**All the 5’s**

***Remember to photocopy 4 pages onto one sheet by going A3→A4 AND back to back on the photocopier***

Going over Question 5 is a nice way to revise all the material on the course; the answers are generally short but need to be precise.

Use a sheet of paper to block off the answers as you go down along and ideally scribble down the answers on the paper rather than just saying them to yourself. Even saying them out loud is a more effective retrieval activity than simply saying them to yourself. Getting someone to test you is also a good idea (or simply test each other if there is another student in the same boat).

Remember to go back over these at regular intervals concentrating on those you didn’t know or got wrong the first time around.

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2023 **[Ordinary Level]**

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| What is meant by the moment of a force? | The moment of a force is = force multiplied by the distance between the force and the fulcrum. |
| A car accelerates from a speed of 17 m s–1 to a speed of 28 m s–1 in a time of 8 s.  Calculate the acceleration of the car. | *a* = (*v* – *u*)/*t*  *a* = (28 – 17)/8 = 1.375 m s–2 |
| Convert 30 °C into kelvin (K). | 30 + 273 = 303 K |
| Which of the following is the unit of work?  joule watt farad metre | joule |
| Name an instrument used to measure voltage. | voltmeter |
| An object has a height of 2 cm. Its image in a mirror has a height of 5 cm.  Calculate the object’s magnification. | Magnification = image height/object height  Magnification = 5 ÷ 2 = 2.5 |
| Explain the difference between heat and temperature. | heat is a form of energy / temperature is a measure of hotness |
| What are complementary colours of light? | Complementary colours consist of a primary and a secondary colour that combine to give white light. |
| Describe how infrared radiation can be detected. | heating effect, etc. |
| What is meant by capacitance? | Capacitance is the ratio of charge to voltage |
| Describe how white light can be separated into its constituent colours. | By using a prism or a diffraction grating. |
| State what each letter in Einstein’s famous equation *E* = *mc*2 stands for. | *E* = energy  *m* = mass  *c* = speed of light |

**2023 [Higher Level]**

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| An airplane starts from rest on a runway and reaches a velocity of 290 km hour–1 in 33 s.  Calculate the acceleration of the airplane in terms of *g*, the acceleration due to gravity. | *v* = 290 km hour–1 so we need to multiply this by 1000 and divide by 3600 to get it terms of m s-1.  *v* = 80.56 m s–1 *t* = 33 s  *v* = *u* + *at 80.56 = 0 + a(33)*  *a* = 2.44 m s–2  But we need to give acceleration in terms of *g* which is 9.8 m s-2 so we need to divide 2.44 by 9.8  *Answer: a* = 0.25 g |
| Explain the term *solar constant*. | This is the solar energy falling normally on the Earth per second per m2. |
| A converging lens of focal length 15 cm is placed in combination with a diverging lens of focal length 5 cm. Calculate the power of the combination. | PT = P1 + P2 = –13.33 m–1 |
| Uranus has a mass of 8.7 × 1025 kg and a radius of 25 400 km.  Calculate the acceleration due to gravity on Uranus. | g = 8.99 m s–2 |
| Draw a diagram to show how a ray of light can be turned through 90° using a 45°–90°–45° prism. | Draw one ray entering *normally* at one short face.  Draw a second exiting at the other short face.  Total internal reflection should be clear from the diagram. |
| State one application of stress polarisation. | To identify weaknesses in plastics |
| What is meant by potential difference? | Work done per unit charge (moved between two points) |
| Calculate the power output of a resistor of resistance 3.4 Ω when a potential difference of 55 V is maintained across it. | V = 55 V, R = 3.4 Ω  V = IR so I = V/R  P = VI therefore = 889.7 W |
| The peak voltage of an a.c. supply is 311 V. Calculate its rms voltage. | Vpeak = 311 V  *=* 219.9 V |
| A proton experiences a force of 4.59 × 10–16 N when it moves with velocity *v* perpendicular to a magnetic field of flux density 18.5 mT. Calculate *v*. | F = qvB  v = 1.55 × 105 m s–1 |
| Explain what is meant by a chain reaction in nuclear fission. | neutrons [4]  from one reaction initiate subsequent reactions / cause a self-sustaining reaction |
| The equation to describe an emission line spectrum is *hf* = *E*2 *– E*1. Explain what each of the symbols in this equation stands for. | h = Planck constant [2]  f = frequency [2]  E2 = higher energy; E1 = lower energy |

2022 Deferred exam **[Higher Level]**

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| An athlete weighing 850 N runs up a stairs in 6 seconds.  If the vertical height of the stairs is 2.5 m, calculate the average power generated by the athlete. | *F* = 850 N *s* = 2.5 m *t* = 6 s  = 354 W  Alternatively you could have used W = mgh instead of W = Fs |
| State Archimedes’ principle. | When an object is immersed in a fluid the upthrust it experiences is equal to the weight of displaced fluid. |
| Calculate the length of a pendulum that has a period of one second. | *l* = 0.248 m |
| A thermocouple thermometer and an alcohol‐in‐glass thermometer each gave a different reading when placed in the same container of water.  Explain why this occurred. | Because different thermometric properties do not change proportionally with change in hotness. |
| A standing wave is set up in a stretched string that is fixed at each end.  Sketch the first two harmonics that are produced when the string is plucked. | A picture containing text, line, screenshot, font  Description automatically generated |
| What is meant by sound intensity? | Sound intensity corresponds to power unit area  OR rate of change of energy per unit area |
| Calculate the effective focal length of two thin lenses in contact, one a converging lens of focal length 5 cm and the other a diverging lens of focal length 15 cm. | *f*1 = 5 cm *f*2 = –15 cm    ftotal = 7.5 cm |
| A precaution usually taken when using electrical equipment is to put a fuse in the circuit.  Explain the role of a fuse. | The fuse is a deliberate weak link which melts and therefore breaks the circuit when current is too high |
| A solid copper cube of side 5 cm rests on a horizontal table.  Find the pressure exerted by the cube on the table.  density of copper = 8960 kg m−3 | First we need to calculate the mass of the object. We can do this by noting that  Mass = density × volume  Density = 8960 kg m−3 volume = (0.05)3 Mass = (8960) × (0.05)3 = 1.12 kg    = 4390.4 Pa |
| What is meant by the U‐value of a material? | Rate of energy transfer through 1 m2 of a surface each second when a temperature difference of 1 K across the surface. |
| How are X‐rays produced? | High speed electrons hit a metal. Some electrons inside the atoms of the metal absorb this energy and jump up to a higher level (‘excited state’). When they fall back down the energy is emitted as X-rays. |
| Name the metal used as a target in the Cockroft and Walton experiment. | lithium |

