



008

```
f f f f f   f f f f f   f f f f f
f f f f f   f f f f f   f f f f f
f f f f f   f f f f f   f f f f f
```

009

```
a b c d e f
b d a f b e d b c e b c a f f c e a e f b b e b e
c e f e e c d f f b b a e f d e e e c a a e f a f
a a e a e f a e d f b a c e e a f e f d f d e a b
c a a e f d f a c e a e f a e d f b a c e e a f e
```

010

```
g g g g g   g g g g g   g g g g g
g g g g g   g g g g g   g g g g g
g g g g g   g g g g g   g g g g g
```

011

```
h h h h h   h h h h h   h h h h h
h h h h h   h h h h h   h h h h h
h h h h h   h h h h h   h h h h h
```

012

```
a b c d e f g h
c d f h a b c g e g g c c a a e e g d h e b c a g
c h h a b g d f h e a f a g e c a g f e a f d d g
c g c d d a b f a f f f a d d h b a g b c a g f e
a f d d g c g c d b a b f a f c f a d d h b a g b
```

013

```
i i i i i   i i i i i   i i i i i
i i i i i   i i i i i   i i i i i
i i i i i   i i i i i   i i i i i
```

014

```
j j j j j   j j j j j   j j j j j
j j j j j   j j j j j   j j j j j
j j j j j   j j j j j   j j j j j
```







033

```

a b c d e f g h i j k l m n o p q r s t u v
g r e a t g q d p t s s k e t t k i b m v s f b p
g k e p b k e g m k s c m e l h l b s m d k r c t
g c a u q q f e d f q o e a a n a t r m u p n n r
k c a b c b o s a q e v i n t m r u s k f t o g u

```

034

```

w w w w w w w w w w w w w w w w w
w w w w w w w w w w w w w w w w w
w w w w w w w w w w w w w w w w w

```

035

```

x x x x x x x x x x x x x x x x
x x x x x x x x x x x x x x x x
x x x x x x x x x x x x x x x x

```

036

```

a b c d e f g h i j k l m n o p q r s t u v w x
g j b q r l o m f g q k k h x o a q j p c n h m g
s a t q k d n e f p i b b i t g a p w w x x h k n
n d u k j p u g c r c v u h v a b b p l v g e o e
q c j u f g w g p p h a e u v x a w a q t o i q d

```

037

```

y y y y y y y y y y y y y y y y
y y y y y y y y y y y y y y y y
y y y y y y y y y y y y y y y y

```

038

```

z z z z z z z z z z z z z z z z
z z z z z z z z z z z z z z z z
z z z z z z z z z z z z z z z z

```

039

```

a b c d e f g h i j k l m n o p q r s t u v w x y z
z e b r a z e r o s v y l a r y l v b t j u d x j
e f z v m n l x y a f h t k a x r h d a v n c k r
y a y c w o y w h o e y v m q k e j y f n u m j g
y z b w c j l z c n s o e y v m q k j y f n l x y

```

040

WA WA Ms Ms my my AL AL FL FL DE DE an an go go is is DC DC  
 IL IL to to PM PM be be MD MD is is MD MD in in St St ad ad  
 in in my my NM NM Mr Mr of of it it as as at at TV TV SD SD  
 OK OK NJ NJ NJ NJ me me do do ND ND if if WI WI me me ha ha  
 SC SC or or MI MI NY NY us us or or Dr Dr NM NM MD MD MD MD  
 is is do do it it TX TX Mr Mr my my ND ND of of AK AK Dr Dr  
 ND ND re re OK OK NY NY in in NM NM MT MT FM FM TV TV St St  
 AK AK WI WI WA WA FL FL to to ad ad my my by by to to ad ad  
 SC SC NH NH ad ad pa pa go go AL AL AC AC PM PM on on on on  
 my my if if DC DC ND ND DC DC UK UK OK OK pa pa at at am am  
 PM PM re re MD MD is is NH NH we we no no Mr Mr NY NY go go  
 by by AC AC ha ha it it GM GM TV TV if if GM GM TV TV FM FM

041

is is at at do do us us DE DE NC NC on on MT MT do do on on  
 up up AL AL DC DC TV TV OK OK Ms Ms no no hi hi me me MI MI  
 TX TX up up FM FM to to am am DE DE OK OK FM FM PM PM WI WI  
 if if no no ha ha my my MT MT at at MT MT FL FL MD MD UK UK  
 SD SD OK OK at at is is re re hi hi no no MD MD up up NJ NJ  
 on on TV TV of of SC SC ad ad GM GM OK OK TV TV go go by by  
 TV TV Dr Dr re re go go if if WA WA AK AK Dr Dr go go of of  
 GM GM AL AL AK AK or or ad ad SC SC NC NC ha ha on on ha ha  
 us us NC NC no no MI MI SC SC WA WA DC DC TV TV be be AC AC  
 of of on on PM PM up up PM PM SD SD MT MT we we in in us us

042

cub cub net net she she elm elm got got  
 yea yea ran ran zig zig ohm ohm Rex Rex  
 did did jam jam boo boo GMT GMT leg leg  
 Kay Kay jar jar pea pea had had rip rip  
 her her eve eve sir sir jay jay Jim Jim  
 jab jab ice ice Amy Amy hip hip bet bet  
 lit lit Gil Gil tin tin ant ant Amy Amy  
 Kay Kay end end tin tin mix mix ale ale  
 map map wax wax tie tie don don box box  
 gel gel tap tap ale ale you you FCC FCC  
 one one mew mew gum gum ion ion now now  
 icy icy bop bop oar oar vet vet air air  
 odd odd USA USA Ike Ike set set fed fed  
 owl owl hug hug ham ham alp alp men men  
 jay jay Joe Joe are are put put Lou Lou  
 vee vee tow tow sir sir nor nor Feb Feb

043

|     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| bet | bet | lee | lee | Tim | Tim | hoe | hoe | log | log |
| car | car | kid | kid | lip | lip | law | law | wet | wet |
| fur | fur | men | men | ape | ape | out | out | boy | boy |
| bed | bed | cub | cub | ACS | ACS | try | try | hop | hop |
| fin | fin | fed | fed | Roy | Roy | run | run | rip | rip |
| men | men | did | did | Rex | Rex | jar | jar | sir | sir |
| all | all | flu | flu | red | red | had | had | Sam | Sam |
| dub | dub | vee | vee | spy | spy | and | and | bit | bit |
| wet | wet | gum | gum | why | why | lad | lad | age | age |
| hub | hub | jet | jet | pea | pea | nut | nut | toe | toe |
| dim | dim | ion | ion | leg | leg | dad | dad | our | our |
| bag | bag | bid | bid | for | for | oak | oak | Dow | Dow |
| lad | lad | lot | lot | fan | fan | Gus | Gus | tap | tap |
| cub | cub | way | way | hen | hen | fat | fat | fan | fan |
| NYC | NYC | add | add | day | day |     |     |     |     |

