Common Misconceptions

Speed, Velocity and Acceleration

1. Define speed

☑ The rate of change of distance.

☒ The rate of change of distance moved with time.

2. In a distance - time graph:

☑ the gradient at any point gives the instantaneous speed.

☒ the gradient at any point gives the average speed.

3. Define velocity

☑ Velocity is the rate of change of displacement

☒ Velocity is speed.

Note : Do not confuse speed with velocity.

Speed is a scalar quantity. Velocity is a vector quantity. Velocity is speed in a specified direction.

4. Describe the motion of object from a graph.

Note : Check the given axes. Is it a speed-time graph or a velocity-time graph?
Take note of the gradient of the graph. Is the slope of the gradient increasing or decreasing?
Clear explanation must be given

5. Define constant acceleration

☑ When the rate of change of velocity is constant.

☒ When the acceleration is at constant speed.

Note: At constant speed, acceleration is zero.

6. Calculation of distance from a speed - time graph.

Note: Calculation must show clear evidence of the formula used

7. When an object is falling at a constant speed, the forces acting on it must be balanced. What are the forces acting on the object?

☑ The balanced forces acting on the object are its weight and air resistance.

☒ The balanced forces acting on the object are its weight and the upthrust.
☒ The gravity is equal to the speed.

☒ The object had reached terminal velocity (the question did not ask for the situation in which the object is in)

Note: The acceleration due to gravity, $g = 10\ ms^{-2}$.

Mass, Weight and density

1. Weight

$$W = mg$$

Note: W is the weight (N), m is the mass (kg) and g is the gravitational pull ($g = 10\ ms^{-2}$)

Example
What is the weight of a 1 kg mass?

☑ W = mg
= 1 x 10
= 10 N

☒ 1 kg = 10 N

2. Density

Note: $1000\ kg/m^3 = 1\ g/cm^3$

** Density of an alloy = total mass / total volume

** A less dense fluid (liquid or gas) will go above a denser fluid.

Dynamics

1. Inertia

☑ Only the mass of the object affects the inertia.

☒ The size of the object affects the inertia

2. Newton's Law of Motion

$$F = ma$$

Note: F is the **Resultant or net** force measured in (N)
m is the mass measured in (kg)
a is the acceleration measured in (m/s^2)

** When the resultant force is zero, it does not mean that there are no forces acting on the body. It is just that all the forces are balanced. A body at rest will remain at rest. A moving body will continue to move at constant speed in a straight line.

** If the velocity/speed is constant
→acceleration is 0 ms^{-2}
→Resultant force is 0 N

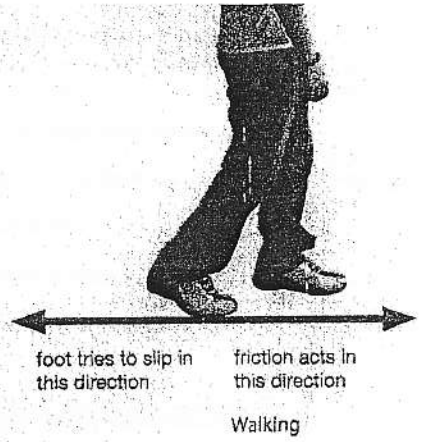
** Force applied – Opposing force (friction) = Resultant force
When resultant force is zero, force applied = friction.
When friction is zero, then force applied = resultant force

** When the forces on an object are unbalanced, a resultant force acts on the object and the object accelerates or decelerates.

Friction

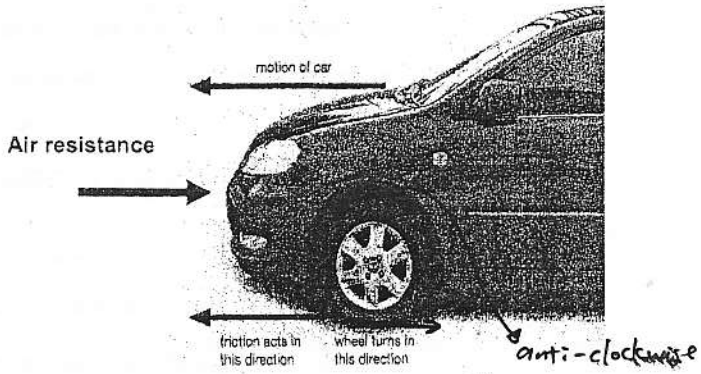
Note: The difference in direction of friction, air resistance and other forces acting on objects.

