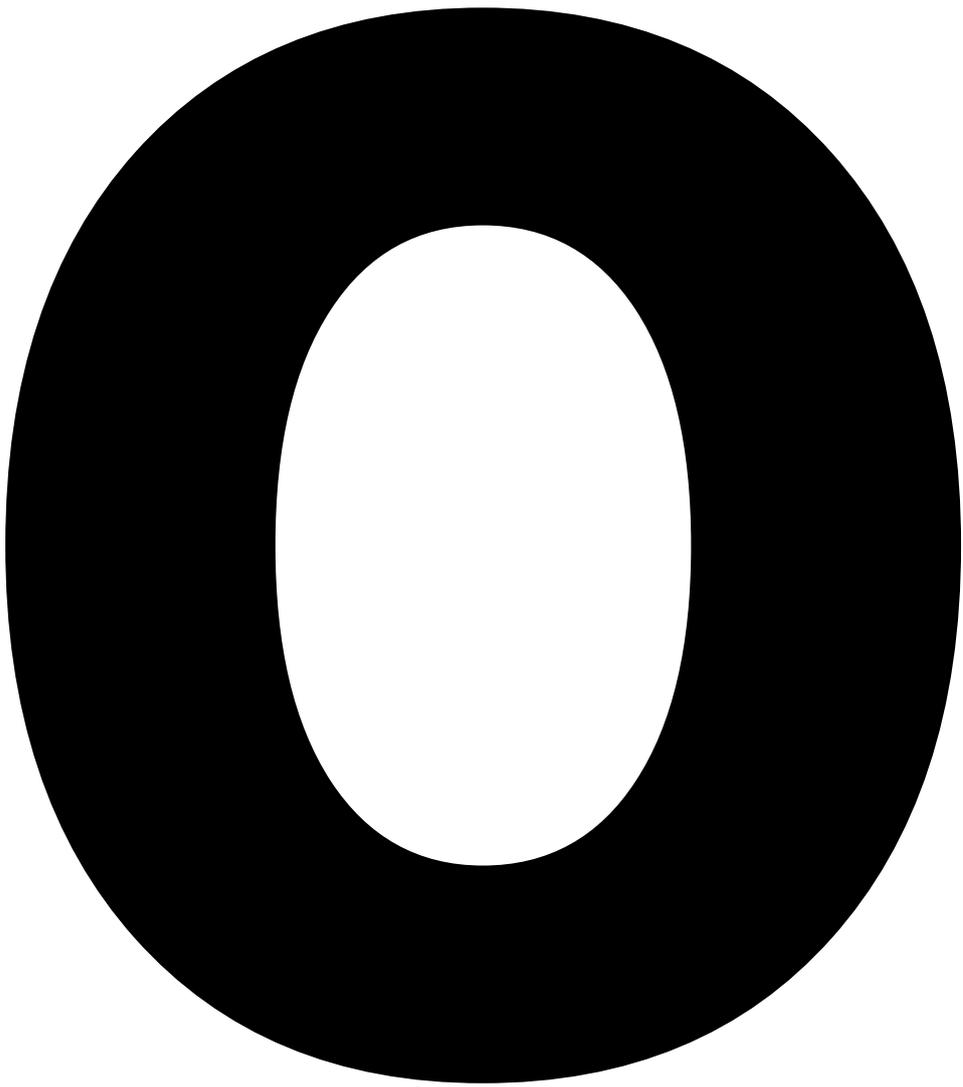
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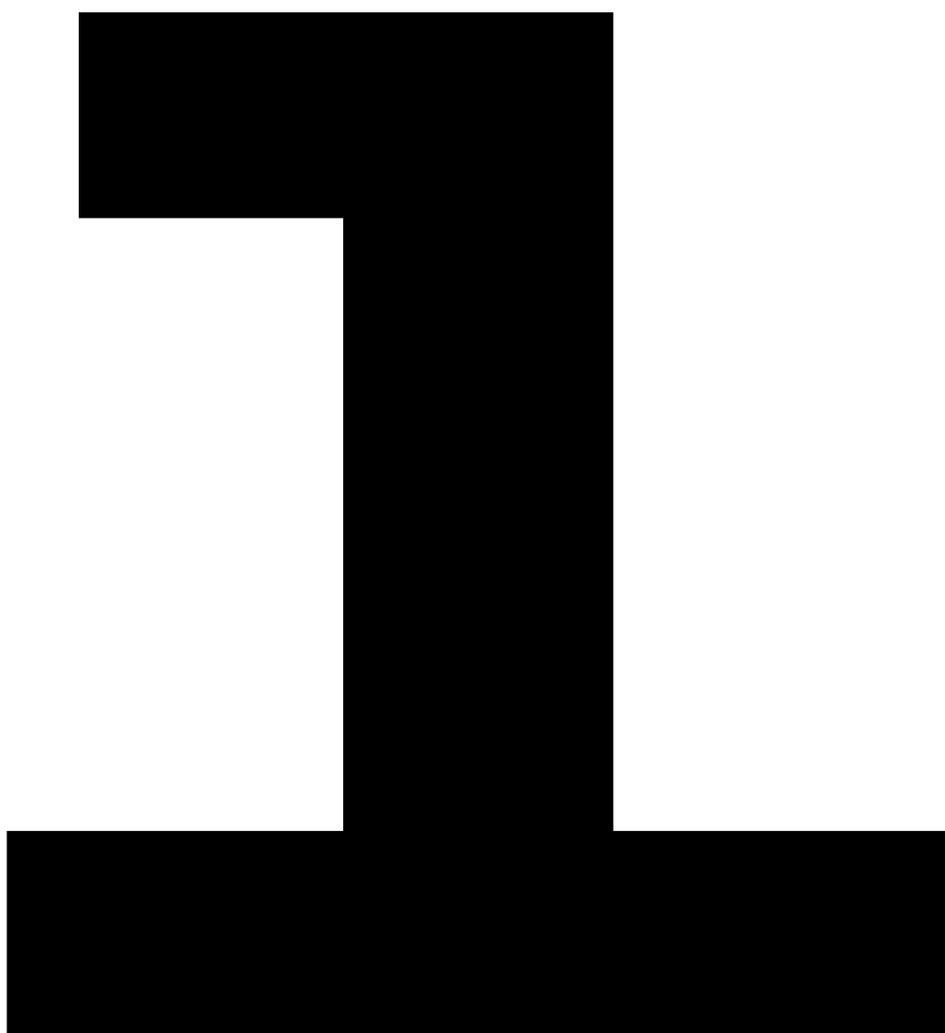
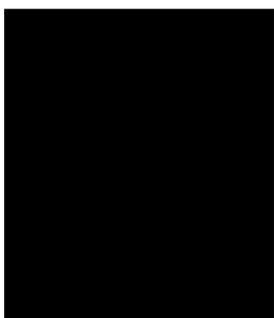
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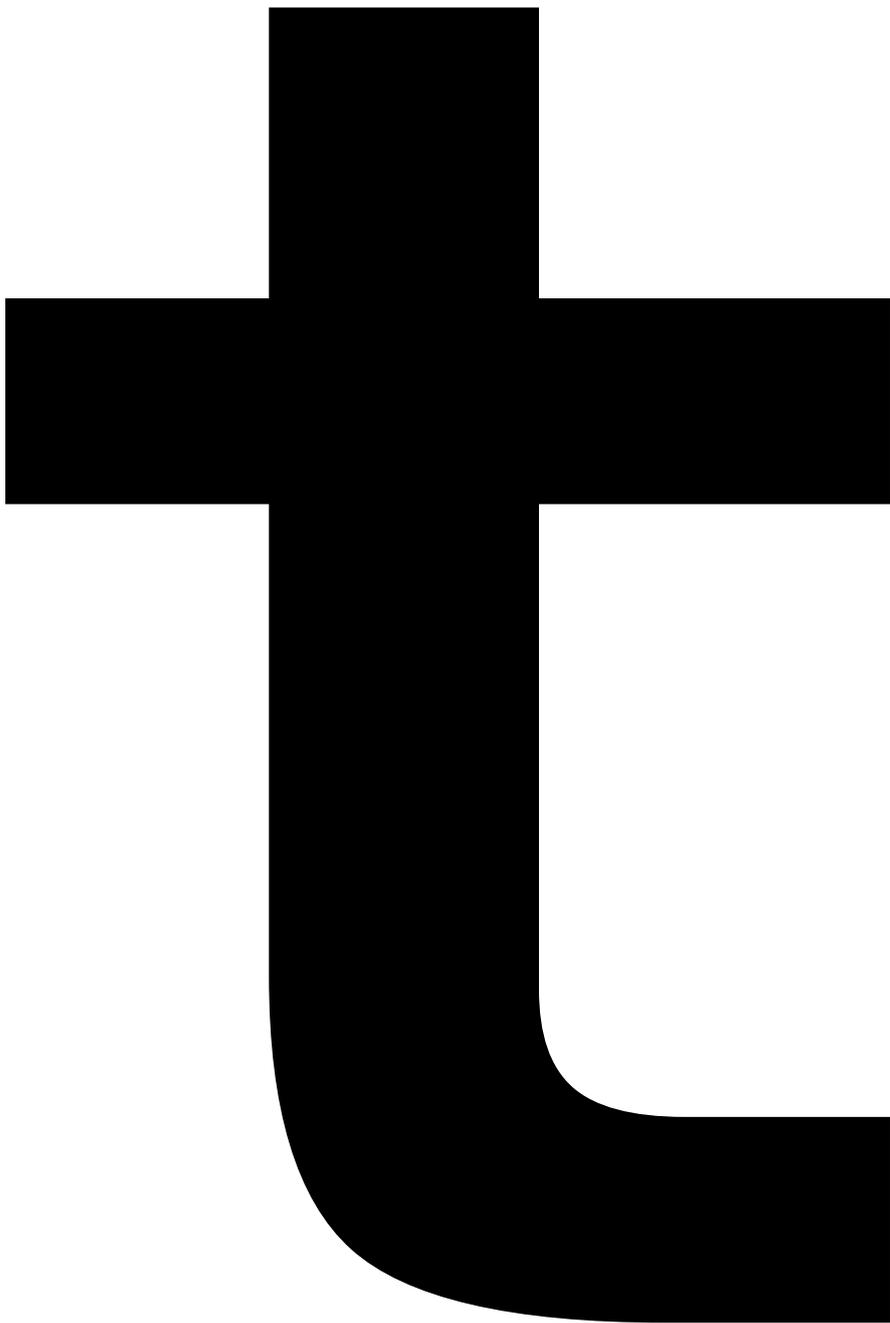


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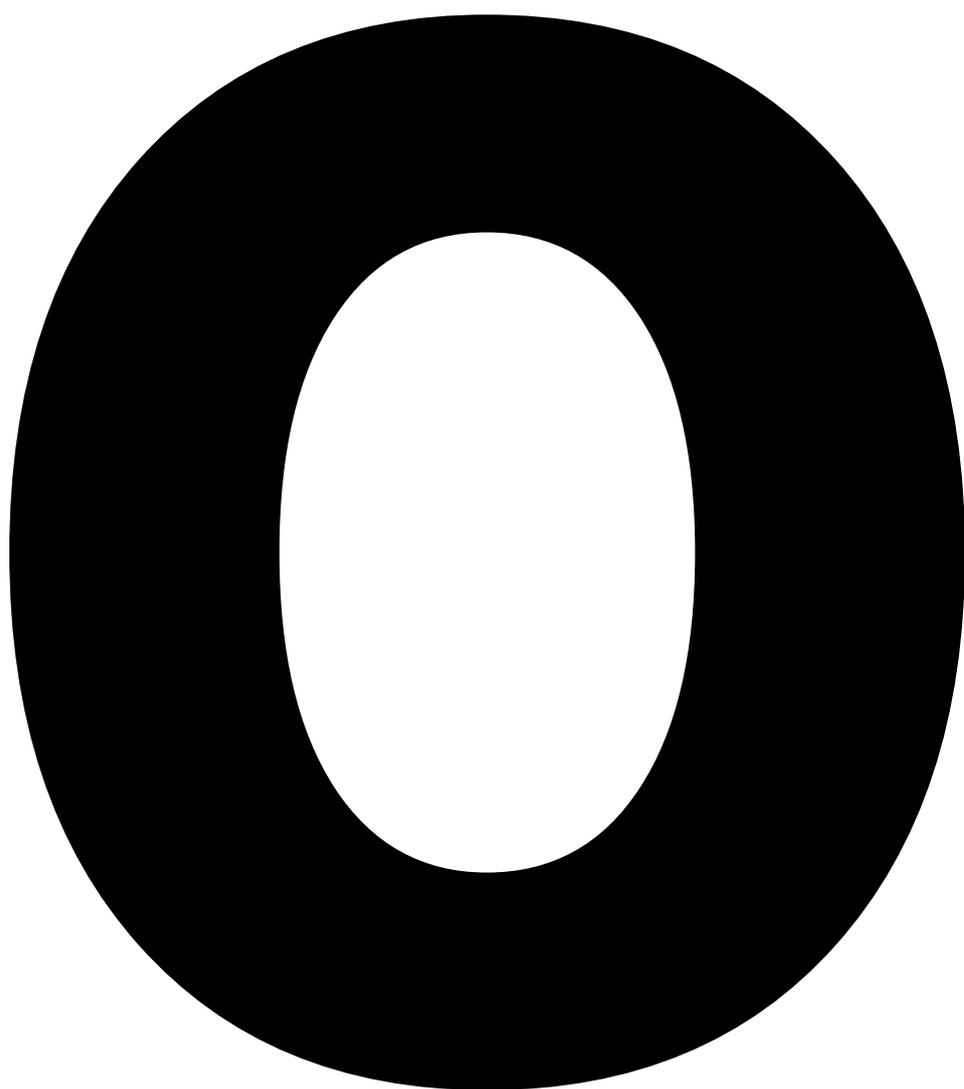


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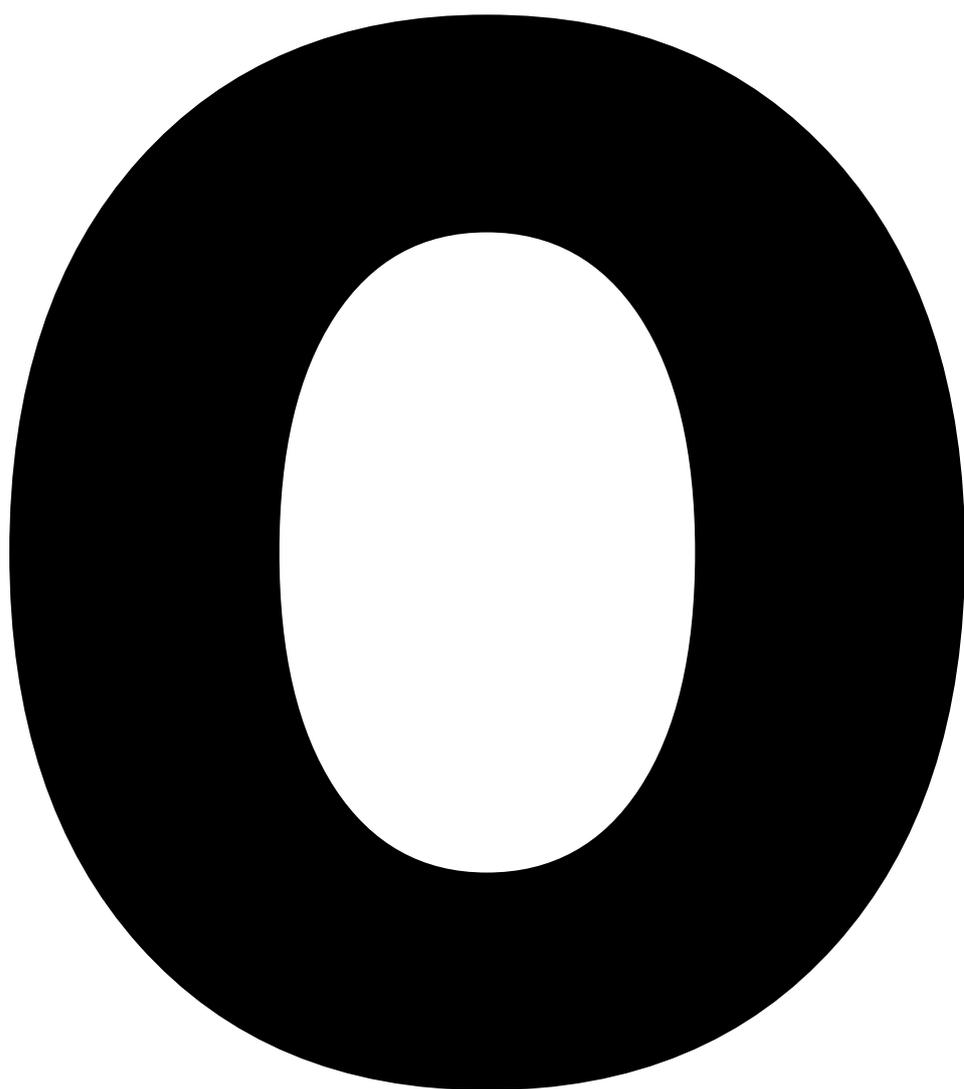
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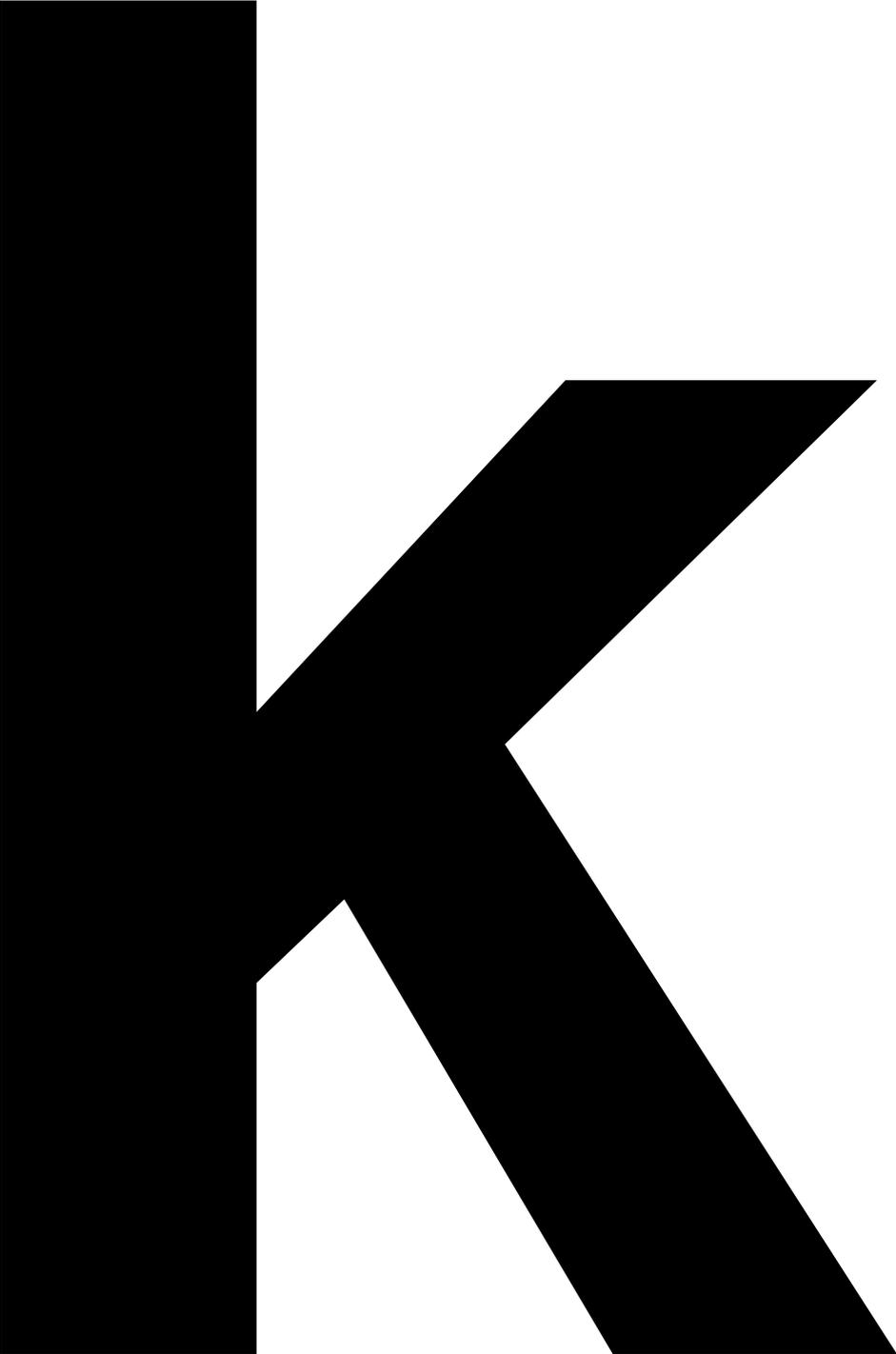
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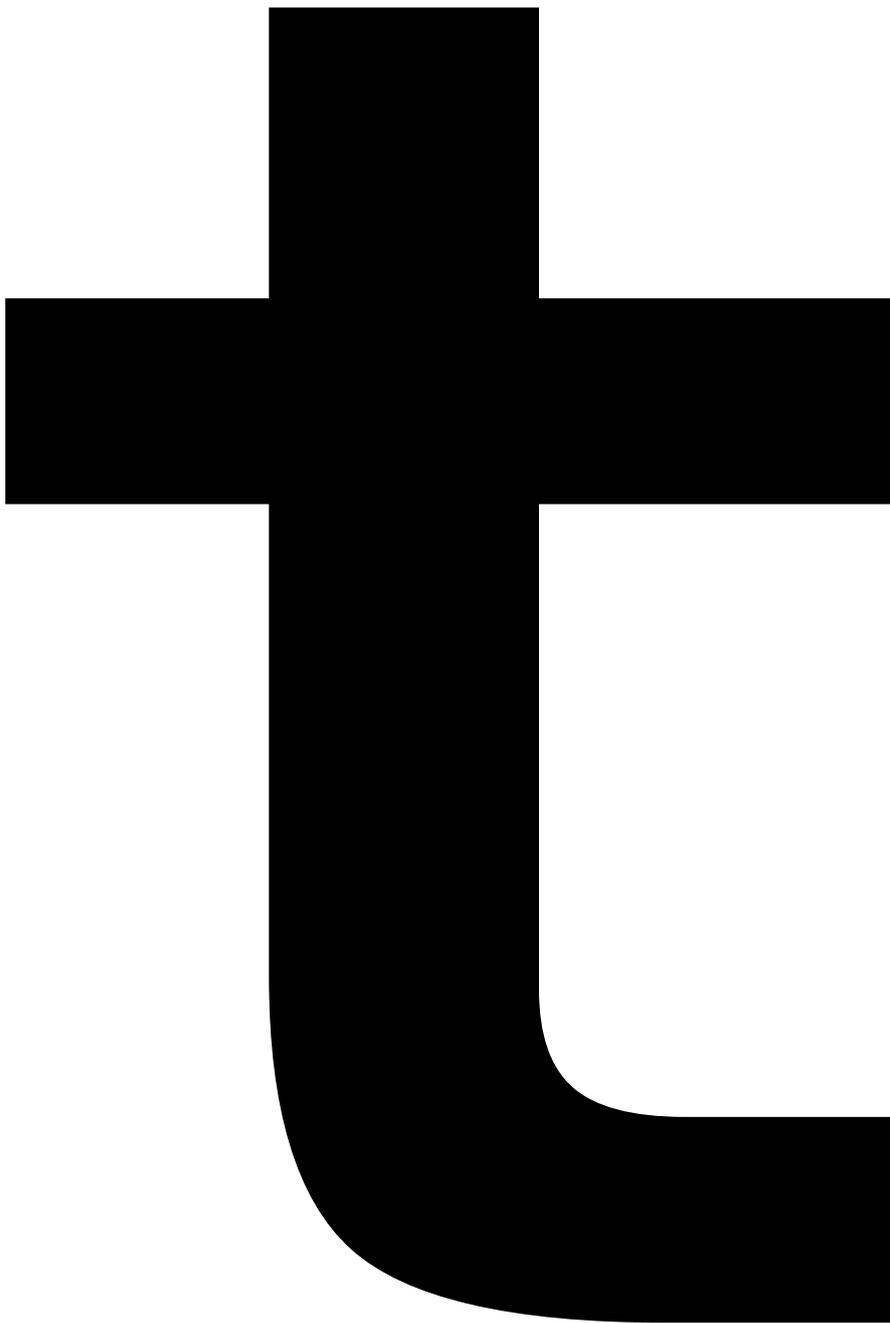
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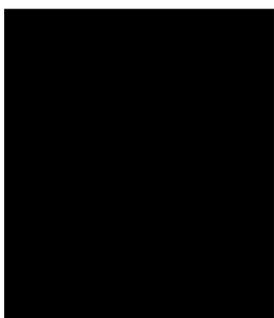


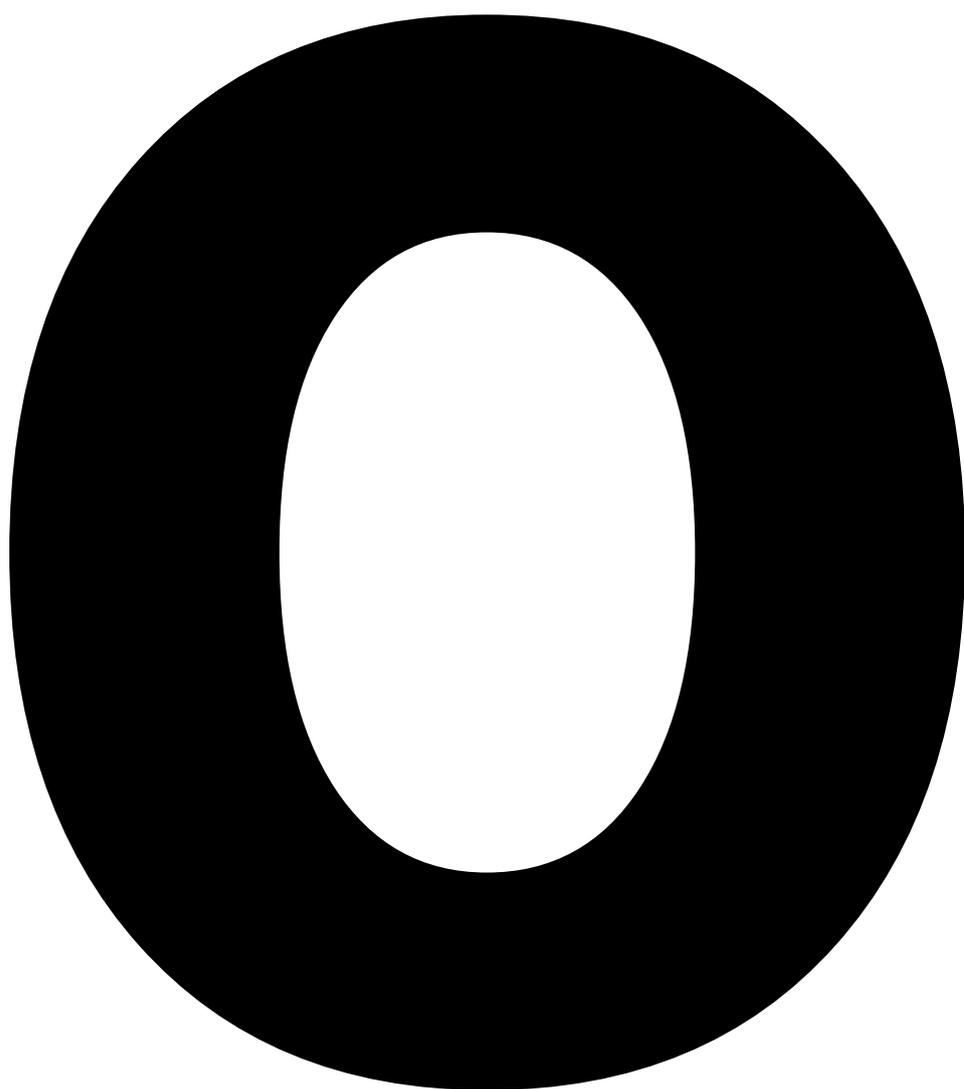
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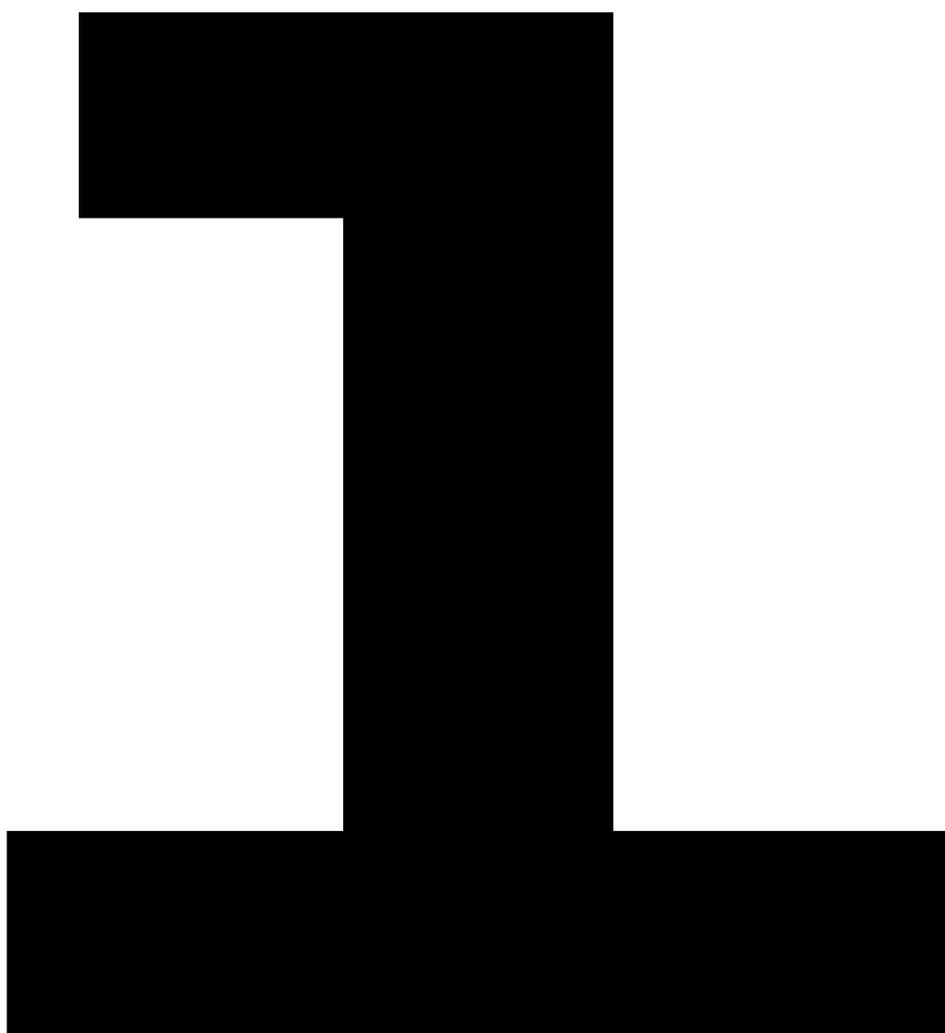
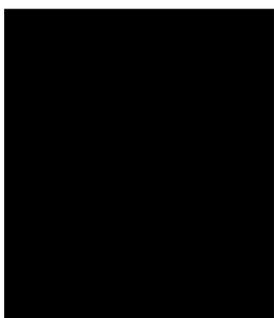




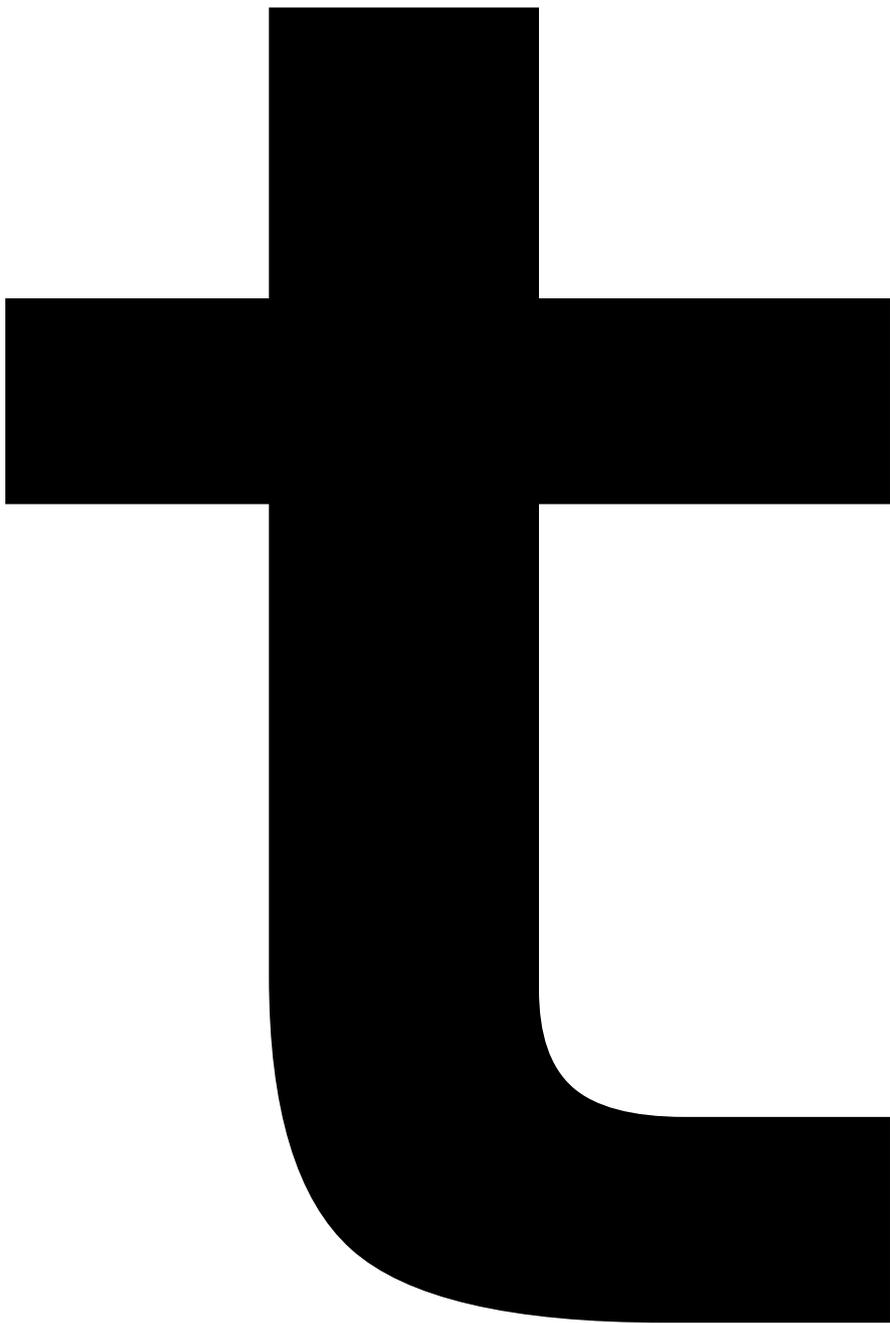




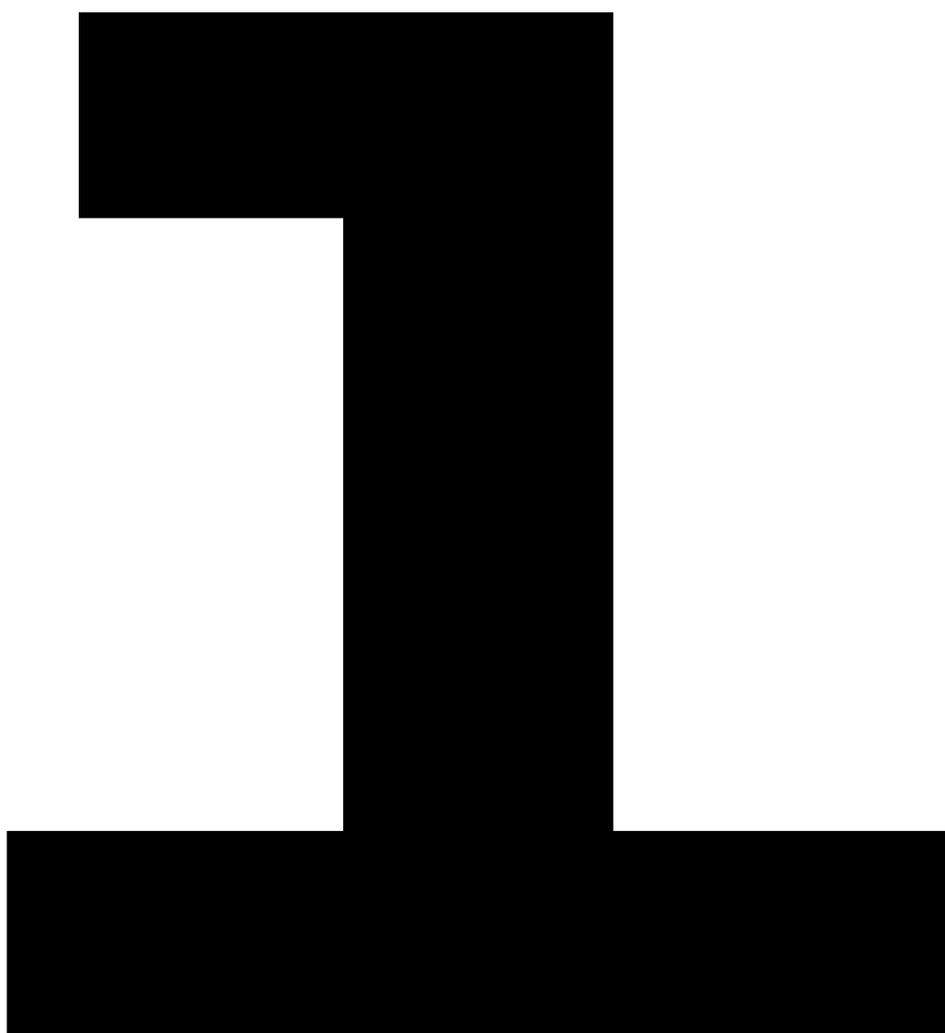
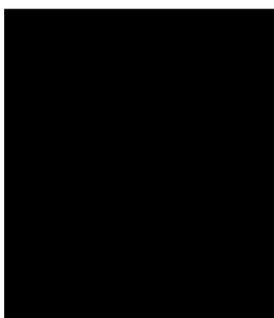
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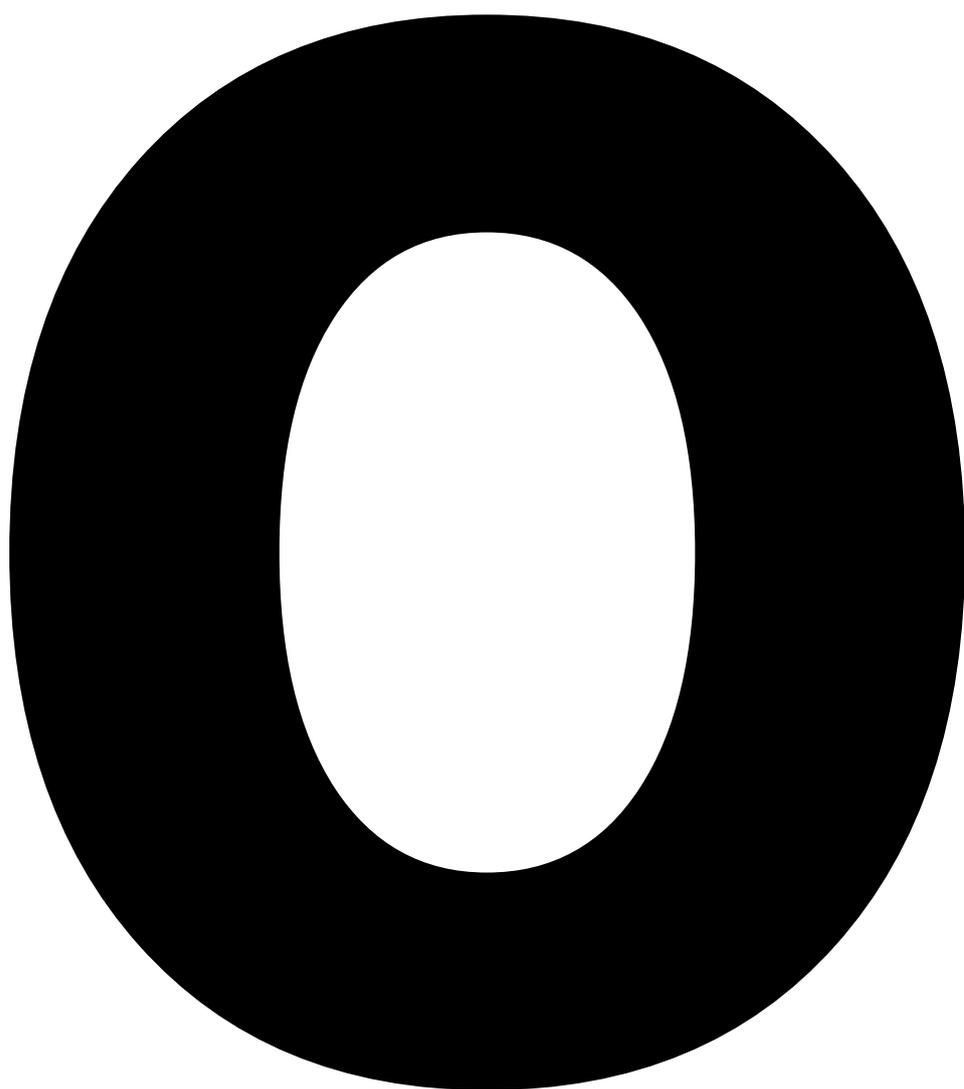
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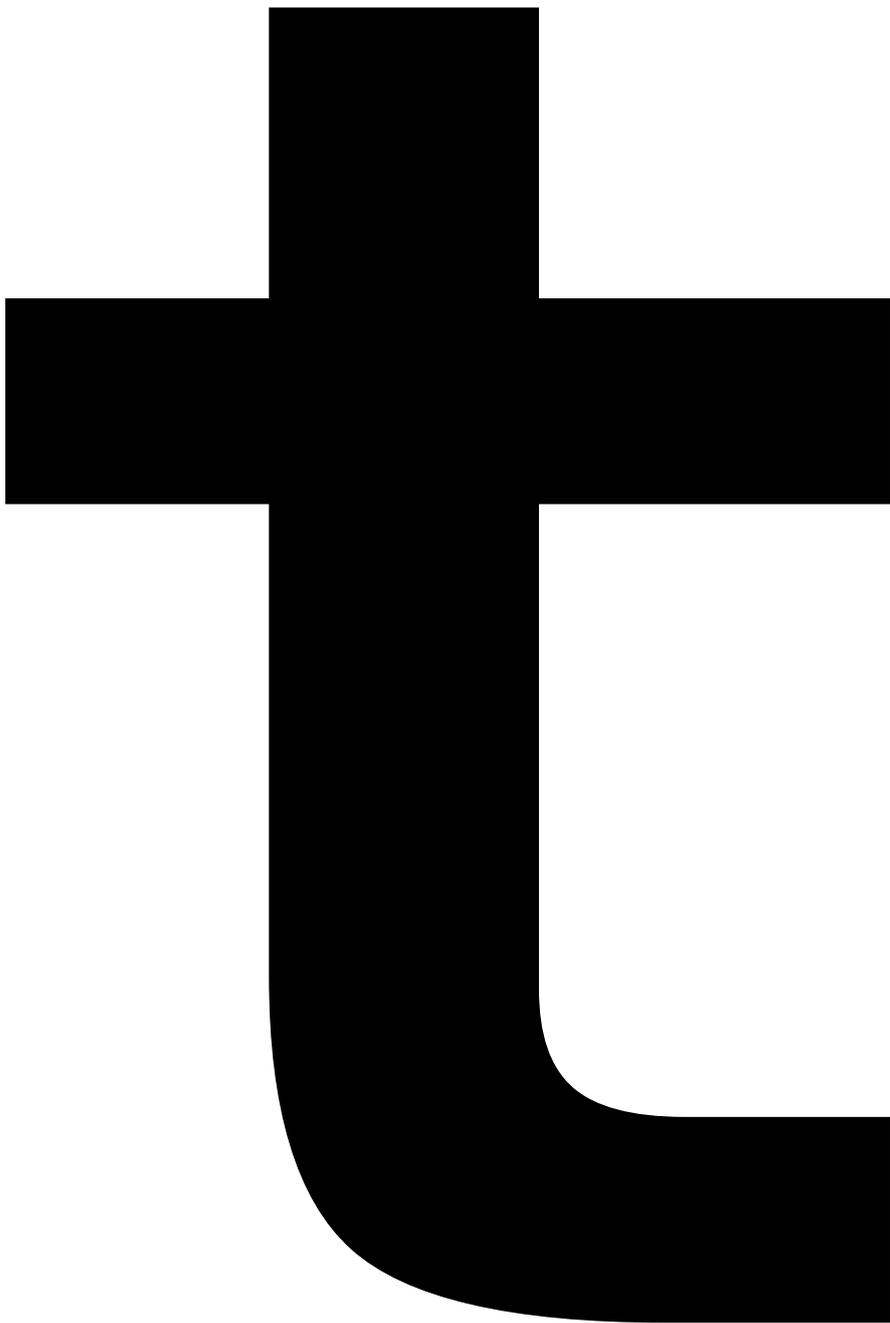


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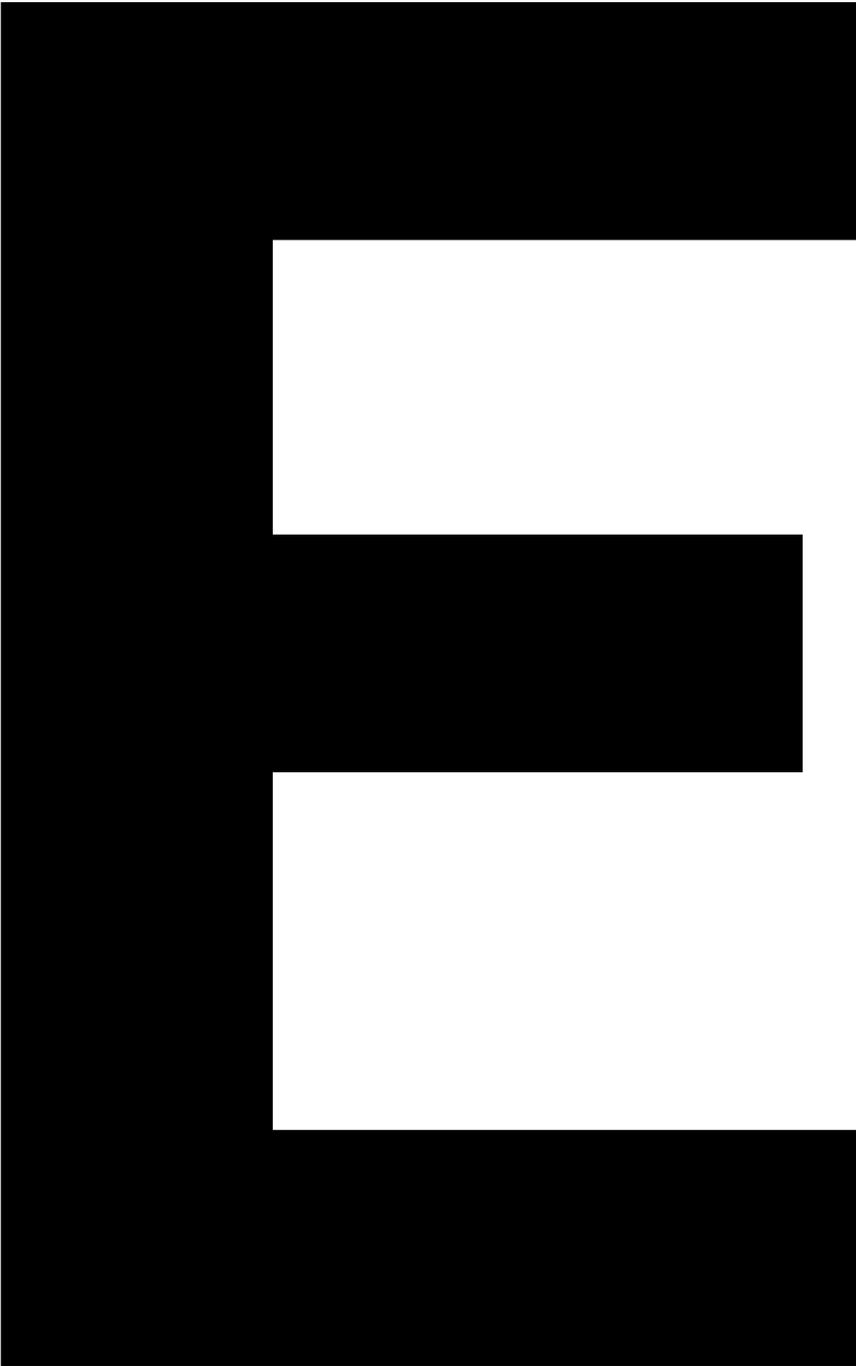
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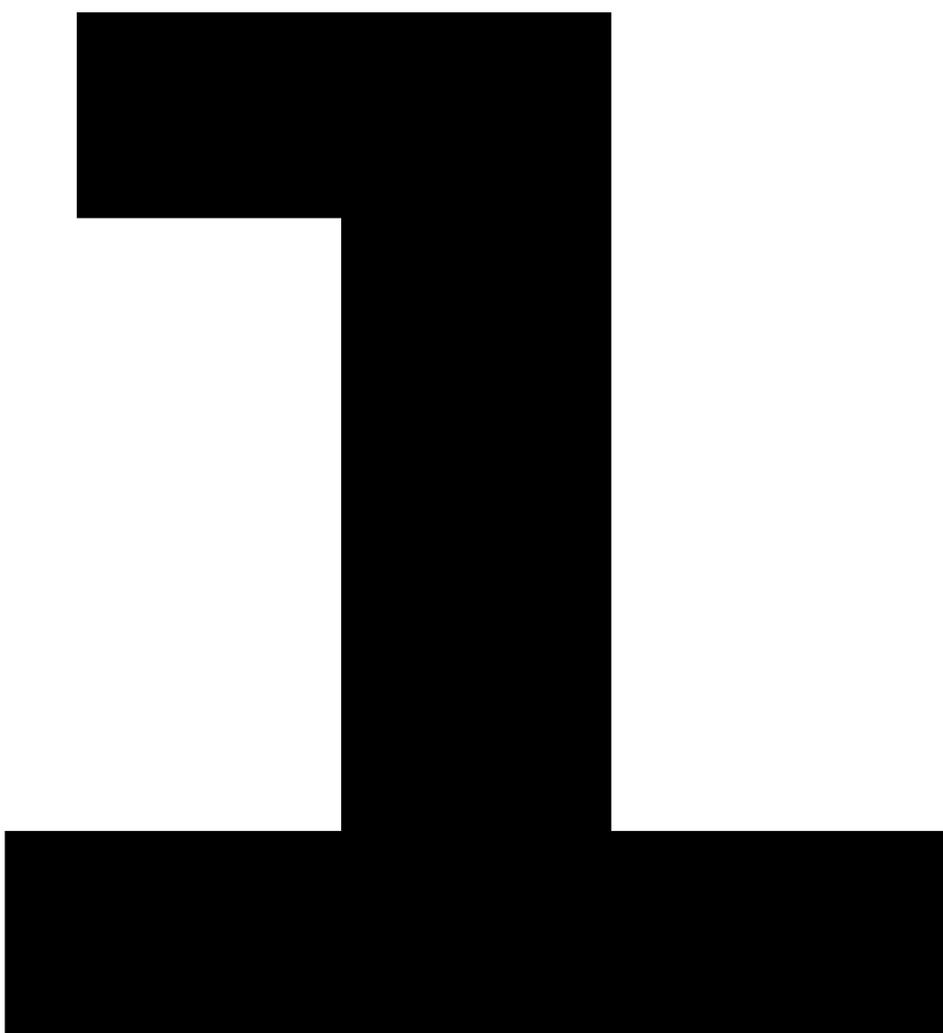
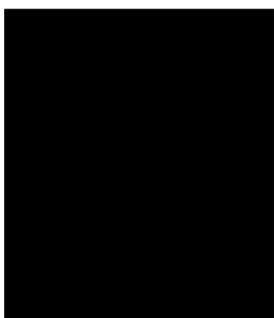






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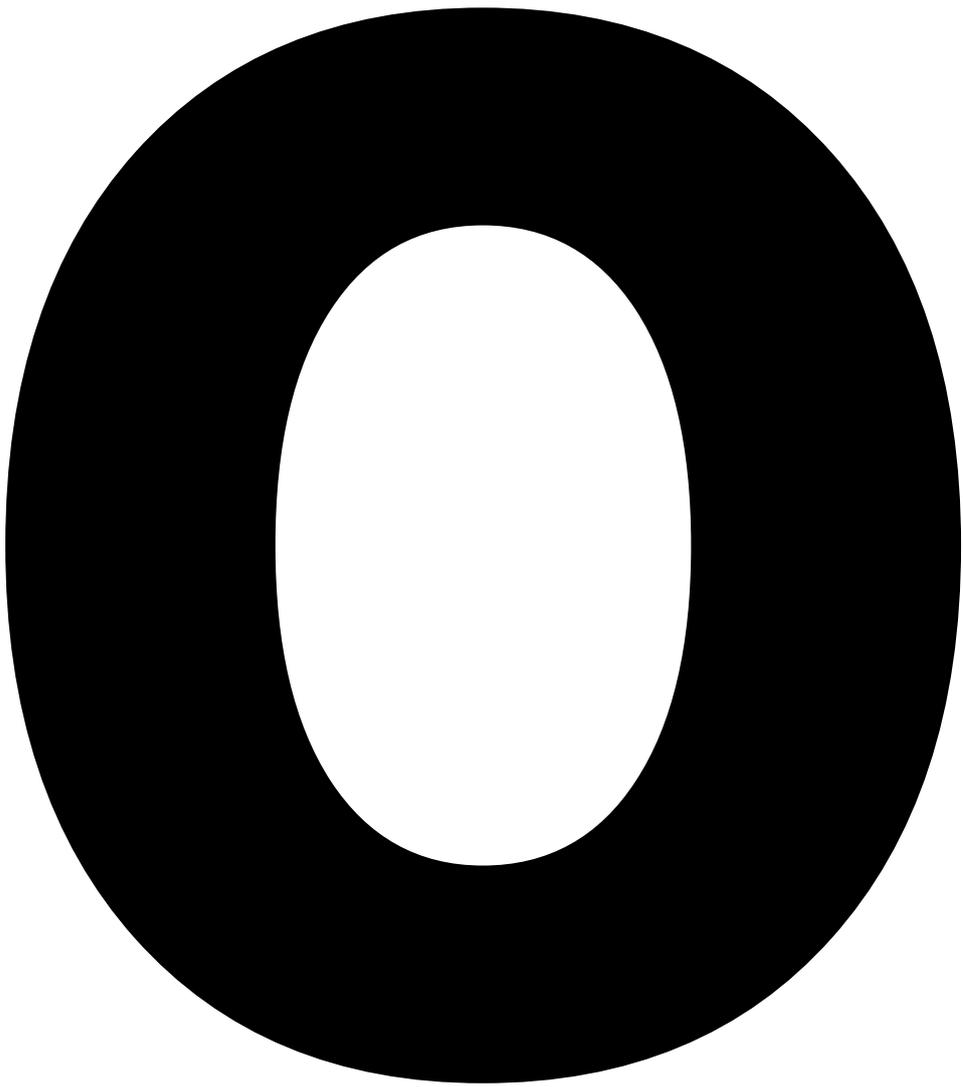
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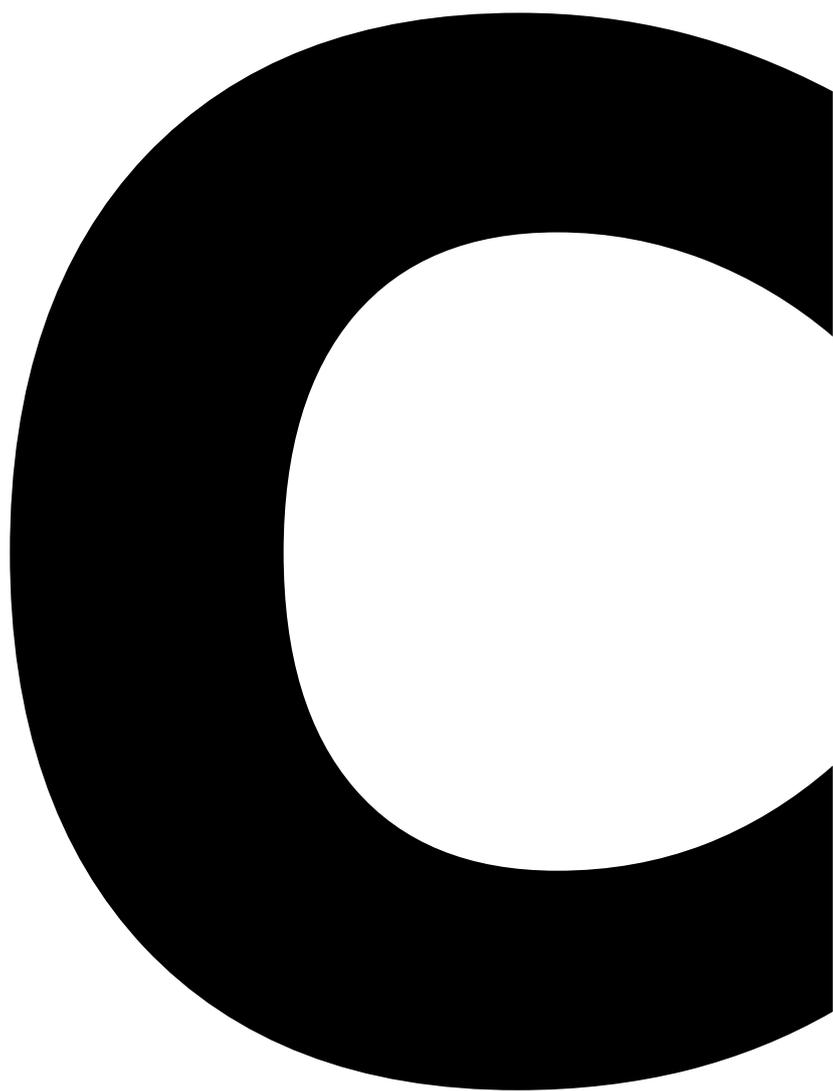


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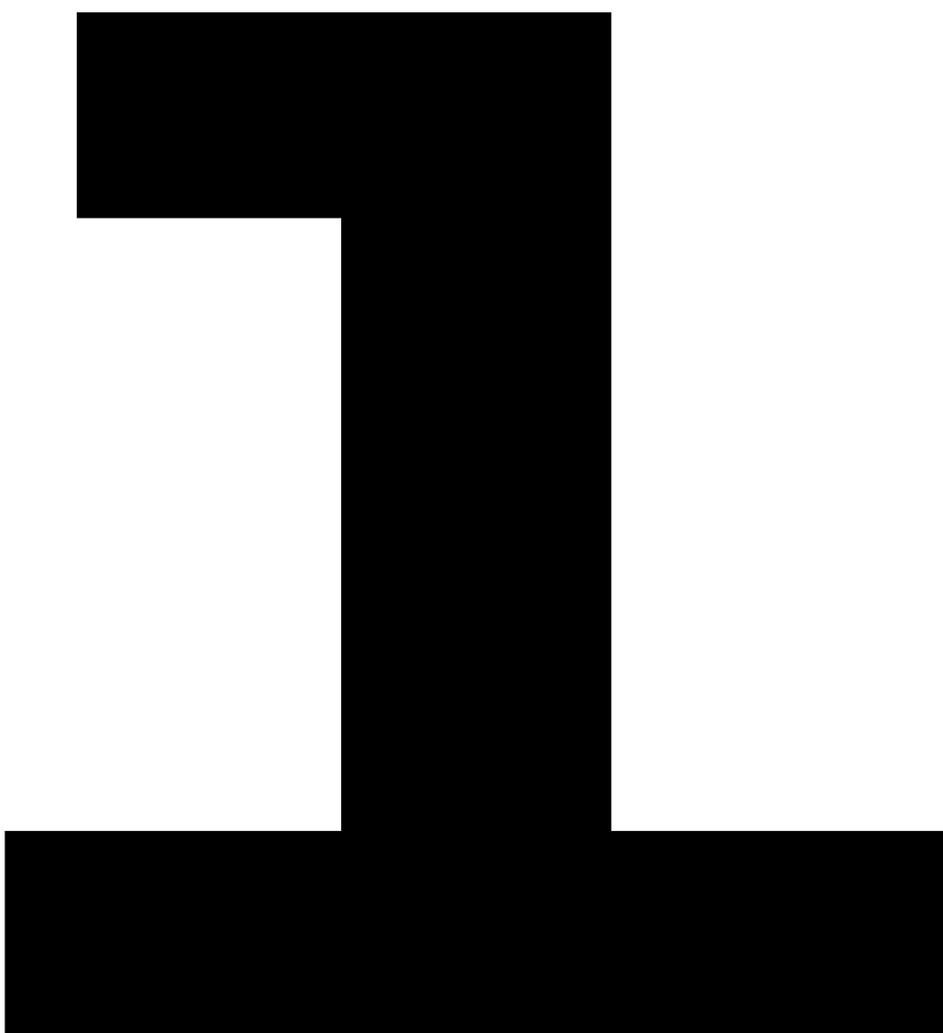
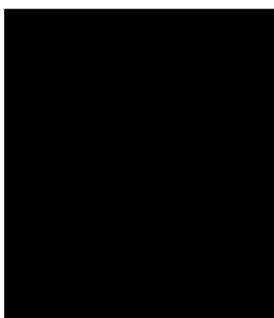
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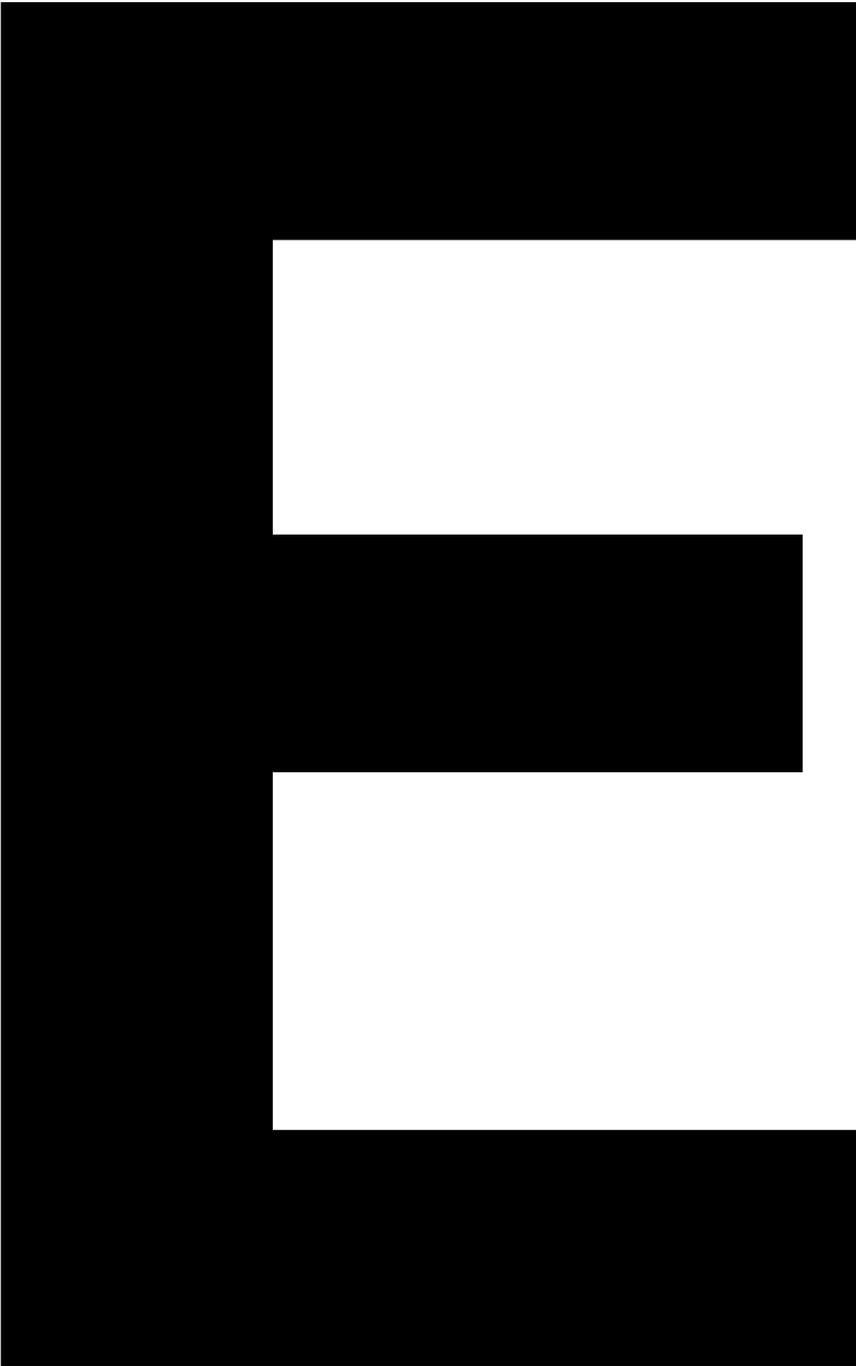
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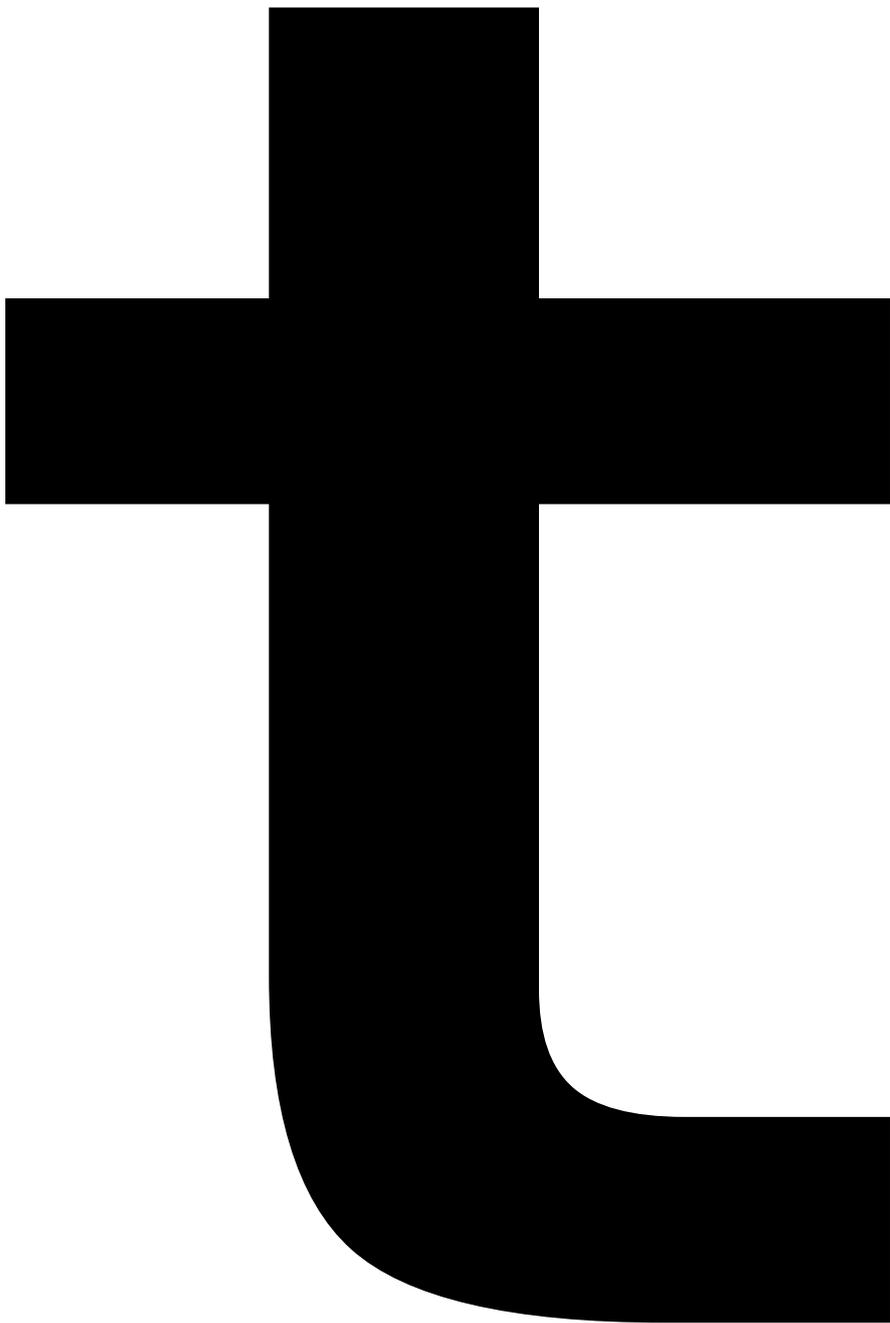


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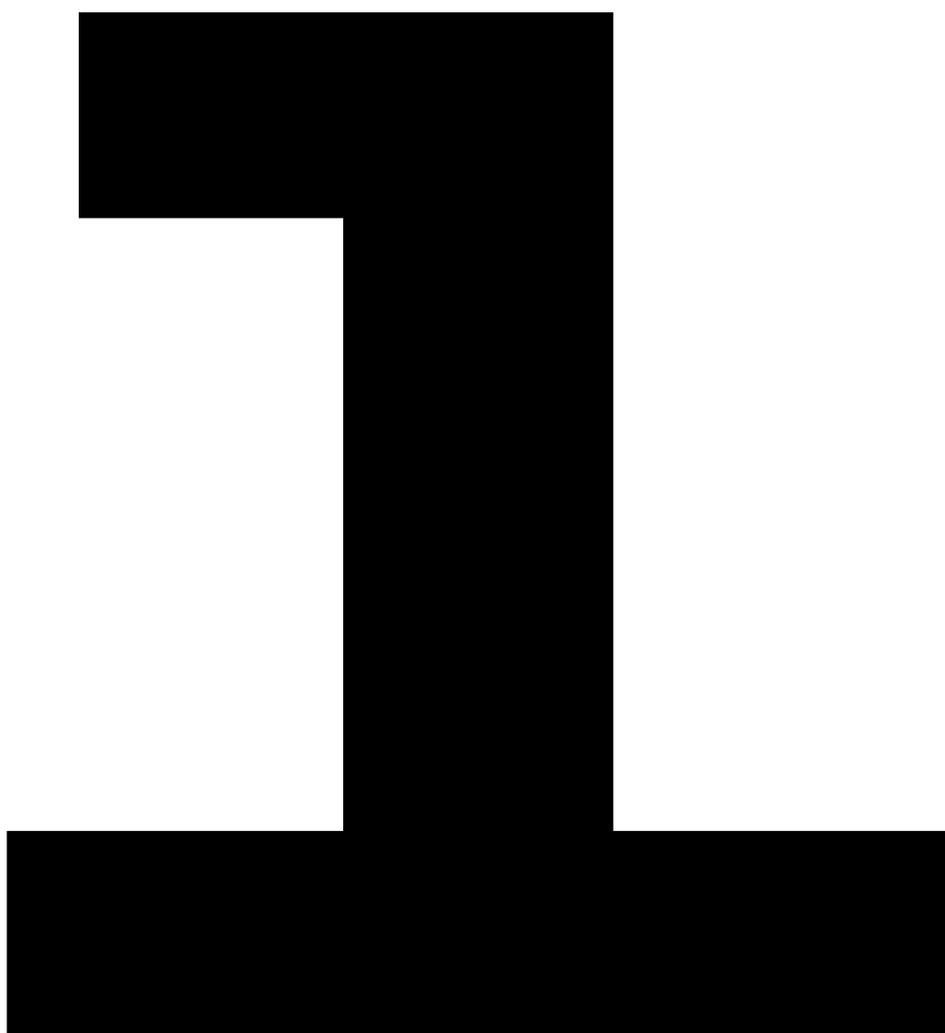
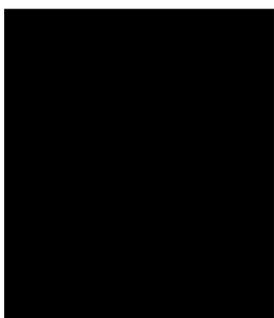
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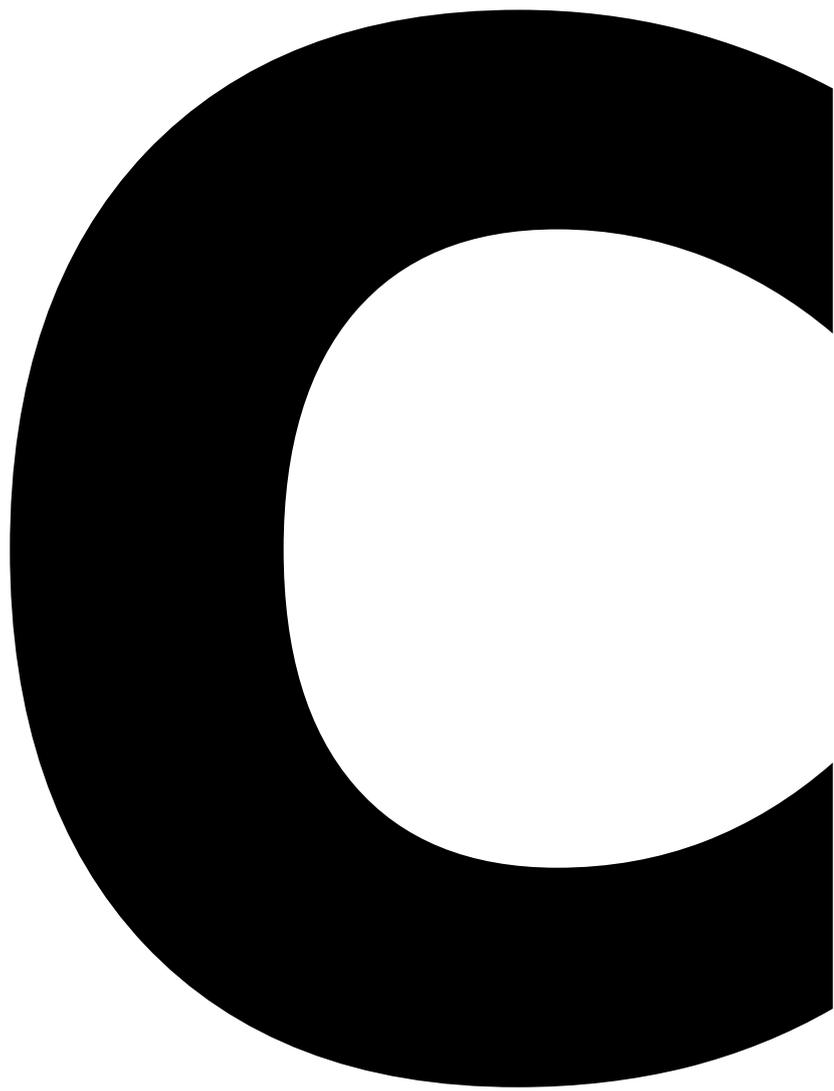


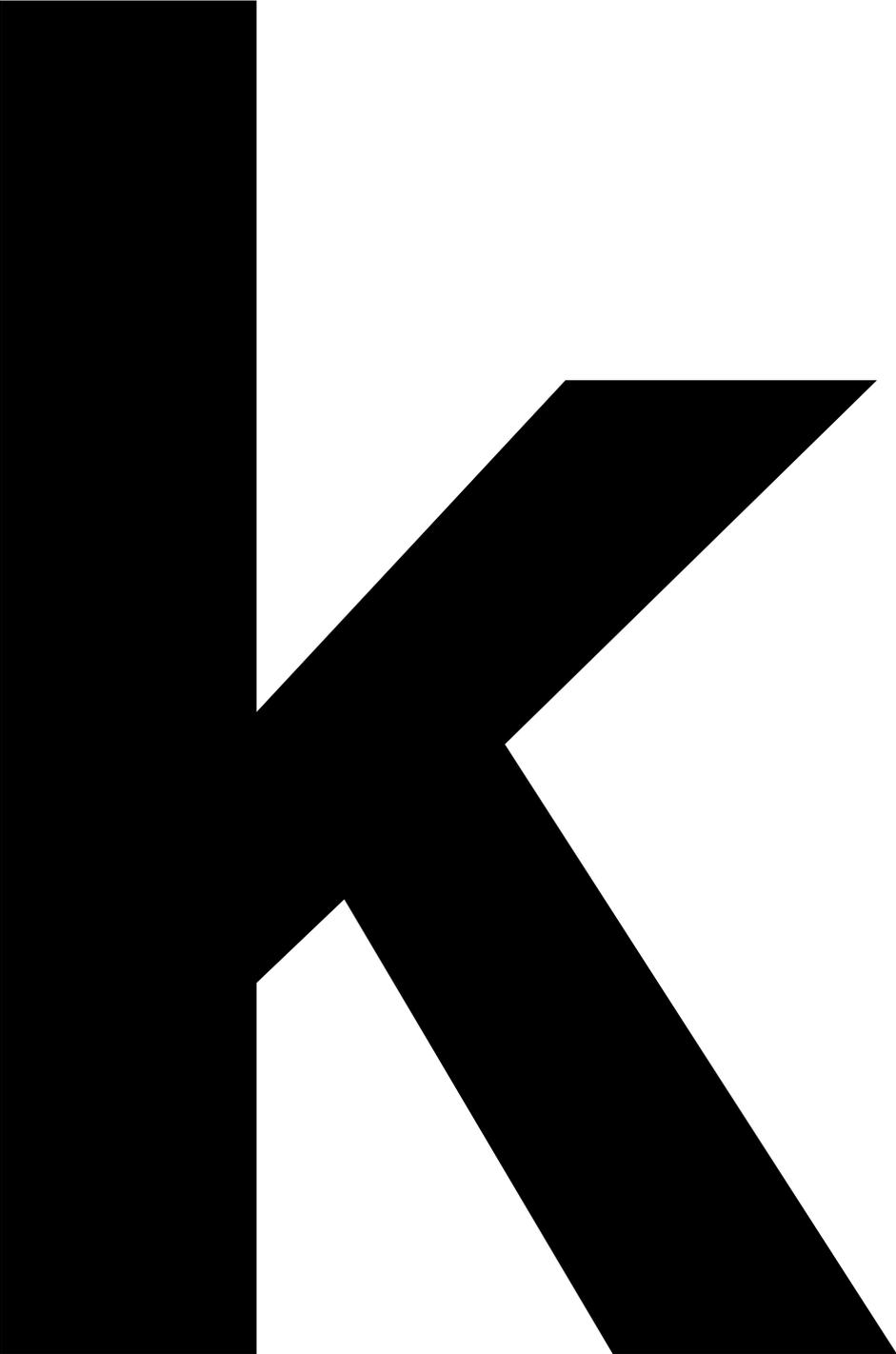
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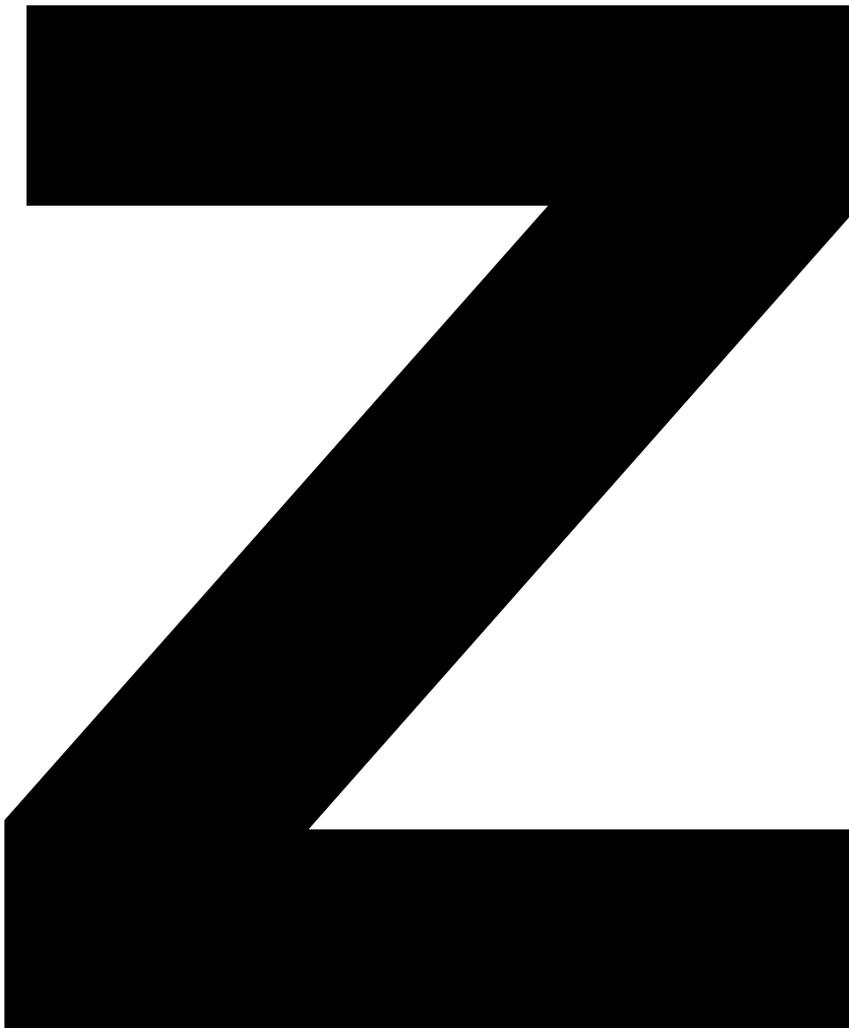
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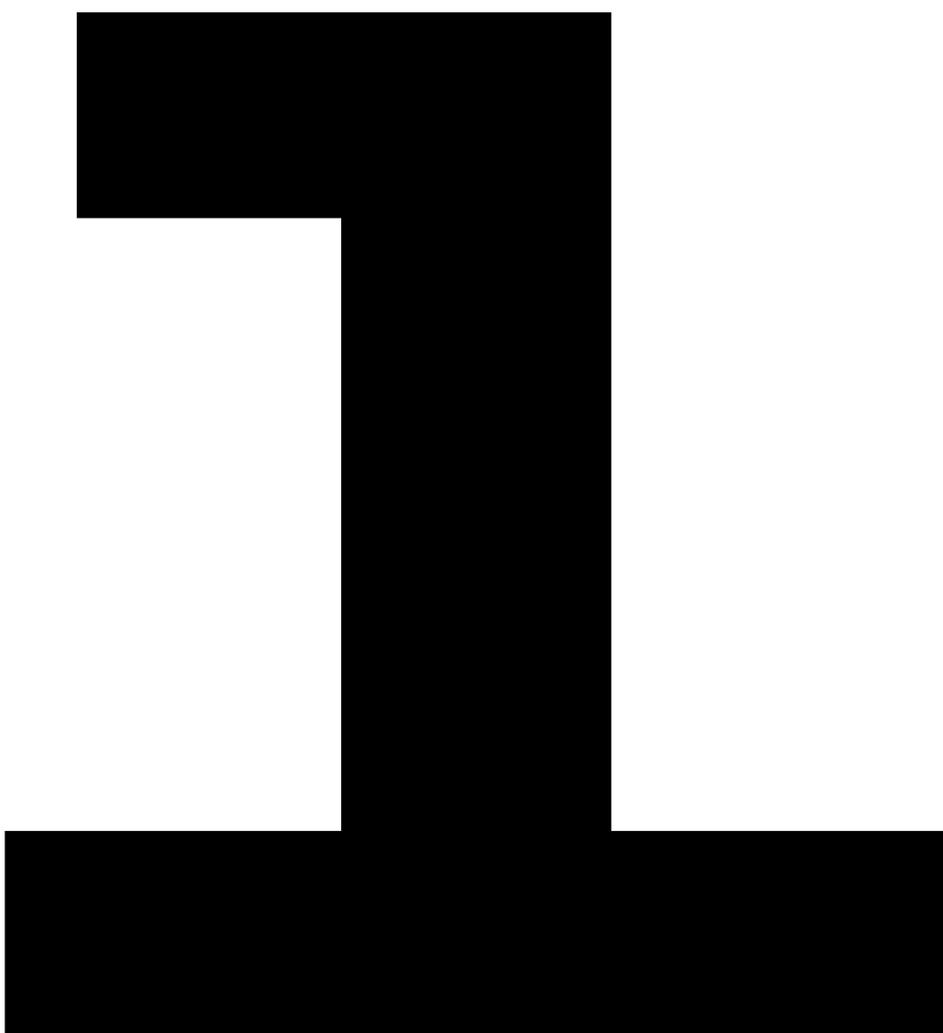
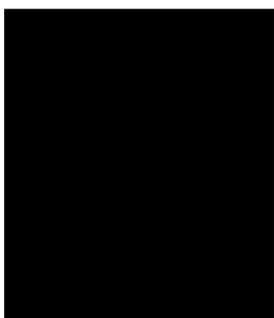
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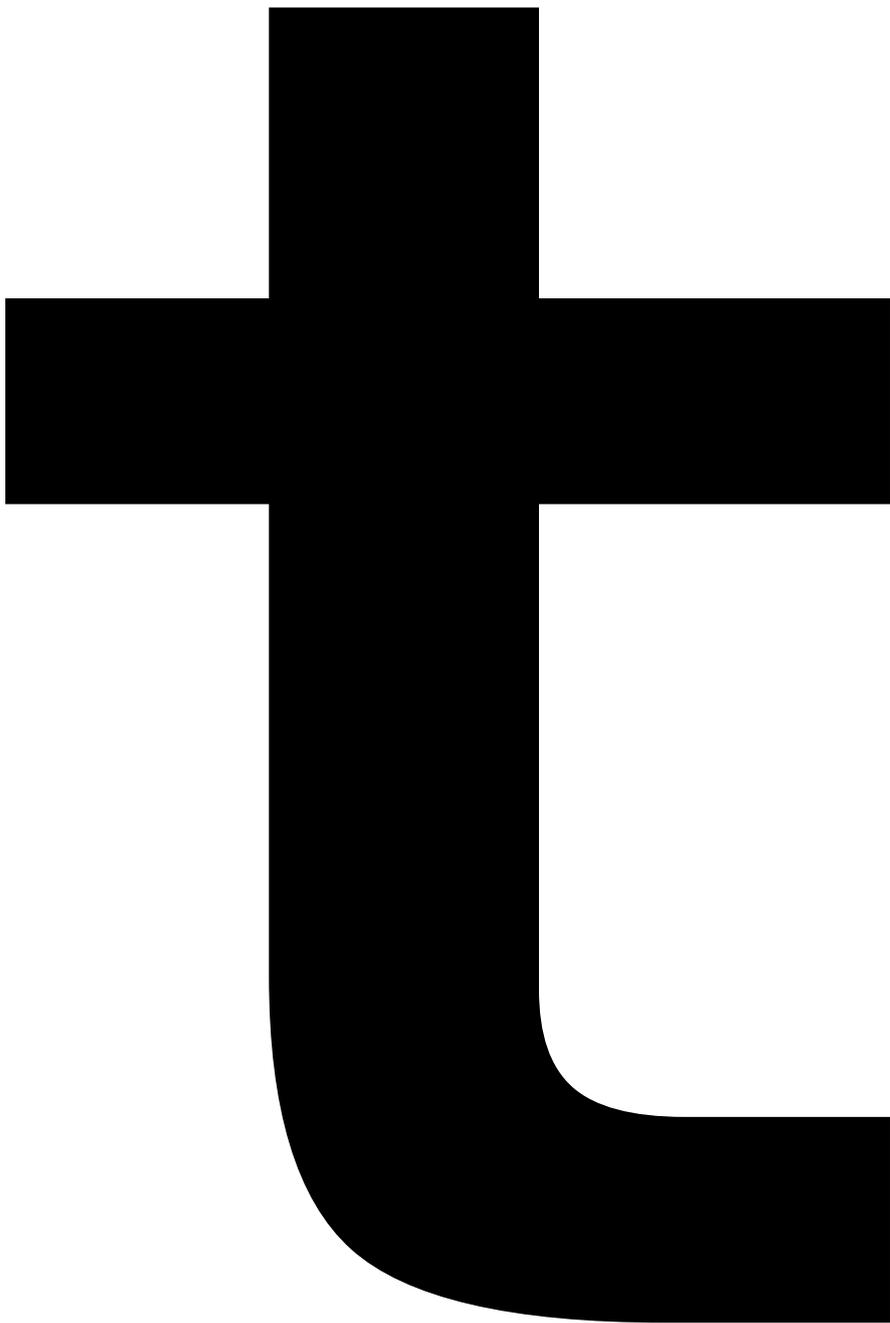
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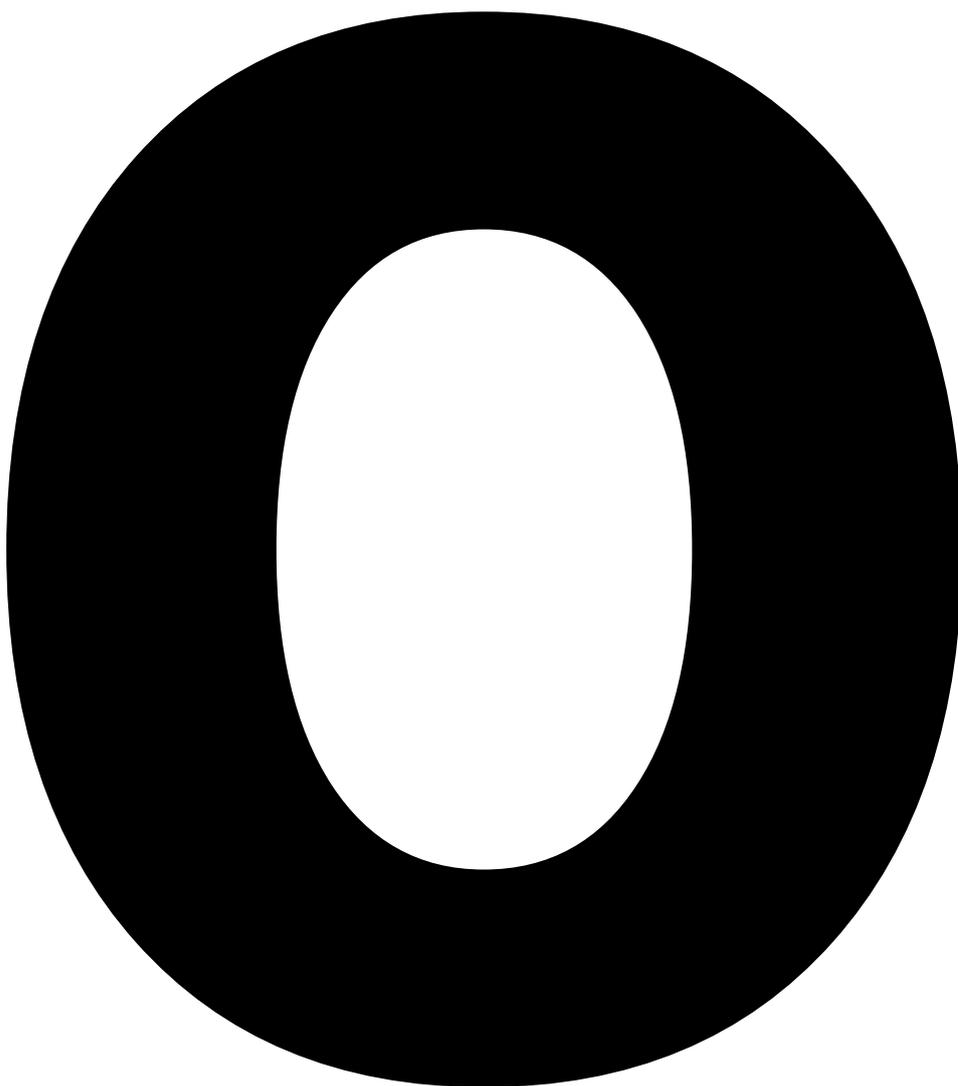