044

|     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| bus | bus | pod | pod | mad | mad | ray | ray | fin | fin |
| ion | ion | guy | guy | red | red | hum | hum | gin | gin |
| fry | fry | oaf | oaf | Jim | Jim | add | add | yea | yea |
| Len | Len | Pam | Pam | set | set | Los | Los | off | off |
| pow | pow | dug | dug | spy | spy | cam | cam | peg | peg |
| bud | bud | lab | lab | bud | bud | rat | rat | you | you |
| egg | egg | try | try | why | why | tax | tax | buy | buy |
| web | web | map | map | pop | pop | Ron | Ron | toe | toe |
| aim | aim | bug | bug | tin | tin | met | met | leg | leg |
| ACM | ACM | lad | lad | lad | lad | Ben | Ben | own | own |
| hey | hey | dim | dim | see | see | sad | sad | mop | mop |
| hop | hop | Tim | Tim | tad | tad | hat | hat | don | don |
| bun | bun | hey | hey | bun | bun | vat | vat | ore | ore |
| bin | bin | sir | sir | sea | sea | sub | sub | old | old |
| was | was | run | run | kid | kid | mop | mop | eve | eve |







053

n4rrx n4wb k4ir a4rl ki4e  
k4xv w4ngg a4if aq4w w4ysh  
nc4f k4qat ay4h n4bxb a4zg  
244 433 411 232 434 314 341 231 242 141 441 212 442 431 212 433 113  
144 112 134 343 124 132 123 122 323 244 224 321 234 233 113 213 444

054

five  
5  
5  
5  
5  
5  
5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5

055

au5n w5vtc w5jqp wc5q ax5y  
n5pg ww5x w5hz aa5c wq5d  
311 555 135 121 141 152 145 525 252 133 122 152 422 131 144 134 535  
524 315 233 535 215 445 551 151 121 322 325 313 313 411 444 253 523

056

six  
6  
6  
6  
6  
6  
6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6

057

ng6g na6t nc6e a6mgu k6mtq  
a6syr a6kbl w6xr a6hnl nf6q  
n6vpx a6of k6to n6mzz n6zww  
361 662 131 453 334 643 415 411 636 412 443 333 313 562 143 534 451  
523 465 226 554 356 313 456 444 561 111 146 335 246 411 112 612 612  
546 165 644 263 134 134 626 622 642 446 634 516 365 434 244 126 366



062

nine

```

9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9

```

063

```

kt9z am9z ny9t a9mvc n9zmj
ad9h kk9t k9pqi wb9u a9zr
n9xyk w9ek kp9x w9vw k9jn
483 277 961 774 637 542 457 997 272 447 992 131 822 945 249 653 364
572 766 816 632 297 396 262 429 122 928 925 153 772 478 826 515 516
826 213 269 484 738 959 474 725 221 825 962 868 821 896 591 538 967

```

064

zero

```

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

```

065

```

kv0o au0x kl0r w0ug wc0e
a0nz kj0i n0eh k0ho n0rf
567 637 141 924 800 697 137 822 461 682 937 578 409 392 199 686 556
781 628 633 092 785 417 483 361 844 909 869 719 579 534 065 871 517
162 038 557 028 732 749 730 583 819 365 663 300 003 041 954 982 560

```

066

cq cq cq de wh8s wh8s wh8s k  
cq cq cq de w9bcr w9bcr w9bcr k  
cq cq cq de n5sj n5sj n5sj k  
cq cq cq de ky2y ky2y ky2y k  
cq cq cq de n8hip n8hip n8hip k  
cq cq cq de kr5c kr5c kr5c k  
cq cq cq de k4gc k4gc k4gc k  
cq cq cq de k7xx k7xx k7xx k  
cq cq cq de kg7q kg7q kg7q k  
cq cq cq de nc0r nc0r nc0r k  
cq cq cq de ae6s ae6s ae6s k  
cq cq cq de a3dm a3dm a3dm k  
cq cq cq de n9cb n9cb n9cb k  
cq cq cq de w6fbp w6fbp w6fbp k  
cq cq cq de k3fmh k3fmh k3fmh k  
cq cq cq de a5ozn a5ozn a5ozn k  
cq cq cq de n1dmi n1dmi n1dmi k

067

cq cq cq de k3vg k3vg k3vg k  
k3vg k3vg de av6d av6d k

cq cq cq de wq8e wq8e wq8e k  
wq8e wq8e de n5zre n5zre k

cq cq cq de w2grw w2grw w2grw k  
w2grw w2grw de nc4p nc4p k

cq cq cq de kw5s kw5s kw5s k  
kw5s kw5s de a6up a6up k

cq cq cq de w6mcz w6mcz w6mcz k  
w6mcz w6mcz de k4rpg k4rpg k

cq cq cq de a9da a9da a9da k  
a9da a9da de a6en a6en k

cq cq cq de w7lc w7lc w7lc k  
w7lc w7lc de at1g at1g k

cq cq cq de kg8c kg8c kg8c k  
kg8c kg8c de w3xzv w3xzv k

068

comma

, , , , , , , , , , , , , , ,  
, , , , , , , , , , , , , , ,  
, , , , , , , , , , , , , , ,  
, , , , , , , , , , , , , , ,  
, , , , , , , , , , , , , , ,

069

period

. . . . . . . . . . . . . . . . .  
. . . . . . . . . . . . . . . . .  
. . . . . . . . . . . . . . . . .  
. . . . . . . . . . . . . . . . .  
. . . . . . . . . . . . . . . . .

070

qth hr is wink, tx.  
qth hr is dallas, tx.  
qth hr is houston, tx.  
qth hr is detroit, mi.  
qth hr is seattle, wa.  
qth hr is boston, ma.  
qth hr is miami, fl.  
qth hr is miami, oh.  
qth hr is denver, co.  
qth hr is las vegas, nv.  
qth hr is  
paris, france.  
qth hr is  
phoenix, az.

071

name hr is carol carol.  
name hr is steve steve.  
name hr is bob bob.  
name hr is chuck chuck.  
name hr is doug doug.  
name hr is harry harry.  
name hr is eve eve.  
name hr is harv harv.  
name hr is ben ben.  
name hr is ken ken.  
name hr is ralph ralph.  
name hr is jeff jeff.

