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EES Module 1

Earth's Resources

WORKSHEETS

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Worksheet 1 Origins: Universe, Sun, Earth

Fill in the blank spaces. **Student Name.....**

The Sun is a a)..... in the galaxy called the b)..... ..... The Earth is the third c)..... in the solar system.

The d)..... Theory proposes that there was an explosion about 14 bya and matter expanded rapidly, e)..... and ..... to form the f).....

The Solar System formed about g)..... bya from dust and gas particles from a h)..... explosion. Shock waves caused the cloud to begin to i)..... because of gravitational attraction. This caused the temperature to j)..... The core of the collapsed material became so hot that k)..... ..... began and the Sun became a star.

The rest of the material formed a spinning l)..... Particles of matter clumped together by a process called m)..... to form the planets.

The most important force involved in the formation of the Earth was n)..... This caused particles in the dust cloud to o).....

As lumps of material p)..... in size the force of gravity between the lumps q).....

When the accumulating material reached a certain size, gravity caused the lumps to collapse into the most compact shape; a r).....

Forcing the particles together also increased the s)..... and eventually the early Earth t)..... This allowed the different materials to u)..... according to differences in their v)..... Substances with higher v)..... sank to form the w)..... of the Earth. Lower density materials tended to x)..... upwards, forming the mantle, y)....., hydrosphere and z).....

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Worksheet 2 Density — Practice Problems

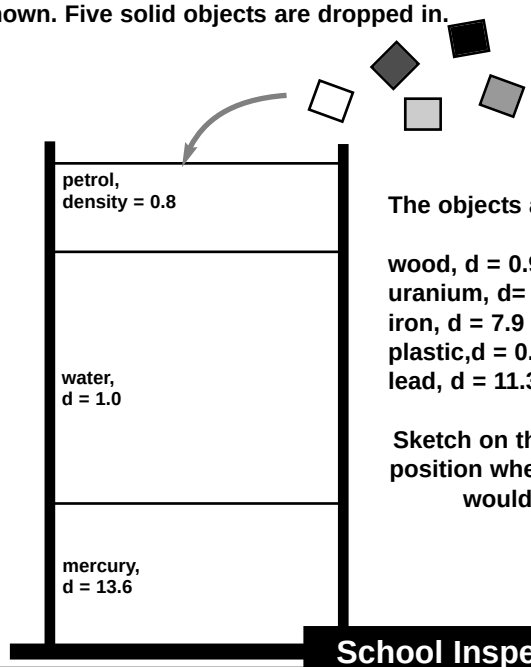
Student Name.....

1. (a)
The following table shows data from a student experiment. Fill in the blank spaces by calculation.

Substance	Mass (g)	Volume (cm^3)	Density (gcm^{-3})
A	32.0	5.00	i)
B	267	83.5	ii)
C	iii)	17.0	5.25
D	875	iv)	11.5
E	5.08	7.29	v)

(b)
If these 5 substances were mixed together and melted, they might differentiate into layers. List the order of substances as they would separate, from top to bottom.

2.
Three different liquids have formed layers in a container as shown. Five solid objects are dropped in.



The objects are:

wood, d = 0.9 gcm^{-3}
uranium, d= 19 gcm^{-3}
iron, d = 7.9 gcm^{-3}
plastic,d = 0.75 gcm^{-3}
lead, d = 11.3 gcm^{-3}

Sketch on the diagram the position where each object would end up.

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Worksheet 3 Earth's Layered Structure

Guided Notes. (Make your own summary)

Student Name.....

1.
We are quite certain that the Earth has a layered structure because of evidence from 3 main studies:

a) ....., which is the study of

b) Considerations of the Earth's .....

and .....
(briefly flesh this out with the scientific argument for a layered structure)

c) Evidence from meteorites.
(Briefly outline WHAT IS the evidence?)

2.
From the data in the KISS notes (PhotoMaster p6, OnScreen slide 11) calculate the approximate depth of each main layer of the Earth, in km.