The diagram below shows the forces acting on a man when he is walking.



Walking

The diagram below shows the forces acting on a moving car and its wheel.



Rolling

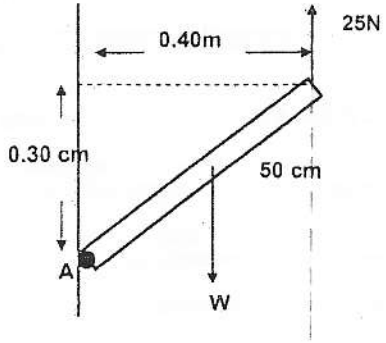
Moment of a Force

1. Moment of a force = F x d

Note: Moment of a force is measured in Nm
F is the force measured in N
d is the perpendicular distance measured in m. This perpendicular distance is the distance from the pivot to the line of action of the force.

** Moment is a vector quantity and its magnitude and direction must be given.

Example. A half-metre rule is freely hinged at one end at A.
What is the moment of the force of 25 N about the point A?



☑ Moment about point A = Force x perpendicular distance
= 25 x 0.40
= 10 Nm anticlockwise

☒ Moment about point A = 25x0.50
= 12.5 Nm

☒ Moment about point A = 25 x 0.30
= 7.5 Nm

2. Centre of Gravity

Note:
** A uniform rod will always has its cg at the centre of the rod.

** Any uniform object that is pivoted at its cg will be in equilibrium. The weight of the object will not give any turning effect as the perpendicular distance is zero.

** If a body is hung freely and when it stops rotating, its centre of gravity is always vertically below the pivot.

3. Stability

☑ A stable equilibrium does not mean that the object will not topple.

☑ A stable object means that the vertical line through its centre of gravity lies within the base

☑ An object which has a heavy base means that it is more stable.

☒ A heavy object means that it is more stable.

Work, Energy and Power

Note:
** Always write out the correct formula.

** Values must be in the correct units before doing the problem.

** Power = Force x dist moved/ time
= force x speed

** If a question asked for energy transfer, it requires two energies to be given and not just one form of energy. Be specific.

Waves

1. Define transverse waves.

☑ The direction of vibrations is perpendicular to the direction of the waves.

☒ particles move perpendicular to the vibrations

☒ it moves perpendicular to the waves.

2. Define longitudinal waves

☑ The direction of vibrations is parallel to the direction of the waves.

☒ particles move parallel to the vibrations

☒ it moves parallel to the waves.

☒ it consists of compressions and rarefactions.

3. Define frequency and period

Note : Do not confuse frequency with period.

Frequency is the number of complete waves produced in 1 s.

Period is the time taken to produce one complete wave.

4. State the properties of Electromagnetic waves

☑ They travel at the same speed of light, 3×10^8 m/s in vacuum or air.

☑ They are transverse waves.

☒ They have a wavelength.

☒ They have the same wavelength.

☒ They obey $v = f\lambda$.

☒ The waves were longitudinal.

5. Define wavefront

☑ A line joining points having the same phase on the wave.

6. State uses of electromagnetic waves

Example. State uses of ultra-violet radiation

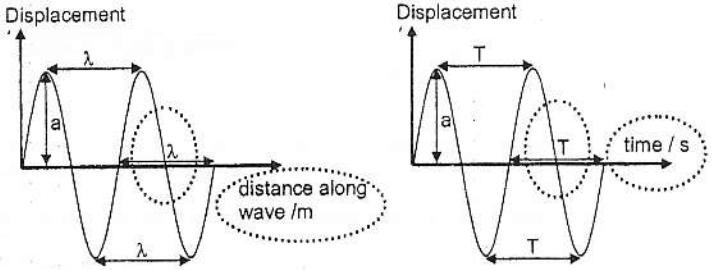
☑ suntan, sterilization, vitamin D, and the testing of bank notes.

☒ can cure cancer, to scan inside the womb.

7. What happens when water waves move from deep to shallow.

☑ wavelength, speed decreases. Frequency remains constant

8. Graphs



9. State the speed of electromagnetic waves in a vacuum.

☑ 3×10^8 m/s

☒ 300 m/s, 330 m/s, 0 m/s, 3×10^{-8} m/s, 8×10^3

10. Name the waves in the electromagnetic spectrum.

Note : Spell the names of the waves correctly.