072

rig hr is tentec tentec.  
rig hr is yaesu yaesu.  
rig hr is kenwood kenwood.  
rig hr is knwd knwd.  
rig hr is elecraft elecraft.  
rig hr is heathkit heathkit.  
rig hr is norcal norcal.  
rig hr is homebrew homebrew.  
rig hr is hb hb.  
rig hr is collins collins.

073

wx hr is clear clear.  
wx hr is cloudy cloudy.  
wx hr is cldy cldy.  
wx hr is rainy rainy.  
wx hr is snowing snowing.  
wx hr is windy windy.  
wx hr is cold cold.  
wx hr is dry dry.  
wx hr is hot hot.  
wx hr is wet es cold.  
wx hr is hot es dry.



074

ur rst is 599 599.  
 ur rst is 579 579.  
 ur rst is 569 569.  
 ur rst is 559 559.  
 ur rst is 339 339.  
 ur rst is 589 589.  
 ur rst is 579 579 wid qsb.  
 ur rst is 559 559 wid qrm.  
 ur rst is 559 559 wid qrn fm local storm.

075

ant hr is dipole dipole.  
 ant hr is 3 el yagi 3 el yagi.  
 ant hr is inv vee inv vee.  
 ant hr is vertical vertical.  
 ant hr is vee beam vee beam.  
 ant hr is g5rv dipole g5rv beam.  
 ant hr is long wire long wire.  
 ant hr is rhombic rhombic.  
 ant hr is loop loop.  
 ant hr is 40m dipole up 10 mtrs 40m dipole up 10 mtrs.

076

question mark

? ? ? ? ? ? ? ? ? ? ? ? ? ? ?  
 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?  
 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?  
 ? ? ? ? ? ? ? ? ? ? ? ? ? ? ?

who? who? what? what? where? where?  
 when? when? why? why? how? how?

double dash or equal sign

= = = = = = = = = = = = = = =  
 = = = = = = = = = = = = = = =  
 = = = = = = = = = = = = = = =  
 = = = = = = = = = = = = = = =

name hr is chuck = town of prescott =  
 state is az az = wx is cold and windy =

077

cq cq cq de k7qo k7qo k7qo k

cq cq cq de k7qo k7qo k7qo k

k7qo k7qo de kl7ja kl7ja k

kl7ja kl7ja de k7qo r tu fer call om =  
ur rst is 589 589 hr in prescott, az prescott, az =  
name hr is chuck chuck = so hw cpy? kl7ja de k7qo k

k7qo de kl7ja r tu chuck fer report fm az =  
ur rst is 559 559 hr in junco, ak junco, ak =  
name is leo leo = so bk to u chuck = k7qo de kl7ja k

kl7ja de k7qo fb leo and tnx fer sig rpt fm ak =  
wx hr is cool and windy = temp is 52 f 52 f =  
rig is tentec corsair 1 running 5w to a vee beam up 10 mtrs =  
hw is signal holding leo? kl7ja de k7qo k

k7qo de kl7ja fb agn chuck = wx hr is cold and snowing =  
temp is 10 f 10 f = have 1 meter of snow and more falling =  
rig is elecraft k2 running 5w to a 3 element yagi at 15 mtrs =  
band sounds like it is closing so will say 73 fer now = 73  
gl es gn fm ak = c u agn chuck <sk> k7qo de kl7ja ee

kl7ja de k7qo fb leo and tnx fer qso = ur my first kl7 on  
this band so qsl sure via buro =73 gl es gn fm az = cul <sk> kl7ja de k7qo ee

078

cq cq cq de k2lu k2lu k2lu k

k2lu k2lu de k7un k7un k

k7un de k2lu tu fer call = ur rst 559 559 in albany ny =  
name is mary = so hw? k7un de k2lu k

de k7un r ok mary es ga = ur rst 599 599 = qth reno nv = name is bill =  
bk to u mary = k2lu de k7un k

de k2lu solid cpy bill es tnx fer report =  
rig is tentec corsair running abt 50 wts = ant is dipole up at 55 ft =  
wx is clear = temp abt 60 deg f = bk to u bill = k7un de k2lu k

de k7un ok mary fb on all = rig is norcal 40a =  
runs abt 2 wts to a long wire at 45 ft = wx is cldy es 50 deg = bk to u mary =  
k2lu de k7un k

r r fb agn bill = dinner about ready = so must run so will sign wid u nw =  
73 es gl bill = cu agn <sk> k7un de k2lu ee

de k7un ok mary = tnx fer qso = c u agn = gl es 73  
<sk> k2lu de k7un ee

079

cq de w4rx w4rx k

w4rx de k0dx k0dx k

k0dx de w4rx tu fer call = ur rst 579 =  
qth is atlanta ga = name is ed = so hw cpy? =  
k0dx de w4rx k

de k0dx r ok ed es gm = ur rst 599 599 =  
qth st louis mo = name is doug =  
bk to u ed = w4rx de k0dx k

de w4rx solid cpy doug = tnx fer report =  
rig is yaesu ft1000mp = running abt 100 wts = ant is  
yagi up at 55 ft = wx is clear es abt 75 f =  
bk to u doug = k0dx de w4rx k

de k0dx ok ed fb on all = rig is kenwood ts840s =  
runs abt 75 wts to a vertical = wx is cldy es 60 deg =  
bk to u ed = w4rx de k0dx k

r r fb agn doug = time to get to wrk =  
so fer nw 73 doug = bcnu <sk> k0dx de w4rx ee

de k0dx ok ed = tnx ed = cul 73 gl <sk> w4rx de k0dx ee

080

cq de kh6jl kh6jl k

kh6jl de kl7aa kl7aa k

kl7aa de kh6jl tu fer call = ur rst 569 =  
qth is honolulu hi = name is ted = so hw cpy? kl7aa de kh6jl k

de kl7aa r ok ted es ge r = ur rst 589 589 =  
qth fairbanks ak = name is henry =  
bk to u ted = kh6jl de kl7aa k

de kh6jl = solid cpy henry es tnx =  
rig is homebrew = running abt 3 wts = ant is  
3 el beam up at 55 ft = wx is clear es abt 75 f =  
bk to u henry = kl7aa de kh6jl k

de kl7aa ok ted fb on all = rig is kenwood ts940s =  
runs abt 75 wts to a 4 el yagi at 100 ft = wx is  
cldy es 30 deg = bk to u ted = kh6jl de kl7aa k

r r = fb agn henry = well time to get some sleep =  
so fer nw 73 henry = bcnu <sk> kl7aa de kh6jl ee

de kl7aa ok ted = tnx = cul = 73 gl  
<sk> kh6jl de kl7aa ee

081

cq de k1es k1es k

k1es de k3az k3az k

k3az de k1es tu fer call ur rst 549  
in bangor me name is jim so hw? k3az de k1es k

