THE THREE PHYSICAL STATES

Substances exist in three physical states, depending on their temperature, pressure and heat content.
Any substance can exist as a solid, a liquid or a gas.
For example, water at atmospheric pressure is a solid (ice) at temperatures below 0°C and a liquid from 0°C to 100°C (at temperatures between 0°C and 100°C). At 100°C and above it is a gas (vapour).
Most solids change into liquids when they are heated to a certain temperature.
Liquids change into gases when [they are] heated.

When a liquid becomes a vapour, the process is called evaporation.
changes to a gas
vaporizes / evaporates

Conversely, when a vapour becomes a liquid, the process is called condensation.
a gas changes to a liquid
liquefies

What causes evaporation or condensation ? (What causes a liquid to evaporate or to condense ?)
Substances change their physical state with the addition or removal of heat.

When a substance is heated, heat is added to it.
(*Heating* a substance means adding heat to it.)
The addition of enough heat to a liquid causes its evaporation.
Adding heat to a liquid eventually causes the liquid to evaporate.

Conversely, when a substance is cooled, heat is removed from it.
(*Cooling* a substance means removing heat from it.)
The removal of enough heat from a vapour causes its condensation.
Removing heat from a vapour eventually causes the vapour to condense.

When a liquid evaporates, it absorbs heat.
Evaporation is a process that absorbs heat.
a process absorbing heat.
a heat-absorbing process.

When a vapour condenses, it releases heat.
Condensation is a process that releases heat (into the atmosphere).
a process releasing heat.
a heat-releasing process.

Heat always flows from a warmer substance (a substance at a higher temperature) to a cooler substance (a substance at a lower temperature).
Heat cannot travel spontaneously from a cold body to a hot body.

« Heat » and « temperature » are two different notions.
Heat is a form of energy that produces random motion of the molecules of the substance containing heat.
Temperature measures the speed of motion of the molecules.
The temperature of a substance also indicates how hot or cold that substance is.
As the temperature of a substance increases, its molecules move faster (more rapidly).
Conversely, as the temperature of a substance decreases, its molecules move less rapidly (more slowly).
If all heat is removed from a substance, all molecular motion stops. That point is called absolute zero. It is the lowest temperature possible.

The heat content of a substance is proportional to the mass of the substance multiplied by its temperature.
1 kilogram of water heated to 100°C contains less heat than 10 kilograms heated to the same temperature.
10 kg of water heated to 50°C contain more heat than 1 kg heated to 100°C.

SPECIFIC HEAT CAPACITY

Heating a substance means adding heat to it.
(Conversely, cooling a substance means removing heat from it.)

(Some) heat is required / needed / necessary to raise the temperature of a substance.
must be added
provided

In what units is heat measured ?
In SI, the unit of heat is the joule.
The joule is also the unit of work.
The first law of thermodynamics states that « heat and mechanical energy are mutually convertible ».
This means that the same unit can be used to measure both heat and work.

How much heat is required to raise the temperature of 1 kg of a substance by 1°C ?
(How many joules are required to raise the temperature of 1 kg of a substance by 1°C ?)

Some substances absorb more heat than others when their temperature is raised.
(Remember : heat and temperature are two different things !)
The amount of heat that must be added to 1 kg of a substance to raise its temperature by 1°C is different for each substance. It is called the specific heat capacity of the substance.
(The heat content, or *enthalpy*, of a substance is measured in kJ/kg.)
Water absorbs more heat than most other substances when its temperature is raised.
a larger amount of heat
The specific heat capacity of most substances is lower than that of water.

The specific heat capacity of water is 4.187 kJ/kg.K, which means that 4.187 kJ of heat must be added to 1 kg of water to raise its temperature by 1°C (or K).
(Raising the temperature of 1 kg of water by 1°C requires 4.187 kJ of heat.
It takes 4.187 kJ of heat to raise the temperature of 1 kg of water by 1°C.)

Heat must be removed to lower the temperature of a substance.
How much heat must be removed to lower the temperature of 1 kg of a substance by 1°C ?
The same amount of heat that was added to 1 kg of that substance to raise its temperature by 1°C.
It is also called the specific heat capacity of the substance.

THERMOMETERS

Temperature is measured with a thermometer.
The two most common temperature scales are the Celsius, also called the Centigrade, scale, and the Fahrenheit scale.
Two temperatures determine the calibration of a Celsius thermometer : the temperature of melting ice and the temperature of boiling water (at atmospheric pressure).
On the Celsius thermometer, the temperature of melting ice (or the freezing temperature of water) is 0°C. The temperature of boiling water is 100°C. There are 100 degrees on the scale between freezing and boiling.
On the Fahrenheit thermometer, the temperature of melting ice (or the freezing temperature of water) is 32°F. The temperature of boiling water is 212°F. There are 180 degrees between the freezing and boiling temperatures.
The Kelvin scale uses the same divisions as the Celsius scale, but zero on the Kelvin scale (0 K) is 273 degrees below 0°C. That is the absolute zero temperature.

