**Short questions from past papers**

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## Reflection

1. **State the laws of reflection of light.** [2005 OL][2011 OL][2012 OL][2014 OL]
2. The incident ray, the normal at the point of incidence and the reflected ray all lie on the same plane.
3. The angle of incidence is equal to the angle of reflection (i = r).
4. **Describe the image that is formed in a concave mirror when an object is placed inside the focus.**

[2003 OL] [2007 OL]

The image is virtual, magnified and upright.

1. **A concave mirror can produce a real or a virtual image, depending on the position of the object.**

**Give one difference between a real image and a virtual image.** [2004 OL]

A real image can be obtained on a screen; a virtual image cannot.

In a real image the light rays meet; in a virtual image they do not.

A real image is always inverted/ a virtual is erect, a real image is in front / a virtual image is behind.

1. **Give two uses for a concave mirror.** [2004 OL][2011 OL][2012 OL]

Torch, headlights, searchlight, dentist mirror, cosmetic mirror, solar furnace.

1. **Concave mirrors, rather than convex mirrors, are used by dentists to examine teeth. Explain why.** [2014]
They give a magnified image
2. **Why is a convex mirror used, instead of a plane mirror, as a door mirror on a car?** [2010]

A convex mirror offers a wider field of view

## Refraction

1. **What is meant by refraction of light?** [2008] [2006][2009 OL][2005 OL][2002 OL][2014 OL]

Refraction is the bending of light as it goes from one medium to another.

1. **State the laws of refraction of light.** [2002][2003 OL][2011]
2. The incident ray, the refracted ray and the normal all lie in the same plane.
3. Sin i/ Sin r is a constant
4. **State Snell’s law of refraction.** [2008]

The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.

1. **What is meant by the refractive index of a material?** [2004 OL]

n = sin i/ sin r, where i is the angle of incidence and r is the angle of refraction.

1. **Define the term *critical angle*.** [2004 OL][2003 OL][2011 OL]

The critical angle corresponds to the angle of incidence in the denser of two media which causes the angle of refraction to be 900.

1. **Define the term *total internal reflection*.** [2003 OL]

Total internal reflection occurs when the angle of incidence in the denser of the two media is greater than the critical angle and light is reflected back into the denser medium.

1. **Explain, with the aid of a diagram, how total internal reflection can occur.** [2011 OL]

The angle of incidence greater than critical angle

Total internal reflection occurs

This is repeated all along the fibre

1. **Give two uses of total internal reflection.** [2003 OL][2005 OL]

Fibre optics, endoscopes, reflective road signs, telecommunications, binoculars, periscope.

1. **Why is each fibre in an optical fibre cable coated with glass of lower refractive index?** [2009]

Because total internal reflection can only occur for rays travelling from a denser to a rarer medium.

1. **How is the escape of light from the sides of an optical fibre prevented?** [2004 OL]

Total internal reflection occurs due to an outer cladding of lower refractive index.

1. **An optical fibre has an outer less dense layer of glass. What is the role of this layer of glass?** [2004][2009]

Total internal reflection will only occur if the outer medium is of lower density.

It also prevents damage to the surface of the core.

1. **Give an expression for the critical angle of the glass in an optical fibre in terms of the speed of light in the glass and the speed of light in air.** [2014]

n = 1/Sin C

n = cair/cglass

sin C = cglass/cair

C = Sin–1(cglass/cair)

1. **Give one use for optical fibres.** [2004 OL]

Endoscope, telecommunications, binoculars.

1. **Give two reasons why the telecommunications industry uses optical fibres instead of copper conductors to transmit signals.** [2004][2011 OL]

Less interference, boosted less often, cheaper raw material, occupy less space, more information carried in the same space, flexible for inaccessible places, do not corrode, etc.

1. **Name a material that is used in the manufacture of optical fibres.** [2004 OL]

Glass / plastic / sand / silicon

## Lenses

1. **A diverging lens cannot be used as a magnifying glass. Explain why.** [2006]

The image is always diminished

1. **How does the eye bring objects at different distances into focus?** [2002]

It can change the shape of the lens which in turn changes the focal length of the lens.

1. **Give a common use for a convex lens.** [2013 OL]Magnification, (eye) glasses, binoculars, contact lenses, camera, etc.

## Velocity and acceleration

1. **Define velocity** [2009 OL][2008 OL][2004 OL][2002 OL]

Velocity is the rate of change of displacement with respect to time.

1. **Explain the distinction between speed and velocity.** [2014 OL]velocity is speed in a given direction // velocity is a vector // sound is a scalar
2. **Define acceleration** [2008 OL][2004 OL][2002 OL]

Acceleration is the change in velocity with respect to time

1. **Explain the term acceleration due to gravity, *g*.** [2006 OL][2003 OL][2012]

It is the acceleration of an object which is in freefall due to the gravitational pull of the earth.OR Acceleration caused by the earth

1. **Why does the value of *g*, the acceleration due to gravity, vary at different locations on the surface on the earth?** [2010]

Locations are at different distances from the earth’s centre / earth is not perfectly spherical / etc.

1. **Why is the acceleration due to gravity on the moon less than the acceleration due to gravity on earth?**[2012 OL]Because the mass of the moon is less than the mass of the earth
2. **Suggest a reason why the module of the spacecraft when launched from the moon does not need a streamlined shape like those that are launched from earth.** [2012 OL]There is no atmosphere on the moon so no air resistance / drag / friction

## Vectors

1. **Give the difference between vector quantities and scalar quantities and give one example of each.** [2014][2003][2013 OL]

A vector is a quantity which has magnitude and direction. Example: force, velocity, acceleration, etc

A scalar is a quantity which has magnitude only. Example: Time, mass, speed etc

1. **Force is a vector quantity. Explain what this means.** [2006 OL]

A vector is a quantity which has magnitude and direction.

## Force, mass and momentum

1. **Define the newton, the unit of force.** [2008]

The newton is the force that gives a mass of 1 kg an acceleration of 1 m s-2.

1. **Define Force** [2004] [2008 OL][2006 OL][2013 OL][2014 OL]

A force is something which causes an acceleration.

1. **Define Momentum** [2004][2004 OL][2010 OL][2013 OL]

Momentum = mass × velocity

1. **State The Principle of Conservation of Momentum.**

[2002][2009 OL][2008 OL][2007 OL][2005 OL][2004 OL][2010 OL][2012 OL][2013][2013 OL]

In any interaction between two objects, the total momentum before the interaction is equal to the total momentum after the collision, provided no external forces act.

1. **State Newton’s first law of motion.** [2011 OL]A body will remain at rest or moving at a constant velocity unless acted on by an (external) force,
2. **State Newton’s Second Law of Motion** [2009][2004] [2003][2007 OL]

Force is proportional to the rate of change of momentum.

1. **State Newton’s Third law of Motion.** [2006]

When body A exerts a force on body B, B exerts a force equal in magnitude (and) opposite in direction to A.

1. **Name two forces acting on a cheetah while it is running.** [2004 OL]

Air resistance, gravity, friction

1. **Why is the astronaut’s weight greater on earth than on the moon?** [2006 OL]

Because acceleration due to gravity is greater on the earth (because the mass of the earth is greater than the mass of the moon).

1. **The earth is surrounded by a layer of air, called its atmosphere.**

**Explain why the moon does not have an atmosphere.** [2006 OL]

Because gravity is less on the moon.

1. A powerful rocket is required to leave the surface of the earth.

A less powerful rocket is required to leave the surface of the moon. Explain why. [2008 OL]

The force of gravity is less on moon so less force is needed to escape.

1. **Using Newton’s first law of motion, explain what would happen to the passengers in a plane if they were not wearing seatbelts while the aircraft was landing.** [2002 OL]

They would continue to move at the greater initial velocity and so would be ‘thrown’ forward.

1. **Draw a diagram showing the forces acting on a car travelling on a road.** [2011 OL]



1. **Draw a diagram to show the forces acting on the ball when it is at position A.** [2006]

Weight (W) downwards; reaction (R) upwards; force to left (due to friction or curled fingers)

1. **Use a diagram to show the forces acting on the skydiver and explain why he reaches a constant speed.** [2003]

Weight acting down.

Air resistance / friction / buoyancy acting up.

Air resistance = weight, therefore resultant force = 0

Therefore acceleration = 0

1. **Draw a diagram showing the forces acting on a rocket at lift-off.** [2012 OL]Weight acting down, thrust acting up.
2. **What is friction?** [2007][2009 OL][2006 OL][2002 OL][2011 OL]

Friction is a force that opposes the relative motion between two surfaces in contact.

1. **A rocket is launched by expelling gas from its engines.**

**Use the principle of conservation of momentum to explain why a rocket rises.** [2007 OL][2010 OL][2013 OL]

The gas moves down (with a momentum) causing the rocket to move up (in the opposite direction with an equal momentum).

1. **A spacecraft is approaching a space station at a constant speed. The spacecraft must slow for it to lock onto the space station. In what direction should the gas be expelled?** [2002]

Forward (toward the space station).

1. **Explain how the principle of conservation of momentum is applied to changing the direction in which a spacecraft is travelling.** [2002]

As the gas is expelled with a momentum in one direction the rocket moves in the other direction with an equal momentum.

## Pressure

1. **Define pressure.** [2006][2009 OL][2007 OL][2005 OL][2002 OL][2013 OL]

Pressure is Force per unit Area.

1. **Give the unit of pressure.** [2002 OL][2005 OL][2014 OL]

The pascal

1. **Name an instrument used to measure pressure.** [2002 OL][2005 OL]

A barometer

1. **Is pressure a vector quantity or a scalar quantity? Justify your answer.** [2006]

It is a scalar quantity because it does not have a direction.

1. **A balloon rises through the atmosphere while the temperature remains constant.**

**What will happen to the balloon as it continues to rise?** [2007 OL]

It will expand.

1. **When air is removed from a metal container it collapses. Explain why.** [2002 OL]

The pressure outside (due to atmospheric pressure) is greater than the pressure inside.