3.
<u>Asthenosphere</u>:
What is it?

(approx.) Thickness?
Rigid or plastic?
Significance for Plate Tectonics?

<u>Lithosphere</u>:
What is it?

Thickness under continents?
Thickness under oceans?
Rigid or plastic?

<u>Crust</u>:
Compare density of crust rocks to mantle rocks.

Thickness under continents?
Thickness under oceans?
Rigid or plastic?

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Worksheet 4 Minerals & Rocks

Fill in the blanks

Student Name.....

a)..... are the basic chemicals which form the rocks of the b)..... of Earth. Each has its own characteristic c).....

The most common and important group are all based on the compound d)....., which has chemical formula e)..... In its pure state it is known as the mineral f)..... Various g)..... can also be incorporated into the crystal lattice forming "h)..... minerals" such as i)....., ... and .....

An important mineral which is NOT a silicate is j)....., which is chemically k)..... (formula.....)

Rocks are generally l)..... of minerals. Rocks are classified into 3 main groups based on m)..... .....

<u>Igneous Rocks</u> are formed from n)..... minerals and are associated with o)..... activity. There are 2 main types:

"Felsic" Igneous rocks are generally p)..... in colour due to a high content of q)..... (mineral) & "feldspar" minerals. Perhaps the commonest & best known example of a felsic igneous rock is r)..... "s)....." igneous rocks usually have a t)..... colour due to a u)..... content of quartz, but high in silicates containing magnesium & v)..... A common example is w)....., formed from volcanic lava.

<u>Sedimentary Rocks</u> are formed from x)..... which have been y)..... and z)..... with other minerals. Sedimentary rocks are the type in which most aa)..... are found.

Common examples are:
ab)..... (cemented pebbles)
ac)..... (compressed silt or clay)

<u>ad)..... Rocks</u> are formed when previous rocks are changed by ae)..... and ..... An example is af)..... which is re-melted sandstone. When great pressure is involved, the rock develops a "ag)....." structure, like the pages in a book. A well-known example is ah)..... (used for floors & roofs) which is derived from the sedimentary rock ai).....

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Worksheet 5 Identifying Rocks

Student Name.....

Use this <u>dichotomous key</u> to identify the rock specimens on the next page.

Start Here...

<u>Level 1</u>
A. Rock fizzes if dilute acid is placed on it ..... go to 12
B. Rock does not fizz with acid..... go to 2

<u>Level 2</u>
A. Crystals or grains visible without a lens..... go to 3
B. Crystals/grains not visible without a lens ... go to 6

<u>Level 3</u>
A. Made up of grains smaller than 2 mm..... go to 4
B. Made up of stones cemented together ..... Conglomerate

<u>Level 4</u>
A. Grains look like sand, easily scratched off ..... Sandstone
B. Crystals not like sand, cannot be scratched off..... go to 5

<u>Level 5</u>
A. Crystals predominantly dark in colour..... Gabbro
B. Mainly pale colours & glassy crystals..... Granite

<u>Level 6</u>
A. Powdery material easily scratched off ..... go to 7
B. Hard, material not easily scratched off ..... go to 9

<u>Level 7</u>
A. Soft, low density, and has many holes ..... Pumice
B. Does not have holes..... go to 8

<u>Level 8</u>
A. Dark colour, burns if ignited ..... Coal
B. Dull (not shiny) does not burn…..... Shale

<u>Level 9</u>
A. Foliated structure, splits in layers ..... Slate
B. Not foliated ..... go to 10

<u>Level 10</u>
A. Glassy or pearly appearance..... Quartzite
B. Not glassy, but may show "sparkles" of reflection from tiny crystals within.....go to 11

<u>Level 11</u>
A. Predominantly black colour ..... Basalt
B. Predominantly light in colour..... Ryolite

<u>Level 12</u>
A. Varied texture, may contain fossils ..... Limestone
B. Hard, perhaps with patterns or swirls of colour..... Marble