☑ ultra-violet, radio waves

☒ radioactive, radar

Refraction of Light

1. Calculate the refractive index.

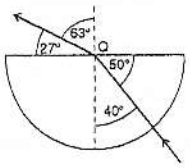


Fig. 1

Note : angle of incidence, angle of reflection and angle of refraction are all measured with reference to the normal.

The value of refractive index is always more than 1. If your value for n is less than 1, recalculate again.

When using the formula n = sin i / sin r, remember the angle of incidence is the one in air or vacuum.

☑ n = sin i / sin r

= sin 63 / sin 40

= 1.39

☒ sin 40 / sin 63

2. State the advantages of optical fibres over copper wires.

☑ carry more telephone conversations, optical fibres are more secure from interference or tapping, data can be sent at a faster rate along an optical fibre, cheaper than copper wires, lighter

☒ The speed of the wave traveling along the fibre was faster.

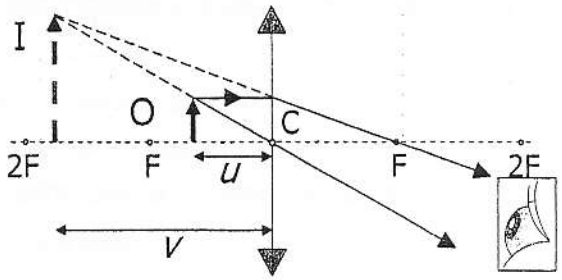
3. Describe why total internal reflection occurs (refer to Fig. 1).

☑ angle of incidence is larger than critical angle.

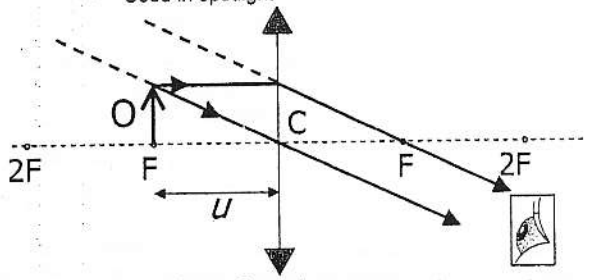
☒ 50 ° is bigger than critical angle.

Converging lens

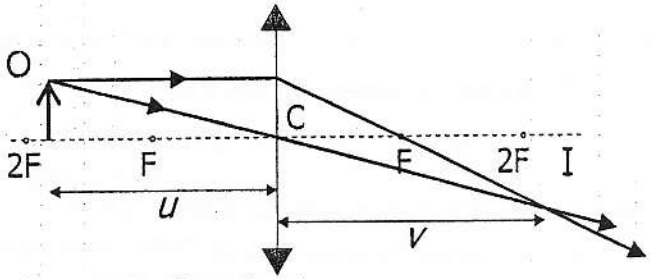
1. Characteristics of image formed
   - Upright, virtual and enlarged (magnified)
   - At the same side of the lens (image behind object)
   - Used in magnifying glass



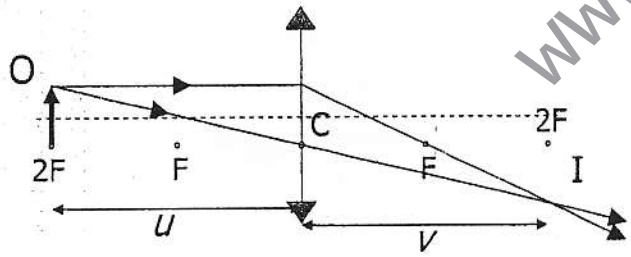
2. Characteristics of image formed
- Upright, virtual and enlarged
- At the same side of the lens, v at ∞
- Used in spotlight



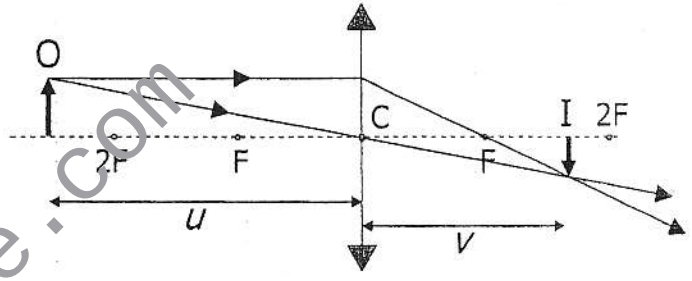
3. Characteristics of image formed
- Inverted, real and enlarged
- At the opposite side of the lens, v >2f
- Used in projector