1. **The earth is covered with a layer of air called the atmosphere.**

**What holds this layer of air close to the earth?** [2005 OL]

Gravity.

1. **The type of weather we get depends on the atmospheric pressure.**

**Describe the kind of weather we get when the atmospheric pressure is high.** [2005 OL]

Good weather, dry, clear skies, little wind, settled.

1. **State Boyle’s law.** [2014][2009][2006][2007 OL][2003 OL][2011 OL]

For a fixed mass of gas at constant temperature, the pressure is inversely proportional to the volume.

1. **State Archimedes Principle.** [2007][2014 OL]

When an object is immersed in a fluid, the upthrust it experiences is equal to the weight of the displaced fluid.

1. **State the law of flotation.** [2008]

For a floating object, the weight of the object equals the weight of the fluid displaced.

## Gravity

1. **State Newton’s Law of Gravitation.** [2013][2010][2008] [2005] [2004][2008 OL][2003 OL][2014 OL]

Any two objects in the universe are attracted to each other with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them.

1. **Give two factors which affect the size of the gravitational force between two bodies.** [2006 OL]

The mass of the objects and the distance between them.

1. **What is the relationship between the acceleration due to gravity g and the distance from the centre of the earth?** [2003]

g is proportional to 1/d2

1. The international space station (ISS) moves in a circular orbit around the equator at a height of 400 km.
2. **What type of force is required to keep the ISS in orbit?**
3. **What is the direction of this force?** [2008]
4. Gravity
5. Towards the centre of the orbit / inwards / towards the earth
6. **An astronaut in the ISS appears weightless. Explain why.** [2008][2013]

He is in a state of free-fall (the force of gravity cannot be felt).

1. **Describe the variation in the weight of the astronauts as they travel to the moon.** [2010]

Weight decreases as the astronaut moves away from the earth and gains (a lesser than normal) weight as she/he approaches the moon

1. **Why is the acceleration due to gravity on the moon less than the acceleration due to gravity on the earth?**

[2003 OL]

The earth has a greater mass than the moon.

1. **The earth is covered with a layer of air called the atmosphere.**

**What holds this layer of air close to the earth?** [2005 OL]

Gravity.

1. **The earth is surrounded by a layer of air, called its atmosphere. Explain why the moon does not have an atmosphere.** [2006 OL][2010]

Because gravity is less on the moon.

## Moments

1. **Define the moment of a force.** [2006 OL][2003 OL][2011]

The moment of a force is equal to the force multiplied by the distance between the force and the fulcrum.

1. **What are the two conditions for the equilibrium of a set of co-planar forces?** [2010][2011]

Forces up = forces down // (algebraic) sum of forces acting is zero

(Algebraic) sum of the moments of the forces about any point is zero

1. **Why is it easier to turn a nut using a longer spanner than a shorter one?** [2006]

The distance from the fulcrum is greater therefore there is a greater turning effect.

1. **Explain why the handle on a door is on the opposite side to the hinges of the door.** [2003 OL]

In order to maximise the distance between the force and the fulcrum.

1. **A crane is an example of a lever. Give another example of a lever.** [2006 OL][2011 OL]

Crowbar / nailbar / nutcracker / wheelbarrow / tongs / door handle etc.

1. **When the toy is knocked over, it always returns to the upright position. Explain why this happens. [2011]**

(toy non-vertical) c.g. has a (turning) moment about fulcrum / point of support/contact /

(c.g. has) zero turning moment when toy is in vertical position

## Work, Energy and Power

1. **Define energy** [2005 OL]

Energy is defined as the ability to do work

1. **Define work.** [2007 OL]

Work is the product of force × displacement

1. **What is the difference between potential energy and kinetic energy?** [2007 OL][2010 OL]

Potential energy is energy a body has due to its position; kinetic energy is energy a body has due to its motion.

1. **Give one factor on which the potential energy of a body depends.** [2012 OL]Mass, acceleration due to gravity, height
2. **Name one method of producing electricity.** [2005 OL]

Solar, wind, wave, tidal, biomass, coal, oil, gas, hydroelectricity, geothermal, nuclear, uranium, turf.

1. **What type of energy is associated with wind, waves and moving water?** [2005 OL]

Renewable energy.

1. **Which of the following is not a renewable source of energy: wind, nuclear, solar, hydroelectric**? [2007 OL]

Nuclear

1. **Give one disadvantage of non-renewable energy sources**. [2005 OL]

They will run out.

1. **How does the sun produce heat and light?** [2005 OL]

Through nuclear reactions.

1. **State one energy conversion that takes place in an electrical generator**. [2003 OL]

Kinetic to electric.

1. **What energy conversion takes place when a fuel is burnt**? [2005 OL]

Chemical to heat.

1. **What energy conversion takes place in a solar panel**? [2004 OL]

Light to electricity, light to heat.

1. **Why is a fluorescent tube an efficient source of light**? [2008]

Most of the (electrical) energy is converted to light (energy)

1. **Why is a filament light bulb not an efficient source of light?** [2007]

Almost all of the energy is given off as heat.

1. **What is the difference between potential energy and kinetic energy?** [2007 OL]

Potential energy is energy a body has due to its position; kinetic energy is energy a body has due to its motion.

1. **Give one factor on which the potential energy of a body depends.** [2005 OL]

Mass, height, acceleration due to gravity (g).

1. **State the Principle of Conservation of Energy.** [2008][2005][2013]

Energy cannot be created or destroyed; it can only be changed from one form to another.

1. **Define Power** [2006] [2002] [2007 OL]

Power is the rate at which work is done.

1. **What is the unit of power**? [2005 OL][2007 OL]

The watt.

## Circular Motion

1. **Define (i) velocity** [2006] **and (ii) angular velocity.** [2006][2005][2013]
	1. Velocity is the rate of change of displacement.
	2. Angular velocity is the rate of change of angle with respect to time.
2. **[2013]**
3. **Name the type of acceleration that the ISS experiences as it travels in a circular orbit around the earth.**Centripetal
4. **What force provides this acceleration?**

Gravitational

1. **Even though the hammer [moving in a circle] moves at a constant speed, it accelerates. Explain.** [2012]Thedirection changes (continuously)
2. **Define ‘Centripetal Force’** [2005]

Centripetal Force is the force - acting in towards the centre - required to keep an object moving in a circle.

1. The moon orbits the earth.

**What is the relationship between the period of the moon and the radius of its orbit?** [2009]The period squared is proportional to the radius cubed.

1. **Give an expression for centripetal force.** [2004]



1. Centripetal force is required to keep the earth moving around the sun. [2004][2013]
2. **What provides this centripetal force?**
3. **In what direction does this centripetal force act?**
4. Gravitational pull of the sun.
5. Towards the centre.
6. **What is the period of a geostationary communications satellite?** [2013]One day/ 24 hours

## Simple Harmonic Motion

1. **State Hooke’s Law.** [2014][2009][2007] [2003] [2002][2011]

Hooke’s Law states that when an object is stretched the restoring force F is directly proportional to the displacement provided the elastic limit is not exceeded

1. **A mass at the end of a spring is an example of a system that obeys Hooke’s Law.**

**Give two other examples of systems that obey this law.** [2002][2012]

Stretched elastic, pendulum, oscillating magnet, springs of car, vibrating tuning fork, object bobbing in water waves, ball in saucer, etc.

1. **The equation F = – ks, where k is a constant, is an expression for a law that governs the motion of a body.**

**Name this law and give a statement of it.** [2002]

Hooke’s Law states that when an object is stretched the restoring force is directly proportional to the displacement, provided the elastic limit is not exceeded.

1. **Give the name for this type of motion and describe the motion.**

Simple harmonic motion; an object is said to be moving with Simple Harmonic Motion if its acceleration is directly proportional to its distance *from* a fixed point in its path, and its acceleration is directed *towards* that point.

## Temperature and thermometers

1. **What is meant by the temperature of a body?** [2009 OL][2008 OL][2014 OL]

The Temperature of an object is a measure of the hotness or coldness of that object.

1. **What does a thermometer measure?** [2005 OL]

Temperature

1. **What effect does the addition of heat have on the molecules of a liquid?** [2014 OL]They move around faster (or change state).
2. **What is the unit of temperature?** [2008 OL][2012 OL]

The SI unit of temperature is the Kelvin (K)

1. **What is *heat*?** [2008 OL]

Heat is a form of energy

1. **What is the difference between *heat* and *temperature*?** [2003]

Heat is a form of energy.

Temperature is a measure of the hotness of an object.

1. **To calibrate a thermometer, a thermometric property and two fixed points are needed.**

**What are the two fixed points on the Celsius scale?** [2005 OL]

The melting point and boiling point of water.

1. **Name two scales that are used to measure temperature.** [2009 OL]

Celsius and Kelvin.

1. **Give the equation that defines temperature on the Celsius scale.** [2002]

T (0C) = T(K) – 273

1. **What is the boiling point of water on the Celsius scale?** [2009 OL]

100 °C

1. **The SI unit is named in honour of Lord Kelvin. What is the temperature of the boiling point of water in kelvin?** [2008]

273.15 + 100 = 373.15 K

1. **The temperature of a body is 300 K. What is its temperature in degrees Celsius?** [2003 OL]

300 – 273 = 27 0C.

1. **The temperature of a body is 34 °C. What is its temperature in kelvin?** [2007 OL]

273 + 34 = 307 (K)

1. **Explain the term *thermometric property*.** [2004] [2003][2005 OL][2004 OL][2002 OL][2011 OL][2013]

A thermometric property is a property which changes measurably with temperature.