2022 **[Ordinary Level]**

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| State Newton’s first law of motion. | A body remains at rest (or moving at constant velocity) unless an (unbalanced, external) force acts on it. |
| A boy applies a force of 20 N to pull his sleigh for 150 m.  Calculate the work done by the boy. | Work = force × displacement Work = 20 × 150 = 3000 J |
| What is the difference between heat and temperature? | Heat is a form of energy.  Temperature is a measure of hotness |
| Draw a labelled diagram to show how light travels through an optical fibre. | total internal refraction shown  fibre |
| Describe how to charge an electroscope. | Bring charged object close and then earth electroscope |
| Two resistors of resistance 4 Ω and 7 Ω are connected in series.  Calculate the combined resistance of the two resistors. | 4 + 7 = 11 Ω |
| When the frequency of a sound wave increases, its pitch also increases.  What is observed to happen to a sound when its amplitude increases? | it gets louder |
| Describe how to show the magnetic field of a bar magnet. | Sprinkle iron filings around the magnet and notice the distribution of the filings OR  Move a compass around the magnet and notice the deflection of the compass. |
| Name the three primary colours of light. | red, blue, green |
| What is meant by nuclear fission? | The break-up of a large nucleus into two smaller nuclei with the release of energy and neutrons. |
| A fuse is a safety device used in an electrical plug. Describe how a fuse works. | The fuse melts/breaks when current is too high |
| Explain what is meant by the half‐life of a radioactive sample. | the time for half the sample to decay / the time for its activity to halve |

**2022 Higher level**

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| Iron has a density of 7.87 g cm–3.  An iron sphere has a mass of 500 g.  Calculate the radius of the sphere in cm. | *Density ρ* = 7.87 g cm–3.  m = 500 g.  = 63.53 cm3    *r* = 2.475 cm |
| Calculate how many electronvolts are in a kilowatt-hour. | 1 kW hour = 1000(60)(60) = 3.6 × 106 J  And there are 1.6 × 10–19 J in 1 eV.  So total number of electronvols =  (3.6 × 106) ÷ (1.6 × 10–19) = 2.25 × 1025 eV |
| Draw a labelled diagram to show the forces acting on a piece of wood floating at rest. | weight labelled downwards  buoyancy/upthrust labelled upwards  equal and opposite force vectors |
| State the thermometric property of (*i*) a thermocouple, (*ii*) a mercury thermometer. | (i) voltage/emf (ii) height/length/volume |
| Transverse waves can be polarised. Explain what is meant by polarisation. | oscillations/vibrations in one plane |
| The sound intensity is 0.18 mW m–2 at a distance of 3 m in any direction from a source of sound. Calculate the power of the source. | *r* = 3 m  Sound intensity = 0.18 mW m–2  = 0.18 × 10-3 W m-2  Power = (sound intensity)(area)  Power = (0.18 × 10-3)(4π32)  P = 0.02 W |
| Describe how an insulated metal sphere can be charged by induction using a nearby charged rod. | earth sphere [when rod is close]  de-earth sphere [while rod is close]  then remove rod |
| A current-carrying wire of length 20 cm is placed in a magnetic field.  When a current of 55 mA flows in the wire the maximum force it can experience is 130 μN.  Calculate the magnetic flux density of the field. | *F* = 130 μN = 130 × 10-6 N = 0.00013 N  *I* = 55 mA = 0.055 A  *L* = 20 cm = 0.2 m  *F* = *BIL*  = 0.0118 T |
| A tungsten cube of side 2 cm has a resistance of 2.8 μΩ.  Calculate the resistivity of tungsten. | R = 2.8 × 10-6 Ω, L = 0.02 m, A = 0.022 m2  = 5.6 × 10–8 Ω m |
| Describe how the Bohr model of the atom explains emission line spectra. | Electron falling from one energy level to another  / E2 – E1 / ΔE  produces light of a particular frequency/wavelength/energy/colour/hf |
| What is thermionic emission? Where does it occur in an X-ray tube? | emission of electrons from a hot surface  Cathode |
| Pair annihilation of an electron and a positron occurs in a positron emission tomography (PET) scanner. Write an equation for this annihilation. | e- + e+ / 2mec2 = 2γ / 2hf |

2021 **[Ordinary Level]**

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| A student arranges a metre stick so that it is in equilibrium. Explain the underlined term. | No acceleration / net force zero / |
| A motorcar starts from rest and has an acceleration of 6 m s–2.  Calculate the distance it travels in 12 s. | = 432 m |
| Water has a density of 997 kg m−3.  Calculate the pressure due to water at a depth of 214 m. | ΔP = ρgΔh = = (997)(9.8) (214)  ΔP = 2.1 × 106 Pa |
| Complimentary colours mix to form white light.  Name the secondary colour which mixes with red light to form white light. | turquoise / cyan |
| What is the Doppler effect? | Apparent change in (wave) frequency /wavelength due to moving source/observer |
| Draw a diagram to show how light is transmitted along an optical fibre. | **A picture containing text, device, meter  Description automatically generated**diagram showing fibre and multiple internal reflections |
| Coulomb’s law may be written as . What do the letters 𝐹, 𝑞, and 𝑑 stand for in this expression? | force, charge and distance between charges |
| State the SI unit of (*i*) magnetic flux density, (*ii*) capacitance. | (i) tesla/T (ii) farad/F |
| A close-up of an object  Description automatically generated with low confidenceThe picture on the right is an X‐ray tube.  The target in an X‐ray tube is usually made of tungsten.  What property of tungsten makes it suitable for this use? | high melting point // high atomic number//high density |
| Silicon is an example of a semiconductor. What is a semiconductor? | substance whose resistivity/conductivity is between that of a conductor and insulator |
| Draw a diagram to outline the Bohr model of the atom. | diagram showing nucleus, electron shell, another electron shell |
| What is the photoelectric effect? | emission of electrons (from a metal surface) by (incident) light |

**2021 Higher level**

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| Define acceleration.  Hence derive the expression *v* = *u* + *at*. | rate of change of velocity  *a* = (*v* – *u*)/*t*  Rearrange: *at* = *v* - *u* *v* = *u* + *at*. |
| A ball is kicked with an initial velocity of 20 m s-1  at an angle of 50° to the horizontal.  Calculate the horizontal distance it travels in 1.2 seconds. | *s* = *ut*  *u* = 20Cos50° = 12.86 m s–1  15.43 m |
| State the laws of equilibrium for a set of co‐planar forces. | sum of the forces (in any direction) is zero  sum of the moments (about any axis) is zero |
| State an expression for the acceleration due to gravity at a distance of 2R above the surface of a planet of mass M and radius R. | 2R above the surface of the planet = 3R from the center: |
| Two different types of thermometer can give different readings when placed in the same environment. Explain why this happens. | Different thermometric properties give different readings at the same level of hotness. |
| Draw a labelled diagram to represent the second harmonic of a stationary wave in a pipe that is open at both ends. | antinode shown at both ends  one full wave shown (i.e. antinode-node-antinode-node-antinode) |
| Calculate the sound intensity 6 m from a loudspeaker of power 20 mW. | *r* = 6 m  P = 20 mW = 20 ×10-3 W  S.I. = 4.4 × 10–5 W m−2 |
| List two primary colours of light.   What colour of light is produced when equal intensities of these two primary colours are mixed? | red and blue // blue and green // green and red  magenta // cyan/turquoise // yellow |
| Distinguish between earthing and bonding in domestic electricity. | **Earthing** means providing a (conducting) path to earth, i.e. joining to earth  **Electrical bonding** is the practice of intentionally electrically connecting all exposed metal items not designed to carry electricity in a room or building as protection from electric shock. |
| Draw a circuit diagram to show how voltage and current are measured for a diode in reverse bias.. | diode shown in reverse bias  (micro)ammeter in series with diode  voltmeter across diode and microammeter |
| Carbon14 undergoes nuclear decay.  The daughter nucleus is nitrogen14.   Write a nuclear equation for this decay. |  |
| In terms of how they interact with the neutrons in a fission reactor, distinguish between a moderator and a control rod. | a moderator slows down neutrons  a control rod absorbs/stops/blocks neutrons |