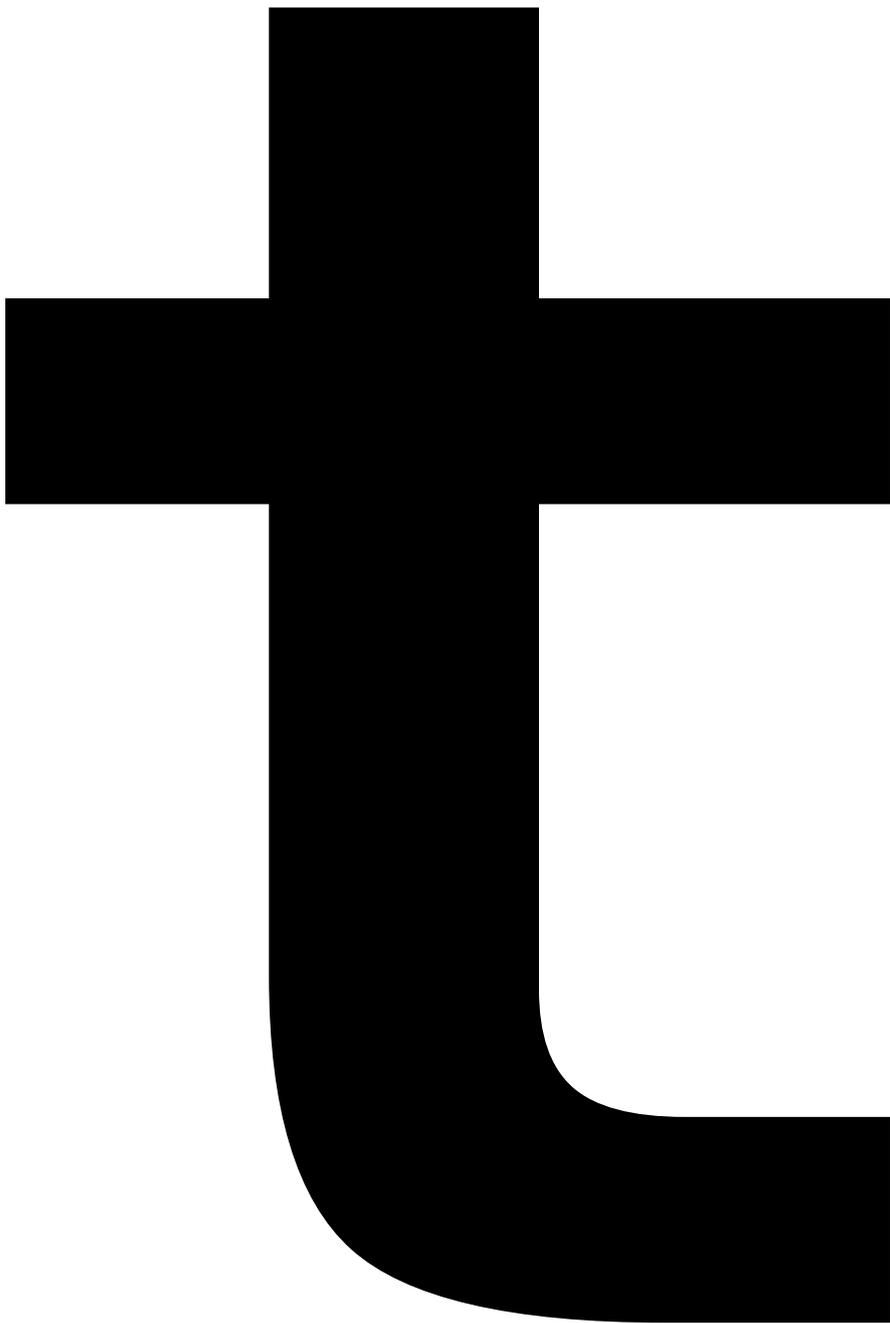
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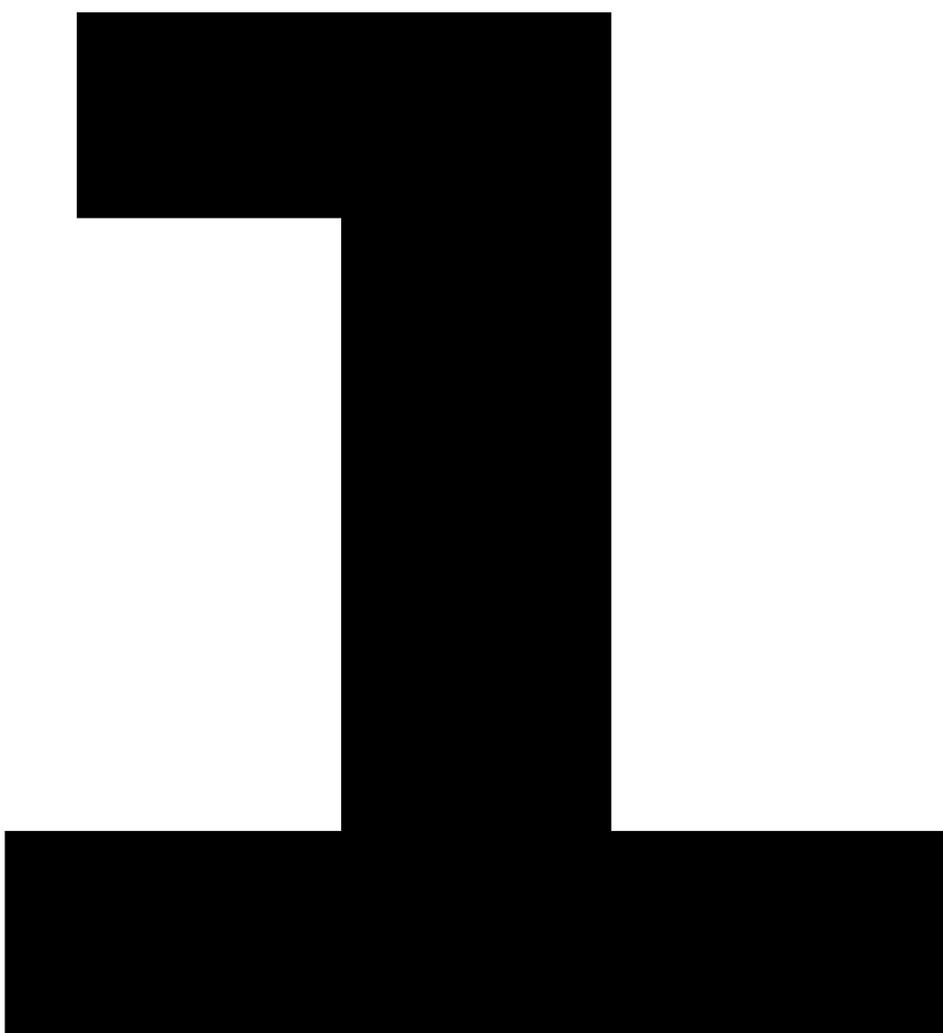
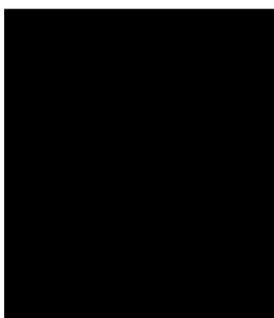




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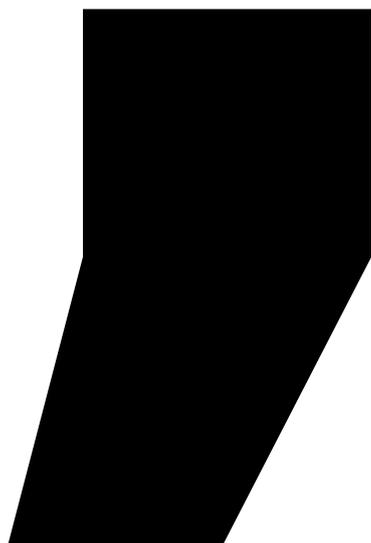
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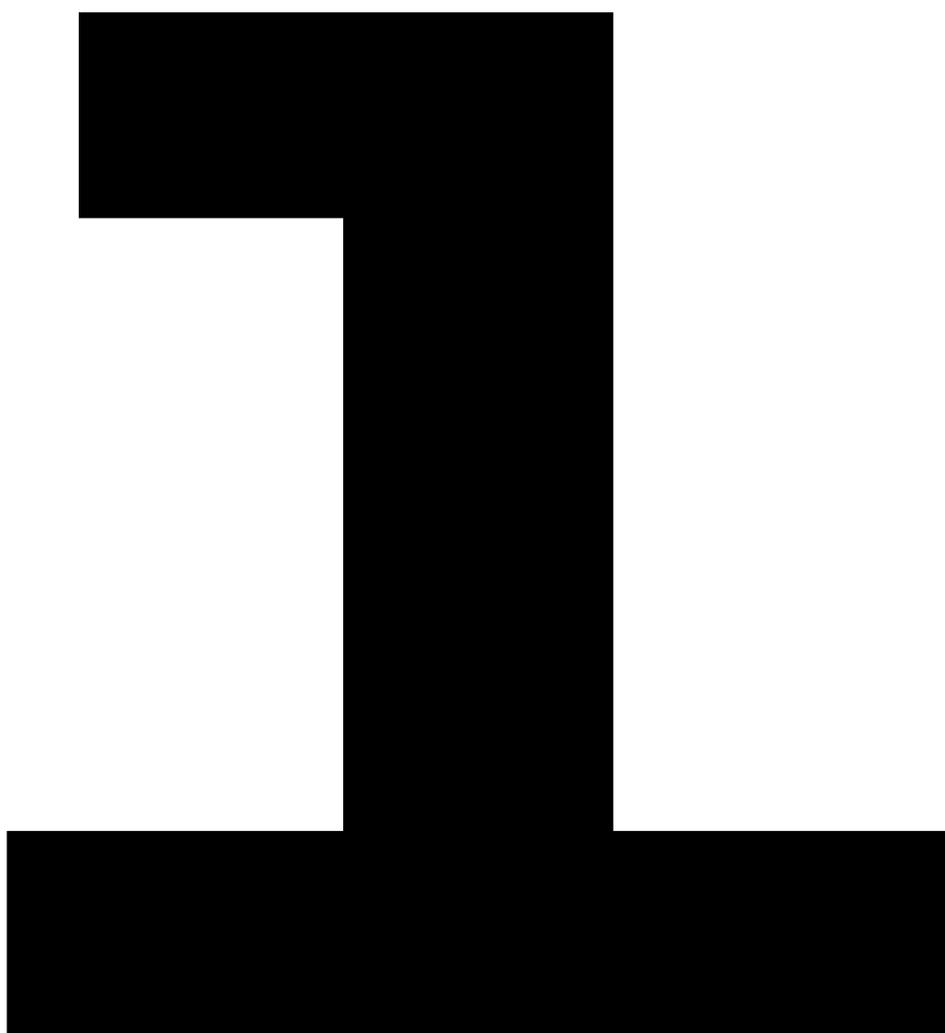
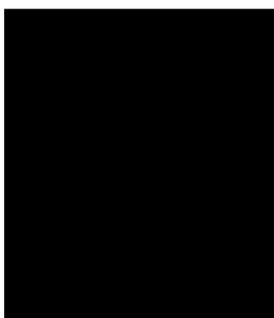
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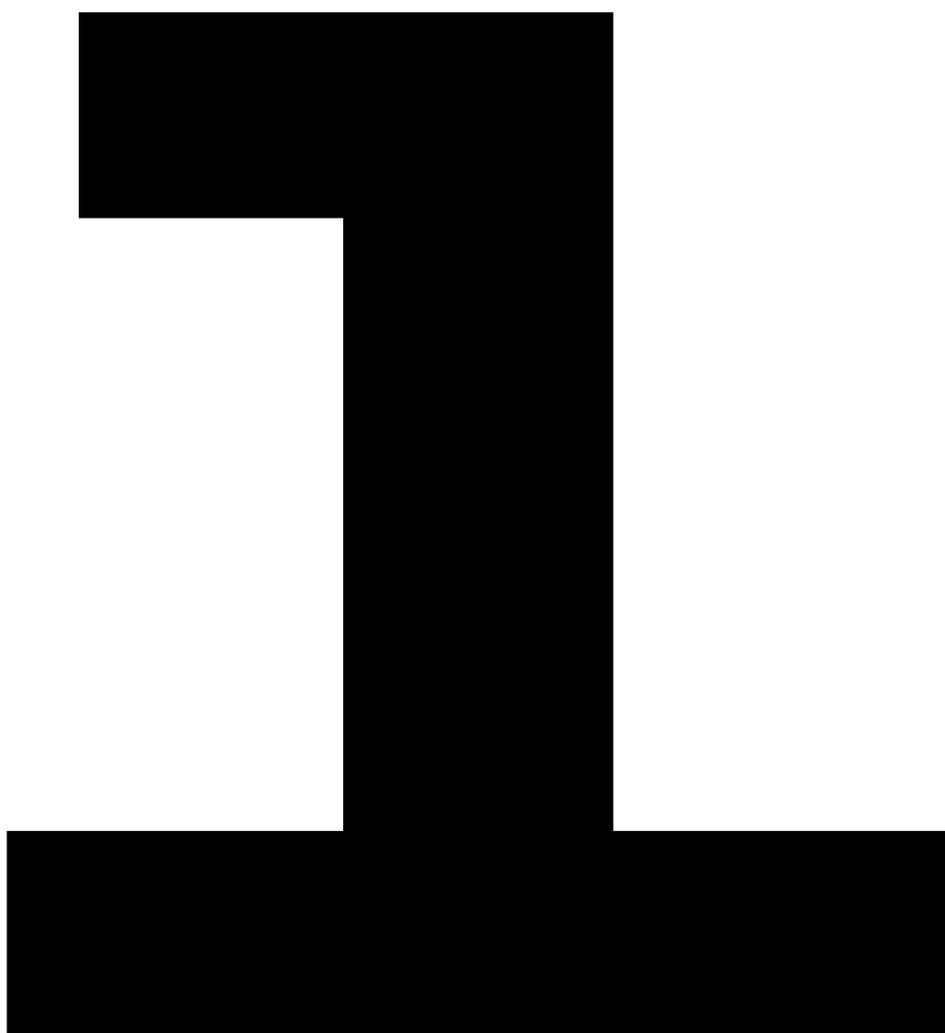
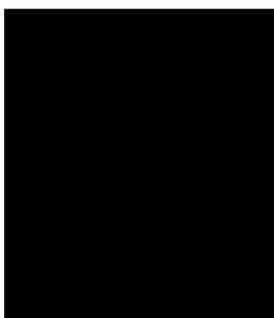


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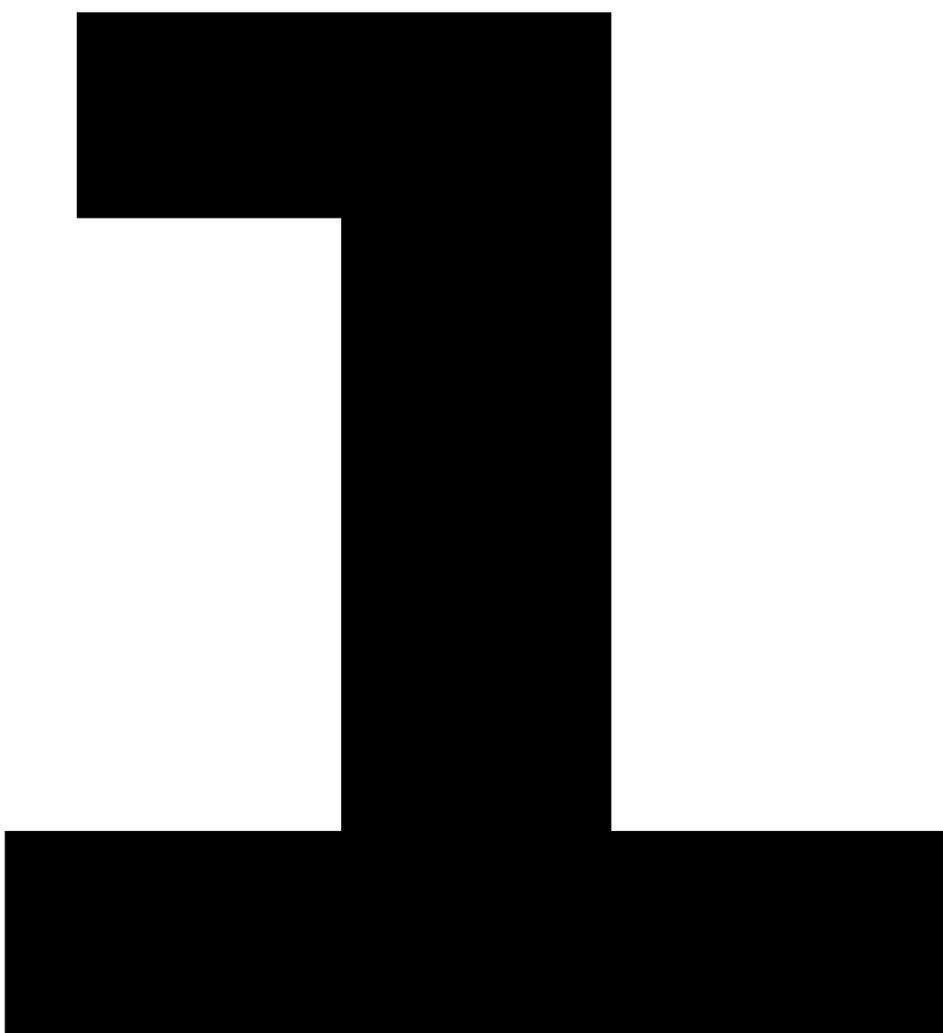
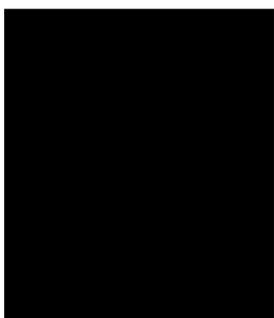
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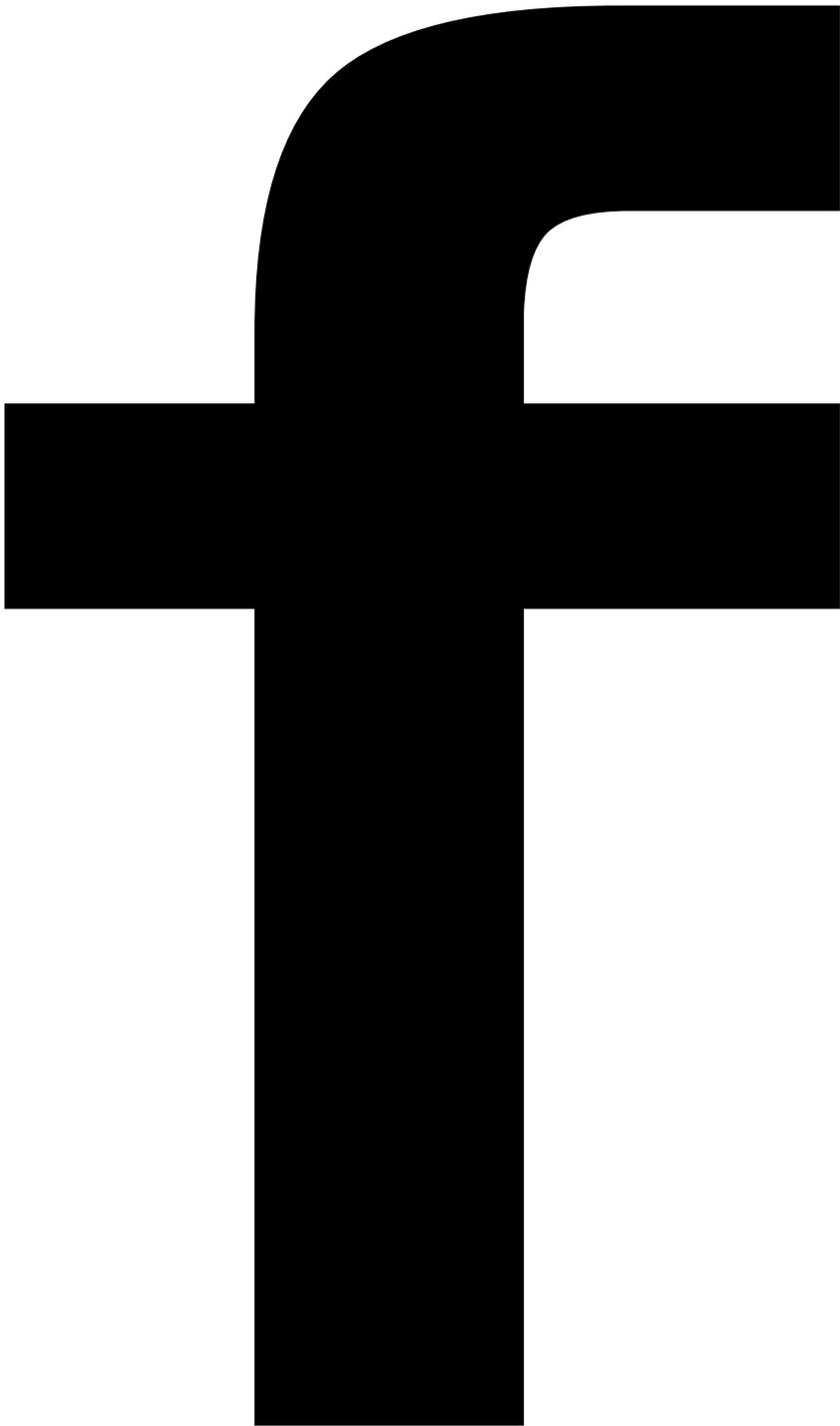
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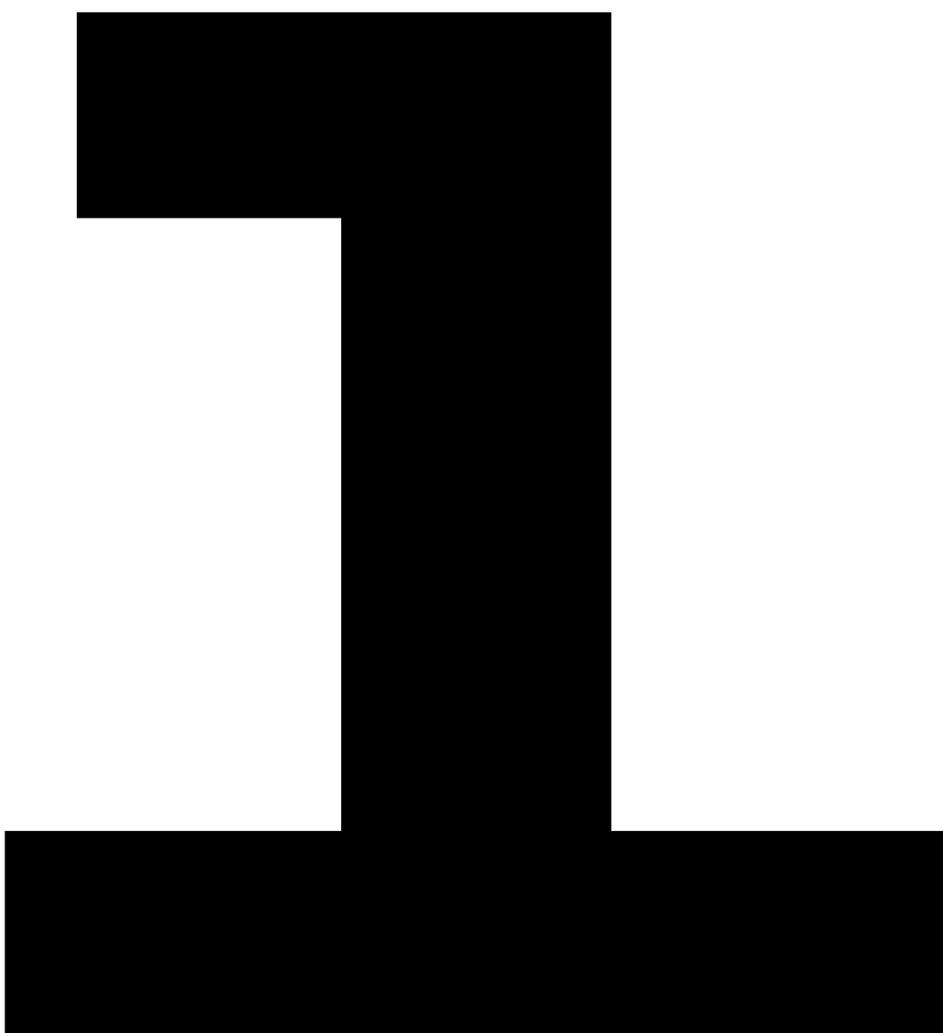
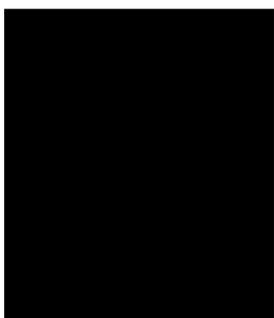
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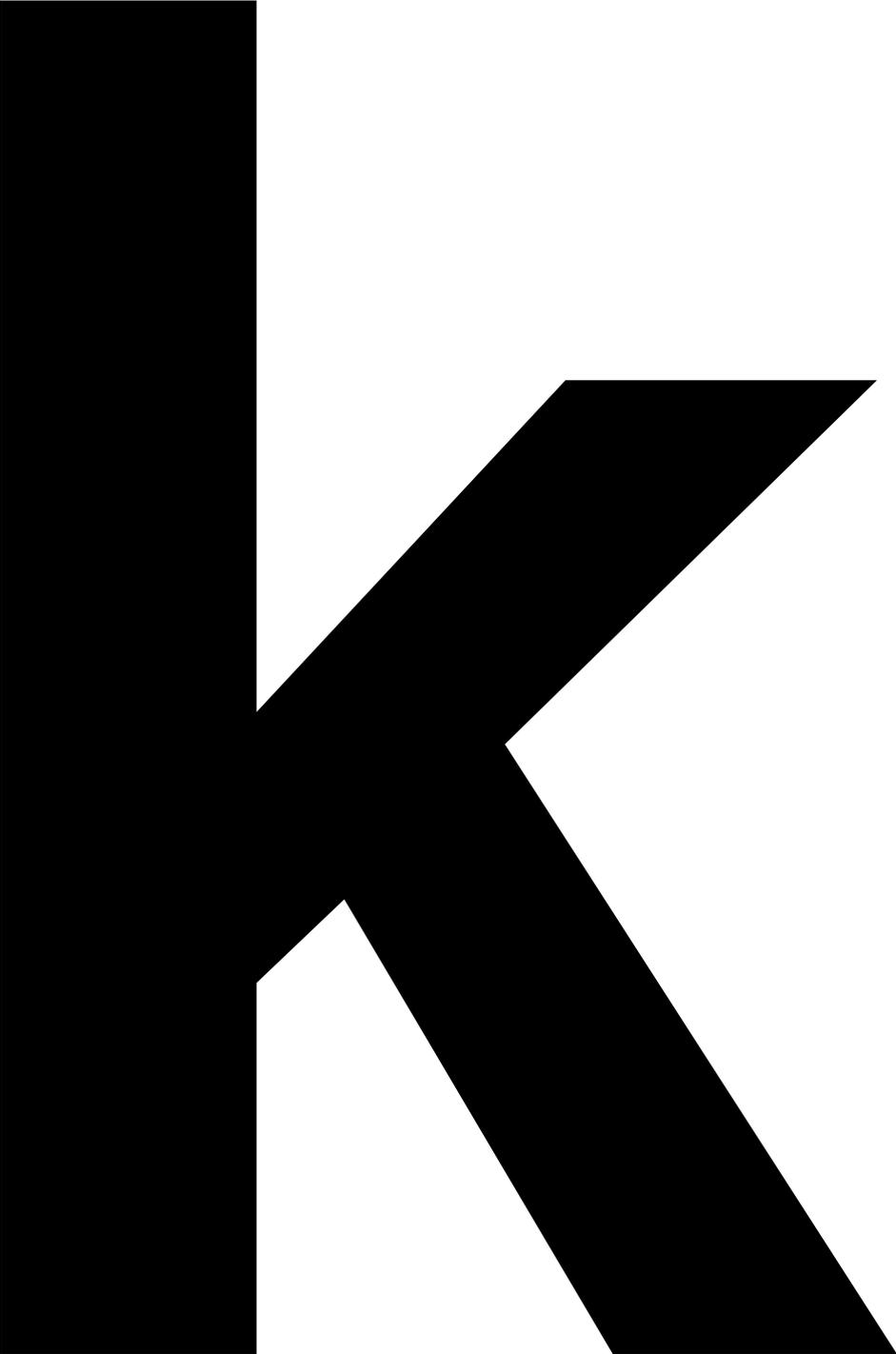
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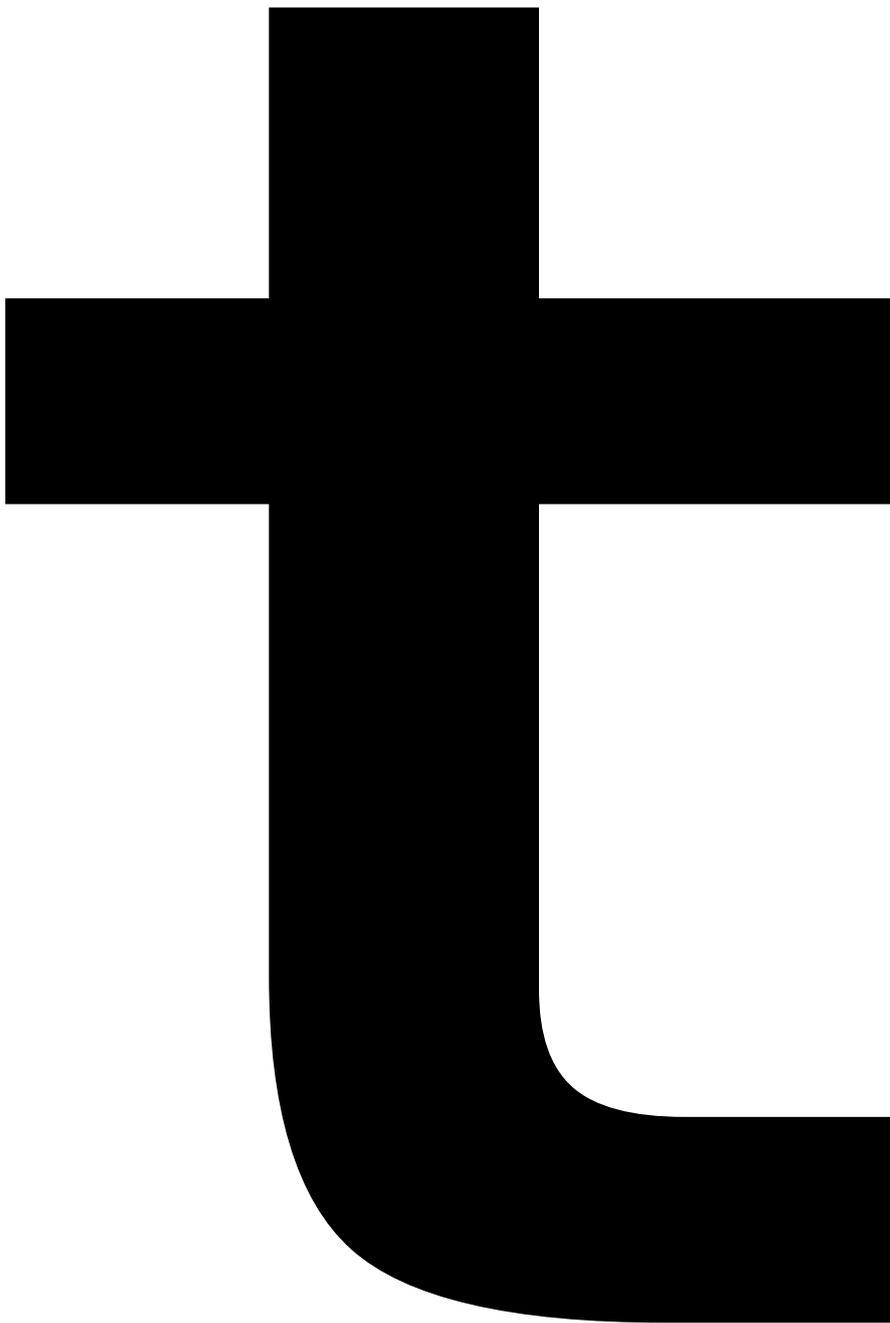
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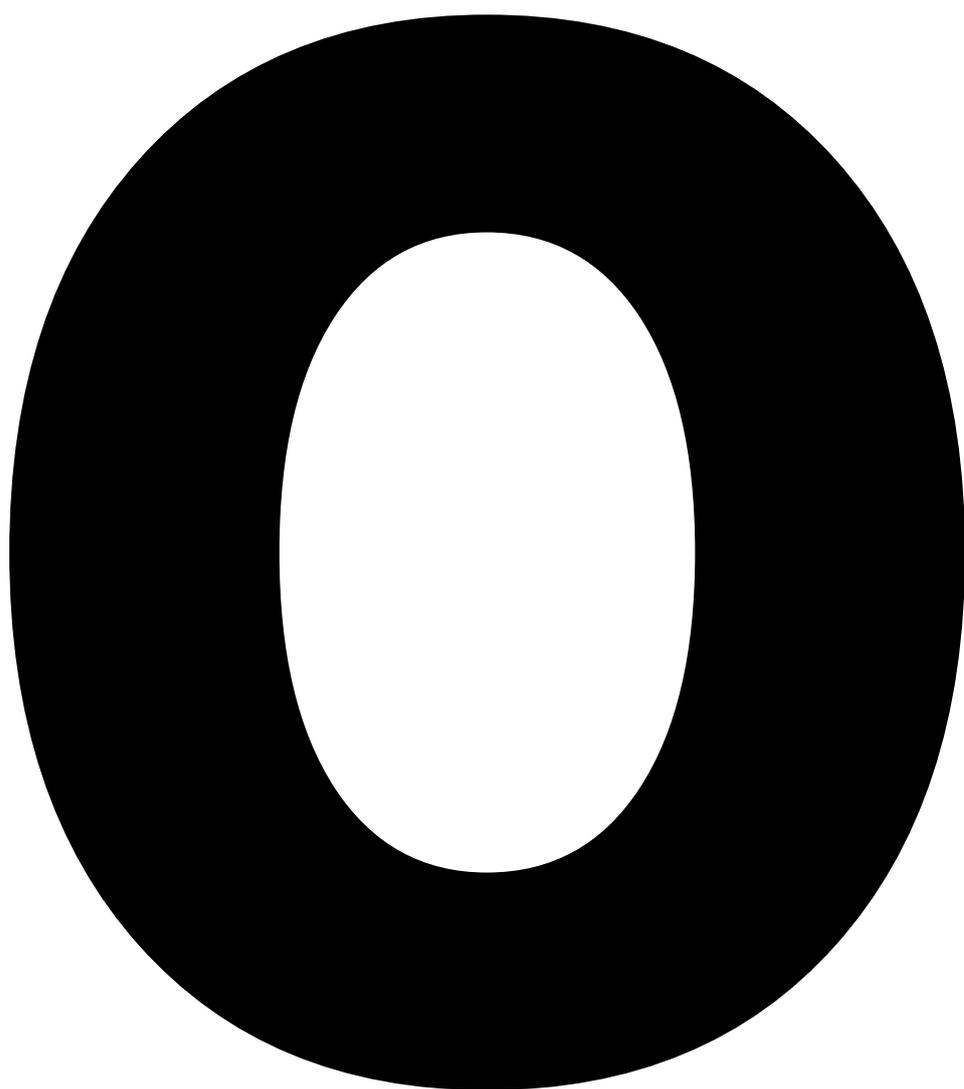
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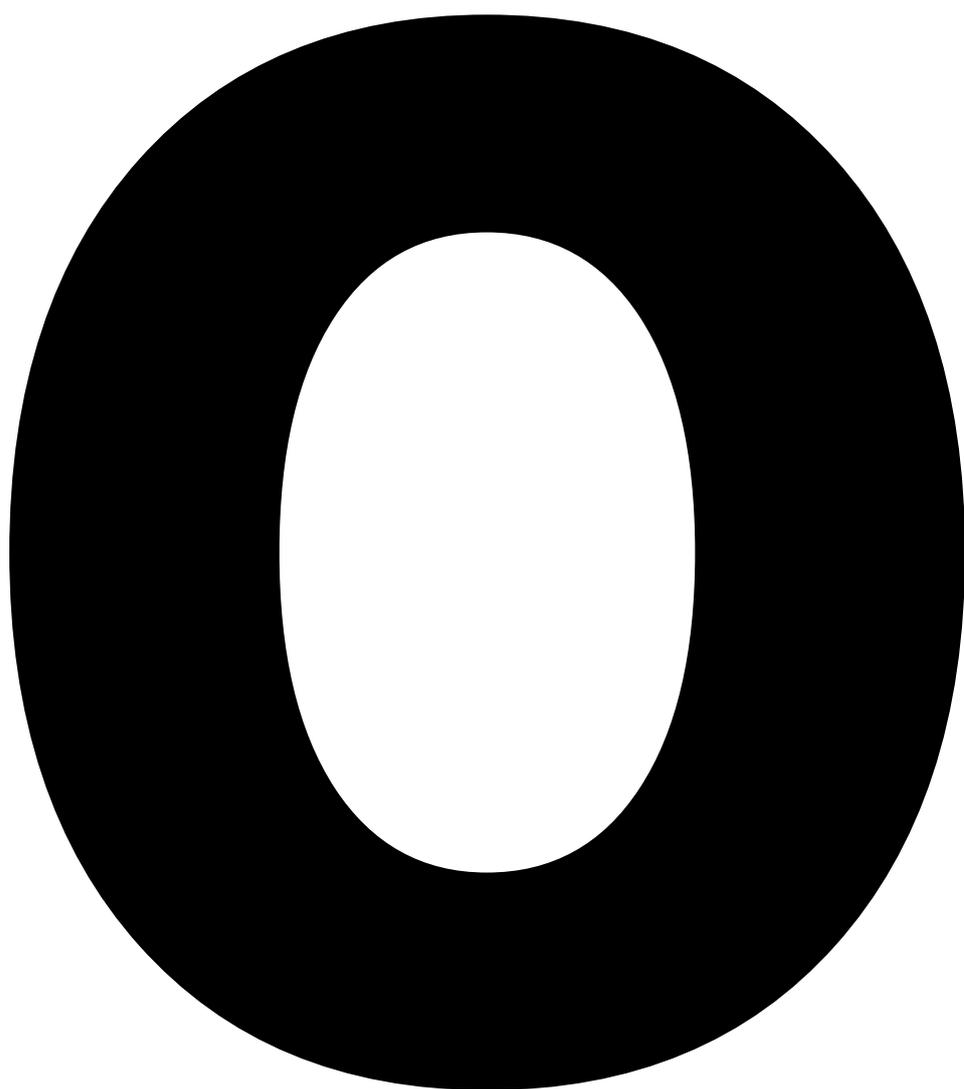






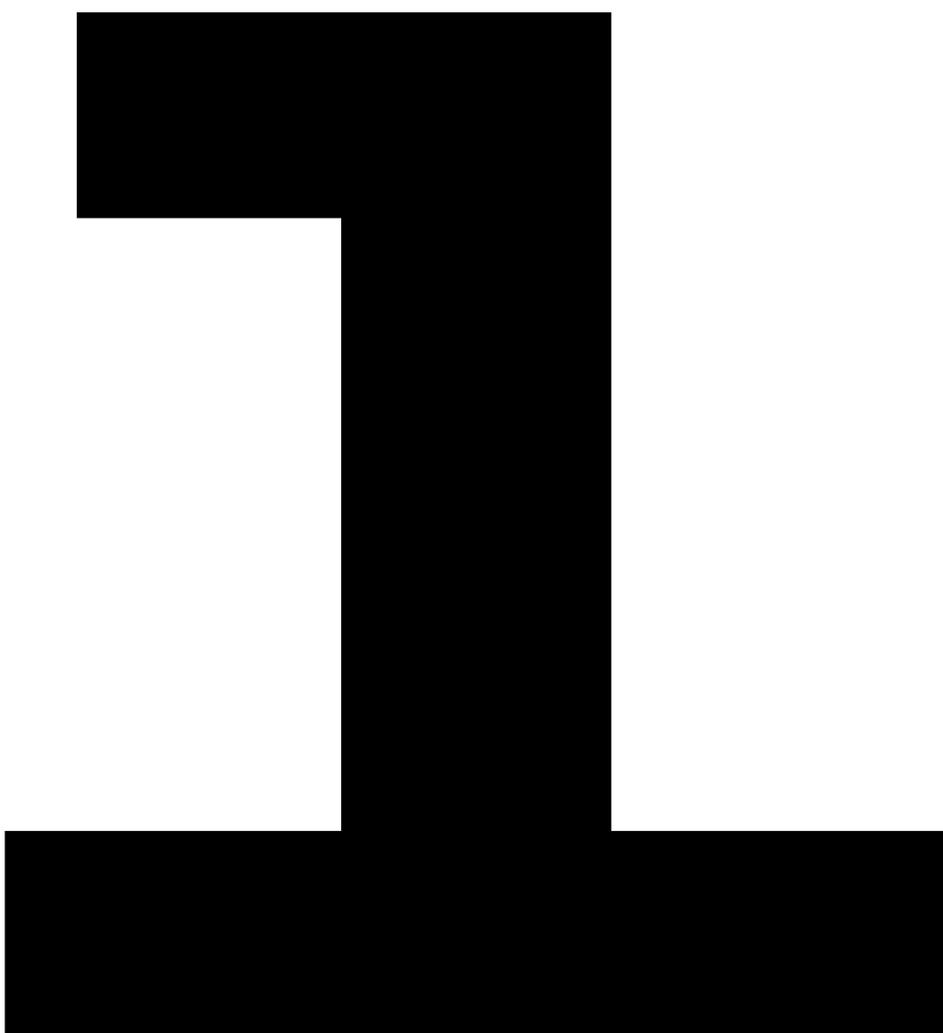
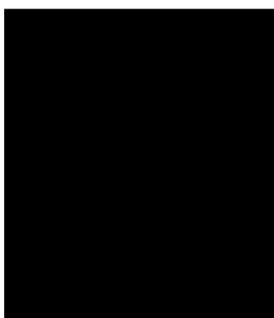
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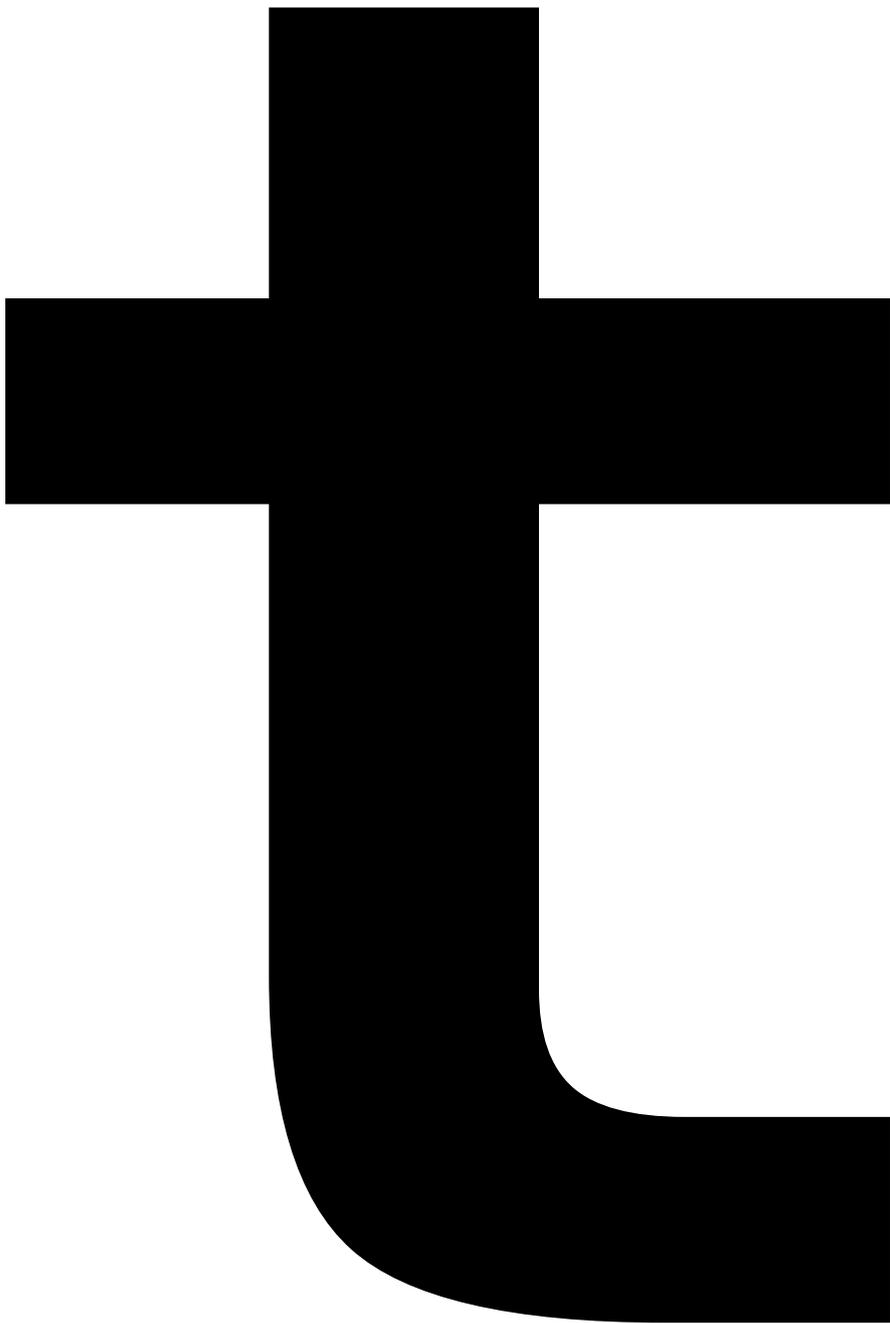
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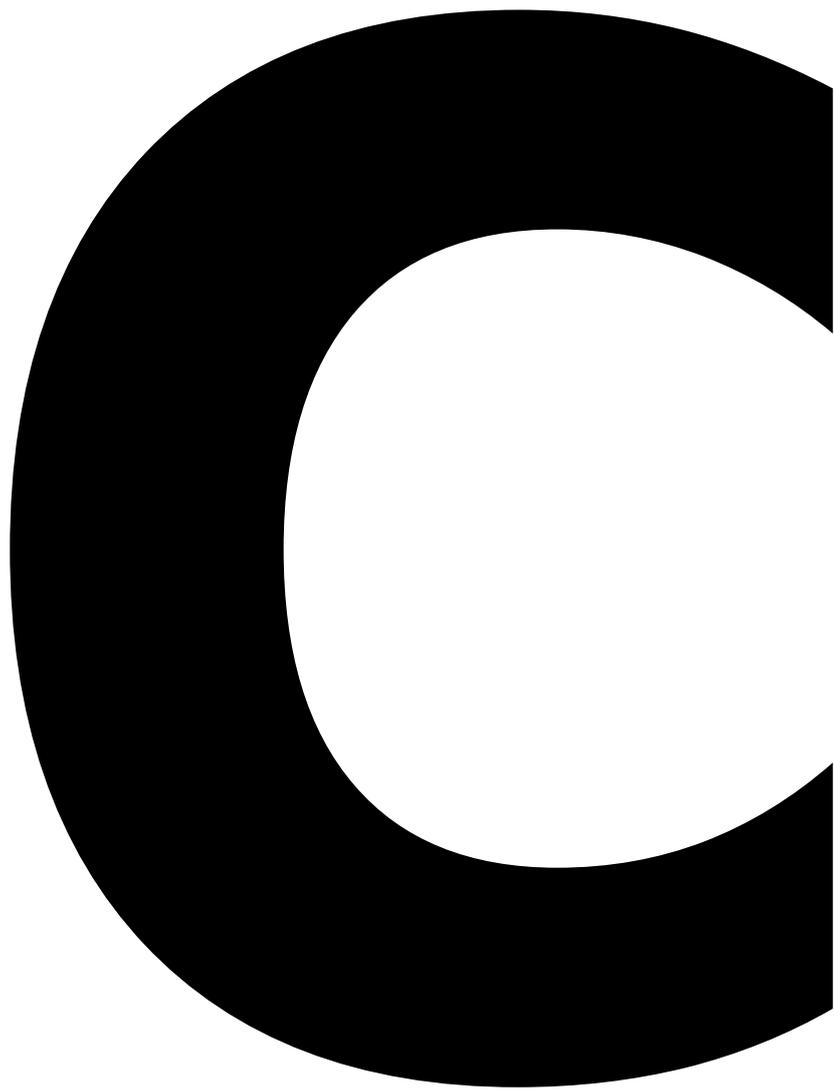
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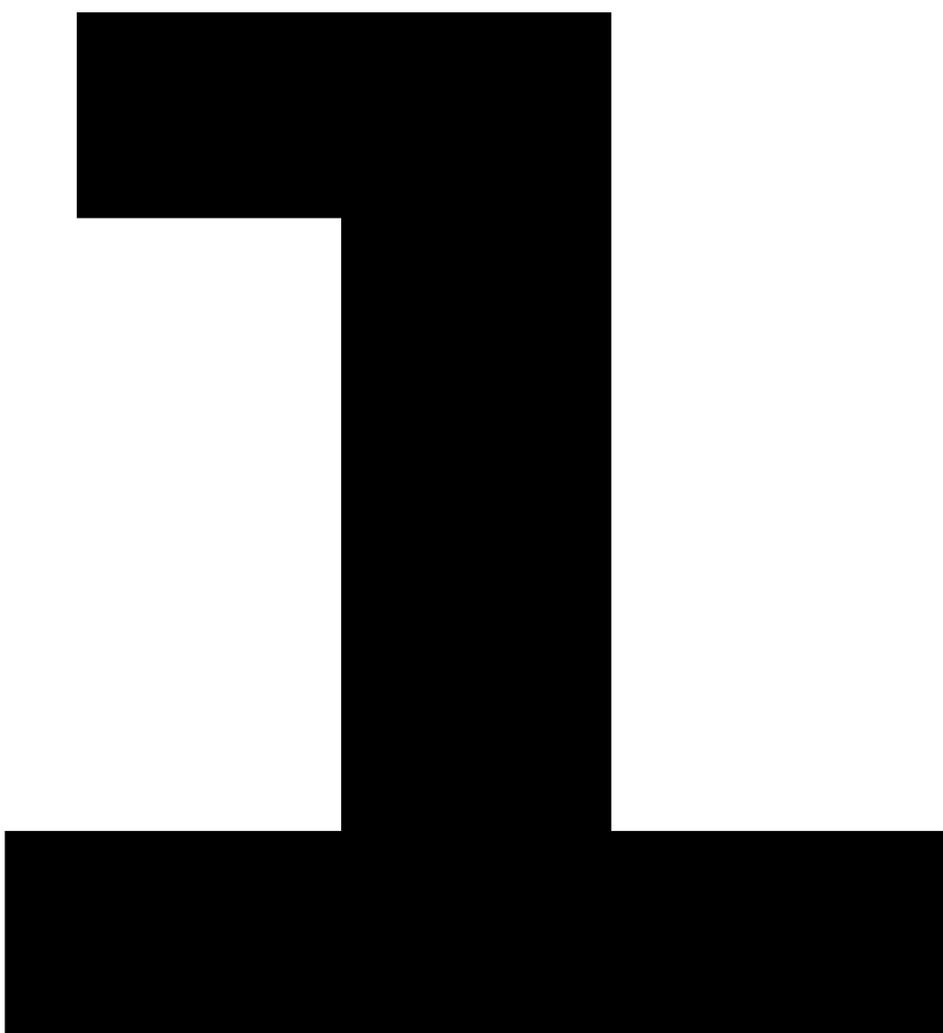
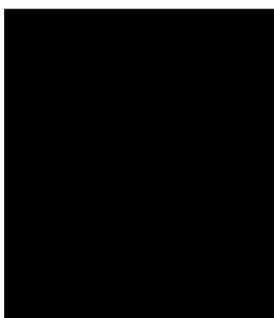
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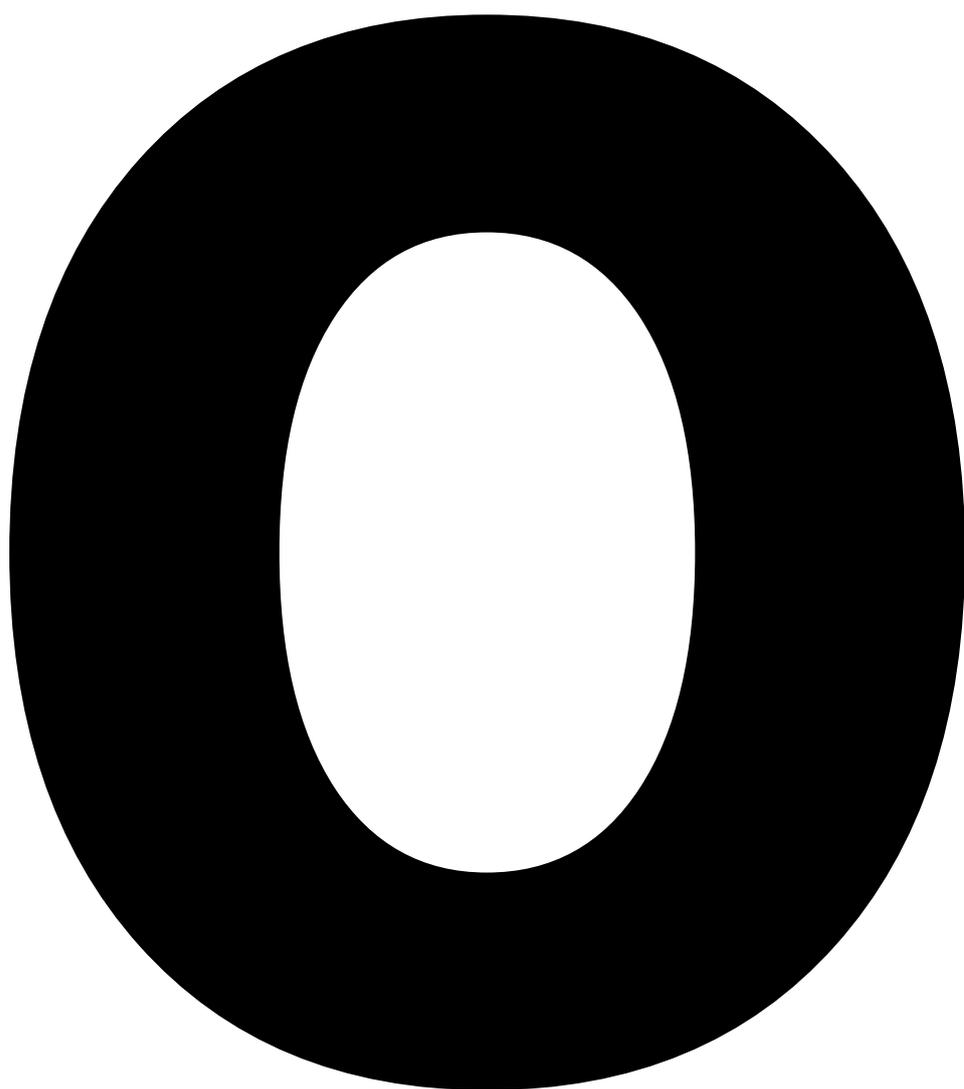
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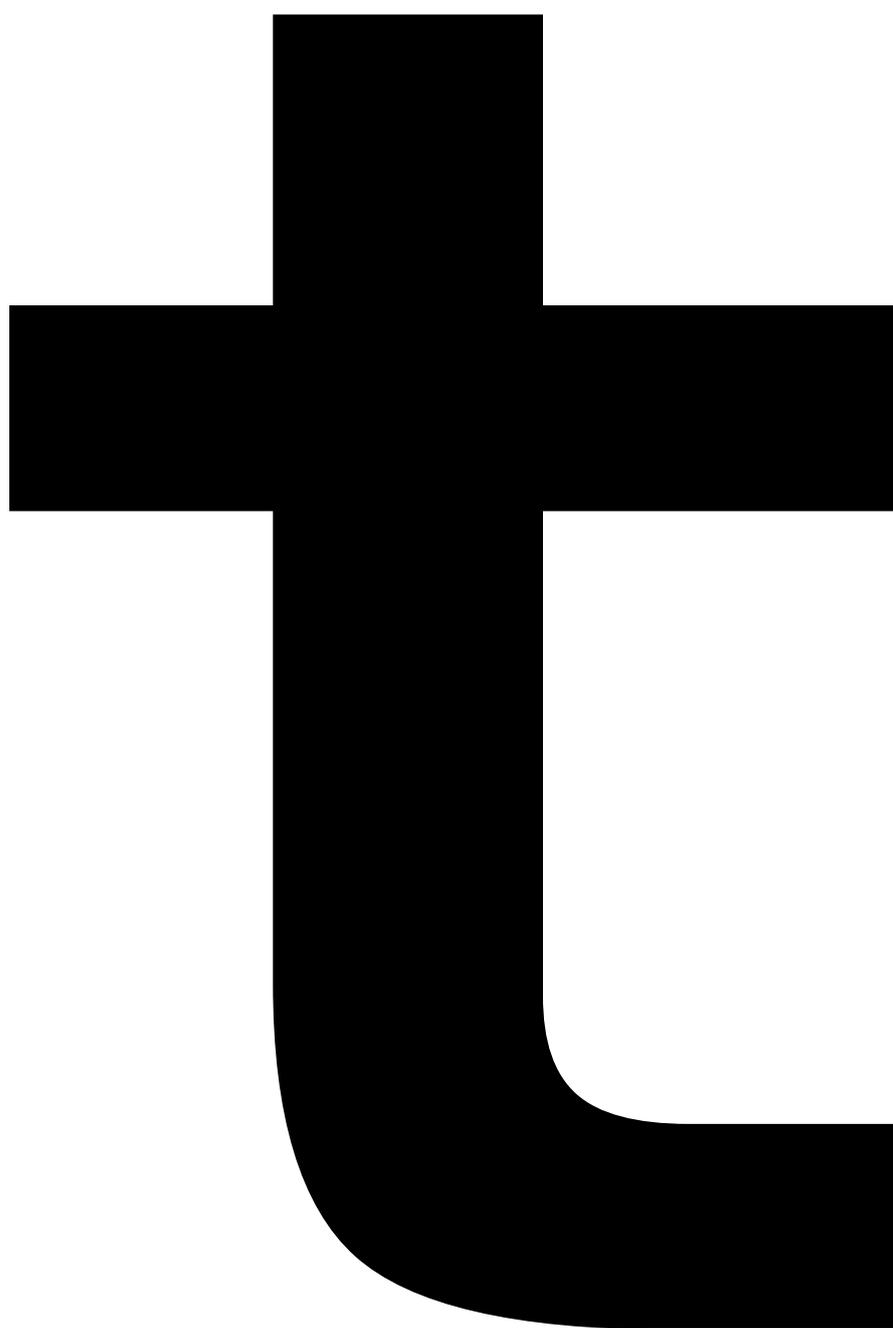


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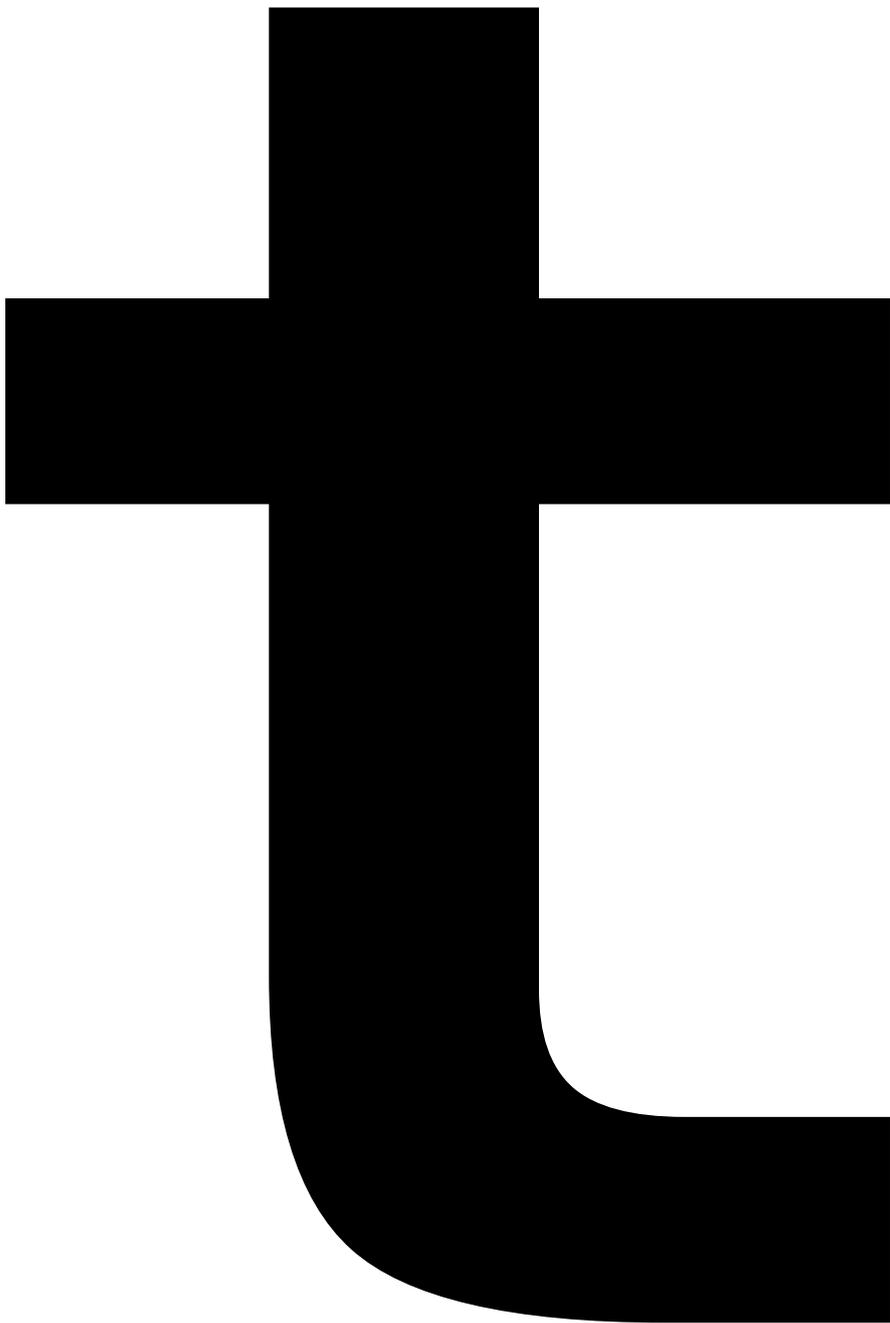
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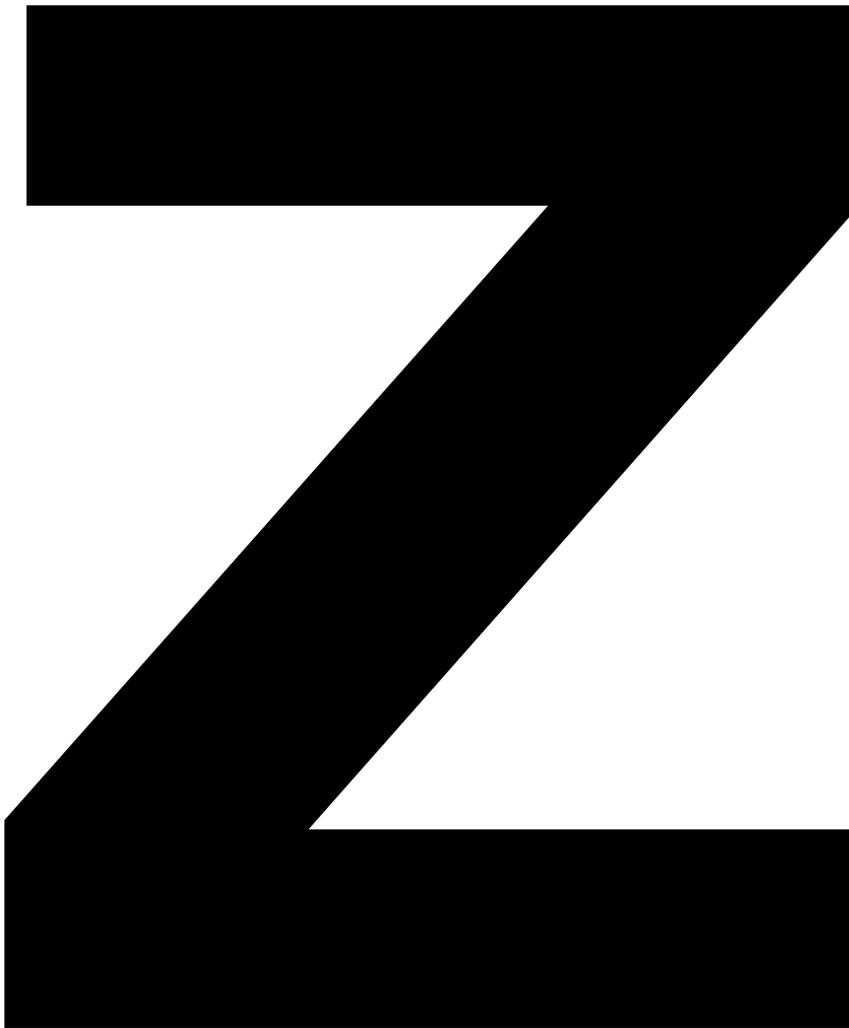
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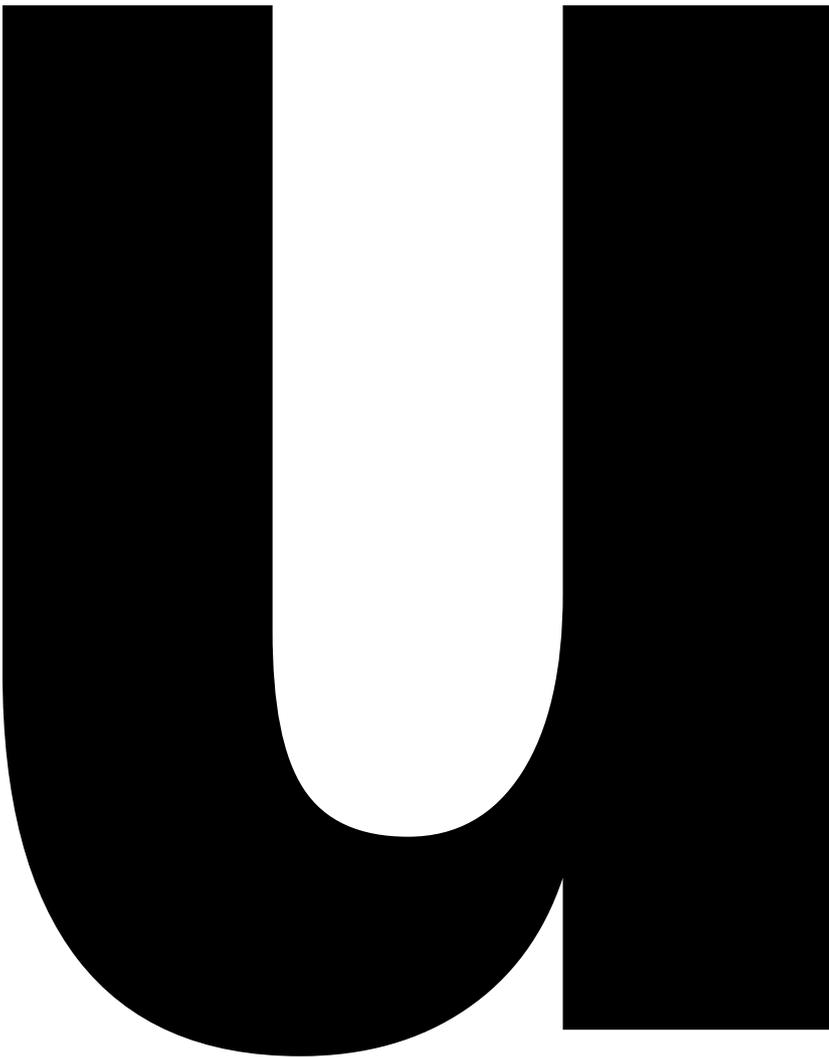




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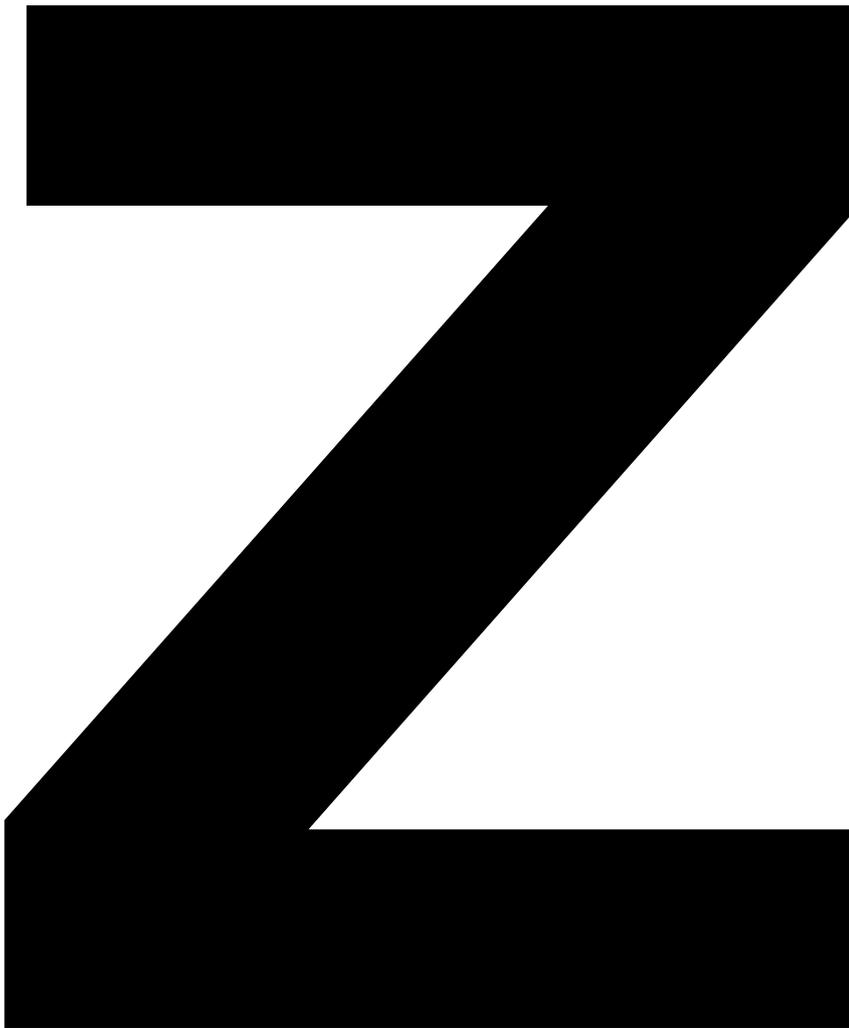
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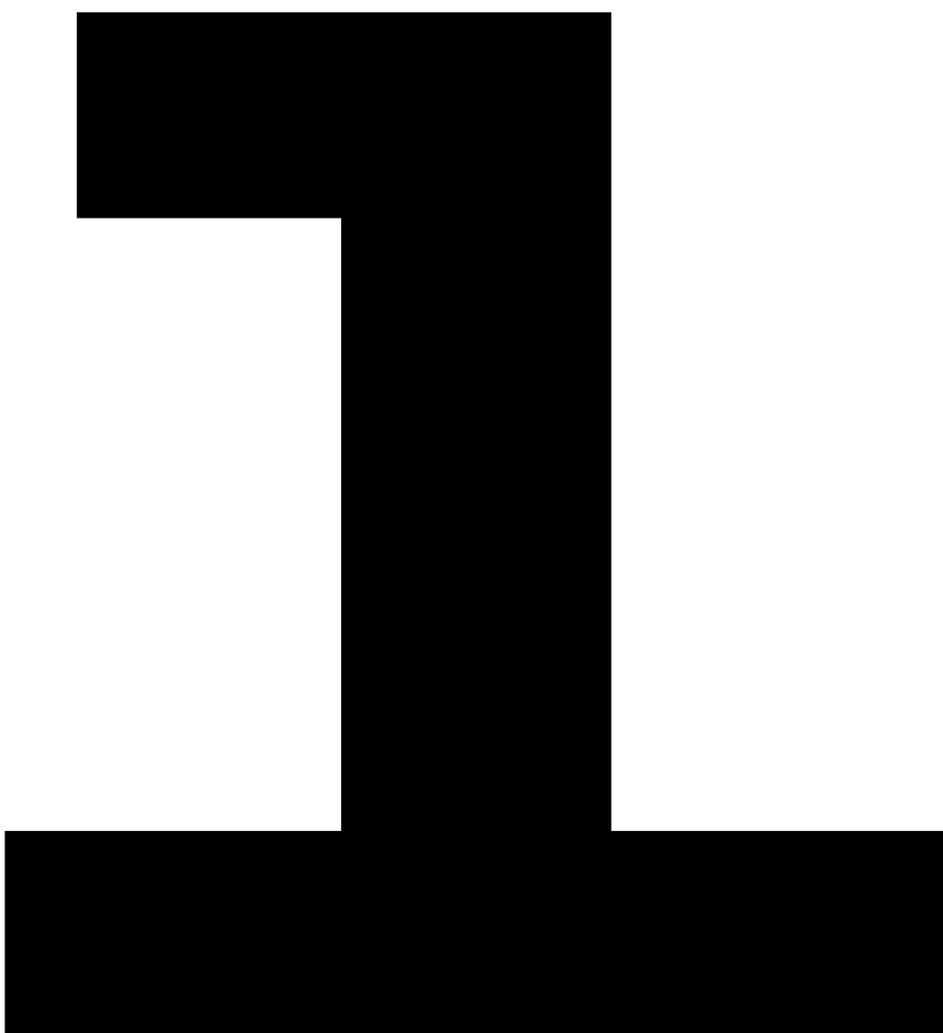
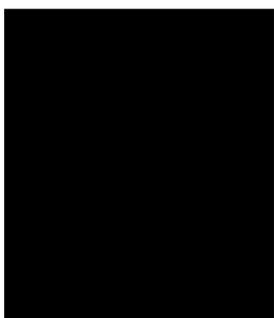
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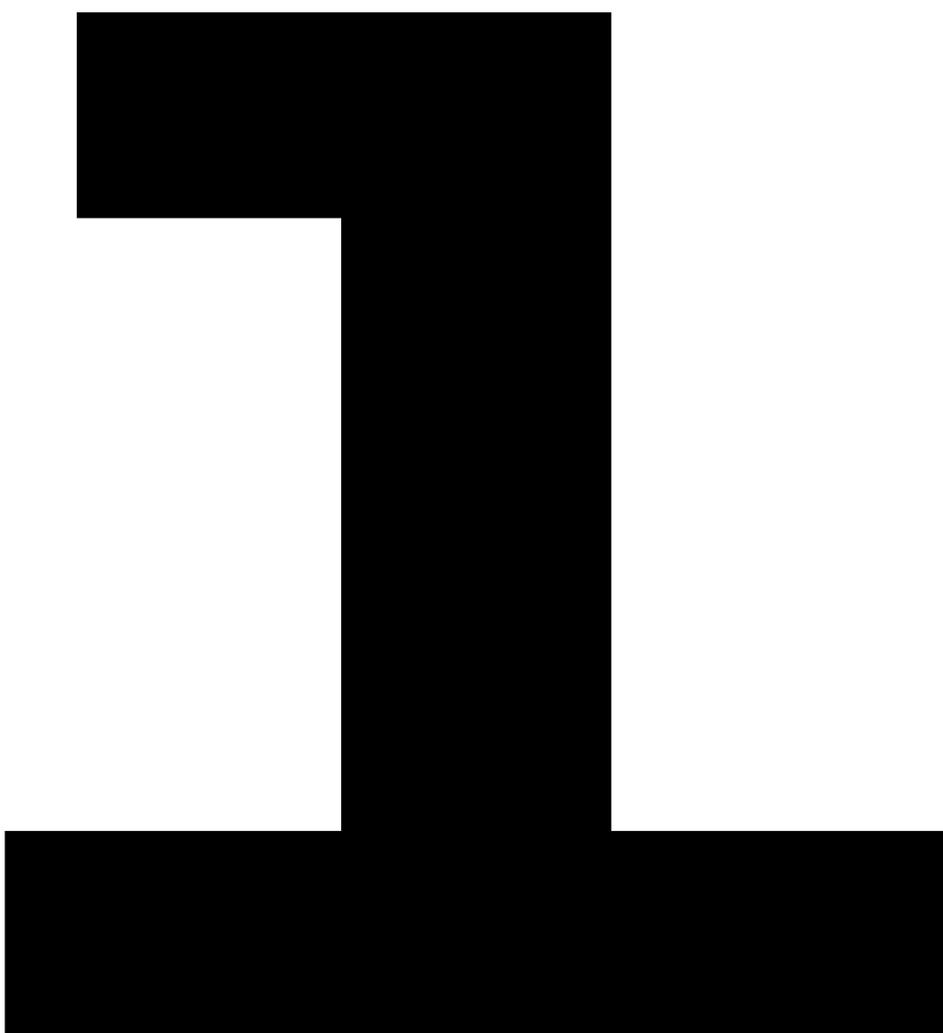
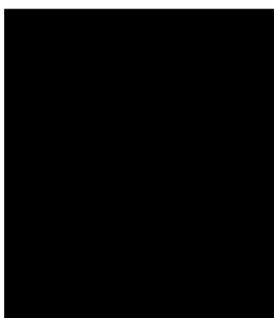