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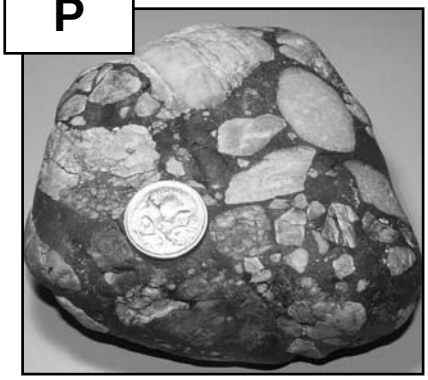
Worksheet 5 (continued)

Use the simplified (K.I.S.S. Principle) key on the previous page to identify the rock specimens shown and described below. In each photo a 5 cent coin gives scale.

rock sample **P**

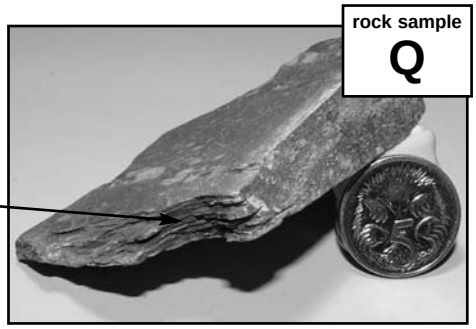


rock sample **Q**

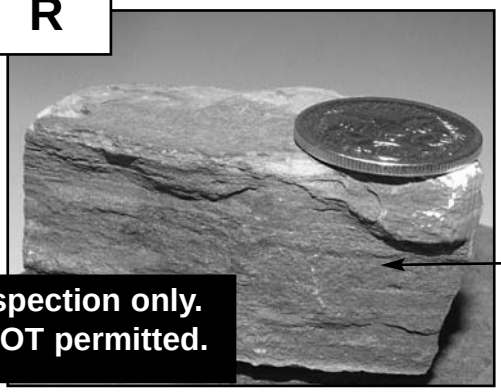
No visible particles

Hard, not easy to scratch

Foliated



rock sample **R**



Fine-grained, no visible particles

Powdery material easy to scratch off

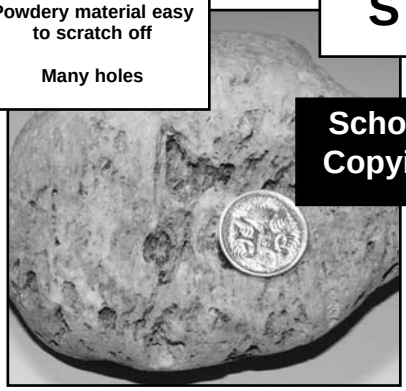
Layers visible

Fine-grained, very low density

Powdery material easy to scratch off

Many holes

rock sample **S**



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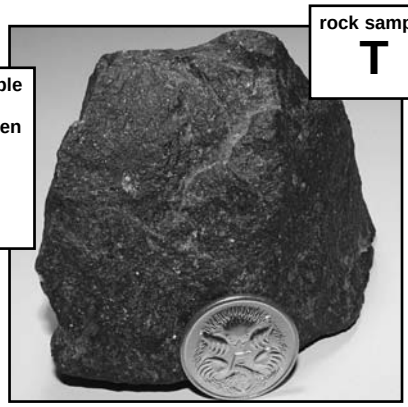
rock sample **T**

Fine-grained, no visible crystals, but tiny "sparkles" can be seen in good light

Hard, not easily scratched

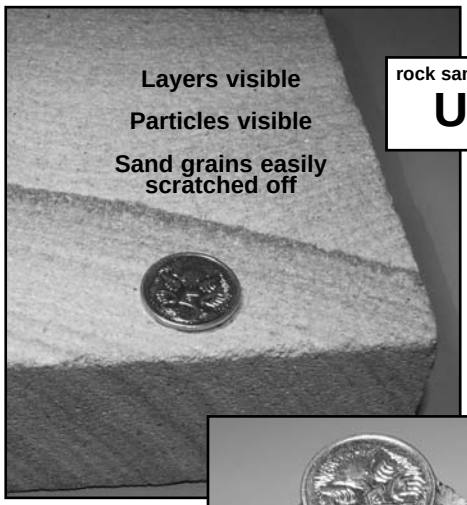


rock sample **U**

Layers visible

Particles visible

Sand grains easily scratched off



rock sample **V**

Hard. Large crystals visible

Fizzes when tested with acid

rock sample **W**

A variety of crystals visible, including some that are glass-like

Very hard, not easily scratched

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Worksheet 6 Soil

Fill in the blank spaces.