de k3az r ok jim es gm ur rst 579 579  
qth baltimore md es name is larry  
bk to u jim k1es de k3az k

de k1es solid cpy larry es tnx  
rig is collins running abt 90 wts ant is  
dipole up at 25 ft wx is clr es 40 f  
bk to u larry k3az de k1es k

de k3az ok jim fb on all using drake tr7  
runs abt 85 wts to a vert gnd mntd wx is  
clr es 34 deg bk to u jim  
k1es de k3az k

r r fb agn larry wl time to wrk sked wid friend

so fer nw 73 larry bcnu <sk> k3az de k1es ee

de k3az ok jim tnx cul 73 gl  
<sk> k1es de k3az ee

082

cq cq de aa5uu aa5uu k

aa5uu de xe1cc xe1cc k

xe1cc de aa5uu tu fer call ur rst 559  
in albuquerque nm name is lisa so hw nw? xe1cc de aa5uu k

de xe1cc r ok lisa es gm ur rst 579 579  
qth cancun mexico es name is jose  
bk to u lisa aa5uu de xe1cc k

de aa5uu solid cpy jose es tnx  
rig is heathkit hw16 running abt 75 wts ant is  
dipole up at 40 ft wx is clr es 45 f  
bk to u jose xe1cc de aa5uu k

de xe1cc ok lisa fb on all using collins s line  
runs abt 85 wts to a dipole wx is  
clr es 84 deg bk to u lisa  
aa5uu de xe1cc k

r r fb agn jose wl time to wrk i am a pilot for airline  
age is 38 so fer nw 73 es 88 jose bcnu <sk> xe1cc de aa5uu ee

de xe1cc ok lisa gracias cul 73 gl  
<sk> aa5uu de xe1cc ee

083

e f j a n x m p r v j b x i m v o k v u v b h s u f p h p l  
v p q a v f y x m f e v z u m c c d w n e v v i r o h y j w  
x i p o r q a v o k e z k t m o m a k u r t o l y o x y f m  
b s e o a s q k b y e d m j m k v a q b a s k z a m d d r x  
q f c y a m o m f w e n m n k c j x j m y y p v l i b c v a





091

Kilometer, pronounced KIHl uh mee tuhr or kuh LAHM uh tuhr, is a unit of distance in the metric system. The word is also spelled kilometre. Its symbol is km. One kilometer equals 1,000 meters, a distance of about five-eighths of a mile.

092

Fort originally was a fortified building or place that provided defense against attack. On the American frontier, many forts also served as trading posts. Many cities that grew up around forts bear their names, including Fort Wayne, IN. The term fort now applies to permanent United States Army posts.

093

Fathom, pronounced FATH uhm, is a unit of length used to measure ropes or cables and the depths of water. One fathom is equal to 1.8 meters. Navigators mark a rope in fathoms and drop it into the water to measure the depth. Sailors of average height often measured fathoms roughly by extending both arms and measuring the rope from fingertip to fingertip.

094

Logbook is the official or legal written record of the events that take place during a ship's voyage. The log may be written up once a day by the captain of the ship, or it may be written by the officer in charge of each watch. It includes a record of the ship's course and speed, the weather, and any ships or lands sighted. It also includes mention of any sickness, death, or crime on board ship, and of any other unusual event.

095

Mauna Kea, pronounced MOW nuh KAY uh, is a volcano on the island of Hawaii. Its peak rises 4,205 meters above sea level and 10,203 meters above the base of the mountain on the floor of the Pacific Ocean. Its rise from base to peak is the greatest in the world. This distance is 1,356 meters longer than the rise from sea level to the peak of Mount Everest. The name Mauna Kea means white mountain.



096

Watt is a unit of power in the metric system. Power is the rate of producing or using energy. The symbol for the watt is a capital W. The watt is commonly used to measure electric power, even in countries that have not adopted the metric system. An electric device uses 1 watt when 1 volt of electric potential drives 1 ampere of current through it. The number on a light bulb shows its power requirement in watts. For example, a light bulb operating at 100 volts and using 2 amperes consumes 200 watts. Often, power is measured in kilowatts. One kilowatt equals 1,000 watts. The watt also is used to measure mechanical power. A machine requires a power of 1 watt if it uses 1 joule of energy in 1 second. The watt was named for the Scottish engineer and inventor James Watt.

097

Zenith, pronounced ZEE nihth, in astronomy, is any point directly above a person on the earth. Zeniths lie on the celestial sphere, which can be pictured as an imaginary sphere that encloses the universe. A point directly below a person on the earth is called a nadir. Astronomers speak of two kinds of zeniths, astronomical zeniths and geocentric zeniths. An astronomical zenith is determined by gravity. It is any point where an extended plumb line would intersect the celestial sphere. A geocentric zenith is determined by geometry. It is any point where a line drawn from the earth's center through a person on its surface would intersect the celestial sphere. The angular distance of a star or other celestial body from a zenith is called the zenith distance. This information can be used to describe the position of such an object.

098

Tugboat, also called tug, is a small, powerful boat that maneuvers large vessels. Tugs that are used in harbors can tow large ocean liners or freighters and aid all types of vessels in entering or leaving their anchoring places. They can tow from the front or side, or push from the back. Tugs measure from 65 to more than 250 feet (20 to 76 meters) long. They are driven by engines with 2,000 to 22,000 horsepower (1,500 to 16,400 kilowatts). The largest tugboats are the oceangoing tugs, which rescue or assist ships at sea. Tugs used on inland lakes and rivers tow or push long lines of barges loaded with heavy cargoes. Modern tugs can push 40 or more barges at once.

099

Teflon is a trade name for polytetrafluoroethylene, a type of synthetic material that is used in cookware, insulation, and many other products. Teflon is manufactured by the DuPont Company, and the name Teflon is a registered trademark of DuPont. Roy J. Plunkett, an American chemist, invented this material in 1938.

Teflon is a polymer, a substance consisting of long, chainlike molecules. Each molecule is made up of a chain of tens of thousands of carbon atoms, with each carbon atom also connected to two fluorine atoms. Teflon is inert - that is, it does not react with most other chemicals. It also resists moisture and remains stable in extreme heat and cold. Teflon feels slippery to the touch, and adhesive materials will not stick to it.

100

Quart is a unit of volume and capacity for both dry and liquid substances in the inch-pound system of measurement. This system is used in the United States. The liquid quart equals 1/4 of a gallon and contains 57.750 cubic inches. It equals 0.946 liter in the metric system. The dry quart equals 1/32 of a bushel and contains 67.200 cubic inches. It equals 1.101 liters. Quarts are divided into two pints. The imperial quart was once used in Britain and such countries as Canada and New Zealand. But it has been replaced with metric units of measurement. The imperial quart contains 69.355 cubic inches, or 1.137 liters.