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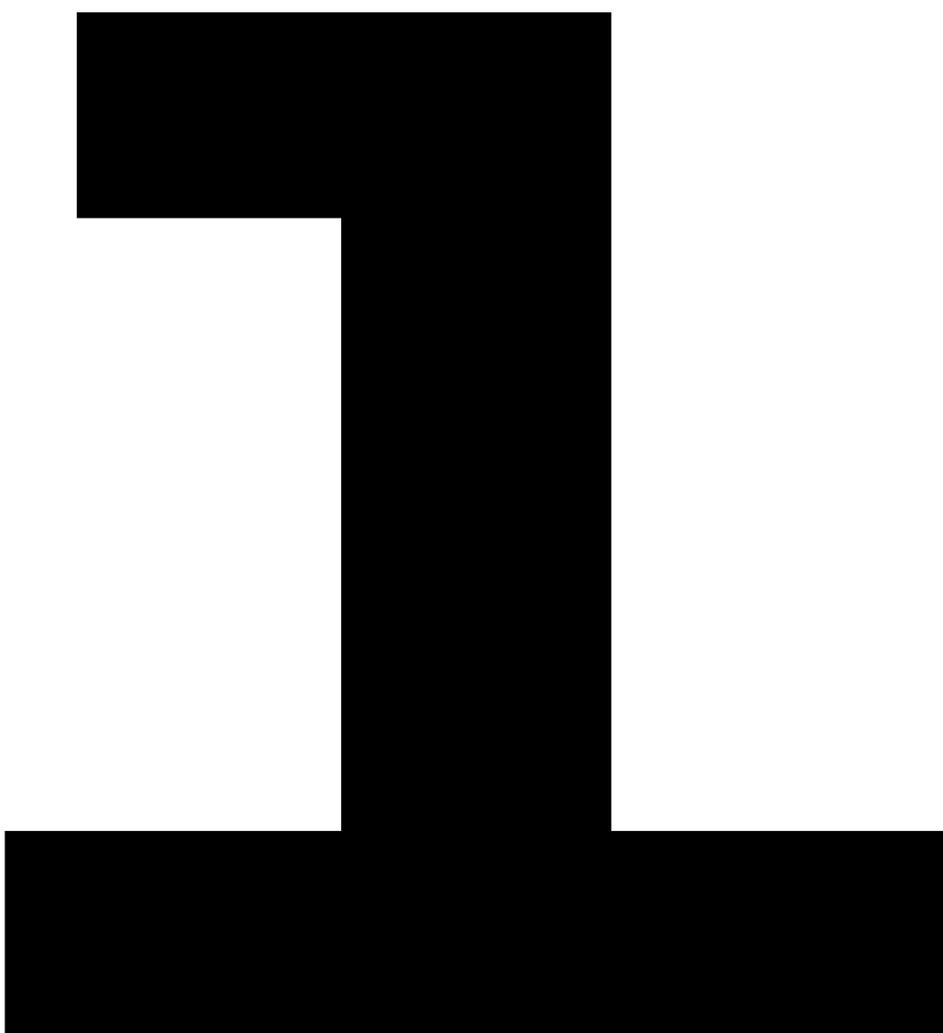
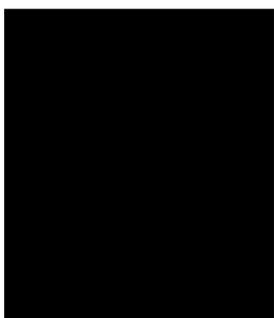


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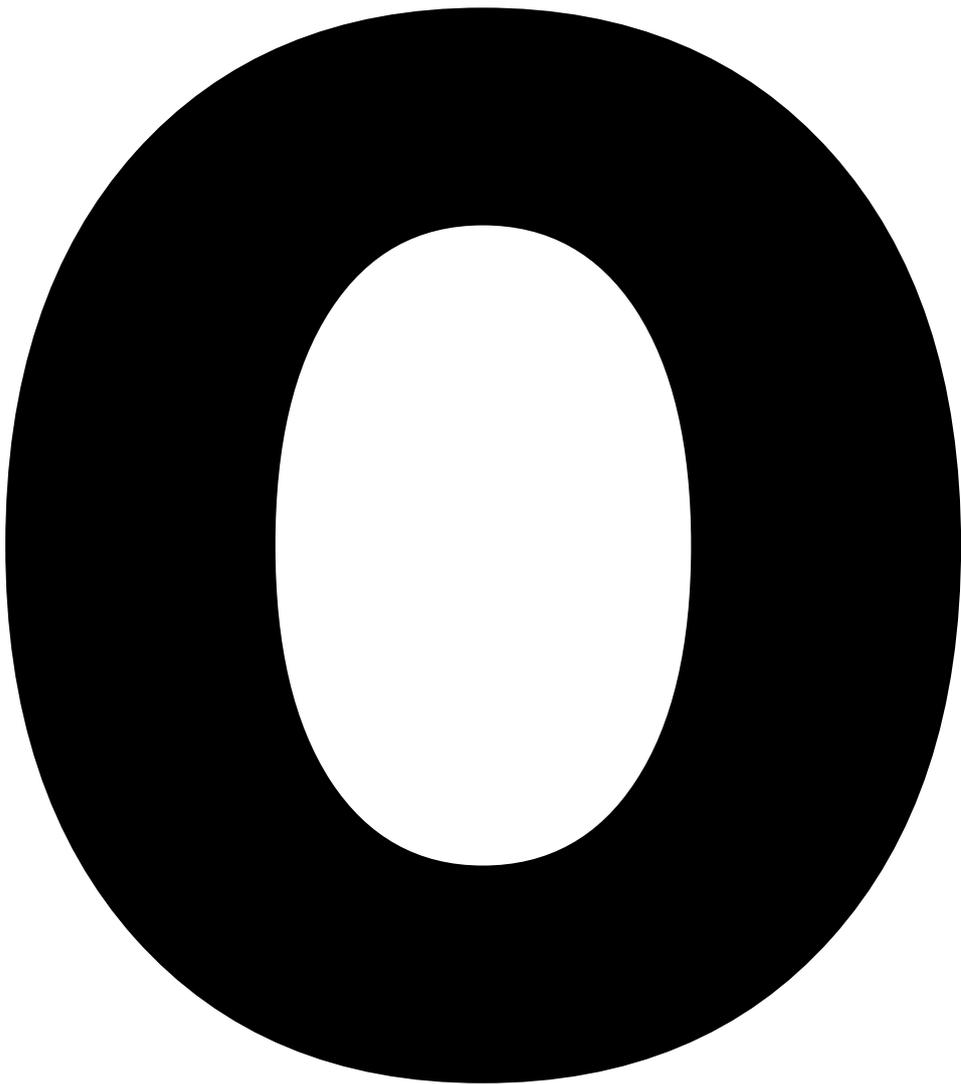
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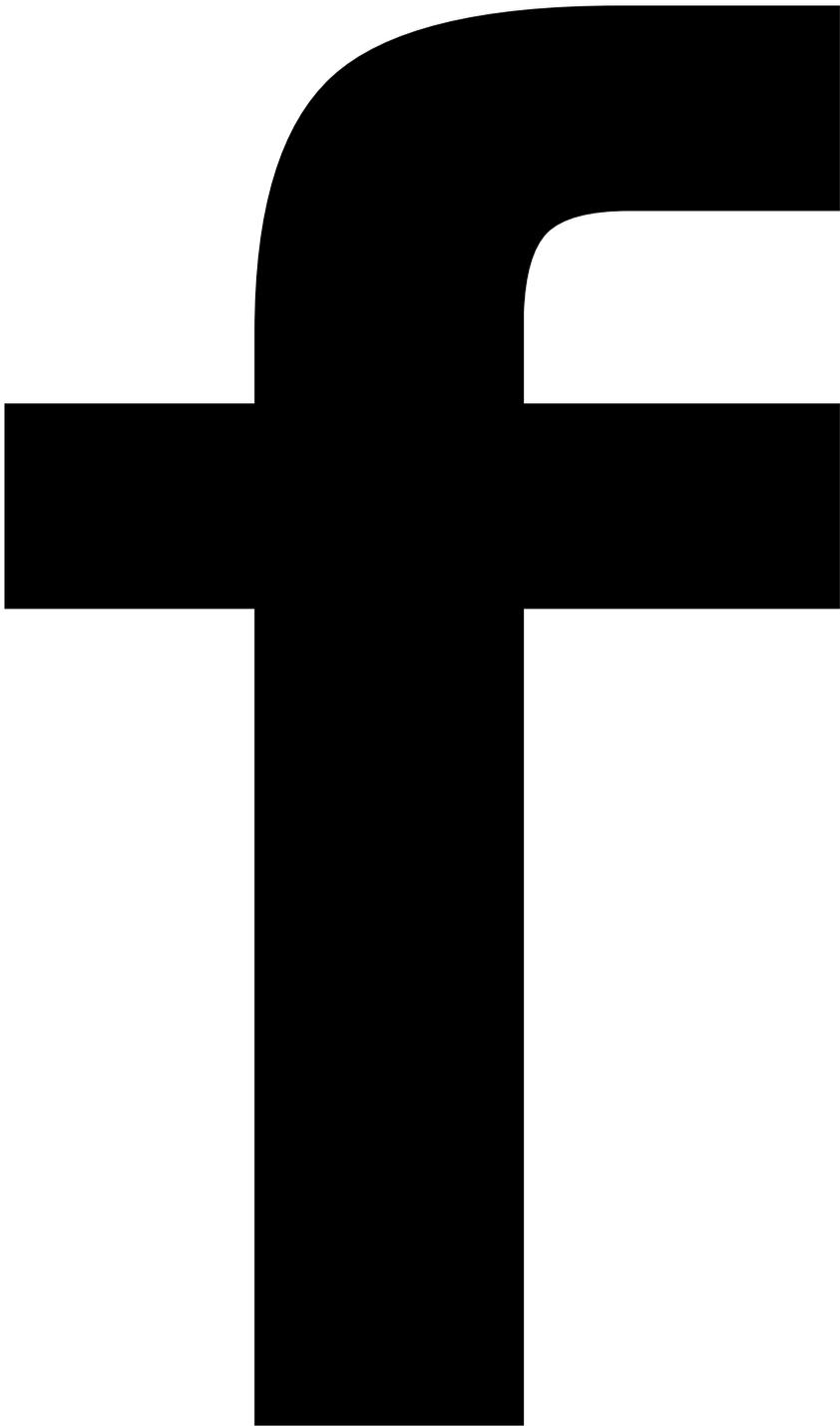


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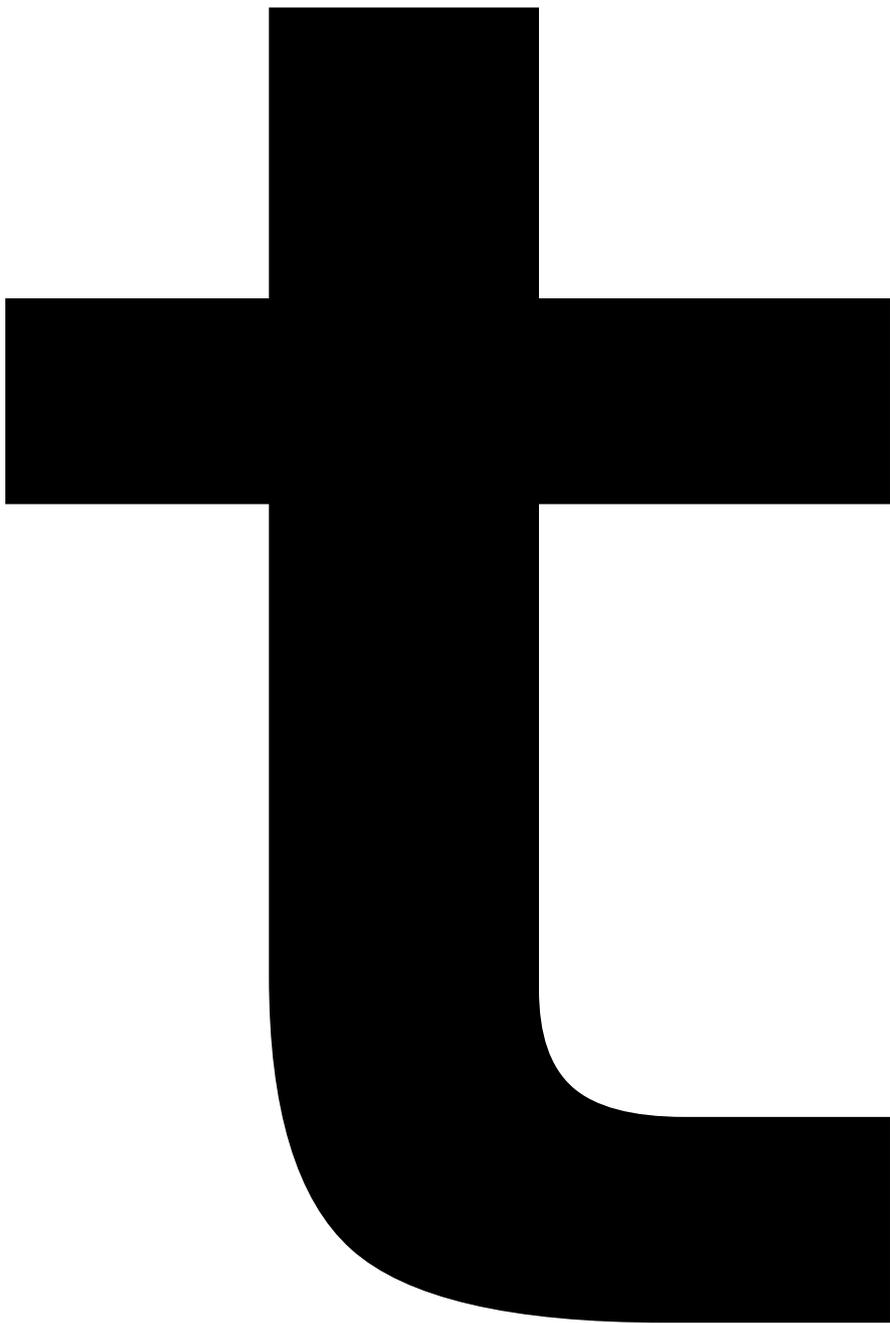
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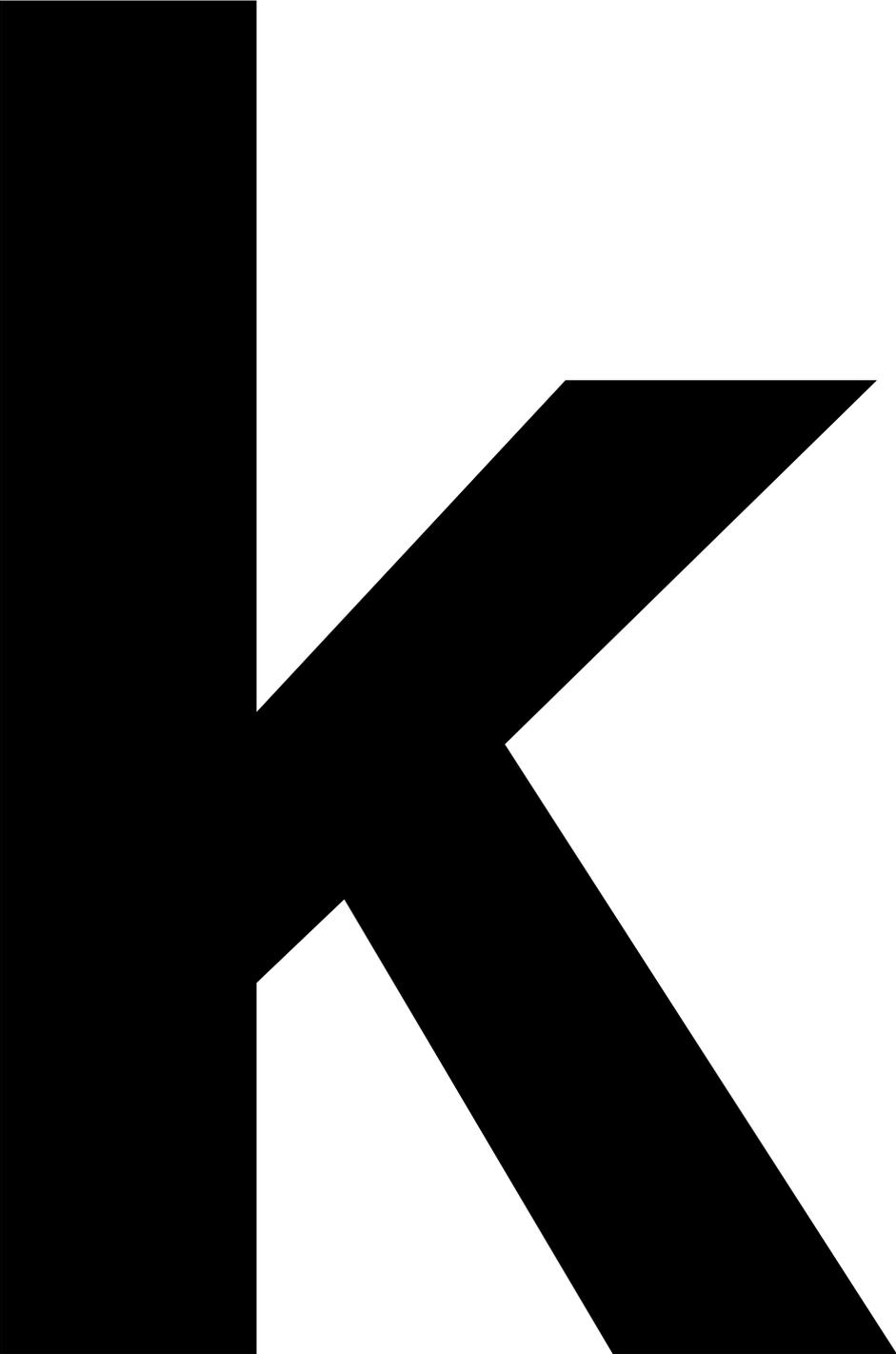
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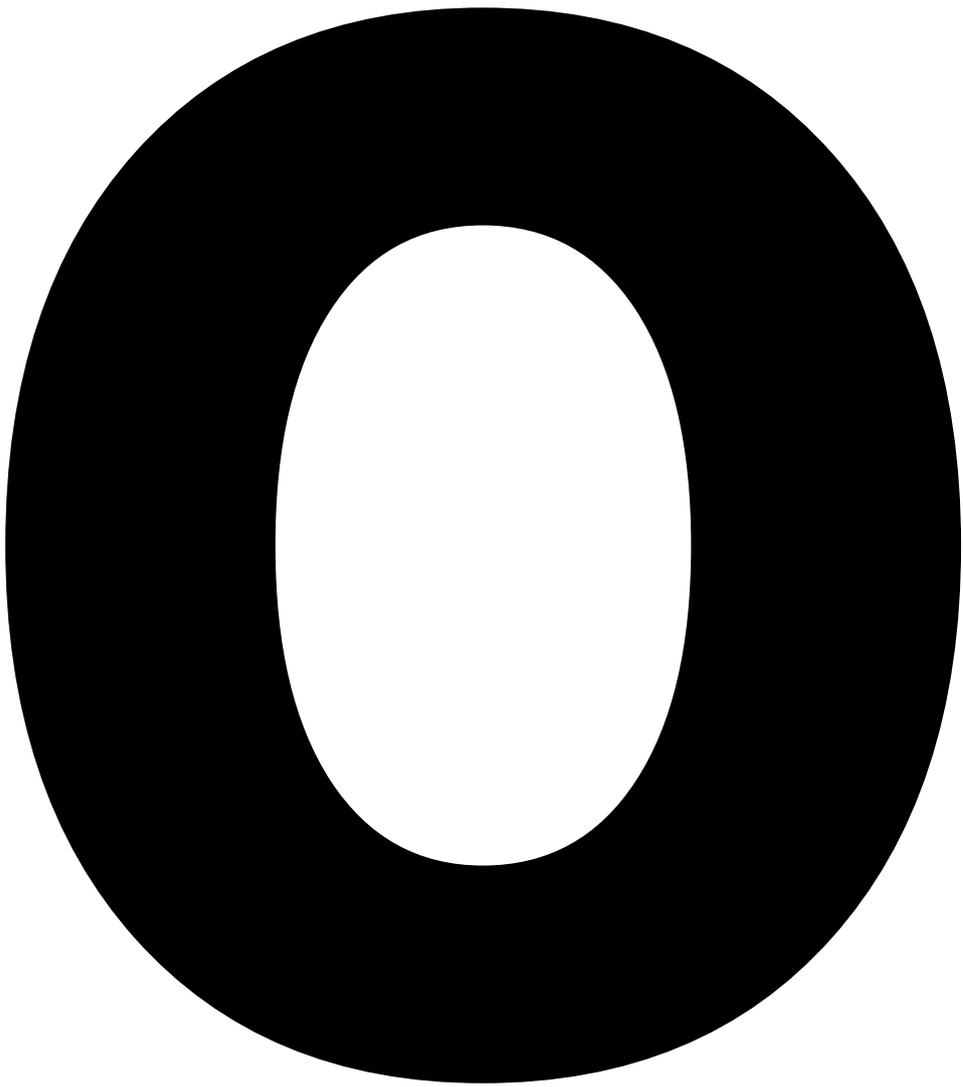
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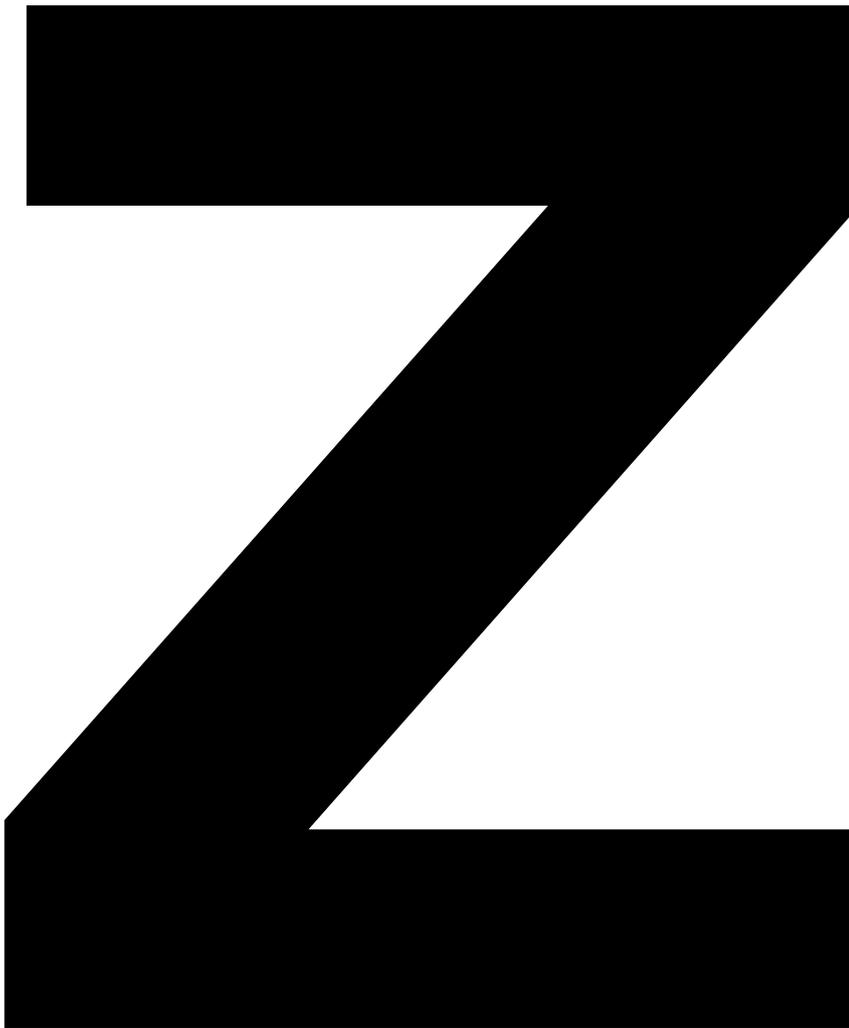


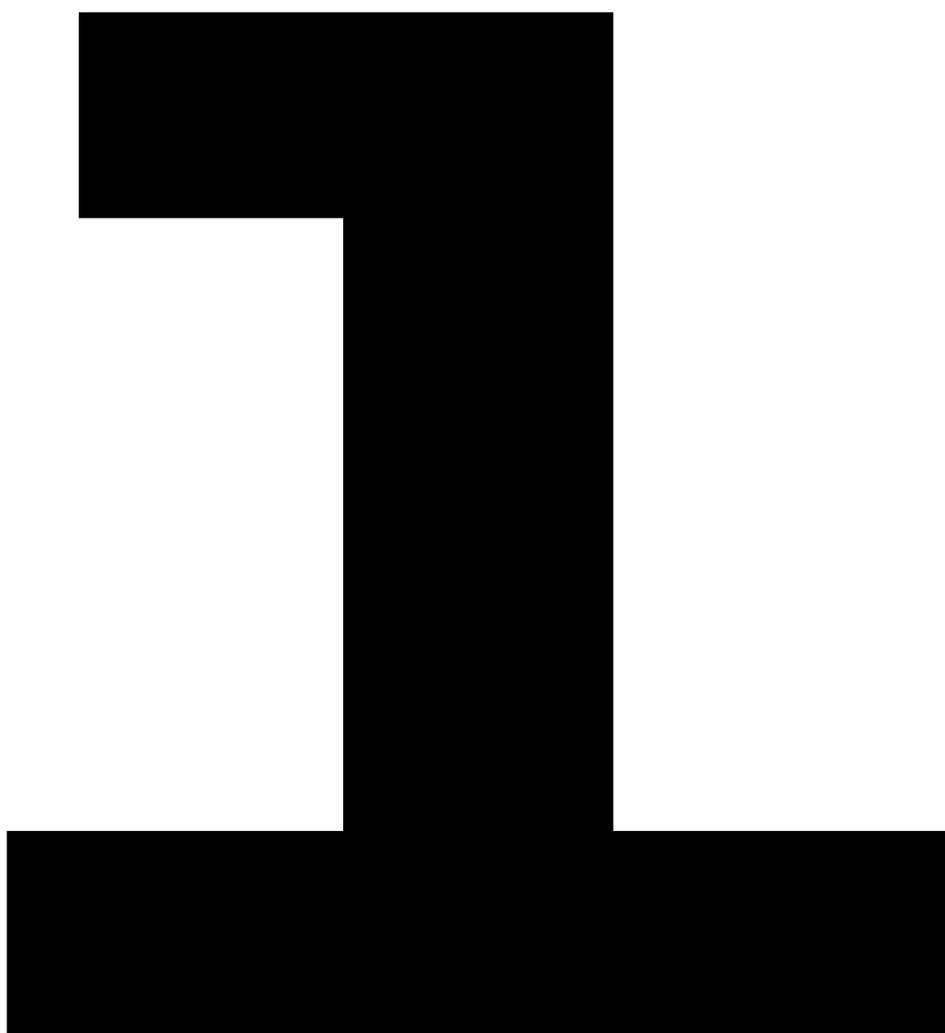
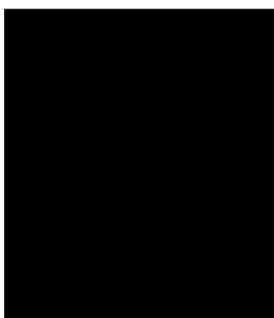
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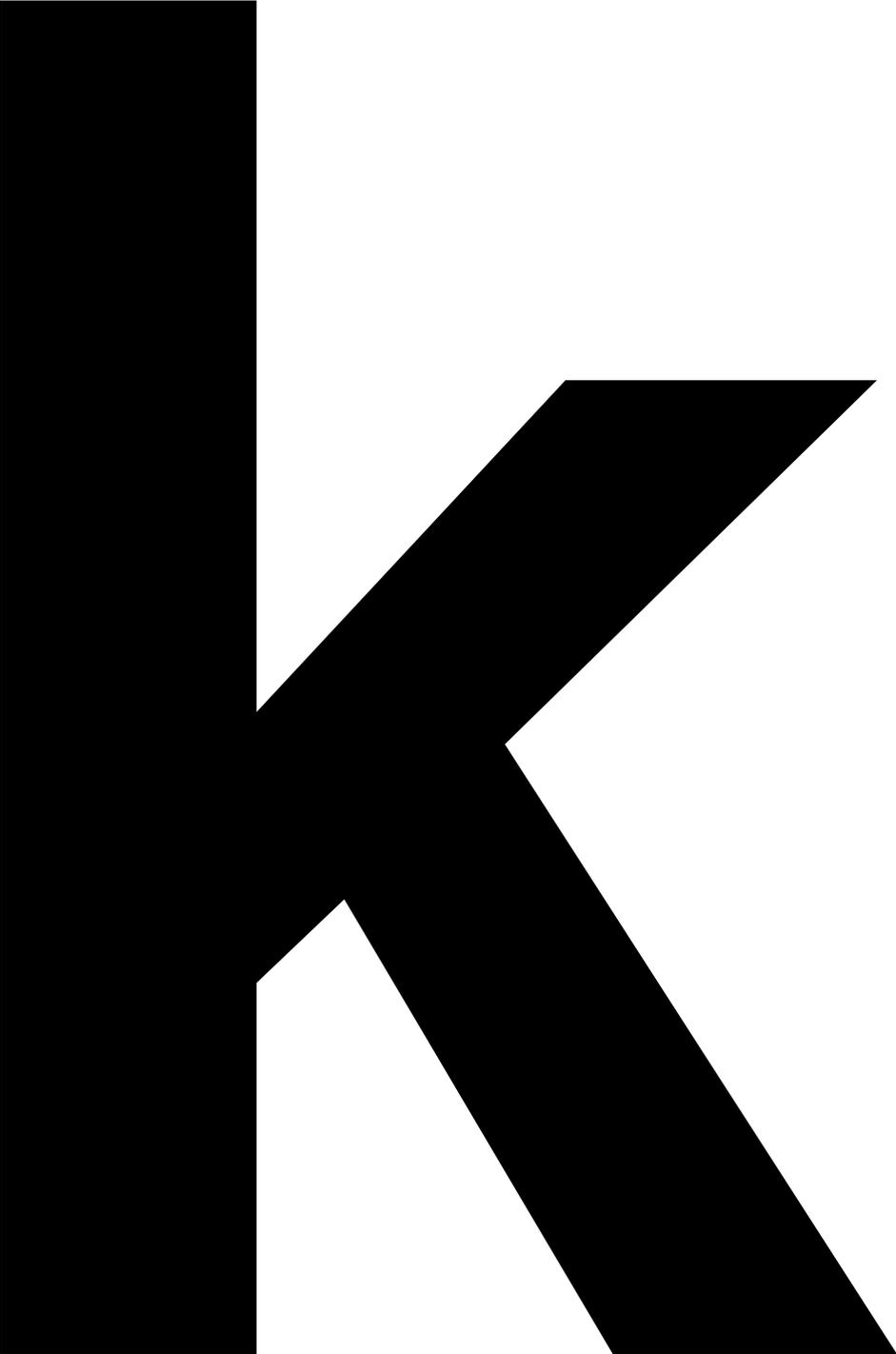
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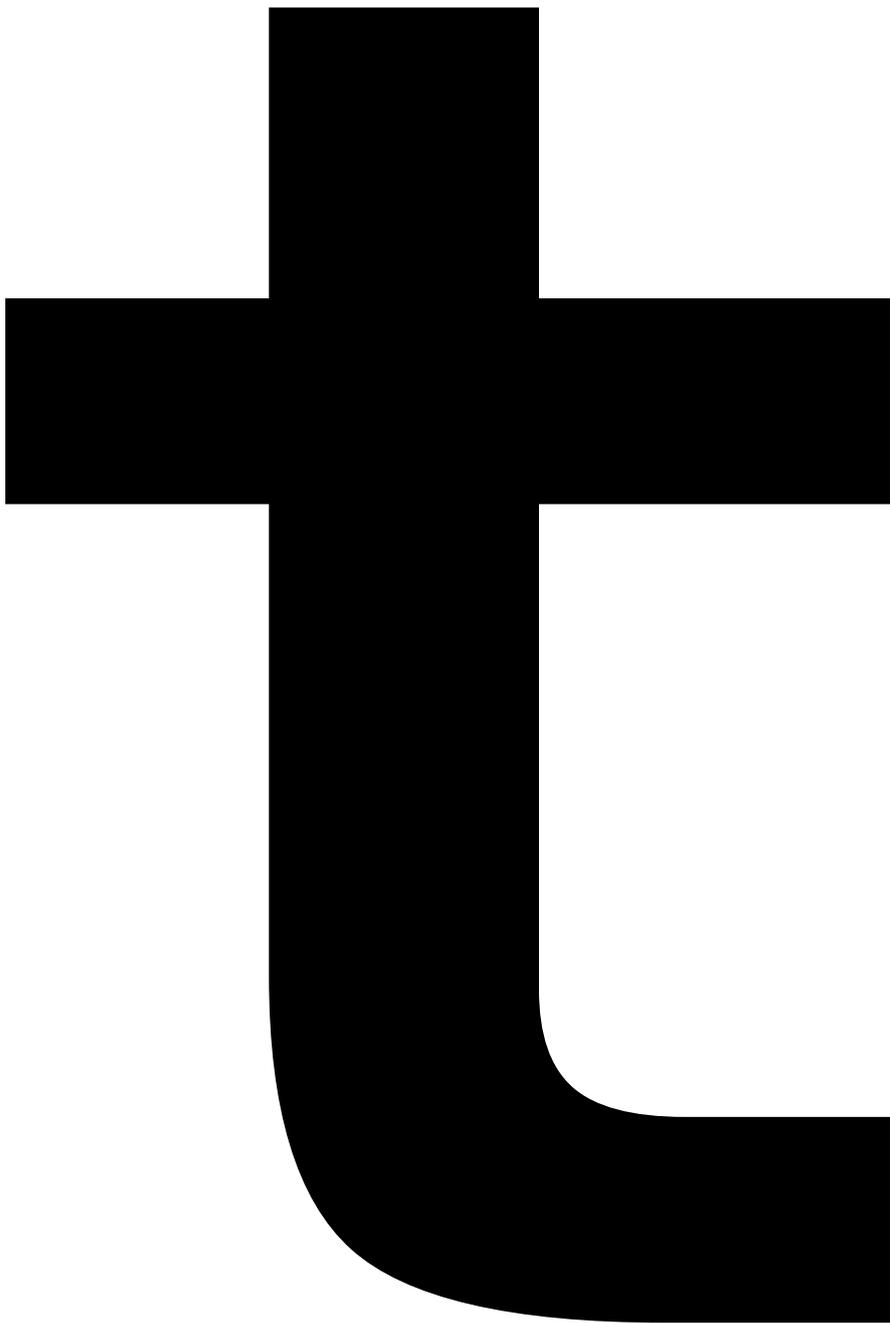
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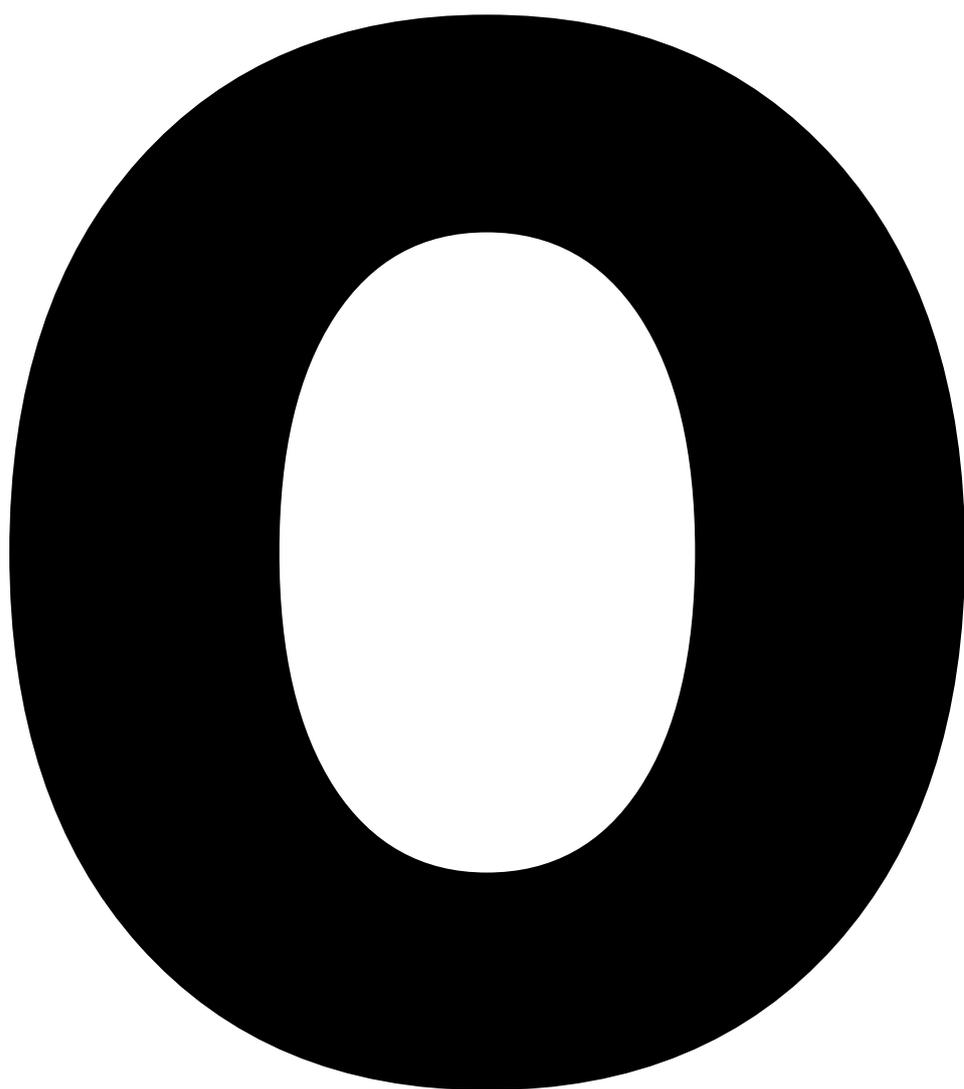
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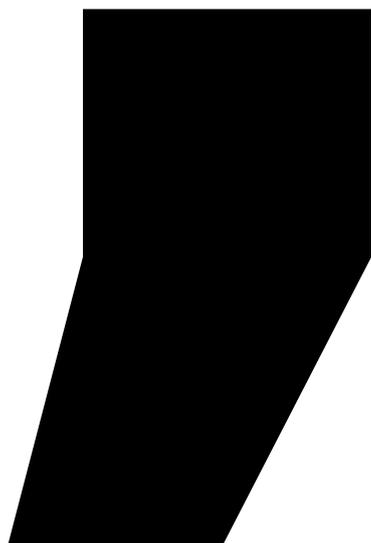
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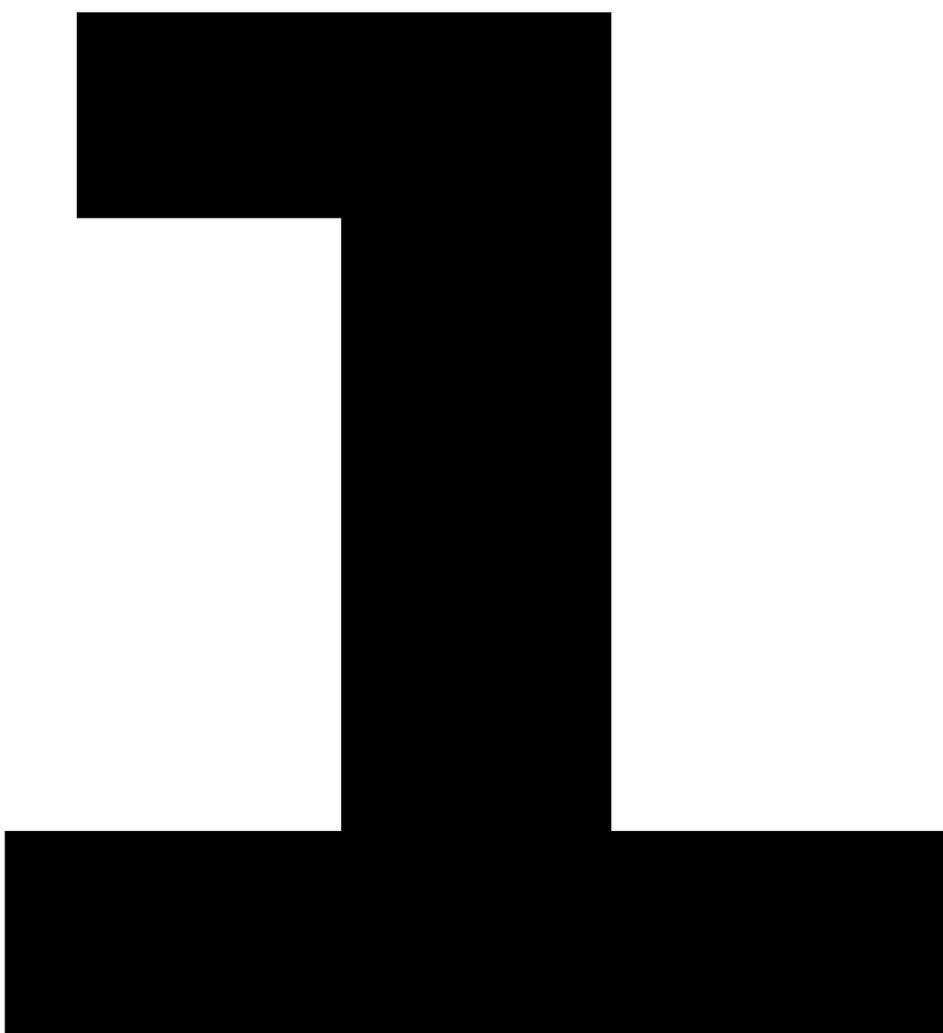
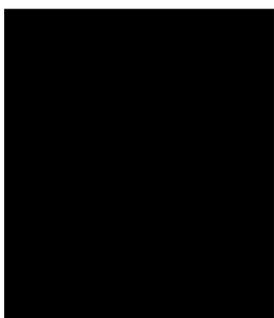




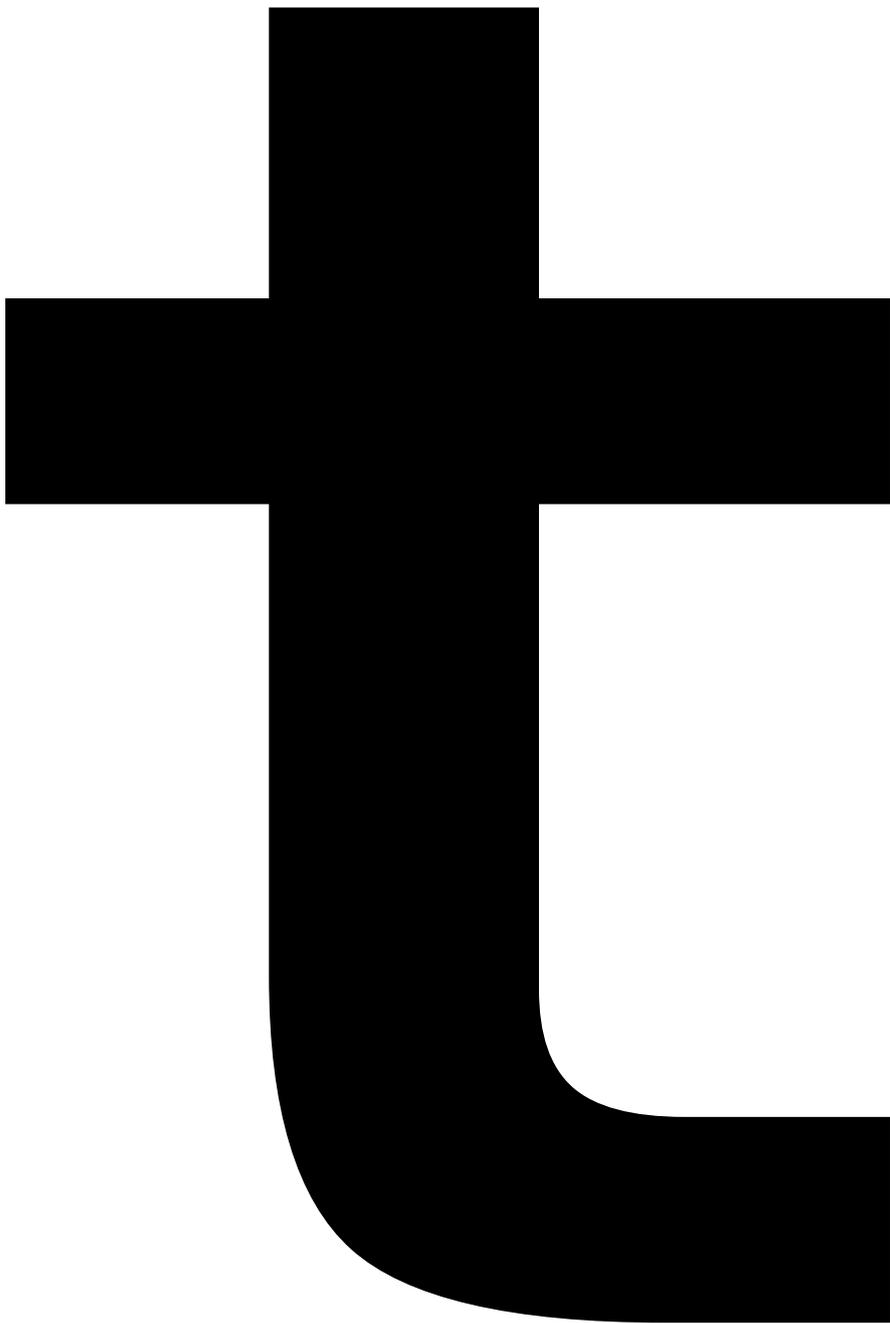


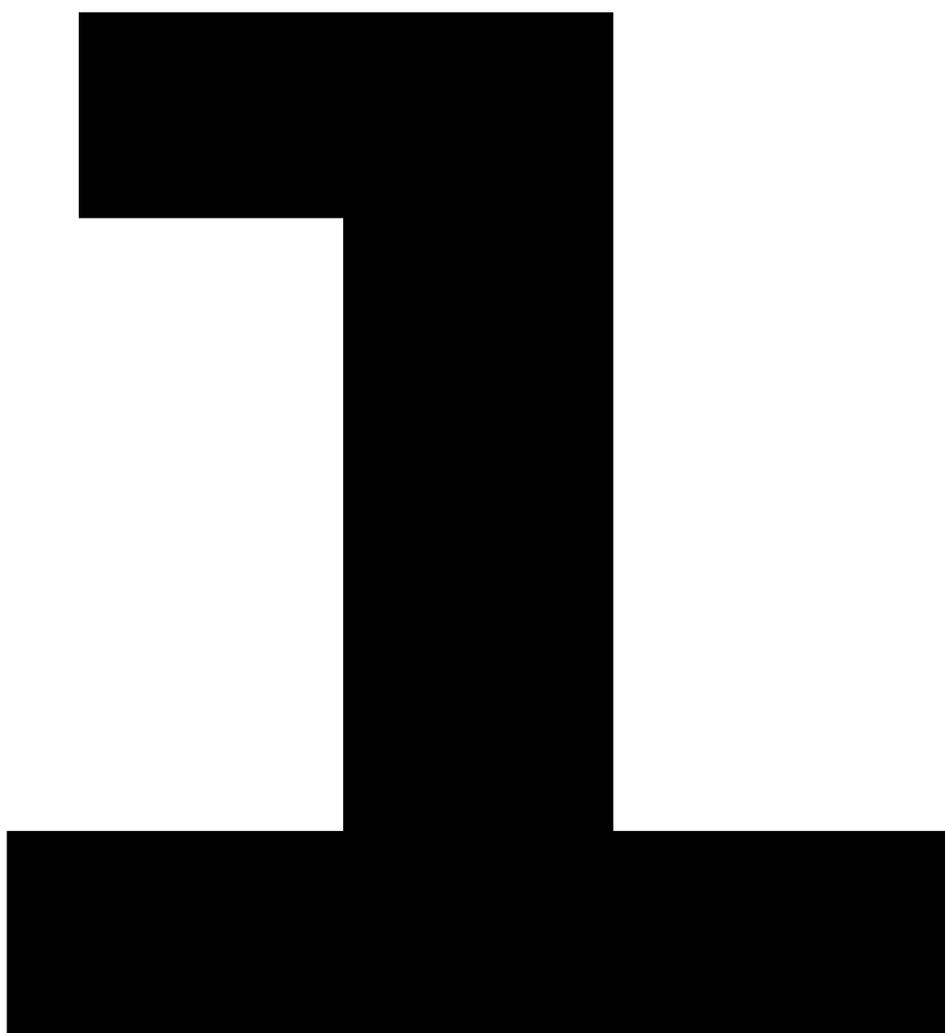
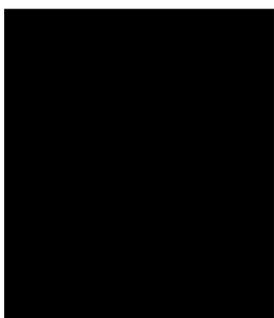
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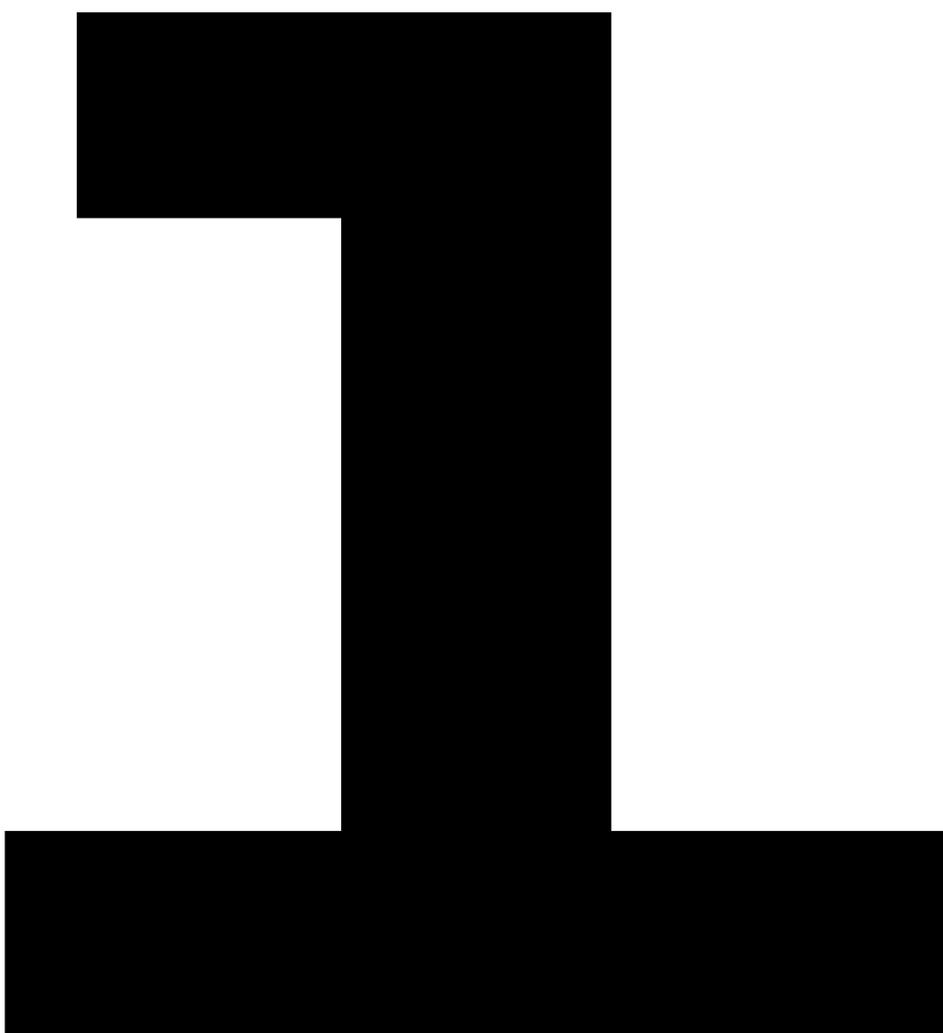
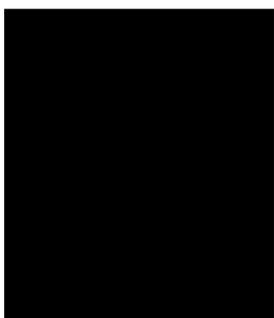
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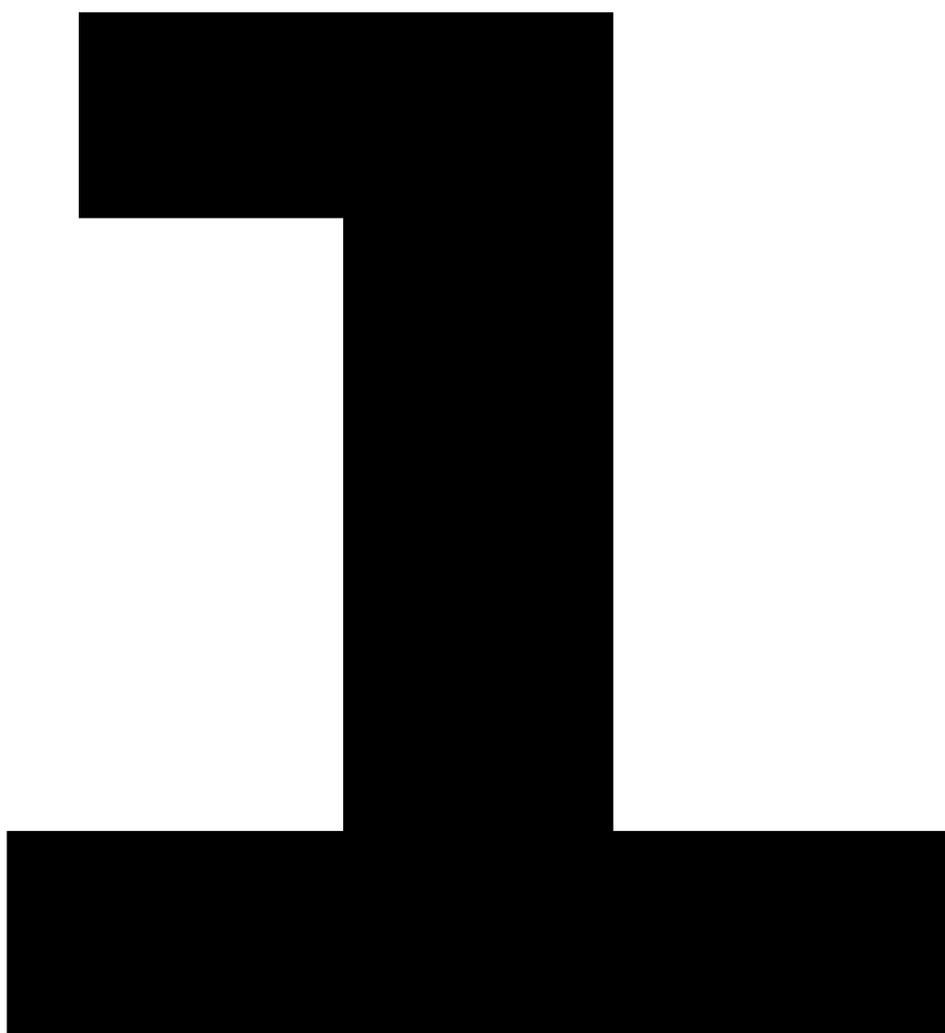
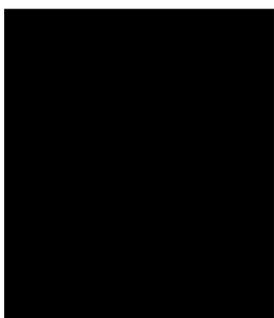
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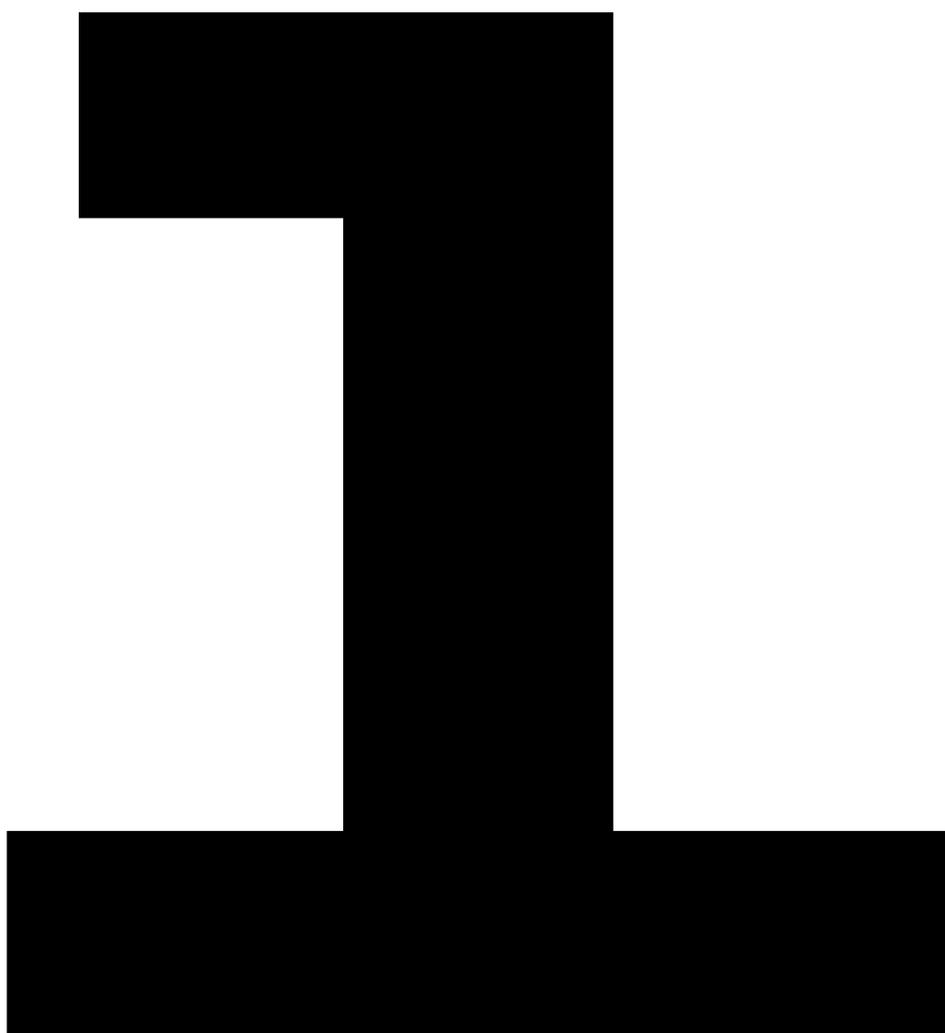
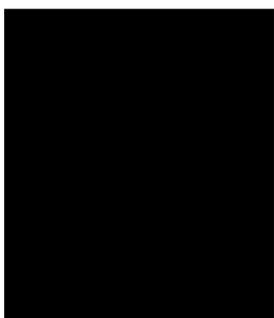


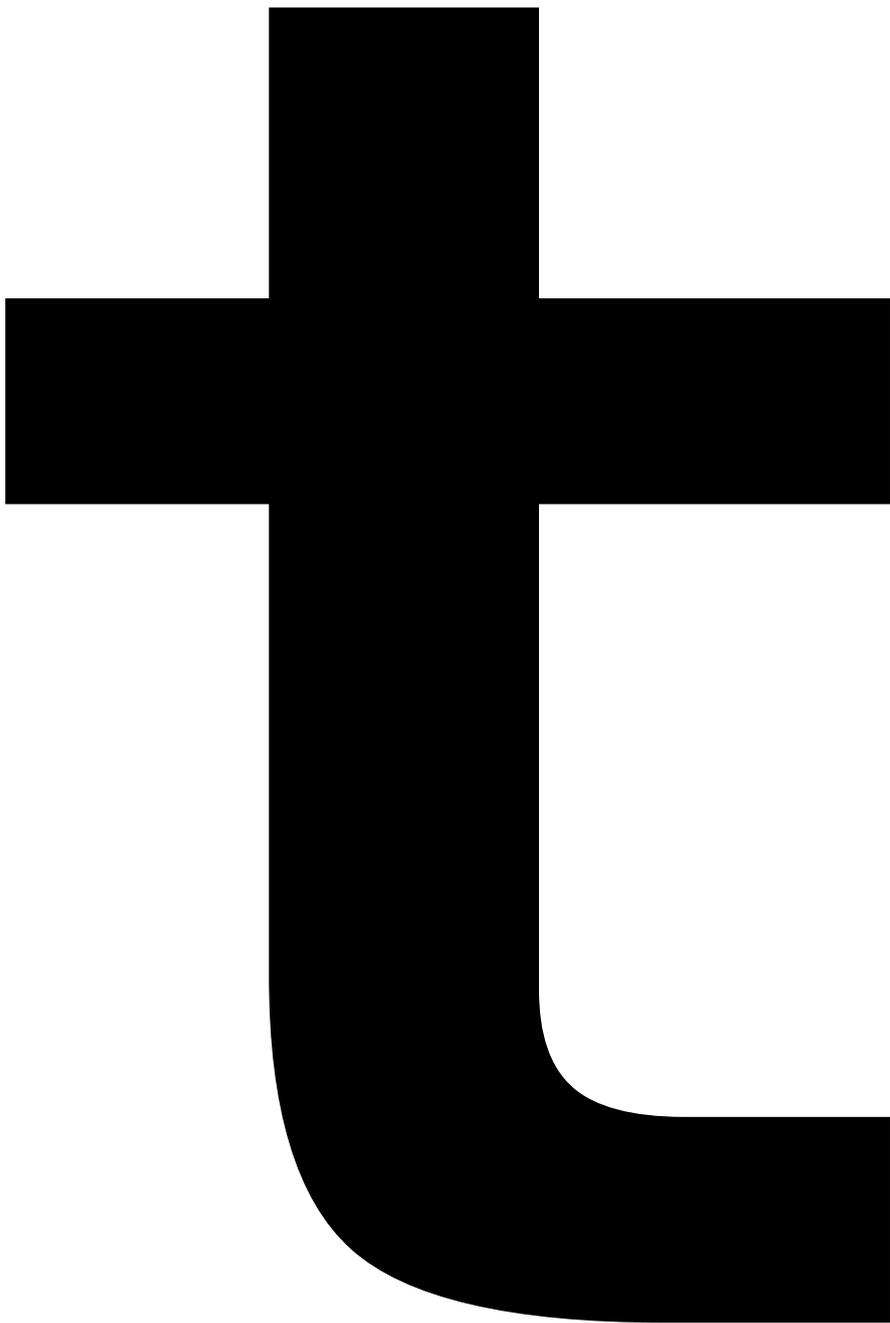
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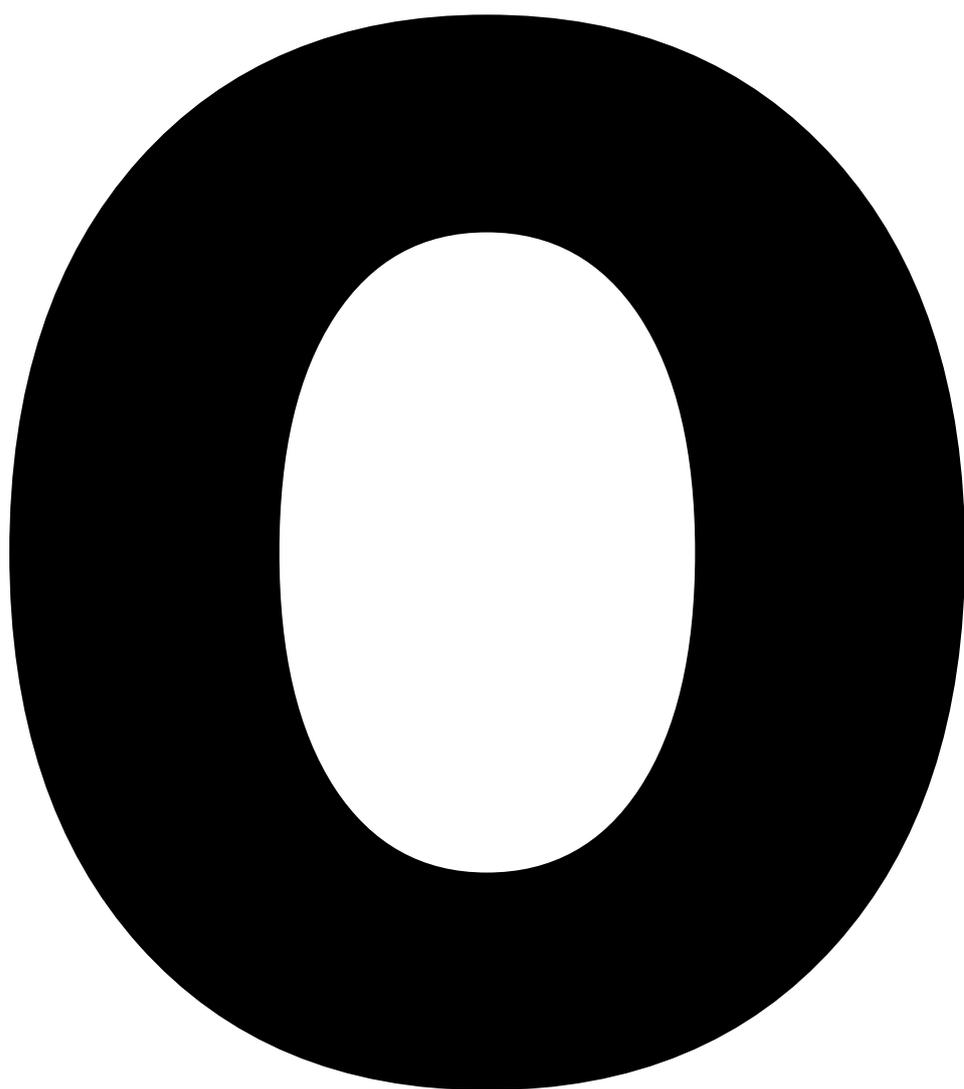
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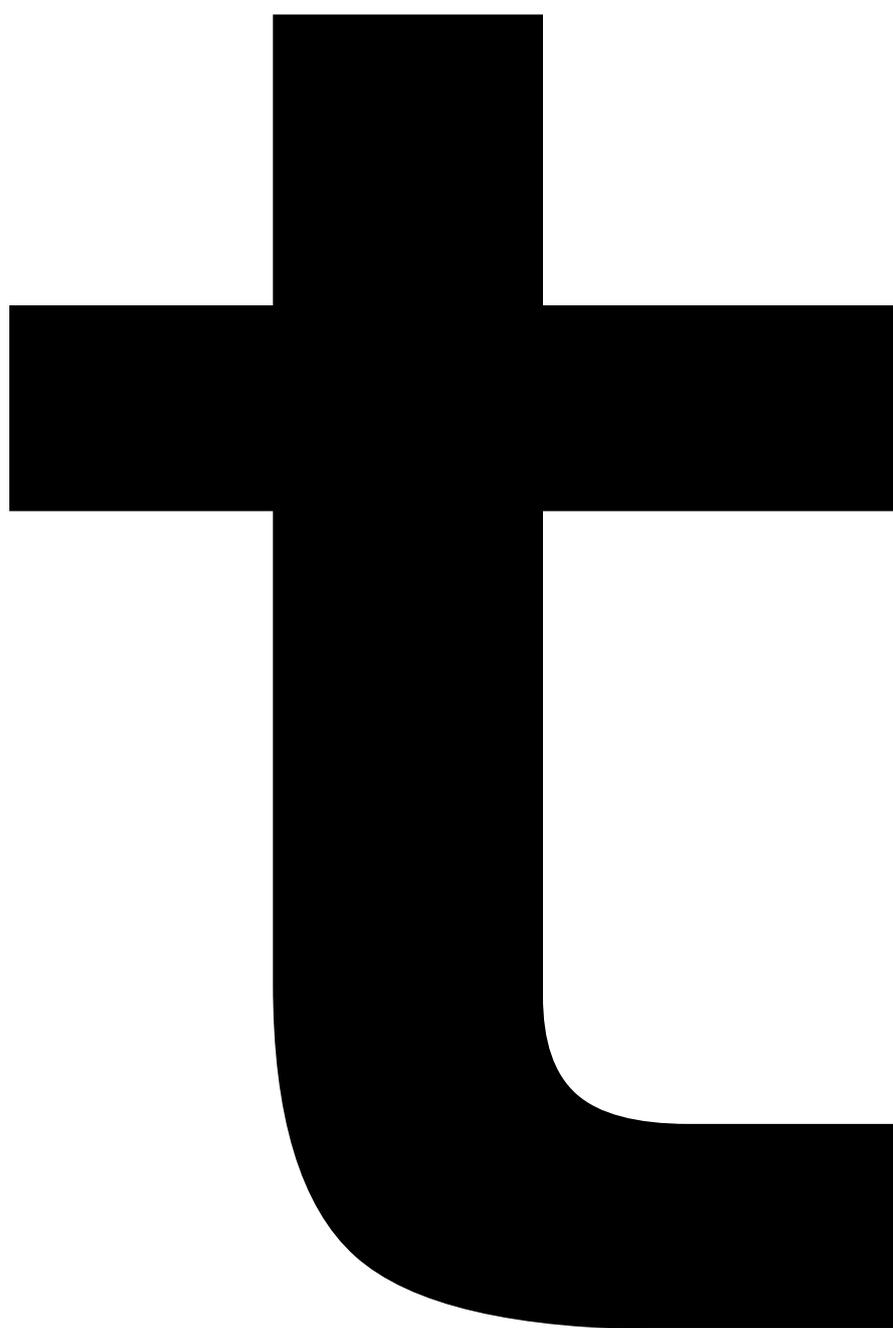
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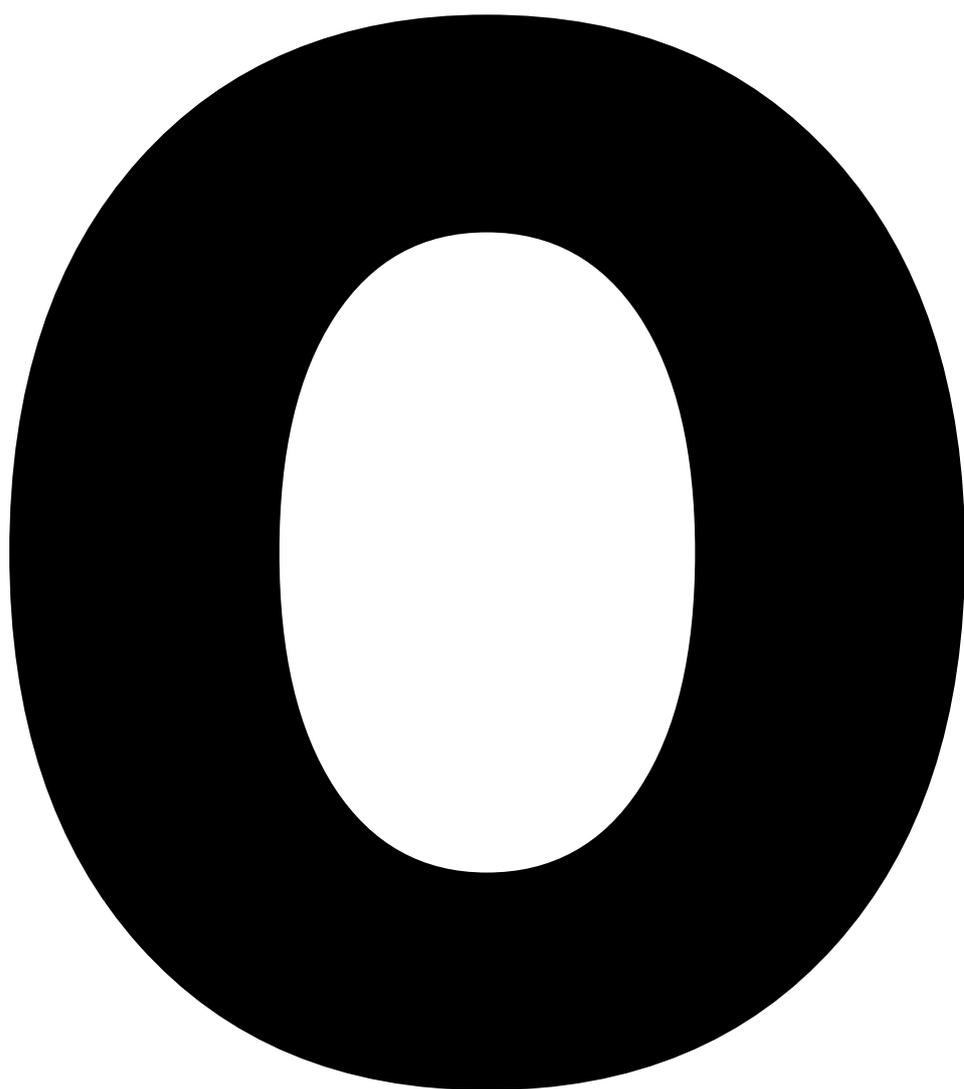
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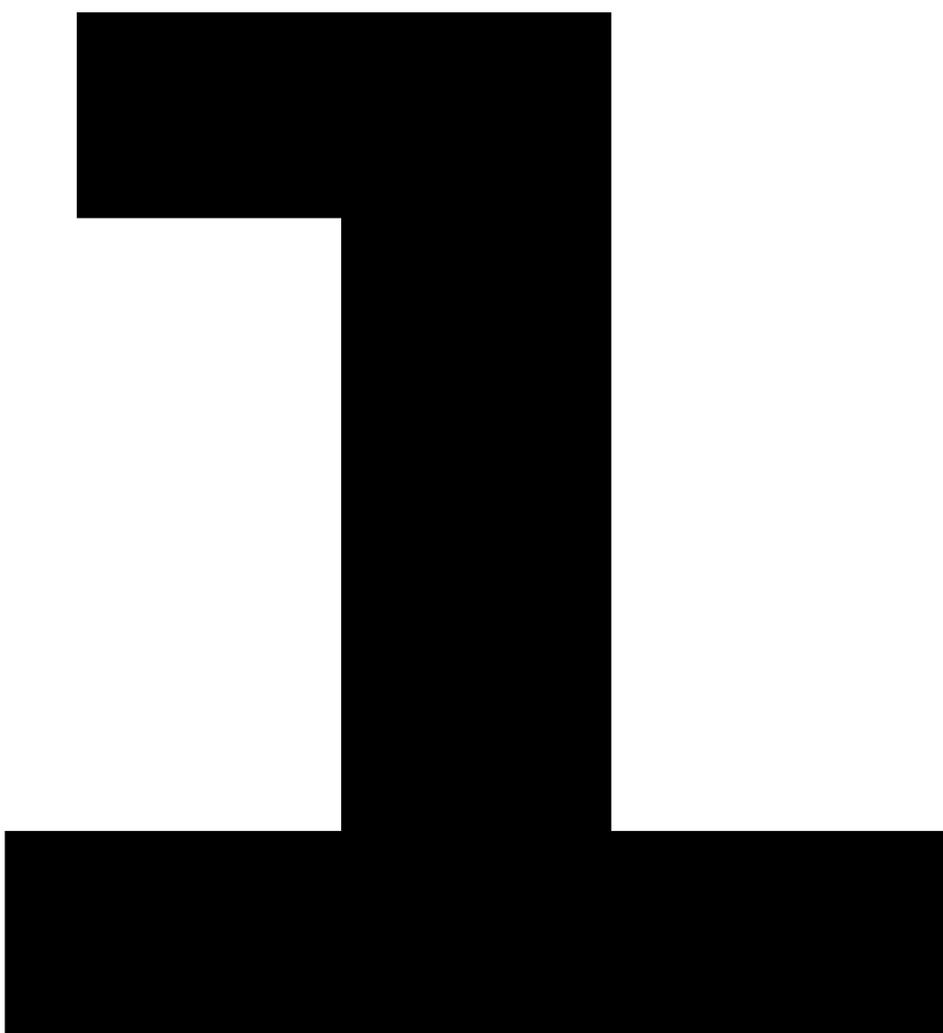
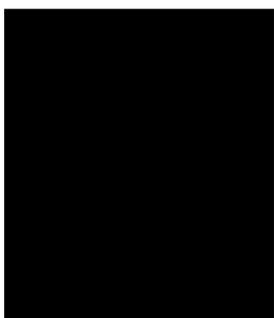
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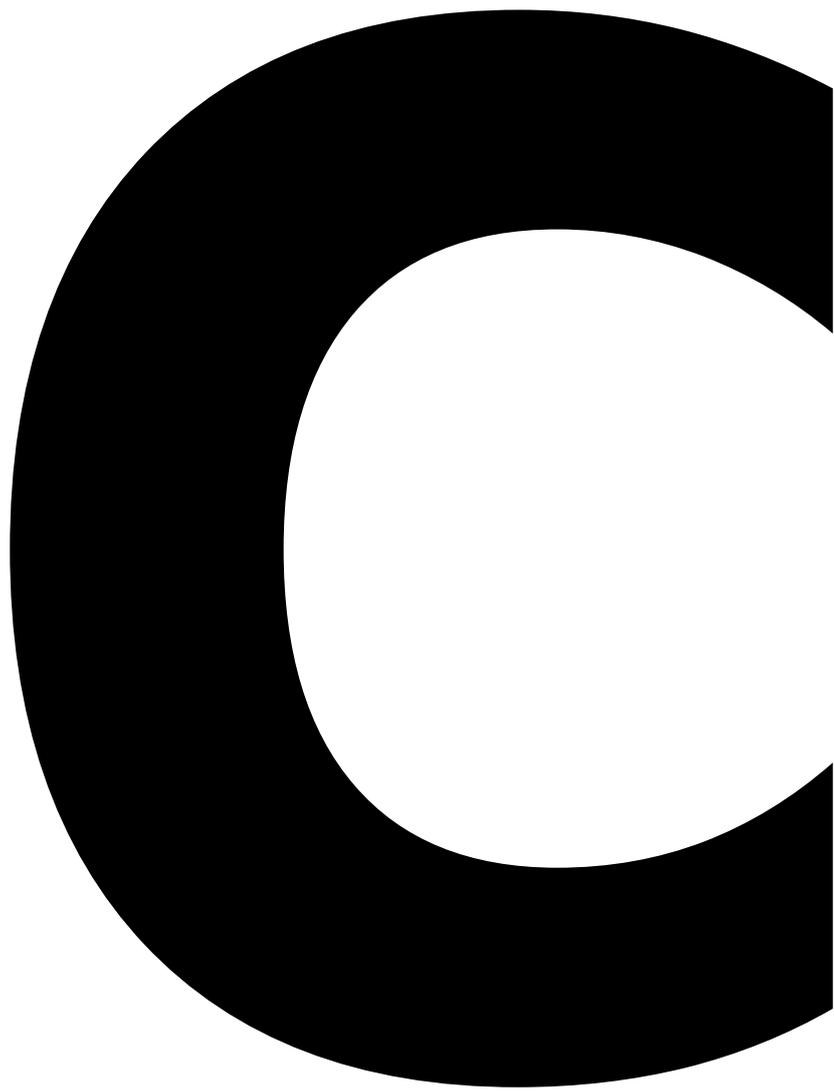
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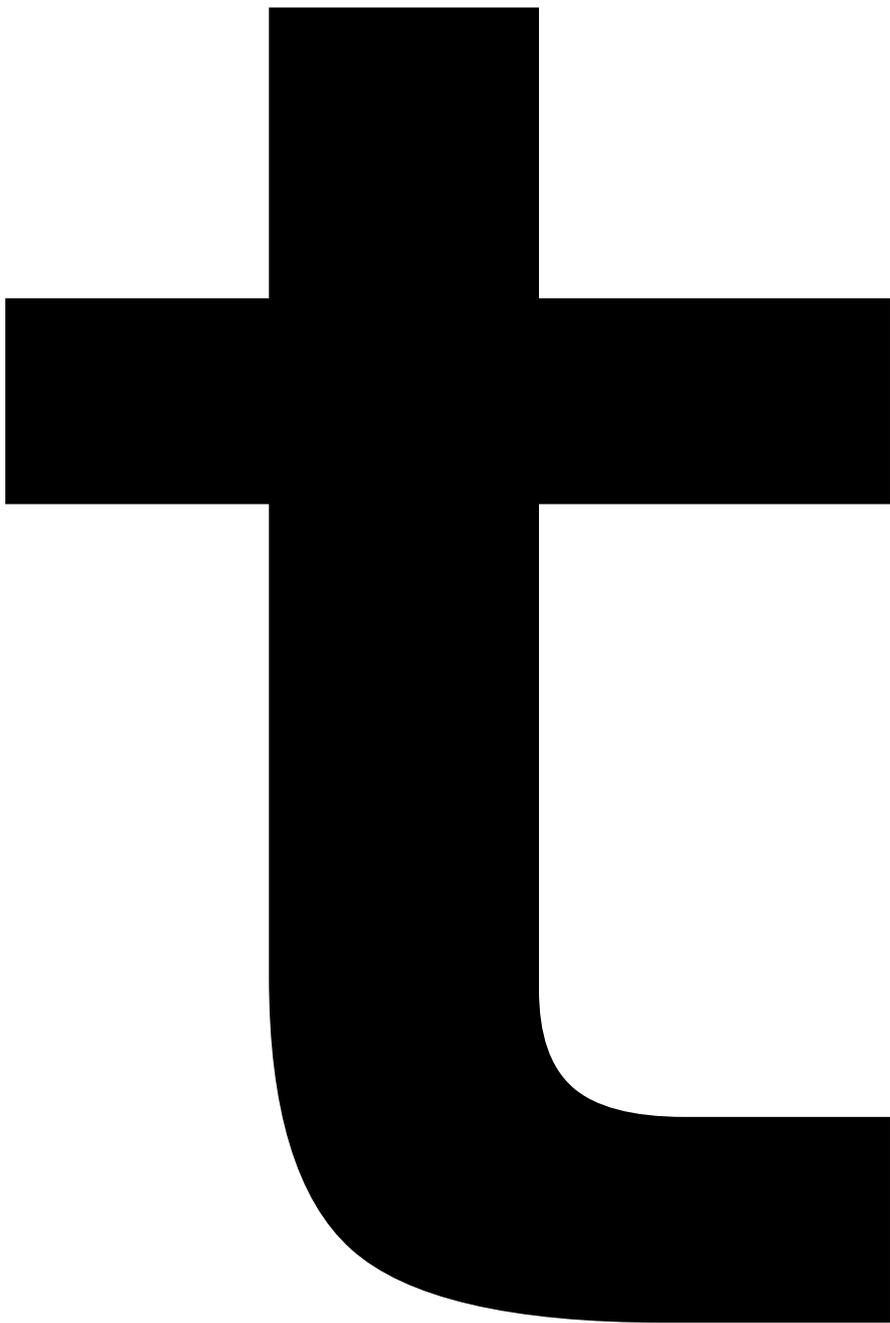
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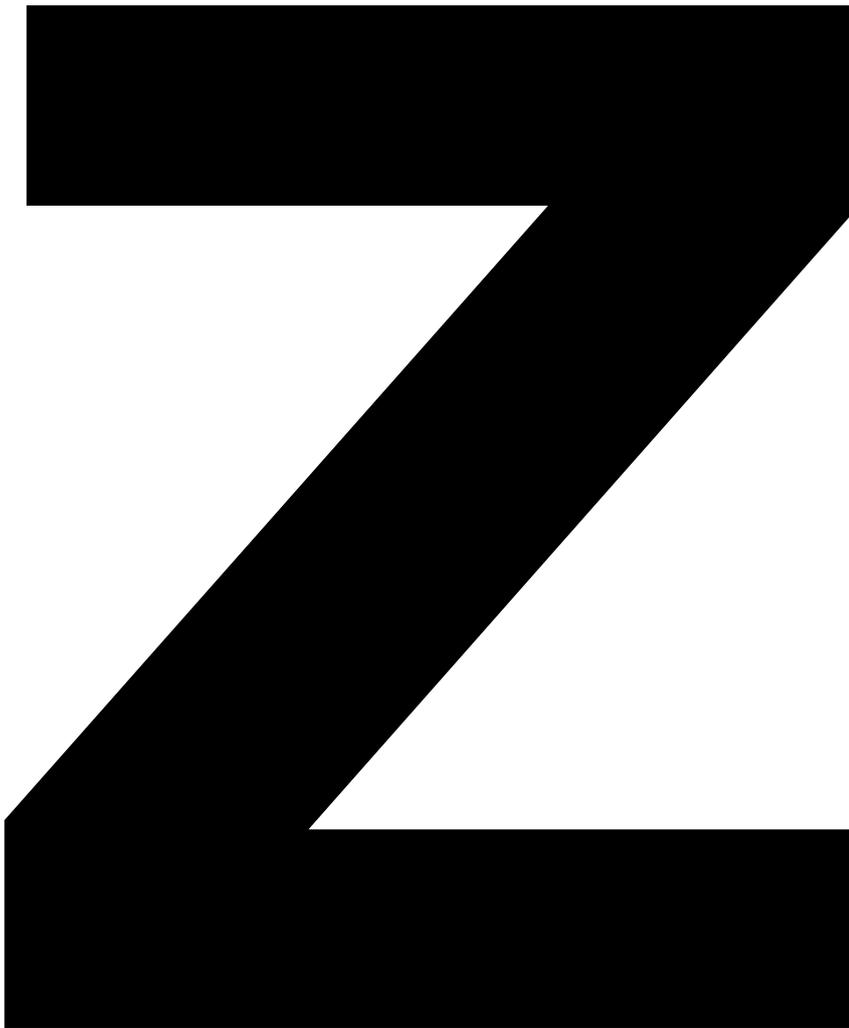
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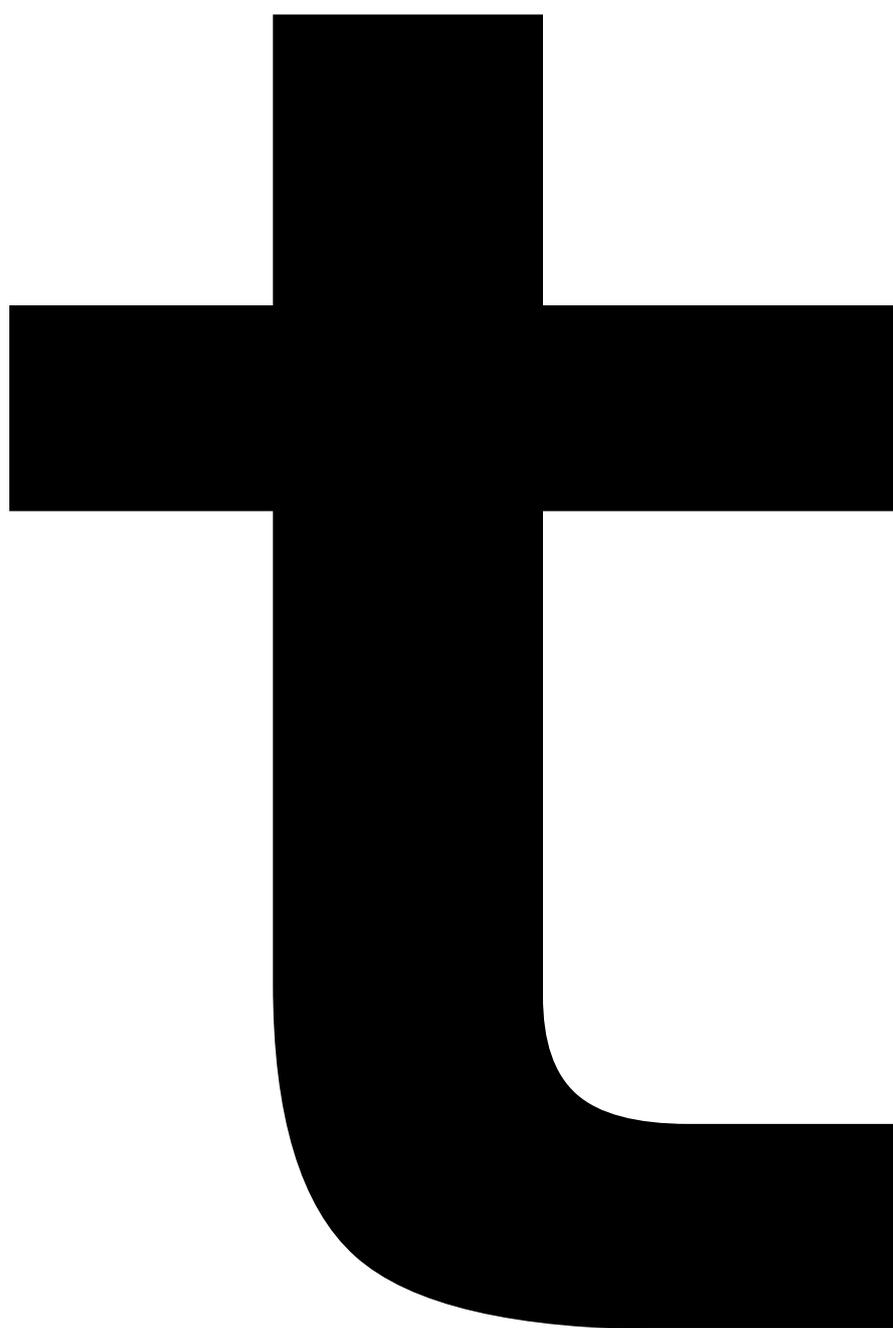