Student Name.....

Soil is a complex mixture of 3 main parts:

• a)..... grains, such as sand & b).....

• c)....., which is dead, decayed d)..... matter, especially plant leaves and animal wastes.

• Water, and various e)..... in the spaces between the solid grains.

The processes which are mainly responsible for forming soil are f)..... of rock, the activities of g)....., and the process of h)..... as water percolates through the soil.

There are 2 kinds of weathering. i)..... weathering is the breaking of rock into smaller particles. For example, sand grains are formed by the breaking of j)..... crystals. In contrast, k)..... weathering occurs when various minerals l)..... with water, oxygen, etc. and change into new substances. For example, silicate minerals like orthoclase turn into m).....

The living things most important in forming humus are the "n).....", which include mainly the many o)..... and ..... which live in the soil. They cause dead materials to rot, so that p)..... needed by plants are released into the soil. Rotting also releases natural acids which cause more q)..... of rock, thereby forming more soil.

As water percolates through soil it washes some chemicals away. This "leaching" can be a good thing, such as when salt or r)..... minerals are washed away. It can also be detrimental, such as when it removes s).....

Various simple tests can help analyse a soil to determine some of its important properties. Gentle heating in an oven allows measurement of t).....
Heating to high temperatures causes the u)..... matter to burn away, leaving behind only the v)..... part of the soil.

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Worksheet 7 Practice Questions **sections 1 & 2**

Answer in the spaces provided.
(on reverse, if insufficient room)

Student Name.....

1. (4 marks)
Outline how the Earth came to have a layered structure, with reference to the force of gravity AND the effects of density.

2. (3 marks)
Assess the importance of seismology in providing our knowledge of the Earth's layered structure.

3. (4 marks)
Explain the connection between the mineral "quartz" and the various "silicate" minerals. Your answer should include some basic details of chemistry.

4. (6 marks)
List the 3 main categories of rocks, with an outline of how each is formed.

5. (6 marks)
"Soil is made up of 3 parts, and is formed by 3 processes".
Explain this statement by:
a) listing the 3 "parts" of soil.

b) describing the 3 processes involved in soil formation.

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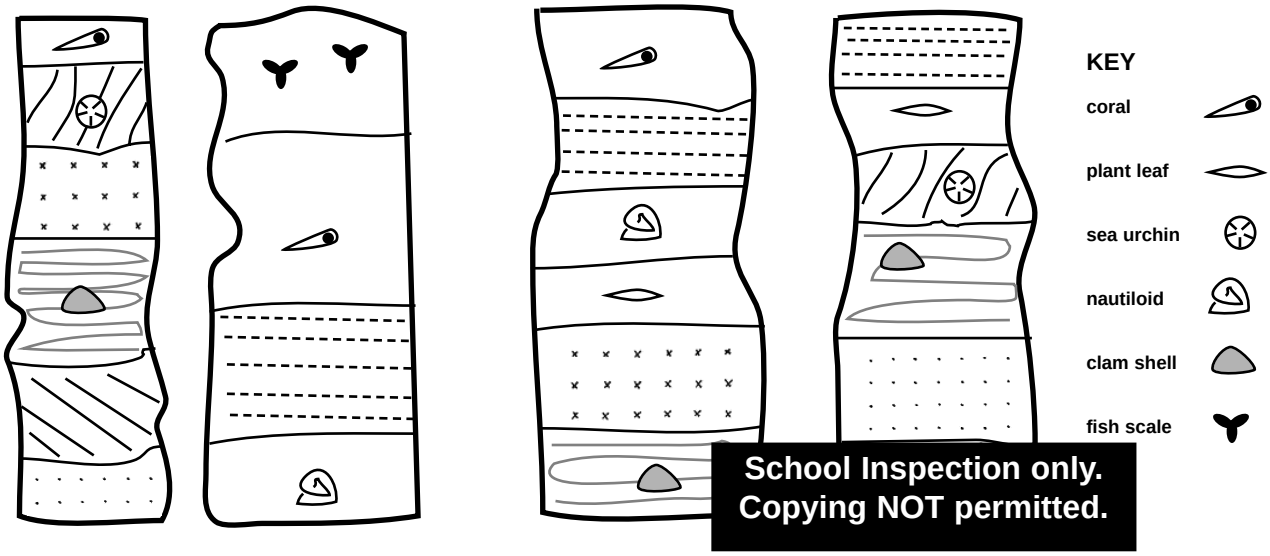
Worksheet 8 Relative Dating of Fossils