101

Kakapo is a rare New Zealand parrot. It now survives only in beech forests in Fiordland and Stewart Island, off the coast of the South Island of New Zealand. Some kakapos have also been released on Little Barrier Island, near Auckland, in an effort to save the birds from extinction.

The bird is about 60 centimeters long. Its plumage is green with black and brown bars. It cannot fly like most other birds but must leap from a high point and glide. It normally travels along the ground, clearing tracks through the bush, low scrub, and grass.

Kakapos eat berries, fern roots, and lizards. The birds nest in large natural crevices or in burrows. Female kakapos usually lay from two to four white eggs.

102

Mint is a place where coins are made.

In the United States and most other countries, only the government may mint coins. American mints are supervised by the United States Mint, a division of the Department of the Treasury. Mints now operate in Denver, Philadelphia, San Francisco, and West Point, N.Y. They make only coins. The Bureau of Engraving and Printing in Washington, D.C., makes paper money. U.S. mints make half dollars, quarters, dimes, nickels, and cents for general circulation. They also make commemorative coins for special occasions and gold and silver bullion coins for investors. Historians believe the world's first mint was founded during the 600s B.C. in Lydia, now a part of Turkey. Ancient Mediterranean civilizations, including Greece and Rome, used coins in commerce. The use of coins gradually spread throughout Europe and Asia. The first mint in the United States was established in Boston in 1652. It produced coins under the authority of the General Court of the Massachusetts Bay Colony. The Articles of Confederation of 1781 gave both the U.S. Congress and the individual states authority to mint money and regulate its value. The first federal mint opened in Philadelphia in 1792 and is still in operation.

103

Photon, pronounced FOH tahn, is the elementary particle that makes up light and all other forms of electromagnetic radiation.

Like all particles, photons have properties of waves, including frequency and wavelength. But photons have no mass and no electric charge. The speed at which photons travel in a vacuum is the speed of light. The exchange of photons between electrically charged particles transmits the electromagnetic force, one of the four fundamental forces.

In 1900, the German physicist Max Planck showed that the energy of a photon (then called a radiation quantum) is proportional to the frequency of its light. The German-born physicist Albert Einstein carried Planck's discovery further. In 1905, Einstein used the idea of photons to explain the ability of light to knock electrons out of atoms - a phenomenon known as the photoelectric effect.

His predictions about photons, which were later confirmed by experiment, contributed much to the development of the quantum theory.

104

Summer is the warmest season of the year. The Northern Hemisphere, the northern half of the earth, has summer weather during late June, July, August, and early September. Summerlike days sometimes occur in mid-autumn. In the Southern Hemisphere, summer lasts from late December until early March. For dates of the first day of summer and details about the position of the earth and sun, see season.

In summer, warm southern winds carry moisture north from the Gulf of Mexico to central and eastern North America. They can bring warm, humid weather to much of the region east of the Rocky Mountains and as far north as Canada. Thunderstorms often develop in and along the northern boundary of this warm, moist air. The highest summer temperatures usually occur in the middle of the continent.

105

Talc is a soft mineral found in flat smooth layers of rock, and in compact masses. It is so soft that it can be scratched with the fingernail, and it feels soapy or greasy. Talc is translucent, which means that it will allow light to go through, yet is not transparent. Talc is white, greenish, or dark gray. Steatite, soapstone, is a compact talc. Talc has many commercial uses. It is sold in slabs or in powdered form. Slabs are used to line furnaces and heating stoves, and for electric insulation, because talc is a poor conductor of heat and electricity. It is ground up to make talcum powder. Powdered talc is also used in crayons, paint, paper, and soap. The leading talc-producing nations include China, Finland, India, and the United States. Montana, New York, Texas, and Vermont are important talc-producing states.

106

Putty is a filler material that is soft when applied but slowly hardens. It is used to fill knotholes, cracks, and other defects in wood surfaces before the surfaces are painted. Putty is also placed around the edges of panes of glass to seal them in a window sash or door.

The most common putty is a mixture of powdered natural chalk, called whiting, and linseed oil to which a small proportion of coloring agents may be added. Putty hardens because some of the oil combines with oxygen from the air and the rest of the oil soaks into the wood.

Some projects require special, more elastic putty. This type of putty is made from vegetable oil, nondrying oils, driers that make the putty harden, synthetic fibers, a powdered limestone filler, and a coloring agent.

**107**

Joule, pronounced jool or pronounced jowl, a unit in the metric system of measurement, is used to measure work or energy. Its symbol is a capital J. One joule is the amount of work done when a force of 1 newton acts on an object that moves 1 meter in the direction of the force.

The joule is used to measure all forms of energy, including heat, electrical energy, and mechanical energy. One joule equals about 0.239 calorie. A calorie is the amount of energy needed to raise the temperature of 1 gram of water by 1 Celsius degree. One joule of energy per second is required to pass an electric current of 1 ampere through 1 ohm resistance. One joule per second equals one watt, a unit of electric and mechanical power.

In the inch-pound system of measurement customarily used in the United States, work or energy is measured in foot-pounds. One joule equals about 0.738 foot-pound. The joule was named for the British physicist James P. Joule.

**108**

Hardness is the ability of a material to scratch a mark on other substances or to resist being scratched by them. Scientists measure the hardness of a material by comparing it with a table of 10 well-known minerals. The minerals are arranged in order from 1 to 10. Each mineral in the table scratches the ones with lower numbers, and can be scratched by all those with higher numbers.

The standard "scale of hardness" follows: (1) talc, (2) gypsum, (3) calcite, (4) fluorite, (5) apatite, (6) feldspar, (7) quartz, (8) topaz, (9) corundum, (10) diamond.

To test another substance, you match it against the minerals of the hardness scale. You can get an approximate idea of the hardness of a mineral by using your fingernail, a copper coin, a piece of window glass, or a knife blade. The hardness of these materials is as follows: fingernail, 2 to 2 1/2; copper coin, 2 1/2 to 3; window glass, 5 to 5 1/2; and knife blade, 5 1/2.

When materials must be accurately tested, as in the manufacture of tools and gears, machinists use an instrument called a sclerometer. This device registers the force required to dent or scratch the material with a diamond or borazon, the hardest substances known.