2020 **[Ordinary Level]**

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| A picture containing text, indoor, device  Description automatically generatedExplain Archimedes’ principle. The diagram may help you answer. | When an object is immersed in a fluid  the upthrust (apparent loss in weight) it experiences equals the weight of displaced fluid |
| What is meant by latent heat? | heat/energy needed to change state of a substance |
| Which of the following is the SI unit of capacitance? | farad |
| State Boyle’s law. | pressure and volume are inversely proportional for a fixed mass of gas at constant temperature |
| An electric heater has a power rating of 1500 W.  It uses a voltage of 230 V. Which fuse should be used in the plug, a 3 A fuse or a 13 A fuse?  Justify your answer. | P = VI  I = P/V  I = 1500/230 = 6.5 A so a 13 A fuse is required. |
| What is a magnetic field? | region/space where magnetic forces can be experienced |
| Ultraviolet light is on the electromagnetic spectrum.  State two properties of ultraviolet light. | travels at *c*, high energy/frequency, causes ionisation, etc. |
| A pair of complementary colours consists of a primary colour and a secondary colour that mix to give white light.  Name a pair of complementary colours. | blue and yellow OR  red and turquoise/cyan OR  green and magenta |
| Name this piece of equipment.  A close-up of a microscope  Description automatically generated with medium confidence | spectrometer |
| What is nuclear fusion? | joining of two nuclei with the release of energy |

**2020 Higher level**

|  |  |
| --- | --- |
| State Boyle’s law. | For a fixed mass of gas at constant temperature, pressure is inversely proportional to volume |
| A neutron star has a density of 3.7 × 1017 kg m–3.  What would the radius of the Earth be if it had the same density as the neutron star?  Mass of the Earth = 6 × 1024 kg | = m3    *r* = 157 m  (which is mind-blowing when you think about it!) |
| A spring has a length of 22 cm when a 2 N weight hangs from it.  The spring constant is 50 N m–1.  Calculate the natural length of the spring. | Force down = Force up  Force down = weight = 2 N  Force up = k(extension)  2 = 50(extension)  extension = 0.04 m = 4 cm  22 cm corresponds to the length of the spring when it is extended by 4 cm, so natural length = 22 cm – 4 cm = 18 cm. |
| Draw a ray diagram to show the formation of an image in a convex mirror. |  |
| What is meant by the amplitude of a wave? | Maximum displacement (from rest position) |
| Name one of the three primary colours of light. What is its complementary colour? | Red and cyan// green and magenta // blue and yellow |
| Draw a labelled diagram to show how an electric field pattern can be demonstrated in the laboratory. | A picture containing text  Description automatically generatedConnected across plates, with oil, semolina  [−1 if “high” not mentioned] |
| Distinguish between intrinsic and extrinsic conduction in a semiconductor. | Intrinsic is through a *pure* semiconductor / intrinsic: equal number of holes and electrons  Extrinsic is through a *doped* semiconductor / extrinsic: excess of holes or electrons |
| Diagram  Description automatically generatedThe diagram shows a sketch of a photocell.  What particles move between the electrodes of the photocell?  In what direction do the particles move? | Ans: electrons  Ans: from cathode to anode |
| Write a nuclear equation to show the pair annihilation of a positron and an electron. | Text  Description automatically generated with medium confidence |

2019 **[Ordinary Level]**

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| State the principle of conservation of momentum. | In a closed system the total momentum before interaction = the total momentum after |
| A force of 2500 N acts on a car of mass 1000 kg.  Calculate the acceleration of the car. | F = ma = 2.5 m3. |
| Which of the following is the unit of electrical charge? | coulomb |
| State Boyle’s law. | For fixed mass at constant temperature pressure is inversely proportional to volume |
| A crane moves a load of weight 7000 N to  the top of a roof which is 4 m high. The crane takes 20 seconds to do this work.   Calculate the power output of the crane. | = 1400 W |
| The boiling point of water is 100 °C.  Convert this temperature to kelvin (K). | 100 + 273.15 = 373.15 K |
| Explain why it is possible to hear around corners but not to see around corners. | The wavelength of sound waves is much larger than the wavelength of light waves. |
| Name the three primary colours of light. | red, green and blue |
| What is a semiconductor? | material whose resistivity lies between that of an insulator and a conductor |
| Name the three forms of nuclear radiation. | Alpha, beta, gamma |

**2019 Higher Level**

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| A crane moves a load of weight 7000 N to the  top of a  roof which is 4 m high. The crane takes 20 seconds to do this work.   Calculate this distance in metres. | *s* = *vt*  *s* = (3.00 × 108)(3.15 × 107)  s = 9.45 × 1015 m |
| An apple has a weight of 1 N and its volume is 121 cm3.  Calculate the density of the apple.  (acceleration due to gravity = 9.8 m s–2) | *W* = *mg m* = 0.102 kg  There are 1 × 106 cm3 in 1 m3  Therefore 121 cm3 = 121 × 10-6 m3    = 843 kg-3 |
| A book is decelerating as it moves to the right on a horizontal table. Draw a labelled diagram to show the forces acting on the book as it moves on the table. |  |
| What is meant by polarisation of light? | The wave is vibrating in one plane only |
| What is the thermometric property of  (i) a mercury thermometer, (ii) a thermocouple? | (i) length/height/volume  (ii) emf/voltage |
| Sketch a graph to show the relationship between resistance *R* and temperature *T* (in °C) for a metallic conductor. |  |
| Power *P* is generated in a resistor of resistance *R* when a potential difference *V* is applied across it.  Write *P* in terms of *R* and *V*. | *P = VI*  Now we use *I = V/R* *P = V2/R* |
| Polonium was discovered by Marie and Pierre Curie in 1898. Polonium–218 has a half‐life of 3 minutes.  Calculate the activity of a sample of polonium–218 that contains 75000 nuclei. | λ = 0.00385 s-1  A = = (0.00385)(75000) = 289 Bq |
| Polonium–218 is produced as the daughter nucleus in the alpha‐decay of radon–222.   Write a nuclear equation for this reaction. |  |
| Neutrinos are sometimes called ghost particles. Why are they very hard to detect? | very small mass  no charge |

2018 **[Ordinary Level]**

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| State Newton’s first law of motion. | A body will remain at rest or moving at a constant velocity unless an external force acts on it. |
| Diagram  Description automatically generatedCalculate the refractive index of the glass block shown in the diagram. | = 1.52 |
| Choose from the list below the instrument used to measure (i) energy and (ii) resistance. barometer joulemeter lens ohmmeter | Energy: joulemeter  Resistance: ohmmeter |
| State one use for a semiconductor diode. | rectifier, LED, switches, p.s.u., |
| State one use for the instrument shown. | measure angles/ measure wavelength of light /  demonstrate interference / demonstrate diffraction /  demonstrate spectra / demonstrate monochromatic light |
| Define capacitance. | Capacitance is the ratio of charge to potential |
| State two characteristics of a musical note. | Amplitude, frequency, overtone, timbre/quality |
| Sketch the magnetic field around a bar magnet. |  |
| Name two sources of ionising radiation. | sun, cosmic, named radioactive element, nuclear weapons, nuclear power plants, etc. |
| State one application of the photoelectric effect. | Solar panels, burglar alarms, automatic doors, control of burners in central heating, soundtrack in films, etc. |