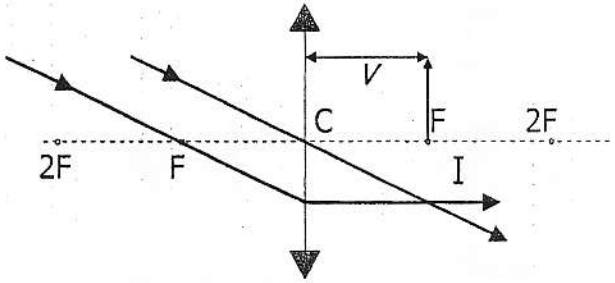
4. Characteristics of image formed
- Inverted, same size and real
- At opposite side of the lens, v = 2f
- Used in full-sized photocopier lens



5. Characteristics of image formed
- Inverted, diminished, and real
- At opposite side of the lens, f < v < 2f
- Used in camera, eye

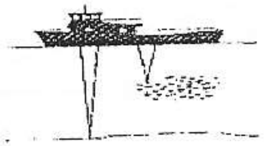


6. Characteristics of image formed
- Inverted, diminished and real
- At opposite side of the lens, v=f
- Used in telescopes



Sound

1. Calculate the depth of the sea.



☑ Depth = (speed x time) / 2

☒ Depth = speed x time

2. Questions relating loudness and pitch.
   Always link clearly loudness with amplitude and frequency with pitch.

☑ The higher the amplitude, the louder the sound. The higher the frequency, the higher the pitch.

☒ A louder sound is produced with a larger frequency.

3. Describe an experiment to determine the speed of sound in air.

Note : Must quote a suitable method of producing a sound and a simultaneous visual signal.

Easier to describe using the direct method.

Avoid methods involving walls producing multiple echos.

☑ Use a tape to measure the distance between the observer and the firer. The distance between the firer and the observer should be large.

☑ speed of sound = distance / time

☒ They should be 5 m apart.

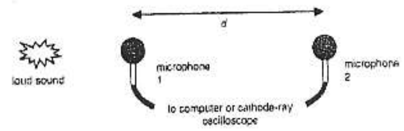
☒ divide the distance and time.

4. How does sound propagate through the air?

☑ air particles vibrate and transfer their vibrations/energy from one particle to another.

☒ Sound particles

5. Why does microphone 2 detects a quieter sound?



☑ the sound has further to travel and the air absorbs the sound or the sound spreads out.

Kinetic Theory of Matter

1. Thermal Energy

- ☑ Heat is a form of energy.
- ☑ Use either the terms, heat or thermal energy.
- ☒ Heat energy is transferred.
- ☒ Hot water contains heat.
- ☑ Hot water contains thermal energy.
- ☒ Heat is trapped.
- ☑ Heat cannot be trapped, heat is transferred.
- ☒ Heat rises
- ☑ Hot air, being less dense, rises.

2. Change in state

- ☑ Upon heating, if there is a change in state, temperature of a body will not rise.
- ☑ When a substance changes from solid to liquid, thermal energy is used to weaken the forces of attraction between the molecules.
- ☒ When a substance changes from solid to liquid, thermal energy is used to break the forces of attraction between the molecules.
- ☑ When a substance changes from liquid to gas, thermal energy is used to break the forces of attraction between the molecules.

3. Increase in temperature

- ☑ Upon heating, if there is no change in state, temperature of a body will rise.
- ☑ As temperature increases, particles gained kinetic energy and move faster.
- ☒ Upon heating, molecules of a substance expands
- ☑ Upon heating, the substance expands as a whole due to the increase in distance between the molecules.

4. Pressure vs volume

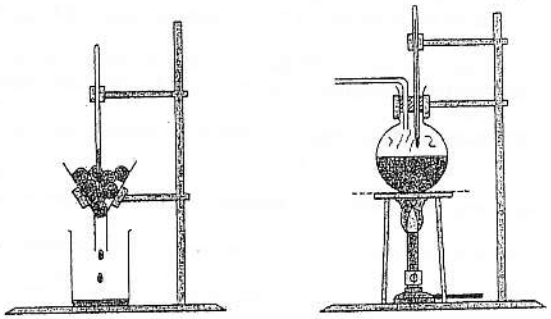
- ☒ For a fixed mass of gas at constant temperature, pressure increases as volume decreases. This is because the force exerted by each molecule on the walls of the container increases.
- ☑ For a fixed mass of gas at constant temperature, pressure increases as volume decreases. This is because the number of molecules per unit volume increases, thus frequency of collisions of the molecules with the walls of the container increases.