1. **What is the thermometric property of (i) a thermocouple (ii) the mercury-in-glass thermometer?** [2005][2014] [2005 OL][2009 OL]

 (i) emf; (ii) length/height/volume

1. **Name a thermometric property other than emf.** [2003][2005 OL][2006 OL][2008 OL][2011 OL][2014 OL]

Length, pressure, volume, resistance, colour

1. **Name one other type of thermometer and state its thermometric property.** [2009 OL]

Thermistor – resistance, Thermocouple – emf, Liquid crystal - colour

1. **Why is it necessary to have a standard thermometer?** [2003][2009][2009 OL][2011 OL][2013]

Different thermometers have different thermometric properties at the same temperature.

## Heat and Heat transfer

1. **What is heat?** [2003][2008 OL][2010 OL][2012 OL][2013 OL][2014 OL]

Heat is a form of energy

1. **What effect does the addition of heat have on the molecules of a liquid?** [2014 OL]
They move around faster (or change state).
2. **Define *specific heat capacity*.** [2006] [2004][2008 OL][2002 OL]

Specific heat capacity is the heat energy required to raise the temperature of 1 kg of a substance by 1 K

1. **Define *specific latent heat*.** [2014][2004][2012 OL]

**Specific latent heat** is the heat energy required to change the state of 1 kg of a substance without a change in temperature.

1. **Explain why snow is slow to melt as the day-time temperatures rises above 0 °C.** [2010]

Latent heat of snow/ice (energy needed for change of state) is (very) large

1. [2003 OL][2004 OL][2005 OL][2006 OL][2007 OL][2008 OL][2009][2011 OL][2012 OL][2013 OL]

**Name three methods by which heat can be transferred.**

Conduction, convection and radiation.

1. **What is meant by conduction?** [2004 OL]

Conduction is the movement of heat energy through a substance by the passing on of molecular vibration from molecule to molecule, without any overall movement of the substance.

1. **How is heat transferred in metals?** [2014 OL]
Conduction
2. **Explain how heat transferred in a solid?** [2010 OL]

Atoms are touching / in contact so the heat/energy gets transferred from one to the other by vibration (without the atoms moving along).

1. **How does the method of heat transfer in a liquid affect the positioning of the heating element in a kettle?** [2013 OL]
The heat rises so the element is at the bottom.
2. **Why are the pipes in the solar panel usually made from copper?** [2004 OL[

It is a good heat conductor.

1. **What is meant by the *U*-value of a material?** [2014 OL][2010 OL]
It is a measure of the heat flow through 1 m2 of material each second (perpendicular to the direction of flow) when a temperature difference of one degree exists between the two sides
2. **How can the U-value of the walls of a house be reduced?** [2010 OL][2012 OL]

Thicker insulation, double glazed windows, etc.

1. **What is the effect of increasing the U-value of a structure?** [2002 OL]

It means that the heat conductivity of the structure is increased.

1. The U-value of a house is a measure of the rate of heat loss to the surroundings.

**Give two ways in which the U-value of a house can be reduced.** [2004 OL]

Fibreglass in attic, insulation in cavity wall, double glazing, carpets

1. In an electric storage heater, bricks with a high specific heat capacity are heated overnight by passing an electric current through a heating coil in the bricks. The bricks are surrounded by insulation.

**Why is insulation used to surround the bricks?** [2006 OL]

To prevent heat-loss.

1. **Name a material that could be used as insulation in a storage heater.** [2006 OL]

Fibre glass / rockwool / cotton wool.

1. **Explain how the storage heater heats the air in a room.** [2006 OL]

The heater heats the air which is beside it. This hot air then rises and is replaced by cold air. This process then gets repeated.

1. **Storage heaters are frequently used to heat buildings. State the principle that underlies the operation of an electrical storage heater. [2013]**Storage heaters have a large heat capacity. They are heated when electricity is inexpensive (off peak). They then store a large quantity of energy which they release energy slowly (during the day).
2. **What is convection?** [2006 OL]

Convectionis the transfer of heat through a fluid by means of circulating currents of fluid caused by the heat.

1. **Explain why heat does *not* travel through solids by means of convection.** [2013]The particles cannot move freely
2. **Why is the heating element of an electric kettle near the bottom?** [2002 OL]

Because hot water rises.

1. **Why does warm water rise to the top of the solar panel**? [2004 OL]

The water expands when heated and therefore has a lower density and gets replaced by water which has a higher density (cold water). This is convection.

1. **Name two processes by which a hot drink cools.** [2011]

**How is the energy lost by each of these processes reduced for a hot drink supplied in a disposable cup?**Conduction – The material the cup is made from is a good insulatorEvaporation – use a lidConvection – Use a lid /insulation

1. An electric toaster heats bread by convection and radiation.

**What is the difference between convection and radiation as a means of heat transfer**? [2008]

Convection requires a medium, radiation does not.

1. **Why are the pipes in the solar panel usually painted black?** [2004]

Black is a good absorber of radiation.

1. **Storage heaters have a large heat capacity. Explain why**. [2004]

They are heated only at night but must release energy slowly during the day.

1. **Why does the temperature of an athlete reduce when she perspires?** [2007]

As the water evaporates it takes heat energy from the body.

1. **Explain the term *evaporation*. [2014 OL]**
process by which a liquid absorbs heat and changes to a gas

## Waves and Wave motion

1. **Explain what is meant by *the* *frequency of a wave*?** [2007 OL][2010 OL][2013 OL]

The frequency of a wave is the number of waves passing a fixed point per second.

1. **What is meant by *the amplitude of a wave*?** [2005 OL]

Amplitude corresponds to the height of the wave.

1. **Explain the difference between *Transverse* and *Longitudinal* waves.** [2005][2006 OL][2013]

A **Transverse wave** is a wave where the direction of vibration is perpendicular to the direction in which the wave travels.

A **Longitudinal Wave** is a wave where the direction of vibration is parallel to the direction in which the wave travels.

1. **Distinguish between interference and diffraction.** [2014][2012][2012 OL]
Interference occurs when waves from different sources overlap to form a resultant wave of greater or lower amplitude.
Diffraction occurs when a wave spreads around an obstacle or passes through an aperture.
2. **Explain the term *diffraction*** [2009][2005 OL][2004 OL][2002 OL]

Diffraction is the spreading out of a wave when it passes through a gap or passes by an obstacle.

1. **Explain the term *interference*.** [2005 OL][2004 OL]

Interference occurs when waves from two sources meet to produce a wave of different amplitude.

1. **Explain the term *constructive interference*.** [2003]

Constructive interference occurs when two waves combine to produce a wave of greater amplitude.

1. **Give two conditions necessary for total destructive interference to occur.** [2011]The waves must have the same amplitude and be out of phase by 1800 (crests over troughs).
2. **Explain the term *coherent sources*.** [2003][2011]

Coherent sources are waves which have the same frequency and are at in phase.

1. **What causes the Doppler effect?** [2010]

Relative motion between source (of waves) and observer

1. **What is the Doppler effect?** [2010][2008] [2007][2006] [2003][2002][2014][2014 OL]

The Doppler Effect is the apparent change in frequency due to *relative motion* between source and observer.

1. **What causes the red shift in the spectrum of a distant star**? [2010]

Distant stars are moving away from us therefore the wavelengths increase.

1. **Give two applications of the Doppler effect.** [2014][2010]

Radar, medical imaging, blood flow measurement (echocardiogram), temperature measurement, (underwater) acoustics, etc.

## Sound

1. **Explain the term *resonance*.** [2007 OL][2010][2012 OL][2013][2013 OL]

Resonance is the transfer of energy so that an object vibrates at its natural frequency.

1. **Explain the term *natural frequency*.** [2007 OL][2010 OL]

Natural frequency is the frequency at which an object will vibrate if free to do so.

1. **Explain the term *fundamental frequency*.** [2013 OL]The lowest resonant frequency of a vibrating object is called its *fundamental frequency*.
2. **What are overtones**? [2013 OL]
Overtones are multiples of the fundamental frequency
3. **What is meant by the frequency limits of audibility** [2011 OL]

These are the lowest and highest frequencies which humans can hear

1. **What is meant by the threshold of hearing?** [2013 OL]

The threshold of hearing is the smallest sound intensity detectable by the average human ear at a frequency of one thousand Hertz.

1. **Define Sound Intensity** [2007] [2002]

Sound Intensity is defined as power per unit area.

1. **The sound intensity level at a concert increases from 85 dB to 94 dB when the concert begins.
By what factor has the sound intensity increased?** [2009]

If sound intensity doubles ⇒ intensity level increases by 3 dB, so if intensity has increased by 9 dB then the sound intensity must have increased by a factor of 8.

1. **State the wave property on which the loudness, the pitch, the quality of a musical note depends.**[2010 OL][2011]

 Loudness depends on amplitude Pitch depends on frequency.
Quality depends on overtones / harmonics

1. **The clarinet is a wind instrument based on a pipe that is closed at one end.** [2011] **What type of harmonics is produced by a clarinet?**Odd harmonics
2. **An opera singer, singing a high pitched note, can shatter a glass. Explain why. [2010 OL]**

Resonance // transfer of energy

## The wave nature of light

1. **Explain the term *dispersion*.** [2009][2007 OL][2010 OL][2013][2013 OL]

Dispersion is the splitting up of white light into its constituent colours.

1. **Give an example of the dispersion of light occurring in nature.** [2010 OL]

Rainbow / oil film colours / soap bubble colours / CD colours

1. **Explain what is meant by a spectrum.** [2007 OL]

A spectrum refers to the range of colours present in white light.

1. **Explain the term *monochromatic light*.** [2009 OL]

Monochromatic light is light of one wavelength only.

1. **Explain the term *diffraction grating*.** [2009 OL]

A diffraction grating consists of a piece of transparent material on which a very large number of opaque (black) parallel lines are engraved.

1. **Name a piece of laboratory equipment used to separate white light into its colours.** [2014 OL]
(glass) prism or diffraction gra**t**ing
2. **Can a diffraction grating which diffracts light also diffract X-rays? Justify your answer.** [2012]No.Line spacing must be similar to the wavelength of the radiation (for diffraction to occur) **/** the spacing between lines in (such) a grating is too large (for diffraction to occur) **/** for x-ray diffraction, gratings in which lines are separated by infinitesimal distances are required.
3. **Explain how the diffraction grating produces a spectrum.** [2009]

Different colours have different wavelengths so constructive interference occurs at different positions for each separate wavelength.