**109**

Vanilla is the name of a group of climbing orchids. The vanilla extract that is used to flavor chocolate, ice cream, pastry, and candy comes from these plants. The vanilla vine has been cultivated in Mexico for hundreds of years. This type of vanilla has been introduced into other tropical areas. Comoros, Indonesia, Madagascar, and Reunion produce much of the worlds supply. Another species grows on the island of Tahiti in the South Pacific. The vanilla vine has little rootlets by which the plant attaches itself to trees. The cultivated plant lives about 10 years. It produces its first crop after three years. The plant produces a fruit in the shape of a cylindrical pod, bean, that measures from 13 to 25 centimeters long. The fruit has an oily black pulp that contains many tiny black seeds. The pods are gathered when they are a yellow-green in color. Then the curing, or drying, process takes place. This process shrinks the bean and turns it a rich, chocolate-brown color. The process also gives the bean the flavor and aroma of vanilla as we know it. Vanilla extract is prepared by a complicated and expensive process. The beans are chopped into small pieces and then percolated with alcohol and water. Food scientists have developed artificial vanilla flavors because of the high cost of vanilla.

**110**

The several kinds of clay tile are made in much the same way. Thin sheets of clay are pressed or molded to shape, and fired in kilns in the same process as is used for making brick. The tile may be left in its rough state. It may also be given a smooth surface, called glazing, by dipping or spraying the tile with a material that joins with the clay. Other ways include throwing salt into the kiln or treating the clay with a chemical wash. Tile pipe is used for sewage-disposal systems and for draining fields of excess water. A continuous tile line is formed by fitting together short sections, each of which has one end enlarged to form a bell into which the small end of the next section fits. Drain tiles are laid with uncemented butt ends through which the drainage water may seep. Sewer pipes are laid with tight cement joints. Finer grades of clay are used in making tiles for roofs, for walls, and for floors. Roofing tiles are made in various shapes and colors. Hollow clay tile blocks are used in load-bearing walls and partitions. Home builders use decorative tiles for interior floors and walls.

They obtain artistic effects by using tiles of different colors. Mosaics are small, unglazed tiles that are combined to form a design in colors. Glazed tiles are popular for the walls of kitchens and bathrooms. Encaustic tiling is the trade name for decorative tiles used in such a way that there is a background of one color and a pattern of another, contrasting color. Floor tiles are made of rubber, linoleum, terrazzo, cork, asphalt, plastic, and terra cotta and other ceramics. Acoustic ceiling tiles are made of cork granules, wood fiber, and mineral fiber.

111

Scissors. A pair of scissors is really two knife blades joined together to form a double lever. Each blade operates as a lever of the first class. A pin or bolt holds the blades together and acts as their common fulcrum or support. The user squeezes the open scissors handles together to apply pressure against both sides of the material, which then is cut.

To most people, scissors and shears refer to the same instrument. But, in the hardware trade, shears refers to scissors with blades more than 15 centimeters long. The handles of scissors usually have rings of equal size. Most shears have a larger ring on one handle for the four fingers of the cutting hand. The thumb of the cutting hand fits through the other ring. Scissors and shears range in size from tiny manicuring scissors to giant, power-operated shears that cut scrap metal for steel-mill furnaces. Pinking shears, or pinking scissors, have sawtooth edges. They are used to give cloth a scalloped edge, which keeps the material from raveling.

Scissors developed shortly after people learned how to make knives. Sharp, sturdy scissors were developed in the late 1200's.

112

Rake is a machine used to gather mowed hay and place it in long piles called windrows. The windrows are then gathered by a hay loader or baler. The first rakes were wooden hand rakes. People still use hand rakes to rake leaves from lawns. Modern rakes are usually pulled by, or mounted on, a tractor. Rakes can also be used to gather straw, green forage, and seed crops.

The dump rake consists of curved steel teeth mounted on an axle between two wheels. The teeth slide over the ground and rake hay as the machine moves forward. The operator dumps the hay in a windrow by pulling a lever that causes the teeth to lift from the ground.

The side-delivery rake leaves the hay in a continuous windrow at the side of the vehicle carrying the rake. In one type of side-delivery rake, the teeth are attached to cylinders that roll along at an angle to the direction traveled. The teeth just clear the ground as the cylinder rotates. As the machine moves ahead, the teeth brush the hay to the side, leaving it in a windrow. A dual rake consists of two side-delivery rakes, which deposit two windrows together at one time.

The finger-wheel rake consists of several wheels with spikes on the rim. The wheels are set at an angle to the direction traveled, and move the hay sideways to form a windrow. The drag-type rake has no moving parts. It has curved fingers that move the hay to one side, much as a snowplow moves snow.

113

Canada's westernmost Prairie Province gained large revenues from its oil resources in 1976. It set aside some of these funds for future generations by establishing the Alberta Heritage Savings Trust Fund, a \$1.5-billion public endowment. The act authorizing the fund provided that 30 per cent of oil royalties would be paid into it annually.

The Progressive Conservatives dominated the 75-seat Legislative Assembly, holding 69 seats. There were also 4 Social Credit members, 1 New Democratic Party representative, and 1 Independent. The Assembly passed 58 bills during its 51-day session, including a measure creating a home-mortgage corporation and a plan to reorganize provincial courts. A \$2.9-billion budget presented on March 19 called for a 7.7 per cent increase in expenditures, modest when compared to the 25 per cent growth each year over the previous five years. There were no tax increases, retaining Alberta's distinction of having the lowest provincial taxes in Canada.

A new policy for exploiting Alberta's billions of tons of coal - half Canada's reserves - was announced in June. A complicated formula will net the province much larger revenues from future coal royalties. The \$2-billion Syncrude Canada, Limited, plant on the Athabaska tar sands passed the halfway point in construction.

114

Cardboard is a popular name for any stiff paper or paperboard that is more than 0.1524 millimeter thick. It usually does not mean paper used for special purposes, such as wallboard or corrugated boxboard. Papermakers



use various names for different kinds of cardboard. The name may be based on the raw material used, such as strawboard or newsboard. It may indicate useful characteristics, such as bending board. Or it may designate the final use, such as poster board or shoe board. A familiar type of cardboard, called bristol board, is used for such products as index cards and postal cards. Manufacturers make cardboard by pasting several layers of paper together or by pressing layers of wet pulp together. They often coat cardboard for decoration or to improve the surface of the cardboard for printing.

115

Water plant, also called aquatic plant or hydrophyte, is a name used for any plant that is specially adapted to live in water. Many botanists also consider the term water plant to include those plants that grow in water-saturated soils.

Water plants may be rooted in the mud and have their leaves and blossoms above or at the surface of the water. Some kinds grow completely underwater. Submerged water plants often have air bladders or large air pores in their stems and leaves that help the plants stand upright or stay afloat. Some of the best-known water plants are water lilies, sedges, and cattails. These plants often grow in lakes and ponds. Some biologists consider certain types of algae to be water plants. However, most scientists do not include algae in the plant kingdom. They classify algae in the kingdoms Protista and Prokaryotae.