Temperature

1. Temperature vs Heat

- ☑ Temperature is the measure of degree of hotness
- ☑ Heat is the amount of thermal energy that flows from a hotter object to a cooler object.

2. Experiment for calibration of thermometer



- ☑ Ice shavings instead of cubes of ice should be used.
- ☑ To determine steam point, thermometer should not be immersed in the boiling water.
- ☑ Conditions for experiment: at atmospheric pressure and pure water must be used.

3. Ice point

   ☒ Ice point is the temperature of ice taken from the freezer of the refrigerator.

   ☑ Ice point is the temperature of pure ice at which it melts. Temperature of ice in the freezer could be less than 0 °C. (depending on the temperature of the freezer)

4. Thermometers

   ☒ A thermometer can be used to measure any temperature.

   ☑ Thermometers have a range of temperatures it can measure due to the boiling point and melting point of the thermometric liquid.

Transfer of thermal energy

1. Conduction

   ☑ depends on material

   ☑ molecules are already vibrating before heating

   ☒ Gas and liquid do not transfer thermal energy by conduction.

   ☑ Conduction is the process where thermal energy is transferred when molecules are in contact. In gas and liquid although the molecules do not have fixed positions, the molecules may collide and thus thermal energy is transferred by conduction.

2. Convection

   ☑ applies to fluids (liquid & gas) only.

3. Radiation

   ☑ is the transfer of thermal energy by infra-red radiation.

   ☑ black surfaces are good emitters/absorbers of radiation

   ☒ black surfaces are good emitters/absorbers of heat

   ☒ black surfaces are good conductors of radiation.

4. Vacuum

   ☑ stops/prevents heat loss by conduction and convection

5. Insulators

   ☒ stop/prevent heat loss by conduction

   ☑ minimise/reduce heat loss by conduction

Thermal properties of matter

1. Heat capacity vs specific heat capacity

   ☒ Heat capacity does not change for materials of the same state.

   ☑ Heat capacity changes for materials of the same state due to the mass of the object.

   ☑ Specific heat capacity is constant for materials of the same state.

   ☑ Specific heat capacity is constant for materials of the same state and is different for the same material in different states.

   ☑ Specific latent heat of fusion (l_f) of a substance is the amount of energy needed to change unit mass of the substance from solid to liquid without a change in temperature

   ☑ Specific latent heat of vaporisation (l_v) of a substance is the amount of energy needed to change unit mass of the substance from liquid to gas without a change in temperature

Static Electricity

1. Charges.

☑ An insulator can be charged by friction.

☑ A conductor can be charged by induction.

☑ A body becomes charged through a gain or loss of electrons (or negative charges).

☒ A body becomes charged through a gain or loss of positive charges.

2. Types of Charges.

☑ There are only two types of charges, positive and negative charge.

☒ There are three types of charges, positive, negative and neutral charge.

☑ A positively charged object is one which has more positive charges than negative charges.

☑ A negatively charged object is one which has more negative charges than positive charges.

☒ Using protons in place of positive charges.

3. Neutral Body.

☑ A neutral body contains the same number of positive and negative charges.

☒ A neutral body has no charge.

4. Properties of Charges.

☑ Like charges repel while unlike charges attract.

☒ Like poles repel while unlike poles attract.

Current Electricity

1. Current

☑ Current is the rate of flow of charges.

☑ The direction of conventional current is taken to be the direction of flow of positive charges. [that is, from the positive terminal to the negative terminal of the cell/battery]

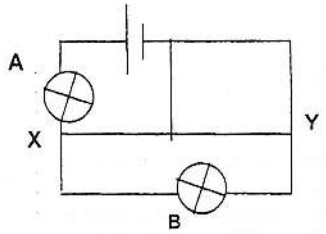
☒ The direction of conventional current is taken to be the direction of flow of negative charges.

☑ The direction of electron flow is opposite to that of conventional current.