1. **Give two differences between what is observed when a narrow beam of light undergoes dispersion as it passes through a prism, and what is observed when a narrow beam of light undergoes dispersion as it passes through a diffraction grating.** [2013]

Red light deviated least in a prism and deviated the most in a grating
Many spectra observable with a grating, only one with a prism

1. **Explain the term polarisation** [2014]**[??]**Polarisation is the restriction of (vibrating electromagnetic) waves to a single plane
2. **What type of wave motion does light have as indicated by polarisation?** [2012 OL]
Transverse
3. **Name a type of wave that cannot be polarised.** [2014 OL]
longitudinal // sound // pressure
4. **Why are Polaroid sunglasses more effective than non-Polaroid sunglasses at reducing glare?** [2012 OL]Polaroid sunglasses remove most of the polarised reflected light (which causes the glare)
5. **What are complementary colours?** [2003 OL]

Complementary colours are pairs of colours consisting of a primary and a secondary colour, such that when combined they give white light.

1. **Only red, green and blue lights are needed to create most lighting effects.**

**Explain why** [2010 OL]

All colours can be made by mixing red, green and blue.

1. **List a pair of complementary colours of light.** [2014]
red and cyan / green and magenta / blue and yellow
2. **How is energy transferred from the sun to the earth?** [2012](by means of) radiation / photons / electromagnetic waves
3. **Light travels as a transverse wave.
Name another type of wave motion and give two differences between these two types of wave motion.
Longitudinal**. [2012]Transverse can be polarized – longitudinal cannot.Transverse waves vibrate perpendicular to the direction in which the wave travels.Longitudinal waves vibrate parallel to the direction (longitudinal) in which the wave travels.

## Static electricity

1. **State Coulomb’s law of force between electric charges.** [2005] [2003][2007 OL][2010 OL][2011][2013]
[2013 OL]

Coulomb’s Law states that the force between two point charges is proportional to the product of the charges and inversely proportional to the square of the distance between them.

1. **Why is Coulomb’s law an example of an inverse square law?** [2006][2005]

Force is inversely proportional to distance squared.

1. **Give two differences between the gravitational force and the electrostatic force between two electrons**. [2005]

Gravitational force is much smaller than the electrostatic force.

Gravitational force is attractive, electrostatic force (between two electrons) is repulsive.

1. **What is the unit of electric charge?** [2010 OL]

The coulomb

1. **Define the unit of charge, the coulomb.** [2013]
The coulomb is the amount of charge that passes when one Amp flows for one second.
2. **What is meant by the term ‘electric field’?** [2014]An electric field is a region (of space) where electrostatic forces are experienced / forces experienced by charged particles
3. **Define electric field strength.** [2009][2007] [2005] [2003] [2002]

Electric field strength is defined as force per unit charge.

1. **Give the unit of electric field strength.** [2007][2003]

The unit of electric field strength is the newton per coulomb (N C-1).

1. **How would you detect the presence of an electric field?** [2010 OL]Using an electroscope
2. **Give one effect of static electricity?** [2008 OL]

Lightning, static discharge, receive shock after walking across carpets, attracts objects, can damage electronics.

1. **Identify two hazards caused by static electricity.** [2004]

Electric shock / explosion in flour mills /explosion when fuelling aircraft/ damage to electronic devices / electrical storm / static cling, etc.

1. **The build-up of electric charge can lead to explosions.
Give two examples where this could happen.** [2003 OL]

Dust e.g. flour mill explosions, inflammable vapours e.g. fuelling aircraft, lightning

1. **How can the build-up of electric charge on an object be reduced?** [2003 OL]

By earthing the object (i.e. using a conductor to connect the object to the earth which allows the charge to flow to earth).

1. **Describe how to charge an electroscope by induction.** [2011]
* Bring a charged rod near the electroscope (the positive and negative charges become separated on it).
* Keeping the charged rod in place, earth the cap by touching it with your finger.
* Some of the negative charge on the metal flows through you to earth.
* Remove your finger, then *and only then* remove the rod.
* The conductor will now be positively charged.
1. **Explain why the gold leaf on the electroscope diverges when a positively charged rod is brought close to the metal cap.** [2005 OL]

Some of the electrons at the bottom of the electroscope are attracted to the top due to the positive charge on the rod and as a result there is an excess of positive charge on the bottom, including on the gold leaf. Because similar charges repel the gold leaf moves away from the main section.

1. **Why should the frame of an electroscope be earthed?** [2011]

If the frame was charged it would affect the degree of deflection of the leaf.

1. **Give one use of an electroscope**. [2005 OL][2011 OL][2013 OL]

To detect charge

1. **All the charge resides on the surface of a Van de Graff generator’s dome. Explain why.** [2007]

Like charges repel and the charges are a maximum distance apart on the outside surface of dome.

1. **Give an application of the fact that all charge resides on the outside of a conductor.** [2007]

Electrostatic shielding / co-axial cable / TV (signal) cable / to protect persons or equipment, enclose them in hollow conductors /Faraday cages (there is no electric field inside a closed conductor), etc.

1. **How does a full-body metal-foil suit protect an operator when working on high voltage power lines? [2011]**All charges will reside on the outside of the conducting suit (because the suit blocks out external electrical fields) so he won’t get shocked.

## Electric current

1. **What is an electric current?** [2010][2006] [2008 OL][2006 OL][2004 OL][2003 OL][2002 OL][2011 OL]

An electric current is a flow of charge.

1. **What is the unit of electric current**? [2003 OL][2011 OL]

The ampere.

## Potential difference and Capacitance

1. **Define potential difference.** [2009][2005] [2004][2002 OL]

Potential difference is the work done in moving a charge of 1 Coulomb from one point to another.

1. **Define the volt [2013]**The potential difference between two points is one volt if 1 J of work is needed to move 1 C of charge from one point to the other
2. **Explain the term *emf.*** [2003]

The term *emf* is used to describe a potential difference when it applies to a full circuit.

1. **Name a source of potential difference.** [2008 OL]

Battery, generator, thermocouple.

1. **Name an instrument used to measure potential difference.** [2007 OL]

A voltmeter

1. **Define capacitance.** [2014][2009][2008] [2004][2002 OL]

The capacitance of a conductor is the ratio of the charge on the conductor to its potential.

1. **Give one use of a capacitor.** [2014][2006 OL][2006 OL][2007 OL][2012 OL][2013 OL]

Store charge / (radio) tuning / smoothing / store energy / flash guns for cameras, phone charger, blocks d.c.

1. **State two differences between a capacitor and a battery.** [2014]

Capacitor discharges faster than a battery / capacitor stores (electrostatic) potential energy while a battery stores chemical energy / battery gives a constant current / battery stores more energy

1. **List the factors that affect the capacitance of a parallel plate capacitor.** [2006]

Common area of plates, distance apart, permittivity of dielectric between plates.

1. **How would you demonstrate that the capacitance of a parallel plate capacitor depends on the distance between its plates?** [2008]

Connect the two parallel plates to a digital multi-meter (DMM) set to read capacitance.

Note the capacitance.

Increase the distance between them – note that the capacitance decreases.

## Resistance

1. **Define resistance.** [2007][2005][2012]

The resistance of a conductor is the ratio of the potential difference *across* the conductor to the current flowing *through* it.

1. **State Ohm’s Law** [2007 OL][2006 OL][2005 OL][2010 OL][2014 OL]

Ohm’s Law states that the current flowing through a conductor is directly proportional to the potential difference across it, assuming constant temperature.

1. **Define resistivity.** [2008] [2007] [2002]

Resistivity is defined as the resistance of a cube of material of side one metre.

1. **Give the unit of resistivity.** [2008]

The ohm-metre

1. **Give two uses for the multimeter.** [2008 OL]

It can function as a voltmeter, ammeter or ohmmeter.

1. **Explain why the resistance of the bulb is different when it is not connected to the mains.** [2006]

Cold filament has lower resistance

1. **How would an observer know that a Wheatstone bridge is balanced?** [2014]zero reading on / no deflection of / no current flowing through galvanometer
2. **Write an expression for the resistance of a wire in terms of its resistivity, length and diameter.** [2014]R = ρl/A R = 4ρl/πd2
3. **The radius of a wire is doubled. What is the effect of this on the resistance of the wire?** [2014]resistance decreases by a factor of 4

## Effects of an electric current

1. **Give one use for electricity in the home.** [2006 OL]

Heating / cooking / lighting /named electrical appliance etc.

1. **List three effects of an electric current.** [2010][2004 OL][2008 OL][2011 OL]

Magnetic effect, heating effect and chemical effect.

1. **Describe an experiment that demonstrates the heating effect of an electric current.** [2002][2004 OL]

Connect a electrical calorimeter containing water to a power supply and notice the increase in temperature using a thermometer.

1. **State the factors on which the heating effect of an electric current depends.** [2004 OL]

Size of current, length of coil, resistance, time

1. **Explain why high voltages are used in the transmission of electrical energy.** [2005][2013][2013 OL]

High voltages result in smaller currents therefore less energy is lost as heat.

1. **Why is the power supplied to domestic customers at lower voltages?** [2013 OL]It is safer
2. **Suggest a method of reducing the energy “lost” in ESB power lines.** [2002]

Transfer the electrical energy at a higher voltage which would result in a lower current, therefore less energy lost as heat.

1. **Why should an appliance be earthed?** [2010 OL]

Provide path for current in event of a fault // to protect against electrocution.

1. **Name two safety devices that are used in domestic electric circuits.** [2004 OL][2005 OL][2007 OL]

Fuse, miniature circuit breaker, residual current device, earthing, 3 pin plug etc.