116

Hexagon, pronounced HEHK suh gahn, is a plane figure that has six sides. It is a type of polygon. The sides of a hexagon meet at points called vertices, forming six interior angles. The sum of a hexagon's interior angles is always 720 degrees. A hexagon is said to be regular if all its sides and angles are equal. Each angle of a regular hexagon measures 120 degrees. The area of a regular hexagon equals one-half the product of its perimeter and its apothem, which is the distance from the center of a regular polygon to the midpoint of one of its sides.

117

Krypton, pronounced KRIHP tahn, is a chemical element that makes up only about one-millionth of the earth's atmosphere. The British chemists Sir William Ramsay and Morris W. Travers discovered it in 1898.

It was named krypton for the Greek word which means the hidden one. Most fluorescent lamps are filled with a mixture of krypton and argon. Krypton is also used in certain electronic tubes, and in luminous sign tubes where a greenish-yellow color is desired.

Krypton is a colorless, odorless, tasteless gas. It does not react readily with other substances and is classed as a noble gas. Its symbol is Kr. The element has the atomic number 36, and an atomic weight of 83.80.

118

Live oak is a beautiful evergreen oak that grows chiefly along the southeastern coast of the United States. It is also found in dry parts of Texas. The tree grows about 50 feet (15 meters) high. Its horizontal limbs form a wide-spreading, dense head. The dark, glossy, oblong leaves may be 2 to 5 inches (5 to 13 centimeters) long. The live oak is a favorite tree for lawns and streets because it resists damage from storms, insects, and diseases. It is the state tree of Georgia.

Scientific Classification. The live oak is a member of the beech family, Fagaceae. It is classified as *Quercus virginiana*.

119

Integer, pronounced IHN tuh juhr, is a number. The most familiar integers are the counting numbers, such as 1, 7, 28, and 105. The complete set of integers also includes zero and such numbers as -1, -7, -28, and -105. For every positive integer, there is a corresponding negative integer that, when added to the positive integer, gives a sum of zero. For example,  $5 + (-5) = 0$ . Integers can be added, subtracted, multiplied, and divided.

Most mathematics involves the use of integers, and some mathematical calculations would be impossible without them. Integers also help describe certain everyday situations. For example, temperatures can be above or below zero.

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| 120 |
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Keck Observatory is an astronomical observatory on Mauna Kea, a mountain on the island of Hawaii. The observatory consists of two identical telescopes, Keck I and Keck II, which are the largest optical telescopes in the world. Keck I was completed in 1992 and Keck II in 1996. The California Association for Research in Astronomy, which is a partnership of the University of California and the California Institute of Technology, operates the observatory. The facility's full name is the W. M. Keck Observatory.

Keck I and II collect and focus visible light waves and infrared waves from objects in space. One use of the telescopes is to analyze radiation coming to Earth from the farthest known galaxies. Astronomers can use the information gathered to determine a galaxy's distance, size, age, and other characteristics. Keck I and II are reflecting telescopes - that is, they use a large mirror to collect and focus light. The light-gathering mirror is a segmented mirror that consists of 36 smaller mirrors mounted together. The segments form a reflecting surface 10 meters in diameter.

An electronic sensing system holds the segments in place. If a segment gets out of position, sensors on its edges activate pistons in the support structure that move the segment.

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VVV 12 A K5KJ 66 NTX  
VVV 1062 B K5GN 72 STX  
VVV 378 A KX1E 56 ME  
VVV 346 B WA8CDU 66 MI  
VVV 11 A WOOF 48 IA  
VVV 951 M N4TO 60 WCF  
VVV 289 A NI6W 79 NV  
VVV 155 A W07Y 60 ID  
VVV 608 B WC4E 84 NFL



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| 123 |
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Almond, pronounced AH muhnd or pronounced AHL muhnd, is a delicious nut. The nuts are the seeds of the beautiful almond tree. Each nut grows in a thin, smooth shell that looks somewhat like a peach stone. A dry, leathery hull covers the shell. The hull splits open when the nut is ripe.

Some almond trees produce sweet nuts; others have bitter ones. Sweet almonds are a popular delicacy when toasted, salted, and eaten whole, or added to candies and rich pastries. Bitter almonds are not edible. Trees that produce them are grown only for oil, although oil is also extracted from the sweet nuts. Oil of bitter almonds contains the poisonous hydrocyanic (prussic) acid. After the acid is removed, the oil is used in flavoring extracts.

The almond tree is native to southwestern Asia. But today it is widely grown in the countries that border the Mediterranean Sea. The trees also thrive in California, where commercial groves produce large annual crops of almond nuts.

Almond trees are well-proportioned and may grow 12 meters high. They have long, pointed leaves that curl, and showy pink blossoms that may be 3.8 centimeters across. The blossoms open early in spring, long before the leaves appear. For this reason, almonds are grown commercially only in regions that do not have early spring frosts.

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| 124 |
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Sonar, pronounced SOH nahr, is a device that uses sound energy to locate objects - measure their distance, direction, and speed. Even produce pictures of them. The word sonar comes from sound navigation and ranging.

People associate the word sonar with devices that detect submarines and other underwater objects. Sonar works well underwater, where sound travels quickly and efficiently over long distances and where radar does not work. However, certain sonar devices operate in the air. For example, some burglar alarms use airborne waves of ultrasound, sound whose pitch is too high for people to hear, to detect movement.

Dolphins and some bats use a natural sonar technique called echolocation. This technique helps them locate food, avoid obstacles, and communicate.

How sonar works. There are two types of sonar. Active and passive. Active sonar uses a transmitter, a device that converts electrical energy to sound energy, to send out sound waves. Transmitters used underwater can produce a sharp pinging sound. The sound waves travel through the water until they strike an object. The object reflects them in various directions. Some of the reflected waves return to the sonar, where they strike a receiver. The receiver converts the sound back into electrical signals. In modern sonars, a computer analyzes these signals to perform the sonars job, such as locating the object or determining the object's distance from the sonar.

A sonar determines distances by measuring the time taken for a sound wave to travel from the transmitter, reflect from the object, and travel to the receiver. This method of finding distance is called echo ranging.

125

Umbrella is a device that protects people from rain and sun. It consists of a circular piece of fabric stretched on a frame attached to a central handle. The frame can be folded when it is not needed.

Umbrellas were originally used as sunshades. In many cultures, they were a symbol of rank. In ancient Egypt and Babylonia, for example, only royalty and nobility were permitted to have umbrellas.