The three physical states : vocabulaire

substances	**les** substances (généralité au pluriel : pas d'article the)
three	trois
state	état
to depend **on**	dépendre **de**
depending on	dépendant de = selon
their	leur(s)
(l'adj. possessif dépend du possesseur et non de la chose possédée; une seule forme par possesseur)	
pressure	pression
content	contenu, teneur
heat	(de la) chaleur (pas d'article : non dénombrable)
heat content	contenu de chaleur (*structure « week end »)*
and	et
any (phrases sans négation)	tout, n'importe quel
can	pouvoir
(auxiliaire de mode : pas de -s à la 3ème p.sg., pas d'infinitif)	
as	comme = sous la forme de
or	ou
for	pour
for example	**par** exemple
water	eau (nom de substance → pas d'article)
at	à
ice	glace
below	en dessous (de)
from ... to ...	de ... à ... (à partir de ... jusqu'à ...)
between	entre
above	au-dessus (de)
vapour	vapeur
most + nom pluriel	la plupart des
to change into/to	**se** transformer en
when	quand
they	ils/elles
to heat	chauffer
to become	devenir
process	processus
to call	appeler
to vaporize = to evaporate	**se** vaporiser, s'évaporer
converse**ly**	inverse**ment**
to liquefy = to condense	**se** liquéfier, se condenser
what ? (sujet d'un verbe)	qu'est-ce qui ?
it causes the liquid to evaporate	« ça cause le liquide s'évaporer » = cela fait évaporer le liquide, cela cause l'évaporation du liquide
with	avec
addition / removal	addition (ajout) / retrait
of (! ≠ Ndls)	de
to add ... to ..	ajouter (additionner) ... à ...
heating	chauffer, le fait de chauffer
(la forme en -ing est ici une variante de l'infinitif, employée comme sujet d'un verbe : means)	
to mean* (* = verbe irrégulier)	signifier, vouloir dire
enough	assez (de)
eventually	! finalement
its	son, sa, ses (possesseur = it)
to cool	refroidir
to remove ... from ...	enlever, retirer ... de ...
a process **that** absorbs heat	un processus **qui** absorbe de la chaleur (pronom relatif sujet)
heat-absorbing	absorbant de la chaleur = endothermique
to release	libérer, relâcher
heat-releasing	relâchant de la chaleur = exothermique
into	dans (avec mouvement)

always	toujours
to flow	circuler, s'écouler
warm / warm**er**	chaud / **plus** chaud (comparatif)
cool / cool**er**	frais / **plus** frais
high	haut, élevé
low	bas
cannot	(un seul mot) ne peut pas (même forme pr ttes pers.)
to travel	voyager, se déplacer
spontaneous**ly**	spontané**ment**
body	corps
hot	(très) chaud
cold	froid
two	deux
to produce	produire
random	aléatoire
motion	mouvement
to contain	contenir
to measure	mesurer
speed	vitesse
also	aussi
to indicate	indiquer
how	comment
how cold it is	« comment froid c'est » = dans quelle mesure, à quel point
that substance	cette substance (adj. démonstratif)
as	comme = au fur et à mesure que
to increase	augmenter, s'accroître
to move	bouger, **se** déplacer
fast / fast**er**	vite / **plus** vite
more	plus
to decrease	diminuer, décroître
less	moins
slow**ly**	lente**ment**
if	si
all	tout, toute, tous
to stop	**s'**arrêter
low / low**est**	bas / **le plus** bas (superlatif)
equal to	égal à
to multiply by	multiplier par
less **than**	moins **que**
same	même

Points de grammaire illustrés :

- verbes au *simple present*, 3ème pers. du sg (+ s), 3ème pers du pl (= infinitif)
- pas d'article défini the devant les noms pluriels = généralités
- pas d'article devant les noms indénombrables (heat, energy), e.a. noms de substances (water, ice)
- structure « week end »
- construction particulière du verbe to cause
- forme en -ing = infinitif sujet / = ant (équivaut à une relative)
- pronom relatif sujet (that)
- adjectifs composés de structure « OPEP » (heat-absorbing, heat-releasing)
- comparatif, superlatif des adjectifs / des adverbes

Specific heat capacity - Thermometers : vocabulaire

some + nom sg	une certaine quantité de
to require sthg	nécessiter, demander, requérir qqch
= to need sthg	= avoir besoin **de** qqch
(*sthg* = something	*qqch* = quelque chose)
to raise	faire monter, augmenter
to + infinitif	pour
must (auxiliaire de mode, cf. *can* texte précédent)	devoir
to provide	fournir
by 1°C	de (différence) 1°C
what units ?	quelles unités ?
SI = Système International	
work	travail
first	premier
law	loi
thermodynamic**s**	**la** thermodynam**ique**
to state	énoncer, dire
that	que (conjonction de subordination)
this	ceci
both A and B	à la fois A et B, aussi bien A que B
how much ?	combien de ? (+ nom singulier)
how many ?	combien de ? (+ nom pluriel)
some + nom pluriel	un certain nombre de, certain(e)s
other (adj.)	autre
others (pronom)	d'autres / les autres
to remember	**se** rappeler
thing	chose
amount	quantité
each	chaque
specific heat capacity	chaleur spécifique/massique
enthalpy (*h*)	enthalpie
large	! grand, important
that of	(pronom) celui (celle) de
for instance	par exemple
which	ce qui (pr. relatif sujet reprenant toute 1 proposition)
to take*	prendre
it takes... to...	« cela prend... pour... » = il faut... pour...
to lower	abaisser, diminuer
was added	**a été** ajouté (*simple past* passif)
scale	échelle
common	courant, commun
the **most** common scale	l'échelle **la plus** courante (superlatif)
to melt*	fondre
to boil	bouillir
to freeze*	geler
there are	il y a (plusieurs choses)
≠ there is	il y a (une chose)
freezing temperature	t° de congélation
boiling temperature	t° d'ébullition
to use	utiliser, employer
the same... as...	le/la/les même(s)... que...
but	mais
that (pronom)	cela