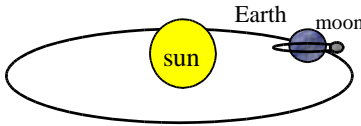


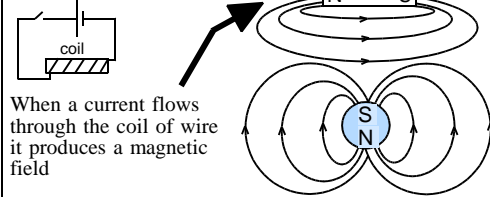
# P2: Earth, Space and Radiation; Higher

Written by  
M J Bradley

## Earth, Sun and Moon



## Electromagnets and magnetic fields



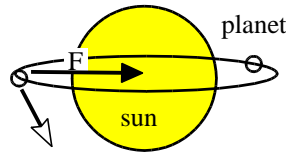
When a current flows through the coil of wire it produces a magnetic field

**Earth's magnetic field:** electric currents in the earth produce a magnetic field. The field can trap charged particles from the sun. Magnetic south pole is near the geographic north pole.

**Aurora Borealis** The charged particles are attracted to the poles. When they hit the atmosphere they make it glow



## Planet Orbits and Centripetal Force

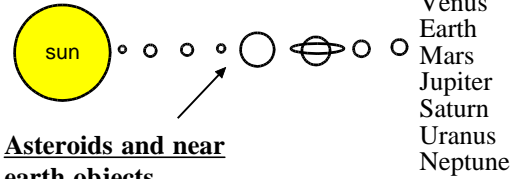


The planets would rather travel in a straight line if it could! Gravity is the **centripetal**(central) force, F which pulls them round in an ellipse shape we call an orbit

**The light year:** This is the distance that light travels in one year - a huge distance

**Solar Flares:** These are huge explosions from the sun's surface which release many charged particles which can disturb the earth's magnetic field damaging satellites and disrupting electricity supplies

## The Solar System



## Asteroids and near earth objects

Asteroids orbit the sun between Mars and Jupiter. The gravity of Jupiter can sometimes cause them to move towards the centre of the solar system and possibly collide with the Earth



## Star Life Cycles

### Type 1: Massive blue type Star



**blue star**

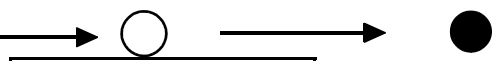
Gas is pulled together by gravity to make a **protostar**. It gets very hot

Nuclear fusion of hydrogen produces vast amounts of light and heat

### red super giant

hydrogen is running out. Red because the star is cooling

next a giant explosion called a **supernova** blasts most of the outer layers off. The star shines very brightly



What is left starts to shrink and becomes an incredibly dense **NEUTRON STAR**

If the star continues to shrink it will become a **BLACK HOLE**. Its gravity is so strong that not even light can escape it

### Star type 2: Small white/yellow Sun type



Sun type star

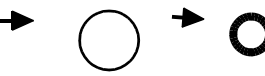
Gas is pulled together by gravity to make a **protostar**. It gets very hot

Nuclear fusion of hydrogen produces vast amounts of heat

### RED giant

hydrogen is running out. Red because the star is cooling

Next the outer layers are thrown off in an explosion called a **NOVA**



the piece that remains is called a **WHITE DWARF**

eventually the star cools down and stops shining completely and becomes a dead star called a **BLACK DWARF**

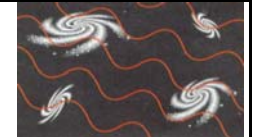
## Big Bang



Many scientists believe that the universe began about 15000 million years ago. The scientific evidence points to an event scientists call the Big Bang in which all the matter in the universe exploded from a point smaller than an atom. Evidence for this includes the red-shift of light from distant galaxies. This is an apparent drop in frequency of the light from distant galaxies which suggests all the galaxies are moving away from us. Other evidence is that scientists have detected the microwave echoes of this fantastic explosion which are still echoing around the universe today.



galaxies moving away



microwave background - the heat of the big bang

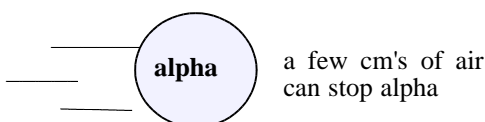
## Nuclear Radioactivity

This is radiation given out by unstable atoms

## Types of Nuclear radioactivity

- 1) **alpha radiation** - particles
- 2) **Beta radiation** - particles
- 3) **Gamma radiation** - electromagnetic waves

## What does it take to stop radiation?



**beta**

a few cm of aluminium stop beta

**gamma** : light speed

lead is needed to stop gamma

## Why can radiation be dangerous?

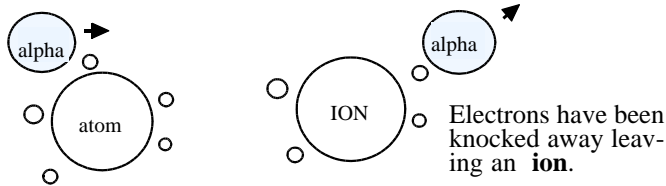
Radiation can be dangerous because it can damage living cells. The DNA which controls how cells reproduce can be damaged so they grow out of control - a cancer. The genes are damaged because radiation causes **ionisation**.