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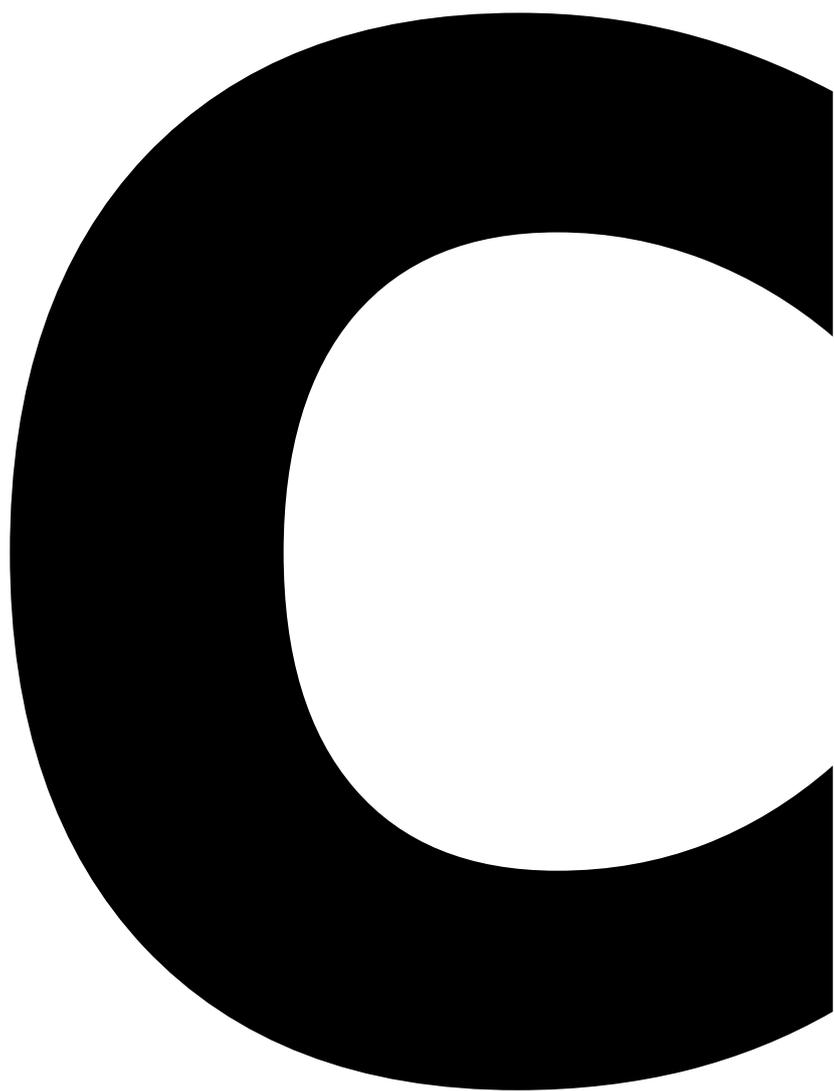
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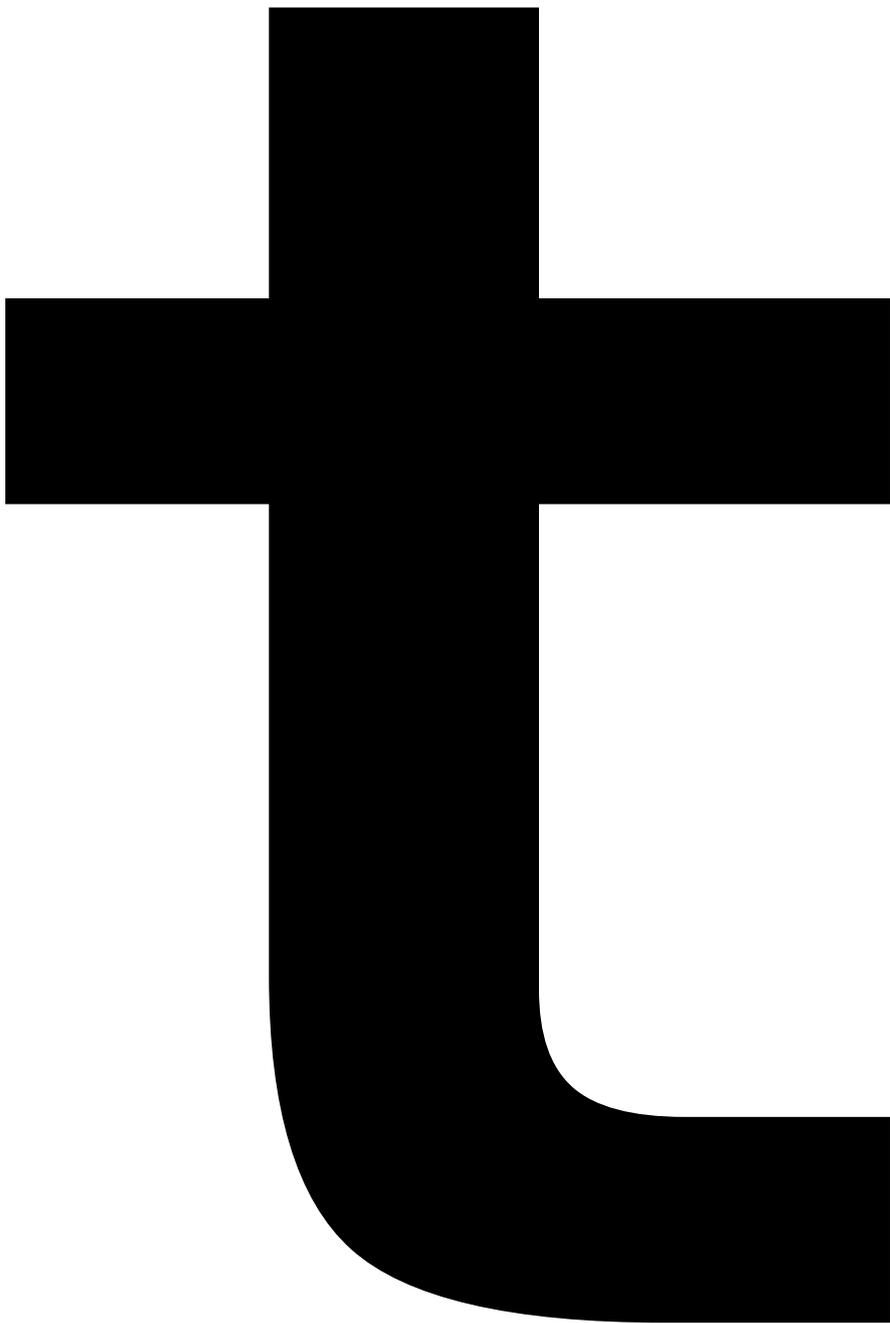


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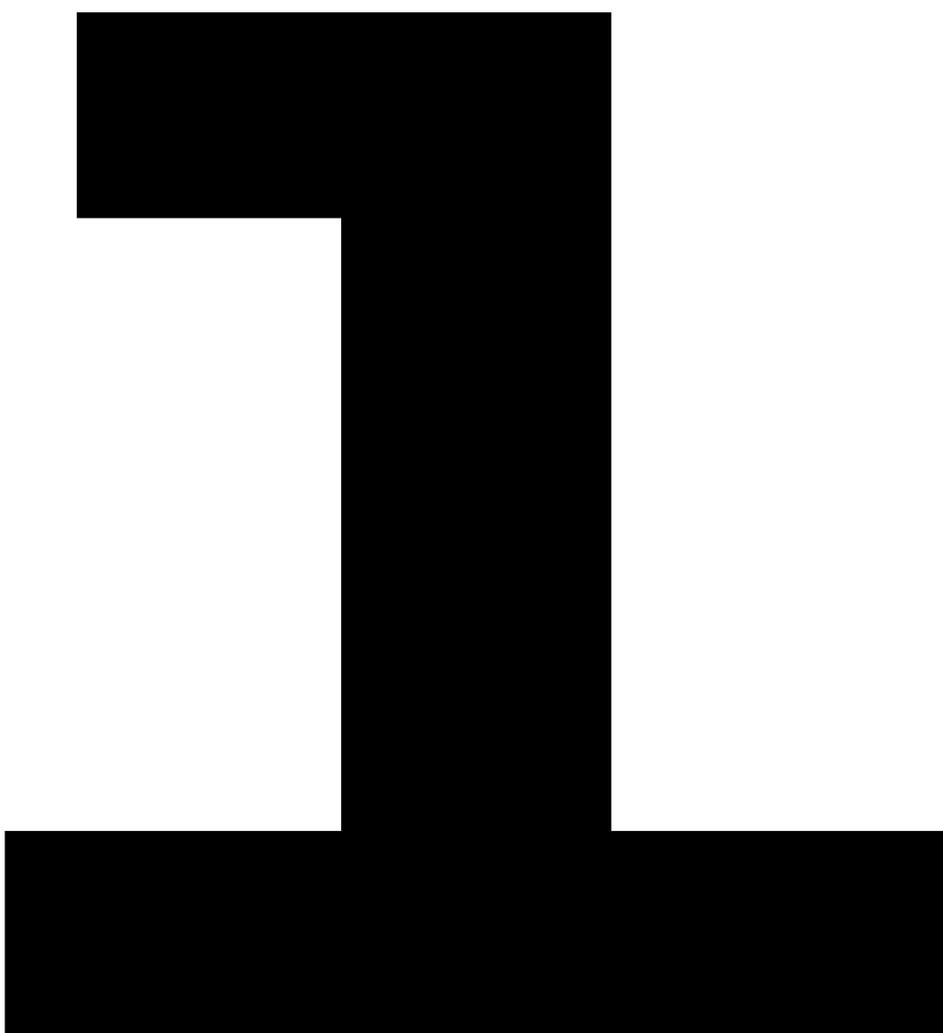
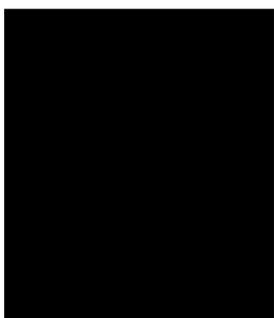
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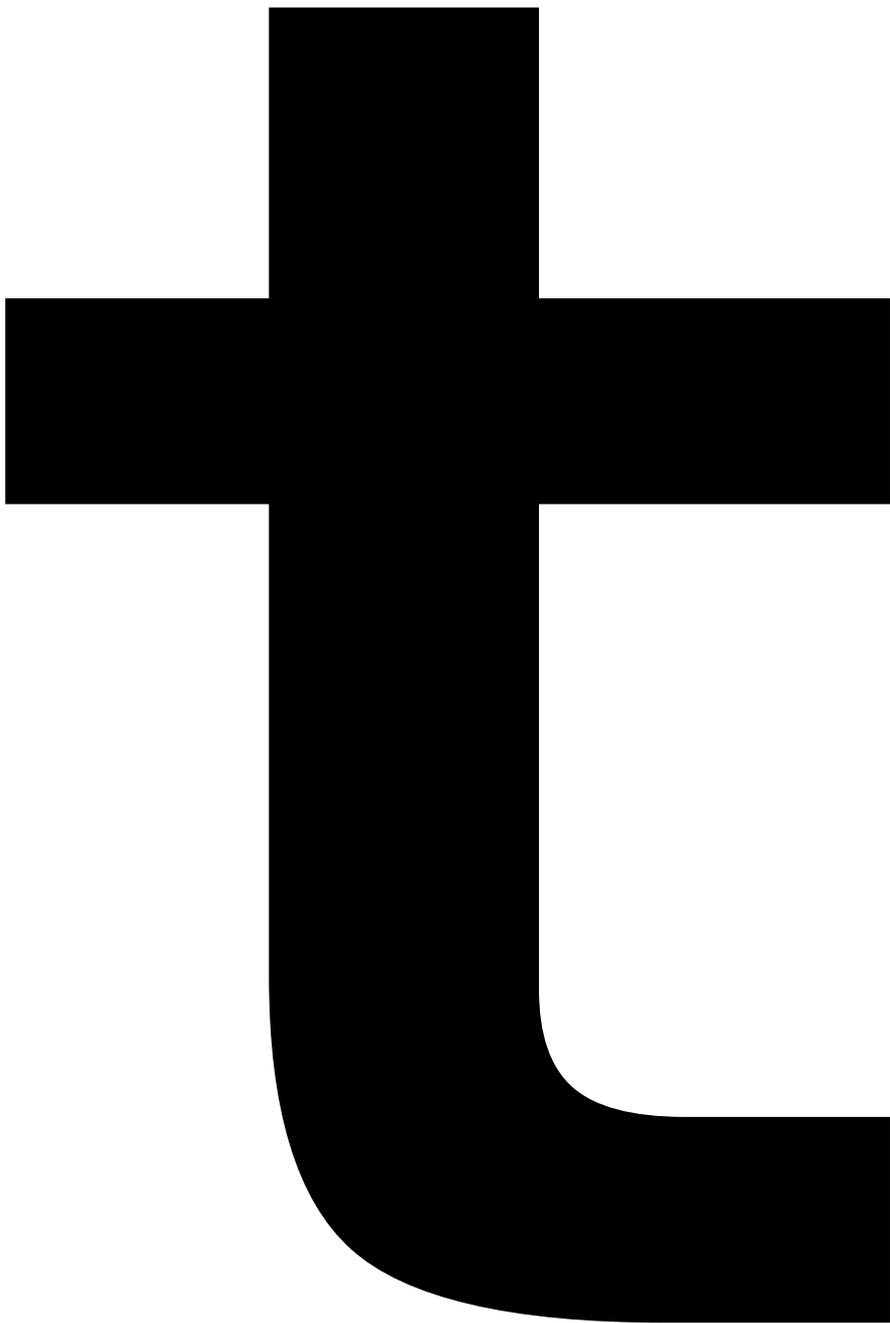
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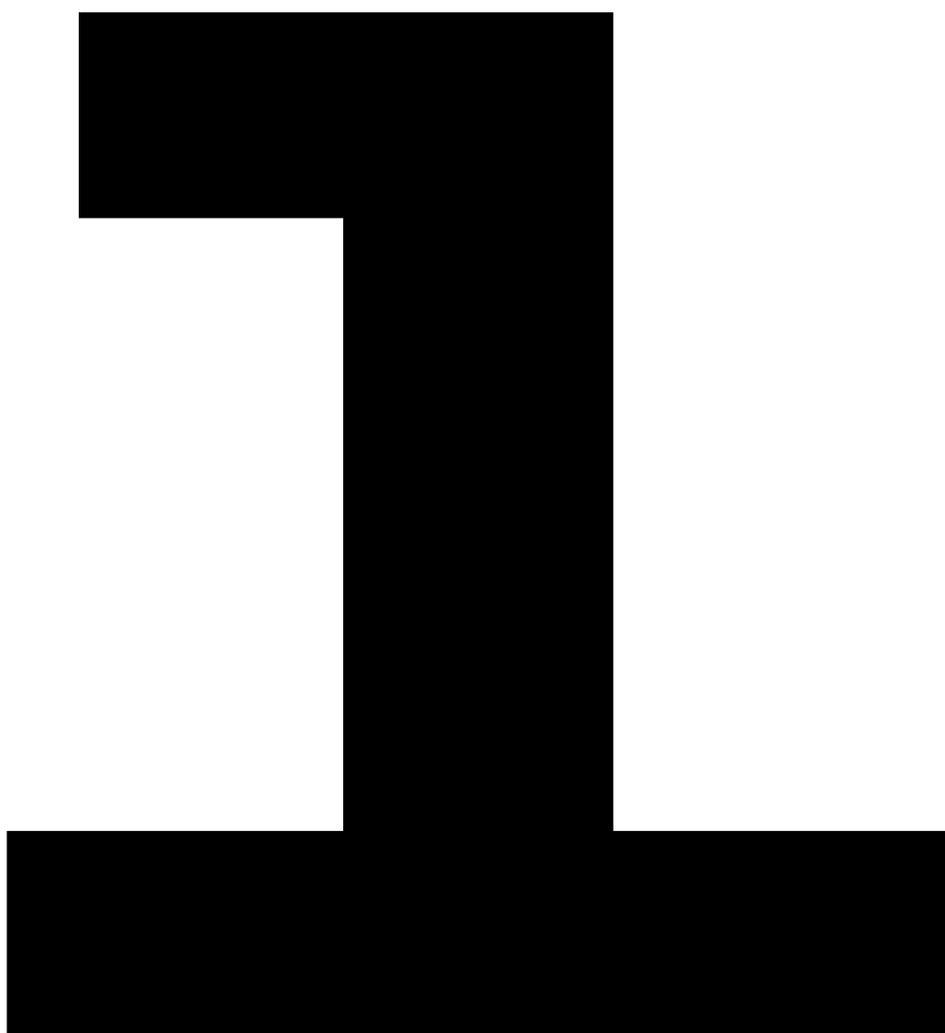
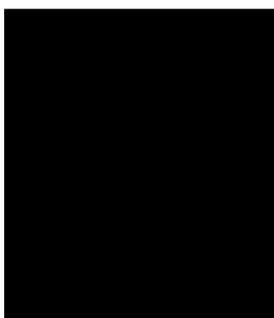
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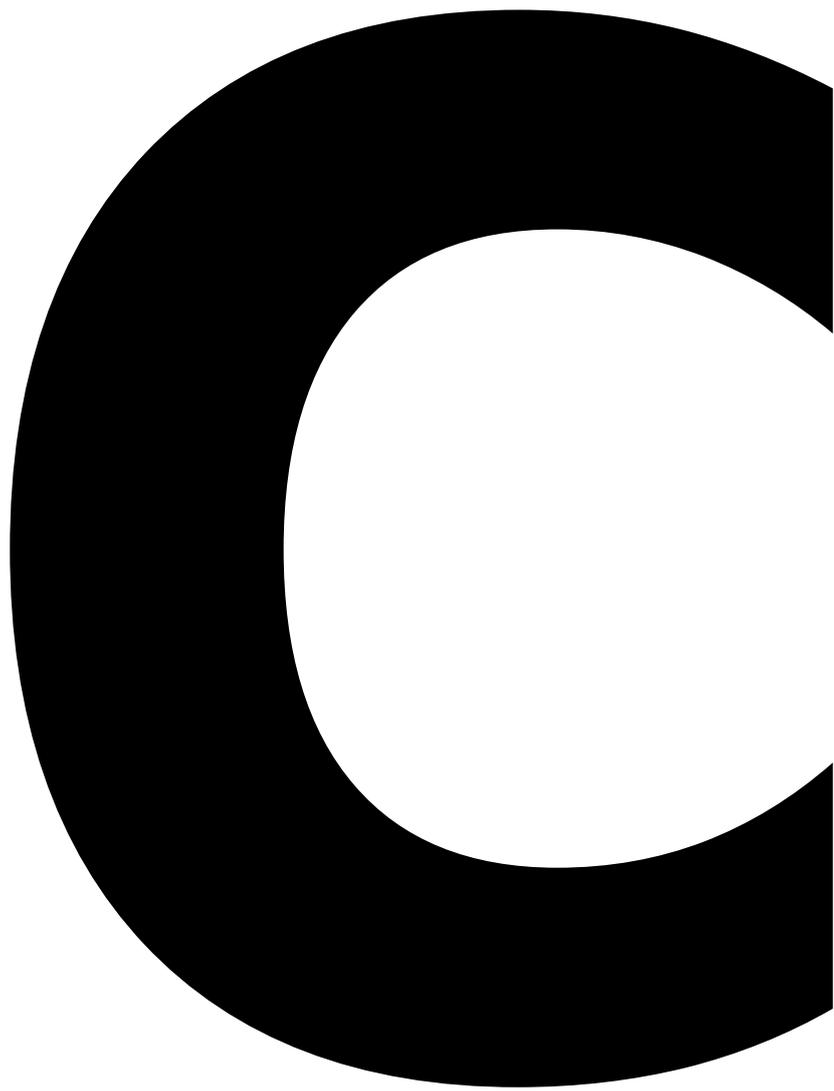


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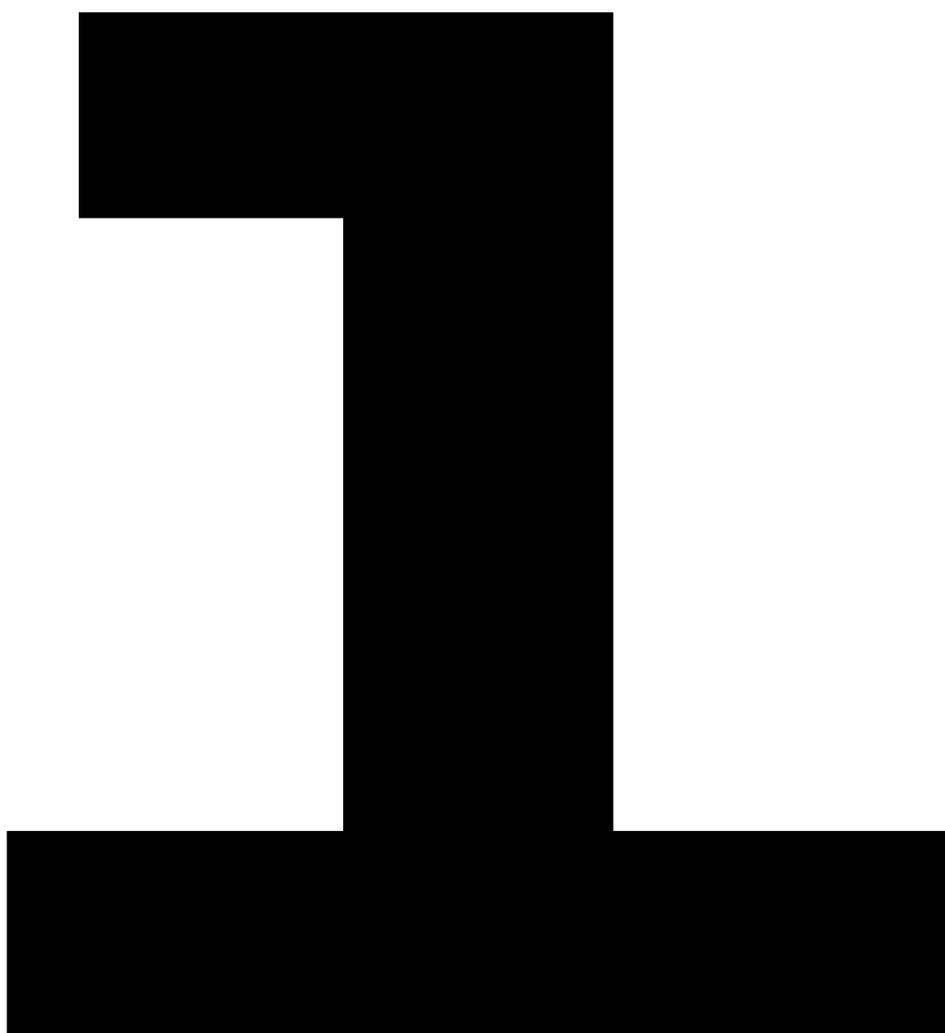
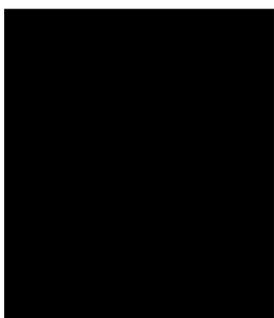




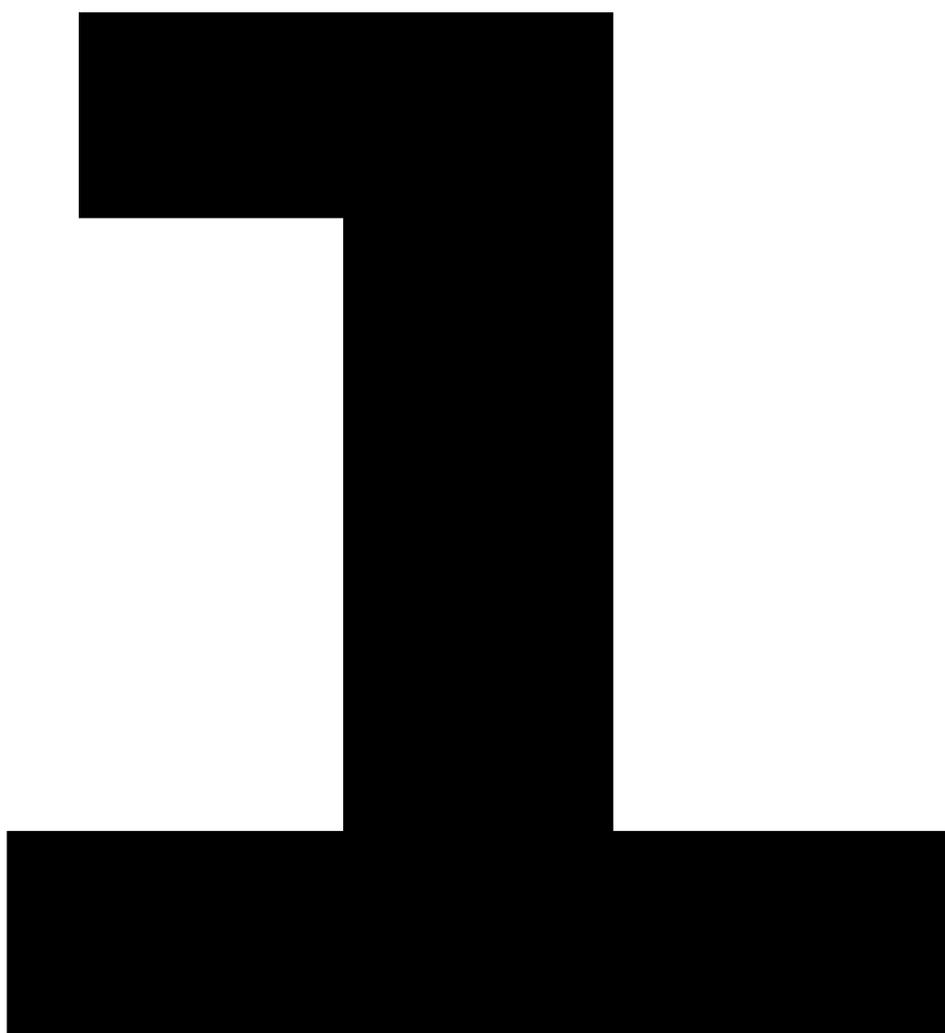
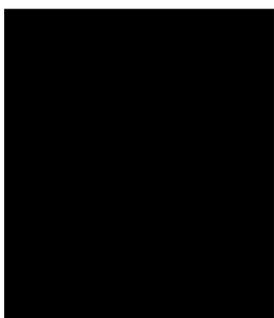
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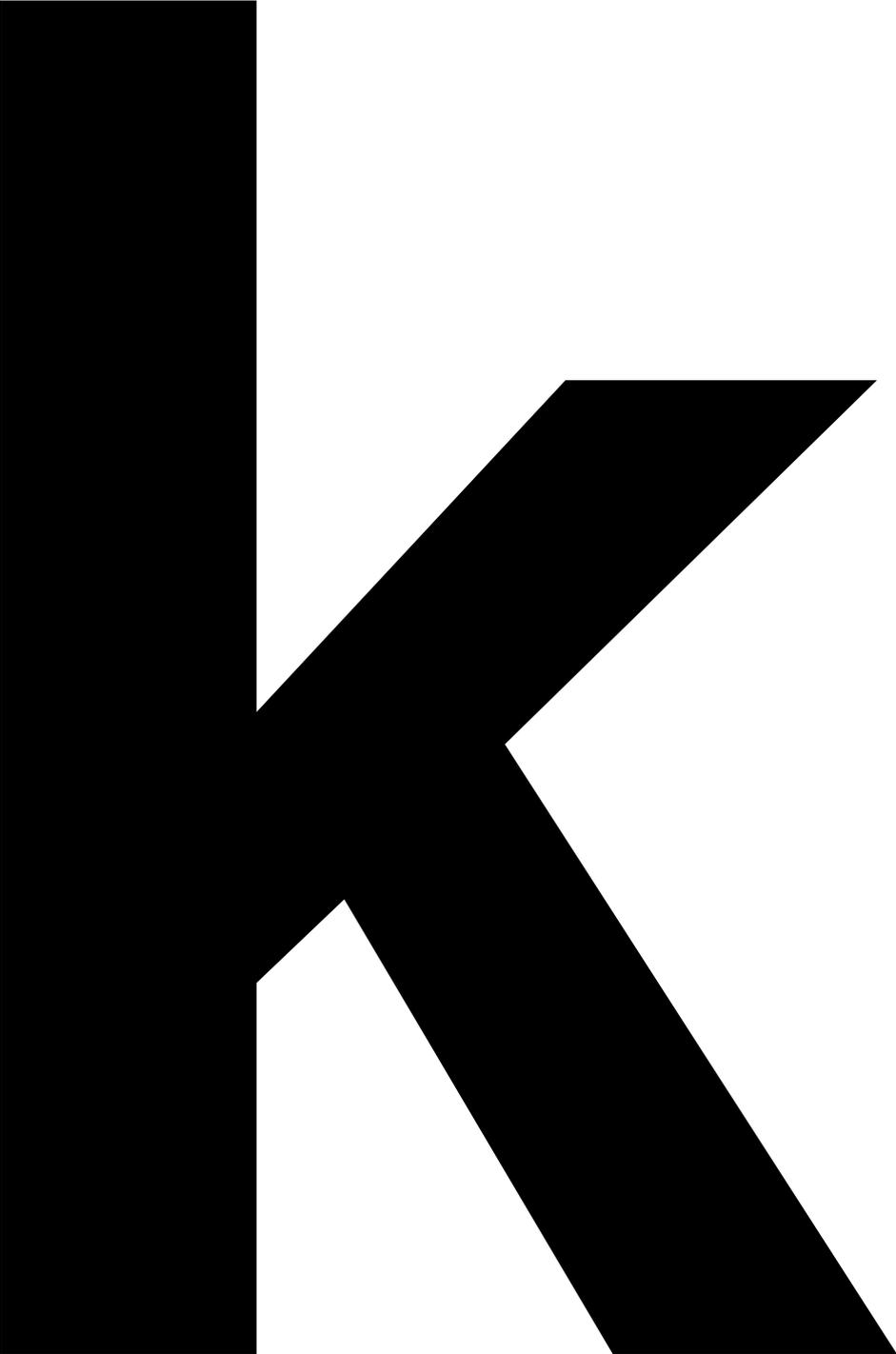
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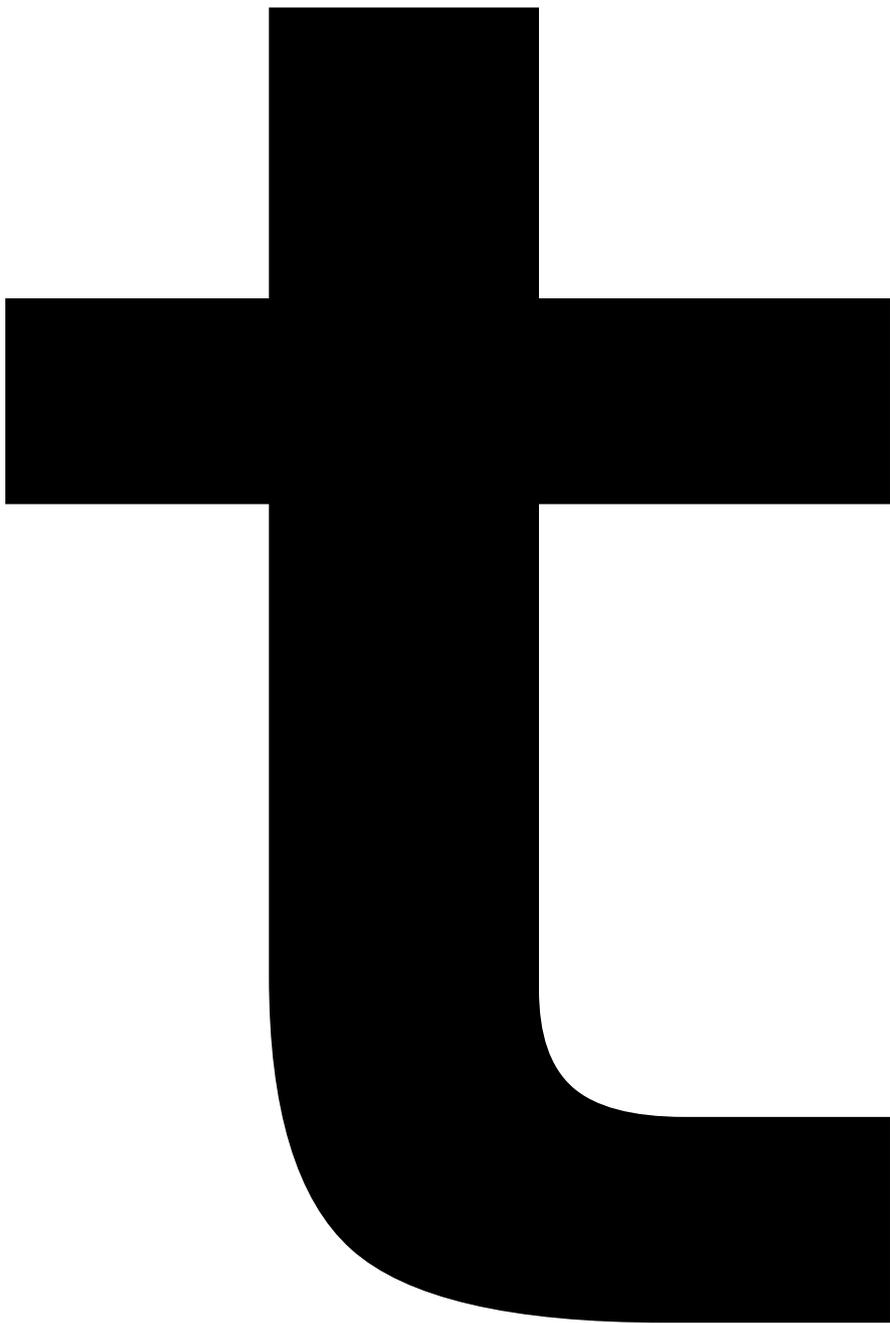
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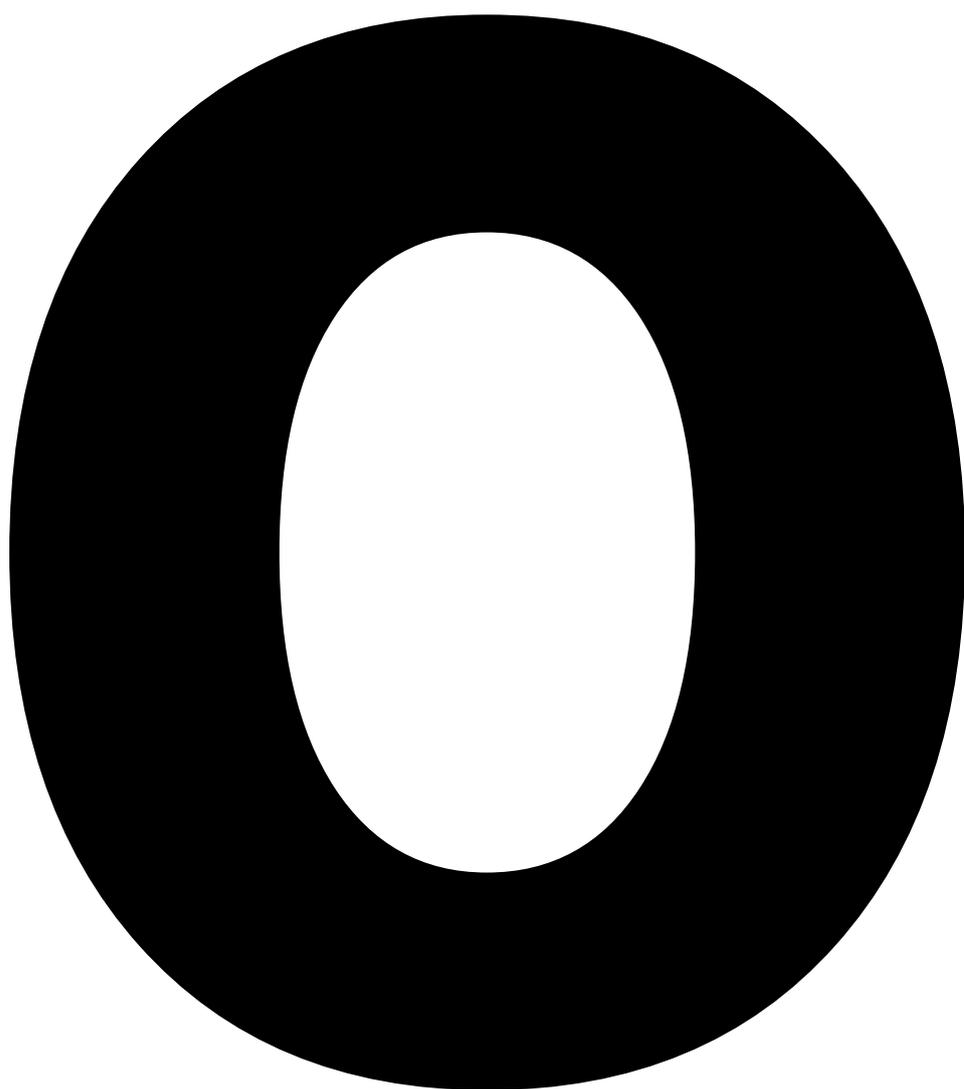
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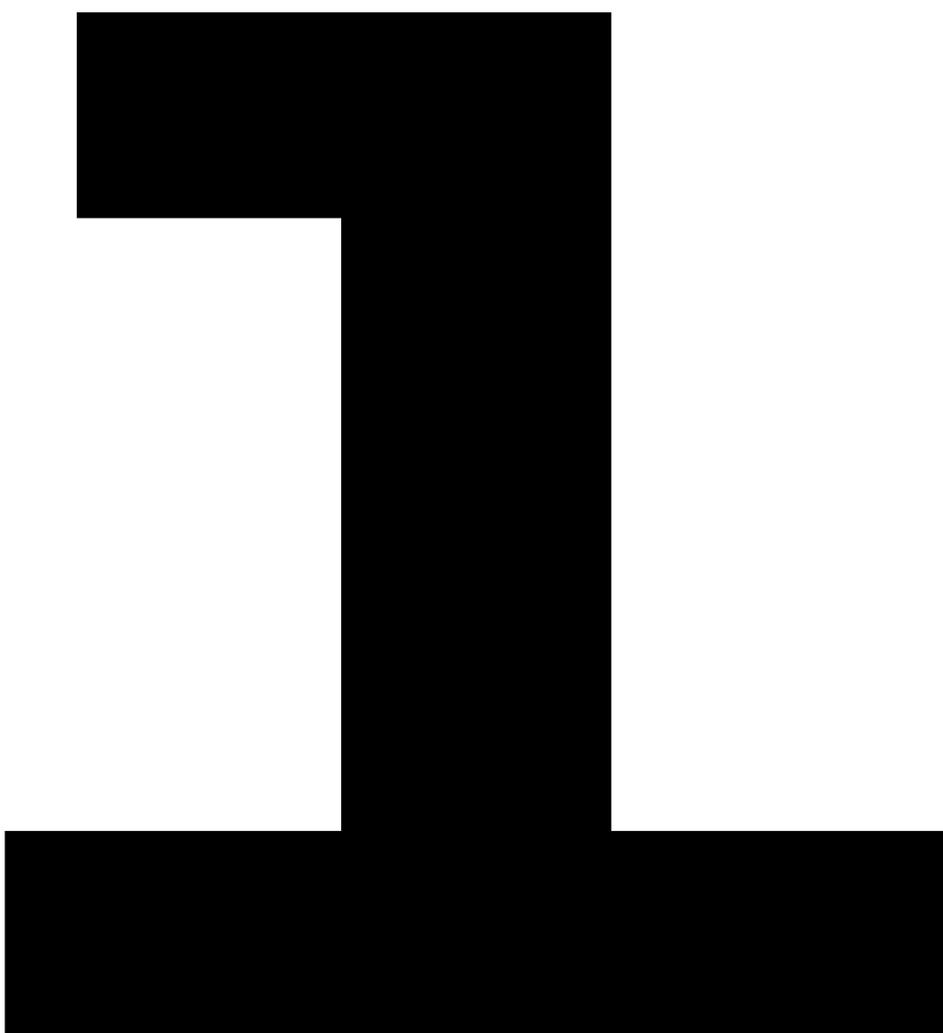
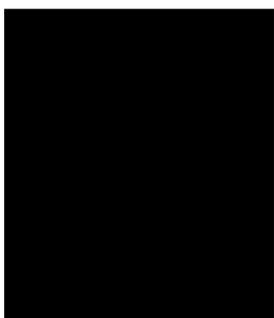


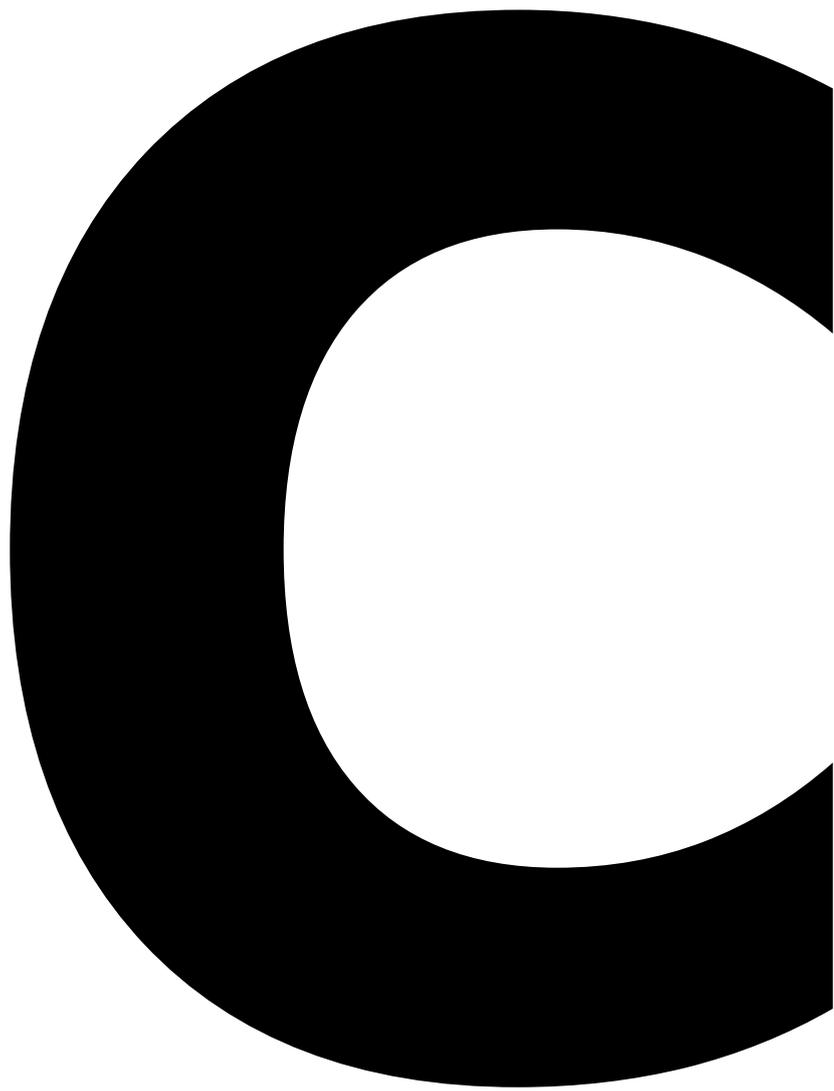




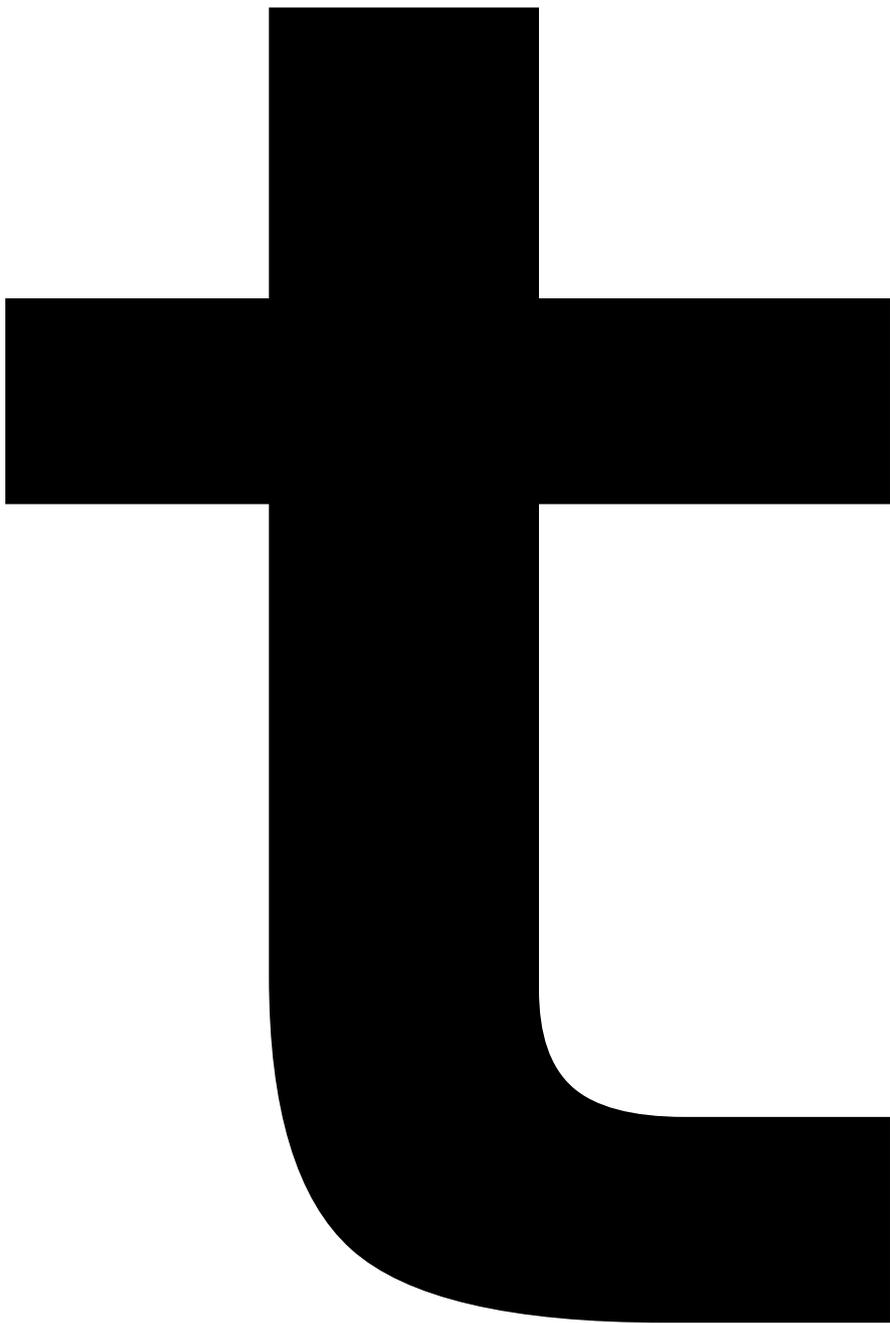
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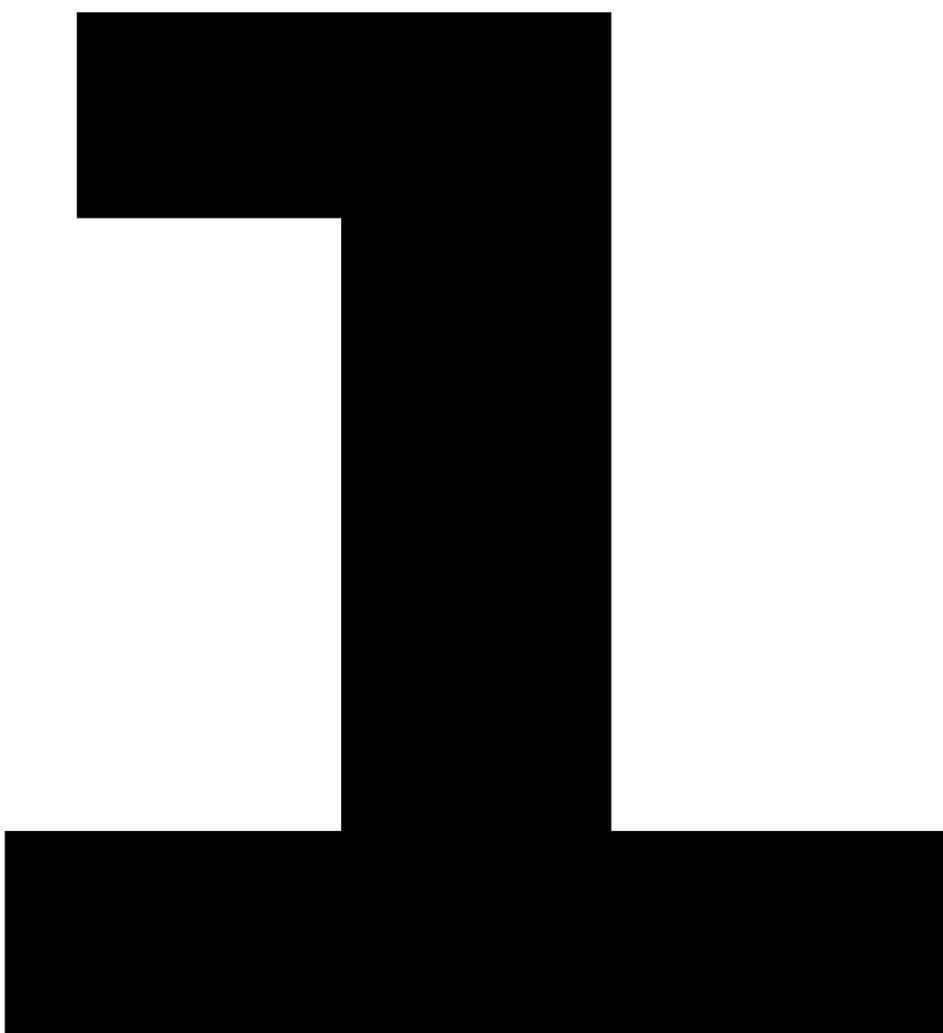
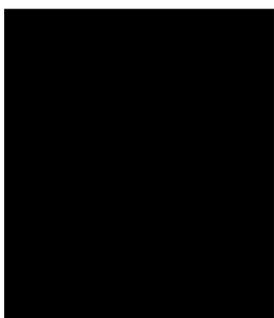
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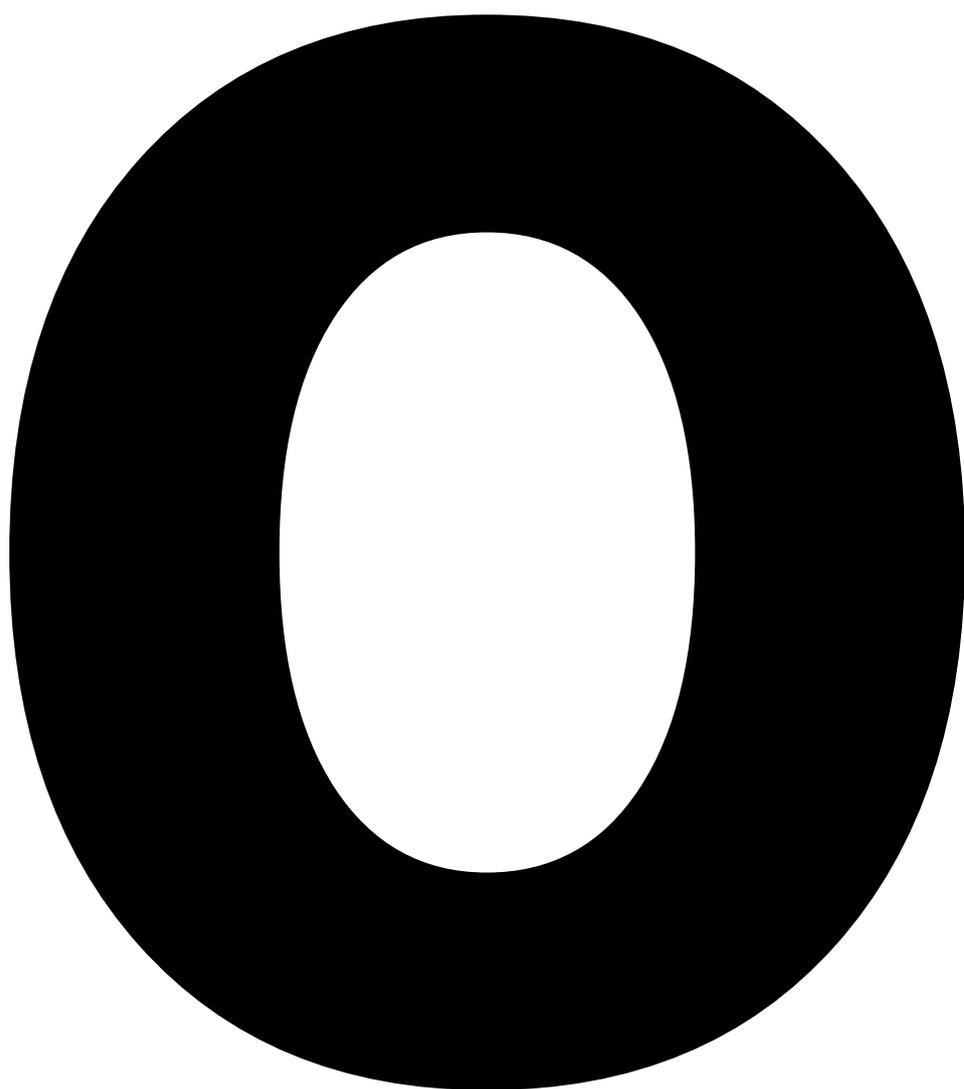
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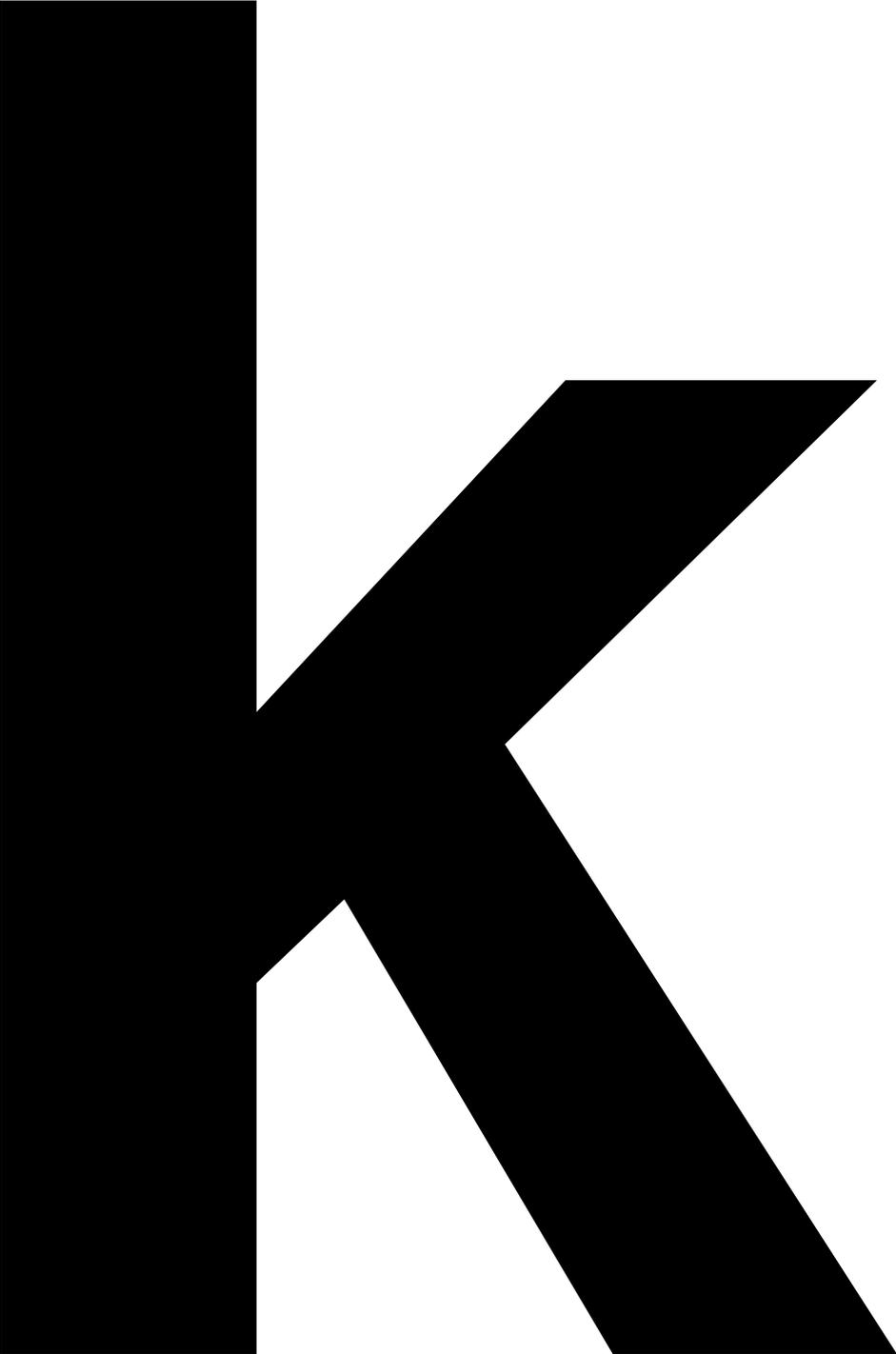
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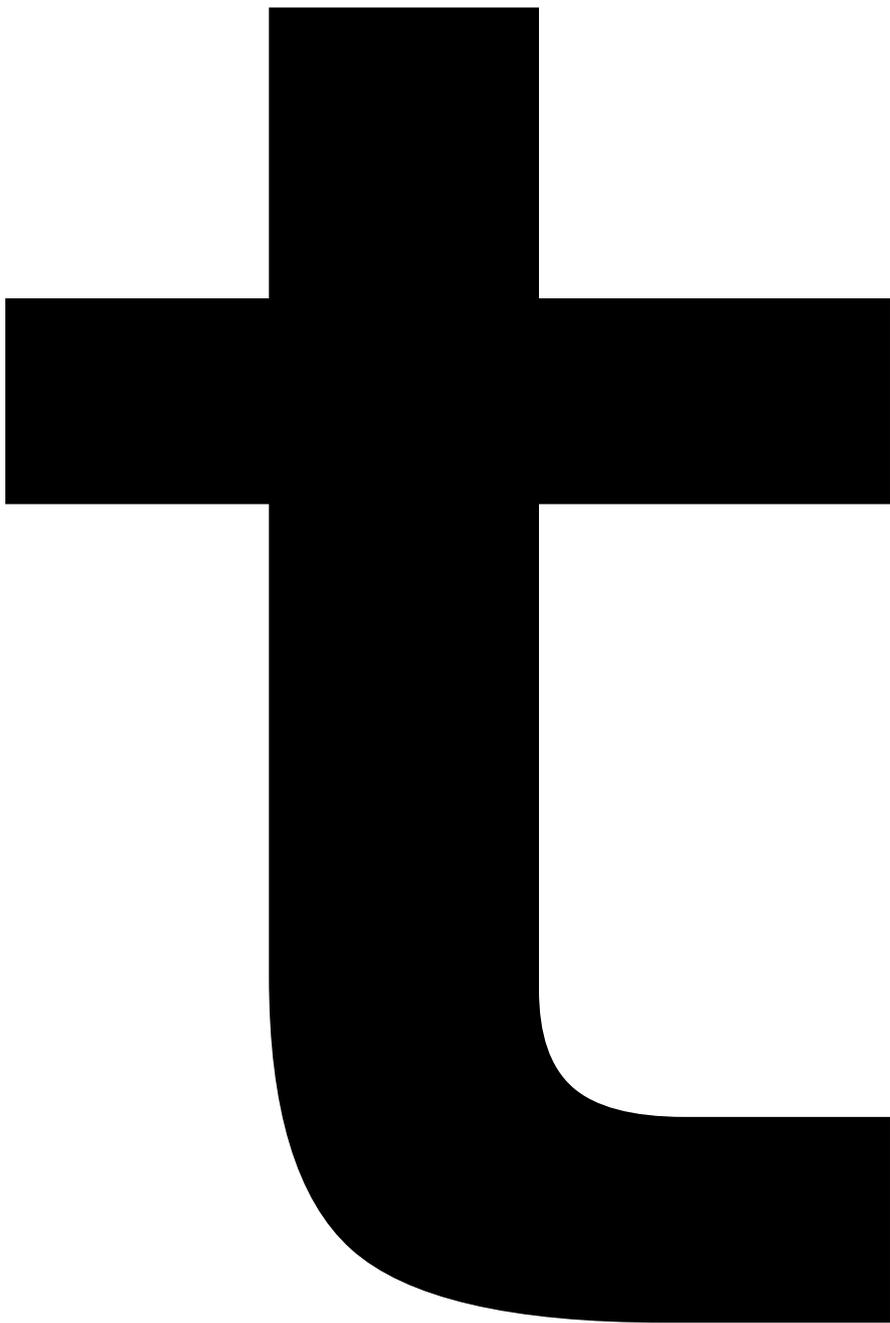
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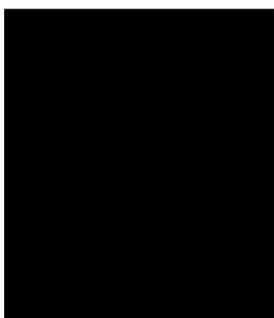
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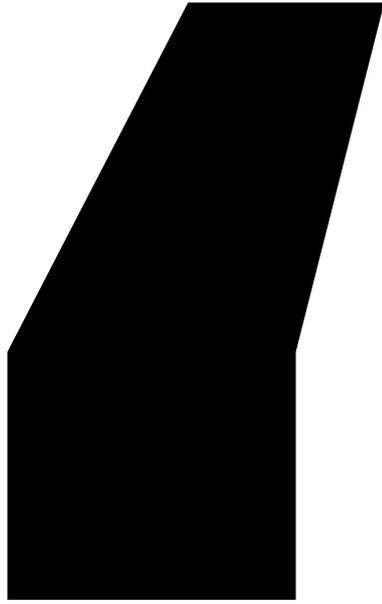
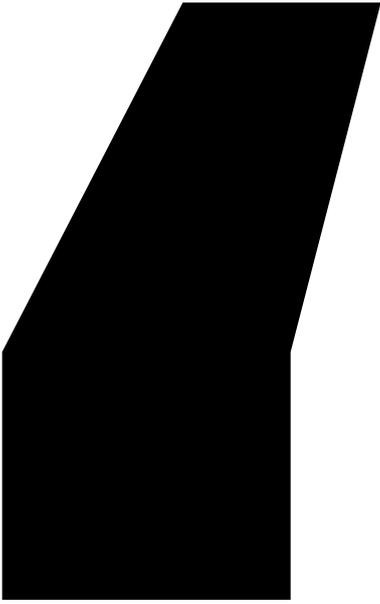
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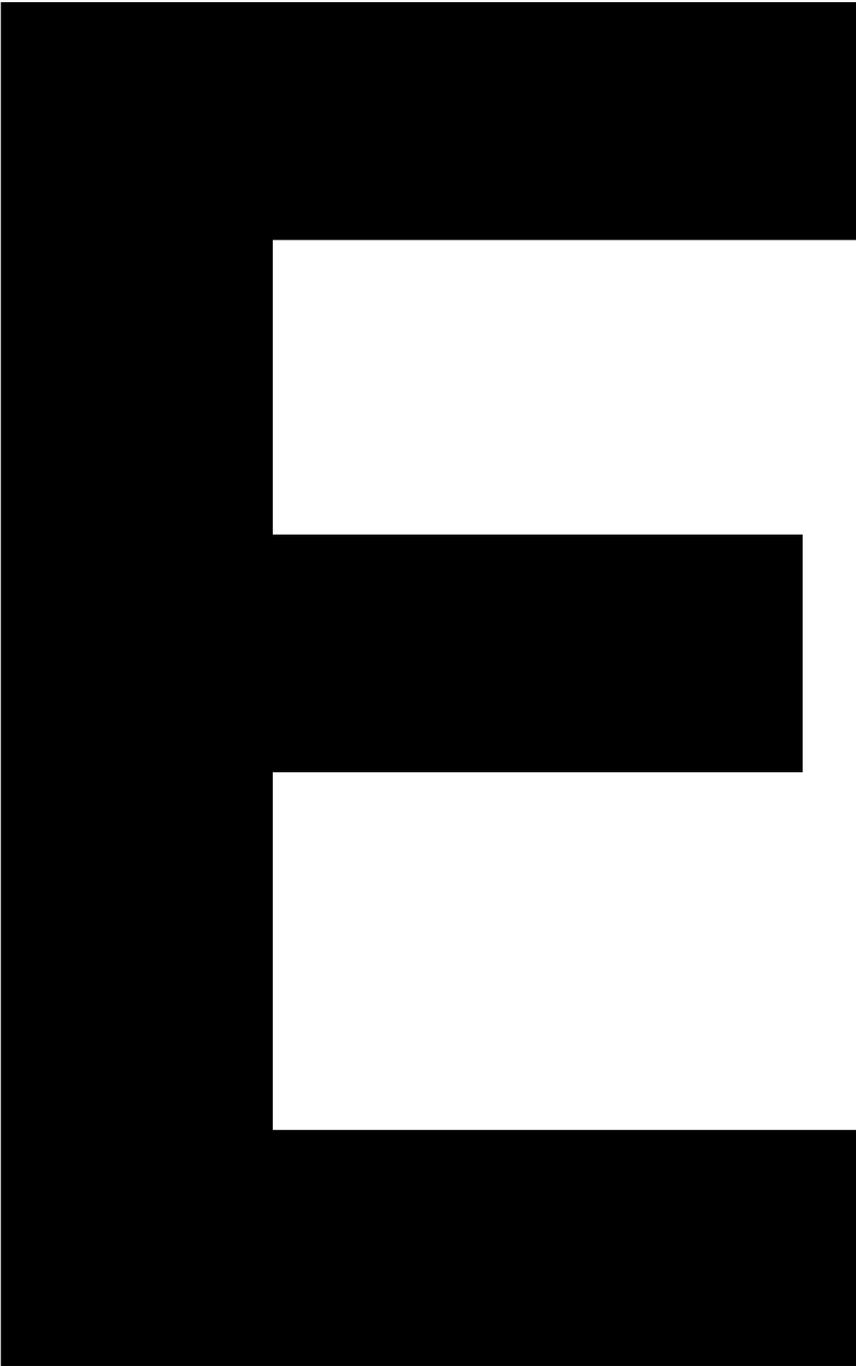


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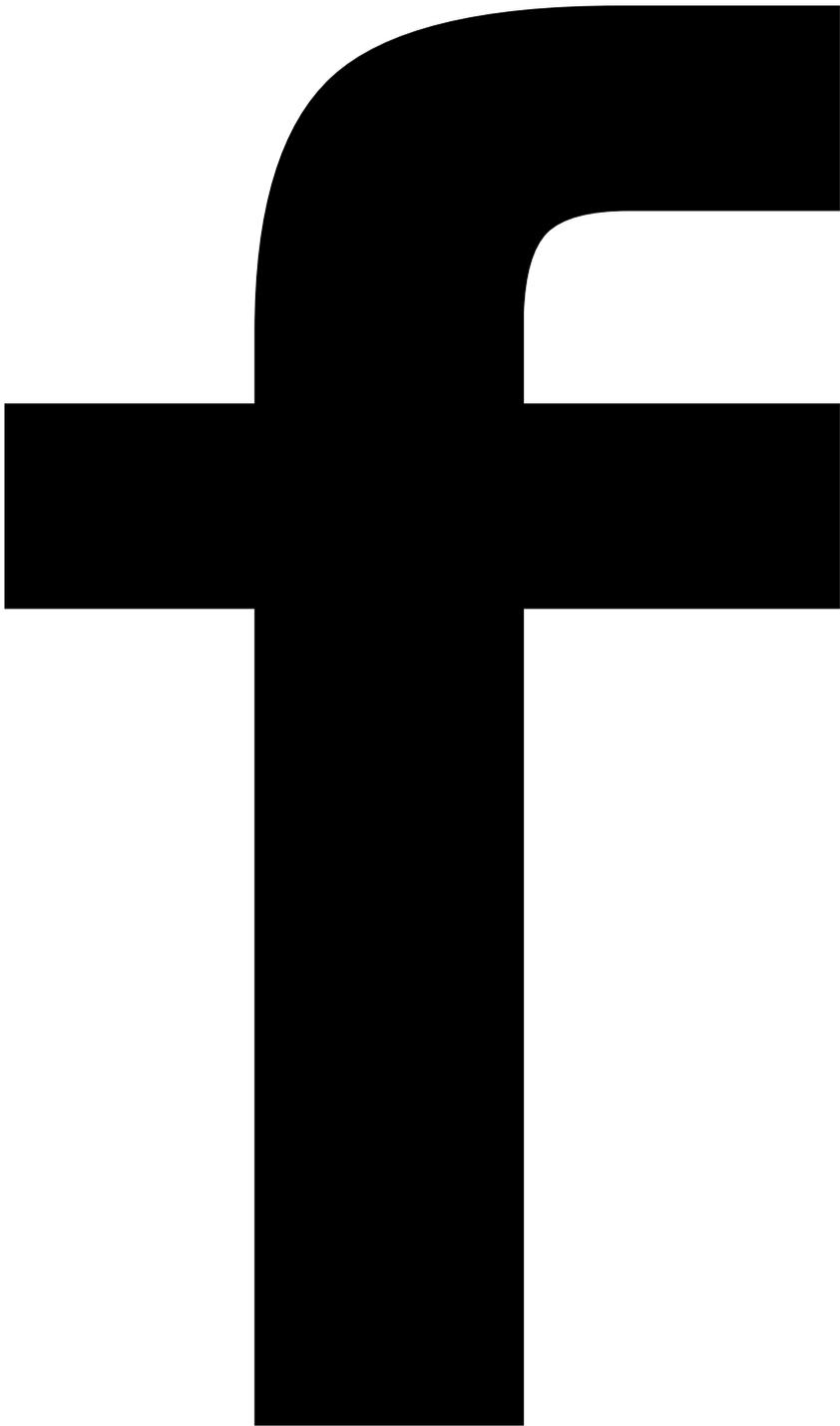
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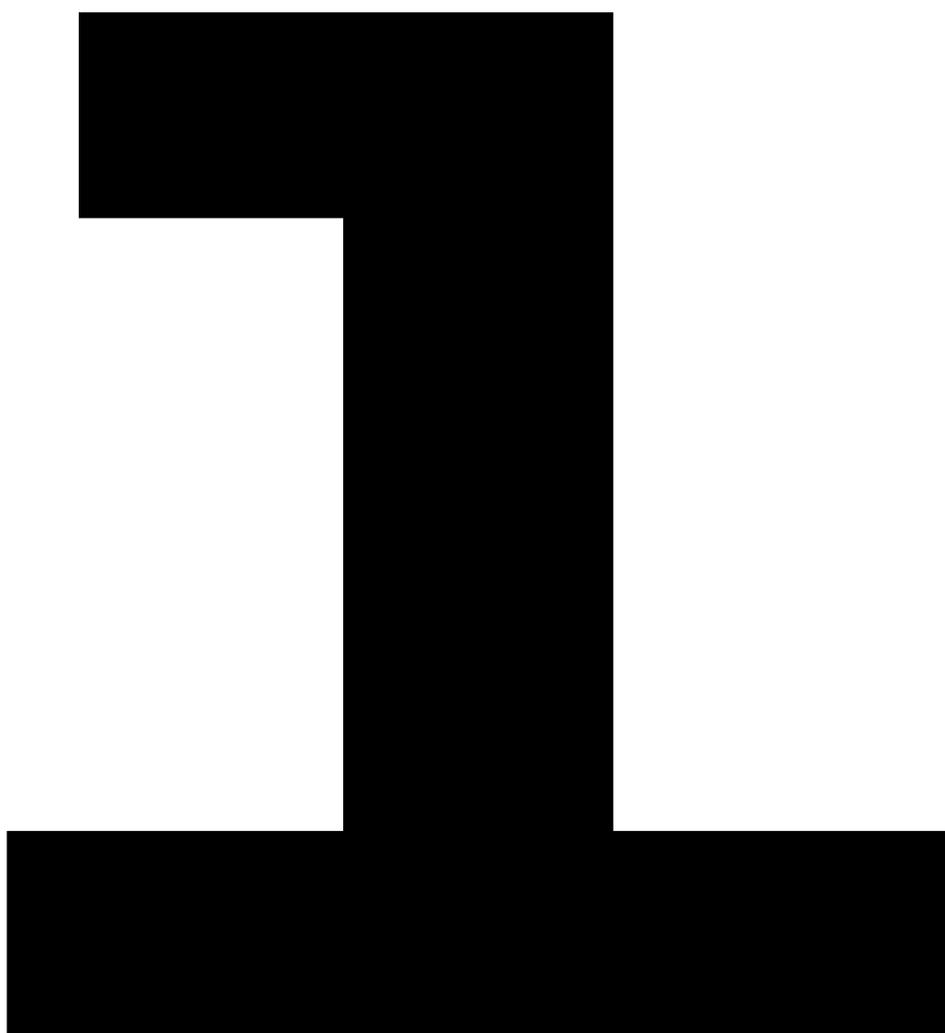
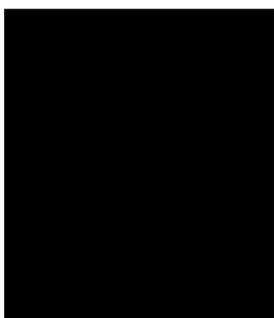
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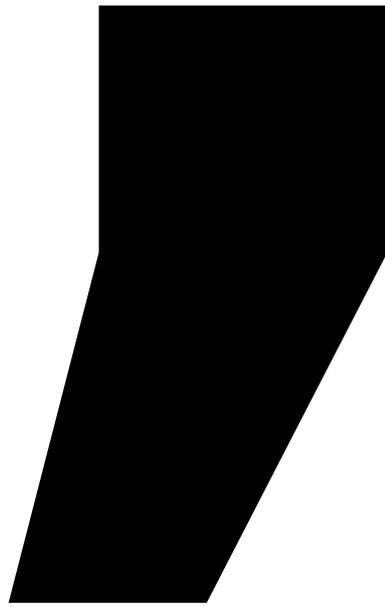
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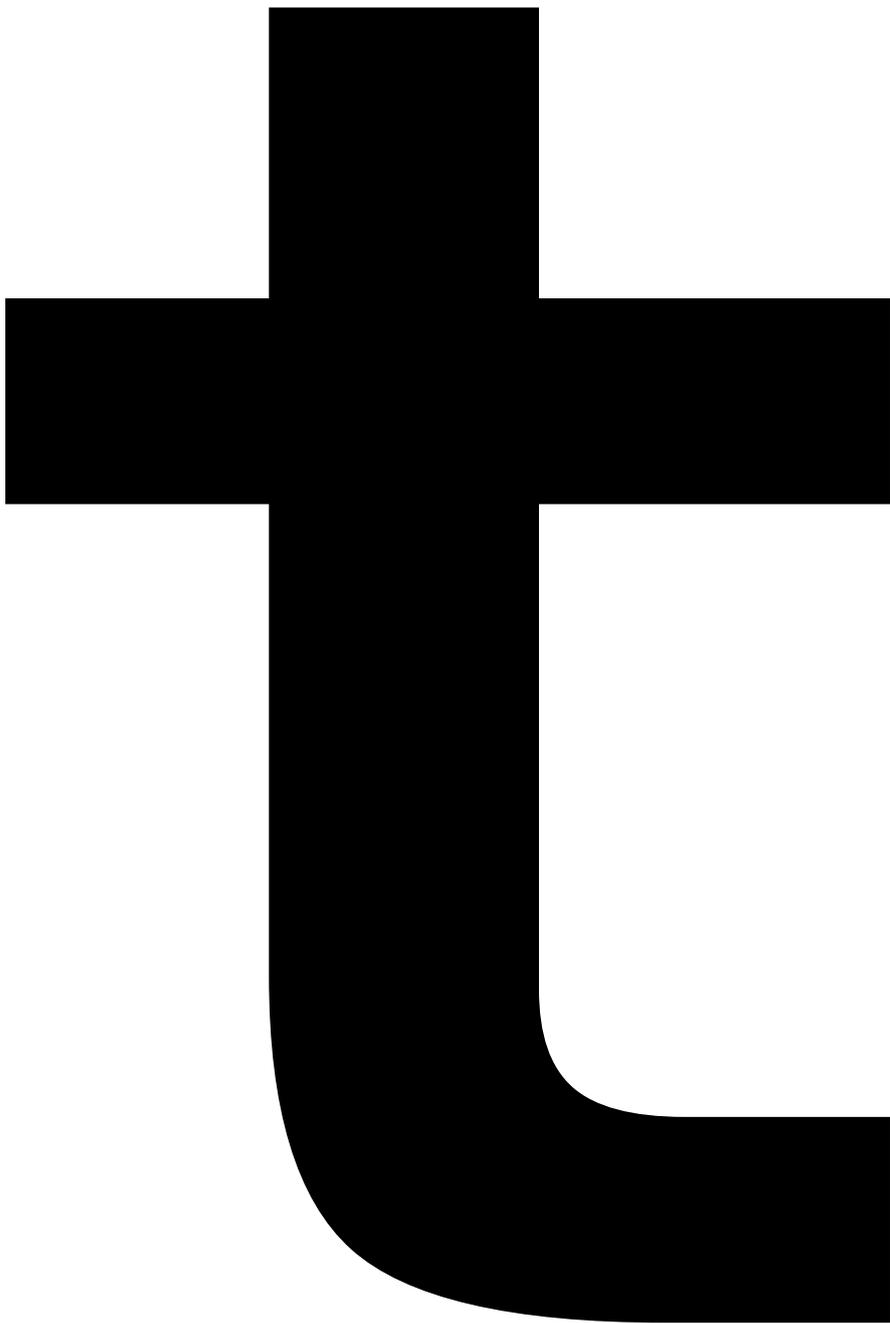
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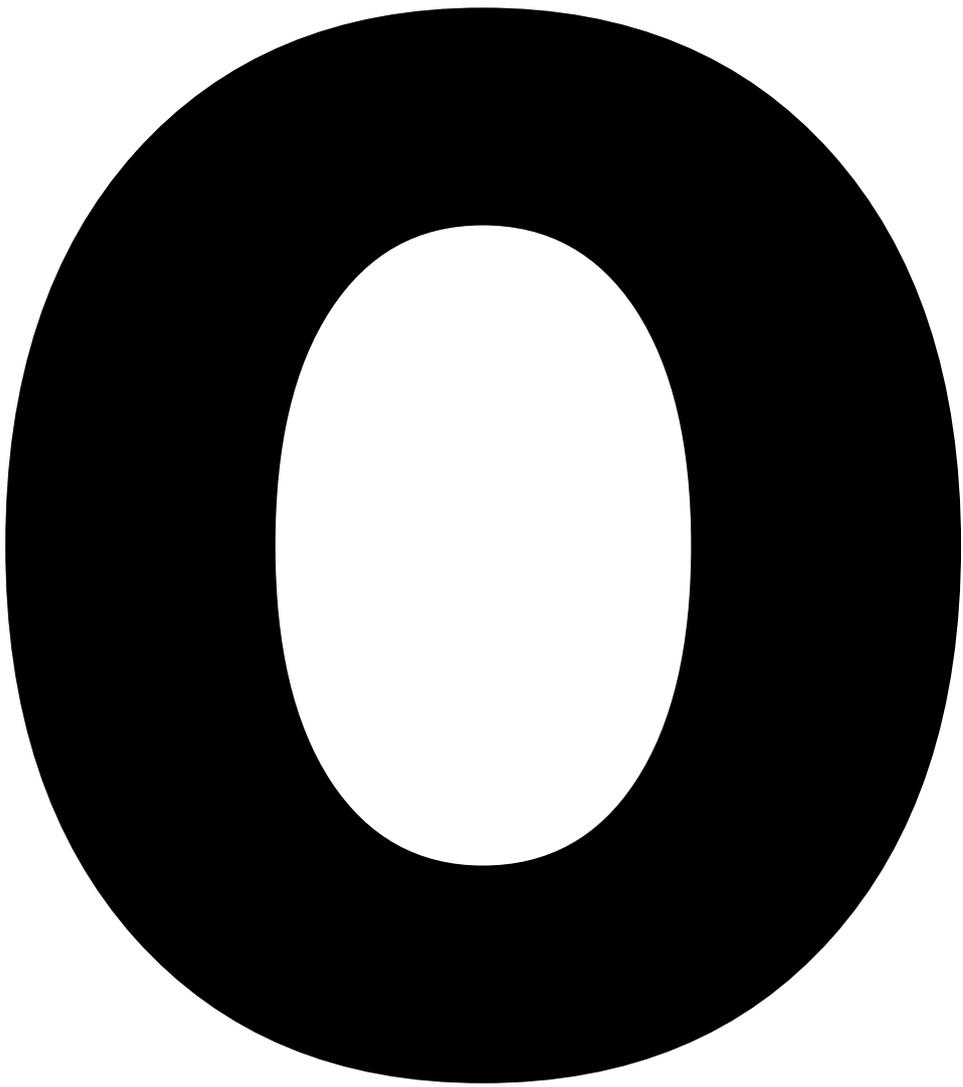
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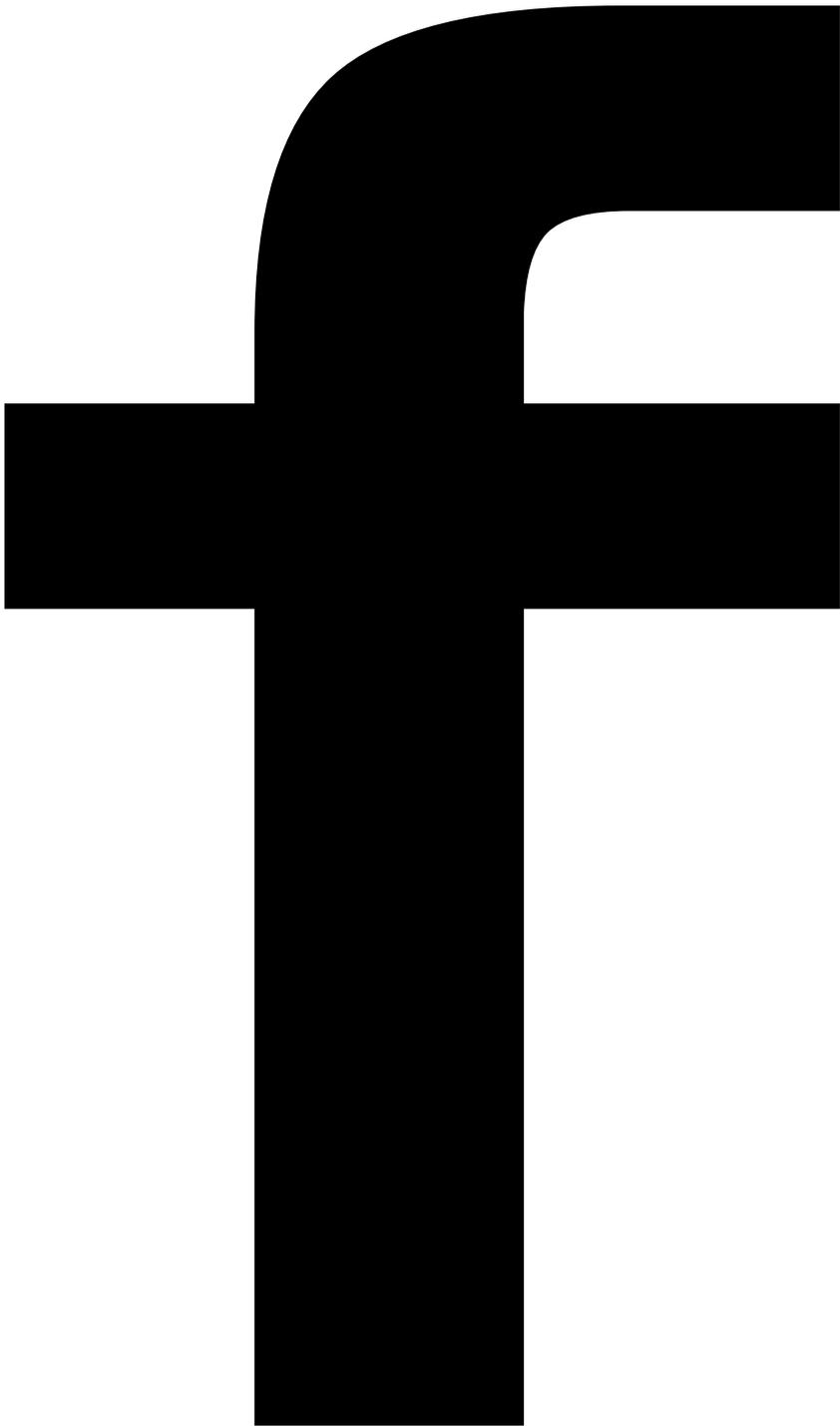
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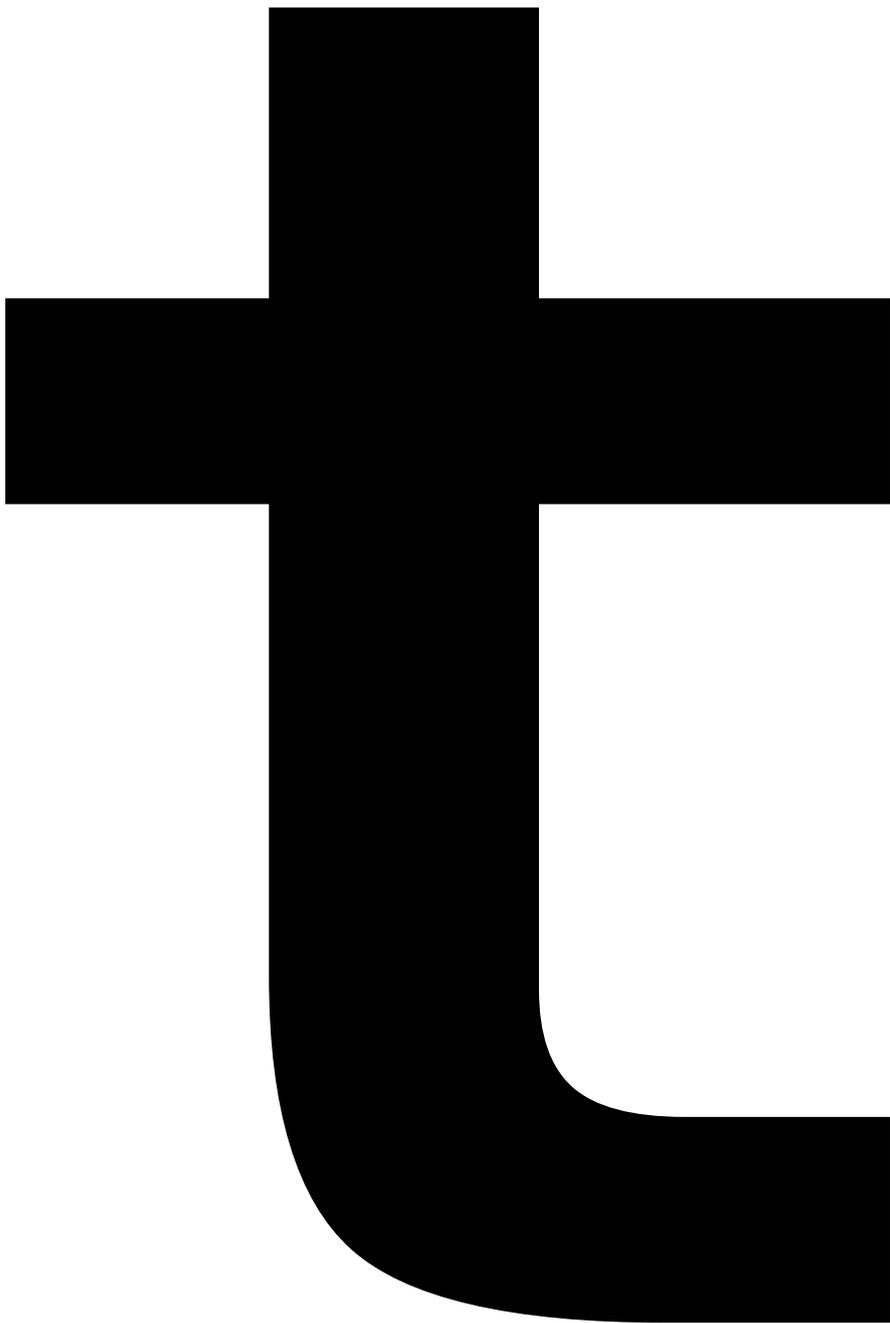
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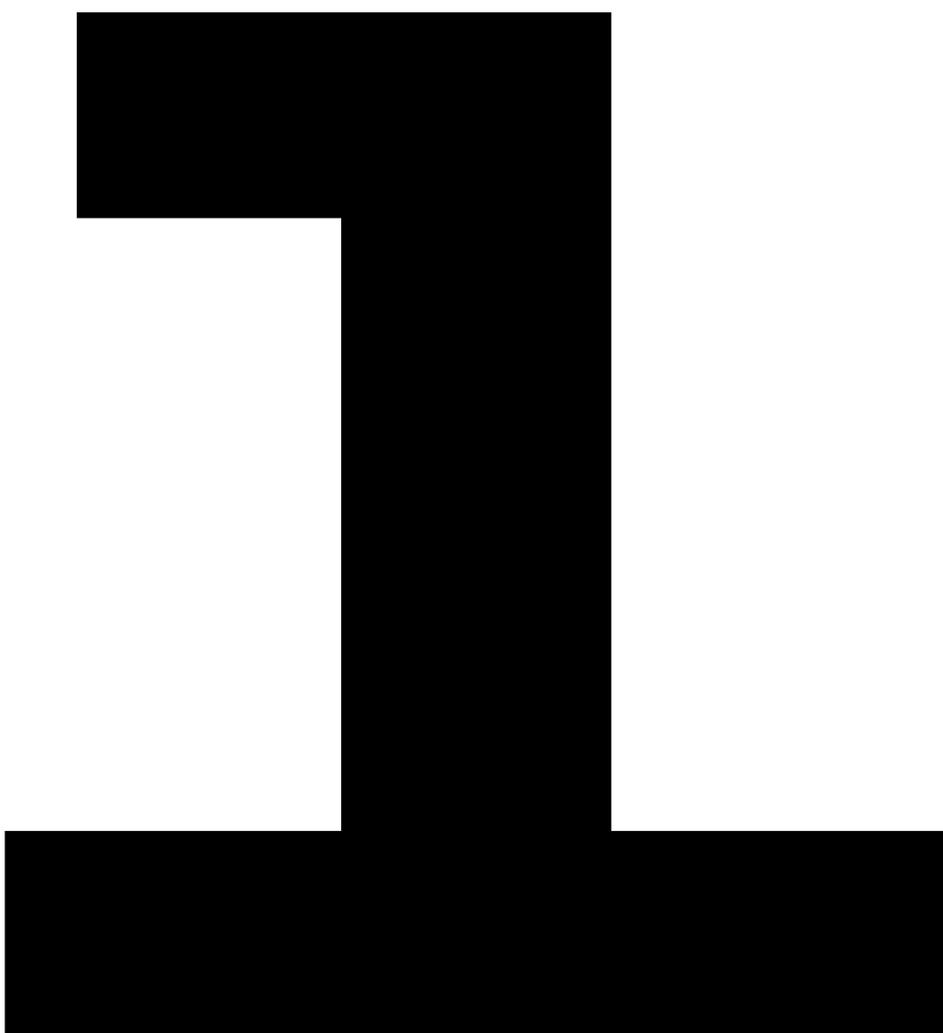
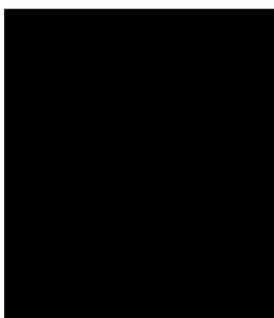