Umbrellas were first widely used against rain during the 1700's, when heavy umbrellas made of wood and oilcloth became common in Europe. During the 1800's, light, decorative sunshades called parasols became fashionable among women throughout Europe and the United States. Many of these umbrellas had whalebone or metal frames and fine silk coverings edged with lace and fringe. They were popular until about the 1920's.

Today, umbrellas are used primarily as protection against rain or snow. Most umbrellas are made with metal or plastic frames and covered with plain or patterned fabric or clear plastic. They come in a wide variety of colors. Many umbrellas fold up to fit in purses and briefcases.

126

Bleach is any substance that lightens, brightens, or removes the color from a material. Manufacturers bleach textiles, paper, and other materials to whiten them or to prepare them to be dyed. Homemakers use laundry bleach to brighten clothes. People also use some bleaches as disinfectants. There are two main kinds of bleaches,

chemical and optical. Chemical bleaches act on the colored molecules that give a material its color.

The bleaches make these molecules colorless or nearly colorless.

The most widely used chemical bleaches include chlorine bleaches and oxygen bleaches. Many household and industrial bleaches are chlorine bleaches, which remove the color from most textiles, wood pulp, pottery, and other materials.

Oxygen bleaches are milder than chlorine ones. People use hydrogen peroxide and other oxygen bleaches to lighten hair and to brighten colored fabrics and other materials that might be harmed by chlorine bleaches. Other chemical bleaches include certain sulfur compounds.

These compounds are used to bleach some wools, silks, and various types of manufactured fibers. Optical bleaches mask yellow discoloration in a material. These bleaches, commonly called fabric brighteners, absorb ultraviolet light and change it to blue light. The combination of the blue light and the yellow discoloration produces white light that makes the material seem brighter.

127

Eclipse is the darkening of a heavenly body. It occurs when the shadow of one object in space falls on another object or when one object moves in front of another to block its light. A solar eclipse takes place when the sun appears to become dark as the moon passes between the sun and the earth. A lunar eclipse occurs when the moon darkens as it passes through the earth's shadow.

Heavenly bodies other than the earth and the moon also can eclipse each other. The planet Jupiter sometimes blocks sunlight from its moons. Likewise, Jupiter's moons sometimes cast shadows on the planet. Sometimes the moon or some other heavenly body blocks light from a planet or a distant star. Astronomers use the term occultation for this blocking action. Astronomers also refer to a certain kind of variable star as an eclipsing binary. An eclipsing binary consists of two stars that revolve around each other so that each periodically blocks the light from the other.

When eclipses occur. The earth and the moon always cast shadows into space, and the moon orbits the earth about once every month. But an eclipse - either solar or lunar - does not occur every month. The moon's orbit is tilted about 5 degrees to the earth's orbit around the sun. For this reason, the moon's shadow generally misses the earth, and so a solar eclipse does not occur. Likewise, the moon most often escapes being eclipsed by passing above or below the shadow of the earth. Thus, a solar or a lunar eclipse can occur only when the earth, sun, and moon are in nearly a straight line.

128

Dew is the name given to the glistening beads of water that often appear on blades of grass, leaves, and car tops early on clear mornings. Dew forms when air near the ground cools to the point where it cannot hold all its water vapor. The excess water vapor then condenses (changes to liquid) on objects near the ground.

During the day, objects absorb heat from the sun. At night, they lose this heat through a process known as thermal radiation. As objects near the ground cool, the temperature of the air immediately surrounding them is also reduced. Colder air cannot hold as much water vapor as warmer air can. If the air continues to cool, it will eventually reach the dew point. The dew point is the temperature at which the air contains as much water vapor as it possibly can hold. If the air cools further, some of the vapor condenses on the nearest available surface.

Dew forms best on calm, clear nights. When the wind is blowing, air cannot stay in contact with cool objects as long and it needs more time to cool to the dew point. When it is cloudy, objects cool more slowly because the clouds radiate heat back to earth. Dew also forms better when the humidity is high.

Dew evaporates as the sun rises. The sunshine heats the ground, which in turn warms the air. This warmer air is able to hold more water vapor, and dew evaporates into this air.

129

Liquid is one of the three basic states in which matter exists. The other two states are gaseous and solid. A liquid is similar to a gas because its molecules are not fixed to each other in any particular way. Liquids and gases are both called fluids because they can flow to fit the shape of any container in which they are put. A liquid is unlike a gas and similar to a solid because it has a definite volume, and its molecules are only slightly compressible. A liquid always seeks its own level. If a liquid is put in a container with several arms, it will rise to the same level in all the arms.

A thin layer on the surface of a liquid has a tension caused by molecular action, and acts like a skin. This is called surface tension. Because of surface tension, a greased needle will rest on the surface of water without sinking.

The molecules of a liquid often have a greater attraction for other



substances than they have for each other. For this reason, they will rise in narrow tubes above their own level. This action is called capillarity. Plants draw water by capillary action.

If liquids are heated beyond a certain point, they vaporize (change into gas). Water changes into steam when it boils. If liquids are cooled below a certain point, they change into solids. Water freezes into ice. Different liquids have different freezing and boiling points. Substances that are normally gases can be cooled and compressed into a liquid state. Some normally solid substances can be heated until they turn into liquids. For more information, see the articles on GAS, SOLID, and WATER.

130

Sprat is one of the smaller sea fish in the herring family. Sprat grow to 20 centimeters long. They live in European coastal waters from the Baltic and North seas to the Mediterranean and Black seas. They have a flattened body with a saw-toothed edge along the belly. Sprat are important food fish. They are eaten fresh or smoked. Some are canned in oil as brisling sardines. Others are processed for oil and fish meal.

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Sirius, pronounced SIHR ee uhs, also called the Dog Star, is the brightest star that can be seen from the earth at night. Sirius has a diameter more than twice as large as that of the sun, and it gives off nearly 30 times as much light. It is a star of the first magnitude.

Sirius forms part of Canis Major, a constellation in the sky of the Southern Hemisphere. Sirius is one of the stars nearest the earth. It is about nine light-years away. A light-year, the distance that light travels in a year, equals about 9.46 trillion kilometers.

Astronomers classify Sirius as a binary star because it has a companion star, Sirius B. Sirius B is a white dwarf, an extremely dense star that can be as small as the earth. It consists of matter that is 4 million times as dense as water. If matter from Sirius B were brought to the earth's surface, it would weigh approximately 120,000 tons per cubic foot (4,000,000 metric tons per cubic meter). Because of its tremendous density, Sirius B exerts a strong gravitational pull on Sirius. This powerful gravitational force causes Sirius to move in a wavy line as it travels through space. Sirius and Sirius B make a complete orbit around each other about every 50 years.