**2018 Higher Level**

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| Draw a labelled diagram to show the forces acting on a skydiver falling with a constant velocity. | Note that for questions such as this one the marking scheme requires that you make the arrows of equal length to reflect that they are equal in size. |
| A picture containing shape  Description automatically generated  A horizontal metre stick is in equilibrium when a weight of 8 N hangs from the 10 cm mark, a weight of 12 N hangs from the 60 cm mark and an unknown weight (X) hangs from the 82 cm mark. The metre stick is supported at its centre of gravity, 50 cm. Calculate X. | Moment of force anticlockwise = (8)(40)  Moment of force clockwise = (12)(10) + (X)(32)  (8)(40) = (12)(10) + (X)(32)  X = 6.25 N m |
| Distinguish between the three methods of heat transfer. | Conduction: no net movement of medium  Convection: circulation of a fluid  Radiation: electromagnetic / photons / through a vacuum |
| A fire‐engine travelling at a speed of 30 m s–1 emits a sound of frequency 2.3 kHz as it approaches an observer. Calculate the frequency observed.  (speed of sound in air = 340 m s–1) | *c* = 340 m s–1  *u* = 30 m s–1  *f* = 2.3 kHz = 2300 Hz  = 2523 Hz |
| The refractive index of a material is 2.4. Calculate the speed of light in this material. | Refractive index =  2.4 =  *Speed of light in medium*  = 1.25 × 108 m s-1 |
| Explain how electrons are  (i) produced,  (ii) accelerated in an X‐ray tube. | They are produced as a result of thermionic emission (at cathode)  They are accelerated via a high voltage |
| Write an expression for the electric field intensity E at a distance *d* from a charge Q. | E = |
| What are the charge carriers in (i) metals, (ii) gases, (iii) semiconductors? | metals: electrons  gases: ions and electrons  semiconductors: electrons and holes |
| Calculate the effective resistance of a 5 Ω resistor and a 7 Ω resistor when they are connected in parallel. | R = 2.9 Ω |
| State (i) a physical quantity that is the same for a quark and its anti‐quark and (ii) a physical quantity that is different for a quark and its anti‐quark. | same: mass and the magnitude of charge different: (sign of) charge |

2017 **[Ordinary Level]**

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| Name an example of (*i*) a vector quantity and (*ii*) a scalar quantity. | Vector: force, velocity, displacement Scalar: mass, speed, distance |
| A door handle is used to open a door. Calculate the moment of the force applied in the diagram. | Moment of a force = Fd  = 40 × 0.12  = 4.8 N m |
| Choose from the list below the instrument used to measure (*i*) electrical current and (*ii*) length.  ammeter protractor metre stick barometer | Answer: ammeter and metre stick |
| Conduction is one method of heat transfer.  Name the other two methods. | convection, radiation |
| Name the instrument shown. | micrometer /screw gauge |
| State one common use for a convex lens. | magnification, (eye) glasses, binoculars, contact lenses, camera, etc. |
| Resonance can cause a wine glass to shatter. What is resonance? | transfer of energy between bodies at the same frequency // at natural frequency |
| Name one source of voltage. | cell, battery, power supply,(charged) capacitor, etc. |
| What sub-atomic particle is released by the photoelectric effect? | electron |
| Name one method of detecting radiation. | Geiger-Muller tube, Geiger counter, solid state detector, cloud chamber, bubble chamber, GLE, photographic film, radiometer, |

**2017 [Higher Level]**

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| --- | --- |
| State Boyle’s law. | For a fixed mass of gas at constant temperature pressure is inversely proportional to volume |
| Sphere A of mass 400 g is travelling horizontally with a speed of 6 m s–1 when it collides with sphere B of mass 150 g travelling in the opposite direction with a speed of 9 m s–1.  Sphere A comes to rest as a result of the collision.  Calculate the new velocity of sphere B. | m1u1 + m2u2 = m1v1 + m2v2  (0.4)(6) + (0.15)(-9) = (0.4)(0) + (0.15)(v)  *v* = 7 m s-1 |
| What is the thermometric property (*i*) of a thermocouple and (*ii*) of a mercury thermometer? | *i*) emf (*ii*) length/volume |
| The diffraction effects of sound waves are noticeable in everyday life, whereas the diffraction effects of light waves are not. Explain why. | Sound has a long wavelength / light has a short wavelength |
| Explain how point discharge occurs. | Charge accumulates at a point  Like charges are repelled / unlike charges are attracted  Air is ionised around the point |
| What is the electric field strength 53 pm from a proton? | A *pm* (‘picometer’)= 1 m      N C-1 |
| What is meant by sound intensity? | Sound intensity = power per unit area |
| A certain RCD has a rating of 30 mA. What is the significance of this number? | Current is cut off if the difference between live and neutral currents is greater than 30 mA |
| What is the function of the moderator in a fission reactor? | Slows down neutrons / increase fission |
| Explain why the gravitational force can be ignored for sub-atomic particles. | Masses are very small / force is proportional to mass /gravitational force is the weakest |

2016 **[Ordinary Level]**

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| State the principle of Archimedes. | When a body is immersed in a liquid the upthrust is equal to the weight of the displaced liquid |
| A tractor applies a force of 500 N to pull a trailer a distance of 3 km.  Calculate the work done by the tractor. | Work = force × displacement  W = Fs = 500 × 3000 = 1.5 × 106 J |
| Choose from the list below the instrument used to measure (i) pressure, and (ii) energy.  opisometer, barometer, hydrometer, joulemeter | (*i*) barometer  (*ii*) joulemeter |
| State two uses for a concave mirror. | Headlights, makeup, shaving mirrors, etc. |
| Conduction is one method of heat transfer. Name the other two methods. | Convection, radiation |
| What is the function of a lightning conductor? | To earth / protect building |
| There are 150 turns in the primary coil of a transformer and 3000 turns in the secondary coil.  Calculate the output voltage when 12 V a.c. is connected across the primary coil. | *Vs* = voltage across the secondary coil,  *Vp* = voltage across the primary coil  *Ns* = Number of turns in secondary,  *Np* = Number of turns in primary coil |
| State one common use of the electroscope. | Test for charge, identify charge, measure potential etc. |
| What is the photoelectric effect? | Emission of electrons from the surface of a metal when electromagnetic radiation of the correct frequency is incident on it. |
| What are alpha-particles? | Helium nucleus / two protons and two neutrons |