The diagrams show sedimentary rock profiles from 4 different locations. Within them are "index fossils" identified in the key. Use the fossils to "correlate" the different profiles and determine the relative ages of all the fossils.
(hint: if possible, cut out each rock profile, then slide them vertically to line up matching fossils.)



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Worksheet 9 Radiometric Dating Practice Problems

Student Name.....

1.
The radiation from a sample of a radioisotope was measured to be 200 units. The same sample, measured 20 years later, was emitting just 12.5 units of radiation.
a) What is the half-life of this isotope?

b) What was the radiation level 10 years after the start?

c) What radiation level would you expect after a further 10 years? (i.e. total 30 years from the start)

2.
A bone found in an ancient tomb was analysed using carbon-14 analysis. (C-14 half-life = 5,730 years) When alive, bone is expected to have 420 ppm (parts per million) of C-14. The bone was found to have 105ppm of C-14.
How old is the bone? Explain your reasoning.

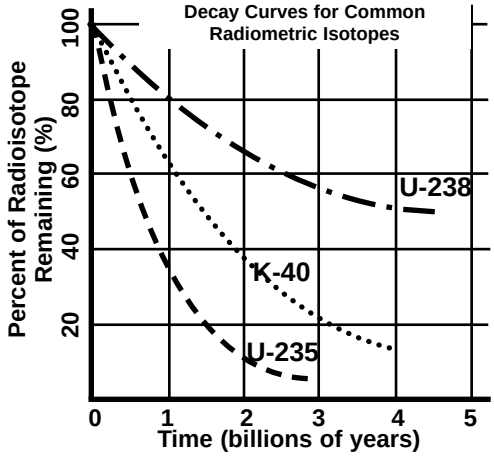
3.
Potassium-40 (K-40) is a radioisotope which decays (half-life of 1.3 billion years) to form the gas argon. Potassium is common in certain minerals. In some types of crystals, any argon formed is trapped, and can be collected and measured, to find the starting quantity of potassium-40.

Analysis of a crystalline rock reveals 0.024 mg/kg of argon trapped within it. Analysis of radiation shows that there is also 0.024 mg/kg of K-40 in the rock. How old is it?

In reality, the amounts of a radioisotope in a rock are never neat fractions of the original amount.

This graph of "Decay Curves" allows you to read the age of a rock from the % of remaining isotope.

U-235, U-238 and K-40 are 3 of the most commonly used for dating ancient rocks.



4.
Approximately how old is a rock if:
a) 20% of original K-40 remains?

b) 60% of original U-235 remains?

c) 80% of original U-238 remains?

d) 70% of original K-40 remains?

5.
The Earth is 4.5by old. What % of the original U-238 has decayed away since the Earth began?

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Worksheet 10 More Radiometric Dating

Fill in the blank spaces. **Student Name.....**

Radioactivity is a phenomenon in which atoms may emit a)....., ... or ..... radiation because the nucleus of the atom is b).....