## What is Background Radioactivity?

This is radiation which is always around us. Materials that give out radiation are called **radioactive**. There is naturally occurring radioactive rock and soil which we cannot avoid. We even get radiation from food, the Sun and stars in space.

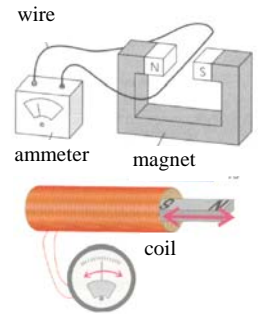
## What is ionisation?

An alpha particle is big and so it is very likely to hit atoms and do a lot of damage. It may knock some of the electrons away leaving the atom with a positive charge which we call an **ion**. The atom has been **ionised**

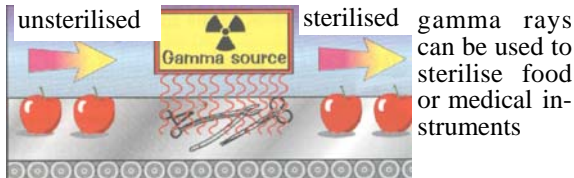


## Generating Electricity

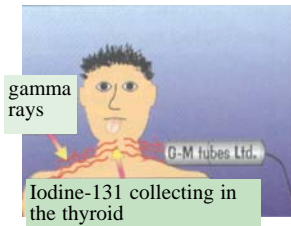
If a wire is moved through a magnetic field current is produced. The same effect can be achieved by using a coil of wire and moving the magnet in and out of the coil. The current is increased by moving the magnet faster, a stronger magnet, or more turns of wire in the coil



## Uses of Radioactivity



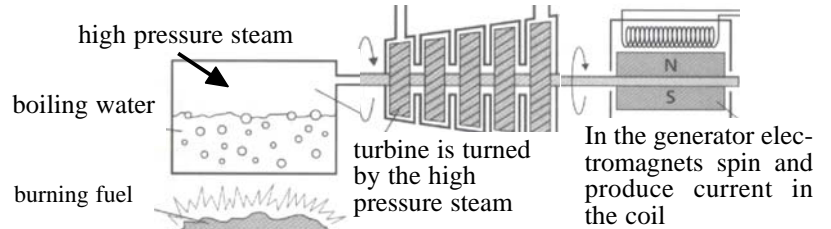
here radiation is used as a **tracer** to check the health of the thyroid gland. A healthy thyroid should absorb iodine and there should be a strong gamma ray emission



## Radiotherapy

This is the treatment of cancer using gamma rays. They have to be directed carefully to kill cancer cells

## Generating Electricity at a Power Station



After the steam passes through the turbine it loses its kinetic energy. It condenses and loses heat energy to the environment in the cooling towers

## Efficiency

Only a certain percentage of the chemical potential energy in the fuel of a power station is converted to electrical energy the rest is wasted. Energy losses are in the cooling towers and in the waste gases of the furnace

$$\text{Efficiency (\%)} = \frac{\text{useful energy}}{\text{input energy}} \times 100$$

## Example.

If fuel is burned providing 100J/s, and 35J/s of electricity is produced what is the efficiency?

## Answer:

$$\text{eff} = \frac{\text{useful energy}}{\text{input energy}} \times 100$$

$$= \frac{35}{100} \times 100 = 35\%$$

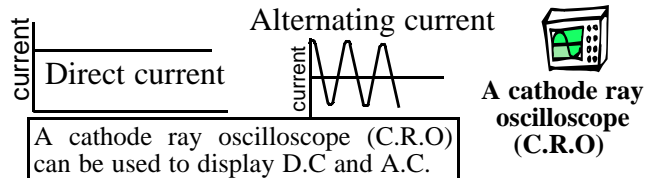
## Transporting Electricity

Electricity is transported at high voltage to reduce energy losses through wires.