**2016 [Higher Level]**

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| A cyclist’s average power output when climbing a mountain is 280 W.  He completes the climb in 18 minutes. How much energy does he use? | work (or energy) = (power)(time)  = (280)(18)(60) = 302400 J |
| A sprinter starts from rest and accelerates uniformly for 3 secs until she reaches a velocity of 10 m s–1.  She then runs at a constant velocity for 6 seconds before decelerating.  Sketch a velocity-time graph of her motion. |  |
| The diagram shows a light ray incident on the interface between glass and air.    Sketch (*i*) the refracted ray, (*ii*) the weak reflected ray. The critical angle of the glass is 42°. | *I was very surprised to see any reference to a weak reflected ray here – it’s not a concept that would normally be on a second level textbook (but it probably should be).*  *Secondly, the fact that there is light at the interface travelling in the fashion shown in the second diagram is something that you see in most textbooks but is a common misconception – so it’s just plain wrong to give this answer. The explanation is a wonderful story invoking probability and quantum physics but this is probably not the place or the time.*  *Bottom line is that we have to play the game so see diagram for answer:* |
| What is meant by the polarisation of a wave? | A wave is polarised if it is vibrating in one plane only. |
| The ear canal acts as a cylindrical pipe closed at one end.  It is of average length 2.3 cm. The speed of sound in air is 340 m s–1.  What is the fundamental frequency of the ear canal? | c = fλ λ = 4*l* = (4)(.023)  λ = 0.092 m = 3696 Hz |
| State and define the SI unit of capacitance. | The farad.  One farad is equivalent to one couloumb per volt |
| Why is it more economical to transmit electrical energy at high-voltage? | Low current so less heat lost |
| When does the photoelectric effect occur? | When a photon/light/em radiation strikes a surface with a suitable frequency/energy |
| What is the value of 1.92 K in degrees Celsius (°C)? | °C = temp in kelvin - 273.15  1.92 - 273.15 = – 271.23 °C  *Note that you would have lost 1 mark here if you used 273 instead of 273.15* |
| What terms are used for hadrons that consist of (i) two quarks, (ii) three quarks? | (i) Mesons (ii) Baryons |

2015 **[Ordinary Level]**

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| State Newton’s law of universal gravitation. | Any two point masses in the universe attract each other with a force that is directly proportional to the product of their masses, and inversely proportional to the square of the distance between them. |
| A small stone is thrown straight up from the ground with an initial speed of 20 m s−1. Calculate the height it has reached after two seconds. | *s* = *ut* + ½ *at*2 *s* = *(20)(2)* - ½ *(9.8)(2)*2 *s* = 20.4 m |
| From the list below, identify  (*i*) the scientist associated with the law of refraction of light and  (*ii*) the scientist associated with the laws of electromagnetic induction.  Faraday Snell Joule Archimedes | (i) Snell   (ii) Faraday |
| A glass block has a critical angle of 42°.  Calculate the refractive index of the glass used in the block. | n = 1/Sin C = 1.49 ± 0.05 |
| Calculate the effective resistance of the resistors shown in this circuit diagram. | RT = 4 Ω |
| State Boyle’s law. | For a fixed mass of gas kept at a constant temperature the pressure is inversely proportional to the volume. |
| State one use of the device shown on the right. | Investigating static electricity // create high voltage // stores charge |
| Name an electronic component that has a p-n junction. | Diode // transistor // LED etc. |
| What is the purpose of a transformer in a mobile phone charger? | Changes the voltage |
| What is meant by the *half-life* of a radioactive substance? | Time taken for the activity to reduce by half OR  Time taken for half of the substance to undergo radioactive decay. |

**2015 [Higher Level]**

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| A hurler strikes a sliotar with an initial velocity of 41 m s–1 at an angle of 30° to the horizontal. How far does the ball travel horizontally in three seconds? | First we need to work out how fast the ball is travelling in the horizontal direction.  So we need to calculate the horizontal component of the initial velocity:  vHorizontal = 41Cos300 = 35.51 m s–1  Then use s = (velocity)(time)  s = (35.51)(3) = 106.52 m |
| Describe the movement of a particle that is undergoing simple harmonic motion. | An object is said to be moving with simple harmonic motion if; its acceleration is directly proportional to its displacement *from* a fixed point in its path, and its acceleration is directed *towards* that point. |
| The refractive index of haematite is 3.2. What is its critical angle? | n = 3.2  sin C = 0.3125 C =  *C* = 18.21° |
| What frequency would be detected by an observer when a source emitting a sound of frequency 512 Hz approaches at a velocity of 28 m s–1?  Speed of sound in air = 340 m s–1 | *f* = 512 Hz  *u* = 28 m s–1  *c* = 340 m s–1  = 557.95 Hz |
| Calculate the energy from the Sun falling on a football pitch of dimensions 106 m × 68 m in 90 minutes.  Solar constant = 1.36 kW m–2 | Time in seconds = 90 × 60 = 5400 s  Area =106 × 68 = 7208 m2  1.36 kW = 1360 joules per sec  1.36 kW m–2means that 1360 joules of energy fall each *second* on *one* *square metre*.  So total energy falling = (1360)(5400)(7208) joules *=* 5.3 × 1010 J |
| Write an expression for the charge stored on one plate of a parallel plate capacitor in terms of the potential difference between the plates, their common area, the distance between them and the permittivity of the dielectric. | *and* |
| Define the ampere, the SI unit of current | The ampere is that unit of current which, if flowing in two parallel conductors placed one metre apart in a vacuum, will cause a force of 2 × 10–7 N m−1 to be exerted on each conductor. |
| Name the wire that contains the fuse in a three-pin plug. What colour is this wire? | Live. The colour is brown. |
| The first artificial transmutation of an atom was achieved by Rutherford in 1919.  An alpha-particle collided with a nitrogen–14 nucleus to create an isotope of oxygen and a proton. Write a nuclear equation for this transmutation. |  |
| Give the quark composition of  (*i*) the proton and (*ii*) the anti-neutron. | 1. up, up, down 2. anti-up, anti-down, anti-down |

2014 **[Ordinary Level]**

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| A crane, powered by an electric motor, has a bucket that weighs 540 N when empty.  The crane uses the bucket to lift 800 N of concrete up 75 m on a building site. Calculate the work done by the crane’s motor. | W = F.s = (540 + 800)(75) = 1.005 × 105 N m |
| Which of the following are vector quantities and which are scalar quantities?  mass force time velocity | Vectors: force, velocity Scalars: mass, time |
| Which of the following is used in the flash of a camera? | capacitor |
| What is the Doppler effect? | Apparent change in wave frequency due to relative motion between the wave source and the observer |
| Name the lens shown and give an application of it. | convex / converging lens  used as a magnifying glass/(eye) glasses /binoculars/camera/etc. |
| What is meant by the *U*-value of a material? | 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 |
| Name the component with the symbol shown in the diagram. | light dependent resistor / LDR |
| Name a piece of laboratory equipment used to separate white light into its colours. | (glass) prism // (diffraction) grating |
| How are X-rays produced? | Produced when high speed electrons hit a metal target |
| In the Sun, a mass of 4 × 109 kg is converted into energy every second. Calculate the energy released each second.  (speed of light, c = 3 × 108 m s−1) | *E = m* c2 = (4× 109)(3 × 108)2 = 3.6 × 1026 J |