Each chemical element has different c)....., which are atoms with different numbers of d)..... in the nucleus. Some isotopes are stable, but others are unstable and radioactive. These are known as "e)....."

The time taken for half of a sample of radioactive atoms to undergo f)..... is known as the "g).....-.....". Each isotope has its own characteristic value, ranging from fractions of a second, to h)..... .....**

"i)..... Dating" is the technique of using radioactivity to measure the j)..... of things. Measuring the amount of k)..... emitted by a rock or artifact, allows the amount of residual radioisotope to be determined. Measuring the amount of "daughter" isotopes present gives a measurement of l)..... ..... Knowledge of the m)..... then allows calculation of the object's age.

Another Practice Problem

Mark value shown is a suggestion only, and are to give you an idea of how detailed an answer is appropriate.

(7 marks)
The element potassium has 2 isotopes known as K-39 and K-40. ("K" is the chemical symbol for potassium)

K-39 is stable, while K-40 is a radioisotope with a half-life of 1.3 billion years.

a) With reference to sub-atomic particles, explain:

i) why K-39 and K-40 are considered the same element.

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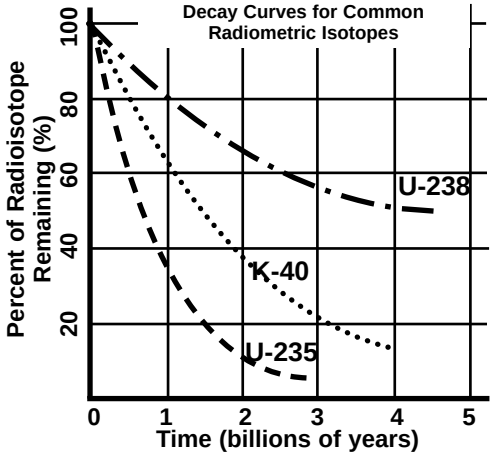
ii) how the atoms of K-39 and K-40 differ.

b) What is meant by the phrase "half-life of 1.3by"?

c) A rock sample containing a potassium-rich mineral was analysed radiometrically. Analysis of radioactivity indicated the presence of 17.3 ppb (parts per billion) of K-40.

A gas chromatogram measurement showed the presence of 69.2 ppb of an isotope known to be the "decay product" of K-40.

Using the following graph, and showing your working and reasoning, estimate the age of the rock.



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Worksheet 11 Geological Resources

Guided Notes. (Make your own summary)

Student Name.....

1.
a) List the types of geological resources, and their uses, important to indigenous Australians before European contact.

Resource	**Use**

b) Outline the indigenous mining methods & the "ownership rules".

2.
Comment briefly on:
a) Australia's world ranking as a supplier of mineral resources.

b) The value & importance of geo.resources to the economy.

c) Sustainability issues.

3.
List & describe 3 different types of "geophysical data" that can help discovery of new geo.resources.

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4.
List & describe 3 different methods of extracting geo.resources.

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ANSWER SECTION

Worksheet 1

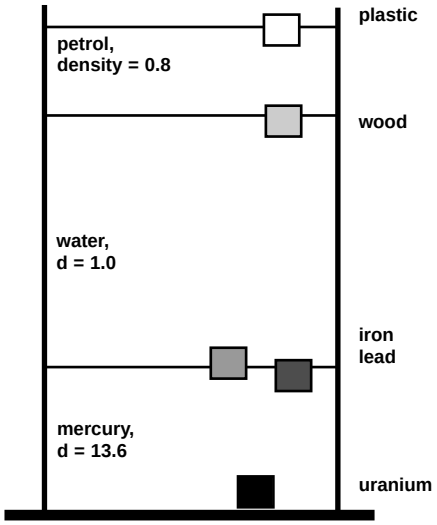
a) star
b) Milky Way
c) planet
d) Big Bang
e) cooling & condensing
f) universe
g) 4.6
h) supernova
i) collapse / condense
j) increase
k) nuclear fusion
l) disk
m) accretion
n) gravity
o) coalesce / clump together / accrete
p) grew / accumulated
q) increased
r) sphere
s) temperature
t) melted
u) separate/form layers
v) density
w) core
x) float
y) crust
z) atmosphere