## Direct and Alternating Current

Direct current D.C is current which flows in one direction. Batteries deliver D.C. Alternating current A.C, is current which flows first in one direction and then the other. The mains supply is alternating current. A.C has a number of advantages over D.C the most important one being that it is easier to send electricity around the country as A.C



**Power** Electric power is the **amount of electrical energy changed to other types in one second**. Power is measured in joules per second. One joule per second is called one **watt or 1W**

**Energy and Power**  $\text{energy} = \text{power} \times \text{time}$   
 $E(\text{J}) = P(\text{w}) \times t(\text{s})$

**The kilowatt hour** - this is a much bigger **unit** of energy than the joule

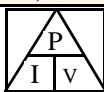
$$E(\text{kwh}) = P(\text{kw}) \times t(\text{h}) \quad \text{cost} = n^\circ \text{ of kwh used} \times \text{cost of each unit}$$

**Off peak electricity** is cheaper and can be used with the right meter installed at night time. Using electrical devices at night can create noise which is a disadvantage when sleeping

$$\text{POWER} = \text{CURRENT} \times \text{VOLTAGE}$$

$$\text{(WATTS)} \quad \text{(AMPS)} \quad \text{(VOLTS)}$$

$$P = I \times V$$



**Example.** What is the voltage across a 1000W fire which uses 4A?  
 $V = P/I = 1000/4 = 250 \text{ V}$

## The problem with fossil fuel power stations

- burning coal, oil or gas produces vast amounts of carbon dioxide which causes global warming

## Burning biomass

Biomass is once living material when burnt it adds no extra CO<sub>2</sub> to the atmosphere, problem is there is not enough

## Other ways of producing electricity

**Wind Turbines** In wind turbine the kinetic energy of the wind is converted to electrical energy.

**Advantages:** There is no burning and so no CO<sub>2</sub> is released into the atmosphere

Renewable energy source

**Disadvantages:** Not always windy



## Nuclear Power Stations

**Advantages** (a) no carbon dioxide (b) Lots of electrical energy produced.

**Disadvantages** radioactive waste has to be stored safely. How it is stored depends upon things like (a) the type of radioactivity emitted and (b) how long it is radioactive

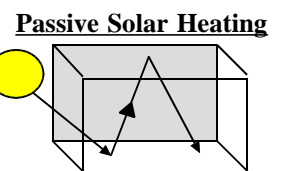
**Photo-cells** These convert light into electricity. These can produce useful amounts of electricity if (a) they have a large surface area (b) sunlight is very intense

**Advantages:** No pollution and a renewable energy source

**Disadvantage:** Not always sunny

## How do photo-cells work?

When light hits silicon atoms electrons are removed from atoms. These free electrons can flow to make current



Short wavelengths pass through glass. The energy absorbed by the floor is re-emitted as infra-red (long wavelength) which reflects from the glass surface raising the temperature of the room

1) What is the centripetal force on the Earth which keeps it in orbit around the Sun?

1b) In which direction is this centripetal force?

2) What are the order of the planets?

3) Which of the following are not in our Solar System

**Sun, asteroids, comets, stars, planets, galaxies.**

4) Asteroids are many millions of \_\_\_\_\_ orbiting the \_\_\_\_\_ between the planets \_\_\_\_\_ and \_\_\_\_\_

5) Near earth objects could \_\_\_\_\_ with the earth

6) The Aurora Borealis are caused by \_\_\_\_\_ particles from the \_\_\_\_\_ hitting the \_\_\_\_\_ atmosphere near to the north and \_\_\_\_\_. They are attracted to the poles because the earth has a \_\_\_\_\_ field

7) The words below describe the life cycle of of a giant star but they are not in the correct order. What is the correct order?

**Super red giant, black hole, super nova, neutron star, stable main sequence star.**

8) What is the evidence for the Big Bang?

9) Which part of the atom does radioactivity come from?

10) Why are some elements radioactive?

11) Which types of radiation are particles?

12) Which type is an electromagnetic wave?

13) Which radiation is only absorbed by large thicknesses of lead?

14) Which radiation is absorbed by a few cm's of air?

15) Radioactivity causes ionisation. What does this mean?

16) Why is ionising radiation a threat to living things?

17) To generate electricity a wire must cut across magnetic \_\_\_\_\_ lines

18) In a fossil fuel power station \_\_\_\_\_, \_\_\_\_\_ or \_\_\_\_\_ is burnt. The heat \_\_\_\_\_ water to make steam. The high pressure steam has lots of \_\_\_\_\_ energy and makes a \_\_\_\_\_ spin. The turbine is connected to an electromagnet inside the \_\_\_\_\_ and spins near to coils in which \_\_\_\_\_ energy is produced

19) The equation for efficiency is \_\_\_\_\_

20) Why is burning large amounts of fossil fuels not good for the planet?