**2014 [Higher Level]**

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| State Boyle’s law. | Pressure and volume inversely proportional for a fixed mass of gas at constant temperature |
| The Martian moon Phobos travels in a circular orbit of radius 9.4 × 106 m around Mars with a period of 7.6 hours.  Calculate the mass of Mars. | T = 7.6 hours = (7.6)(60)(60) seconds  *r* = 9.4 × 106 m      M = 6.538 × 1023 kg |
| On what thermometric properties are the following based: (i) the thermocouple thermometer and  (ii) the mercury-in-glass thermometer? | (i) emf  (ii) length/height/volume |
| The *U*-value of the material in a double-glazed window in a house is 2.8 W m–2 K–1.  The window has an area of 3.0 m2. How much energy is lost through the window in one hour if the temperature inside the house is 20 °C and the outside temperature is 11 °C? | *{The clue is in the unit. The U-value is 2.8 W m–2 K–1. That means 2.8 Joules are lost every second per square meter for every one degree of a temperature difference.*  *We are interested in the heat lost through 3 m2, over a period of one hour when the temperature difference is 9°.}*  So total heat lost = 2.8 × 60 × 60 × 3 × 9  = 272160 J |
| List a pair of complementary colours of light. | red and cyan / green and magenta / blue and yellow |
| What are the charge carriers in (*i*) semiconductors and (*ii*) metals? | (i) electrons and holes; (ii) electrons |
| What do the letters in the acronyms (*i*) RCD and (*ii*) MCB stand for? | residual current device; miniature circuit breaker |
| The work function of tungsten is 4.50 eV. Calculate the maximum kinetic energy of an electron ejected from a tungsten surface when electromagnetic radiation whose photon energy is 5.85 eV shines on the surface. | Energy of incident photon = Work function + kinetic energy of electron  5.85 eV = 4.50 eV + kinetic energy of electron  Kinetic energy of electron = 1.35 eV  1 eV = 1.6 × 10−19 J  So 1.35 eV = (1.35)( 1.6 × 10−19) = 2.16 × 10−19 J |
| Describe Rutherford’s model of the atom. | mostly empty space / dense core / positive core / electron cloud *(any two)* |
| Give two reasons why the Cockcroft and Walton experiment was significant to the understanding of particle physics | First experimental verification of E = mc2 / first transmutation using artificially accelerated particles / first artificial splitting of a nucleus / development of linear accelerator |

2013 **[Ordinary Level]**

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| Give an example of (i) a vector quantity, (ii) a scalar quantity. | Vector: Velocity, acceleration, force etc  Scalar: Time, mass, speed etc |
| The spanner shown in the diagram is used to turn a nut.  Calculate the moment of the force applied by the spanner to the nut. | 50 × 0.1 = 5 N m |
| Which of the following scientists is associated with the discovery of the structure of the atom?  Einstein Rutherford Faraday Coulomb | Rutherford |
| What is meant by the threshold of hearing? | The threshold of hearing is the smallest sound intensity detectable by the average human ear at a frequency of one thousand hertz. |
| How does light travel through an optical fibre? | By total internal reflection |
| Give a common use for a convex lens. | Magnification, (eye) glasses, binoculars, contact lenses, camera, etc. |
| What colour is the wire that is connected to the fuse in a standard three-pin plug? | Brown |
| Give a common use for a capacitor. | Store charge / conducts a.c. /(radio) tuning / filtering / smoothing / timing / store energy / flash camera / phone charger, etc. |
| What is the photoelectric effect? | The photoelectric effect is the emission of electrons from a metal due to electromagnetic radiation of a suitable frequency falling upon it. |
| Name one method for detecting radioactive particles. | Geiger-Muller tube, Geiger counter, solid state detector, cloud chamber, bubble chamber, GLE, photographic film, radioactive sensor, etc. |

**2013 [Higher Level]**

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| What is the shortest stopping time for a car which is travelling at 16 m s−1 and has a maximum deceleration of 2.5 m s−2? | *v* = *u* + *at*. 0 = 16 – 2.5*t*  *t* = 6.4 secs |
| State the law of conservation of momentum. | The principle of conservation of momentum states that in any collision between two objects, the total momentum before impact equals total momentum after impact, *provided no external forces act on the system*. |
| Explain why heat does *not* travel through solids by means of convection. | The particles cannot move freely |
| Storage heaters are frequently used to heat buildings. State the principle that underlies the operation of an electrical storage heater. | Storage heaters are heated when electricity is inexpensive (off peak). They have a large heat capacity which means that they can absorb a of heat energy with only a small increase in temperature. This means that they release the heat slowly the following day. |
| If a diamond has a refractive index of 2.42, what is the speed of light in the diamond? | Speed of light in diamond = 1.24 × 108 m s-1 |
| Define the volt | The potential difference between two points is one volt if 1 joule of work is needed to move 1 coulomb of charge from one point to the other |
| A positively-charged rod is brought near to a neutral, conducting sphere that is on top of an insulating stand, as shown in the diagram. How would a student charge the sphere negatively by induction? | Earth the sphere  remove the earth connection and then  remove the rod. |
| Explain what is meant by the statement: “Zinc has a threshold frequency of 1.04 × 1015 Hz”. | Below this frequency electromagnetic radiation /photons will not cause emission of electrons from the surface of the zinc because the photons have insufficient energy. |
| Give one benefit of switching from fossil fuels to nuclear power for the generation of electricity.  Explain your answer. | No carbon dioxide is produced in nuclear power generation |
| Give an expression for the minimum frequency of a photon that can form an electron and a positron by pair production. | but an electron and a positron have the same mass.  *hf* = 2*mc*2 |

2012 **[Ordinary Level]**

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| A tow-truck pulls a car with a net horizontal force of 500 N.  Calculate the work done in towing the car a distance of 2 km to a garage. | *W = Fs* = (500)(2000) =106 J |
| Give one factor on which the potential energy of a body depends. | mass, acceleration due to gravity, height |
| Which one of the following instruments is used to measure atmospheric pressure?  hydrometer barometer thermometer joulemeter | Answer: barometer |
| The Tacoma Narrows Bridge collapsed, soon after construction, due to resonance.  What is resonance? | Resonance is the transfer of energy which results in an object vibrating at its natural frequency. |
| A building has a low U-value. What is the advantage of this? | Low energy loss |
| Why is a lightning conductor made of copper? | Good conductor and doesn’t corrode |
| Why does a magnet that is free to rotate point north? | Because of the earth’s magnetic field. |
| What is the principle of operation of a transformer? | A change in magnetic flux induces an emf. |
| The photo shows an LDR.  Draw the electrical circuit symbol for an LDR. | See diagram |
| What is the main source of energy in the sun? | Nuclear fusion (or hydrogen) |

**2012 [Higher Level]**

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| Cork and Sligo are about 330 km apart by road.  Using the map of Ireland shown on page 4, estimate the displacement of Sligo from Cork.  The scale of the map is 1 cm to 37.5 km. {or at least it was before I reduced it} | *This was a bizarre question in that the student had to use a ruler to measure the straight line distance between Sligo and Cork.*  This distance = 7.7 cm. Now we need to multiply this by 37.5  Displacement = (7.7)(37.5) = 288.75 km  *Note that displacement should also include a reference to direction;* Sligo is approximately due north of Cork. |
| A pendulum moves with simple harmonic motion.  Give another example of a body that moves with simple harmonic motion. | A mass oscillating on a spring, a vibrating tuning fork |
| The European aerospace group EADS is developing a hypersonic jet aircraft that will fly at four times the speed of sound, 330 m s-1.  Express the speed of the aircraft in kilometres per hour. | First convert *m* to *km* and then convert *seconds* to *hours*.  Before we do that we first need to calculate the actual speed of the aircraft: 4×330 = 1320 m s-1  Now to convert from *m* to *km* divide by 1000: 1320 m s-1 = 1.320 km s-1  To convert from *kilometres per second* to *kilometres per* *hour* multiply by (60)(60) or 3600:  1.320×3600 = 4752 km h–1 |
| What is the focal length of a lens which has a power of -2 m-1? | = = – 0.50 m = –50 cm  *Strictly speaking we didn’t need to include the ‘minus’ sign; it merely signifies that it is a diverging or concave lens.* |
| List three conditions necessary for an observer to see a rainbow. | Observer’s back to sun / (bright) sunlight /(suspended) droplets of water /proper angle of viewing, etc.  *A bit bizarre to look for three conditions. I could only get two * |
| How is energy transferred from the sun to the earth? | (by means of) radiation / photons / electromagnetic waves |
| A person smokes a cigarette at the entrance to a building. Explain how a significant amount of the smoke from the cigarette can enter the building. | *See my comment to part (e).*  (reference to) convection currents / diffusion / wind assisted / pressure variations, etc. |
| Sketch the magnetic field due to a current in a solenoid. | Uniform field inside solenoid / divergent field outside |
| It takes 30 minutes for a 100 g sample of a radioactive isotope to decay to 12.5 g.  What is the half-life of the radioisotope? | It takes one half-life to go from 100 g to 50 g,  another half-life to go from 50 g to 25 g  and another half-life to go from 25 g to 12.5 g.  So 30 mins corresponds to 3 half-lives.  Therefore one half-life = 10 mins = 600 seconds |
| Which Irish physicist is associated with the development of the linear accelerator? | Walton |