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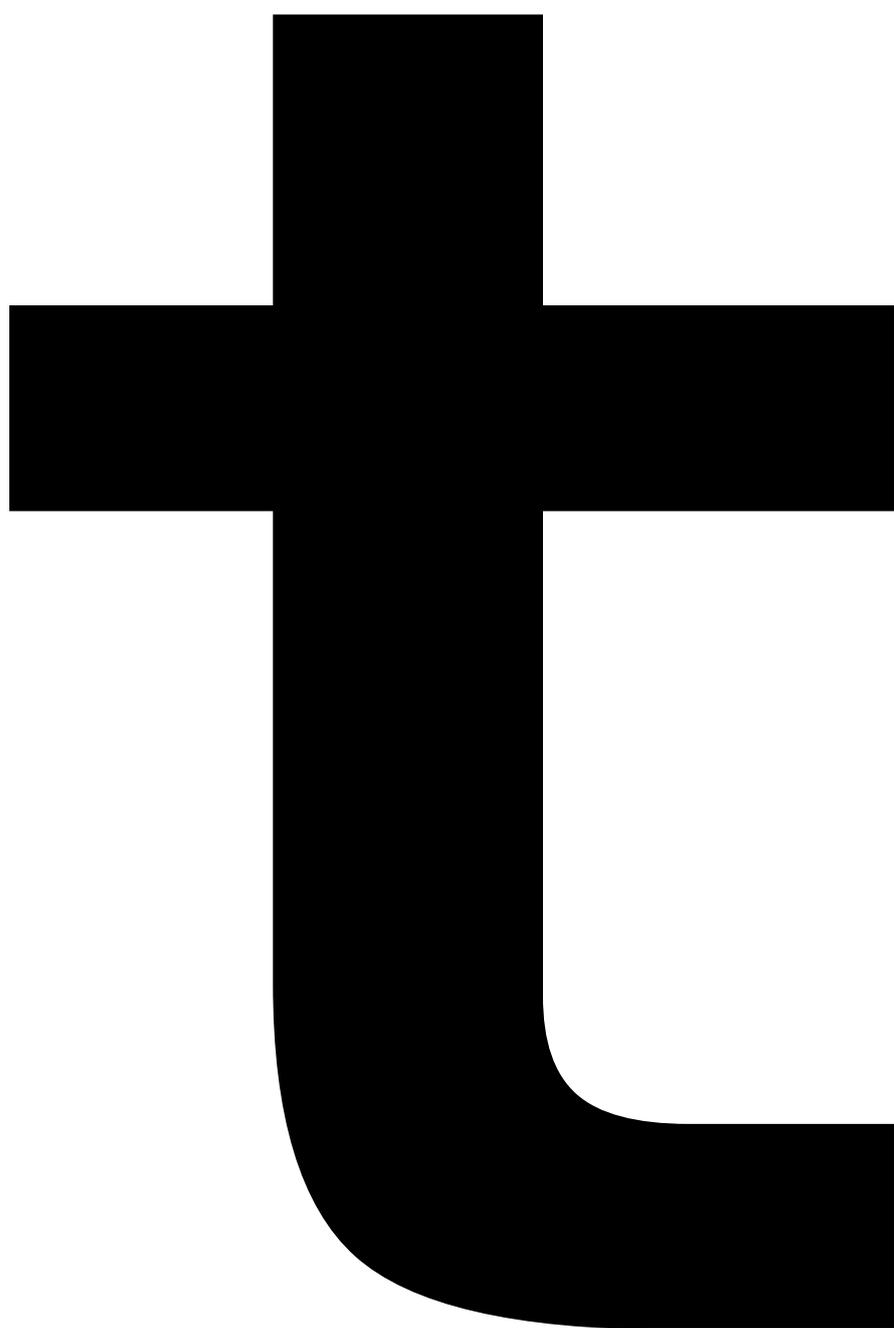
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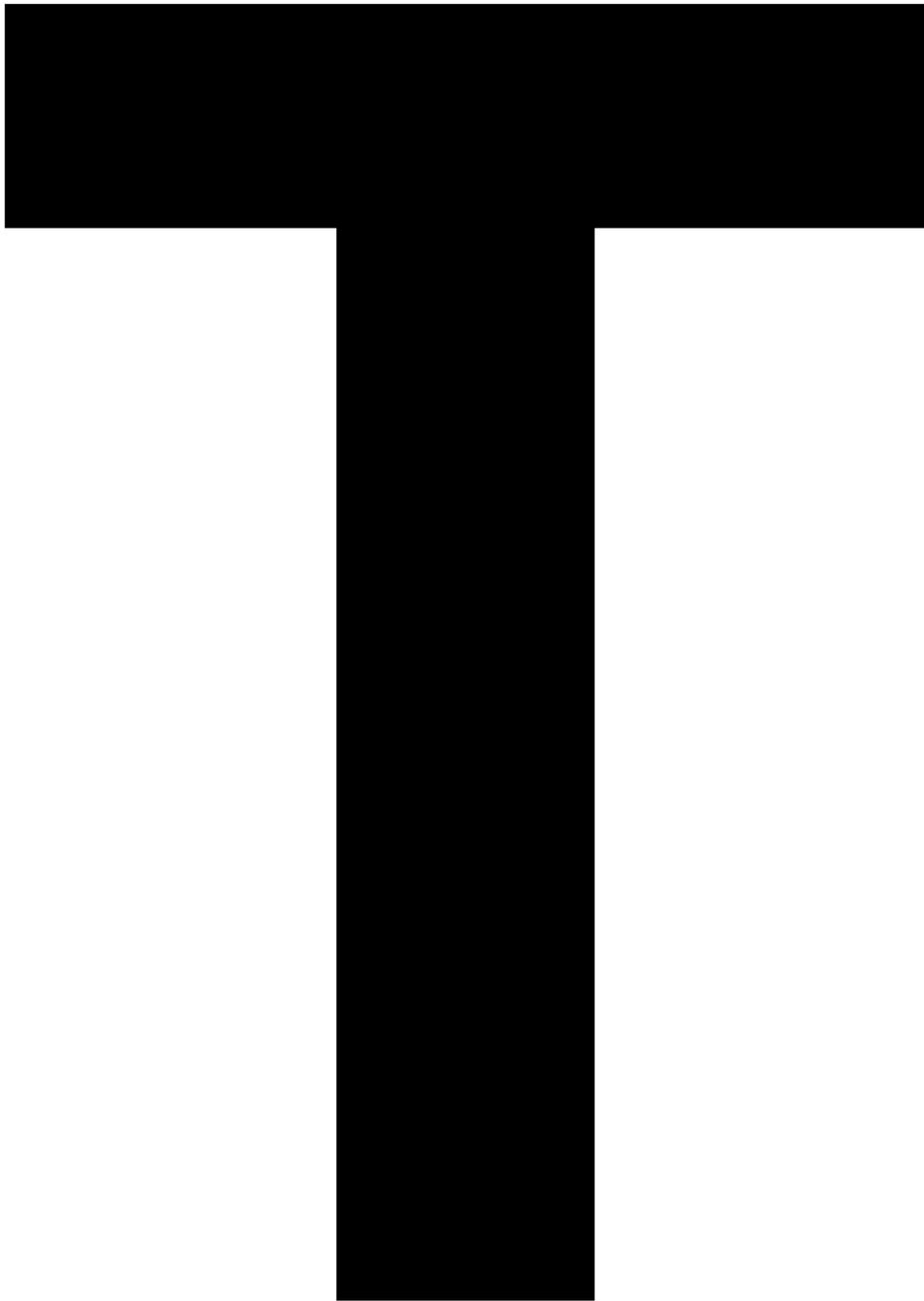
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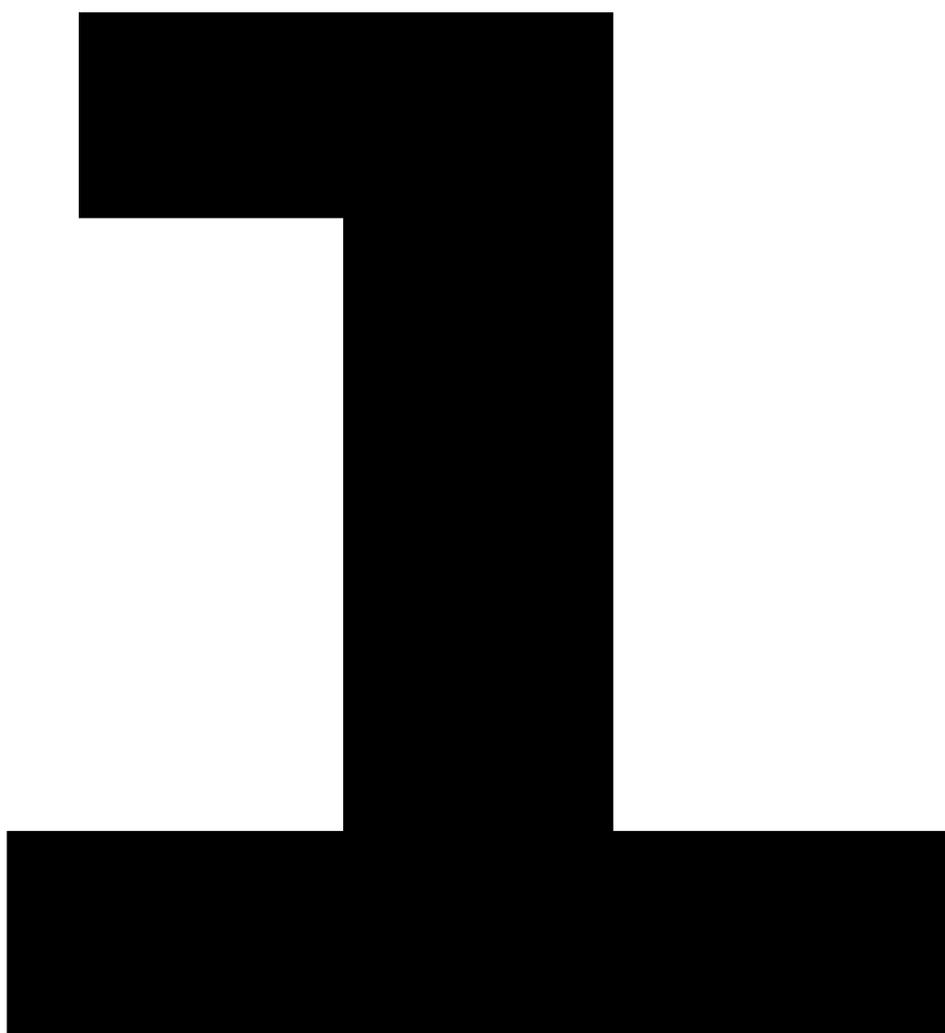
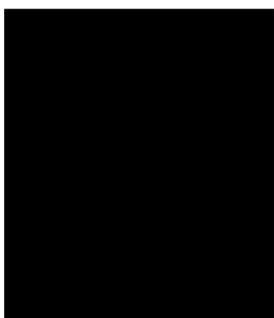


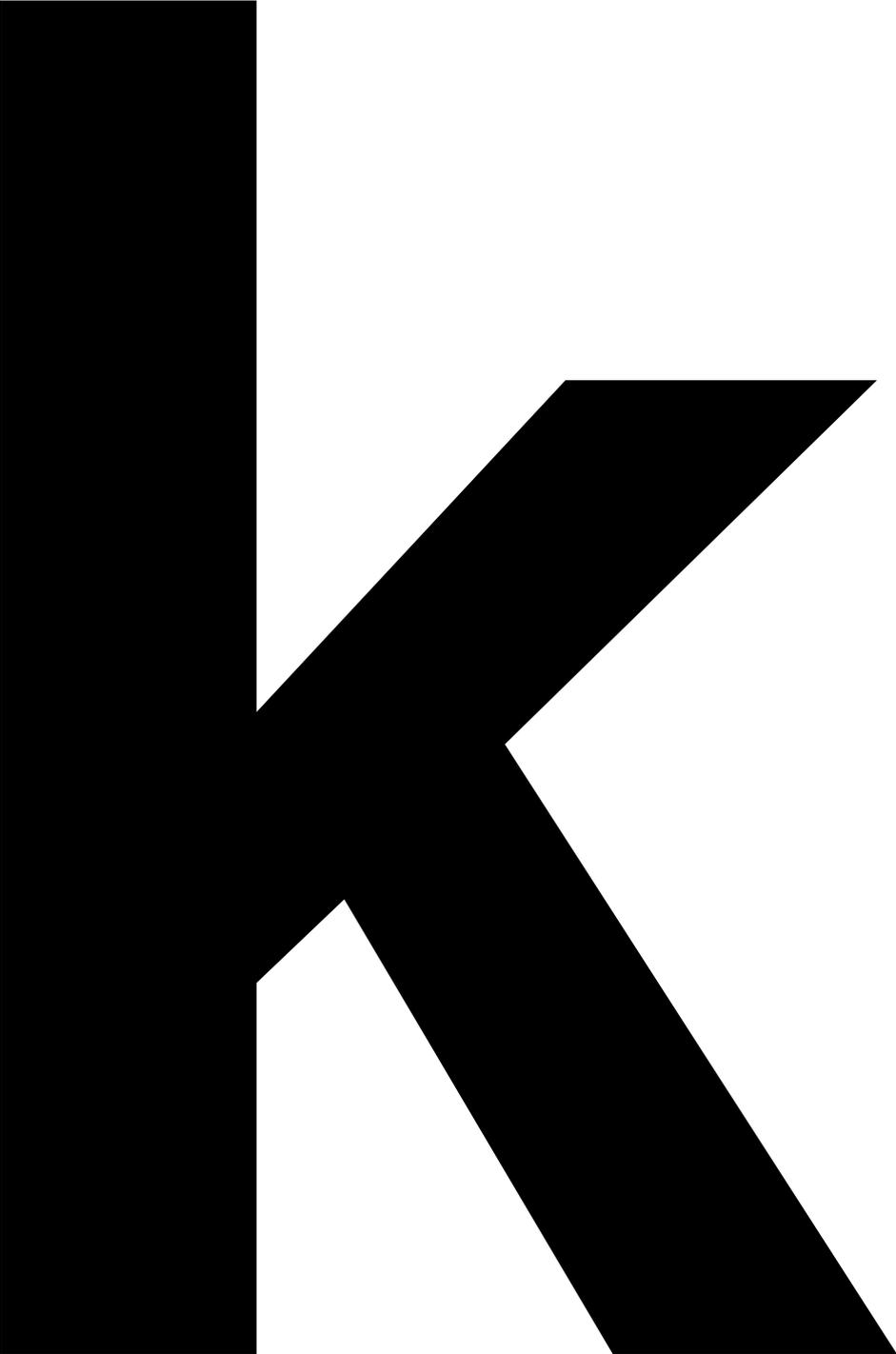
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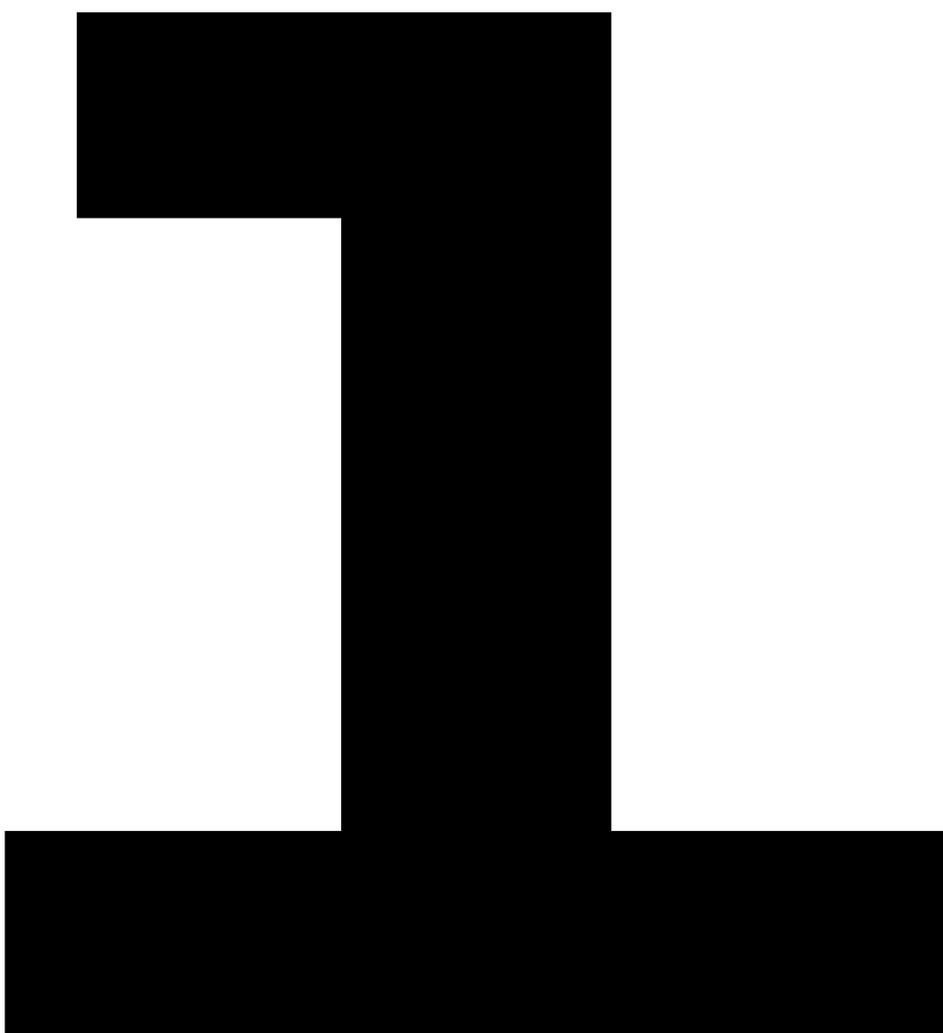
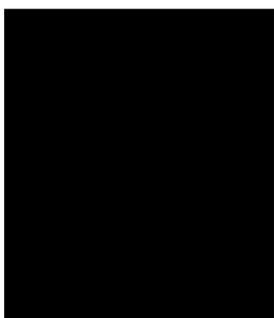
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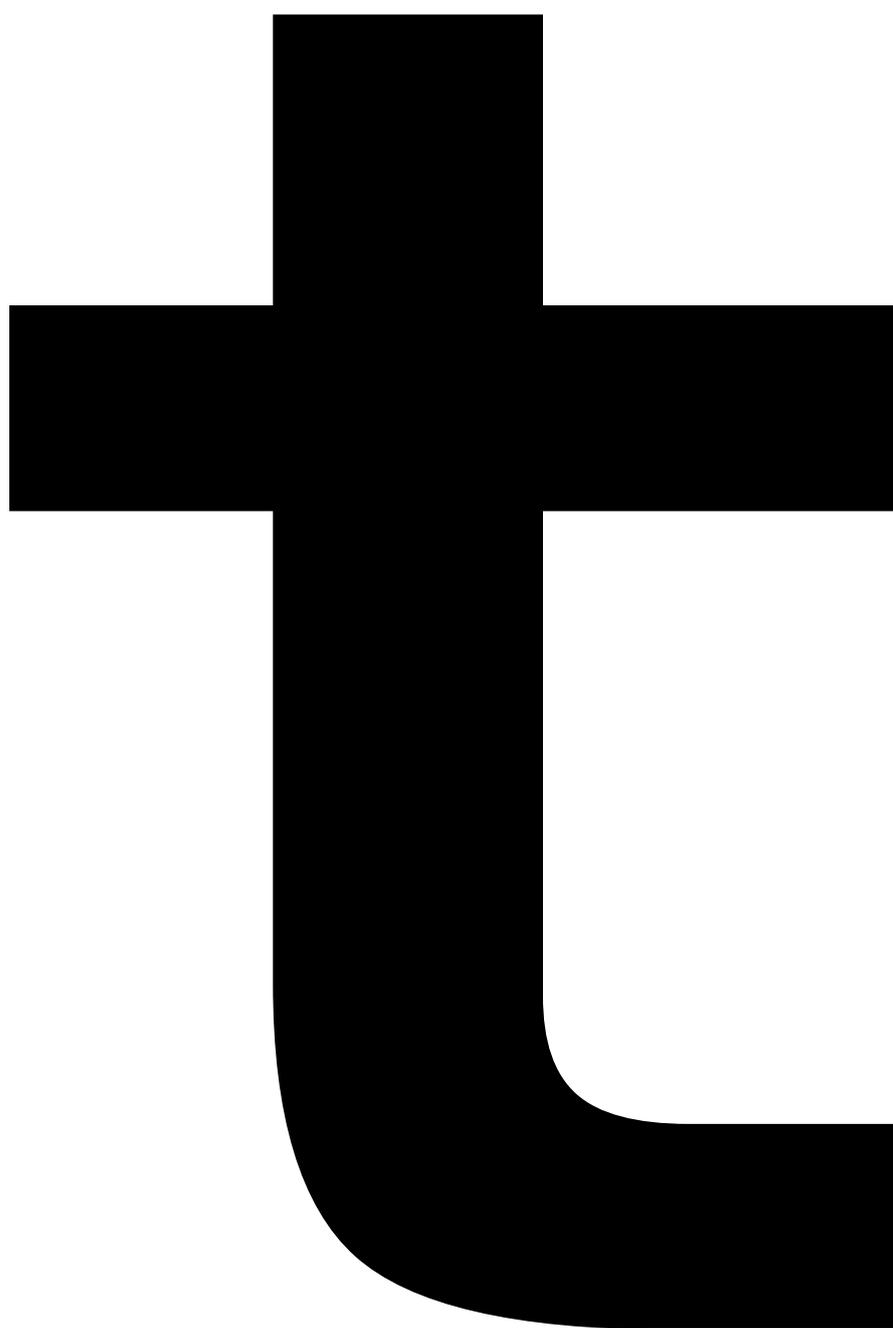
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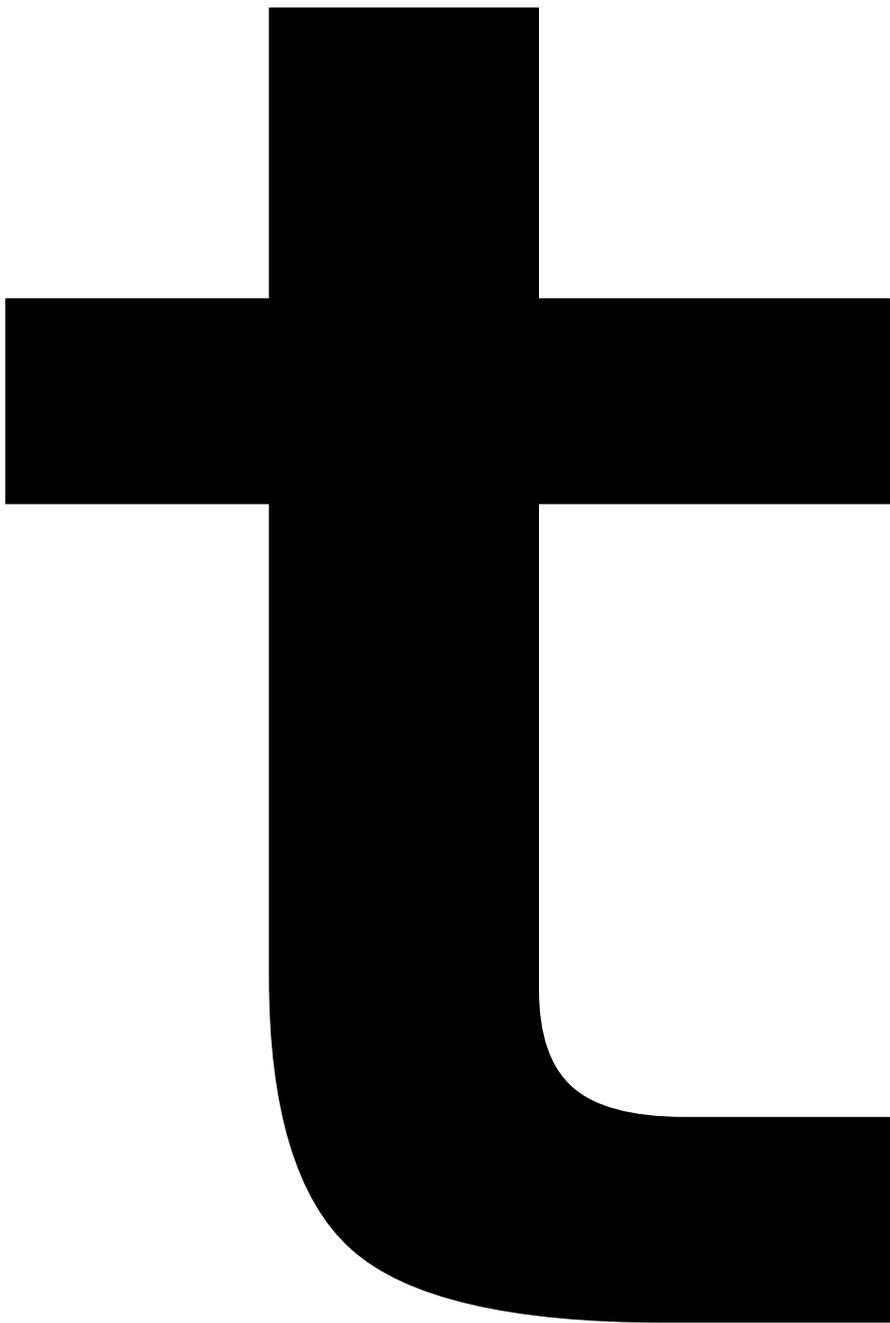
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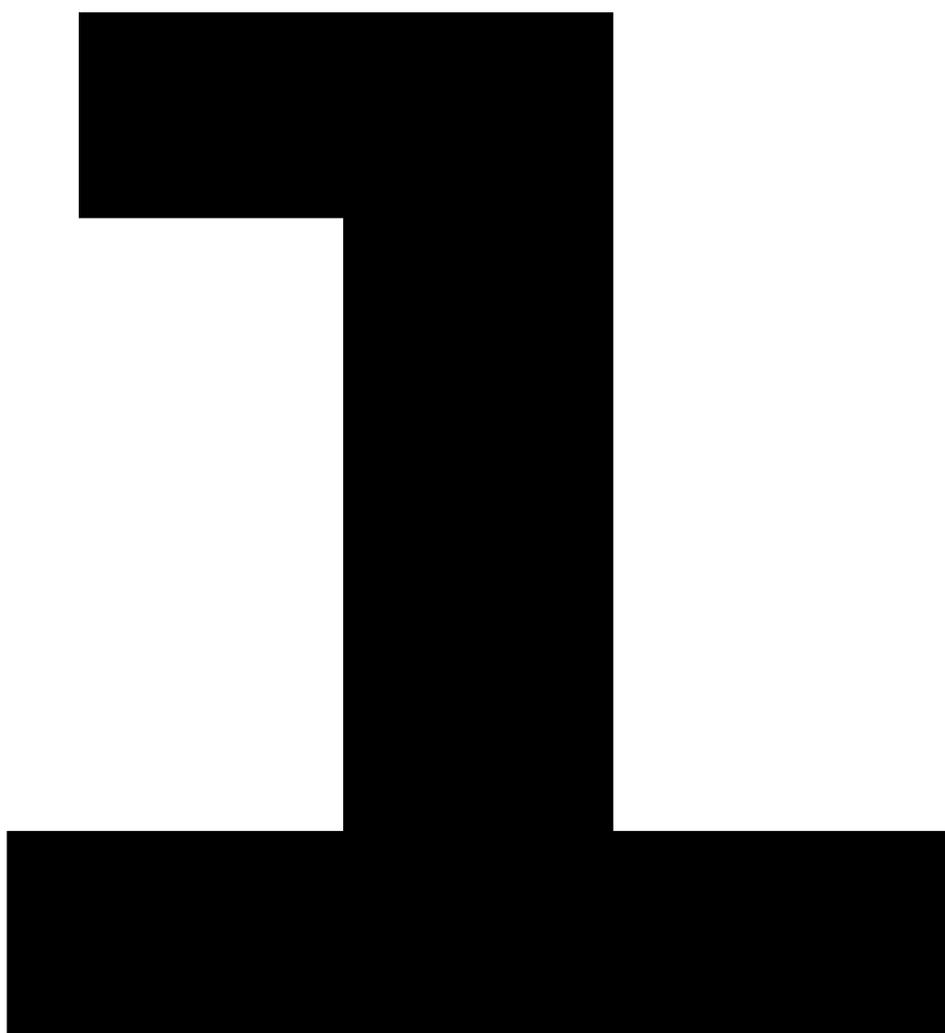
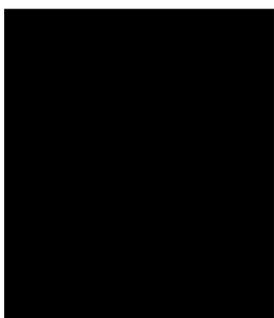
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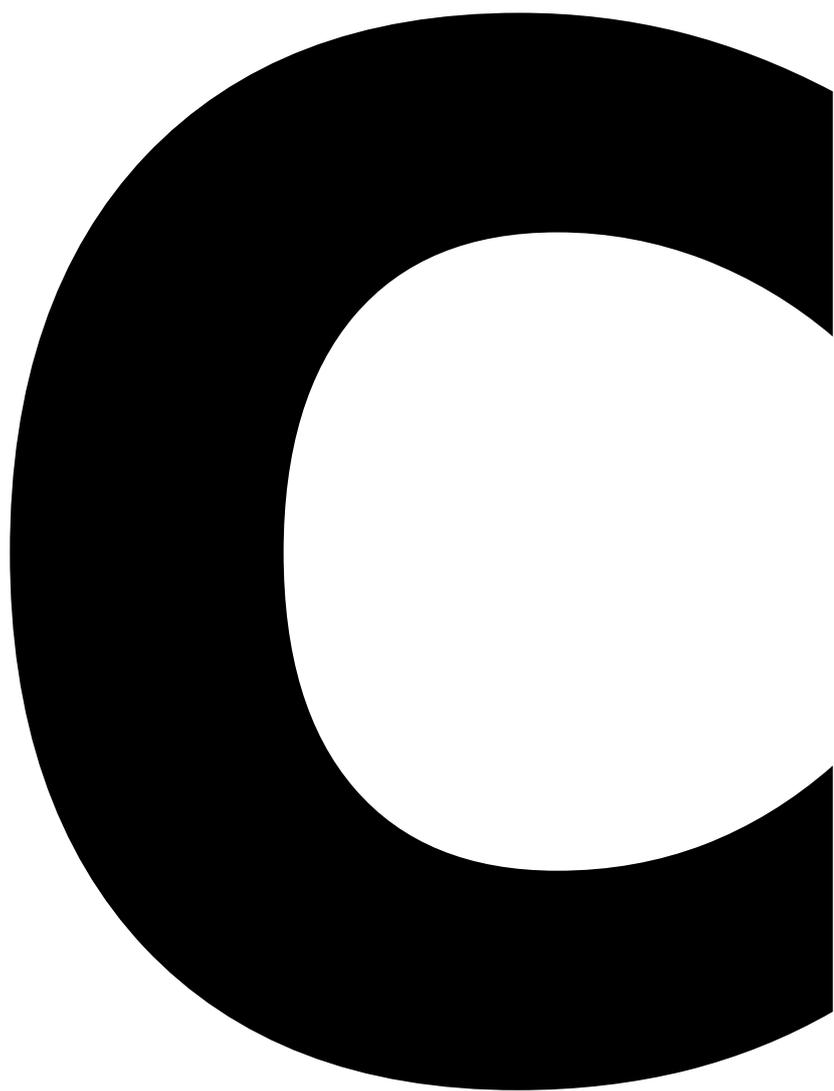
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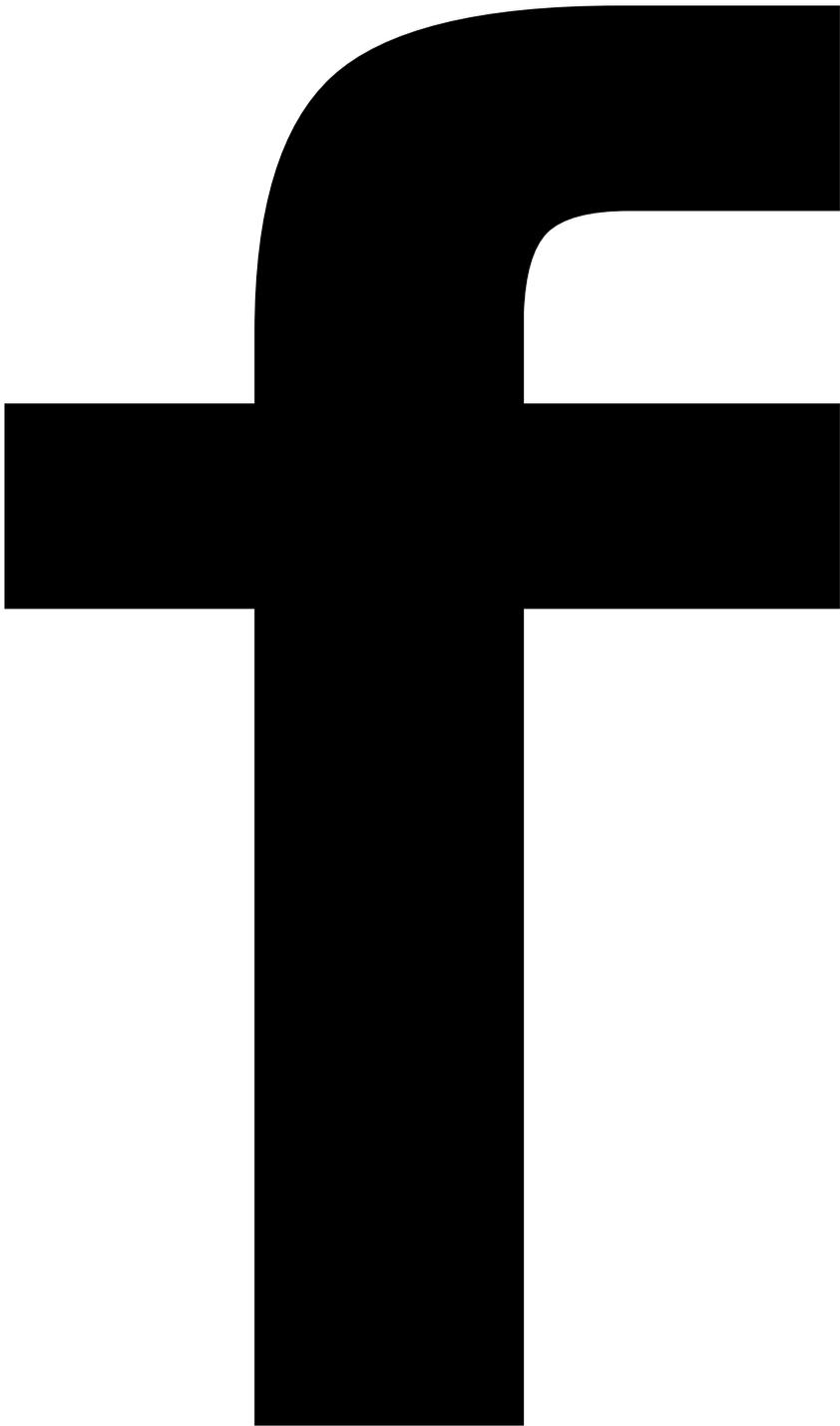




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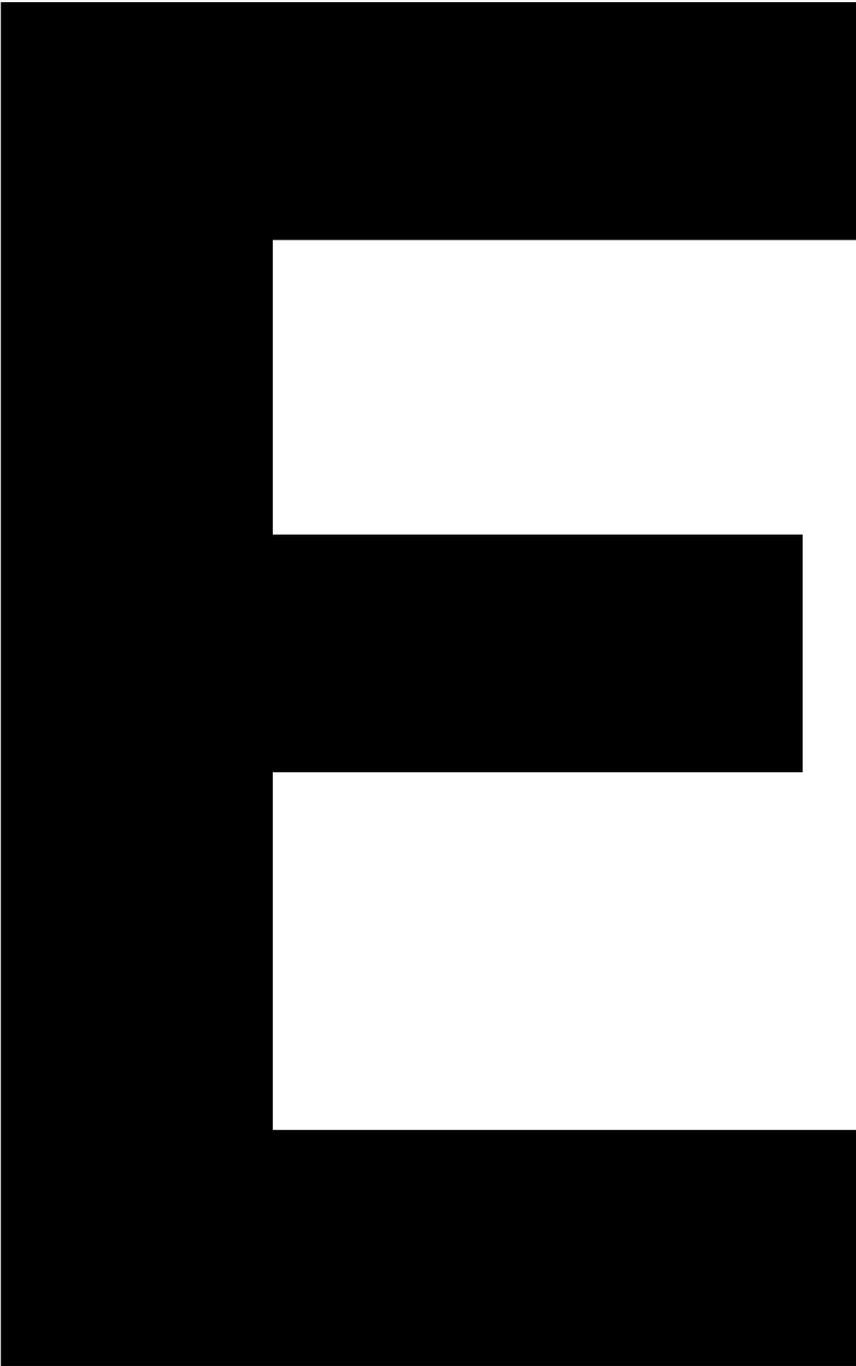
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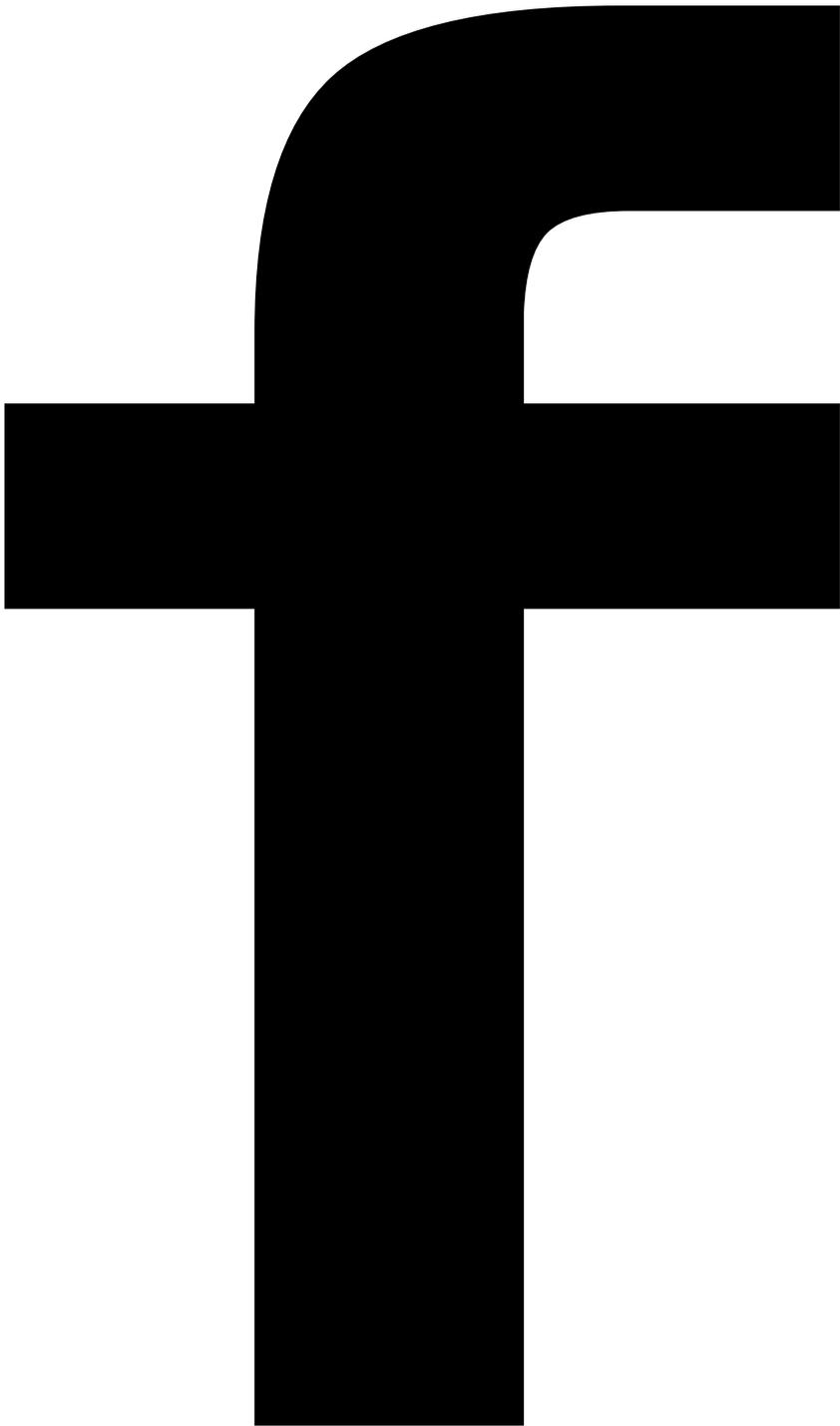
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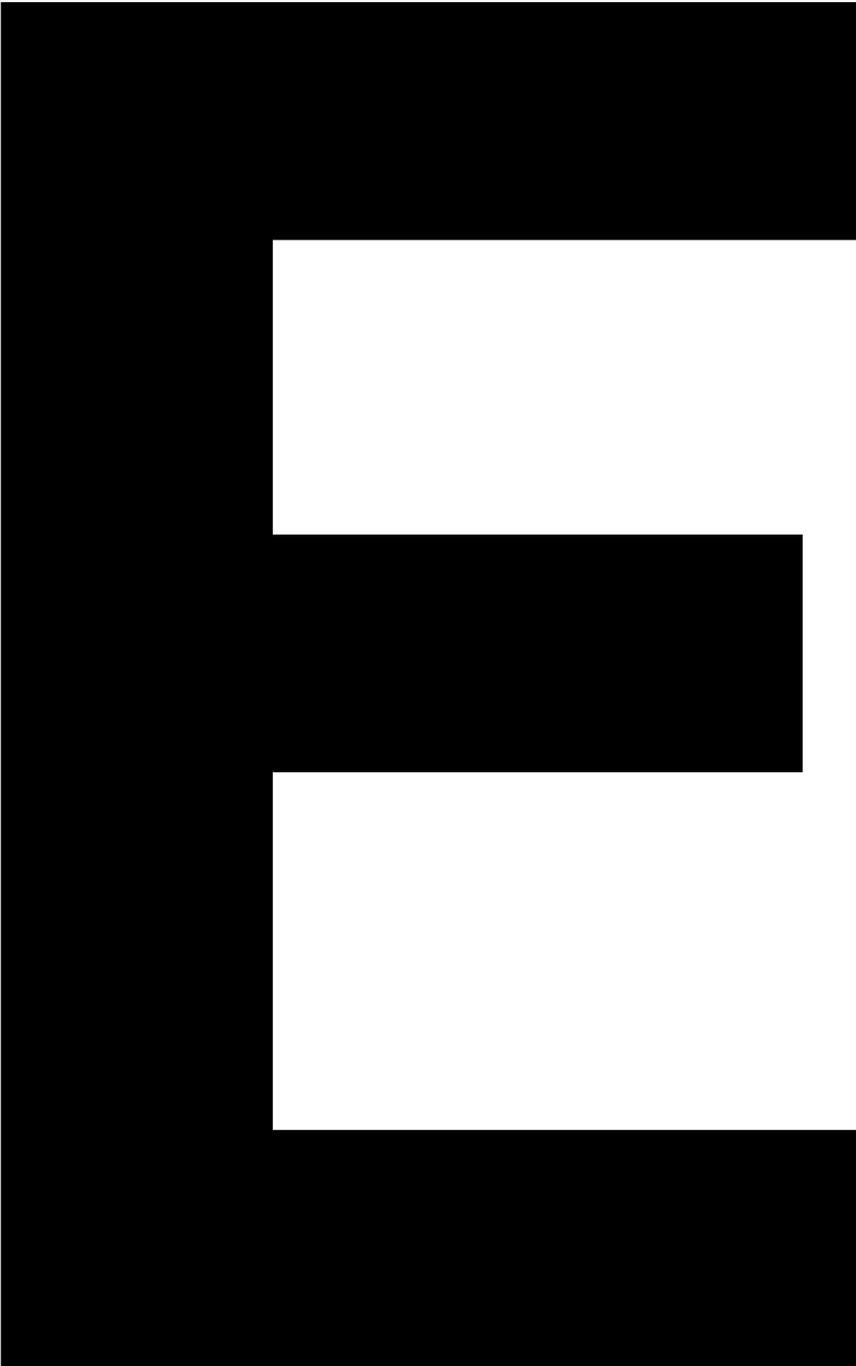
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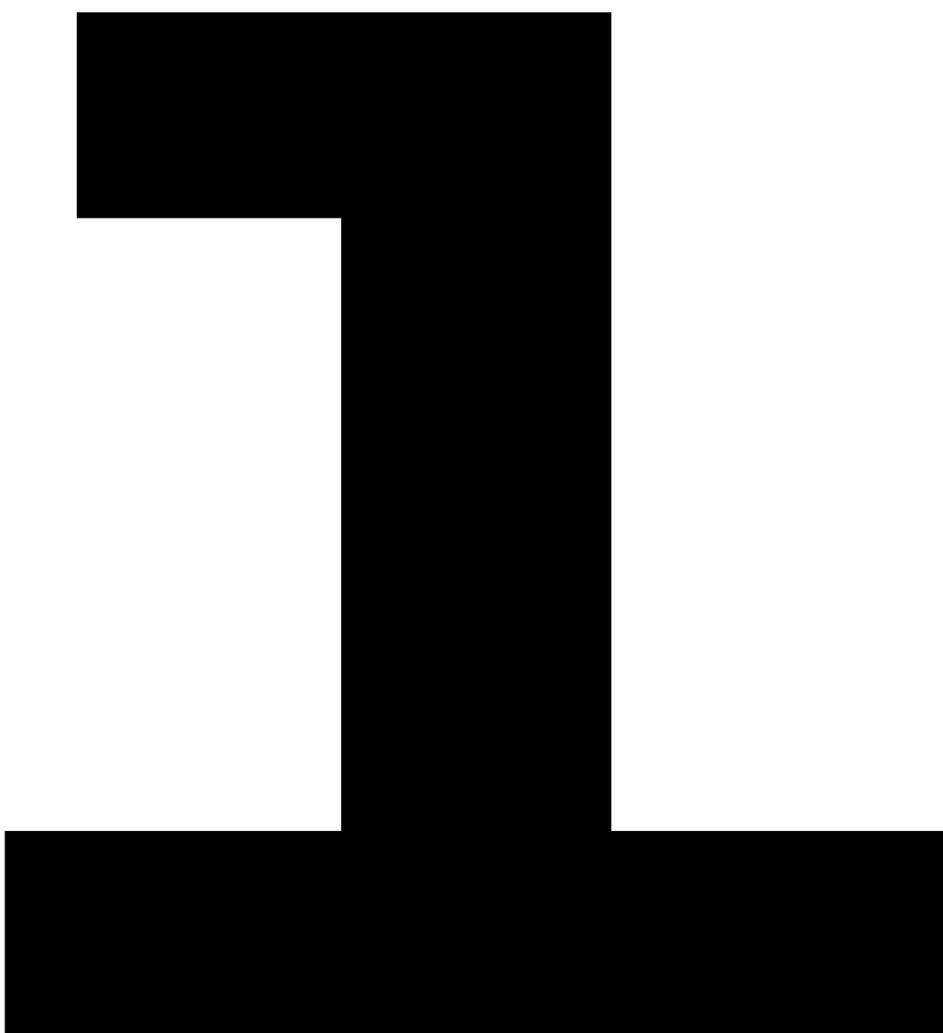
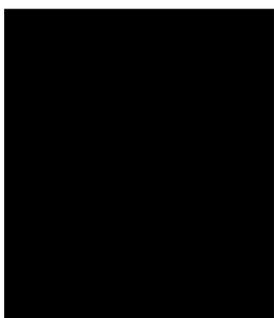
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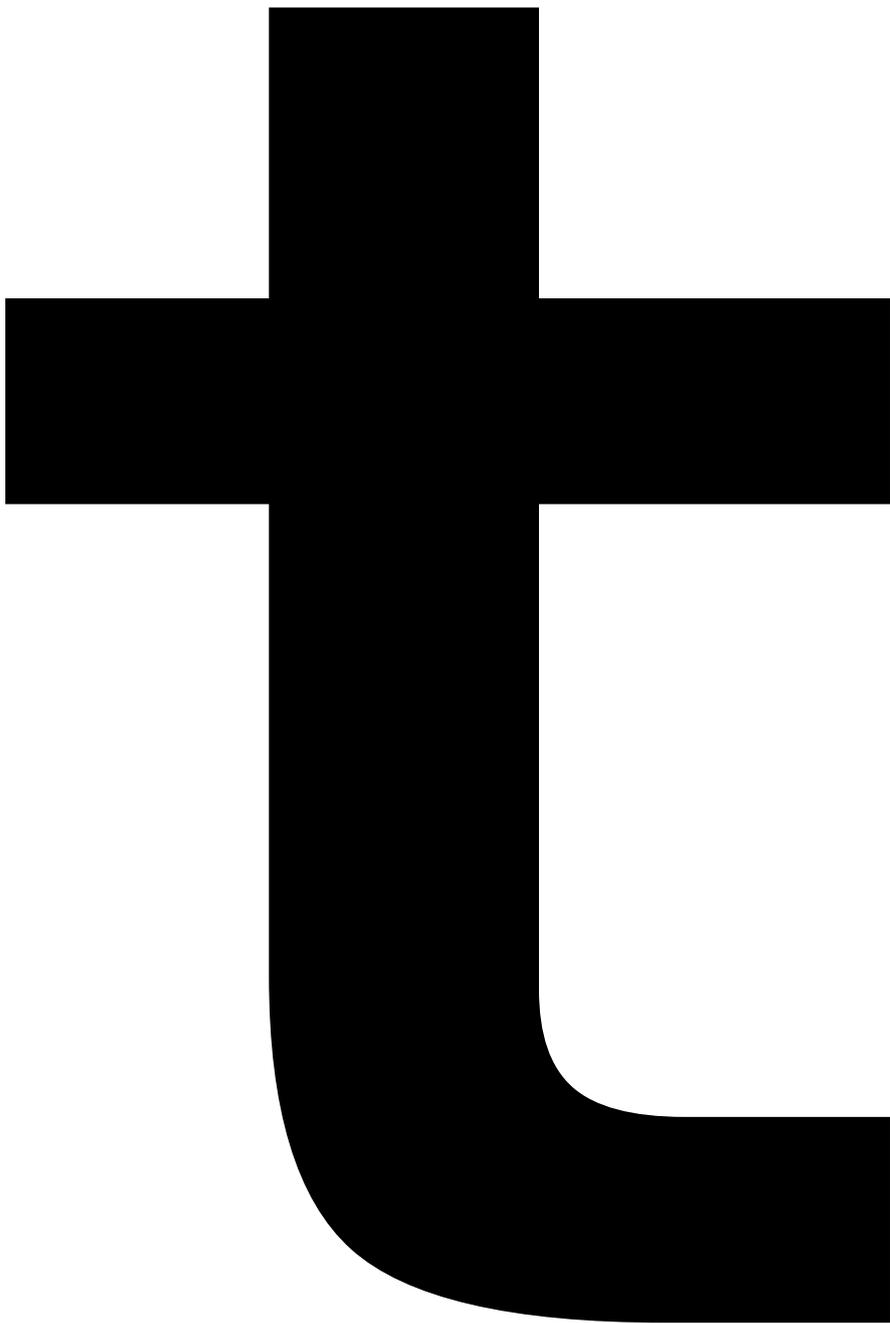




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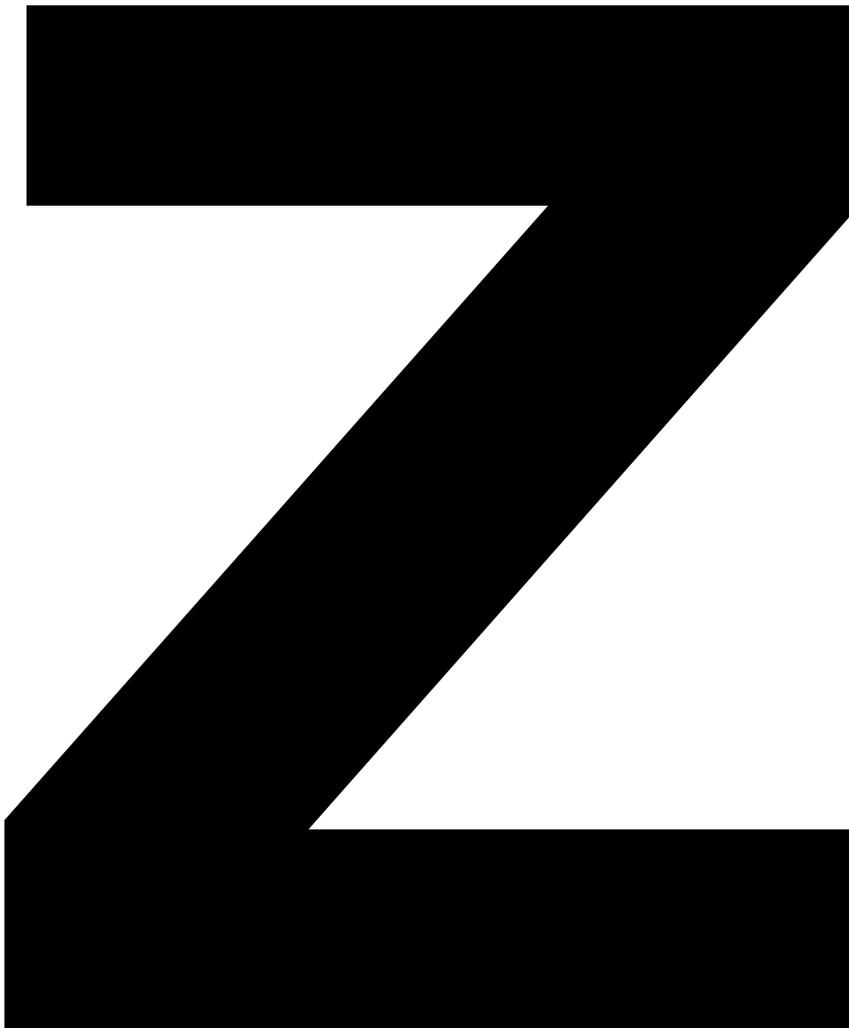
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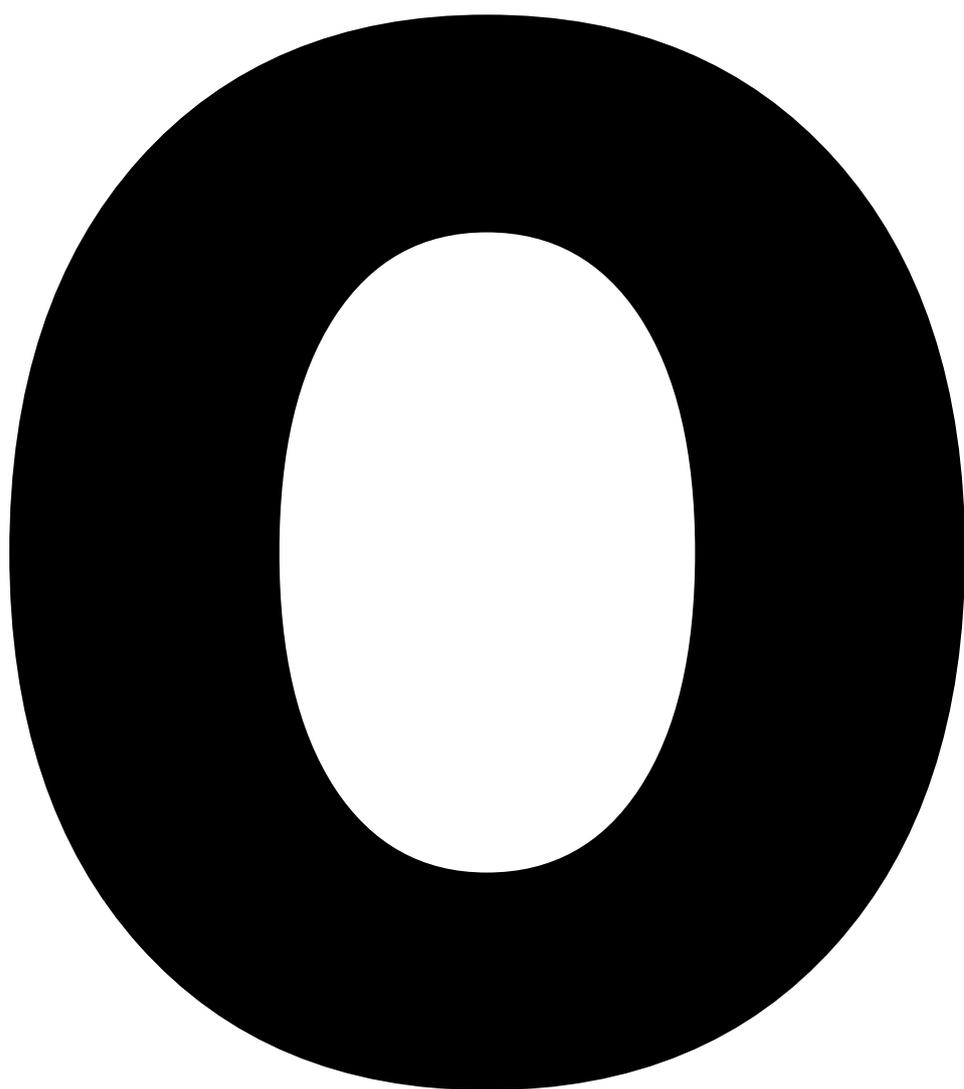
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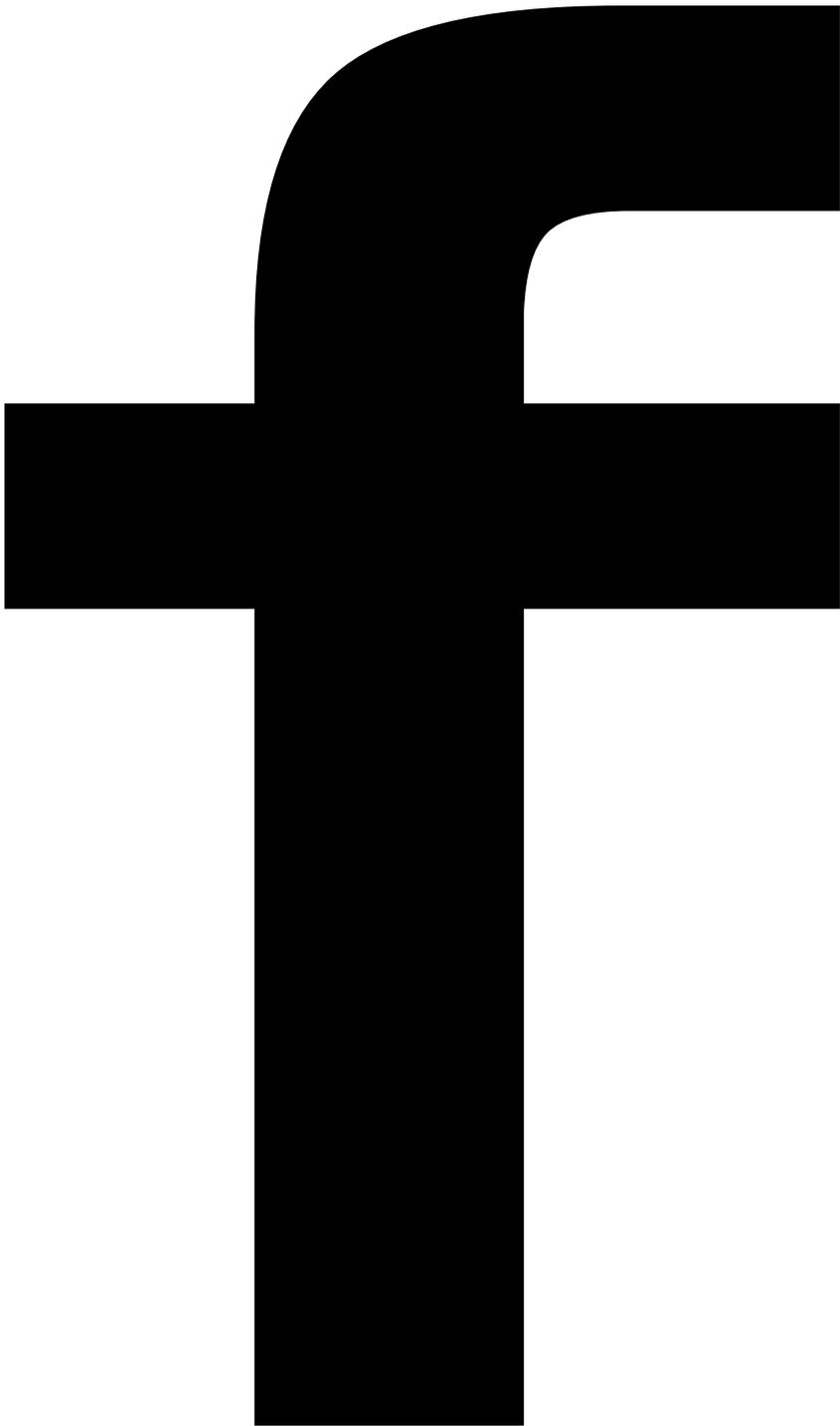
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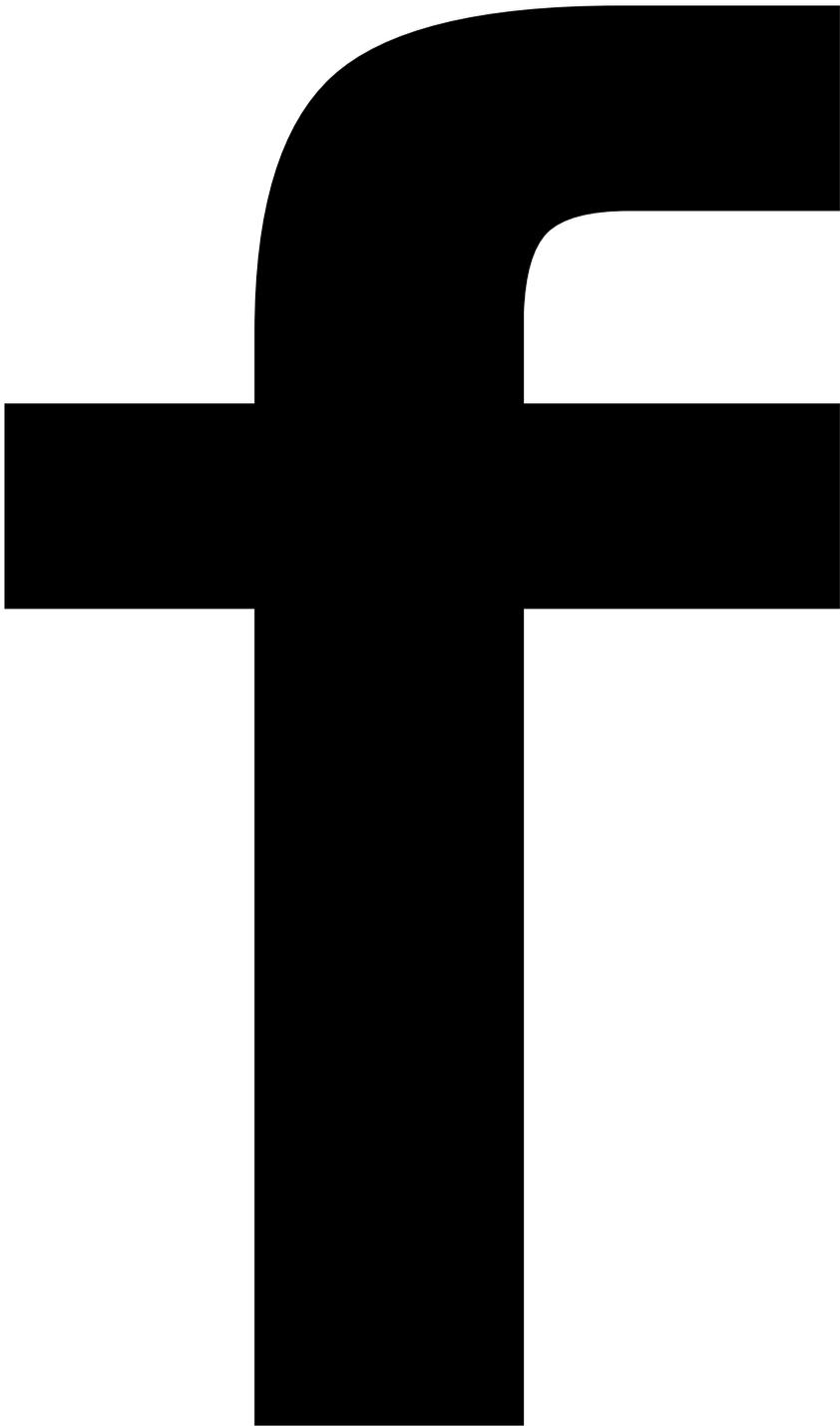


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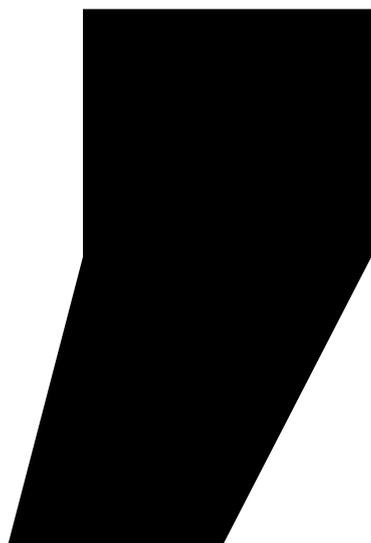






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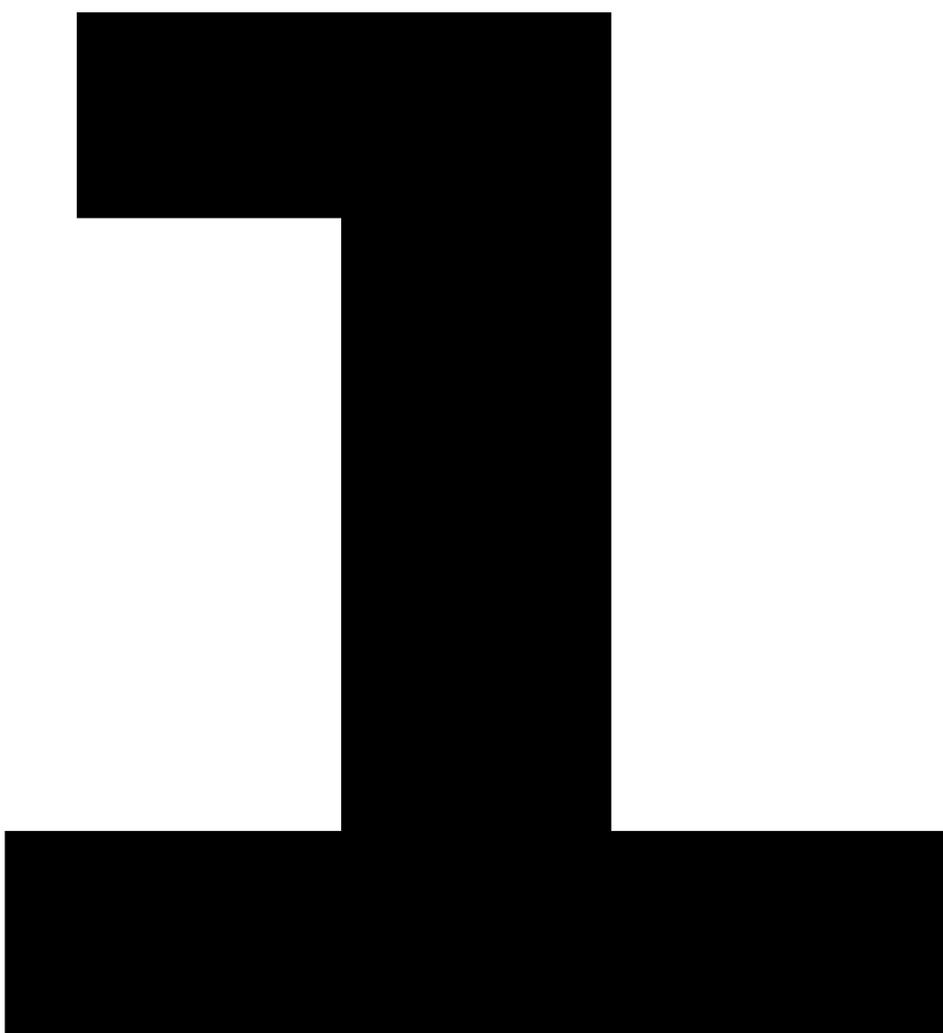
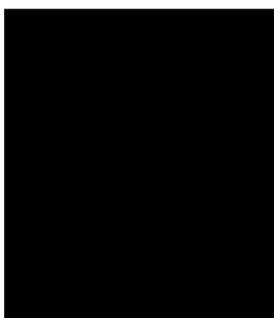


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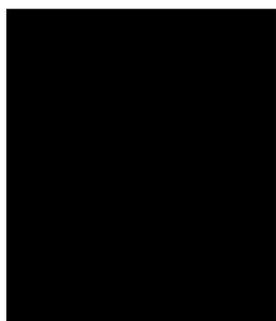