21) An advantage of nuclear power stations is that no \_\_\_\_\_ is produced. A serious disadvantage is that \_\_\_\_\_ waste is produced.

22) Photo cells work by converting \_\_\_\_\_ energy into electrical energy. Photo cells have silicon atoms and when light hits them \_\_\_\_\_ are removed which can flow to make an electrical \_\_\_\_\_

23) Photo cells will create greater currents if .....

24) Wind turbines convert the \_\_\_\_\_ energy of the wind into \_\_\_\_\_ energy. An advantage is that no \_\_\_\_\_ is produced and a disadvantage is .....

25) energy(J) = power(w) x \_\_\_\_\_(s) or E = \_\_\_\_\_

26) How much energy does a 200W fan use in 10s?

27) The kilowatt hour is a much bigger unit of \_\_\_\_\_ than the joule

28) energy in kwh = power in \_\_\_\_\_ x time in \_\_\_\_\_ or E = \_\_\_\_\_

29) How many kilowatt hours of energy are used by a 3kw heater left on for 5 hours?

30) The electric power device depends upon \_\_\_\_\_ and \_\_\_\_\_

31) electric power(w) = current(A) x \_\_\_\_\_(v) or P = \_\_\_\_\_ x \_\_\_\_\_

32) What is the electric power of a heater if it uses 5A of current at a voltage of 250V?

33) Alternating current constantly reverses \_\_\_\_\_. Direct current travels in one \_\_\_\_\_ only. Current from a battery is \_\_\_\_\_

34) An advantage of off peak electricity is ..... A disadvantage is.....

35) Biomass is once \_\_\_\_\_ material. It can be burnt in \_\_\_\_\_ and has the advantage there is no extra \_\_\_\_\_ put into the atmosphere

1) Gravity

1b) Towards the centre of the Sun

2) mercury, venus, earth, mars, jupiter, saturn, uranus, neptune

3) stars, galaxies

4) rocks, sun mars, jupiter

5) collide

6) charged, earths, south, pole, magnetic

7) **stable main sequence star, super red giant, super nova, neutron star, black hole**

8) Galaxies are moving away from each other, microwave background radiation,

9) The nucleus

10) Their atoms are unstable

11) alpha and beta

12) gamma

13) gamma

14) alpha

15) It means that it strips away electrons from atoms which it hits leaving positive ions.

16) because DNA in cells is damaged

17) field

18) coal, natural gas, oil, boils, kinetic, turbine, generator, electrical

19) efficiency =  $\frac{\text{useful energy out}}{\text{input energy}} \times 100$  (%)

20) carbon dioxide is released which causes global warming

21) carbon dioxide, radioactive

22) light, electrons, current

23) they have a big surface area and light is intense

24) kinetic, electrical, carbon dioxide, not always windy

25) time  $E = P \times t$

26)  $E = P \times t = 200 \times 10 = 2000 \text{ J}$

27) energy

28) kw, hours,  $E = P \times t$

29)  $E = P \times t = 3 \times 5 = 15 \text{ kwh}$

30) current, voltage

31) voltage,  $P = I \times V$

32)  $P = I \times V = 5 \times 250 = 1250 \text{ W}$

33) direction, direction, d.c.

34) Cheaper noise at night time

35) living power stations carbon dioxide

## P2 : Earth, Space and Radiation

Name \_\_\_\_\_

1) This question is about nuclear radiation.

a) From what part of the atom does nuclear radiation come from?

\_\_\_\_\_ [1]

b) What are the three types of nuclear radiation? \_\_\_\_\_ [3]

c) Which nuclear radiation is an electromagnetic wave moving at the speed of light? \_\_\_\_\_ [1]

2) An experiment was done by a scientist to find out which nuclear radiation can penetrate the furthest into materials. Fill in the missing blanks on their scientific report

\_\_\_\_\_ particles were absorbed by just a few cm's of air. It took several cm's of aluminium to absorb \_\_\_\_\_ particles. It took a thick piece of lead to absorb \_\_\_\_\_ [3]

3) The majority of scientists believe that the universe began in 'The Big Bang'

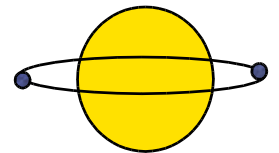
Describe what the big bang was and the evidence which supports the theory.

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [4]

4) The diagram shows the orbit of the Earth around the Sun.