2011 **[Ordinary Level]**

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| --- | --- |
| What is friction? | Friction is a force which opposes the relative motion between two obects. |
| What is the relationship between *G*, the gravitational constant and *g*, the acceleration due to gravity? |  |
| A crowbar is an example of a lever.  Give another example of a lever. | door handle, scissors, wheelbarrow, tongs etc |
| Which of the following terms is associated with a wave motion?  half-life interference induction doping | Interference |
| Name the three ways by which heat can travel from one place to another | conduction, convection, radiation |
| Give two uses of a concave mirror | headlights, makeup, shaving mirrors, etc |
| What is the colour of the earth cable in a standard 3-pin plug? | yellow & green |
| How does a miniature circuit breaker (MCB) improve safety in a domestic circuit? | It breaks the circuit when the current gets too high. |
| Give a use for an electroscope. | Test for charge, identify charge, measure potential |
| Give a disadvantage of a named renewable source of energy. | biomass/ tide /sun / wind is not always there |

**2011 [Higher Level]**

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| A car of mass 1500 kg is travelling at a constant velocity of 20 m s–1. What force is required to stop it in a distance of 50 m? | *We will need to use F = ma, but before we do that we first need to work out the acceleration.*  *v2 = u2 + 2as*  0 = (20)2 + 2(a)(50)  *a* = - 4 m s-2  *F = ma*  *F* = 1500a  *F* = - 6000 N  *The negative sign indicates that the force is in the opposite direction to the initial velocity of the car.* |
| Why does the value of *g*, the acceleration due to gravity, vary at different locations on the surface on the earth? | Locations are at different distances from the earth’s centre / earth is not perfectly spherical / earth is not of uniform density etc. |
| Why is a convex mirror used, instead of a plane mirror, as a door mirror on a car? | A convex mirror offers a wider field of view |
| What causes the Doppler effect? | The Doppler Effectis the apparent change in the frequency of a wave due to the relative motion between the source of the wave and the observer. |
| The capacitance of a parallel plate air capacitor is 5 pF.  If the plates of the capacitor are 2 cm apart, what is the common area of the plates?  Take εair = ε0. | A = 0.0113 m2 |
| A residual current device (RCD) is rated at 30 mA.  Explain the significance of this rating. | RCD trips if more than 30 mA flows to earth (if the current difference between *L* and *N* is greater than 30 mA) |
| The physicist Robert Millikan is usually associated with what physical quantity? | The charge on an electron |
| What property of light controls the current in a photocell? | light intensity/ brightness |
| What is the role of neutrons in a nuclear reactor? | To cause (nuclear) fission / to initiate reaction |
| Give the difference between the quark composition of a baryon and of a meson. | Baryon: 3 quarks  Meson: quark and antiquark |

2010 **[Ordinary Level]**

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| --- | --- |
| State Boyle’s law | For a fixed mass of gas kept at a constant temperature) the pressure is inversely proportional to the volume |
| A concrete mixer delivered 50 m3 of concrete to a building site, what was the mass of the concrete delivered?  (density of concrete = 2400 kg m−3) | Density = mass/volume  mass = density × volume  mass = 2400 × 50  = 120000 kg |
| State Archimedes’ Principle | When a body is immersed in a fluid/liquid it experiences an upthrust equal in size to the weight of the fluid displaced. |
| Which of these scientists is associated with the law of refraction of light?  Rutherford Snell Joule Einstein | Snell |
| If the temperature of an object is 28 0C, what is its temperature in Kelvin? | 273.15 + 28 = 301.15 K |
| Give one difference between a light wave and a sound wave | Light waves travel faster than sound waves, light travels in transverse waves, sound in longitudinal waves |
| Sketch the magnetic field surrounding a bar magnet |  |
| Give a common use of capacitors? | Store charge, tune radio, flash guns, smoothing, filtering. |
| In relation to semiconductors, what is meant by the term doping? | Doping is the addition of a small amount of atoms of another element to a pure semiconductor to increase its conductivity. |
| What type of nuclear reaction occurs in a nuclear power station? | Fission. |

**2010 [Higher Level]**

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| --- | --- |
| What are the two conditions for the equilibrium of a set of co-planar forces? | Forces up = forces down // (algebraic) sum of forces acting is zero  (Algebraic) sum of the moments (of the forces about any point) is zero |
| What is the critical angle of a sample of glass whose refractive index is 1.46? | C = C = 43.2o |
| Name the parts labelled A and B of the spectrometer shown in the diagram. | A = (turn)table, B = telescope |
| Explain why snow is slow to melt as the day-time temperatures rises above 0 °C. | Latent heat of snow/ice (energy needed for change of state) is (very) large |
| What is the positive charge stored on a 5 μF capacitor when connected to 120 V d.c. supply? | Q = CV  Q= (5 × 10–6)(120)  Q = 6.0 × 10–4 C |
| Which of the following devices is adjusted when tuning into a radio station?  Transformer, diode, capacitor, rheostat | Capacitor |
| State Faraday’s law of electromagnetic induction. | Faraday’s Law states that the size of the induced emf is proportional to the rate of change of flux. |
| The peak voltage of an a.c. supply is 300 V. Calculate its rms voltage. | Vrms = = = 212 V |
| Name the naturally occurring radioactive gas which seeps into buildings from underground rocks and which can cause lung cancer. | Radon (gas) |
| Give two advantages of a circular accelerator over a linear accelerator. | Smaller (less space) // greater speeds/energy |

2009 **[Ordinary Level]**

|  |  |
| --- | --- |
| State the principle of conservation of momentum. | The principle of conservation of momentum states that in any collision between two objects, the total momentum before impact equals total momentum after impact, *provided no external forces act on the system*. |
| A man opens a door by applying a force of 5 N to the door.  The distance from the point of application of the force to the fulcrum is 120 cm.  Calculate the moment of the applied force. | M = 5 × 1.2 = 6 N m |
| Which of the following is the unit of energy; kilogram, watt, joule, ampere? | The joule |
| Calculate the wavelength of a radio wave whose frequency is 252 kHz.  Speed of a radio wave = 3.0 × 108 m s−1. | *f* = 252 kHz = 252000 Hz  *c* = 3.0 × 108 m s−1  ***c = f λ***  λ = 1190.48m |
| Draw a diagram to show the path of a ray of light travelling through an optical fibre. |  |
| Name the property on which the pitch of a musical note depends. | Frequency |
| Name the instrument shown in the diagram. | A gold leaf electroscope |
| What are isotopes? | Atoms which have the same atomic number but different mass number. |
| Give one application of the photoelectric effect. | Burglar alarms, automatic doors, control of burners in central heating, sound track in films, etc |
| List two properties of X-rays. | Electromagnetic waves, have short wavelength, cause ionisation , penetrate materials, no mass, no charge, effect photographic film, etc. |