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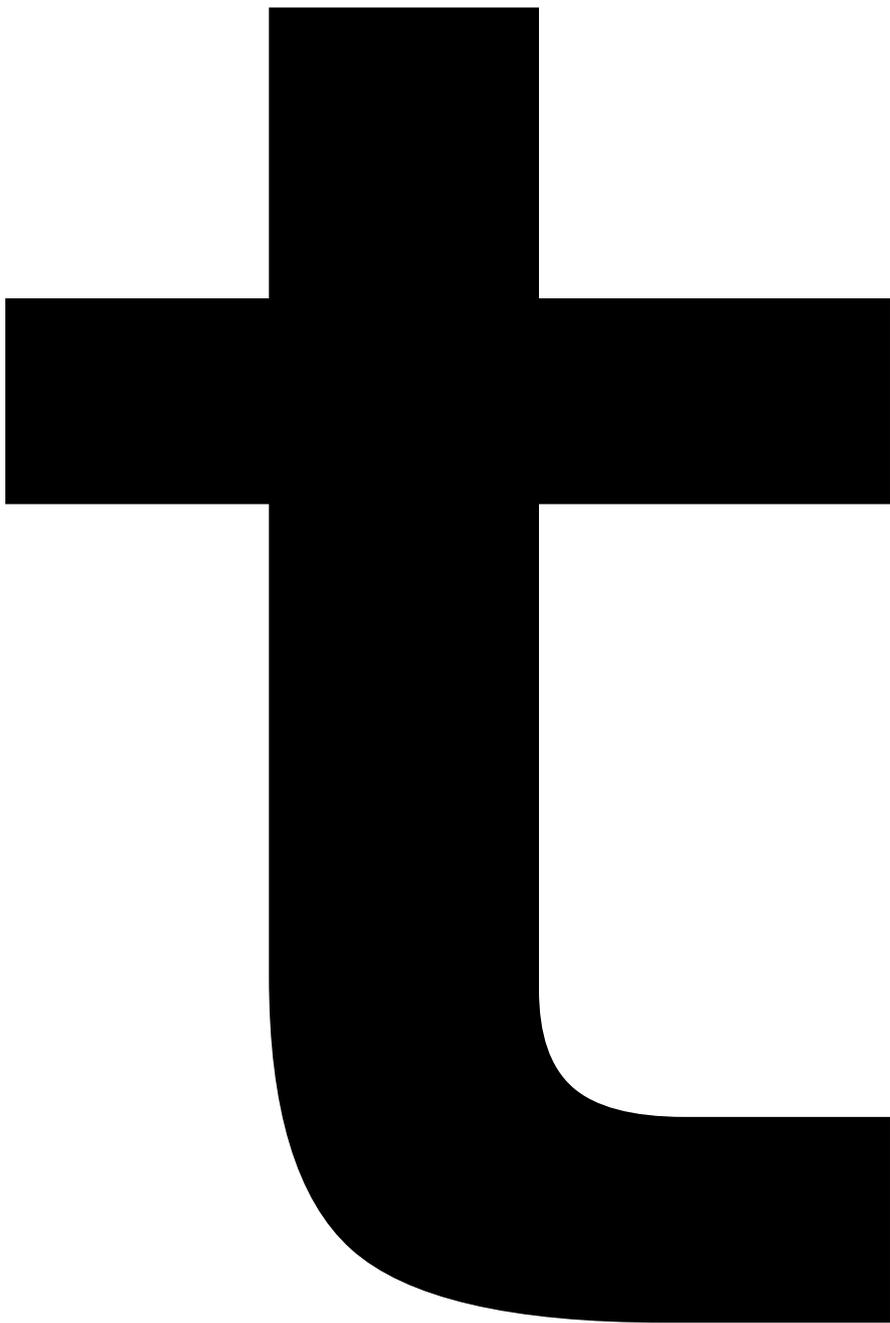
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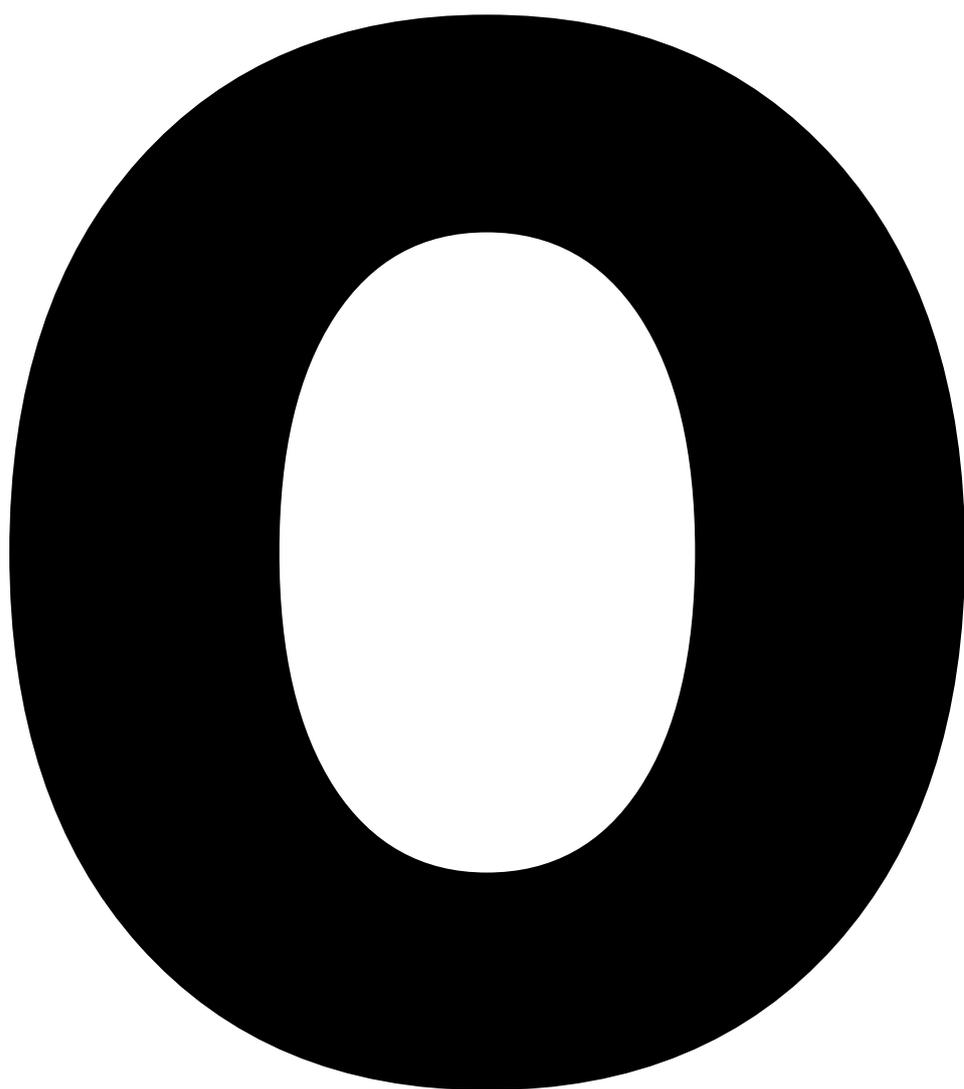
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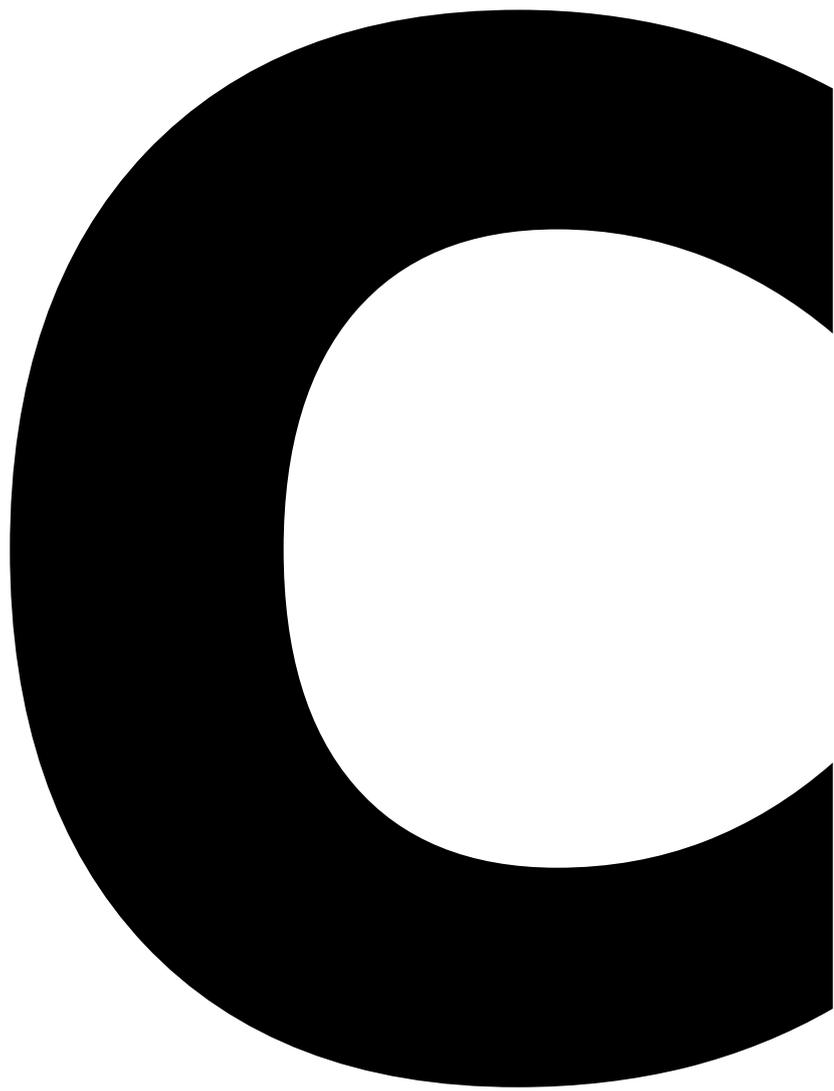
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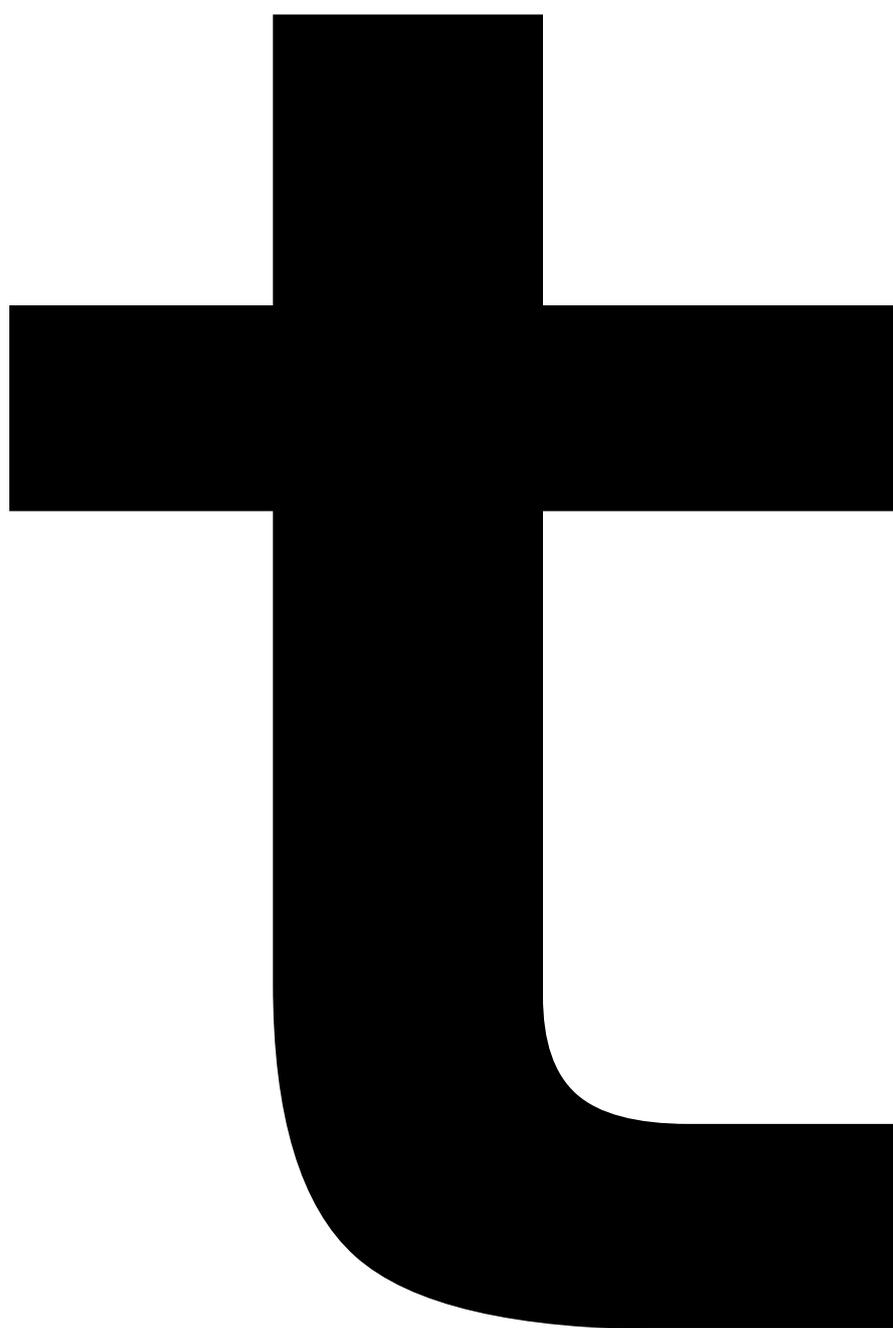
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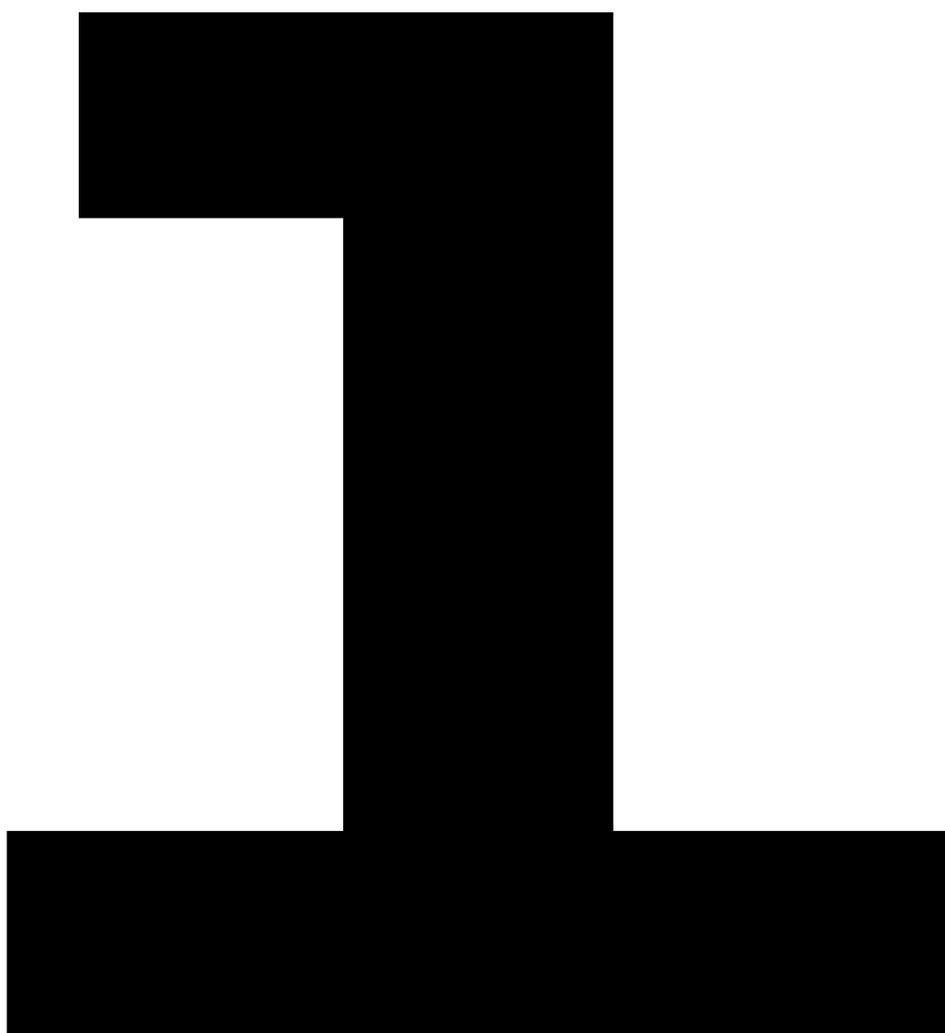
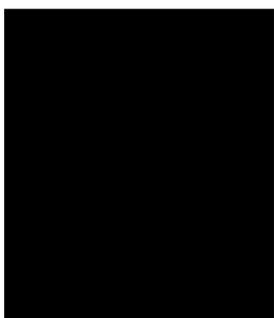
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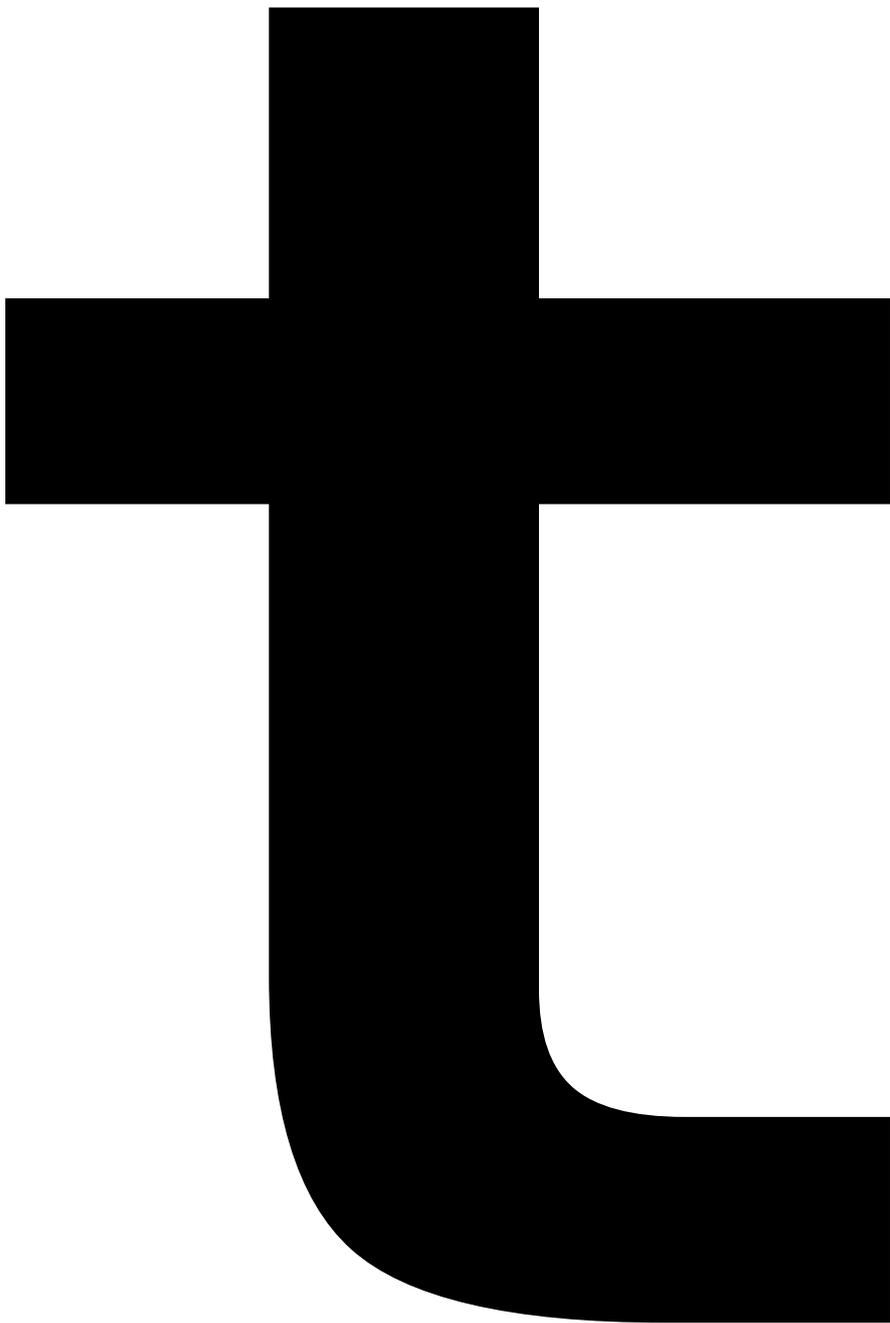
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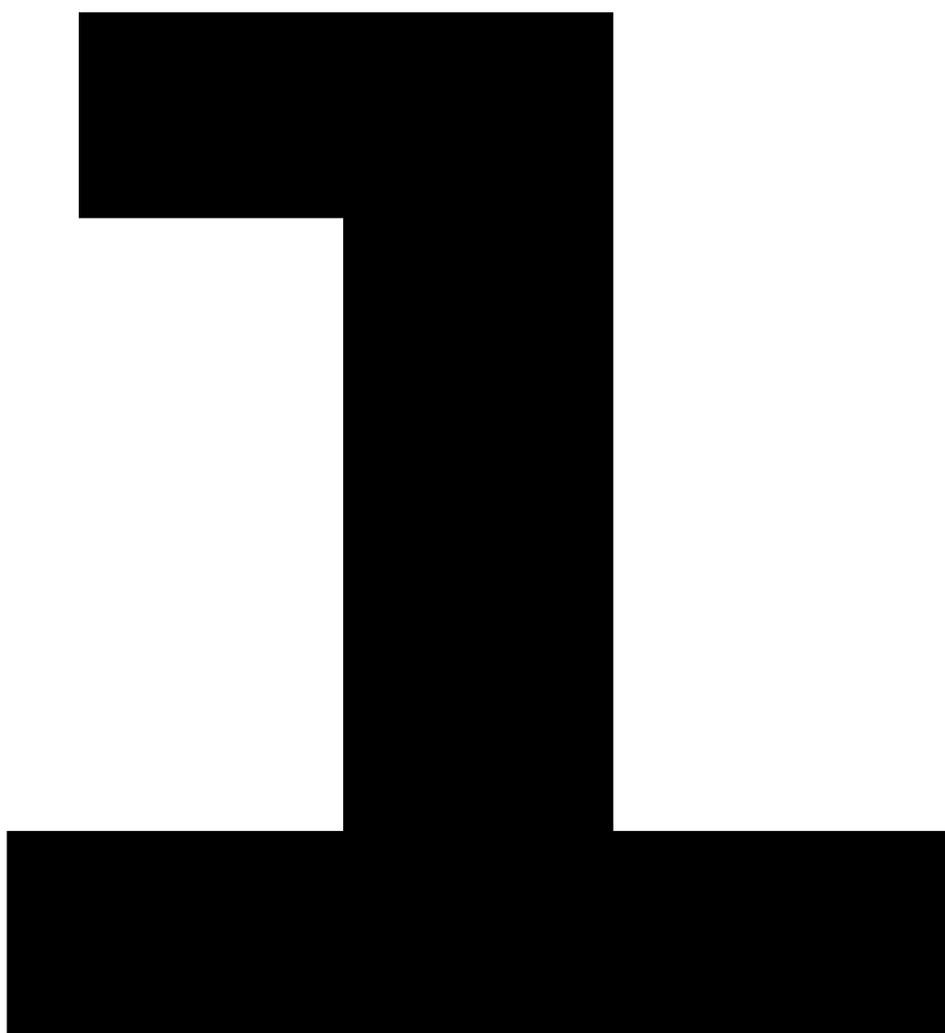
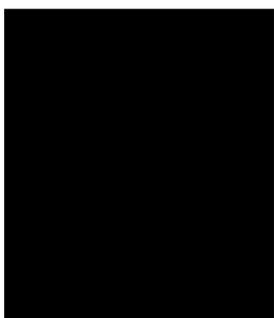
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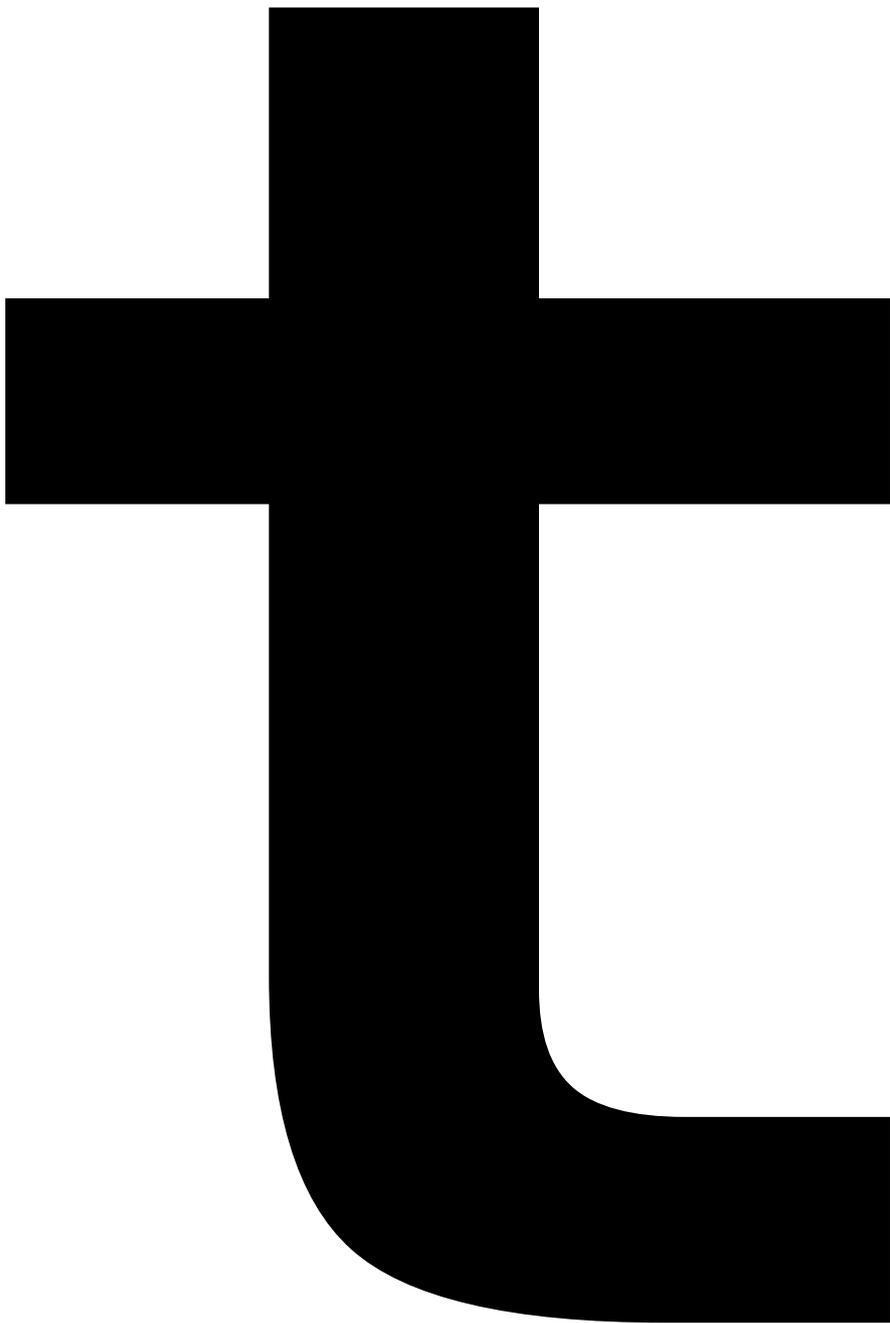
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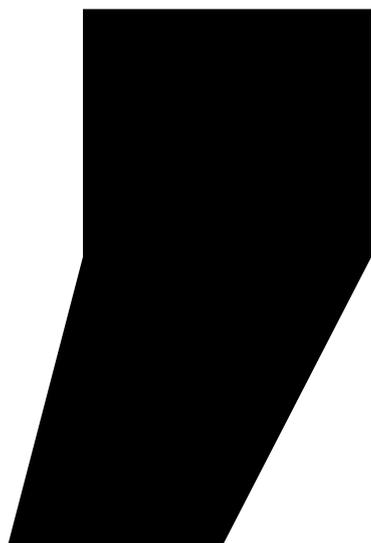
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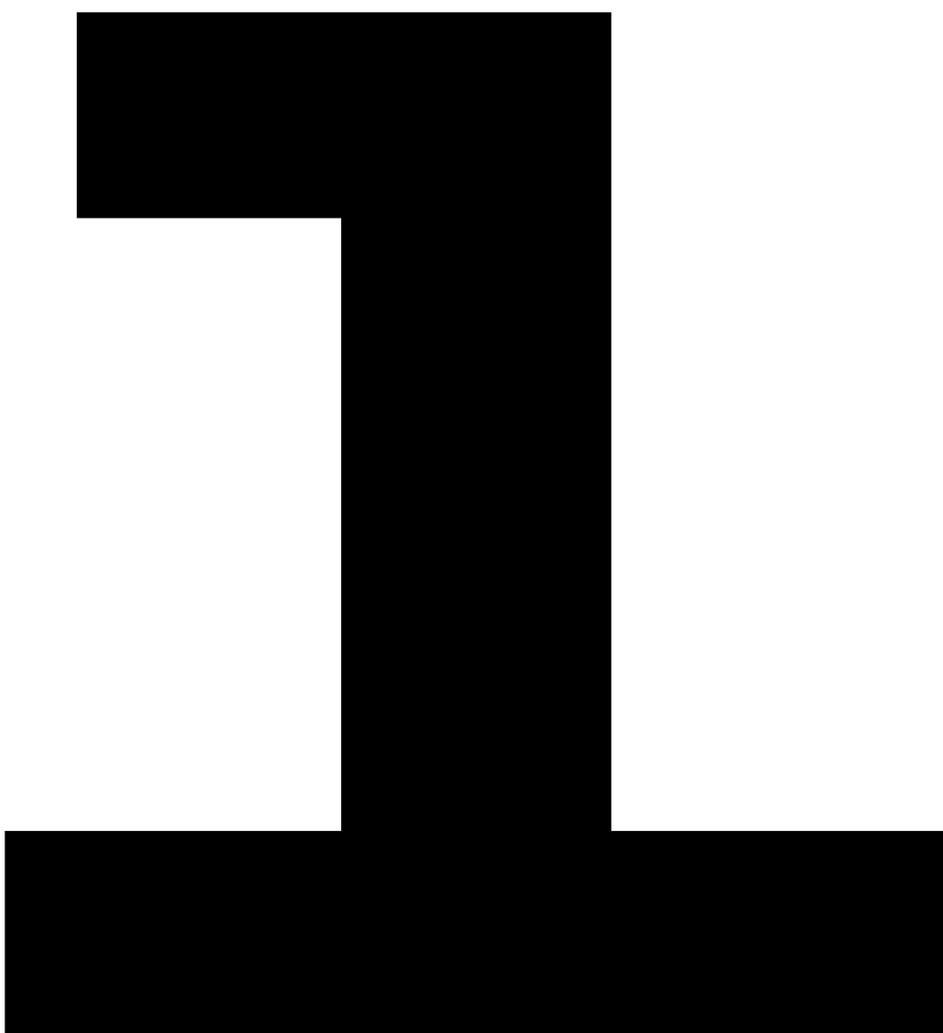
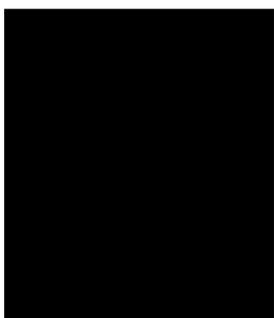


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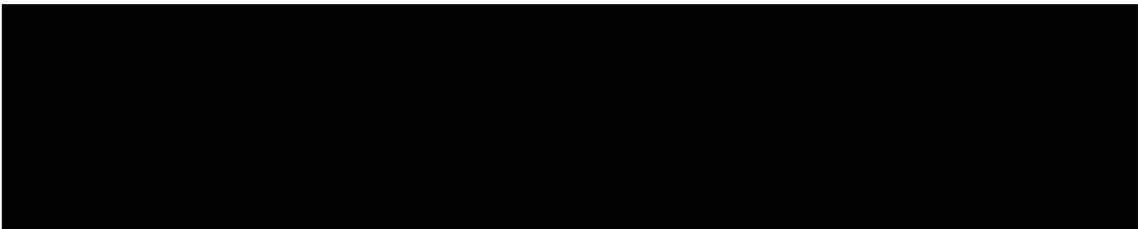
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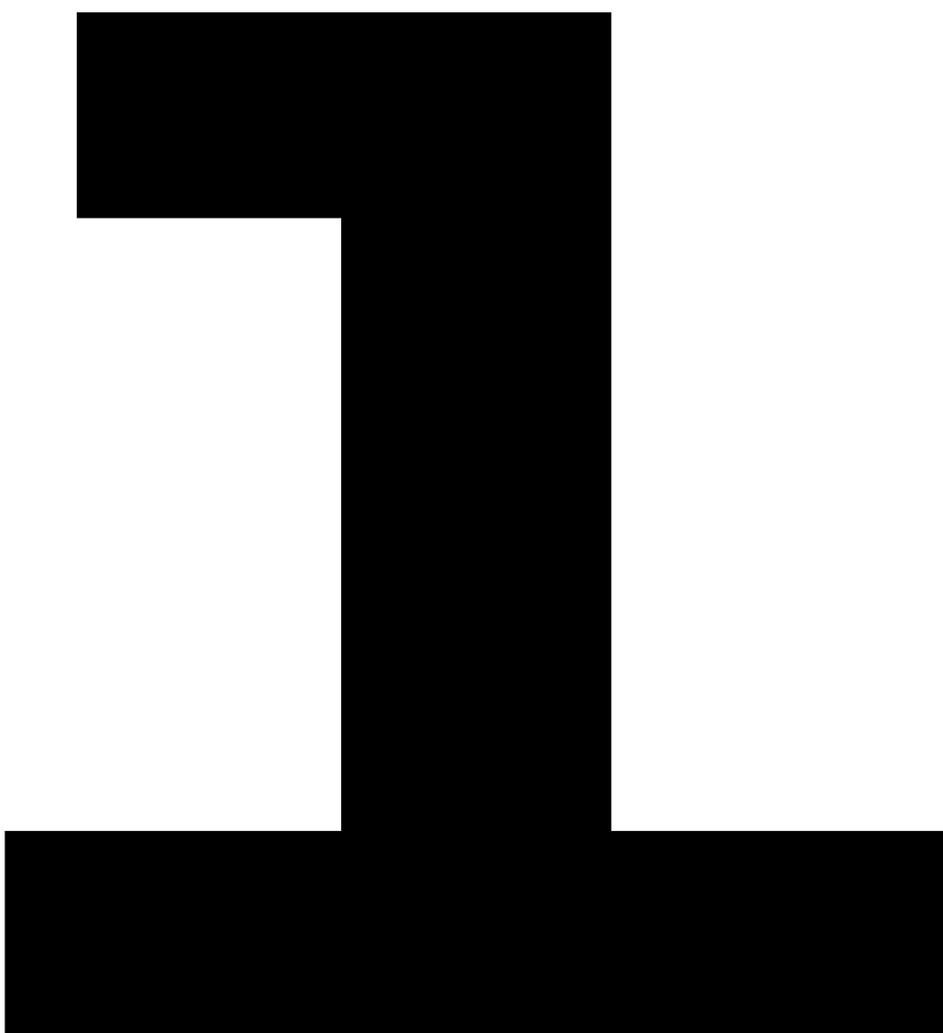
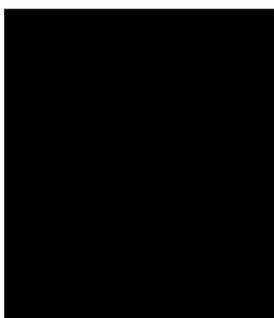
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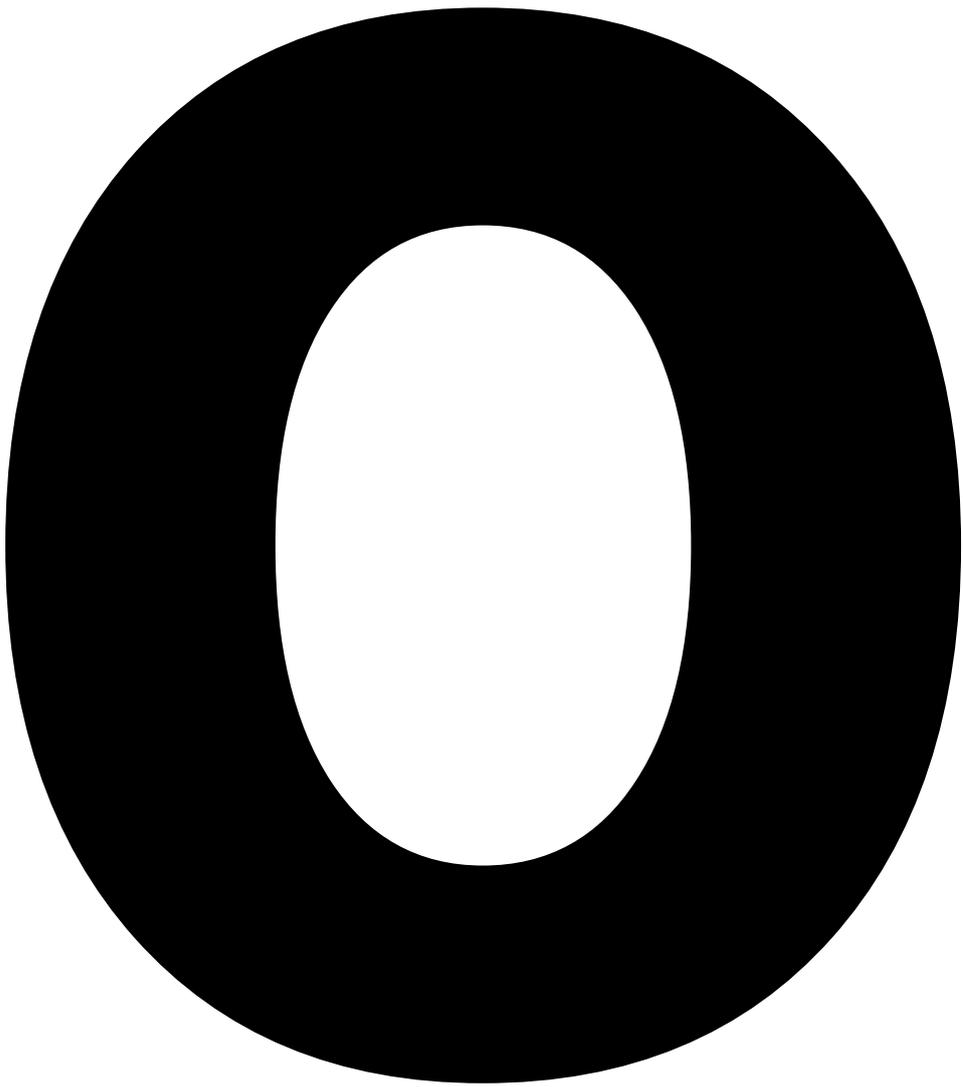


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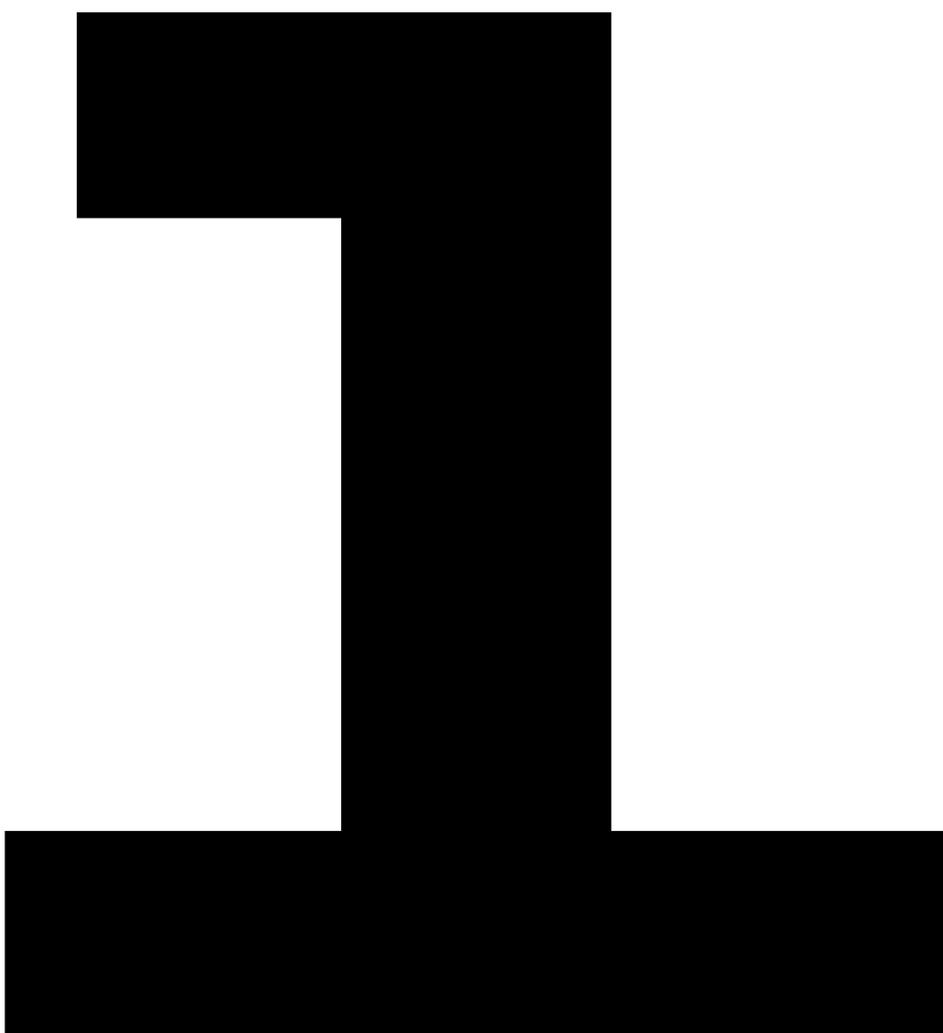
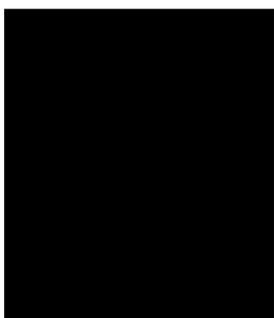


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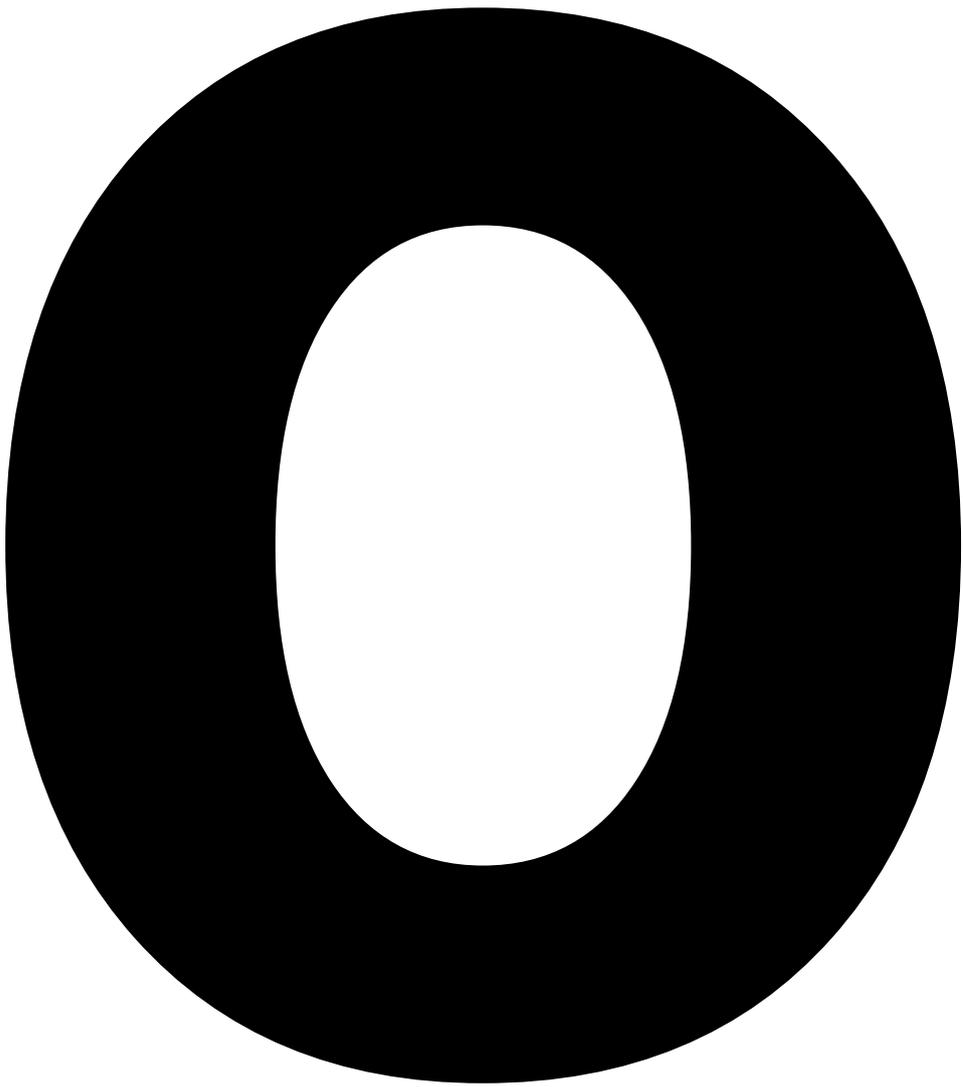


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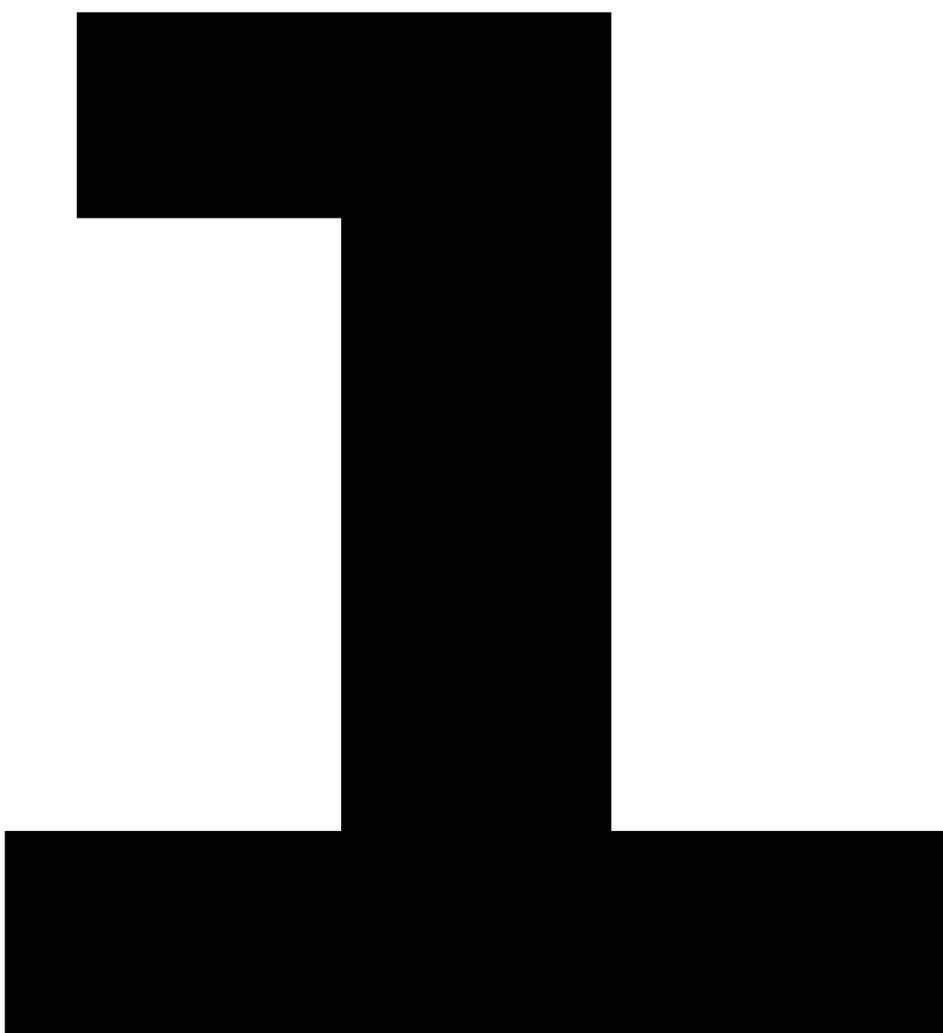
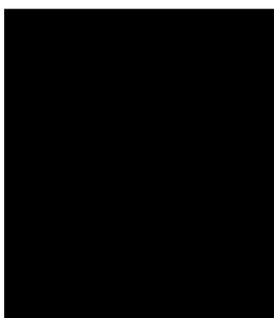
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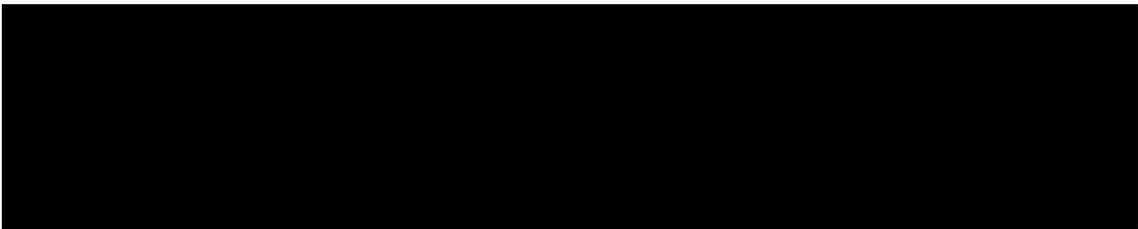


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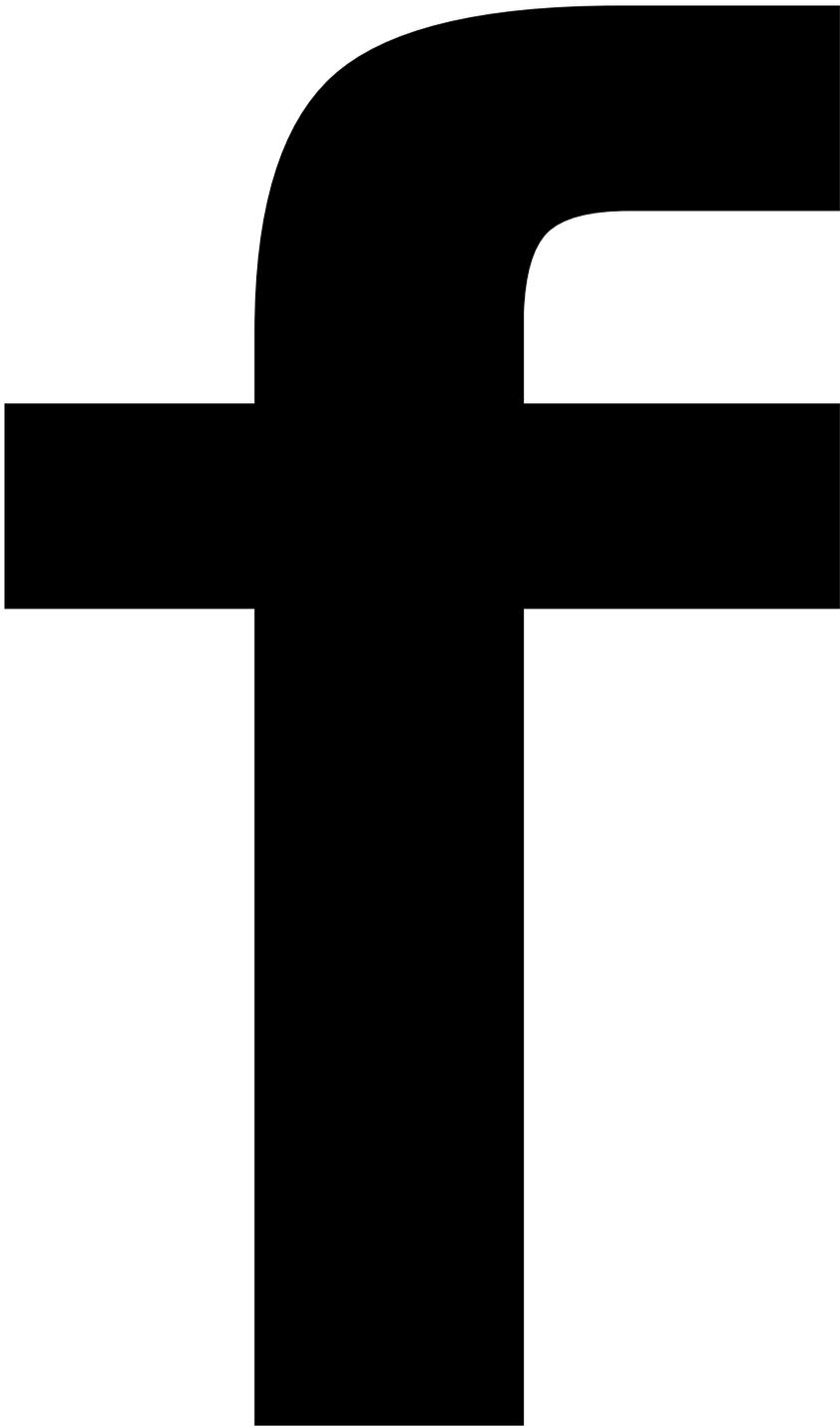
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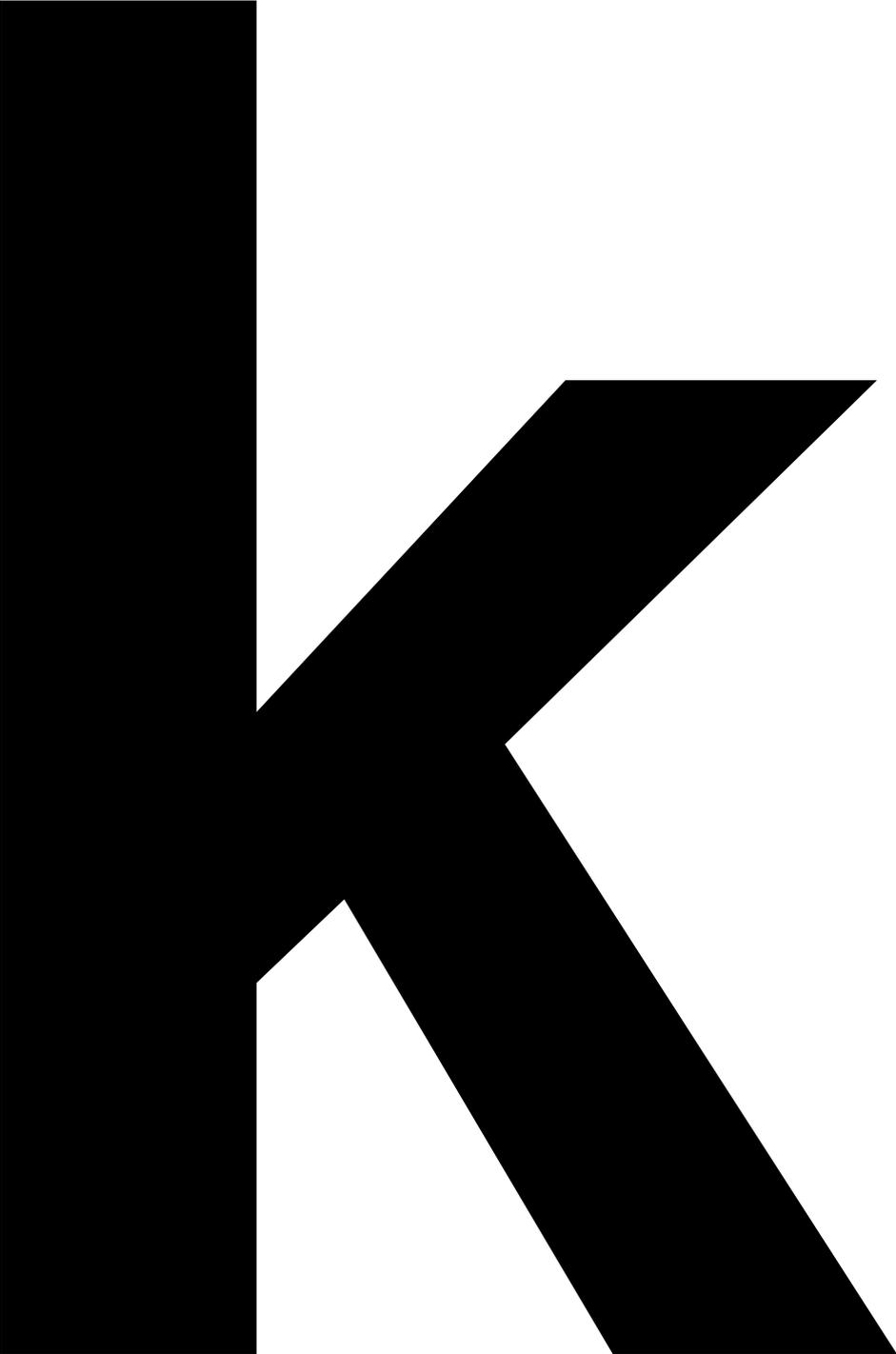
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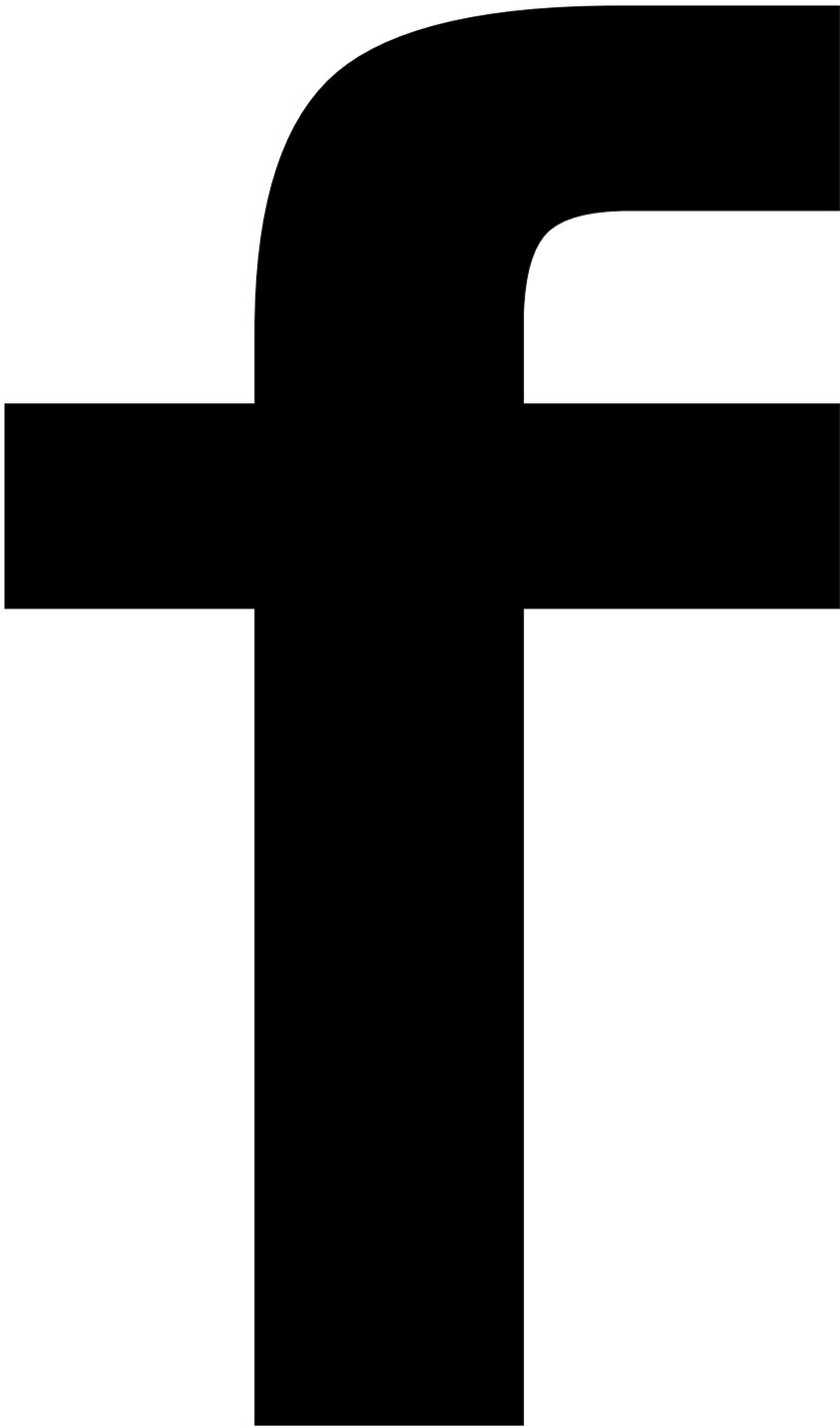
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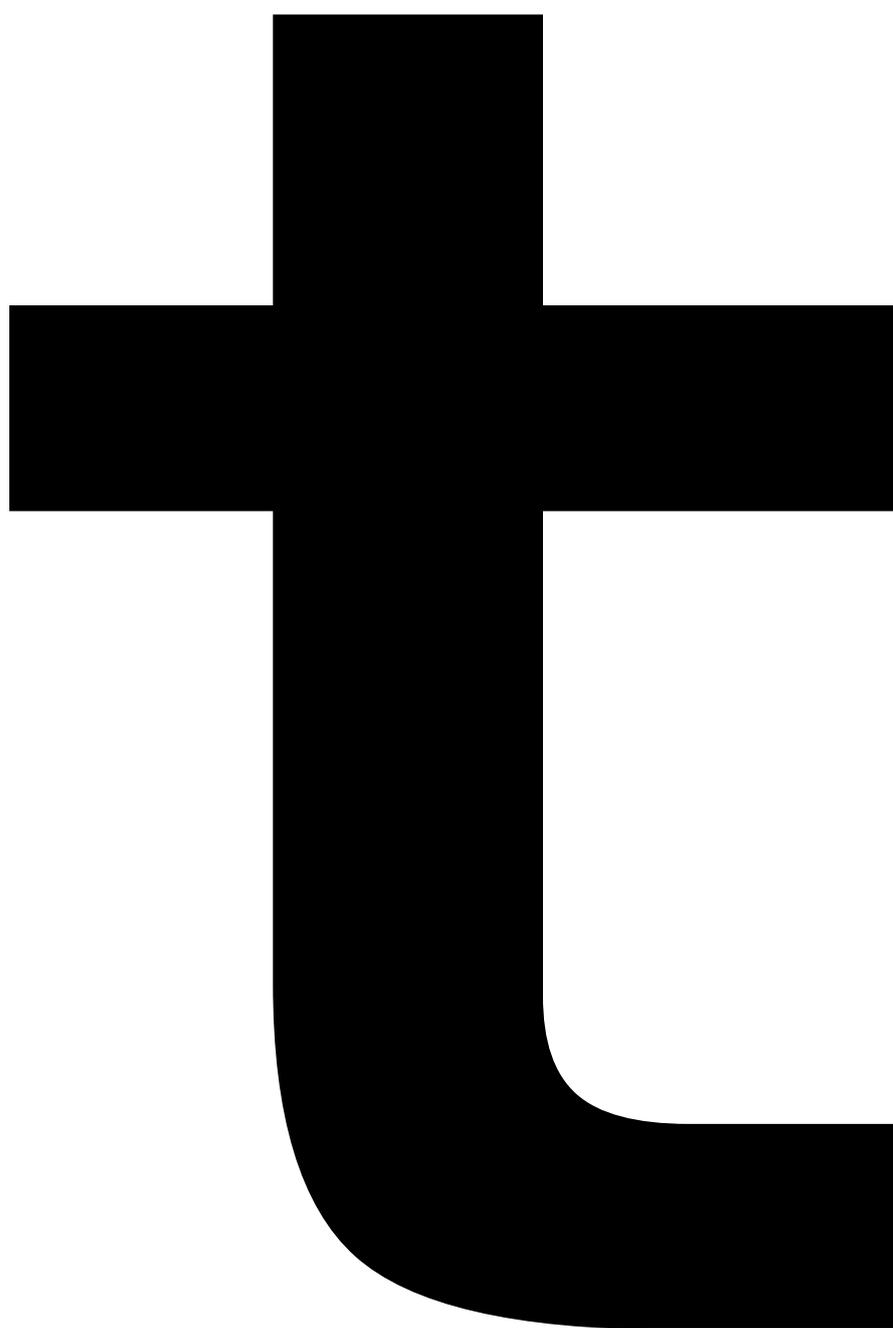
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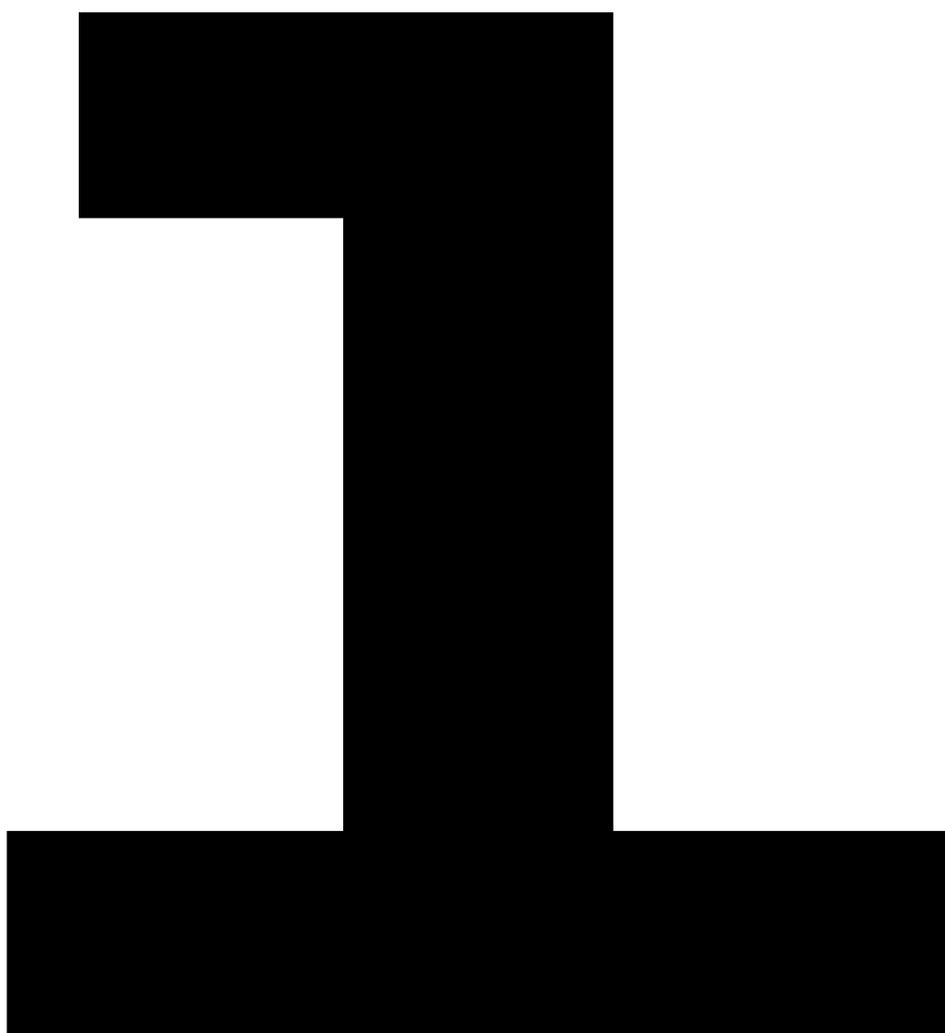
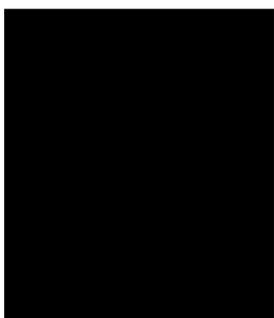
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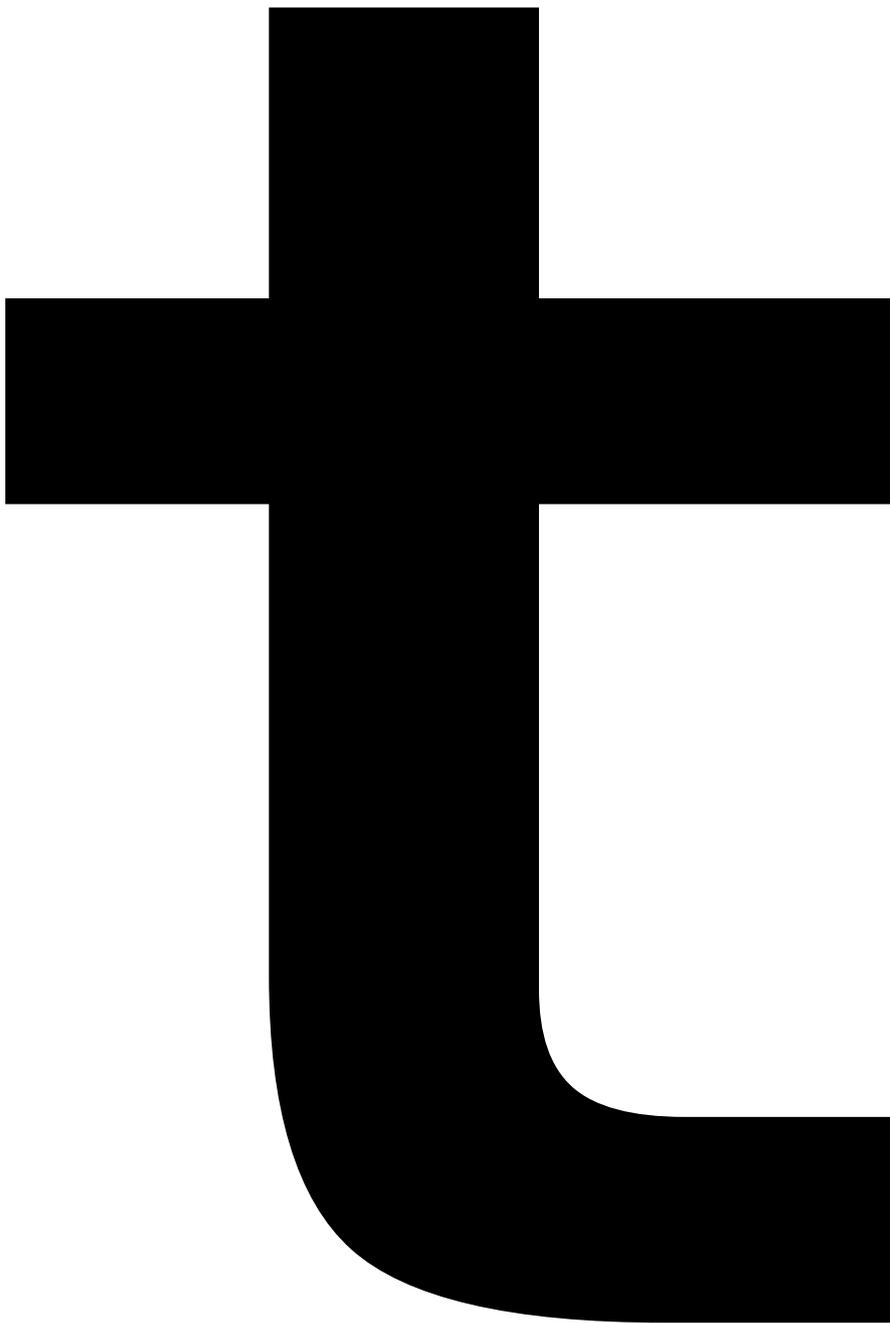
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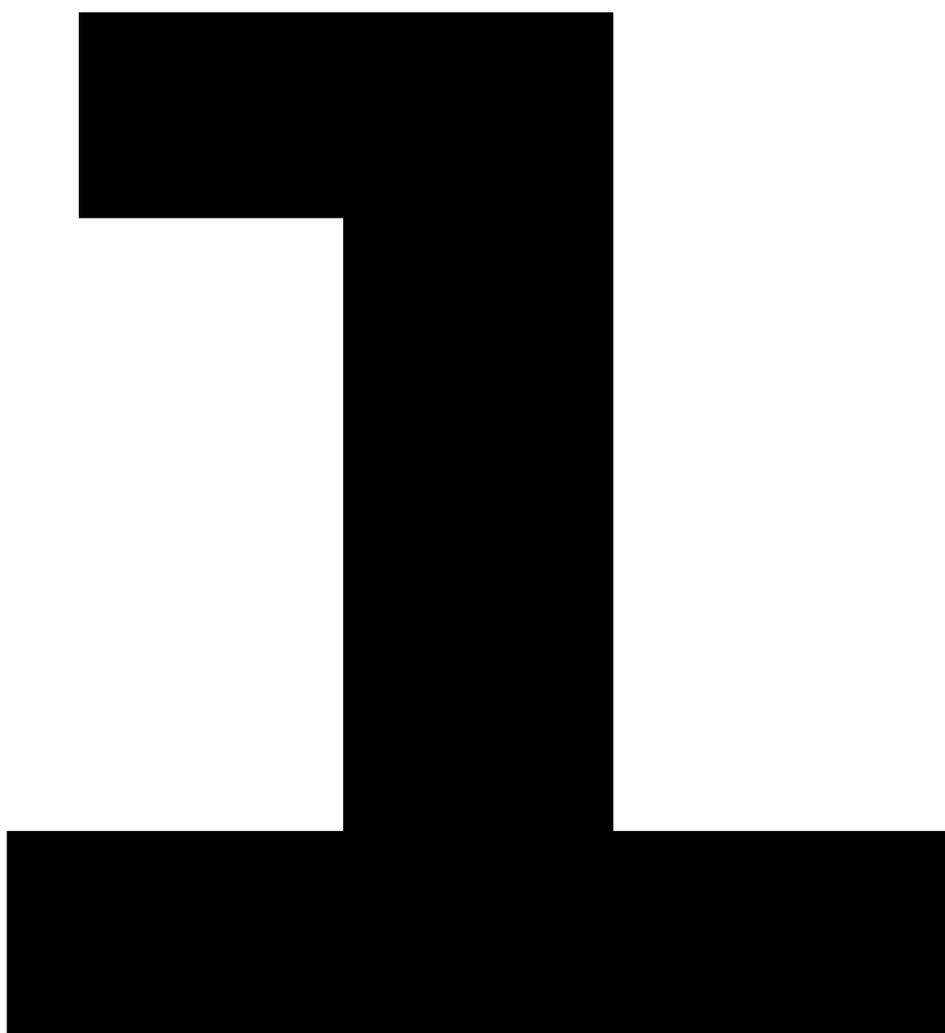
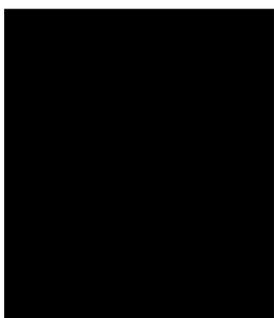
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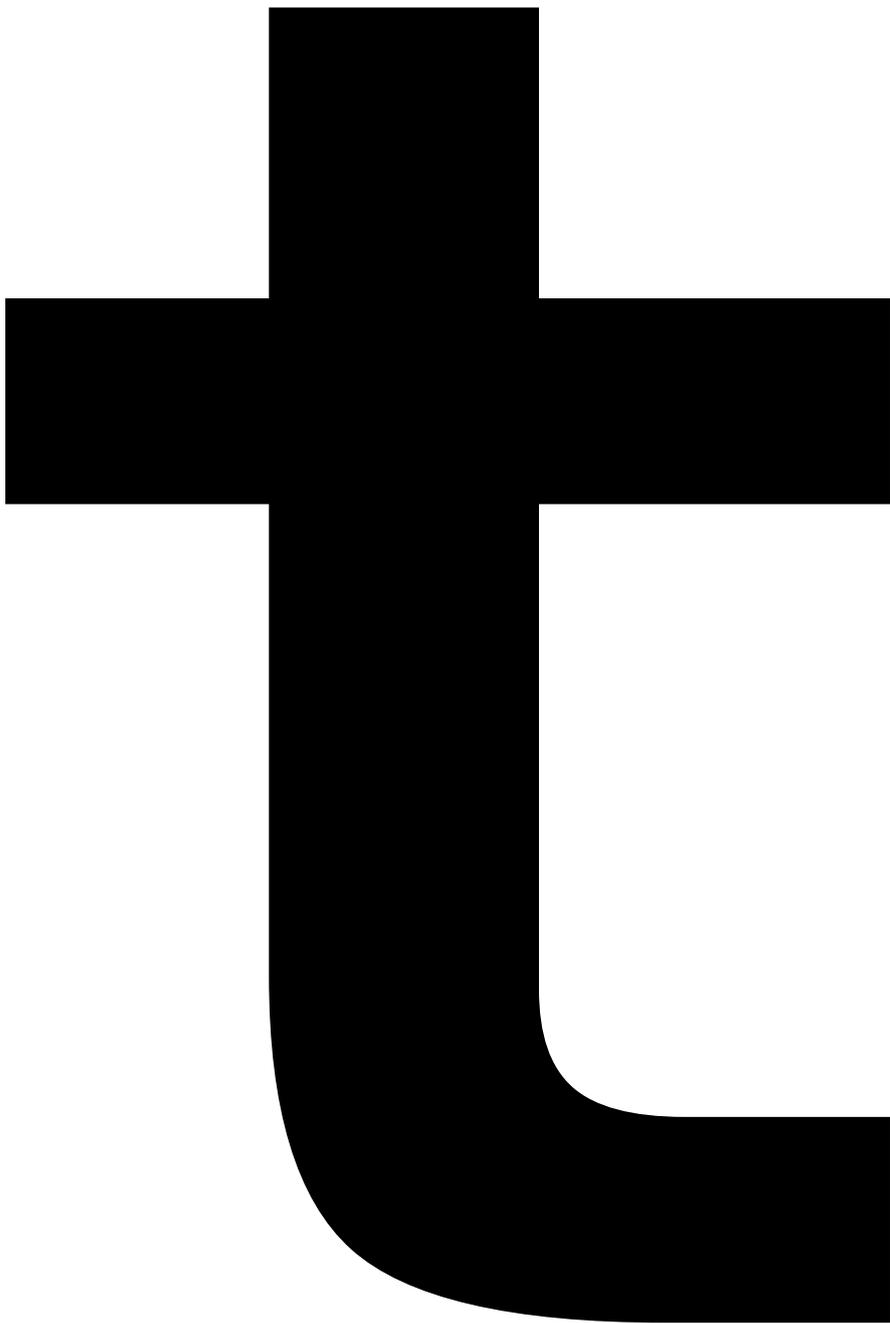
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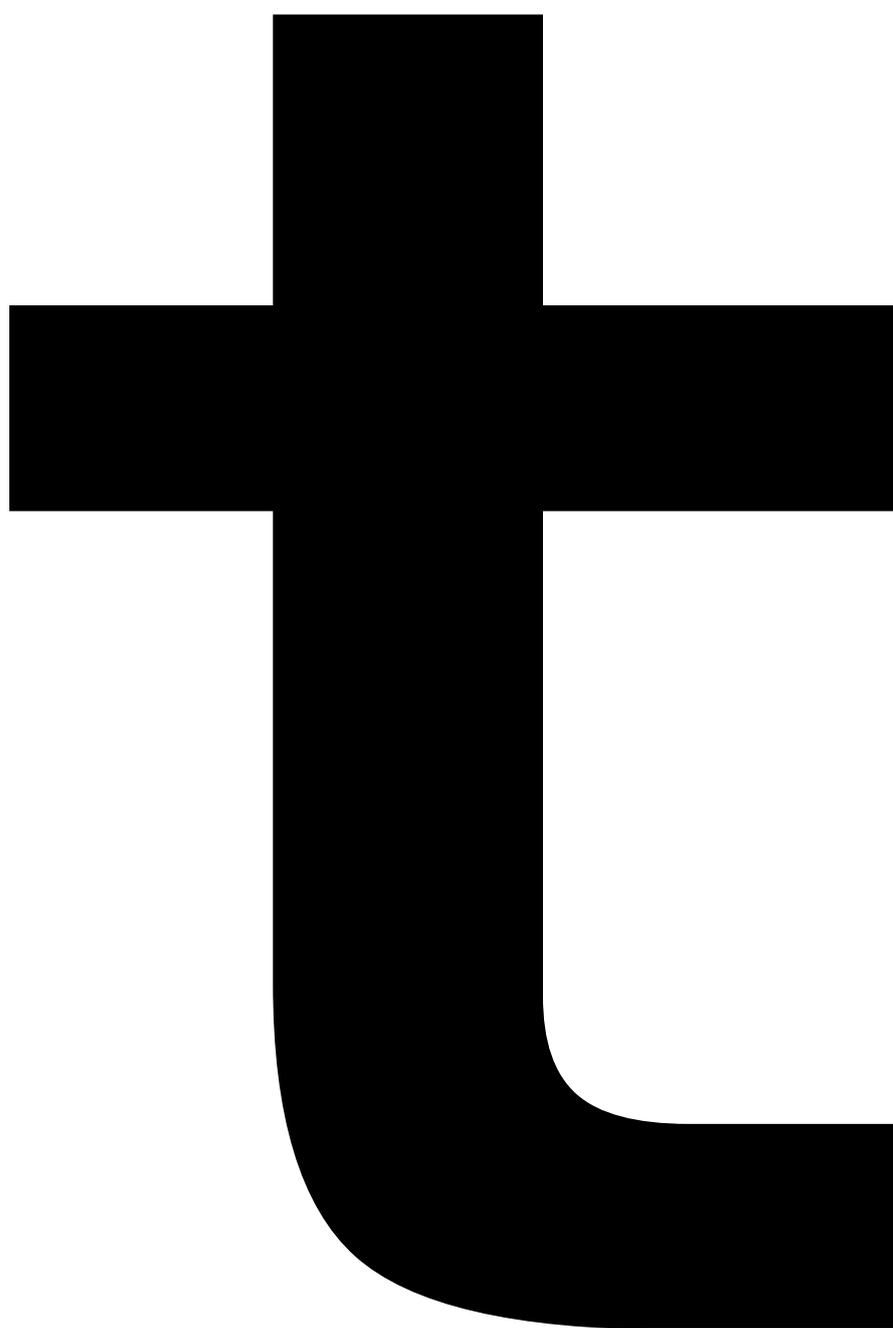


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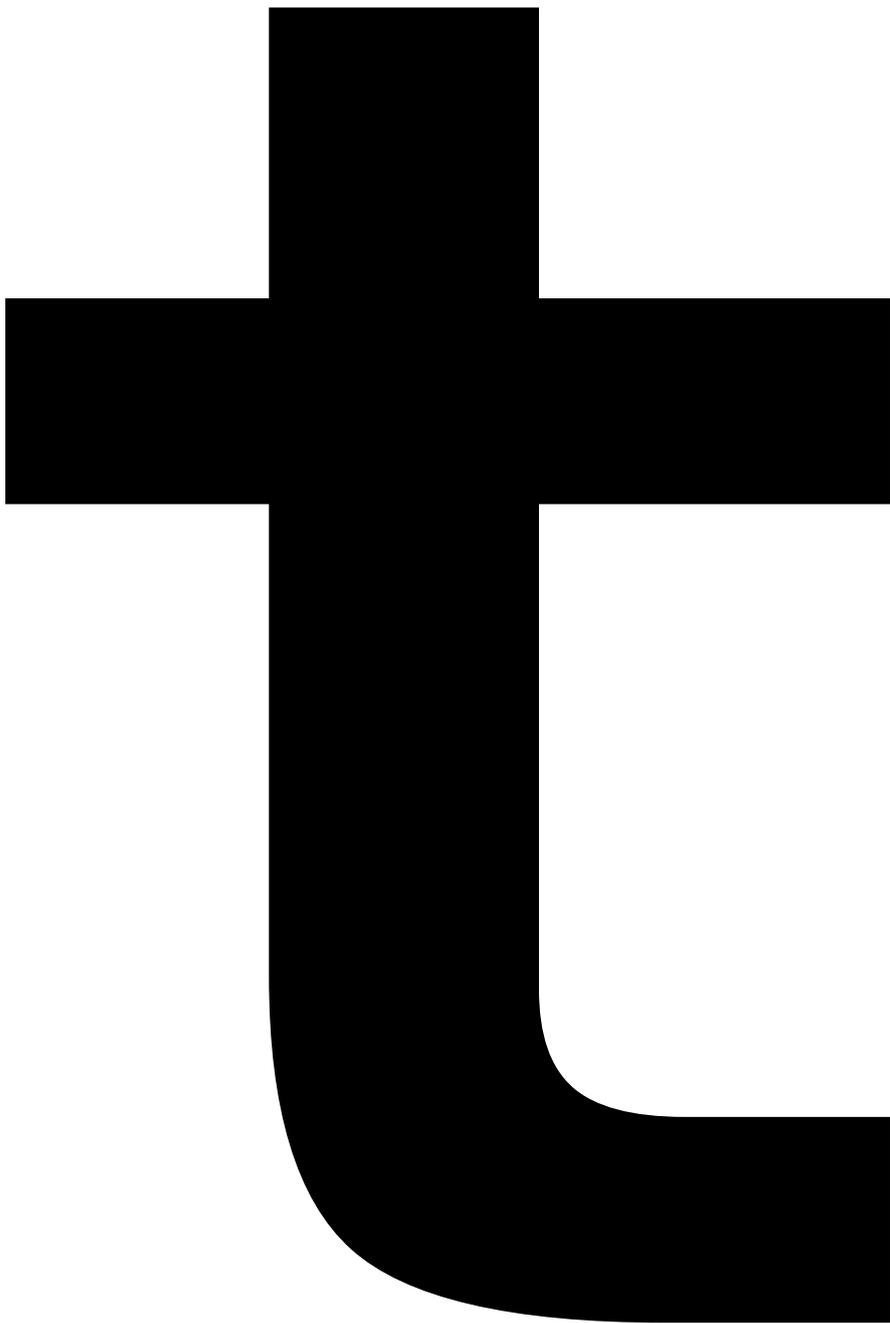
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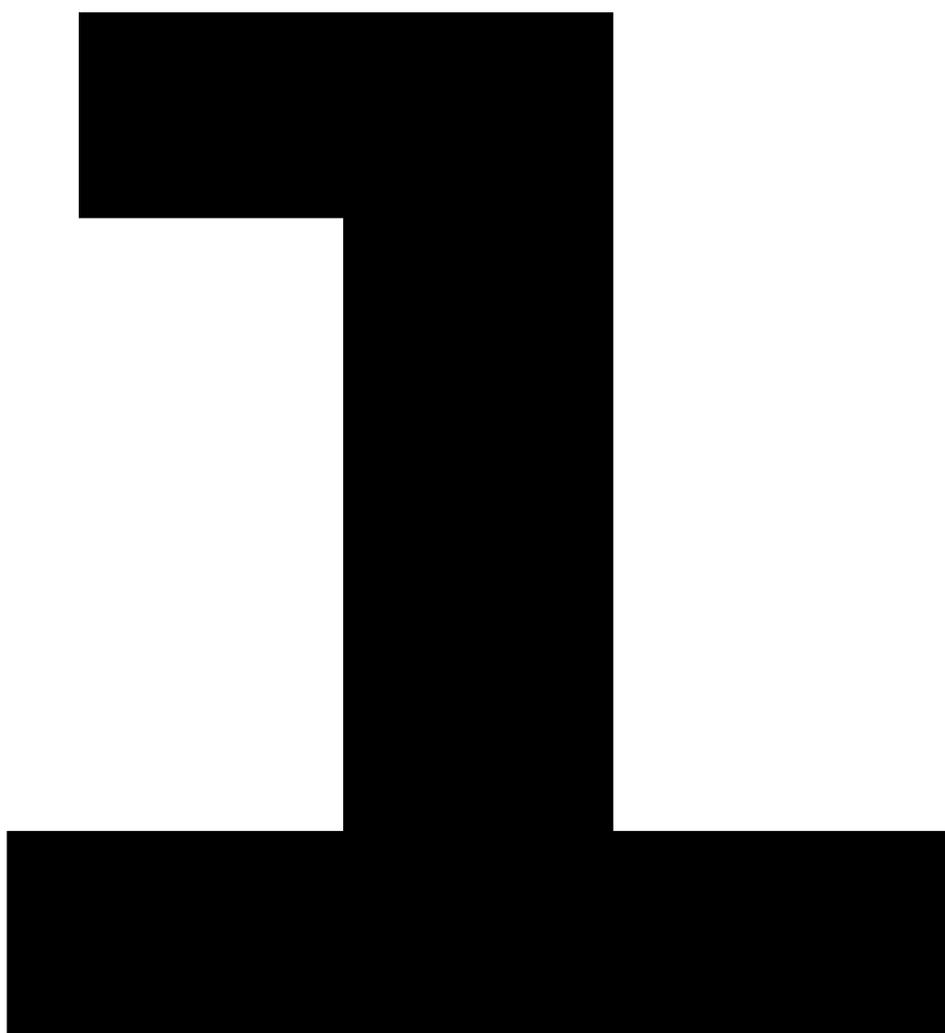
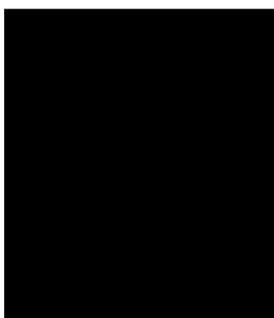