1. **What is the colour of the earth wire in an electric cable?** [2006 OL][2011 OL]

Green and yellow

1. **What is the colour of the wire that should be connected to the fuse in a plug?** [2009 OL]

Brown

1. **Give the standard colour of the insulation on the wires connected to each of the terminals L, N and E on the 3 pin plug.** [2003 OL]

L (live) is brown, N (neutral) is blue, E (earth) is green-yellow

1. **What is the purpose of the wire connected to the terminal E on the plug?** [2003 OL]

The earth wire protects from electrocution / shock by conducting the current to earth.

1. **Name and give the colour of the wire that should be connected to the fuse in a standard three-pin plug.** [2004] [2008 OL]

Live, brown

1. **Give one safety precaution that should be taken when wiring a plug.** [2006 OL]

Screw connections are fully tightened / fit the correct size fuse / ensure to match the colour codes

1. **Explain why a fuse is used in a plug.** [2003 OL][2009 OL][2010 OL][2012]

It ‘blows’ and breaks the circuit if too large a current flows, preventing possible electrocution.

1. **Explain how a fuse works.** [2009 OL][201 OL]

When too high a current flows the thin wire heats up and melts which breaks the circuit.

1. **What will happen when a current of 20 A flows through a fuse marked 13 A?** [2006 OL]

The fuse blows which stops the current.

1. **Why would it be dangerous to use a fuse with too high a rating?** [2009 OL]

It would allow too large a current to flow so the device could overheat.

1. **Explain why replacing a fuse with a piece of aluminium foil is dangerous.** [2004]

If a very large current flows the foil may still not break and so may start a fire.

1. **Name a common material used to conduct electricity in electric cables.** [2006 OL]

Copper

1. **Some electrical appliances are supplied with two-pin plugs. Why is an earth wire not required in these devices?** [2004][2006 OL]

They have a plastic housing so even if they are in contact with a live wire the current will not travel along the cover.

1. **Why is the coating on electric cables made from plastic?** [2006 OL]

It is an insulator.

1. **A toaster has exposed metal parts. How is the risk of electrocution minimised?** [2008]

The metal parts are earthed.

1. **Bonding is a safety precaution used in domestic electric circuits.** [2003 OL]

**How does bonding improve safety in the home?**

Bonding is where all metal pipes are connected to earth preventing accidental electrocution.

**MCBs and RCDs**

1. **What do the letters in the acronyms (i) RCD and (ii) MCB stand for?** [2014][2010 OL]

residual current device; miniature circuit breaker

1. **Name another device with the same function as a fuse.** [2009 OL]

Circuit breaker, trip switch, RCD, MCB

1. **What is the purpose of a miniature circuit breaker (MCB) in an electric circuit?** [2003][2002 OL][2011 OL]

It behaves as a fuse when too large a current flows

1. **When will an RCD (residual current device) disconnect a circuit?** [2009]

When the magnitude of the current flowing in is different from that flowing out.

1. **An RCD is rated 30 mA. Explain the significance of this current.** [2006]

The RCD trips the circuit if the current reaches 30 mA.

1. **What is the purpose of a residual current device (RCD) in an electrical circuit?** [2004][2002][2010 OL]

It acts as a safety device by breaking the circuit if there is a difference between the live and the neutral in a circuit.

1. **Name a device that is often used nowadays in domestic electric circuits instead of fuses.** [2003 OL]

Miniature circuit breakers (MCBs) or residual current devices (RCDs).

1. **Give one advantage of a Residual Current Device (RCD) over a Miniature Circuit Breaker (MCB).** [2004]

RCD responds v. Quickly, RCD responds to tiny currents

1. **What are the charge carriers when an electric current passes through an electrolyte?** [2008]

Ions

1. **How would the VI graph for a metal differ if its temperature were increasing?** [2003]

If temperature was increasing it would no longer be linear; instead there would be a curve to the right because resistance would increase.

1. **Name the unit of electrical energy that is used in the delivery of electricity to homes and businesses.** [2013 OL]
The kilowatt-hour
2. **What is the kilowatt-hour?** [2004 OL]

The kilo-watt hour is the amount of energy used by a 1000 Watt appliance in one hour.

1. **What is the function of the ESB meter?** [2006 OL]

It records the amount of units used.

## Semiconductors

1. **What is a semicnductor?** [2003 OL][2006 OL][2009 OL]

A semiconductor is a material whose resistivity is between that of a conductor and insulator.

1. **Name a material used in the manufacture of semiconductors.** [2003 OL][2006 OL]

Silicon, germanium

1. **Why is silicon a semiconductor**? [2007]

It has a resistivity between that of a conductor and an insulator.

1. **Give one difference between conduction in metals and conduction in semiconductors.** [2002 OL]

There are two types of charge carriers (holes and electrons) in semiconductors, whereas with metals electrons are the only charge carriers.

Conduction increases with temperature for semiconductors whereas conduction decreases with temperature for metals.

1. **As the temperature of a room increases, explain why the resistance of a thermistor decreases.** [2005]

More energy is added to the thermistor therefore more electrons are released and are available for conduction.

1. **Give two uses of semiconductors.** [2002 OL]

Rectifiers, transistors, diodes, thermistors, thermometers, radios/TV, etc.

1. **Give a use for a thermistor.** [2005 OL]

Thermometer, heat sensor, temperature control.

1. **Give a use for a light depenent resistor.** [2012]Used in light meters / (to control) street lights / security alarms / (control) traffic lights / used in re-charging circuits, etc.
2. **What is doping?** [2004][2003 OL][2009 OL]

Doping is the addition of a small amount of atoms of another element to a pure semiconductor to increase its conductivity.

1. **Semiconductors can be made p-type or n-type. How is a semiconductor made p-type?** [2002 OL]

By doping it with Boron.

1. **Explain how the presence of phosphorus and boron makes silicon a better conductor.** [2009]

When phosphorus is added more electrons become available as charge carriers.

When boron is added more positive holes become available as charge carriers.

1. **Give one difference between a p-type semiconductor and an n-type semiconductor.** [2003 OL]

P-type material contains more holes than n-type material.

N-type material contains more free electrons than p-type material.

1. **What are the charge carriers in (i) semiconductors (ii) metals?**
[2014][2008][2003 OL][2013 OL]

(i) Electrons and (positive) holes (ii) electrons

1. **What is a p-n junction?** [2003 OL][2006 OL]

A p-n junction is the region connecting the p-type semiconductor to the n-type semiconductor

1. **What happens at the boundary of the two adjacent layers?** [2009]

Electrons and holes cross the junction cancelling each other out and recombine and as a result there are no free charge carriers.

A depletion layer is therefore formed between the n-type and p-type regions and as a result a junction voltage is created.

1. **A p-n junction is formed by taking a single crystal of silicon and doping separate but adjacent layers of it. A depletion layer is formed at the junction. Explain how a depletion layer is formed at the junction.** [2004][2009 OL]

Electrons from n-type and holes from p-type cross the junction and recombine cancelling each other out and as a result there are no free charge carriers across this narrow insulating region.

A depletion layer is therefore formed which now acts as a ‘barrier’ between the n-type and p-type regions and as a result a junction voltage is created.

1. [2009]
2. **Describe what happens at the boundary when the semiconductor diode is forward biased.**
3. **Describe what happens at the boundary when the semiconductor diode is reverse biased.**

The depletion layer breaks down and the diode conducts.

The width of depletion layer gets increased and the region acts as an insulator.

1. **Why does the p-n junction become a good conductor as the potential difference exceeds 0.6 Volts**? [2004]

The depletion layer is overcome and as a result a large current flows.

1. **What is a diode?** [2003 OL]

A diode is a device that allows current to flow in one direction only.

1. **Give a use of a semiconductor diode.** [2009]

A rectifier

1. **Give an example of a device that contains a rectifier.** [2003 OL]

Radio, television, computer, battery charger, mobile phone charger.

1. **Draw the electrical circuit symbol for an LDR.** [2012]See diagram

## Magnets and magnetic fields

1. **What is a magnetic field?** [2003 OL][2005 OL][2006 OL][2009 OL][2013 OL][2014 OL]

A Magnetic Field is any region of space where magnetic forces can be felt.

1. **Give one use of the earth’s magnetic field.** [2004][2003 OL]

Navigation, protective layer around the earth which deflects dangerous cosmic rays (sometimes called solar winds).

1. **Why does a magnet that is free to rotate point towards the North?** [2007]

It is the north end of the magnet which is being attracted to the south-end of the Earth’s magnetic field (which is located at what we call the north pole).

1. **How does a compass indicate the direction of a magnetic field?** [2014 OL]It experiences a force in a magnetic field and points in the direction of the field lines
2. **A solenoid carrying a current and containing an iron core is known as an electromagnet.**

**Give one use of an electromagnet.** [2006 OL]

Electric bell / scrap yard crane / speaker / doorbell.

1. **State one advantage of an electromagnet over an ordinary magnet.** [2006 OL]

It can be turned on and off.

1. **Sketch the magnetic field due to a current in a solenoid.** [2012]Uniform field inside solenoid / divergent field outside

## Current in a magnetic field

1. **A current-carrying conductor experiences a force when placed in a magnetic field. Name two factors that affect the magnitude of the force.** [2002][2002 OL][2005 OL]

Strength of magnetic field, size of current flowing, length of conductor in magnetic field.

1. **Name two devices that are based on the principle that a current-carrying conductor in a magnetic field experiences a force.** [2002 OL][2002 OL][2006 OL]

Motor, galvanometer, loudspeaker.

1. **State the principle on which the definition of the ampere is based**. [2007]

A current-carrying conductor in a magnetic field experiences a force.

1. **Define the ampere, the SI unit of current.** [2006][2003]

The ampere is the amount of charge which, if flowing in two very long parallel wires one metre apart in a vacuum will experience a force of 2 × 10-7 N per metre length.