Worksheet 2

1. a)
i) 6.40
ii) 3.20
iii) 89.3
iv) 76.1
v) 0.697

b) top: E
B
C
A
D bottom

2.
diagram



Worksheet 3

1.
We are quite certain that the Earth has a layered structure because of evidence from 3 main studies:

a) Seismology, which is the study of earthquake shock waves & how they travel through the Earth.

b) Considerations of the Earth's *Density & Magnetism*.
(briefly flesh this out with the scientific argument for a layered structure)
The density of the crust rocks is much lower than that of the Earth itself, suggesting there must be a high density core. Earth's magnetic field suggests iron, and the density matches.

c) Evidence from meteorites.
(Briefly outline WHAT IS the evidence?)
Composition of "stoney" meteorites matches with the chemical composition of Earth rock. Their age matches the Moon & the most ancient Earth rocks. Therefore, meteorites are the left-overs from planet formation. 10% iron meteorites suggest that there should be a lot of iron somewhere... must be in the core.

2.
From the data in the KISS notes (PhotoMaster p6, OnScreen slide 11) calculate the approximate depth of each main layer of the Earth, in km.

Crust = 64km, mantle = 2880km, outer core = 2240km, inner core = 1216km

3.
Asthenosphere:
A layer of upper mantle immediately below the lithosphere.
Rigid or plastic? ***Plastic***
Significance for Plate Tectonics?
This is the "slippery layer" on which the plates slide.

Lithosphere:
The crust rock layer with some upper mantle rock attached underneath.

Thickness under continents? ***100-200km***
Thickness under oceans? ***10km***
Rigid or plastic? ***Rigid***

Crust:
Lower density than mantle rock.

Thickness under continents? ***75km***
Thickness under oceans? ***5-10km***
Rigid or plastic? ***Rigid***

Worksheet 4

a) Minerals
b) crust
c) properties
d) silicon dioxide
e) SiO_2
f) quartz
g) metals
h) silicate
i) orthoclase, olivine, biotite mica
j) calcite
k) calcium carbonate, CaCO3
l) mixtures
m) how they were formed.
n) molten
o) volcanic
p) lighter
q) quartz
r) granite
s) Mafic
t) darker
u) lower
v) iron
w) basalt
x) sediments
y) compressed
z) cemented
aa) fossils
ab) conglomerate
ac) shale
ad) Metamorphic
ae) heat and pressure
af) quartzite
ag) foliated
ah) slate
ai) shale

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Worksheet 5

P = conglomerate
Q = slate
R = shale
S = pumice
T = basalt
U = sandstone
V = marble
W = granite

Worksheet 6

a) mineral
b) clay
c) humus
d) organic
e) gases
f) weathering
g) living things
h) leaching
i) Physical
j) quartz
k) Chemical
l) react (chemically)
m) clay
n) decomposers
o) bacteria & fungi
p) nutrients
q) weathering
r) toxic
s) soil nutrients
t) moisture content
u) organic
v) mineral

Worksheet 7

1.
Gravity caused the early Earth to collapse into a sphere. It became hot enough to melt, so different density materials could flow. Higher density materials sank towards the core, while lower density material floated towards the surface. Layers formed according their density.

2.
Seismology measures the behaviour of earthquake shock waves as they travel through the Earth. Waves travel at different speeds in different density layers and may refract as they pass into a new layer, or reflect off the boundary.
By studying speeds, refractions, reflections, etc., seismologists can measure the depths & thicknesses of the layers.
Assessment: this has been <u>vitally important</u> in illucidating the Earth's internal structure.

3.
Pure quartz is the crystal of silicon dioxide (SiO_2) which forms a strong "lattice" of atoms in 3-dimensions. Various metal ions can be embedded into the crystal lattice, changing its colour & other properties to form a variety of "silicate minerals".