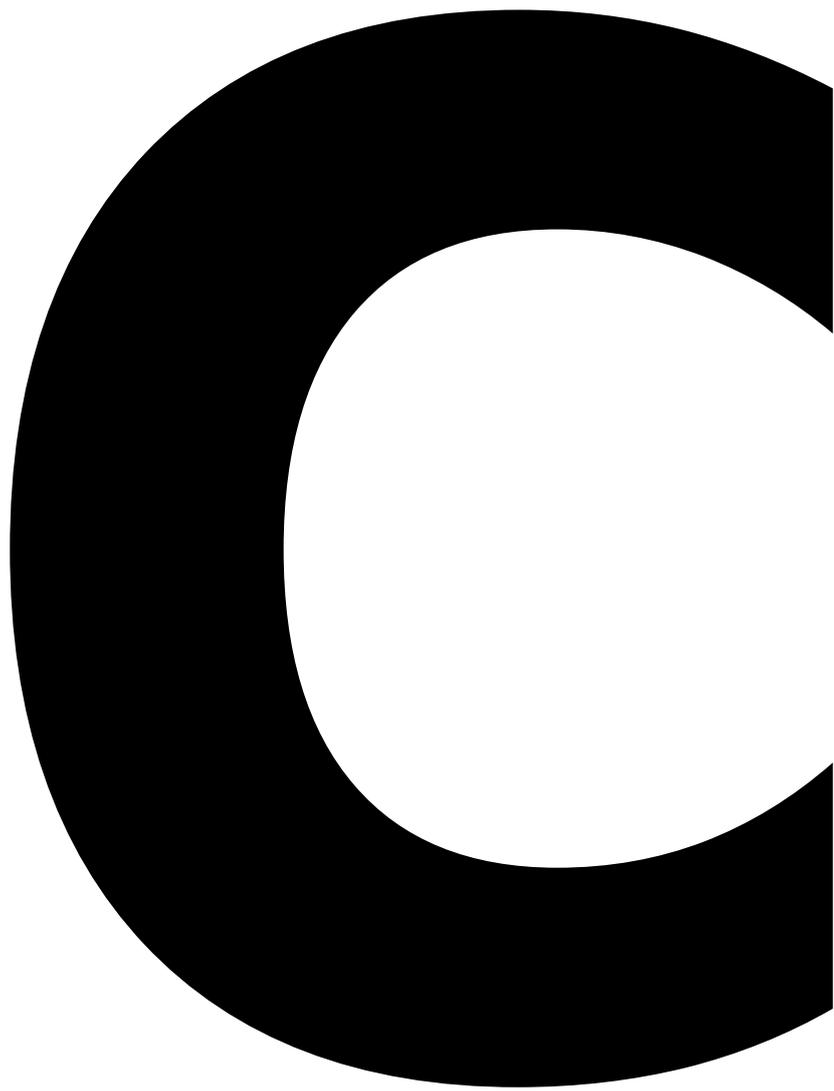


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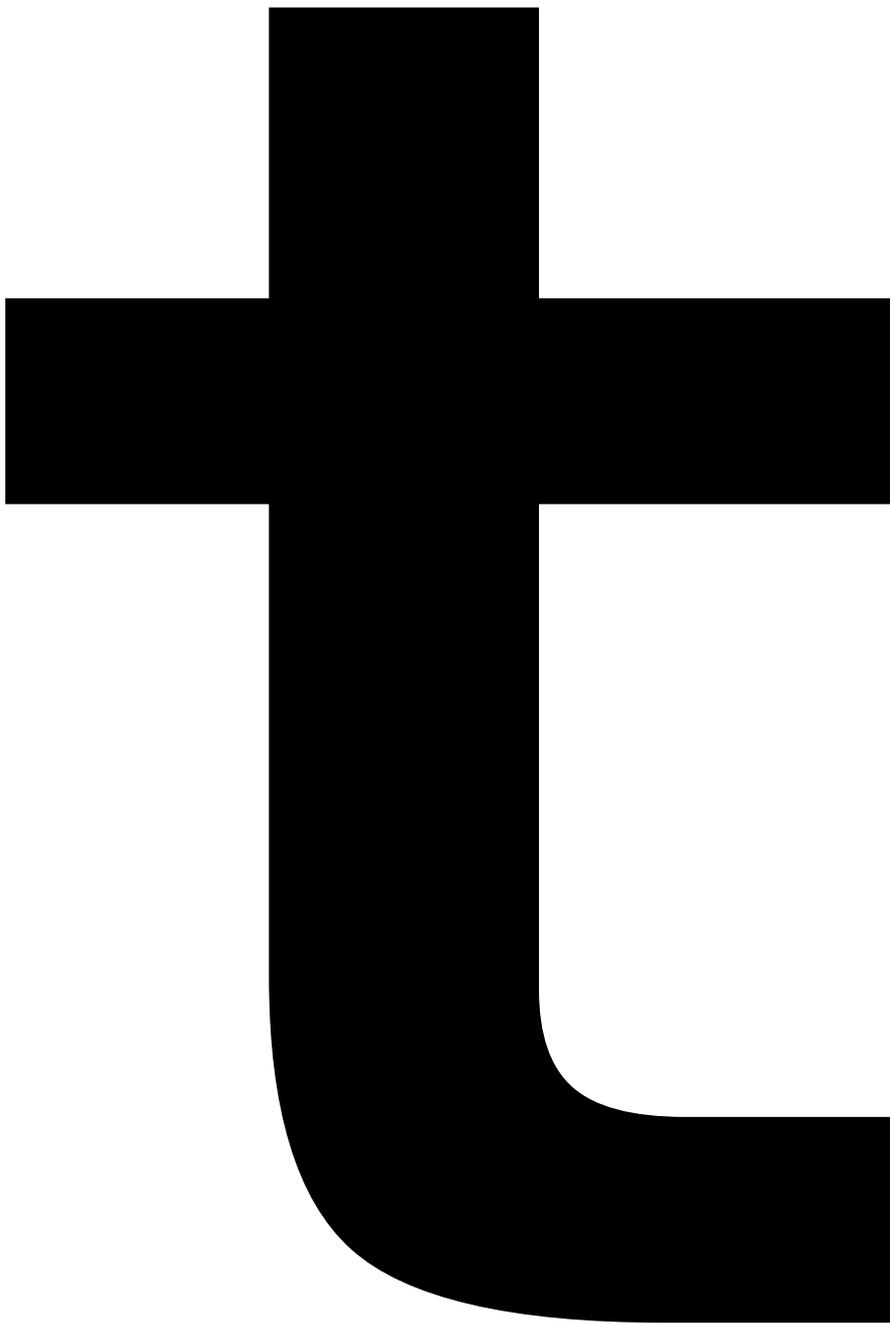
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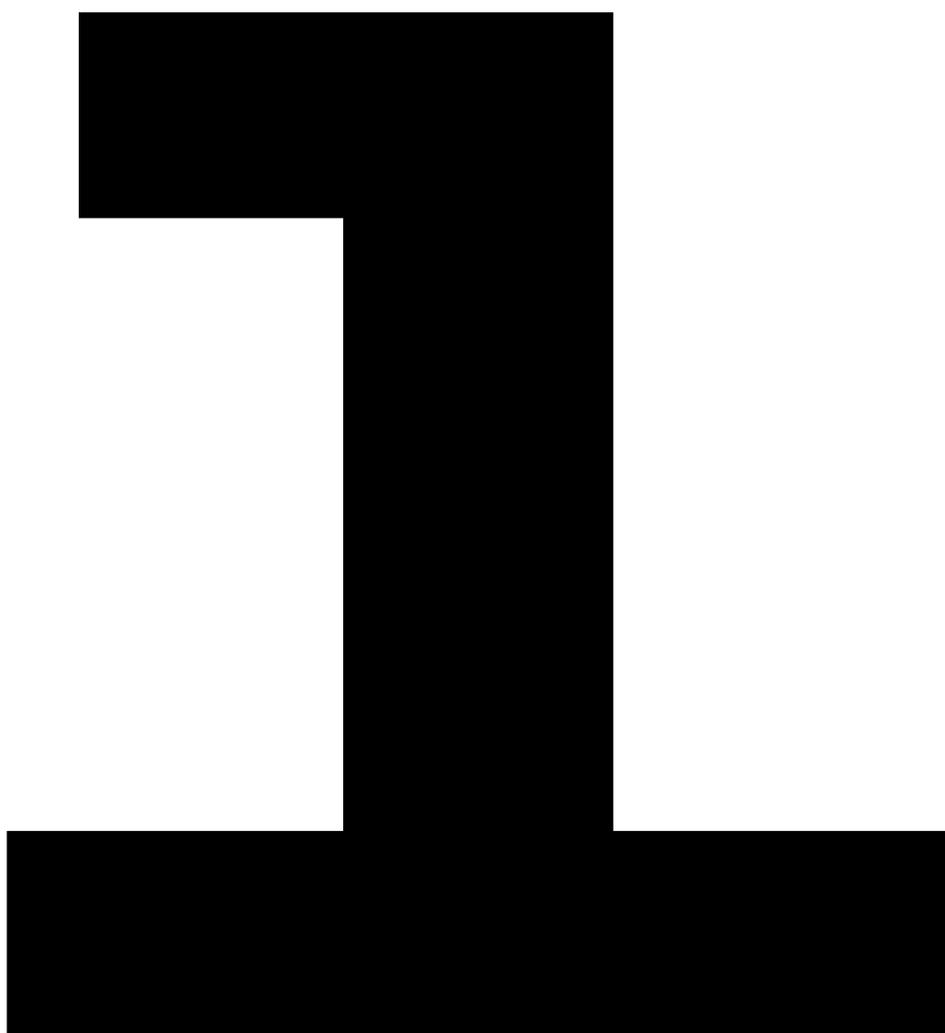
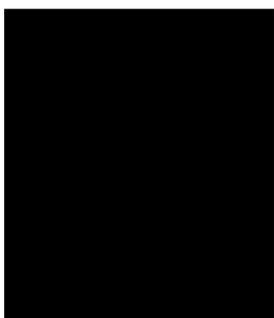
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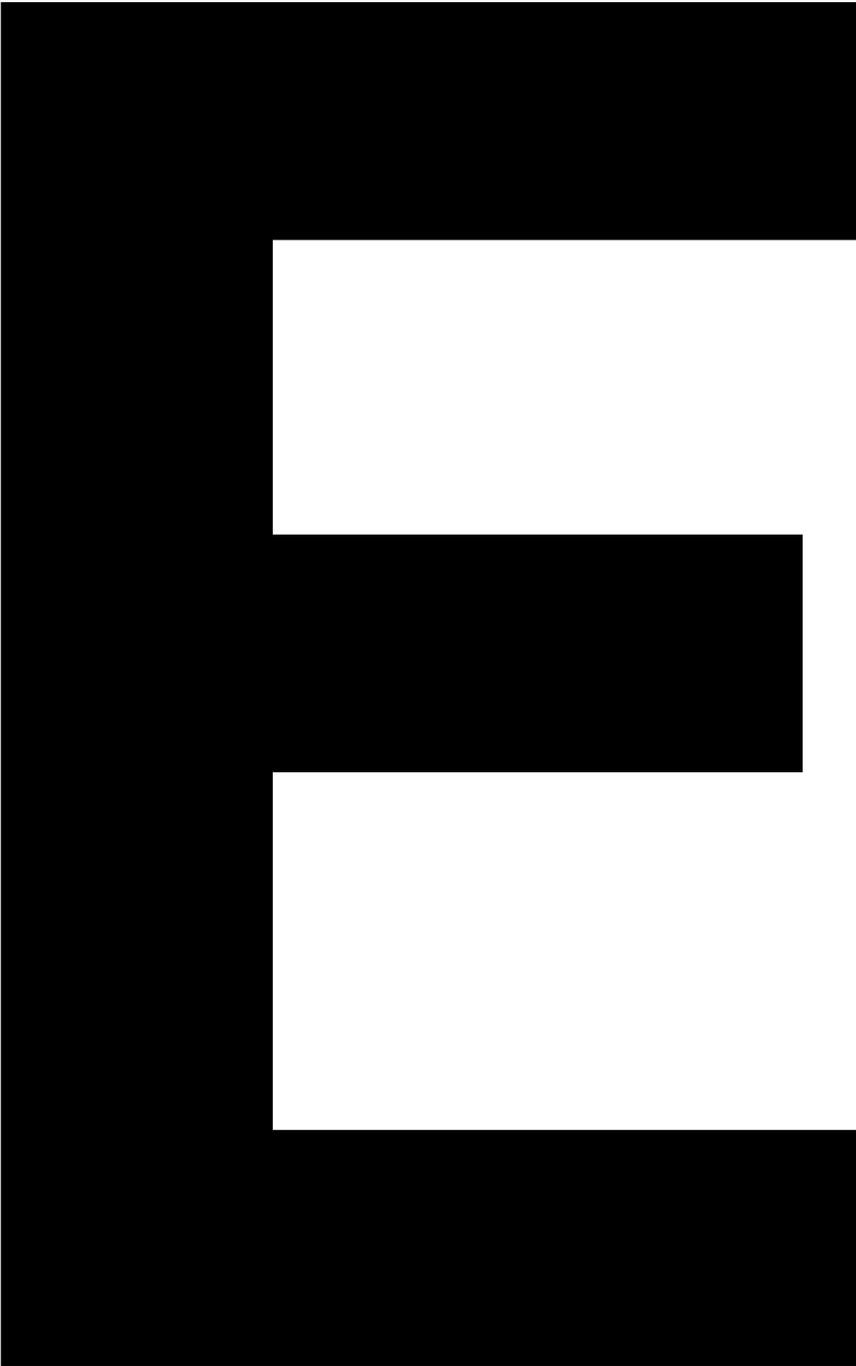


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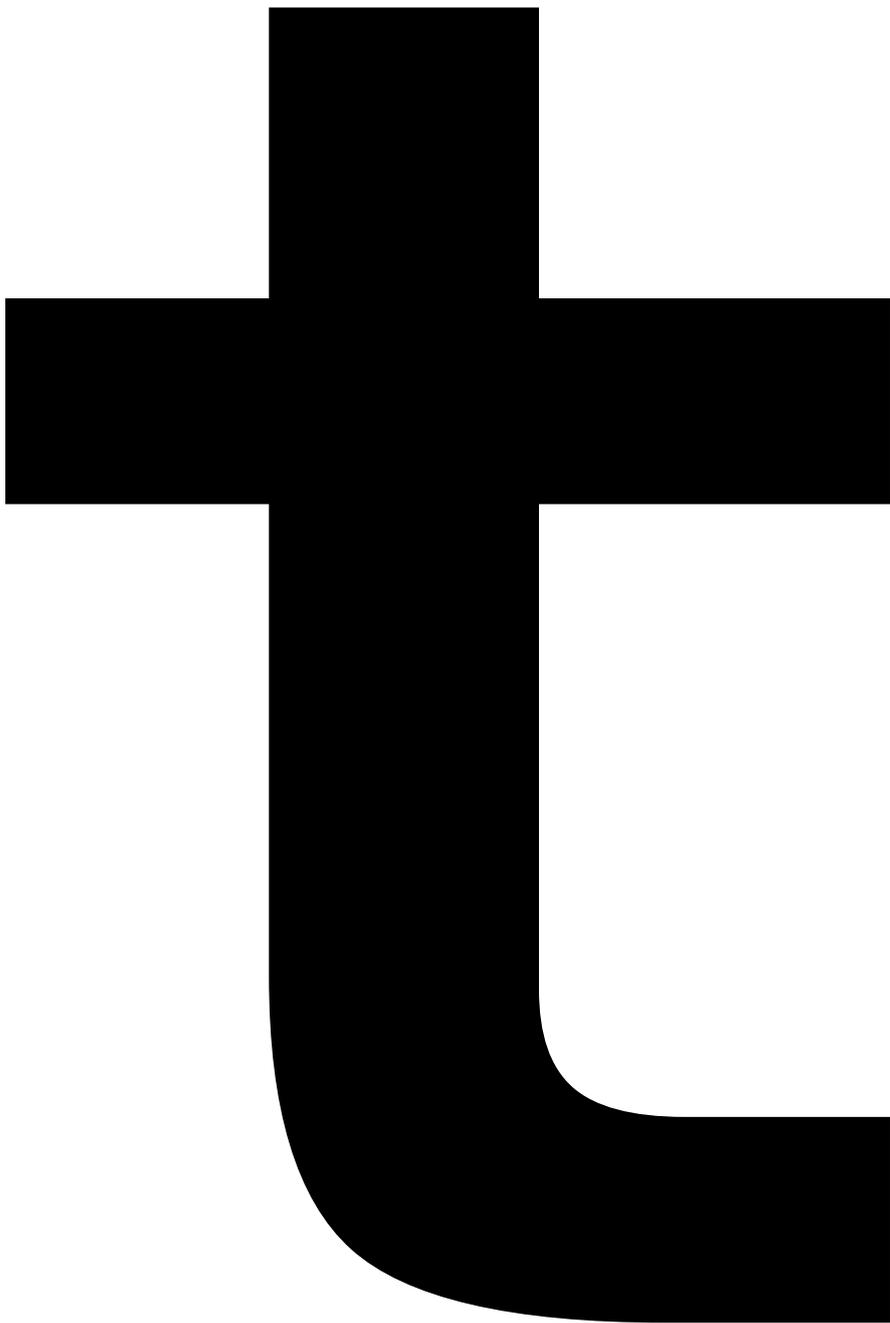
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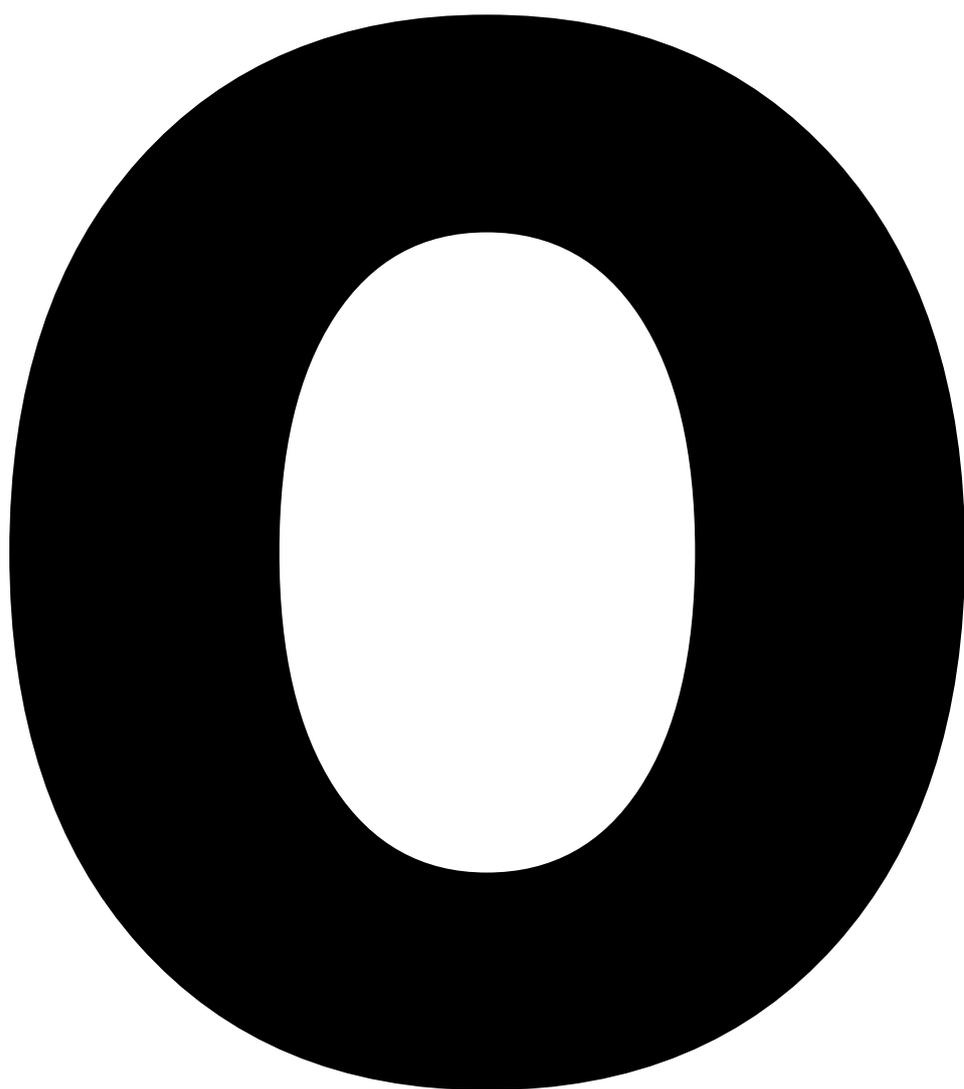
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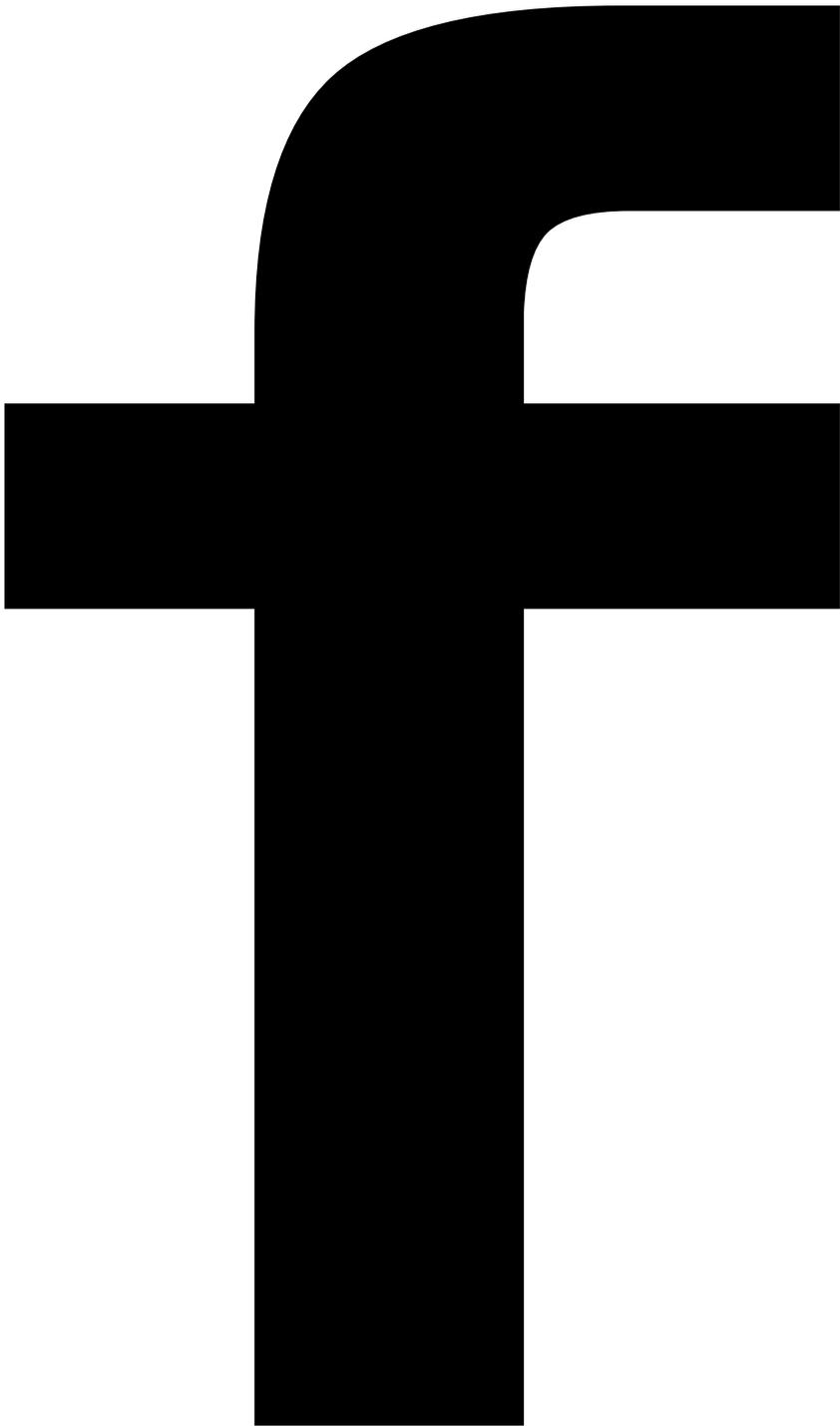
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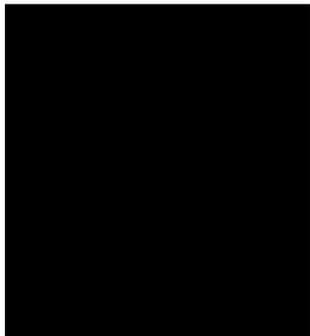
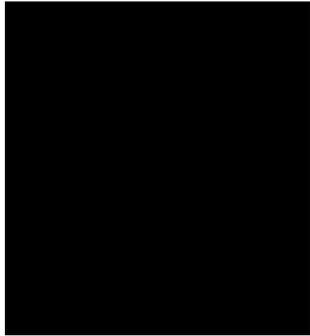


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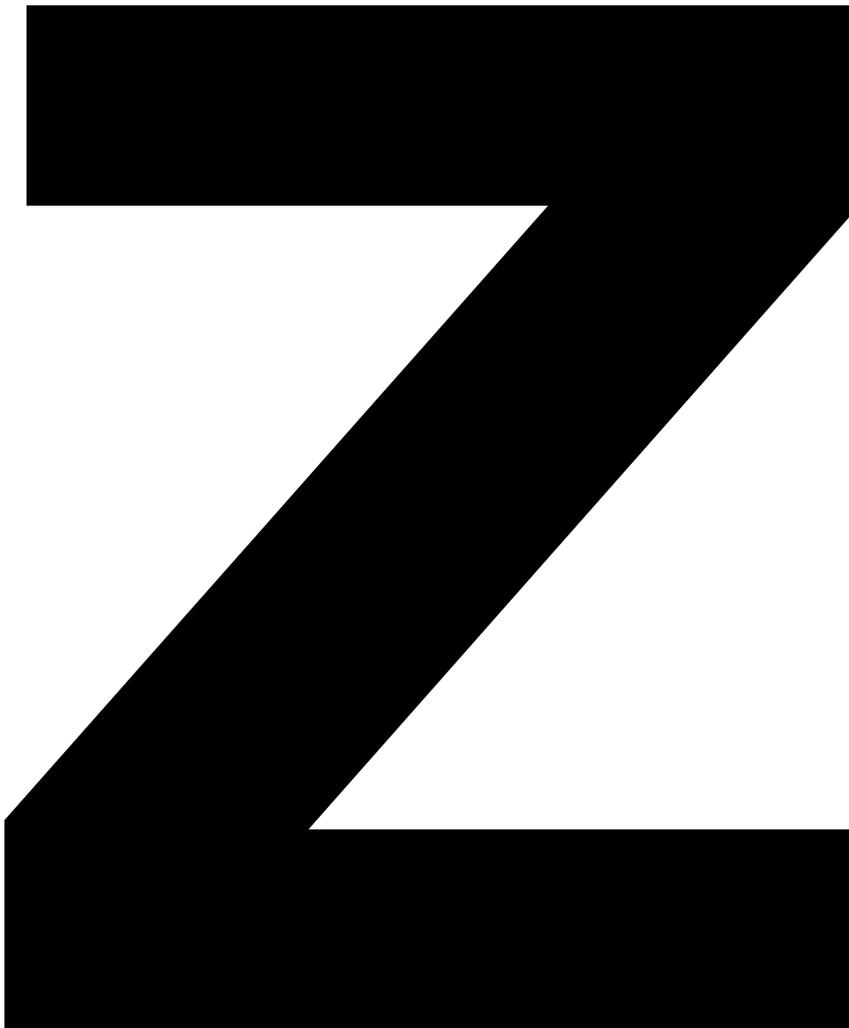
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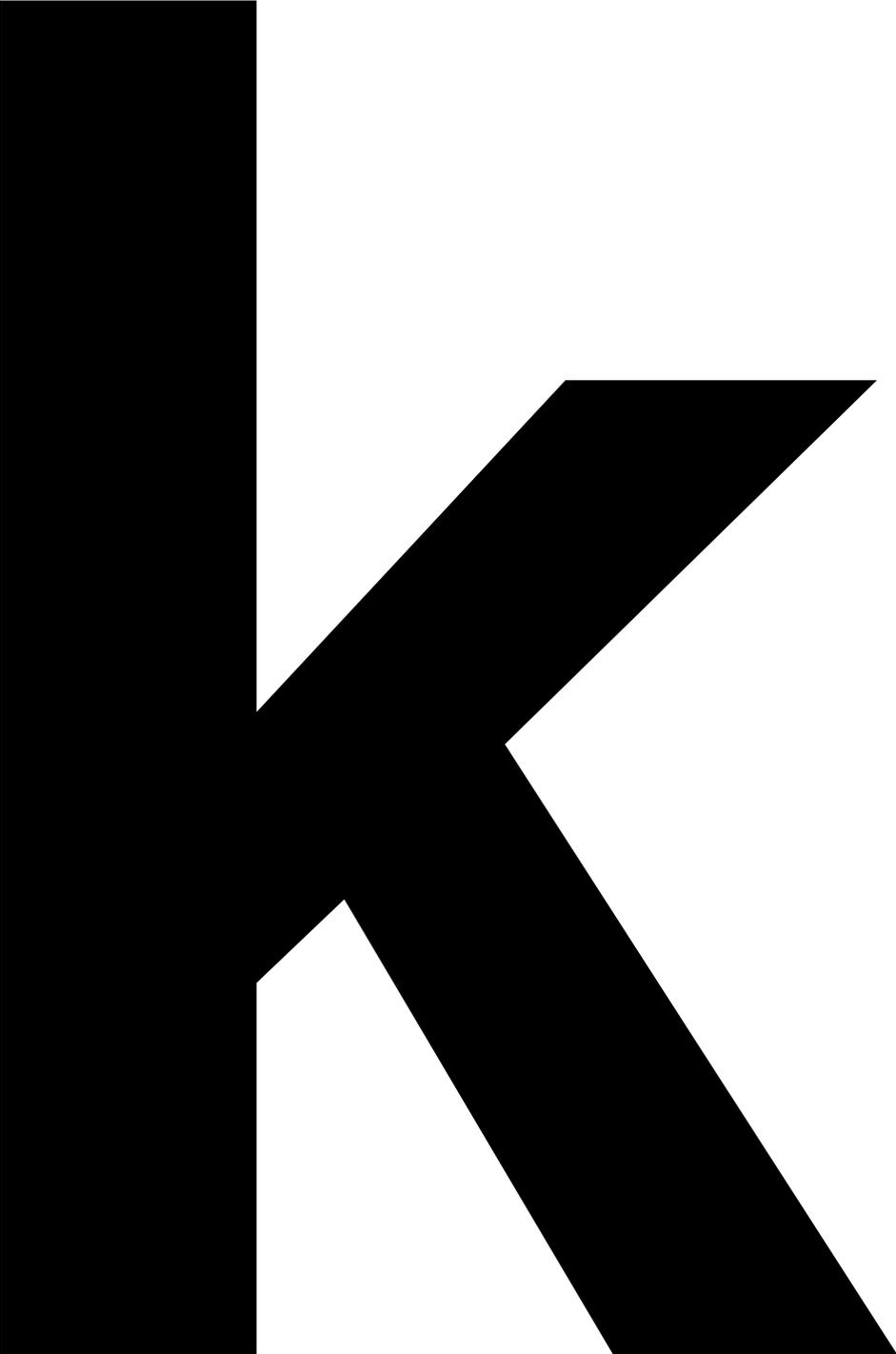
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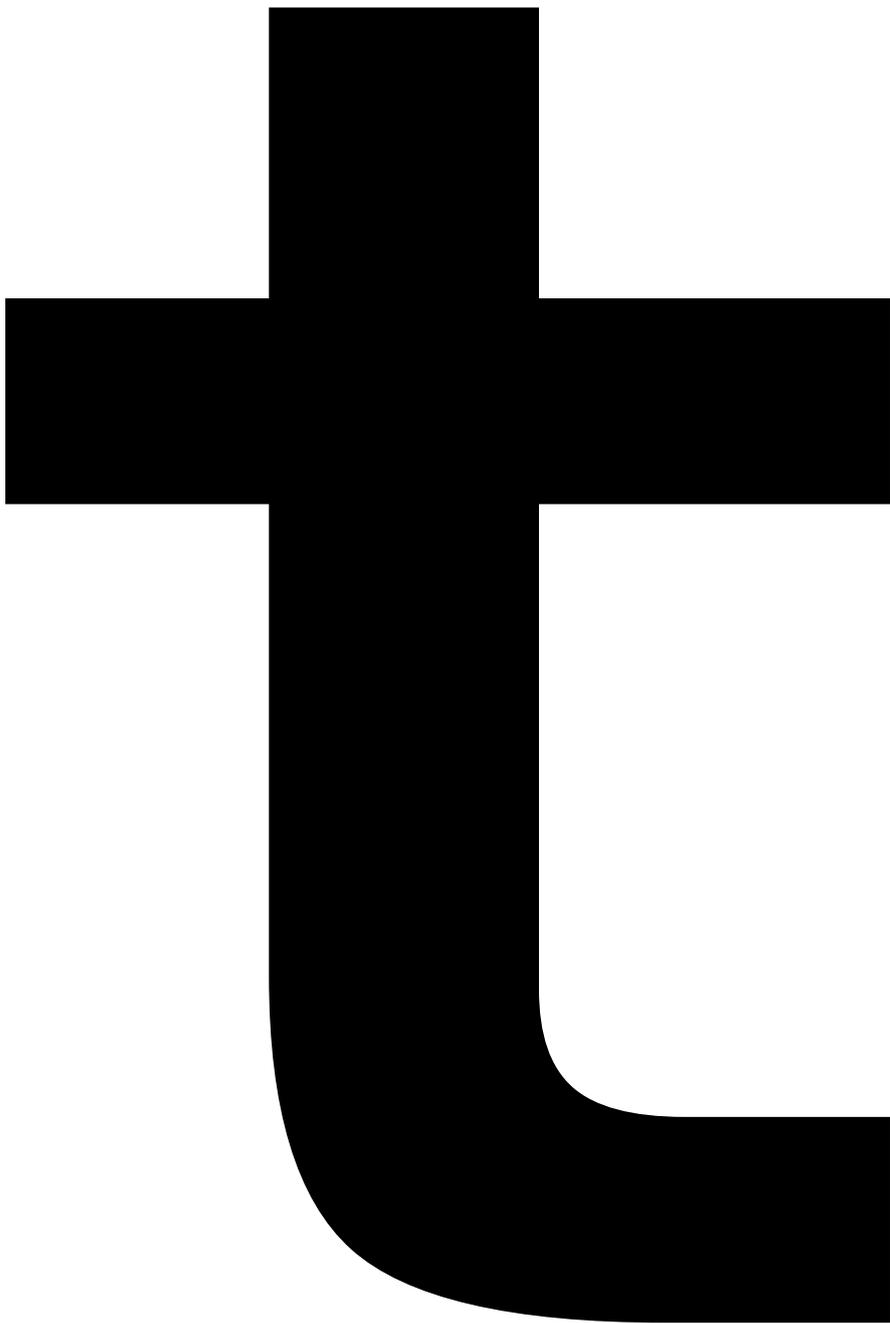
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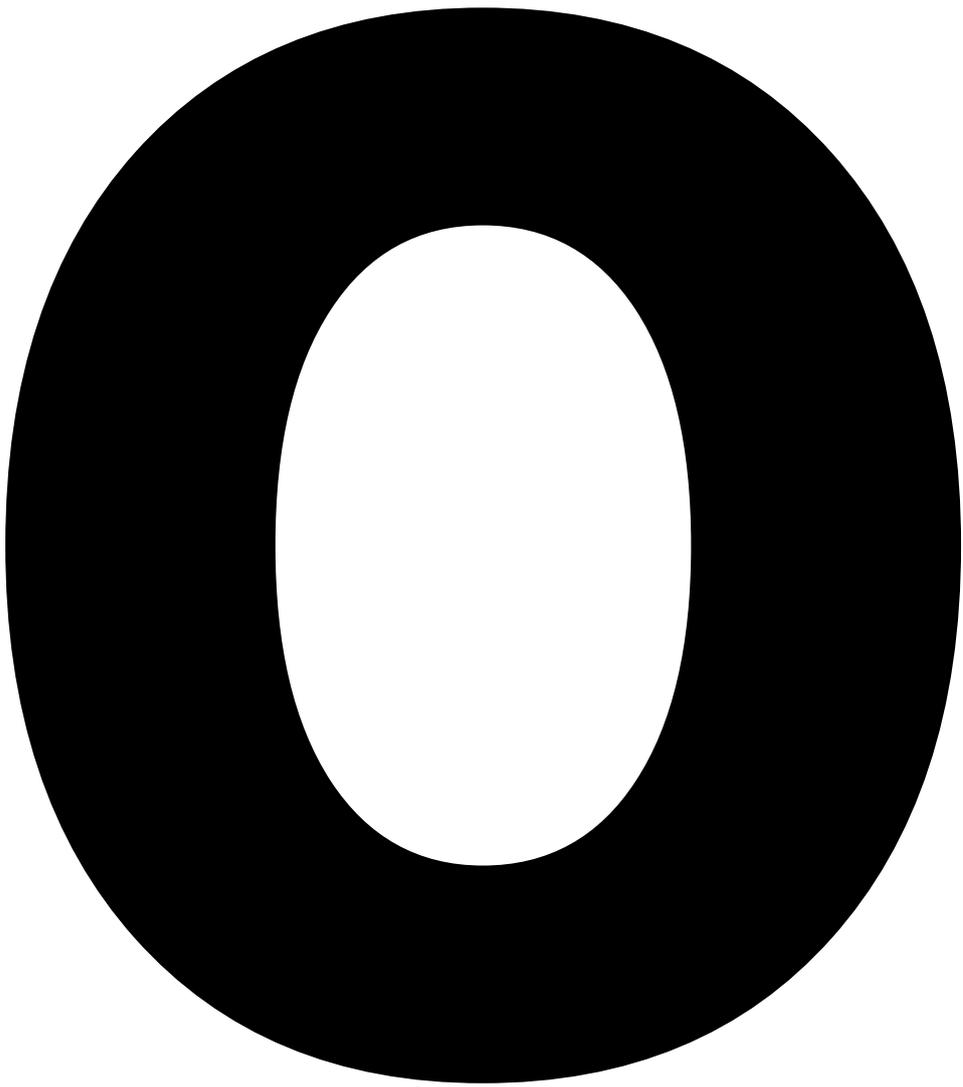
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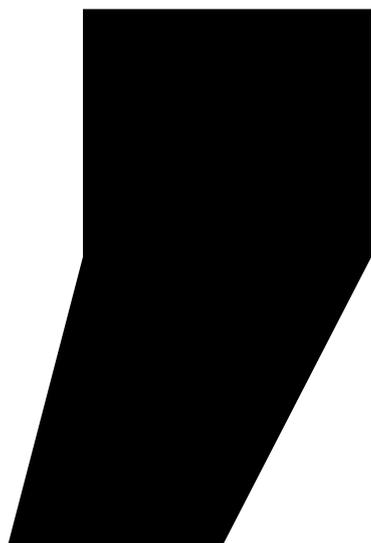


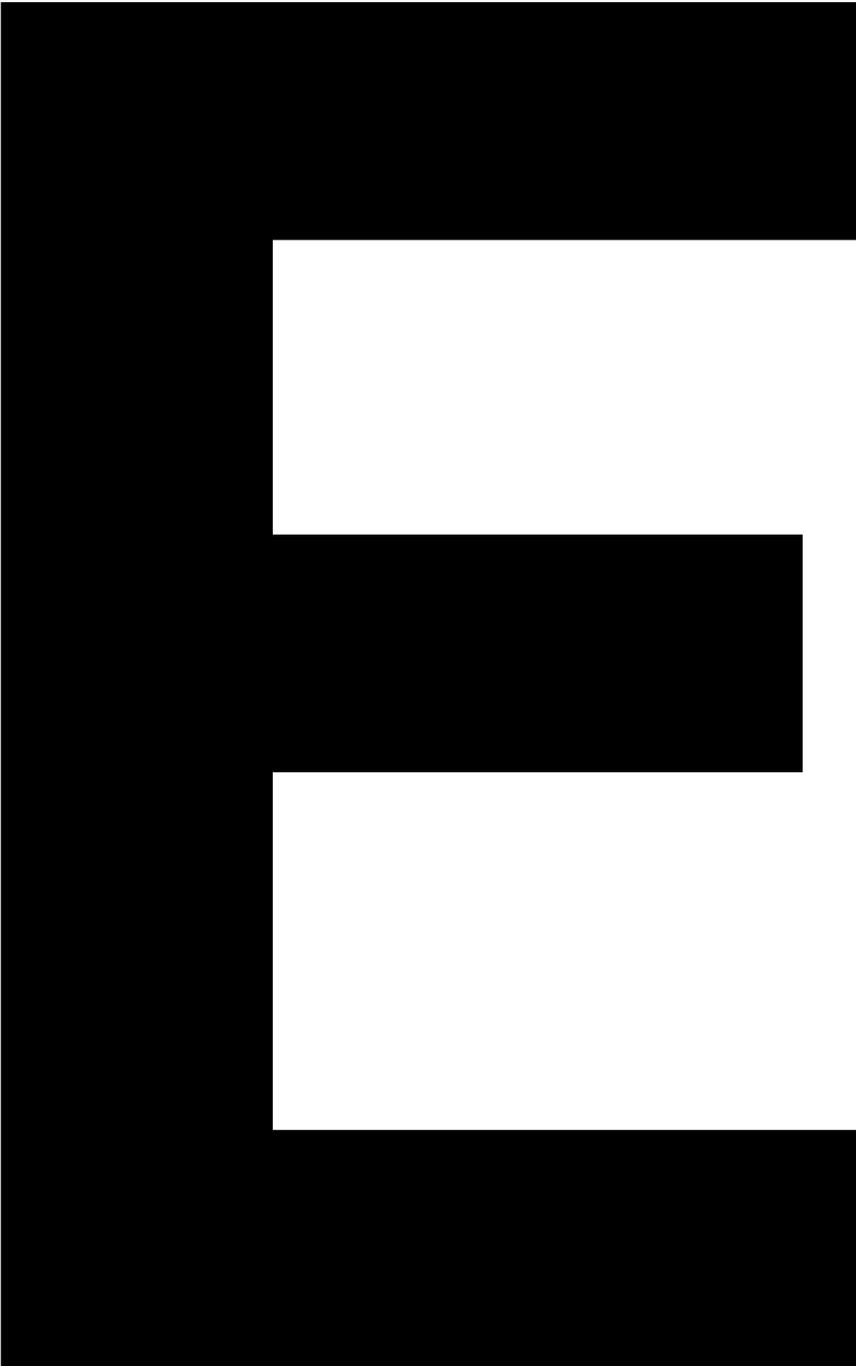


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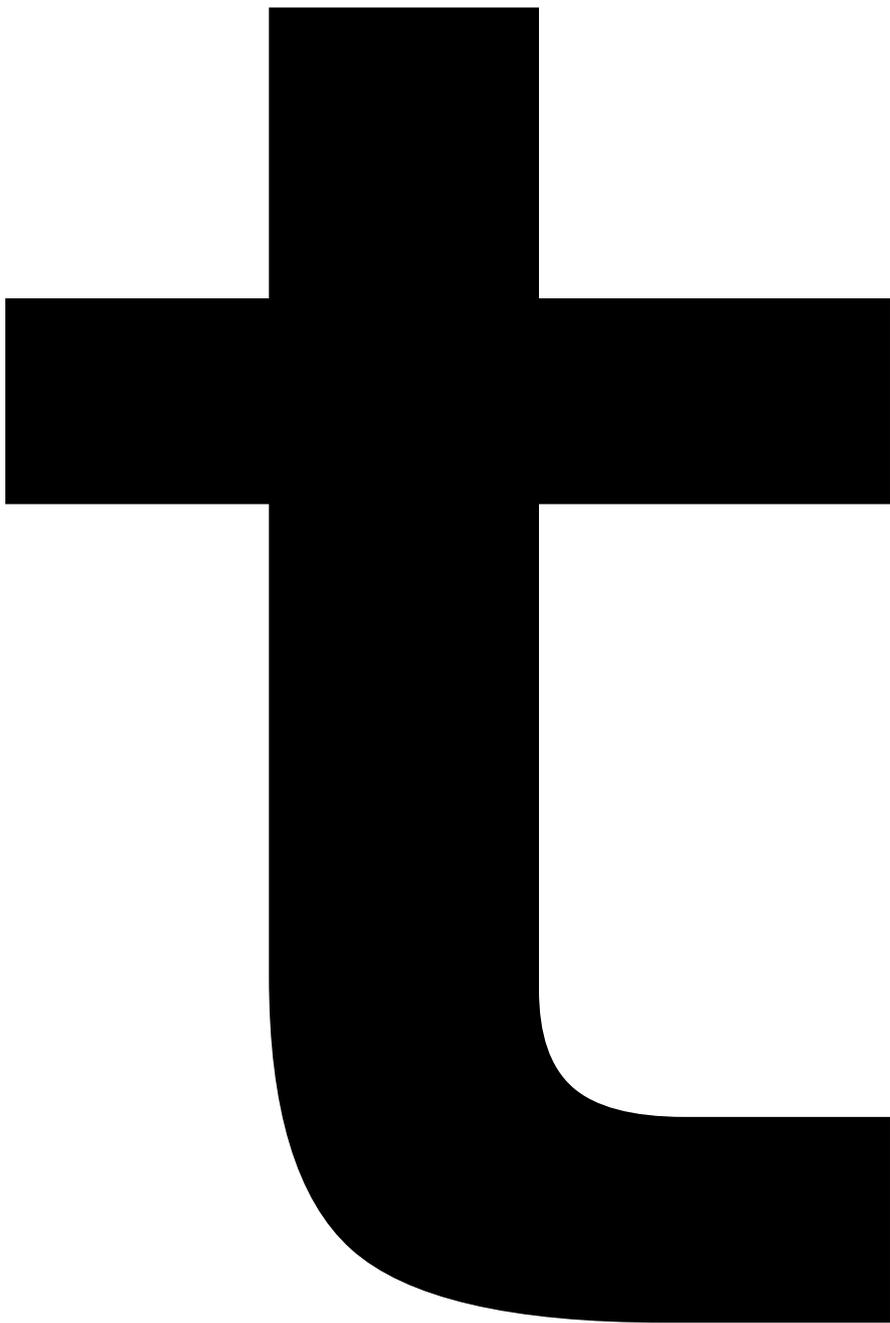
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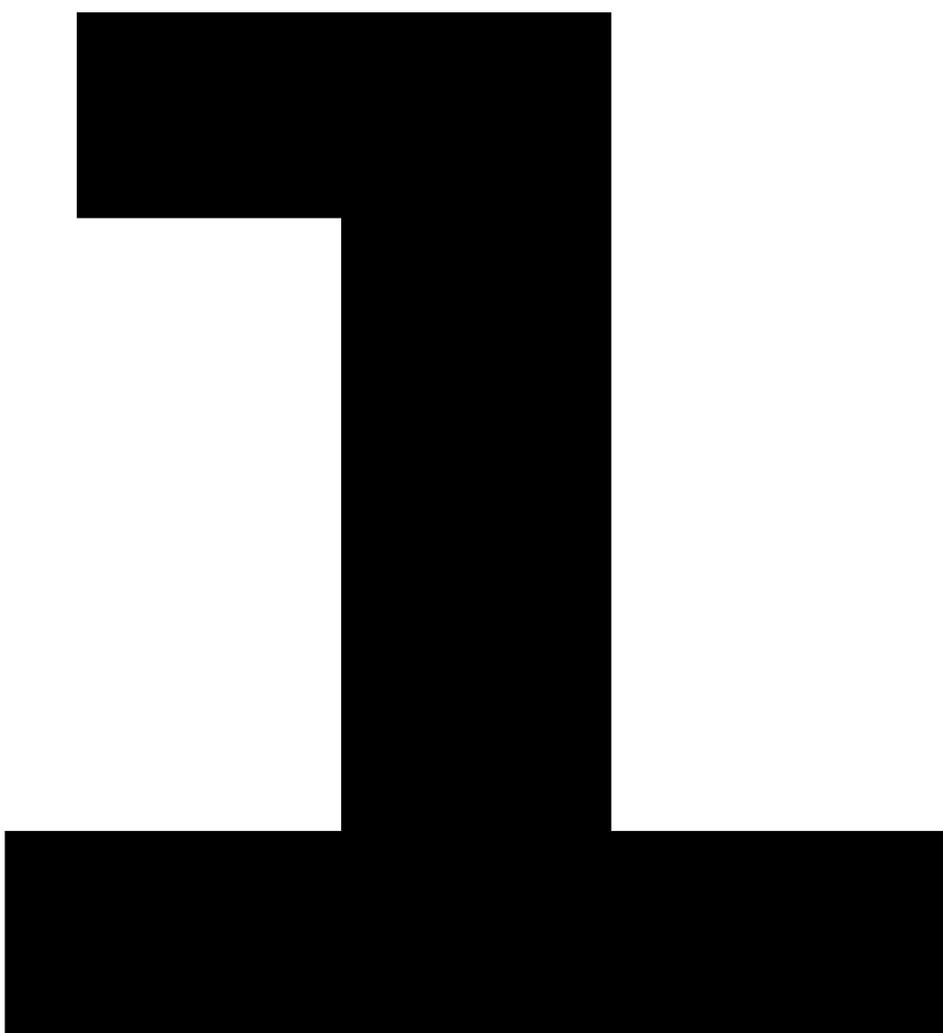
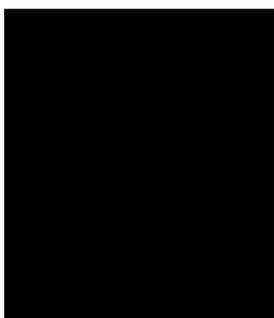




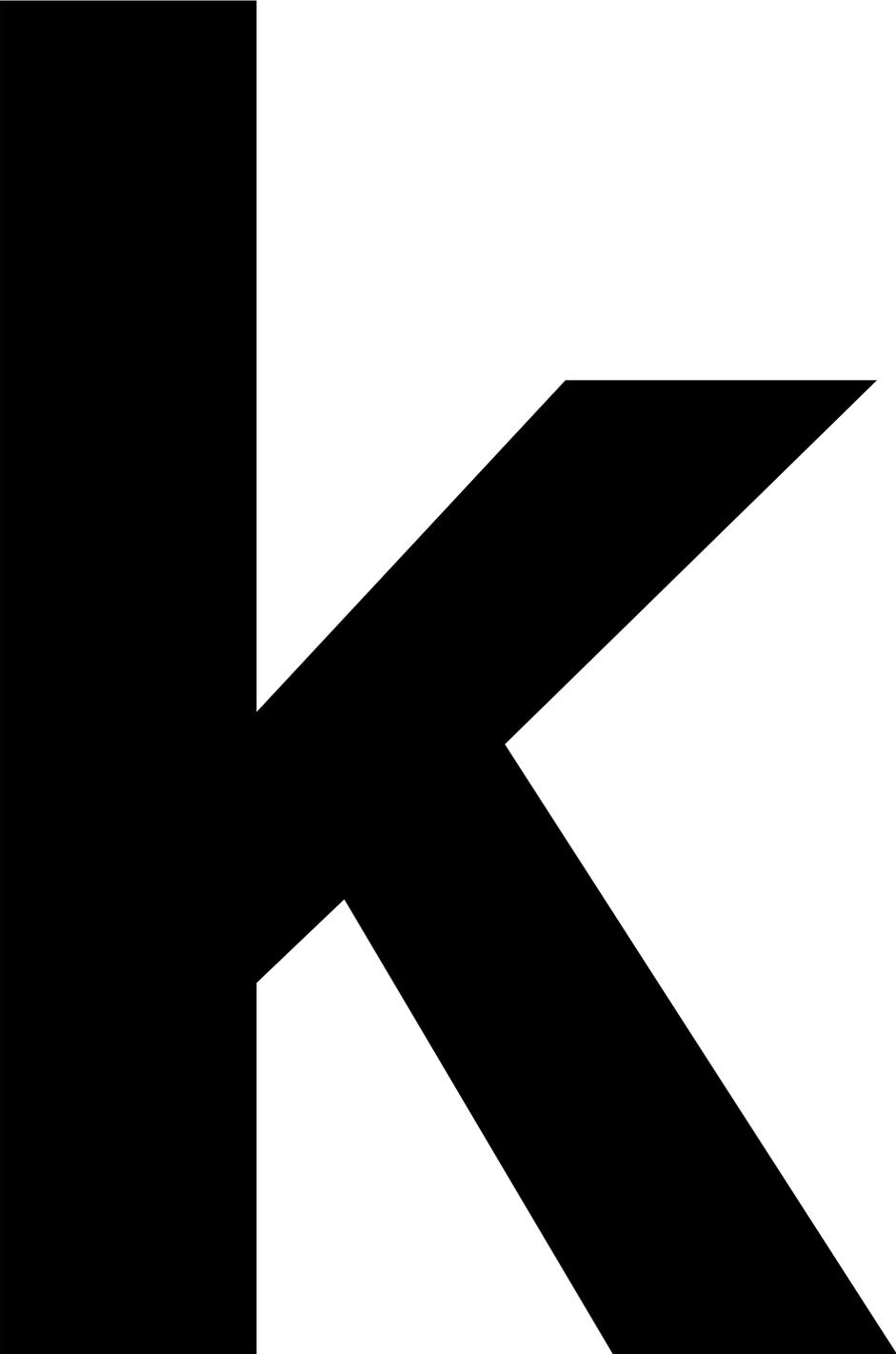
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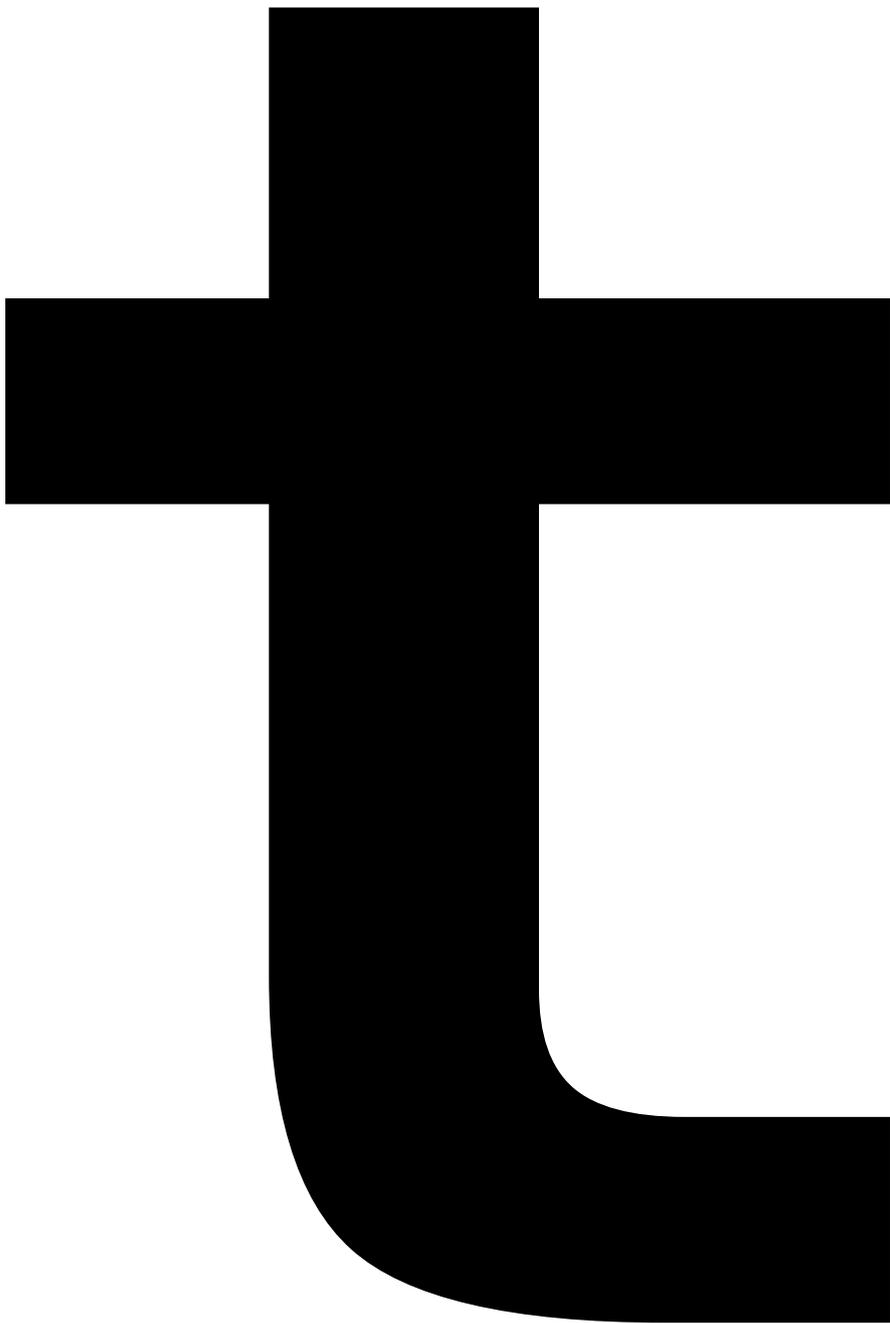
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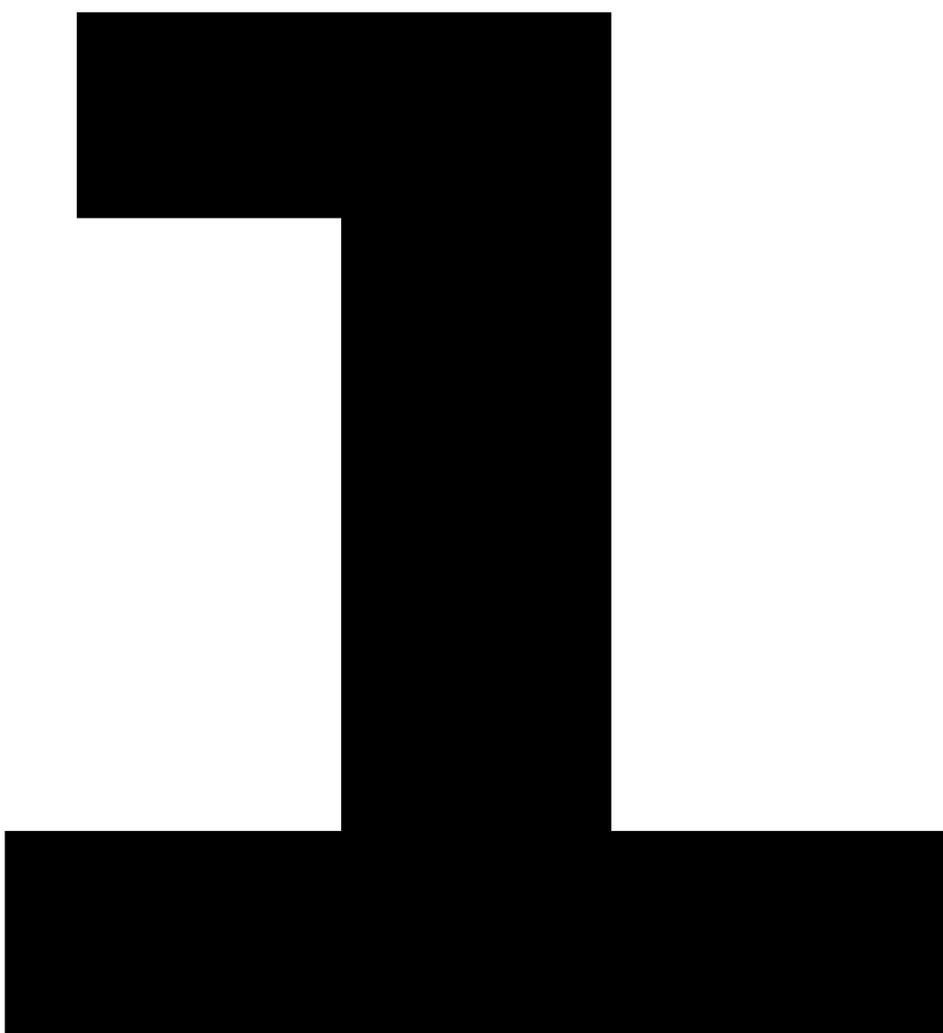
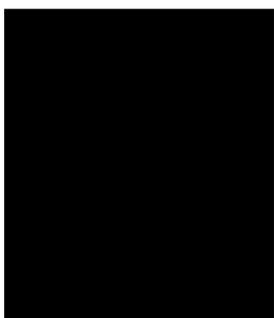
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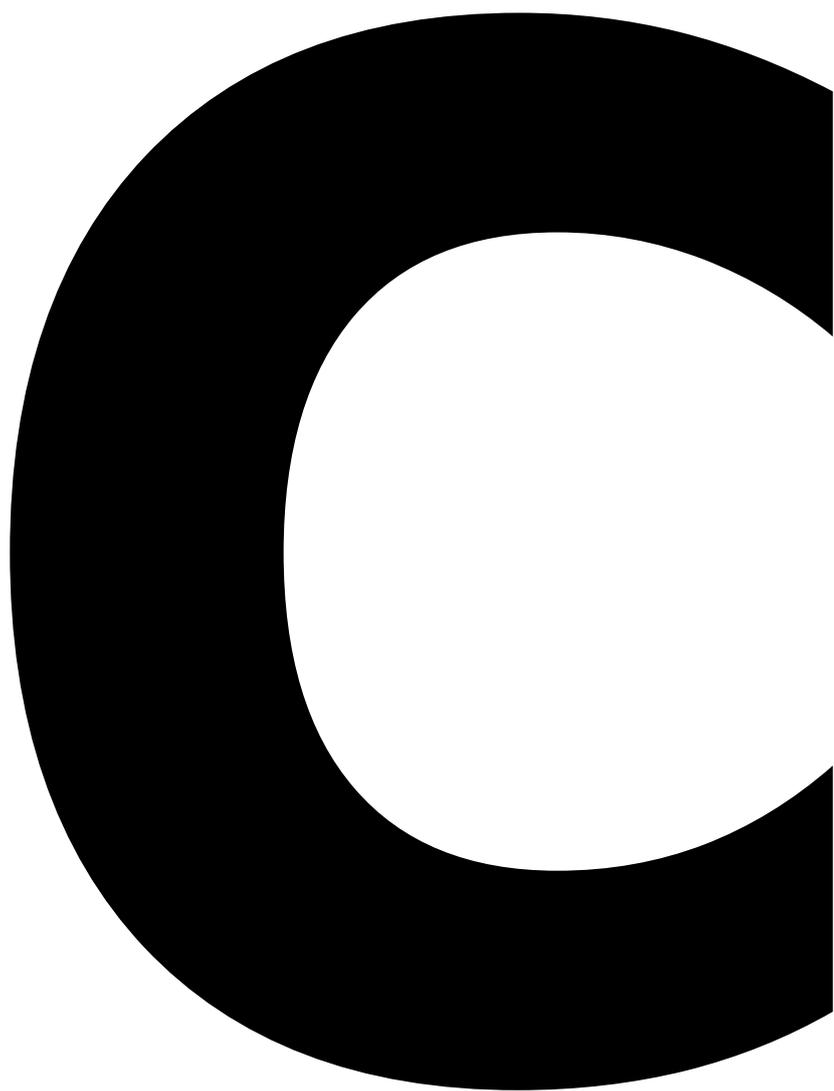
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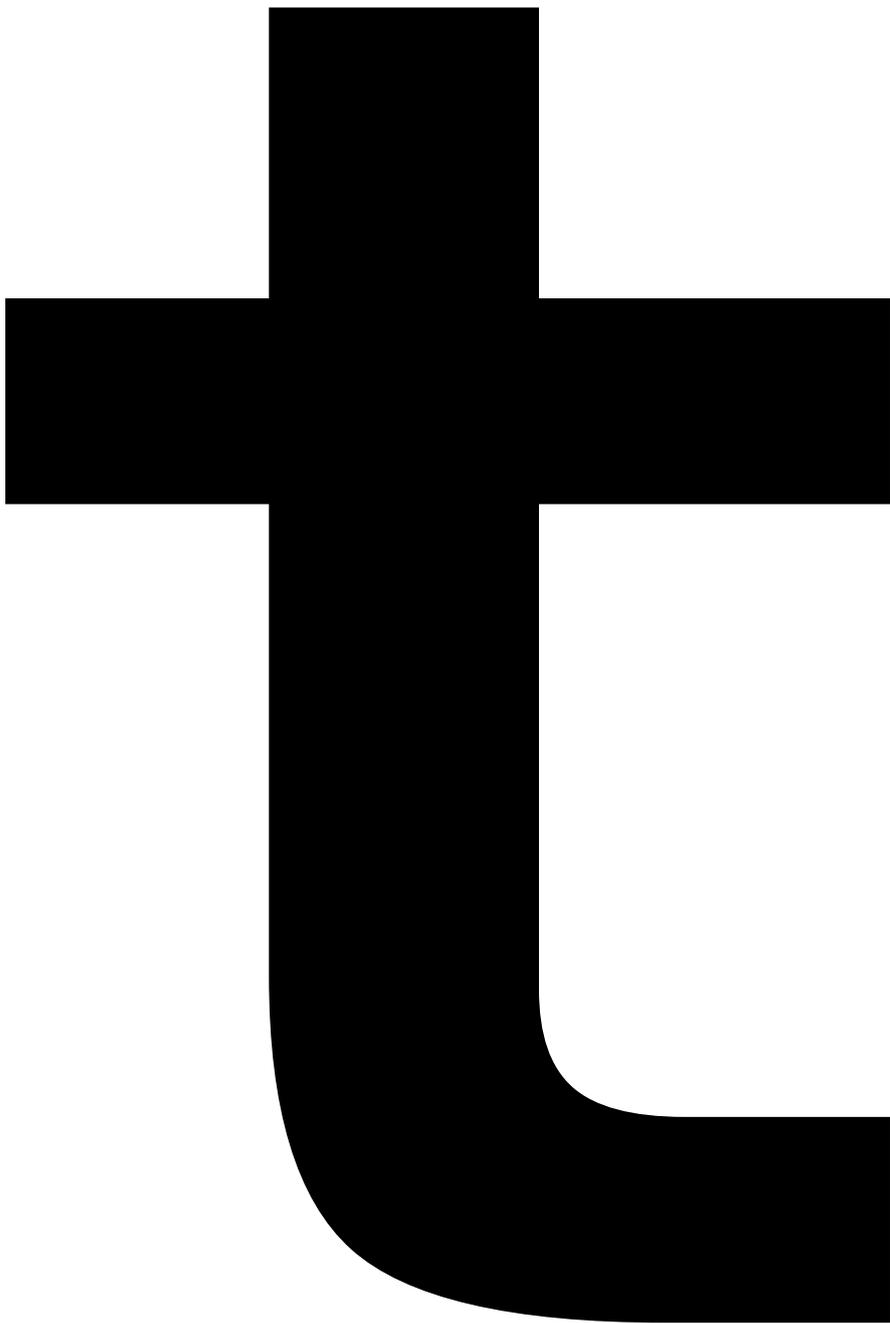
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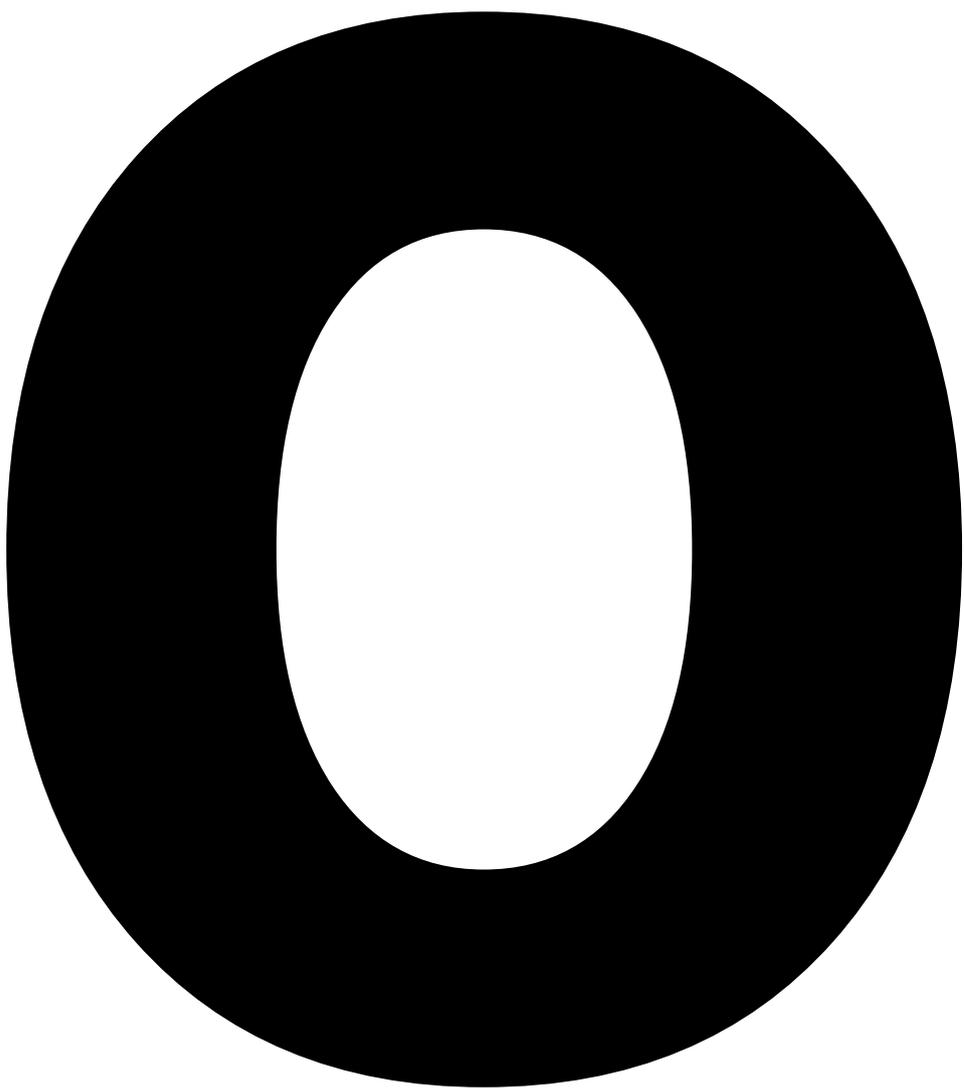
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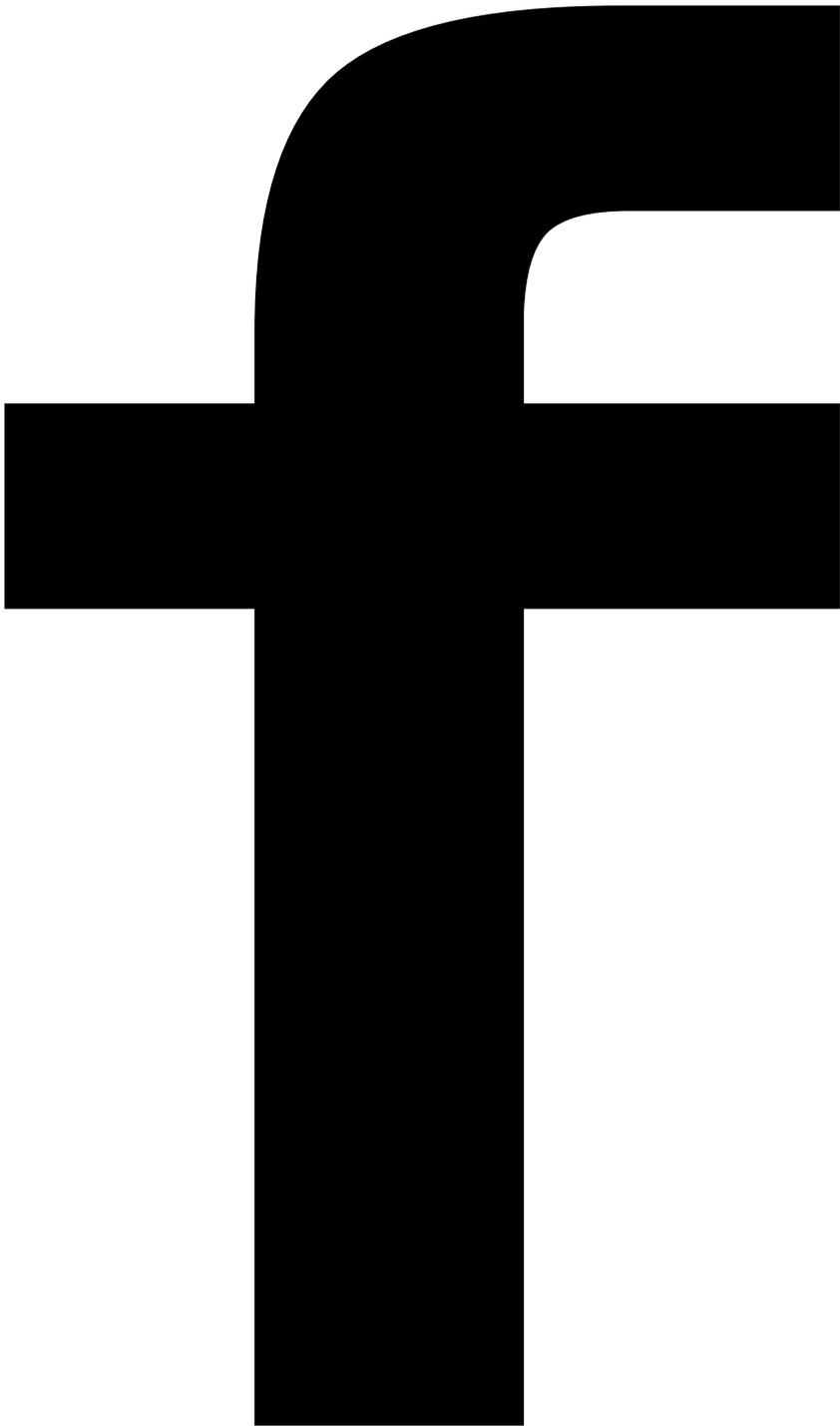
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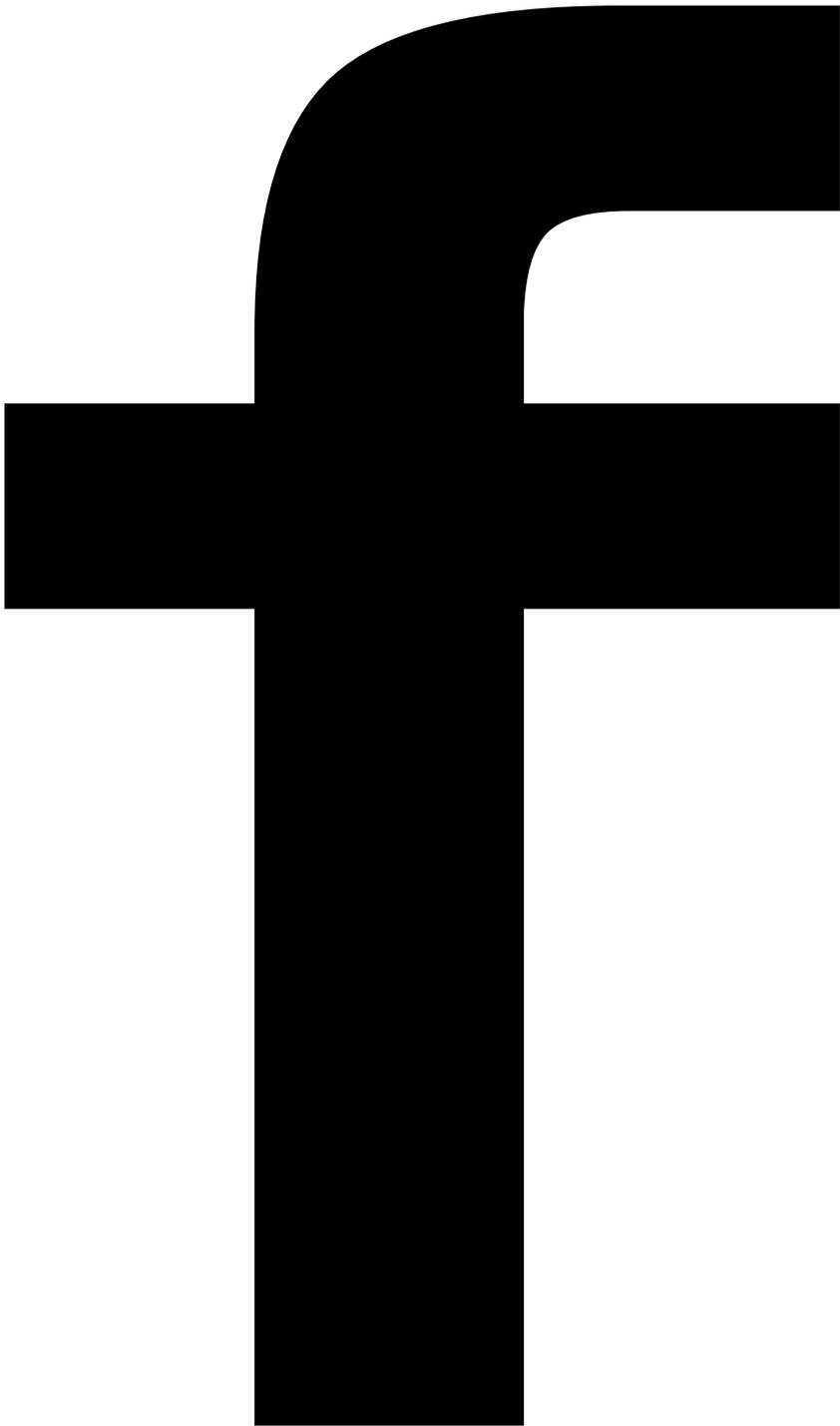
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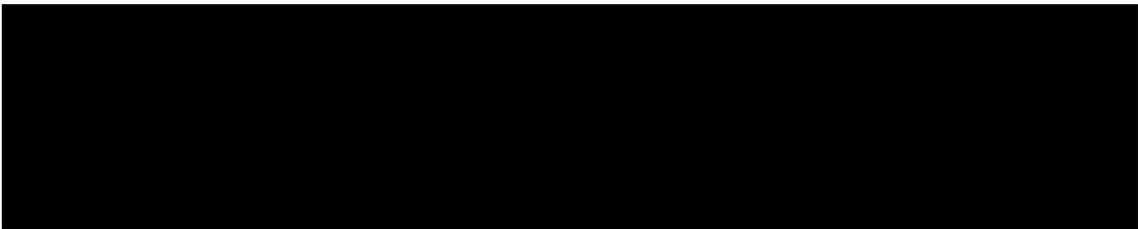




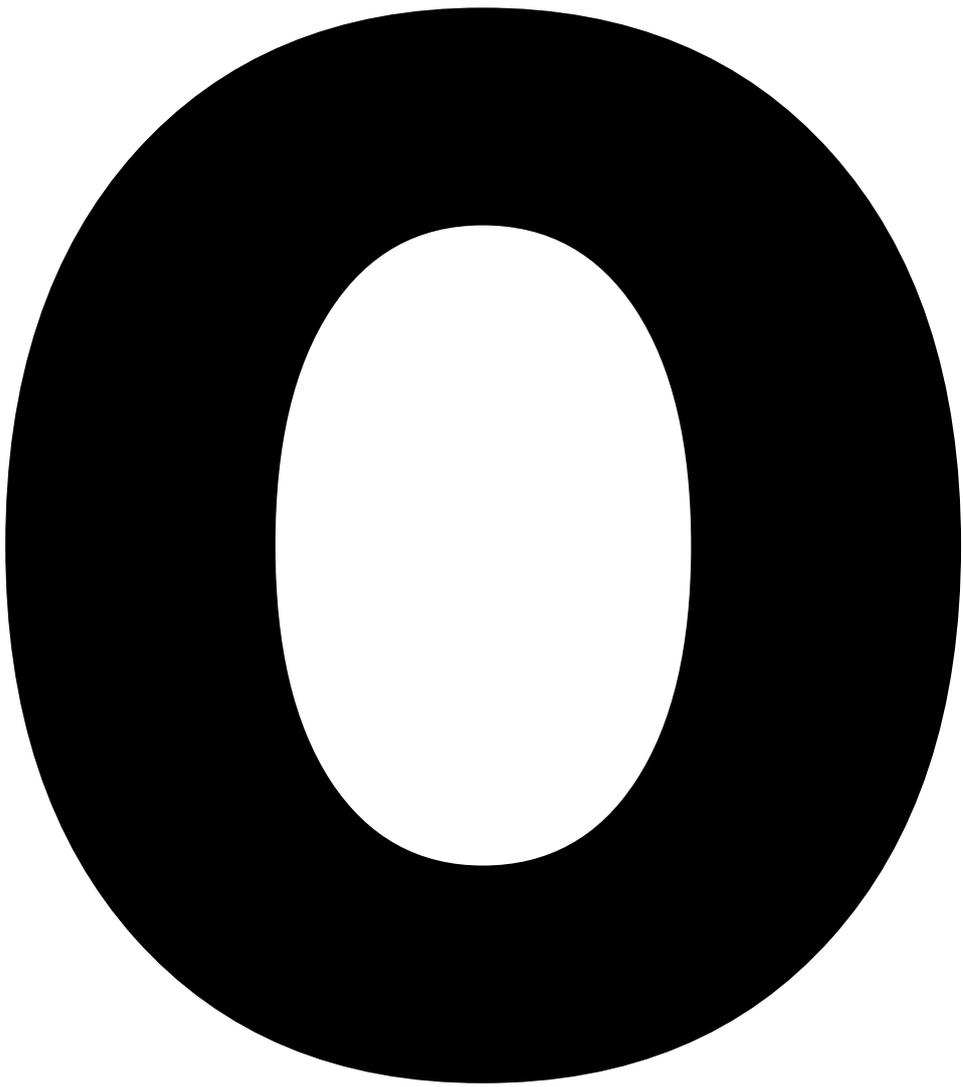




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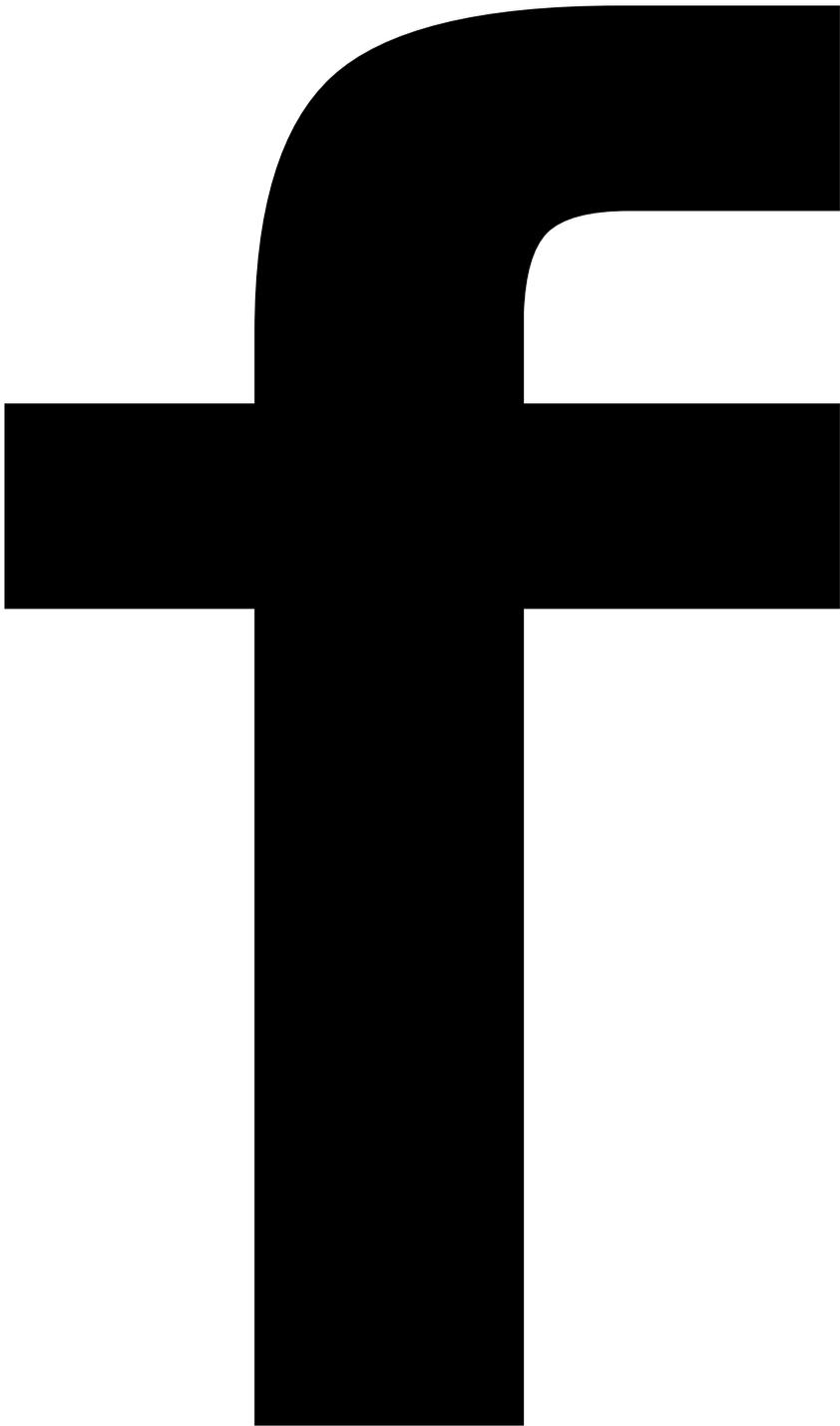
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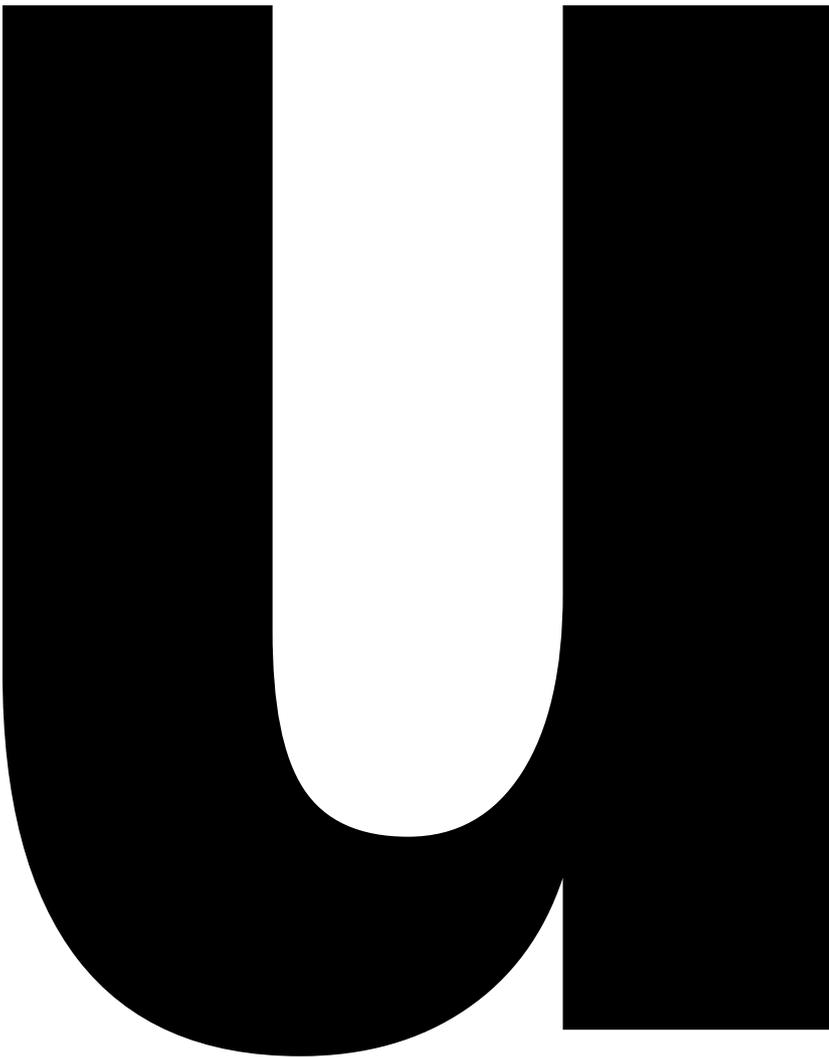