1. **Give an expression for the force acting on a charge *q* moving at a velocity *v* at right angles to a magnetic field of flux density *B*.** [2003]

F = Bqv

1. **Give an application of the magnetic field due to a current.** [2013 OL]
Electromagnet, speaker, motor, induction coil, transformer, etc
2. **Give an expression for the momentum of a particle in the cyclotron in terms of the magnetic flux density of the field, the charge on the particle and the radius of its circular path at any instant.** [2014]

From Newton II, F = (mv – mu)/t

Ft = (mv – mu)

But F = Bqv

(Bqv) t = (mv – mu)

But vt = r

Bqr = (mv – mu)

{Ridiculous question}

## Electromagnetic induction

1. **Explain the term *emf*** [2003][2012]

emf stands for electromotive force. It is a potential difference applied to a full circuit.

1. **What is electromagnetic induction?** [2008][2004][2002][2002 OL][2004 OL][2007 OL][2008 OL]

Electromagnetic Induction occurs when an emf is induced in a coil due to a changing magnetic flux.

1. **State Faraday’s law of electromagnetic induction.** [2014][2010][2007][2005][2011 OL]

Faraday’s Law states that the size of the induced emf is proportional to the rate of change of flux.

1. **State Lenz’s law of electromagnetic induction.** [2002]

Lenz’s Law states that the direction of the induced emf is always such as to oppose the change producing it.

1. **State the laws of electromagnetic induction.** [2008][2003]
See Faraday’s Law and Lenz’s Law above.
2. **Define magnetic flux**. [2006][2005]

Magnetic flux is defined as the product of magnetic flux density multiplied by area.

1. **Electricity produced in a generating station is a.c. What is meant by a.c.?** [2008 OL]

Alternating current

1. **What is a diode?** [2003 OL]

A diode is a device that allows current to flow in one direction only.

1. **Give an example of a device that contains a rectifier.** [2003 OL]

Radio, television, computer, battery charger, mobile phone charger.

1. **Name a device that is based on electromagnetic induction.** [2004 OL][2005 OL]

Dynamo, generator, induction motor, transformer, dynamo

1. **What is the principle of operation of a transformer?** [2012]A change in magnetic flux induces an emf.
2. **What is a transformer used for?** [2003 OL]

To increase or decrease voltage.

1. **The transformer is a device based on the principle of electromagnetic induction. Name two devices that use transformers.** [2002 OL][2007 OL]

Computer, radio, TV, doorbell, washing machine, mobile phone chargers, power supply, etc.

1. **How is the iron core in a transformer designed to make the transformer more efficient?** [2002 OL]

It has a laminated core.

1. **The efficiency of a transformer is 90%. What does this mean?** [2002 OL]

10% of the power in is lost.

1. **State one energy conversion that takes place in an electrical generator.** [2003 OL]

Kinetic to electric.

## The electron

1. **The physicist Robert Millikan is usually associated with what physical quantity?** [2011]

The charge on an electron

1. **List two properties of the electron.** [2003][2003 OL][2005 OL][2006 OL][2008 OL]

Negative charge, negligible mass , orbits nucleus, no internal structure, deflected by electric / magnetic field etc.

1. **Name another subatomic particle.** [2005 OL]

Proton, neutron.

1. **Name the Irishman who gave the electron its name in the nineteenth century.** [2003]

George Stoney

1. **What is thermionic emission**? [2010][2002 OL][2009 OL]

Thermionic emission is the emission of electrons from the surface of a hot metal.

1. **Give two ways of deflecting a beam of electrons.** [2008] [2002 OL][2005 OL]

By means of an electric field and a magnetic field.

1. **What are cathode rays?** [2009 OL]

Cathode rays are streams of high speed electrons.

1. **Give a use of a cathode ray tube.** [2002 OL][2005 OL][2009 OL]

Old-style televisions/ computer monitor, X-ray machine/oscilloscope /heart monitor/ECG.

1. **How are electrons accelerated in a cathode ray tube**? [2007]

By a the high positive voltage at the anode.

1. **How can the beam of electrons be deflected?** [2012 OL]Electric field/electrode/magnetic field/magnet/X-Y plates
2. **Why is a vacuum needed in a cathode ray tube?** [2012 OL]Electrons not blocked / easier to pass through / electrons not absorbed
3. **What happens when the electrons hit the screen?** [2005 OL][2009 OL]

Light is emitted (the screen fluoresces).

1. **What happens to the energy of the electron when it hits the screen of the CRT**? [2003]

It gets converted to light.

1. **Which one of the following is emitted from a metal surface when suitable light shines on the metal**?

**protons, neutrons, electrons, atoms** [2004 OL]

Electrons

1. **What is the photoelectric effect?** [2008][2005][2003][2005 OL][2008 OL][2013 OL]

The Photoelectric Effect is the emission of electrons from a metal due to light of a suitable frequency falling upon it.

1. **Distinguish between photoelectric emission and thermionic emission.** [2004]

Photoelectric Effect: Emission of electrons when light of suitable frequency falls on a metal.

Thermionic Emission: Emission of electrons from the surface of a hot metal.

1. **Give two applications of the photoelectric effect.** [2005][2006 OL][2009 OL][2010 OL][2012]

Sound track in film, photography, counters, photocell, burglar alarm, automatic doors, etc.

1. **What is a photon?** [2003 OL][2009]

A photon is a packet of electromagnetic radiation.

1. **Why as the quantum theory of light revolutionary?** [2008]

Light has a particle nature (as well as a wave nature)

1. A freshly cleaned piece of zinc metal is placed on the cap of a negatively charged gold leaf electroscope and illuminated with ultraviolet radiation. [2004]
2. **Explain why the leaves of the electroscope collapse.**

Photoelectric emission occurs (electrons get emitted from the surface of the metal).

The leaves become uncharged and therefore collapse.

1. **Explain why the leaves do not collapse when the zinc is covered by a piece of ordinary glass.**

Ordinary glass does not transmit UV light

1. **Explain why the leaves do not collapse when the zinc is illuminated with green light.**

The energy associated with photons of green light is too low for the photoelectric effect does not occur, so no electrons are emitted from the electroscope.

1. **Explain why the leaves do not collapse when the electroscope is charged positively.**

Any electrons emitted are attracted back to the positive electroscope.

1. **Give one application of the photoelectric effect.** [2011 OL]Photocell, alarms, photocopiers, light meters, photodiodes, etc
2. In an experiment to demonstrate the photoelectric effect, a piece of zinc is placed on a gold leaf electroscope.

The zinc is given a negative charge causing the gold leaf to deflect. [2006 OL]

1. **Explain why the gold leaf deflects when the zinc is given a negative charge.**

Some of the excess electrons flow down to the bottom and the gold leaf moves away from the main section because similar charges repel.

1. **Ultraviolet radiation is then shone on the charged zinc and the gold leaf falls. Explain why.**

Many electrons are emitted from the zinc as a result of the ultraviolet radiation shining on it. Electrons from the main part of the electroscope flow up to replace this so there aren’t as many electrons on the gold leaf to feel the repulsion.

1. **What is observed when the experiment is repeated using infrared radiation?**

Infrared radiation will not have sufficient energy to release electrons so the gold leaf will not diverge to begin with.

1. **In the photoelectric effect, what happens when the intensity of the light is increased?** [2011 OL]Number of electrons released increases
2. **Explain what is meant by the statement: “Zinc has a threshold frequency of 1.04 × 1015 Hz”.** [2013]Below this frequency electromagnetic radiation /photons will not cause emission of electrons (from the zinc).
3. **How can the speed of electrons emitted in the photoelectric effect be controlled?** [2011 OL]

Change the frequency of the radiation

1. **Give two applications of a photocell.** [2003 OL] [2002 ][2008 OL]

Burglar alarm, smoke alarms, safety switch, light meters, automatic lights, counters, automatic doors, control of central heating burners, sound track in films, scanner reading bar codes, stopping conveyer belt, solar cells etc.

**X-rays**

1. **What are X-rays?** [2010][2006][2004 OL][2007 OL][2013 OL]

High frequency electromagnetic radiation.

1. **What property of light controls the current in a photocell?** [2011]

(light) intensity/ brightness

1. **How do X-rays differ from light rays?** [2010]

X-rays penetrate matter / cause ionization, light rays don’t.

1. **Give three properties of X-rays** [2010 OL]

Electromagnetic waves / have short wavelength, ionise, penetrate, no mass,no charge, effect photographic film, cause fluorescence, diffraction, etc.

1. **State a property of X-rays that makes them suitable for medical use.** [2013 OL]Very energetic
2. **Give two uses of X-rays.** [2010][2004 OL][2007 OL][2010 OL][2013 OL]]

To photograph bones/ internal organs, to treat cancer, to detect flaws in materials.

1. **Who discovered X-rays?** [2006]

X-rays were discovered by Wilhelm Röntgen in 1895 (shouldn’t have got asked – not on the syllabus).

1. **How are X-rays produced?** [2009][2013 OL][2014 OL]

Accelerated (fast moving) electrons strike a (heavy) metal target causing electrons in the target to rise to a high orbital level. When these electrons fall back down to a lower lever they emit they energy as X-rays.

1. **How are the electrons emitted from the cathode?** [2006][2005][2004 OL][2007 OL]

The electrons are emitted from the cathode due to thermionic emission because the filament is hot.

1. **How are the electrons accelerated?** [2006]

By the high voltage between the anode and cathode.

1. **What is the function of the high voltage across the X-ray tube**? [2004 OL][2007 OL][2013 OL]

To accelerate the electrons.

1. **Name a suitable material for the target T in the X-ray tube**. [2004 OL][2007 OL][2013 OL]

Tungsten

1. **What happens when the electrons hit part B?** [2007 OL][2013 OL]

Some inner electrons in the tungsten target get bumped up to a high orbital, then quickly fall back down to a lower lever, emitting X-rays in the process.

1. **Why is a lead-shield normally put around an X-ray tube?** [2002 OL]

For protection (to prevent X-rays entering the body).

1. **Give one safety precaution when using X-rays.** [2007 OL][2013 OL]

Use a lead shield, lead apron, lead glass, monitor dosage.