2. Differences between a series circuit and a parallel circuit.

Series circuit	Parallel circuit
Same current for all components	Current splits into the branches.
Sum of potential differences of each component will add up to the emf of battery.	Same potential differences for components.
Total resistance, $R = R_1+R_2+R_3+..$	$1/R = 1/R_1 + 1/R_2 + 1/R_3 + ...$

3. Short circuit



Note:
Bulb A lights up. Bulb B will not light up as a short circuit has occurred. XY is a conductor and has a much lower resistance compared to B. Current will take the easiest path, XY and thus bypassing B.

4. Potential differences in an open circuit

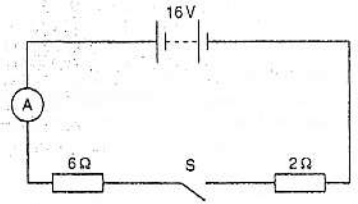


Fig. 8.1

☑ In an open circuit (where there is no current flow), there is no potential differences across each of the electrical component (the two given resisitors, but the potential difference across the switch is 16V.

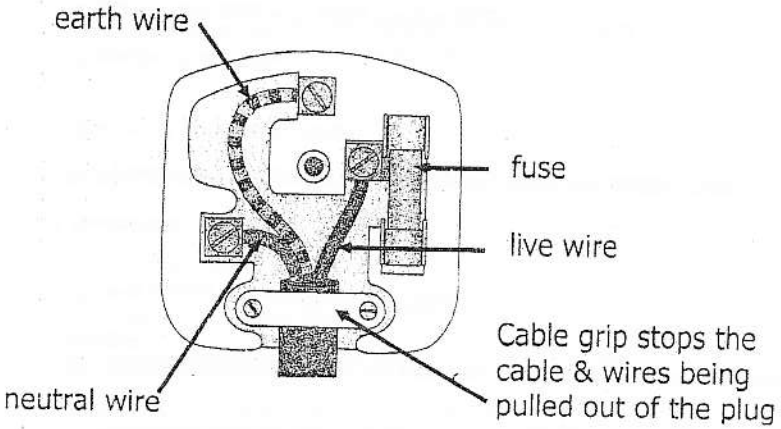
☒ The potential differences across the resistors are non-zero.

☒ The potential difference across the switch is zero.

Practical Electricity

1. Types of Wires

☑ Three types of wires : Live (Brown), Neutral (Blue) & Earth (Green & Yellow).



Note:

☑ The fuse and the switch are always connected to the live wire.

2. Fuse

☑ Fuses are used to protect equipment and wiring from excessive current flow.

☑ A 5A fuse (or a fuse with a rating of 5A) would allow a maximum current of 5A to pass through it. Always choose a fuse that has a rating higher than the normal current used by the electrical device. It should be the next higher rating available. For example, if the device uses 3.5A, use a 5A fuse.

☑ When the current exceeds the fuse rating, the fuse melts and breaks the circuit, isolating the electrical appliance from the mains supply. This prevents the appliance from being damaged.

☒ When the voltage exceeds the fuse rating, the fuse blows up.

Note:
The normal operating current of an electrical appliance may be 4A. But if the live wire accidentally touches the metal casing (which is of low resistance), the current will surge beyond 4A and in the process melts the fuse and stops the current flow.

3. Earthing

☑ In the event of an electrical fault (such as the live wire accidentally touching the case), the earth wire allows excess current to flow from the casing of the device to the ground. This prevents the user from getting an electric shock.

4. Double Insulation

☑ Double insulation means two levels of insulation:
- **The electrical cable** is insulated from the internal components of the appliance.
- The **internal metal parts** which would become live if a fault developed are also insulated from the external casing

☒ Double insulation refers to two layers of insulation around the cable.

Magnetism

1. Magnetisation

☒ When an iron bar is magnetised by passing a current through the solenoid wrapped around the iron bar, it is possible for the iron bar to have only one pole i.e. either the north or south pole. The iron bar has been magnetised by induction.

☑ A magnetized iron bar must have 2 poles, north and south at opposite ends if is magnetised by passing a current through the solenoid wrapped around the iron bar. It is magnetised but not by induction.

☒ All metals can be magnetised.

☑ Only ferromagnetic materials like iron and steel can be magnetised, i.e. metals like aluminium and copper cannot be magnetised.

2. Demagnetisation

☒ A magnet can be demagnetised by heating.