4.
Igneous rocks form from molten lava or magma which cools & solidifies.
Sedimentary rocks form from erosion sediments which are compacted & cemented together.
Metamorphic rocks are formed by changes (due to heat and/or pressure) to sedimentary or igneous rocks.

Worksheet 7 (cont.)

5.
a) Soil contains <u>mineral grains</u>, <u>humus</u> (organic material) plus <u>water and gases</u>.

b) <u>Weathering</u> is the breakdown of rock which forms the mineral part of soil.

Humus is formed by <u>biological processes</u>, especially the decomposition of dead matter and wastes.

<u>Leaching</u> is the process of water percolating through the soil and washing soluble chemicals away.

Worksheet 8

Oldest to youngest:

clam shell, sea urchin, leaf, nautiloid, coral, fish scale.

Worksheet 9

1.
a) 200 -> 100 -> 50 -> 25 -> 12.5
∴ 4 half-lives have occurred in 20 years
∴ half-life = 5 years
b) 10yr from start = 2 half-lives.
Radiation level was 50 units.
c) 2 more half-lives: 12.5 -> 6.25 -> 3.125 units

2.
420 -> 210 -> 105
∴ 2 half-lives have occurred
∴ Age = 2 x 5,730 = 11,460yr

3.
Assuming all the argon is a decay product from K-40, original amount of K-40 = 0.024 + 0.024 = 0.048mg/kg
i.e. exactly half the K-40 has decayed = 1 half-life.
∴age = 1.3 billion years.

4. (approximate values from graph)
a) 3by b) 500my c) 1by d) 750my

5.
1 half-life, so 50% has decayed.

Worksheet 10

a) alpha, beta or gamma
b) unstable
c) isotopes
d) neutrons
e) radioisotopes
f) decay
g) half-life
h) billions of years
i) Radiometric
j) age
k) radiation
l) how much was present originally
m) half-life

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Worksheet 10 (cont.)

Another Practice Problem

a) i) Both types of atom contain the same number of protons and electrons. This gives both the same chemical behaviour, so they are considered the same element... potassium.

ii) They have different numbers of neutrons. (K-40 has one more than K-39)

b) Over a period of 1.3 by, half of the atoms in any starting amount will have decayed.

c) Original amount of K-40 = 17.3 + 69.2 = 86.5 ppb
% of K-40 remaining = (17.3/86.5) x100 = 20%
From graph, age = 3by approx.

Worksheet 11

a)

Resource	Use
Ochre	Art, decoration, for culture & rituals.
Sandstone	Abrasive tools for smoothing & shaping wooden implements.
Flint	Cutting blades, spear points.

b)
Mining methods: simple scraping of surface deposits, or hammering of rock outcrops.

Ownership: resources controlled by the "custodians" of that area. Permission needed to take resources.

2.
a) Aust. is one of the world's largest suppliers of a wide range of geo.resources including iron ore, bauxite, uranium & diamonds.

b) Geo.resources contribute only about 8% of GDP, but are vital to Aust's international trade & econ.growth. Royalties & taxes paid to state & Fed. govts. are very important for supply of services such as health, education, etc.

c) Non-sustainable because geo.resources are non-renewable and some (eg coal) are environmentally damaging.

Worksheet 11 (cont.)

3.
Some minerals can affect the Earth's magnetic field & tiny variations can be detected by surveying with a magnetometer. The data can give clues to possible mineral resources, even if deep underground.

Seismic measurements of shock waves from small explosives allow underground "mapping" of geological features. This can show geol. formations, rock layers, etc. & give clues to the location of resources.

4.
Drilling: usually used to extract petroleum & natural gas.

Pit or open-cut mining: for shallow, wide-area deposits such as coal or iron ore. Surface layers are removed, then the resource is simply scraped or excavated from large, open pits.

Underground mining is used for deep resources and/or for minerals which tend to occur in "seams" rather than over wide areas. Mining usually requires a vertical shaft with elevators, with tunnels radiating off to follow the seams of minerals.

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