1. **Justify the statement “X-ray production may be considered as the inverse of the photoelectric effect.”** [2002]

X-ray: Electrons in, electromagnetic radiation is emitted.

Photoelectric: electromagnetic radiation in and electrons are emitted.

## The atom, the nucleus and radioactivity

1. **Rutherford had bombarded gold foil with alpha particles. What conclusion did he form about the structure of the atom?** [2014][2005]

The atom was mostly empty space with a dense positively-charged core and with negatively-charged electrons in orbit around it.

1. **What is the structure of an alpha particle?** [2009][2005][2008 OL]

An alpha particle is identical to a helium nucleus (composed of 2 protons and 2 neutrons).

1. **How are the electrons arranged in the atom**? [2008 OL]

They orbit the nucleus at discrete levels.

1. **Describe the Bohr model of the atom.** [2006]

A dense positively-charged nucleus with the negatively-charged electrons in orbit at discrete levels around it.

1. **Describe how an emission line spectrum is produced.** [2007]

When the gas is heated the electrons in the gas are move up to higher orbital level and as they fall back down they emit electromagnetic radiation of a specific frequency.

1. **When the toaster is on, the coil emits red light.** [2008]

**Explain, in terms of movement of electrons, why light is emitted when a metal is heated.**

Electrons gain energy and jump to higher energy. Then when they fall back down they emit electromagnetic radiation in the form of light.

1. **What are isotopes?** [2007][2003][2009 OL][2011 OL]

Isotopes are atoms which have the same atomic number but different mass numbers.

1. **Give two examples of radioisotopes.** [2002 OL]

Iodine, caesium, radon, carbon 14, etc.

1. **How many neutrons are in a 14C nucleus?** [2003]

Eight

**Radioactivity**

1. **What is radioactive decay?** [2003][2003 OL]

Radioactive decay is the breakup of unstable nuclei with the emission of one or more types of radiation.

1. **What is radioactivity?** [2004 OL][2005 OL][2007 OL][2010 OL][2011 OL][2012 OL][2014 OL]

Radioactivity is the breakup of unstable nuclei with the emission of one or more types of radiation.

1. **Name the three types of radiation.** [2009 OL]

Alpha (α), beta (β) and gamma (γ).

1. **What are alpha-particles?** [2011 OL]

Consist of two protons and two neutrons // helium (nucleus)

1. **Which radiation is negatively charged?** [2009 OL]

Beta (β)

1. **Which radiation has the shortest range?** [2009 OL]

Alpha (α)

1. **Which radiation is not affected by electric fields?** [2009 OL]

Gamma (γ)

1. **Write a nuclear equation to represent the decay of carbon-14 by beta emission.** [2007]

 (accept *e* in lieu of β)

1. **14C decays to 14N. Write an equation to represent this nuclear reaction. [**2003]
2. **Cobalt−60 is a radioactive isotope and emits beta particles**. [2005]

**Write an equation to represent the decay of cobalt−60.**

1. **Write an equation for the beta-decay of iodine–131.** [2013]
2. **Name the French physicist who discovered radioactivity in 1896.** [2004 OL]

Henri Becquerel (you shouldn’t have been asked this).

1. **Define the becquerel.** [2013]
One Bq = one disintegration per second.
2. **What is measured in becquerels?** [2002 OL]

Rate of decay, activity of a radioactive substance.

1. **Apart from “carbon dating”, give two other uses of radioactive isotopes.** [2003][2002 OL][2005 OL]

Medical imaging, (battery of) heart pacemakers, sterilization, tracers, irradiation of food, killing cancer cells, measuring thickness, smoke detectors, nuclear fuel, detect disease, detect leaks.

1. **Give two examples of radioisotopes.** [2002 OL]

Iodine, caesium, radon, carbon 14, etc.

1. **Give two uses of radioisotopes.** [2011 OL]Medical, industrial, agriculture, smoke detectors, energy source, etc
2. **Name an instrument used to detect radiation/ alpha particles/ measure the activity of a sample.**

[2008][2007][2003 OL][2004 OL][2005 OL][2007 OL][2008 OL][2009 OL][2013][2013 OL]

Geiger Muller tube.

1. **What is the principle of operation of this instrument?** [2008][2007][2004 OL]

Incoming radiation causes ionisation of the gas.

1. **Give an application of radioactivity.** [2005]

Smoke detectors, carbon dating, tracing leaks, cancer treatment, sterilising, etc.

1. **Give one use of a radioactive source.** [2004 OL]

Carbon dating, radiotherapy, sterilising medical equipment, killing bacteria in food, smoke alarm

1. **Distinguish between radioactivity and fission**. [2005]

Radioactivity is the breakup of unstable nuclei with the emission of one or more types of radiation.

Nuclear Fission is the break-up of a large nucleus into two smaller nuclei with the release of energy (and neutrons).

1. **Radioactivity causes ionisation in materials. What is ionisation**? [2005]

Ionisation occurs when a neutral atom loses or gains an electron.

1. **Explain the term half-life**. [2007][2002 OL][2005 OL]

Time for half the radioactive nuclei in a sample to decay

1. **Why does the 12C in dead tissue remain “undisturbed”?** [2003]

It is not radioactive / it is not exchanging with the atmosphere / it is stable.

1. **What is meant by background radiation?** [2002 OL]

Radiation which is in the environment due to rocks/cosmic radiation.

1. **Name the naturally occurring radioactive gas which seeps into buildings from underground rocks and which can cause lung cancer.** [2010]

Radon (gas)

1. **Give two precautions that are taken when storing the plutonium / dealing with radioactive sources.**

[2003 OL][2004 OL]

Use thick shielding, use a tongs, use protective clothing, etc.

1. **Give two effects of radiation on the human body.** [2004 OL][2002 OL]

Cancer, skin burns, sickness, cataracts, cause sterility, genetic, etc.

## Fission, fusion and nuclear energy

1. **What is meant by nuclear fission**? [2014][2007][2004][2002][2002 OL][2003 OL][2004 OL][2006 OL]
[2009 OL][2012 OL][2013][2013 OL][2014 OL]

Nuclear fission is the break-up of a large nucleus into two smaller nuclei with the release of energy (and neutrons).

1. **Name a material in which fission occurs**. [2006 OL]

Uranium, Plutonium.

1. In 1939 Lise Meitner discovered that the uranium isotope U–238 undergoes fission when struck by a slow neutron. Barium–139 and krypton–97 nuclei are emitted along with three neutrons.

**Write a nuclear reaction to represent the reaction.** [2008]



1. Plutonium is produced in a fission reactor when one of the neutrons released in the fission reaction converts uranium–238 into plutonium–239 with the emission of two beta-particles.

**Write an equation for this nuclear reaction.** [2014]

1. **Name two parts of a nuclear fission reactor**.

Fuel rods, control rods, shielding, moderator, coolant.

1. **Name a fuel used in a nuclear reactor.** [2009 OL][2013 OL]

Plutonium or uranium.

1. **What is the function of the moderator in a fission reactor**? [2014][2007][2004]

To slow down fast neutrons to facilitate fission.

1. **Give an example of a moderator.** [2014]
graphite / (heavy) water
2. **What is the role of neutrons in nuclear fission**? [2009 OL][2014 OL]

To make the nucleus unstable which causes fission.

1. **What is the role of neutrons in a nuclear reactor?** [2011]

To cause (nuclear) fission / to initiate reaction / any valid answer

1. **In a nuclear fission reactor, neutrons are slowed down after being emitted. [2008]**

**Why are the neutrons slowed down?**

Only slow neutrons can cause (further) fission.

1. **How are fast neutrons slowed down?** [2008]

They collide with the molecules in the moderator.

1. **In a nuclear reactor, how can the fission be controlled or stopped?** [2009 OL]

Dropping the control rods absorbs the neutrons and prevents further fission

1. **What is the function of the control rods?** [2014][2004][2012 OL][2014 OL]

They absorbed neutrons which would otherwise cause fission.

1. **What type of material are control rods made of?** [2012 OL]
Boron / steel / silver / indium / cadmium, etc. // neutron absorber
2. **Describe what happens to the coolant when the reactor is working.** [2006 OL]

It gets hot.

1. **Explain how the heat exchanger operates.** [2014]
heat/energy from reactor transfers to liquid/water in heat exchanger (to drive a turbine)
2. **Why is it necessary to use a heat exchanger?** [2014]
The material in a reactor is radioactive / allows the core to reach a higher temperature
3. **What is the purpose of the shielding**? [2006 OL]

It prevents radiation from escaping and harming humans.

1. **Name a material used as shielding in a nuclear reactor**. [2005 OL][2006 OL]

Lead, concrete.

1. **What is a chain reaction?** [2014][2003 OL][2012 OL]

This occurs when at least one neutron gets released during fission causing more fission to occur in another nucleus and this then becomes a self-sustaining reaction.

1. **Describe how a chain reaction occurs in the fuel rods.** [2006 OL]

A neutron is fired into the material and this splits the nucleus of one of the atoms releasing more energy and neutrons. This process then continues.

1. **Explain how the chain reaction is controlled.** [2006 OL]

The control rods can move up and down and when they are lowered they absorb the neutrons which prevents further fission.

1. **How is the energy produced in a nuclear reactor used to generate electricity?** [2009 OL][2013 OL]

The energy produced is converted to heat. This is used to generate steam which drives a generator.

1. **Give one advantage and one disadvantage of a nuclear reactor as a source of energy.** [2009 OL]

Advantage; abundant fuel / cheap fuel / no greenhouse gases / no global warming , etc.

Disadvantage; risk of nuclear contamination / fallout / difficulty of dealing with waste / dangerous, etc.

1. **Name three types of radiation that are present in a nuclear reactor.** [2003 OL]

Alpha, beta and gamma.

1. **Give one effect of a nuclear fission reactor on the environment.** [2006 OL]

It can cause pollution due to nuclear waste.