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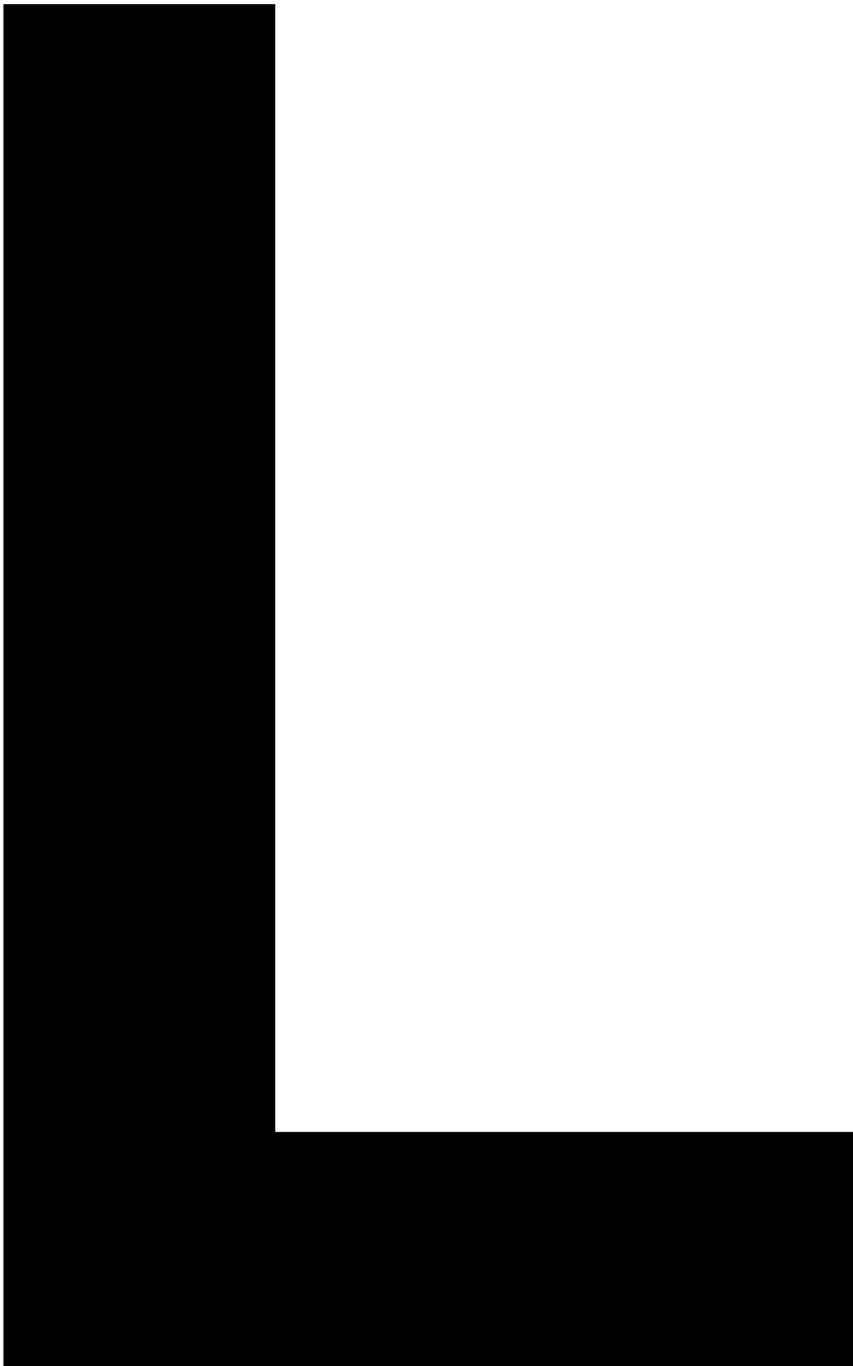
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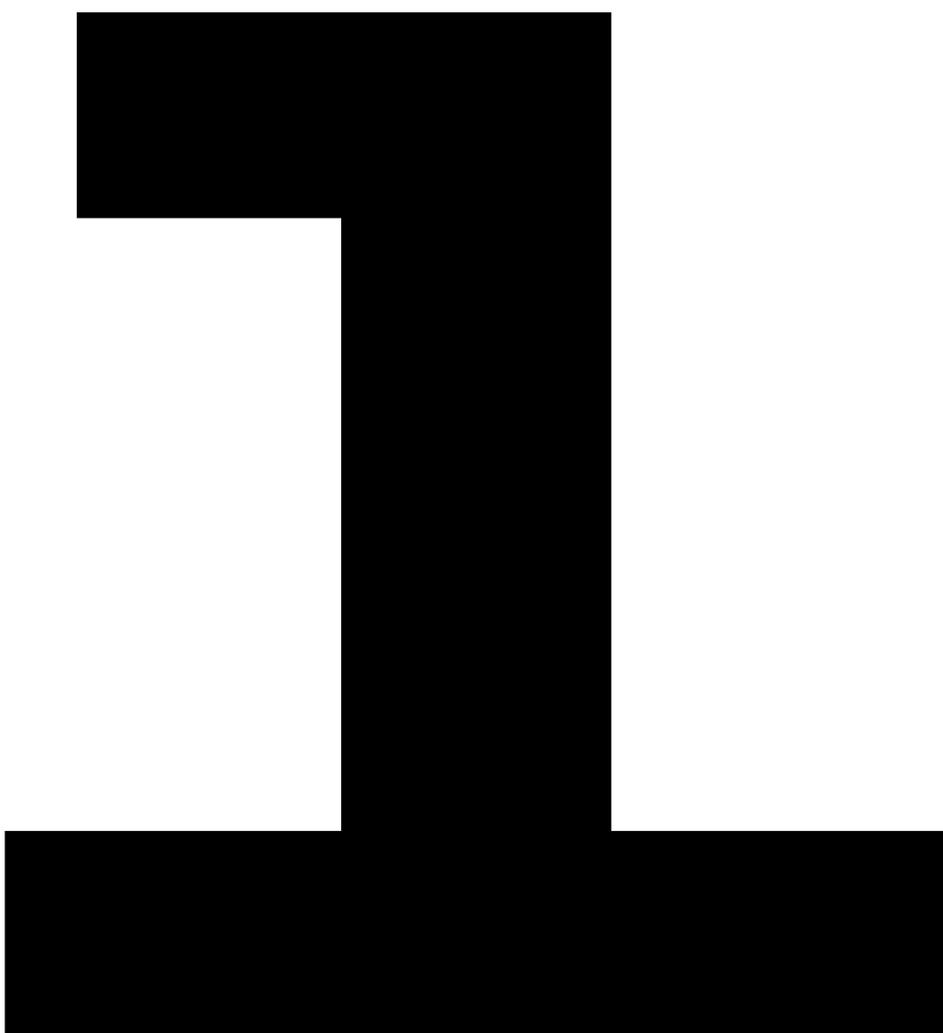
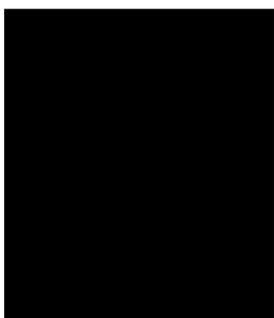


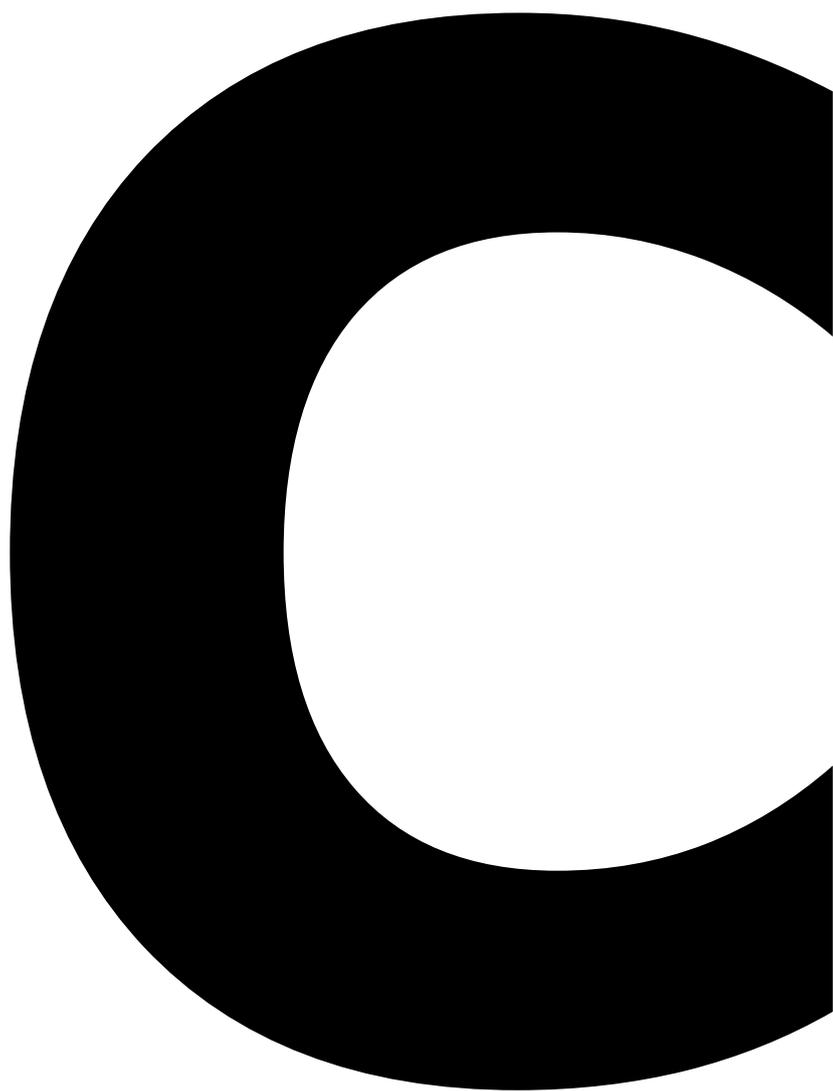


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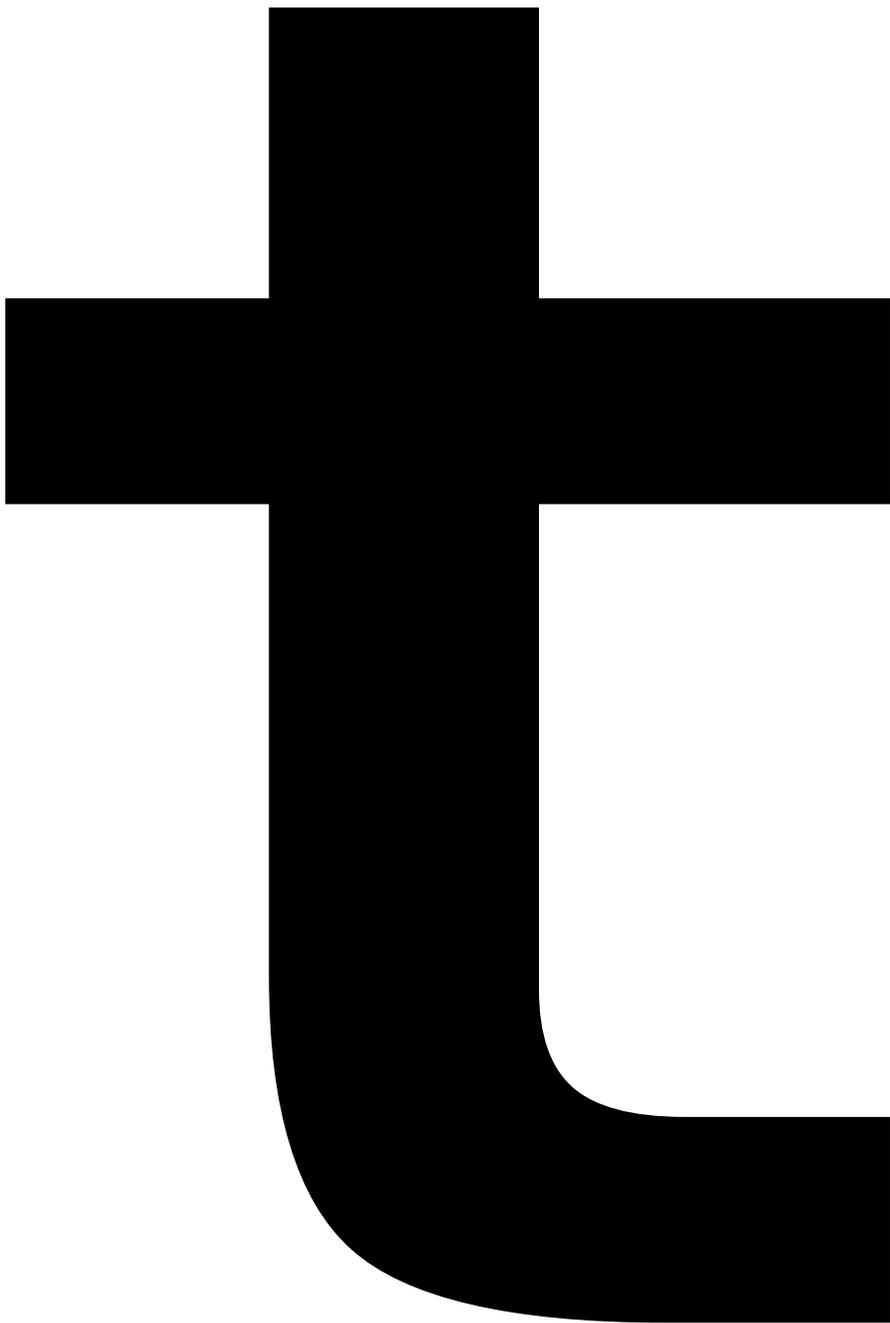


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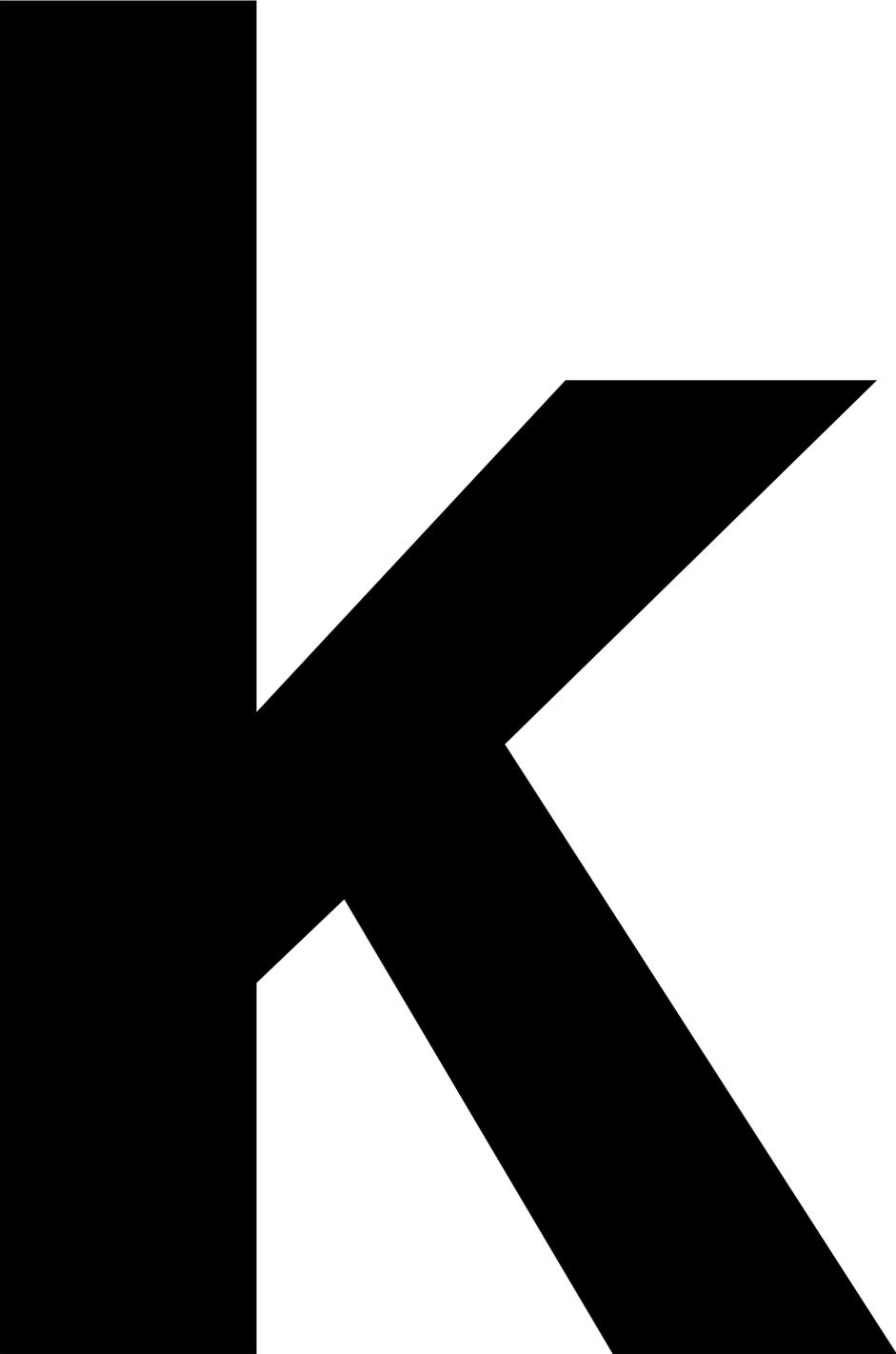
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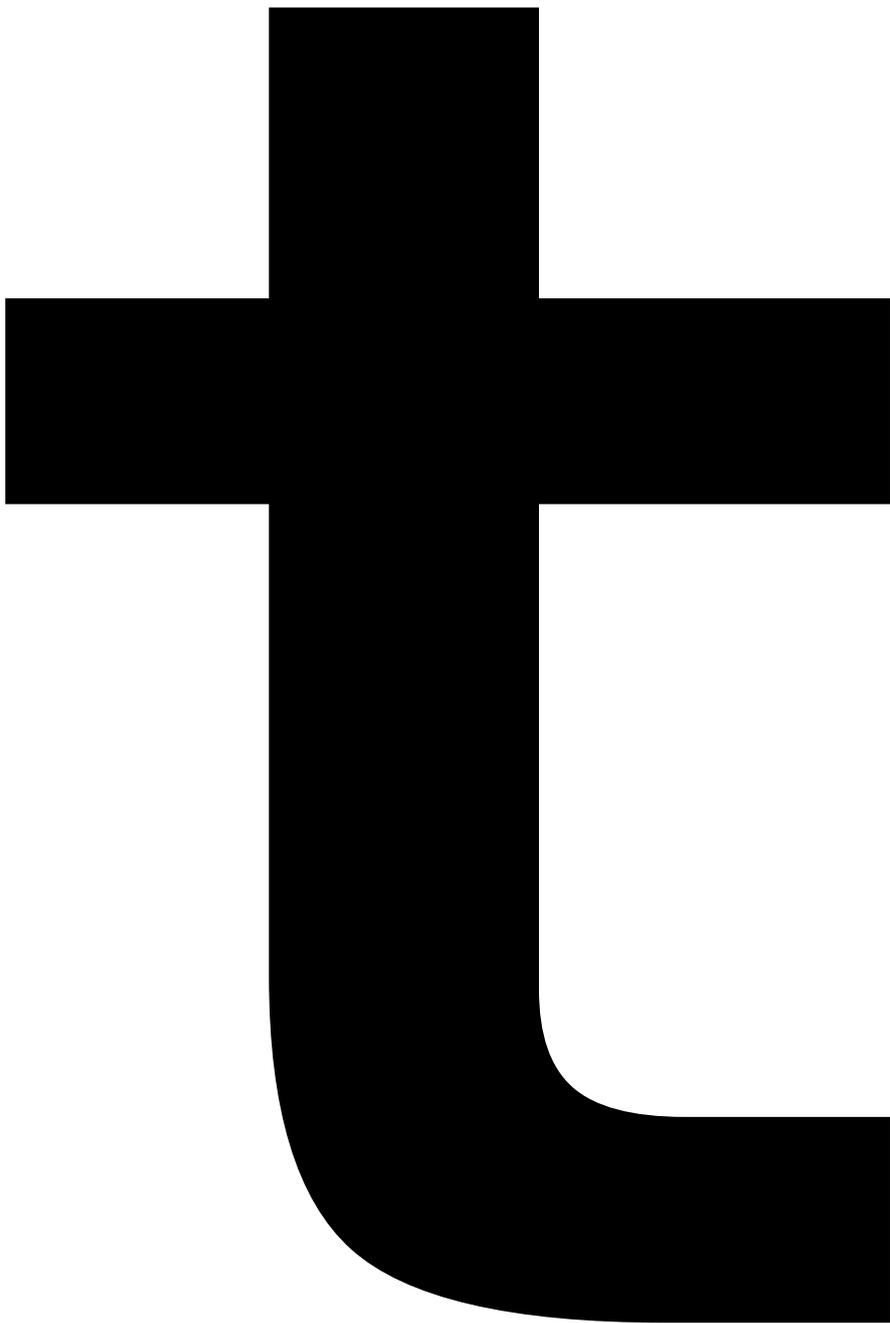
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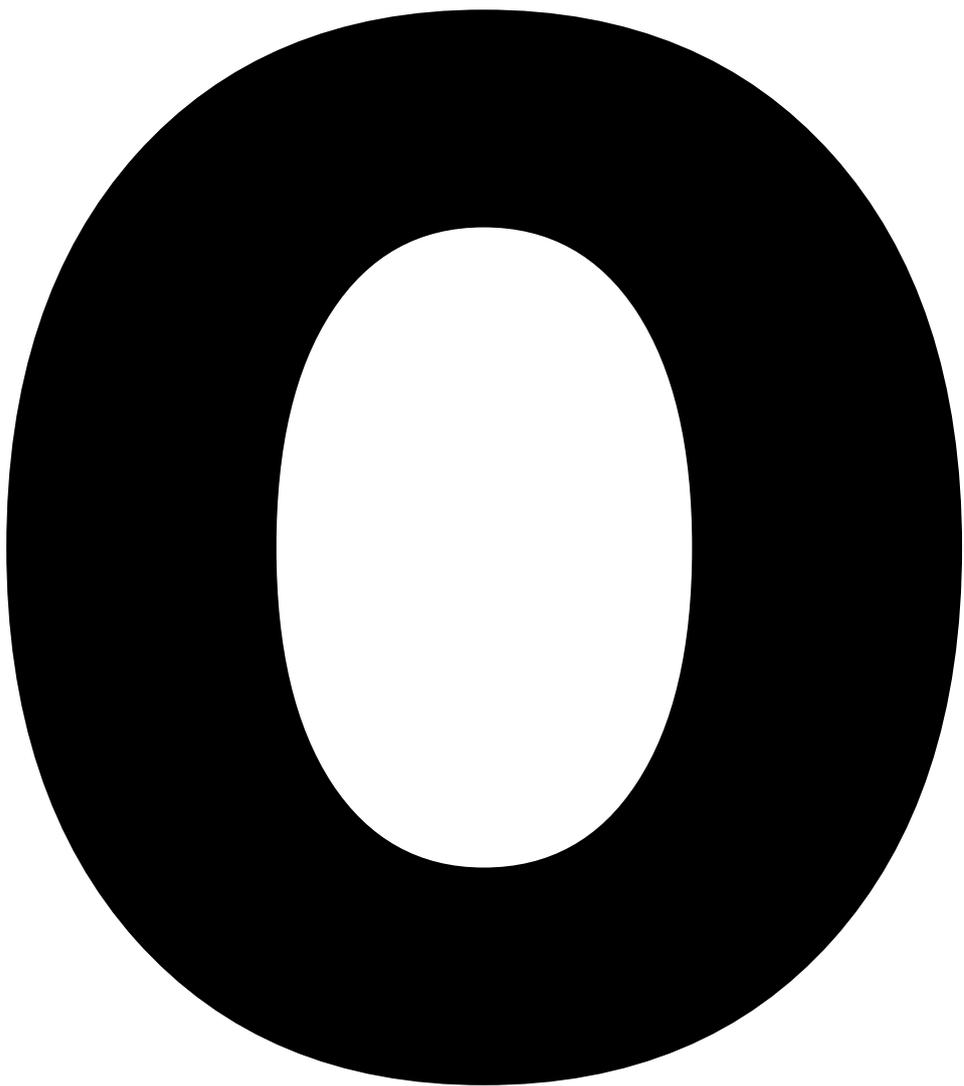
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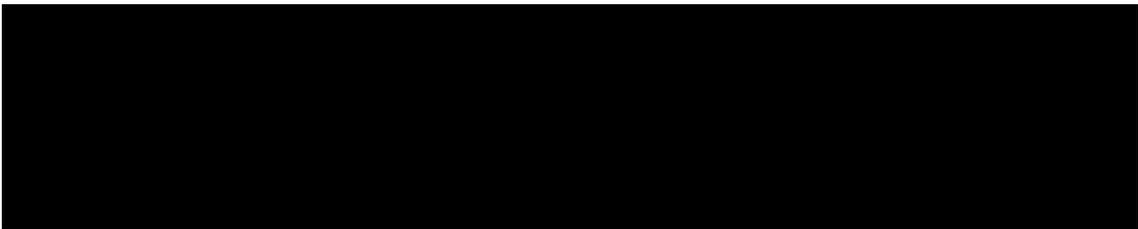




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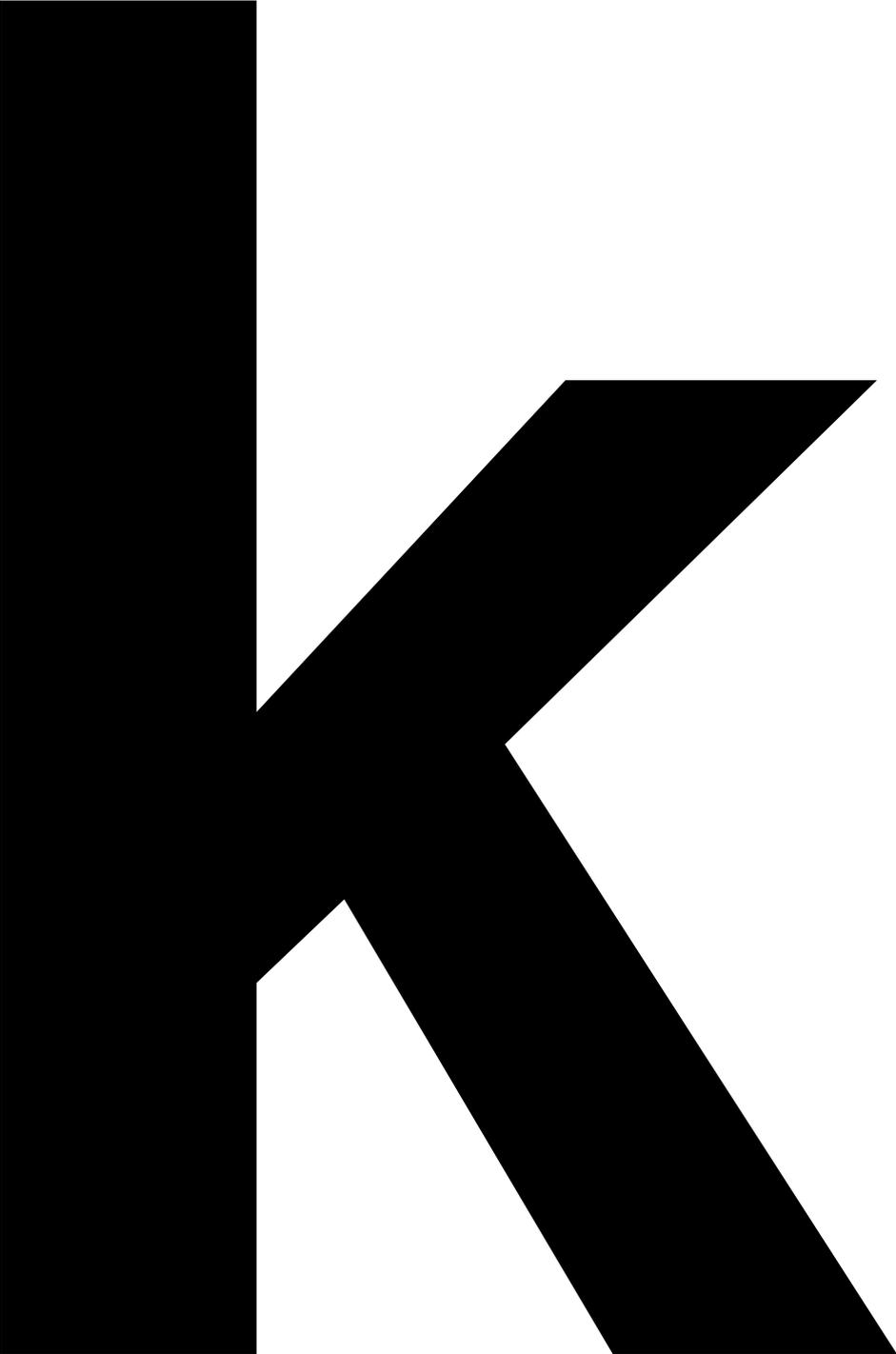
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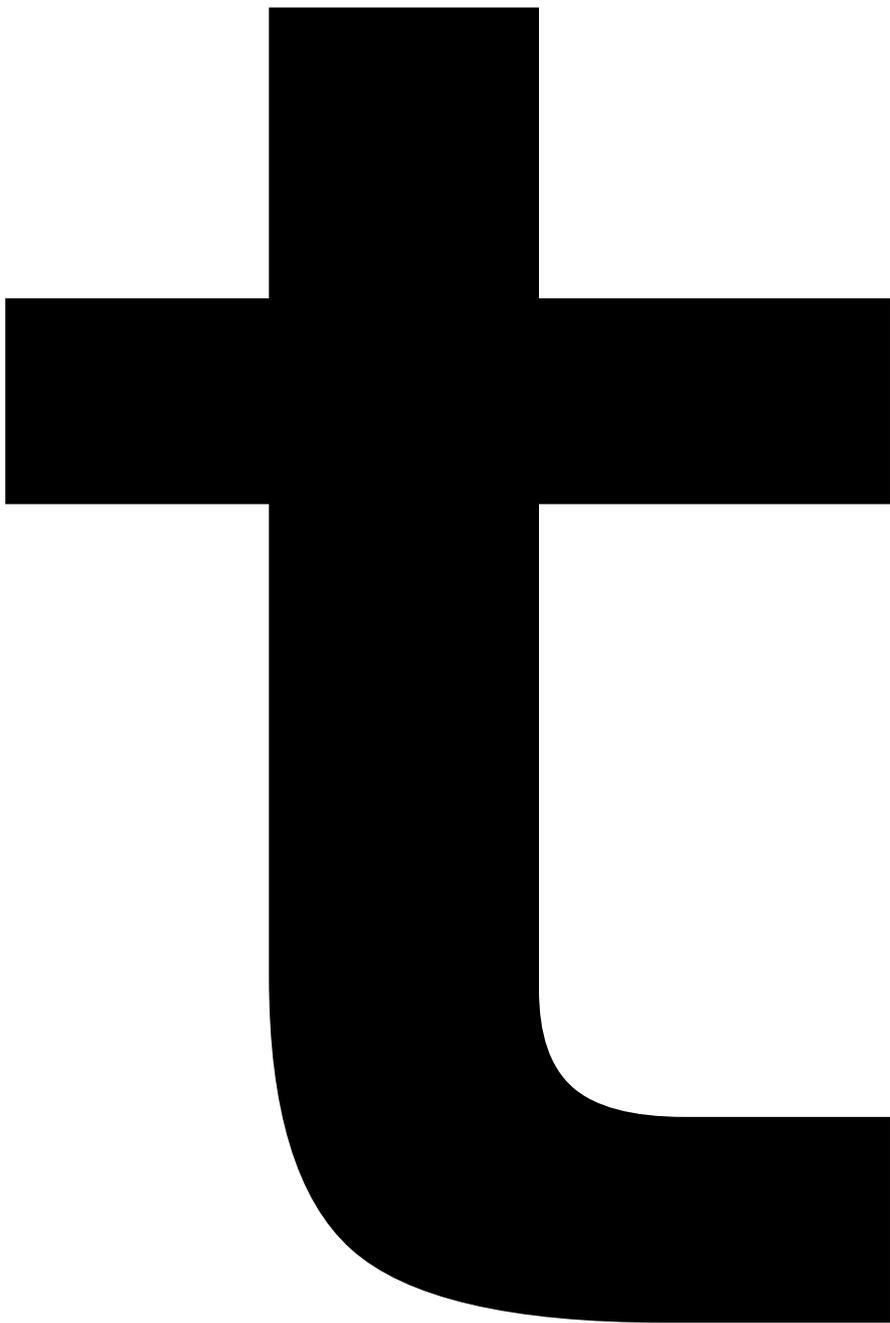
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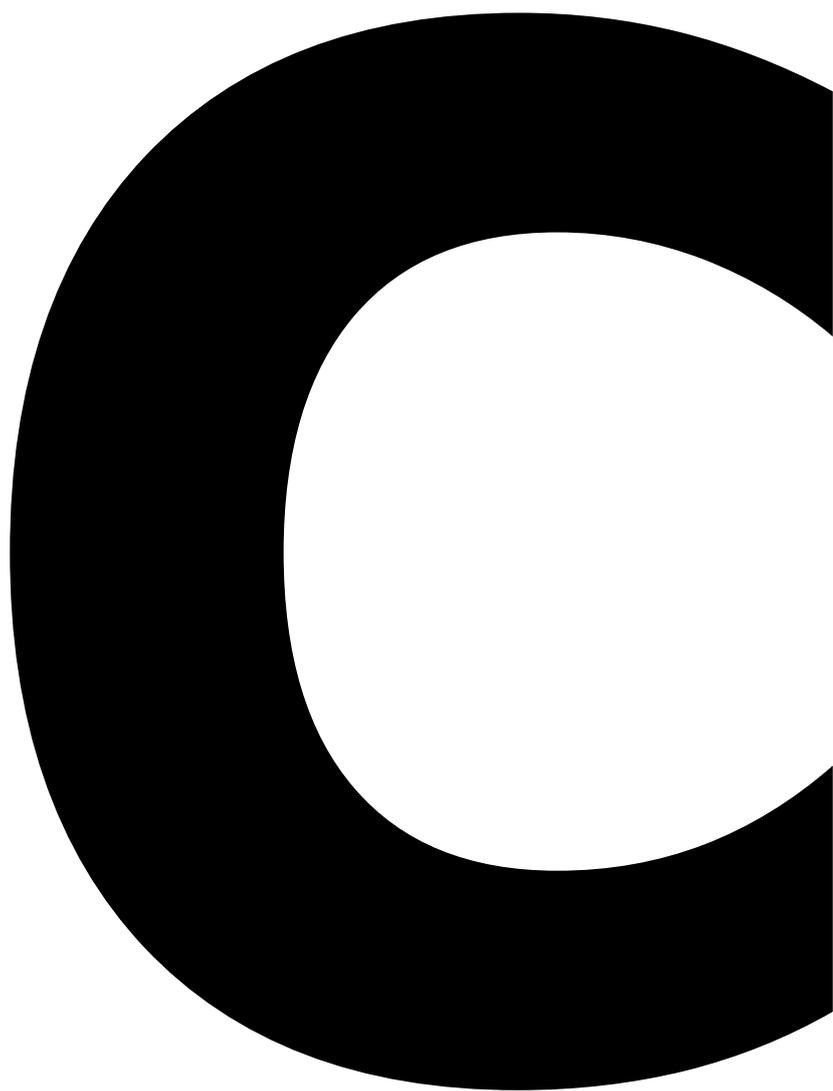
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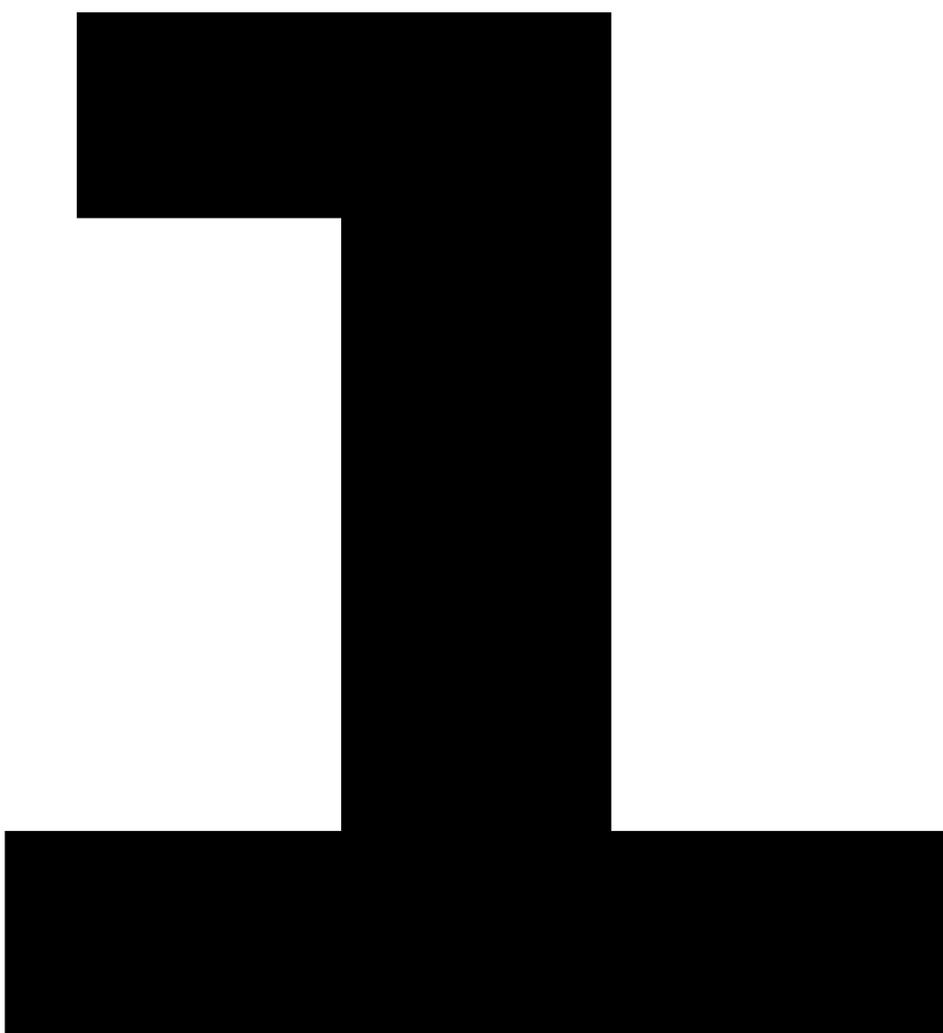
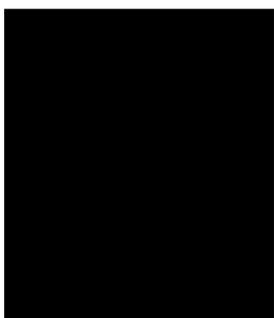
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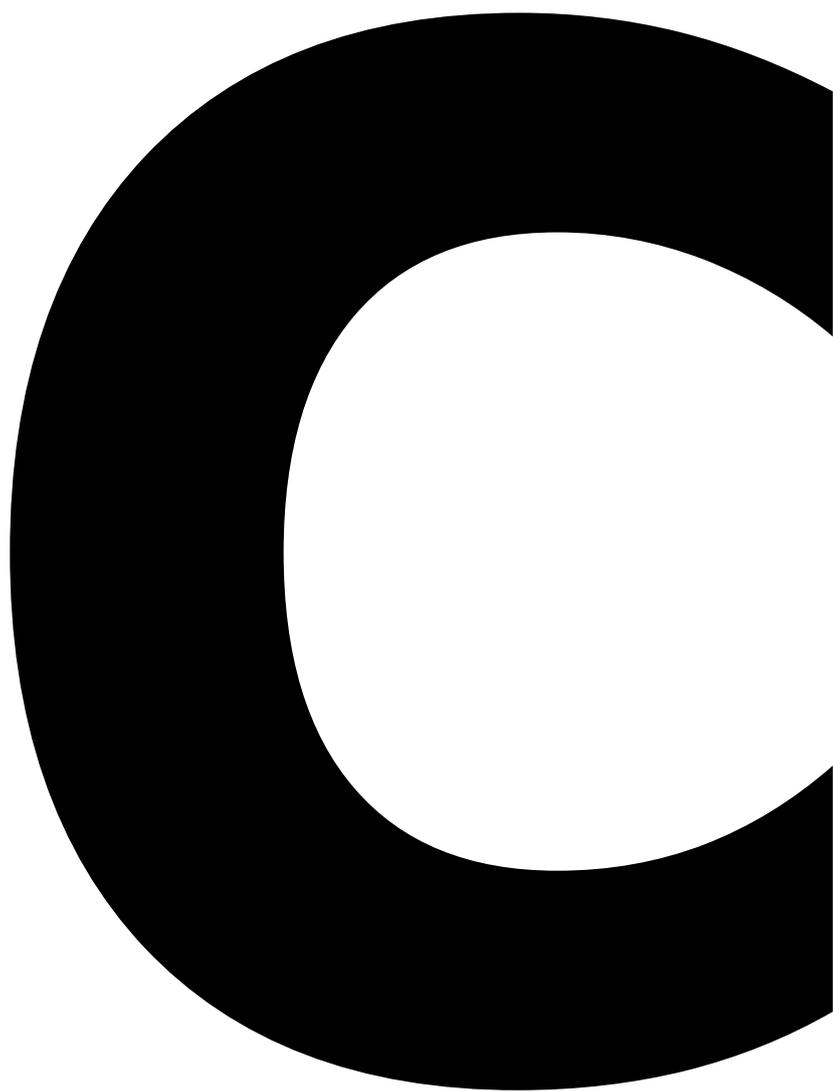
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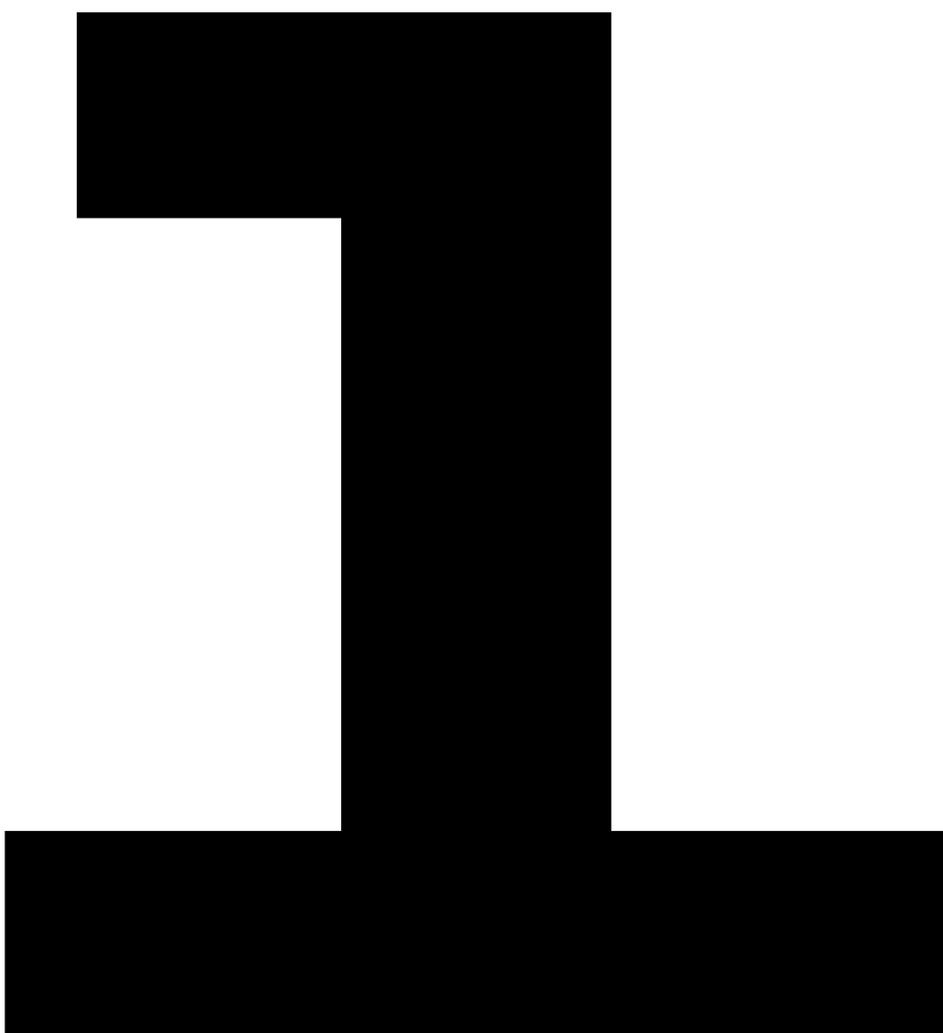
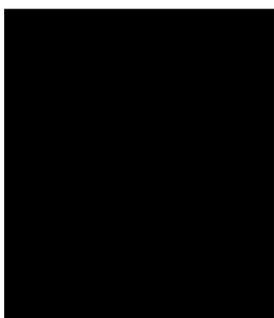
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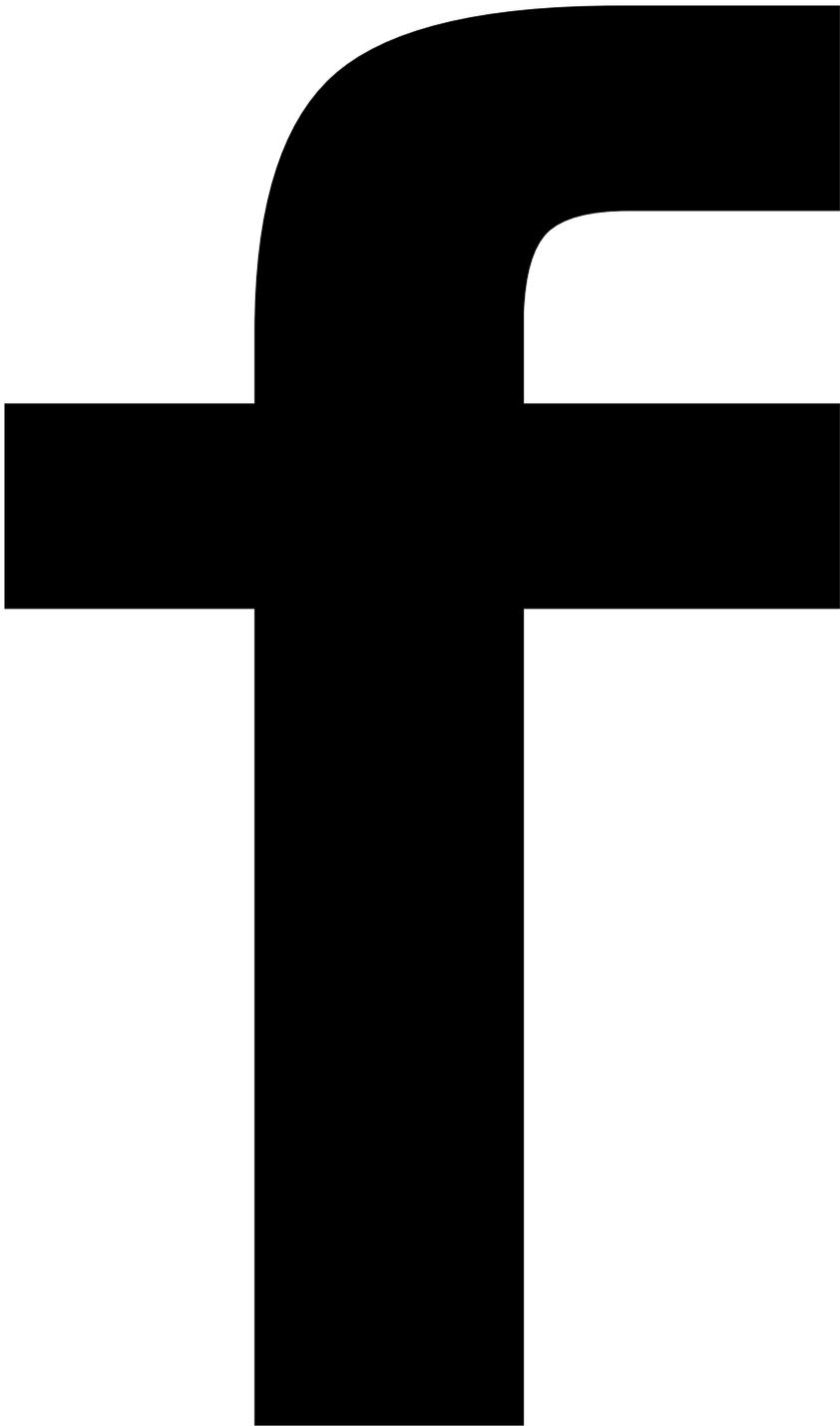
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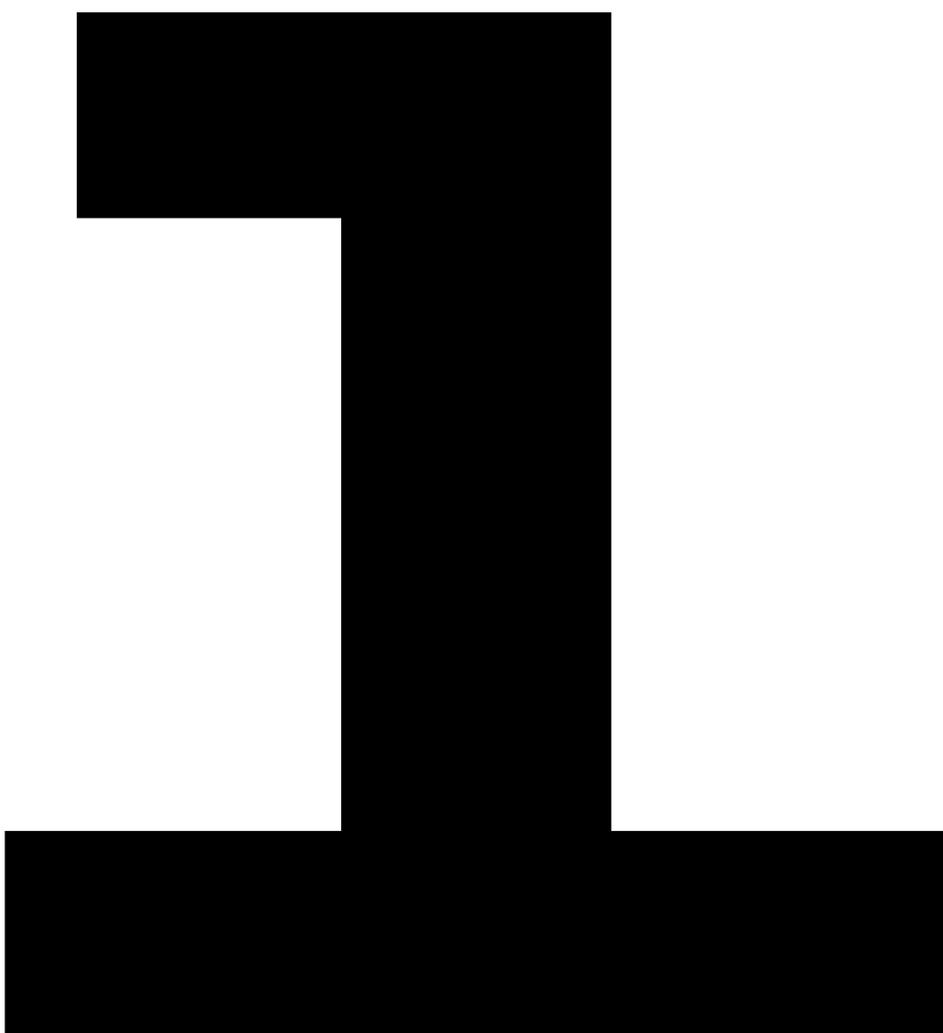
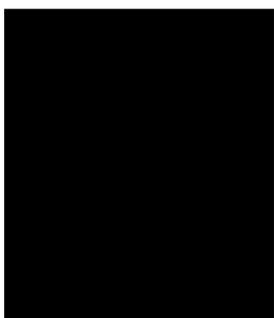


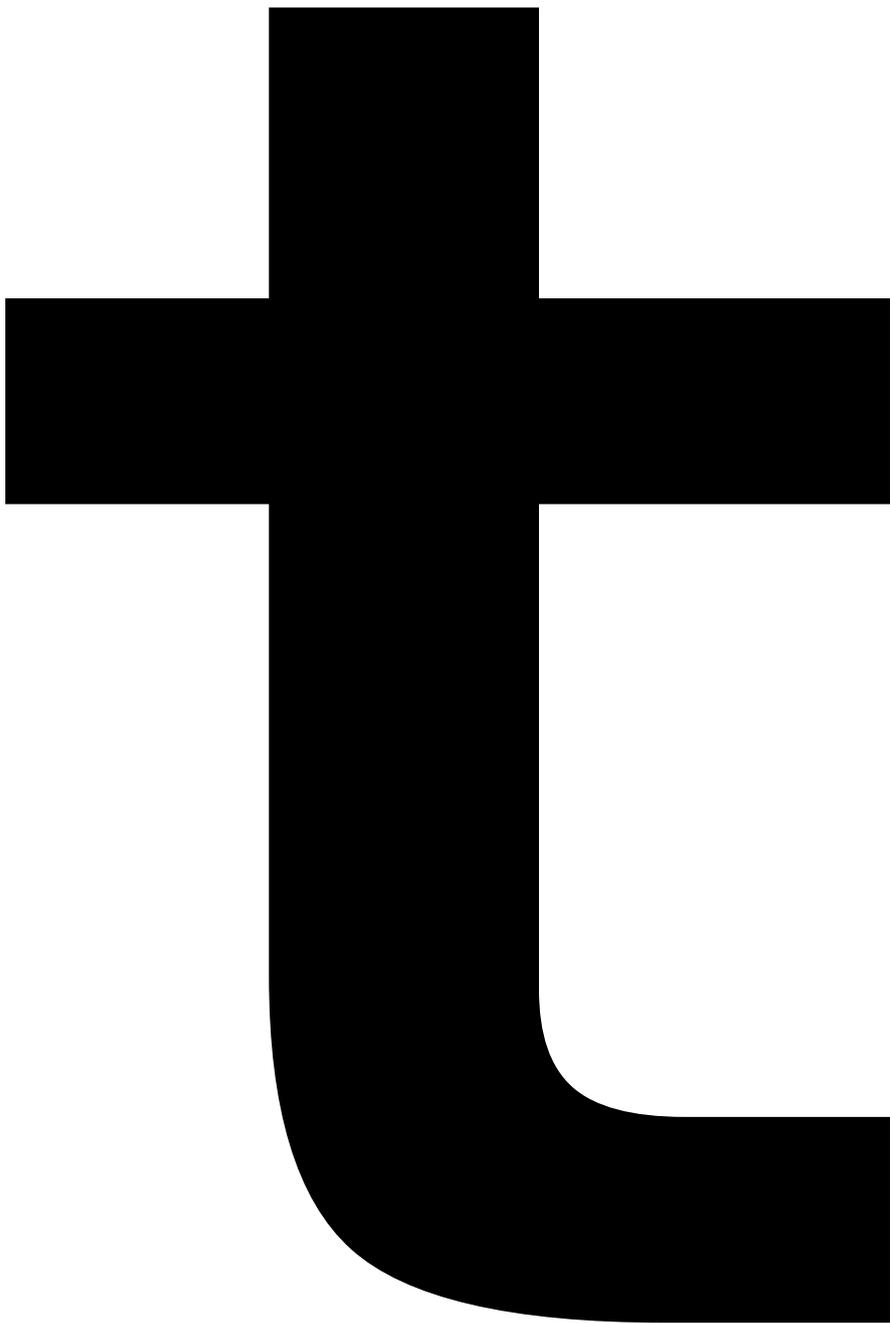
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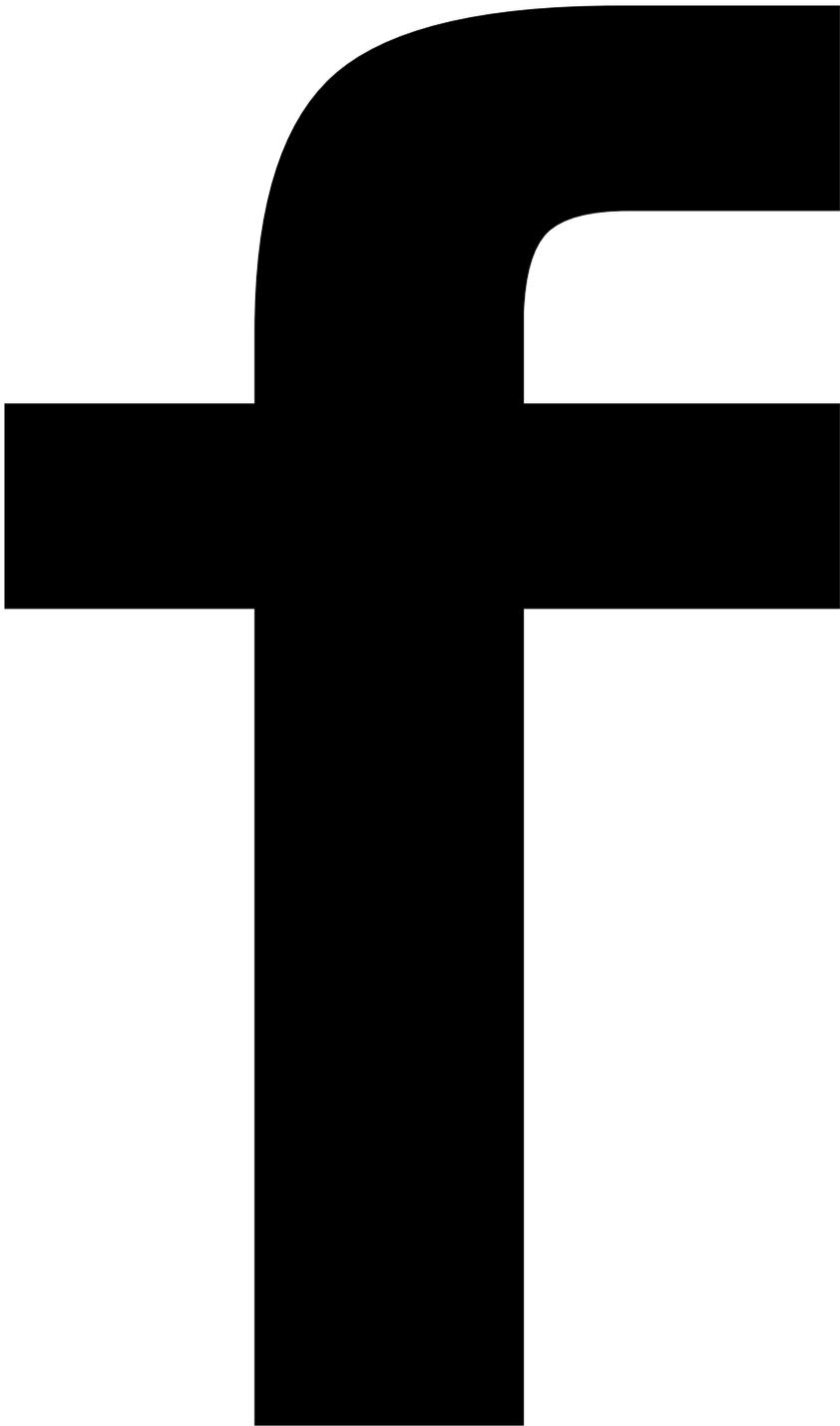
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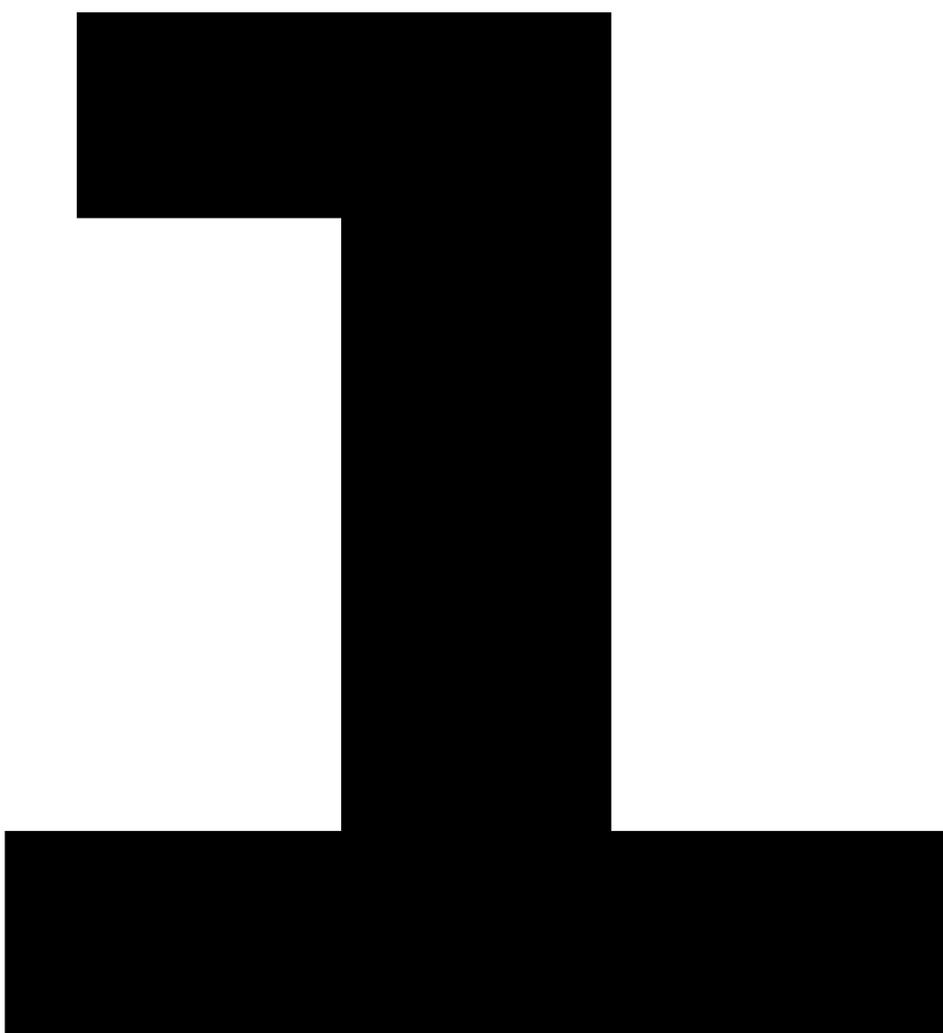
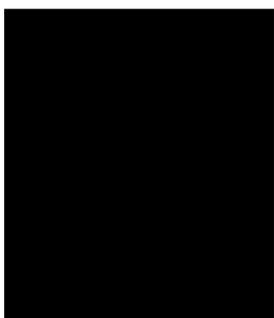
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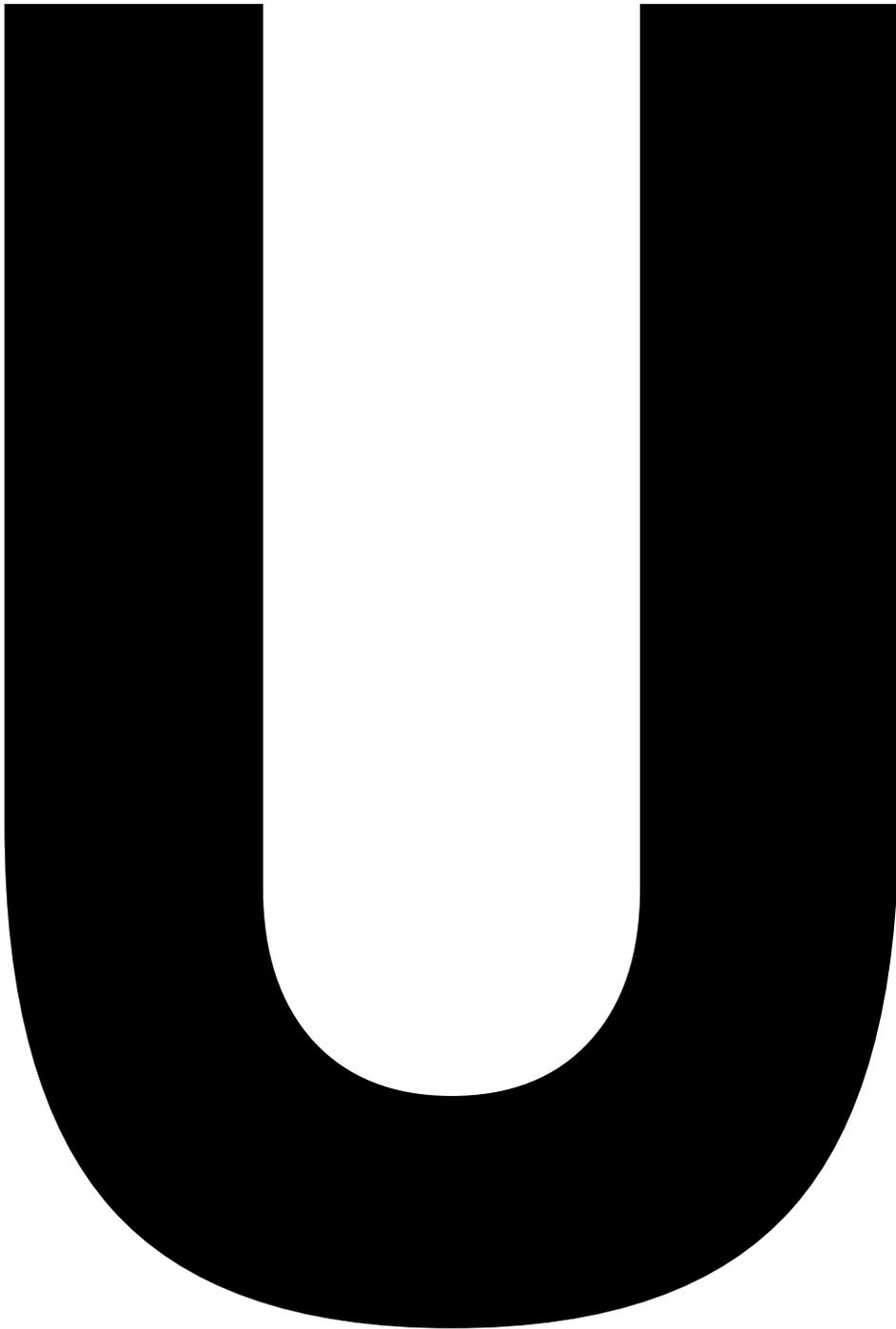
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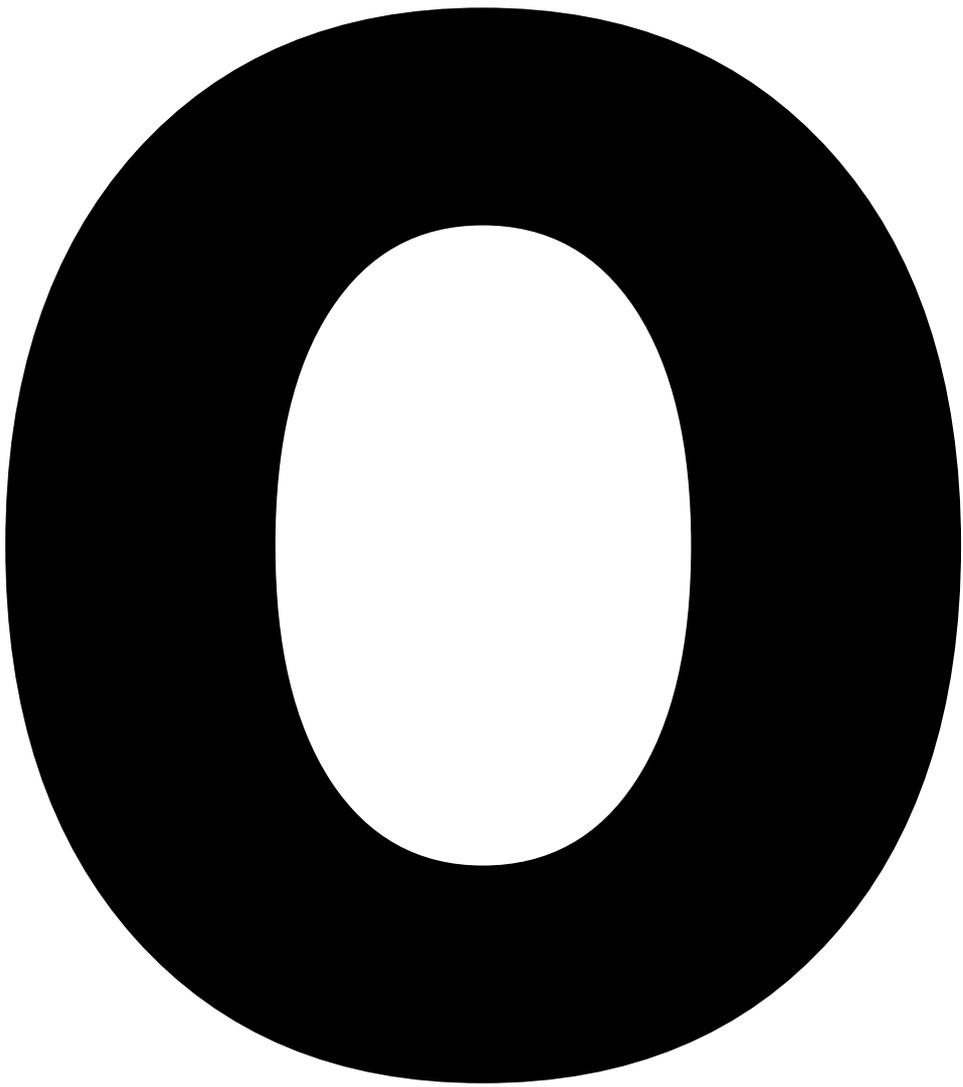


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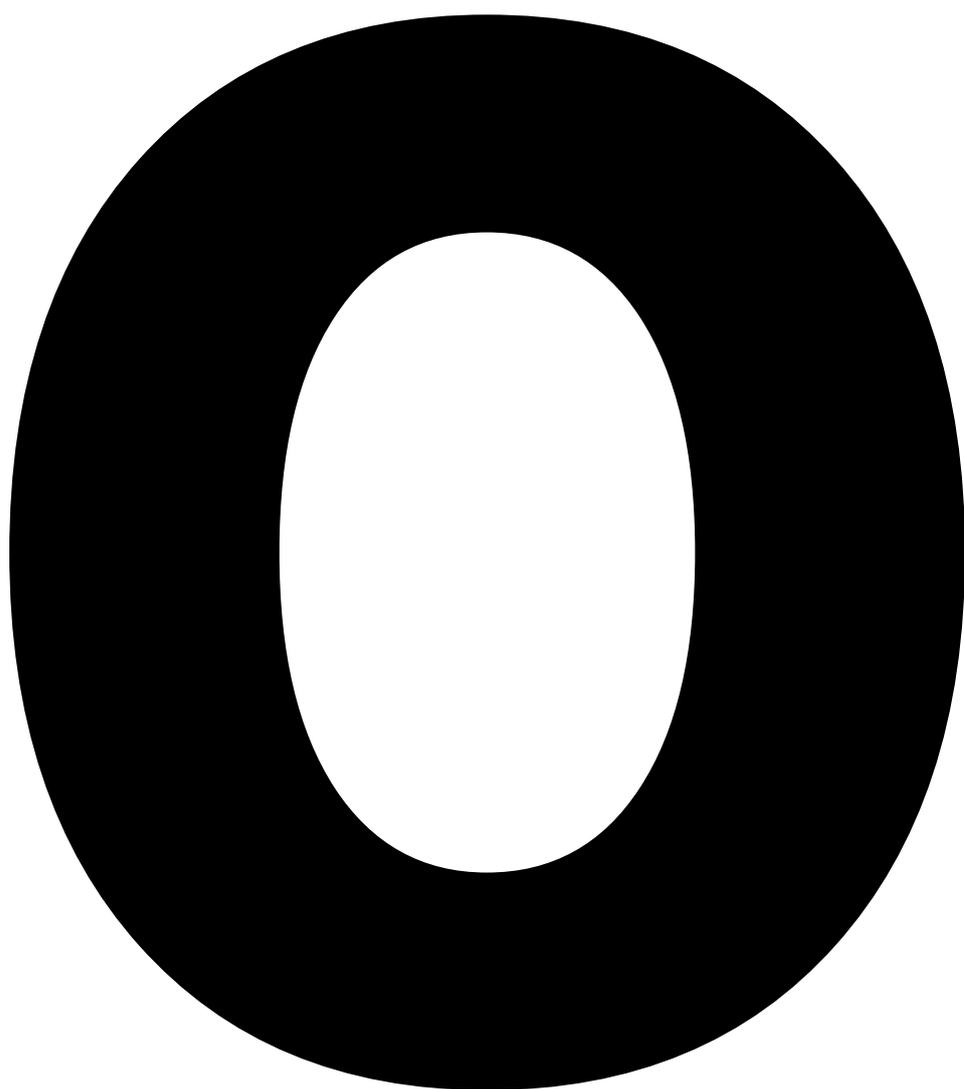
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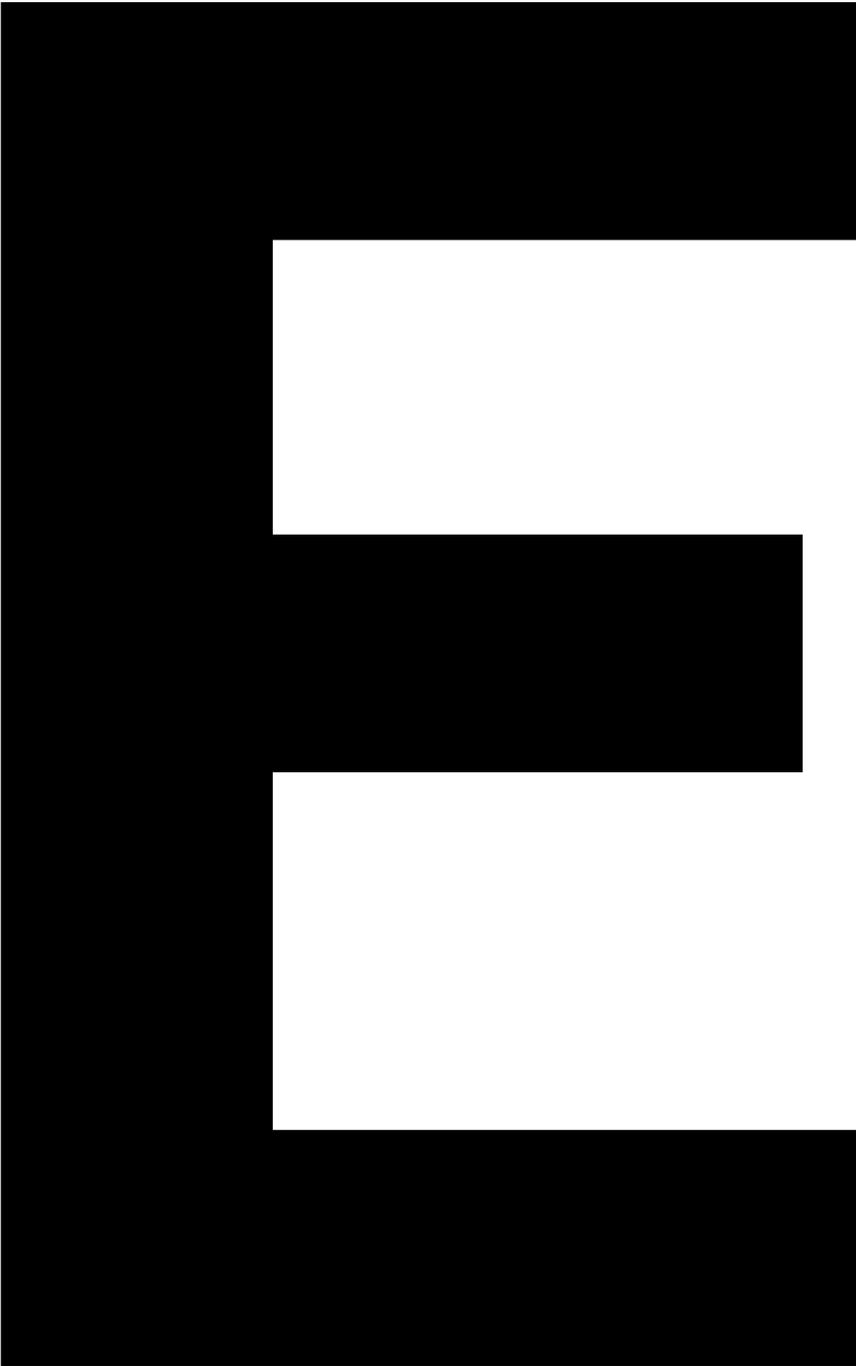


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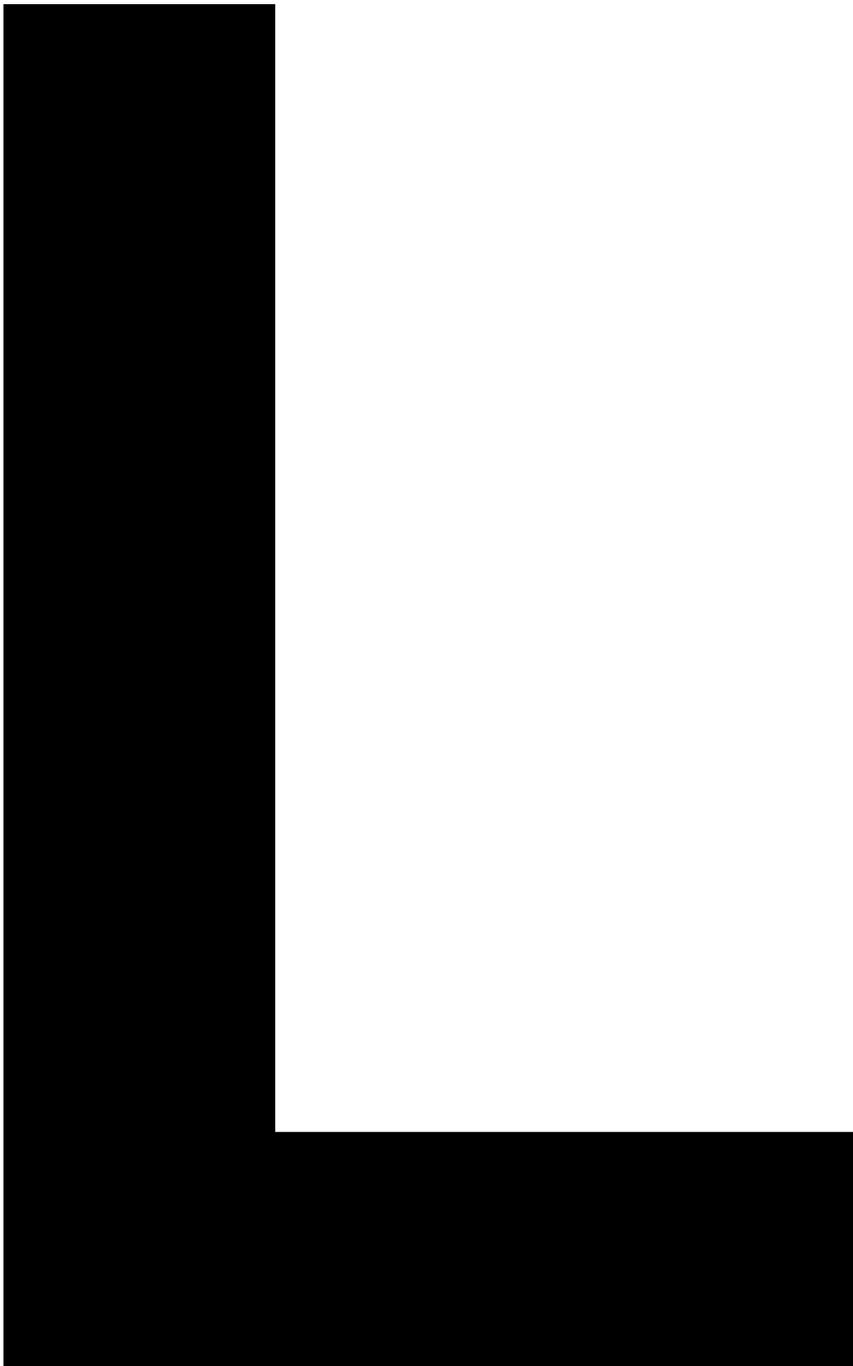
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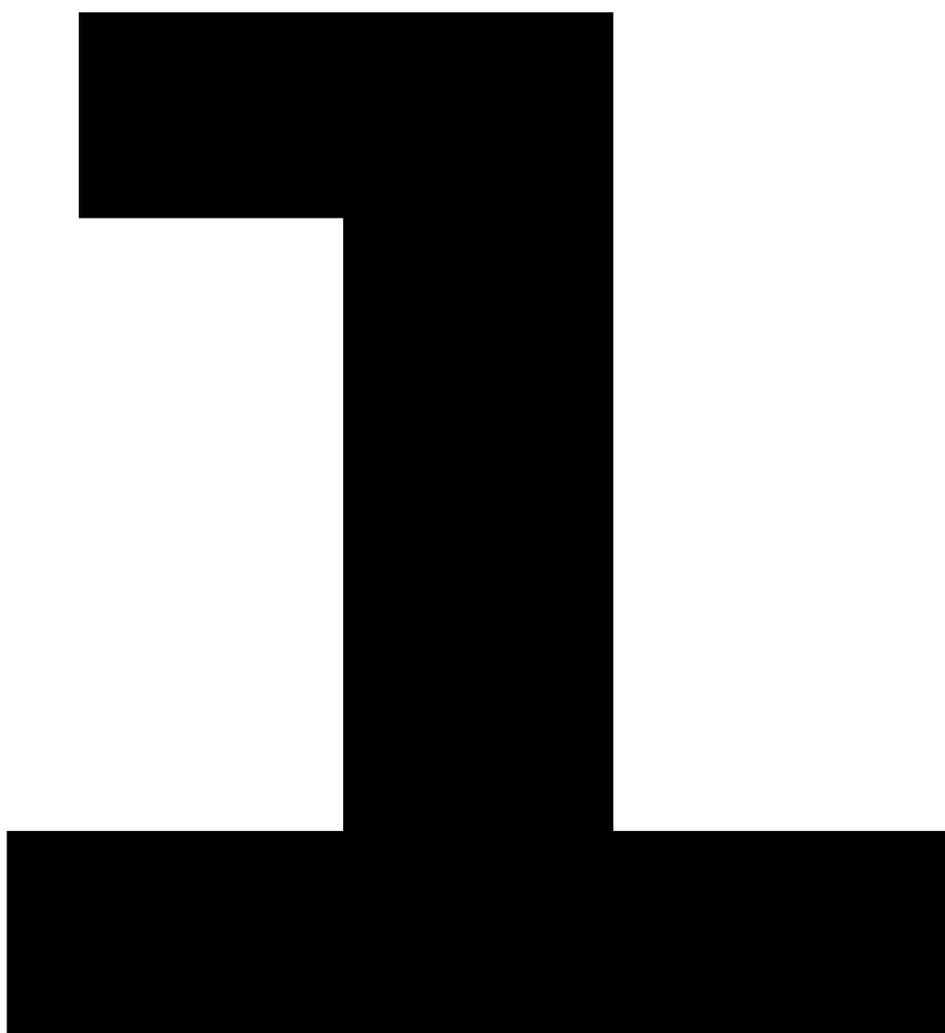
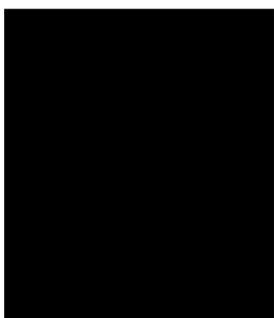


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