(a) What is the centripetal force that keeps the Earth in orbit? \_\_\_\_\_ [1]

(b) Draw an arrow on the diagram showing the direction of this centripetal force on the Earth. [1]



5) Which of these are in the solar system **galaxy, comet, Jupiter, universe, moon, super nova, sun, stars**

\_\_\_\_\_ [1]

6) Place the following in order of size - largest first **Jupiter, Sun, Universe, Earth, Moon, comet, galaxy**

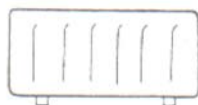
\_\_\_\_\_ [1]

7) Complete this table explaining the life stages in an average sun type star

protostar	gravity pulling together hydrogen gas and getting hotter
main sequence sun type	
red giant	
white dwarf	
black dwarf	

8) A gardener wants to buy a heater for a greenhouse. Two electric heaters are on sale.

**A** 240 volts, 1 kilowatt  
(or 1000 watts)



**B** 240 volts, 2 kilowatts  
(or 2000watts)



(a) **Heater B** is used for 4 hours. Calculate how many kilowatt-hours would be used.

\_\_\_\_\_  
 \_\_\_\_\_  
 Answer \_\_\_\_\_ kWh [3]

(b) Each kilowatt-hour costs 6 pence. Calculate the cost of using **heater B** for 4 hours

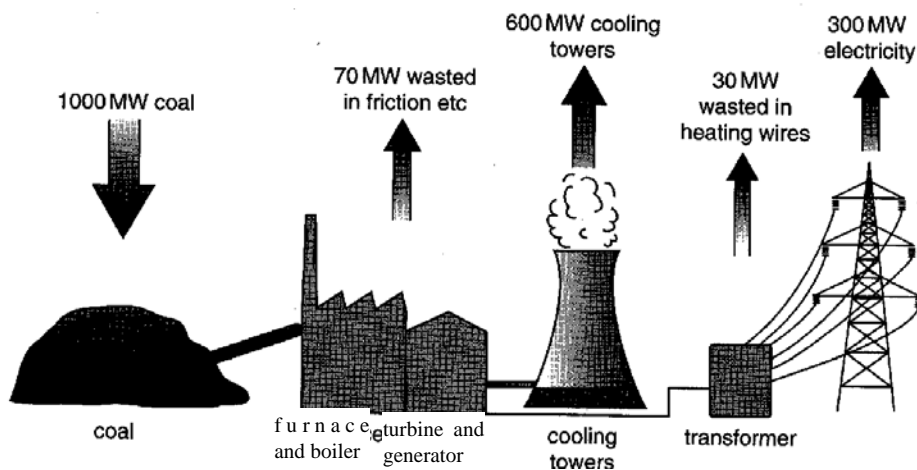
\_\_\_\_\_  
 \_\_\_\_\_

9 (a) Look at the diagram of a power station.

The power station uses coal and generates electricity.

(i) The energy is transferred from coal to electricity. What happens in the furnace and boiler? \_\_\_\_\_

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [2]



(ii) What happens in the turbine and generator? \_\_\_\_\_

\_\_\_\_\_  
 \_\_\_\_\_ [2]

(iii) Where is the most power wasted? \_\_\_\_\_ [1]

(iv) What is the total power wasted? \_\_\_\_\_ [2]

(v) How much electrical power is being generated? \_\_\_\_\_ [1]

(vi) Calculate the efficiency of the power station \_\_\_\_\_

\_\_\_\_\_  
 \_\_\_\_\_ [4]

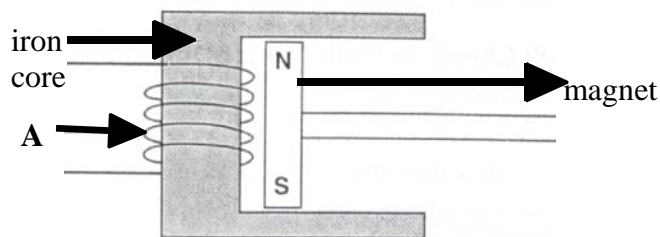
(vii) Why are fossil fuel power stations bad for the environment? \_\_\_\_\_ [2]

10) This is a simple electricity generator

(a) What is part A? \_\_\_\_\_ [1]

(b) Explain how the generator produces electricity

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [3]



11) This question is about photocells. Photocells provide electricity when light shines on them. Emma investigates photocells. Look at the diagram.

She puts a photocell near a bright light. The photocell is connected to an ammeter. Her teacher tells her she must use a DC meter.

(a) What does DC mean? \_\_\_\_\_ [1]

(b) Emma does the experiment at night. There is a lot less light. How does the reading on the ammeter change?

\_\_\_\_\_ [1]

(c) Light is shining on a photocell and it produces an electric current. Describe how. In your answer use your ideas about: (i) energy (ii) electrons

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [3]