1. **Give one positive and one negative environmental impact of fission reactors.** [2008]

Positive: no CO2 emissions / no greenhouse gases / no gases to result in acid rain / less dependence on fossil fuels.

Negative: radioactive waste / potential for major accidents etc.

1. **Distinguish between radioactivity and fission.** [2005]

Radioactivityis the breakup of unstable nuclei with the emission of one or more types of radiation.

Nuclear Fission is the break-up of a large nucleus into two smaller nuclei with the release of energy (and neutrons).

1. **Give an application of fission.** [2005]

Generating electrical energy, bombs

1. **Give one precaution that should be taken when storing radioactive materials.** [2006 OL]

Store in lead or use a tongs when handling.

1. **In Einstein’s equation *E = mc2*, what does *c* represent?** [2005 OL]

The speed of light.

1. **Distinguish between fission and fusion.** [2006][2012]

Nuclear Fission is the break-up of a large nucleus into two smaller nuclei with the release of energy (and neutrons).

Nuclear Fusion is the combining of two small nuclei to form one large nucleus with the release of energy.

1. **What is meant by nuclear fusion?** [2003] [2008 OL]

Nuclear fusion is the combining of two small nuclei to form one large nucleus with the release of energy.

1. **What is the source of the sun’s energy?** [2007][2009 OL]

Nuclear fusion

1. **How does the sun produce heat and light?** [2005 OL]

Through nuclear reactions.

1. **The core of** **our sun is extremely hot and acts as a fusion reactor.**

**Why are large temperatures required for fusion to occur?** [2006]

Nuclei are positively charged so enormous energy is required to overcome the very large repulsion.

1. In the sun a series of different fusion reactions take place. In one of the reactions, 2 isotopes of helium, each with a mass number of 3, combine to form another isotope of helium with the release of 2 protons. [2006]

**Write an equation for this nuclear reaction**.



1. **Give one benefit of a terrestrial fusion reactor under each of the following headings:** [2006]
	1. **fuel; (b) energy; (c) pollution.**
2. Fuel: plentiful / cheap
3. Energy: vast energy released
4. Pollution: little (radioactive) waste / few greenhouse gases
5. **Controlled nuclear fusion has been achieved on earth using the following reaction.**

****

**What condition is necessary for this reaction to take place on earth?** [2006]

Very large energy/temperature is necessary.

1. **Fusion can only take place at very high temperatures. Explain why.** [2012]Nuclei must have very high speeds / energy to overcome force of repulsion between the nuclei if they are to combine
2. **What are the advantages of fusion over fission in terms of fuel sources and reaction products?**(hydrogen) fuel (from the sea) is plentiful – (uranium for fission is scarce) no radioactive waste with fusion – (fission results in radioactive waste)

## Particle Physics

1. **Which Irish physicist is associated with the development of the linear accelerator?** [2012]

Walton

1. **Give two reasons why the Cockcroft and Walton experiment was significant to the understanding of particle physics** [2014]
first experimental verification of E = mc2 / first transmutation using artificially accelerated particles / first artificial splitting of a nucleus / development of linear accelerator
2. **List three quantities that are conserved in nuclear reactions.** [2011]

Momentum, charge, mass-energy

1. **In the Cockcroft and Walton experiment how were the protons accelerated?** [2009][2013]

They were accelerated by the very large potential difference which existed between the top and the bottom

1. **In the Cockcroft and Walton experiment how were the alpha particles detected?** [2009][2013]

They collide with a zinc sulphide screen, where they cause a flash and get detected by microscopes.

1. **Explain why. High voltages can be used to accelerate alpha particles and protons but not neutrons.**[2005][2013]

Alpha particles and protons are charged, neutrons are not.

1. **Why is the tube evacuated?** [2013]
So that particles do not collide with gas particles

1. **What is the purpose of accelerating the particles to high velocities?** [2013]
To overcome repulsive forces // to create new matter
2. **What is the purpose of the magnets?** [2013]
To contain the particles (in a circular path)
3. **Most of the accelerated protons did not split a lithium nucleus. Explain why.** [2009]

The atom is mostly empty space so the protons passed straight through.

1. **Write a nuclear equation to represent the splitting of a lithium nucleus by a proton.**

[2009] [2007] [2005][2002][2013]

** +  →  + K.E.**

1. **Circular particle accelerators were later developed.** [2005][2009][2010][2013]

**Give an advantage of circular accelerators over linear accelerators.**

Circular accelerators result in progressively increasing levels of speed/energy and occupy much less space than an equivalent linear accelerator.

1. **In beta decay, a neutron decays into a proton with the emission of an electron.**

**Write a nuclear equation for this decay.** [2004]

1. **In initial observations of beta-decay, not all three quantities appear to be conserved.** [2011]

**What was the solution to this contradiction?**

The discovery of the neutrino which accounted for the missing momentum.

1. **Give two reasons why it is difficult to detect a neutrino.** [2008]

Neutrinos have no charge and very small mass.

1. **In beta decay it appeared that momentum was not conserved.**

**How did Fermi’s theory of radioactive decay resolve this?** [2007]

Fermi (and Pauli) realised that another particle must be responsible for the missing momentum , which they called the neutrino.

1. **Momentum and energy do not appear to be conserved in beta decay.**

**Explain how the existence of the neutrino, which was first named by Enrico Fermi, resolved this.** [2004]

Momentum and energy are conserved when the momentum and energy of the (associated) neutrino are taken into account.

**Antimatter**

1. **What is a positron?** [2012]

A positron is a particle which has the same mass as an electron but with a positive charge.

1. **Compare the properties of an electron with that of a positron.** [2007]

Both have equal mass / charges equal / charges opposite (in sign) / matter and anti-matter

1. **What happens when an electron meets a positron?** [2007]

Pair annihilation occurs.

1. **Give one contribution made to Physics by Paul Dirac.** [2003]

Dirac predicted antimatter.

1. **Write an equation to represent pair annihilation.** [2014]

e− + e+ = 2hf / 2γ / 2mec2

1. **Why do the photons produced in pair annihilation travel in opposite directions?** [2014]So that momentum is conserved
2. A carbon–11 nucleus, which has a half-life of twenty minutes, decays with the emission of a positron.

**Write a nuclear equation to represent the decay of carbon–11.** [2014]

**Pair Production**

1. **In an accelerator, two high-speed protons collide and a series of new particles are produced, in addition to the two original protons. Explain why new particles are produced.** [2005]

The kinetic energy of the two protons gets converted into mass.

1. **What is the effect on the products of a pair production reaction if the frequency of the γ-ray photon exceeds the minimum value?** [2003]

The electrons which were created would move off with greater speed.There may also be more particles produced.

1. Write a reaction that represents pair annihilation. [2003]

e+ + e- → 2γ

1. **Explain how the principle of conservation of charge and the principle of conservation of momentum apply in pair annihilation.** [2003]

Total charge on both sides is zero

Momentum of positron + electron = momentum of photons

**Fundamental Forces**

1. **Baryons and mesons are made up of quarks and experience the four fundamental forces of nature.**

**List the four fundamental forces and state the range of each one.** [2008]

Strong (short range), Weak (short range), Gravitational (infinite range), Electromagnetic (infinite range).

1. **List the fundamental forces of nature that pions experience.** [2006]

Electromagnetic, strong, weak , gravitational

1. **Beta decay is associated with the weak nuclear force. List two fundamental forces of nature and give one property of each force.** [2004]

Strong: acts on nucleus/protons + neutrons/hadrons/baryons/mesons, short range

Gravitational: attractive force, inverse square law/infinite range, all particles

Electromagnetic: acts on charged particles, inverse square law/infinite range

1. **Name the four fundamental forces of nature.** [2002]

Gravitational, Electromagnetic, Strong (nuclear), Weak (nuclear)

1. **List the fundamental forces of nature in increasing order of their strength.** [2011] [2009]gravitational < weak (nuclear) < electromagnetic < (strong) nuclear
2. **List the three fundamental forces that electrons experience in increasing order of strength.** [2014]
gravitational, weak (nuclear) and electromagnetic
3. **Which force is responsible for binding the nucleus of an atom**? [2002][2005]

Strong

1. **Which fundamental force of nature is involved in beta-decay?** [2011]The weak force.
2. **Give two properties of the strong force. [**2002]

Short range, strong(est), act on nucleons, binds nucleus

**Quark Composition and Particle Classification**

1. **Name the three positively charged quarks.** [2008]

Up, top, charm

1. **What is the difference in the quark composition of a baryon and a meson?** [2008]

Baryon: three quarks

Meson: one quark and one antiquark

1. **What is the quark composition of the proton?** [2008]

Up, up, down

1. **A kaon consists of a strange quark and an up anti-quark. What type of hadron is a kaon?** [2007]

It is a meson.

1. **Pions are mesons that consist of up and down quarks and their antiquarks**.

**Give the quark composition of (i) a positive pion, (ii) a negative pion. [**2006]

π+ = up and anti-down

π- = down and anti-up

1. **Name the three negatively charged leptons.** [2006]

Electron (*e*) , muon (*μ*), tau (*τ* )

1. **Give the quark composition of the neutron.** [2004]

Up, down, down

1. **A huge collection of new particles was produced using circular accelerators. The quark model was proposed to put order on the new particles. List the six flavours of quark.** [2005]

Up, down, strange, charm, top and bottom.

1. **Give the quark composition of the proton.** [2005]

Up, up, down.

1. **Give the difference between the quark composition of a baryon and of a meson.** [2011]

Baryon: 3 quarks, meson: quark and antiquark

1. **Leptons, baryons and mesons belong to the “particle zoo”.**

**Give (i) an example, (ii) a property, of each of these particles.** [2003]

LEPTONS; electron, positron, muon , tau, neutrino

Not subject to strong force

BARYONS; proton, neutron

Subject to all forces, three quarks

MESONS pi(on), kaon

Subject to all forces, mass between electron and proton, quark and antiquark