☑ A magnet can be demagnetised by heating strongly and cooling it while lying in a east-west direction.

☒ A magnet can be demagnetized by putting it into a solenoid and passing an a.c. current through the solenoid, then switching off the current.

☑ A magnet can be demagnetized by putting it into a solenoid with an a.c. current switched on and withdrawing it in an east-west direction far away from the solenoid.

Other general comments:

- Do not get confused between magnetic and electrostatic attraction or repulsion. For questions on static electricity, make sure you do not use the terms north and south poles, should be like charges and unlike charges.

- Similar point: electrostatic induction occurs due to the separation of charges in a neutral body when it is brought near a charged object. (see Figure 1 below)

  Magnetic induction occurs when an unmagnetised magnetic object e.g steel bar or iron bar is brought near a magnet. (see Figure 2)

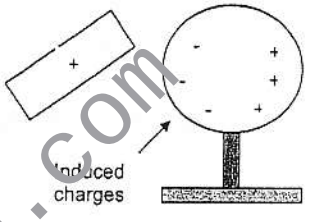


Figure 1

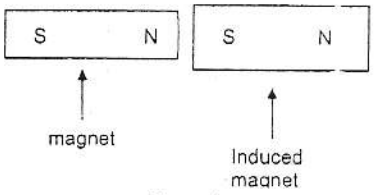


Figure 2

- Note that when asked to trace the magnetic field pattern for a hollow solenoid, lines of force inside and outside the solenoid must be drawn and the direction of the lines of force must be in same direction (see Figure 3 below)

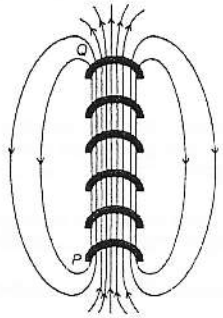


Figure 3

Electromagnetism and Electromagnetic Induction

1. Direction of electron vs current flow

☒ Direction of electron flow is the same as that of current.

☑ Direction of electron flow is opposite to that of current flow.

2. Electric Motor

☒ When coil is vertical in an electric motor, current can flow into the coil, hence the coil continues to rotate.

☑ When coil is vertical, no current flows into the coil. However a rotating coil has inertia, so it will continue to rotate past the vertical position and current will then flow in so that the coil will continue to rotate.

3. Electromagnetic Induction

☒ When a wire is moved between magnetic poles to produce an induced current, induction of electromagnetic field has occurred.

☑ When a wire is moved between magnetic poles to produce an induced current, electromagnetic induction has occurred.

4. Transformer

☒ In a transformer, current can flow from the primary coil to the secondary coil to produce an induced current in the secondary coil as the soft iron core is an electrical conductor.

☑ In a transformer, as alternate current flows in the primary coil, a change of magnetic flux occurs in the primary coil. These magnetic field lines can cut into the secondary coil, hence producing a change in flux and an induced current in secondary coil.

☒ For transformers, the power loss in the cables can be calculated using the formula: V_s^2 / R where V_s is the voltage across the secondary coil.

☑ For transformers, power loss should be calculated using the formula: I^2R where I is the current flowing in the cables. The formula Power loss = V_s^2 / R cannot be used as V_s is not the voltage drop across the cables.

Other comments:

It is easy to get mixed up between electromagnetism and electromagnetic induction.

Please note:

- When current flows from a source e.g. a battery into a coil placed in a magnetic field, a force is produced and the coil turns. Use Fleming's Left Hand Rule to predict the direction of the force if given the direction of the current and the magnetic field. e.g. d.c. motor
- When a coil is turned in a magnetic field, there is a change in the magnetic lines of force linking the coil and an current is induced in the coil. Use Fleming's Right Hand Rule to predict direction of flow of induced current in the coil if given the direction of the force and the magnetic field. e.g. a.c. generator

Pressure

1. Effect of force and area on pressure

☒ Pressure depends only on the force of the molecules hitting the surface.

☑ Pressure depends on the force per unit area of the molecules hitting the surface.

2. Factors affecting levels of liquid in manometer

☒ For manometer, change in diameter of tube will affect the difference in levels of the liquid even if pressure is kept the same.

☑ For manometer, change in density of liquid will affect the difference in levels of liquid in the two tubes if pressure is kept the same. Change in diameter of tube will not affect the difference in levels of liquid.