**2009 [Higher Level]**

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| --- | --- |
| State Boyle’s law. | For a fixed mass of gas at constant temperature, pressure is inversely proportional to volume. |
| The moon orbits the earth.  What is the relationship between the period of the moon and the radius of its orbit? | The period squared is proportional to the radius cubed |
| Why is it necessary to have a standard thermometer? | Different types of thermometer have different thermometric properties which can cause them to give slightly different readings for the same temperature. |
| 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? | If sound intensity doubles  sound intensity *level* increases by 3 dB. When the sound intensity level increased from 85 to 88 dB, it meant that the sound intensity doubled (or was multiplied by 2).  When the sound intensity level increased from 88 to 91 dB, it meant that the sound intensity doubled again (or was multiplied by 2).  When the sound intensity level increased from 91 to 94 dB, it meant that the sound intensity doubled again (or was multiplied by 2).  So sound intensitynew = sound intensityold ×2×2×2  So if the original *sound intensity* *level* has increased by 9 dB then the *sound intensity* must have increased by a factor of 8. |
| Draw a ray diagram to show the formation of an image in a convex mirror. |  |
| Define electric field strength. | Electric field strength is defined as force per unit charge. |
| When will an RCD (residual current device) disconnect a circuit? | When the magnitude of the current flowing in is different from that flowing out. |
| What is the average emf induced in a coil of 20 turns when the magnetic flux cutting it decreases from 2.3 Wb to 1.4 Wb in 0.4 s? | Induced emf =  =  = 45 V  (we can ignore the ‘minus’ sign). |
| How are X-rays produced? | 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. |
| Arrange the fundamental forces of nature in increasing order of strength. | Gravitational, weak, electromagnetic, strong. |

2008 **[Ordinary Level]**

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| State the principle of conservation of momentum. | The principle of conservation of momentum states that in any collision between two objects, the total momentum before impact equals total momentum after impact, *provided no external forces act on the system.* |
| A solid block in the shape of a cube of length 120 cm rests on a table.  The weight of the block is 25 N.  Calculate the pressure it exerts on the table. | P = F/A P = 25 ÷ (1.2)2 P = 17.4 pa |
| Which of the following is the unit of energy?  Kelvin watt newton joule | The joule |
| What physical quantity is measured in decibels? | Sound intensity |
| A concave lens has a power of 0.1 cm−1.  What is the focal length of the lens? | 1. cm |
| Give one effect of static electricity? | Lightning, static discharge, receive shock after walking across carpets, attracts objects, can damage electronics. |
| Give two uses for the instrument shown. | It can function as a voltmeter, ammeter, ohmmeter or thermometer. |
| What is the colour of the live wire in an electric cable? | Brown |
| State two properties of X-rays. | Electromagnetic waves, have short wavelength, cause ionisation, penetrate materials, no mass and no charge. |
| What is nuclear fusion? | Nuclear fusion is the combining of two small nuclei to form one large nucleus with the release of energy. |

**2008 [Higher Level]**

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| State the law of flotation. | When a body floats in a liquid its weight is equals the weight of fluid displaced. |
| The head of a thumbtack has an area of 500 mm2.  Its point has an area of 0.3 mm2. The pressure exerted at the head of the thumbtack is 12 Pa.  What is the pressure exerted at the point of the thumbtack? | Note there are one million (1000 × 1000) mm2 in a m2.  So 1 mm2 = 1 × 10-6 m2.  The key to this question is the fact that while *the pressure* changes (as a result of the area over which the force is exerted changing), *the force* itself is constant.    Force = (Pressure)(Area)  At the head: F = Pressure × Area  F = (12)(500 × 10-6)  F = 6.0 × 10-3 N  At the point:  = = 2.0 × 104 Pa |
| What is the relationship between the frequency of a vibrating stretched string and its length? | Frequency is proportional to |
| Why does diffraction not occur when light passes through a window? | For diffraction to occur the slit width needs to be approximately the same as the wavelength of the wave, and a window is too wide (relative to wavelength of light). |
| Why is a fluorescent tube an efficient source of light? | Most of the (electrical) energy is converted to light (energy) |
| What is the force exerted on an electron when it is in an electric field of strength 5 N C–1? | F = EQ   F = (5)(1.6 × 10–19)  F = 8.0 × 10–19 N |
| What are the charge carriers when an electric current  (i) passes through a semiconductor? (ii) passes through an electrolyte? | (i) electrons and (positive) holes  (ii) ions |
| Give two ways of deflecting a beam of electrons. | By means of an electric field and a magnetic field. |
| Name an instrument used to detect radioactivity.  What is the principle of operation of this instrument? | A Geiger-Muller tube. Ionisation. |
| The existence of the neutrino was proposed in 1930 but it was not detected until 1956. Give two reasons why it is difficult to detect a neutrino. | No charge and very small mass. |

2007 **[Ordinary Level]**

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| State Newton’s second law of motion. | The rate of change of momentum is directly proportional to the applied force. |
| Which of the following is not a renewable source of energy:  Wind nuclear solar hydroelectric | Nuclear |
| The temperature of a body is 34 °C. What is its temperature in kelvin? | 273.15 + 34 = 307.15 K |
| Name two methods by which heat can be transferred. | Conduction, convection, radiation. |
| The diagram shows parallel rays of light approaching a concave mirror.  Copy the diagram and show the paths of the rays after they strike the mirror. |  |
| Give one application of the Doppler effect. | Red shift of stars / speed detection. |
| Name two safety devices that are used in domestic electric circuits. | Fuse, (trip) switch, miniature circuit breaker / MCB, residual current device / RCD, earthing,bonding, etc. |
| Name the electrical component represented in the diagram. | LDR / light dependant resistor |
| Draw a sketch of the magnetic field around a bar magnet. |  |
| The half life of a radioactive element is 3 days.  What fraction of a sample of the radioactive element will remain after 9 days? | After 3 days (one half-life) ½ would remain  after 6 days (two half –lives) ¼ would remain  after 9 days (three half-lives) ⅛ would remain. |

**2007 [Higher Level]**

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| State Archimedes’ principle. | When an object is immersed in a fluid, the upthrust it experiences is equal to the weight of the displaced fluid. |
| Why is a filament light bulb not an efficient source of light? | Almost all of the energy is given off as heat. |
| Why does the temperature of an athlete reduce when she perspires? | As the water evaporates it changes state. As a result it takes a lot of heat energy (from the body). |
| How is infra-red radiation detected? | Temperature sensor / photographic film. |
| The refractive index of a liquid is 1.35, what is the critical angle of the liquid? |  C = 47.80 |
| Calculate the energy stored in a 5 μF capacitor when a potential difference of 20 V is applied to it. | E = ½ CV2  = ½ (5 x 10-6)(20)2  = 1.0 x 10-3 J |
| Why does a magnet that is free to rotate point towards the North? | The north end of a magnet points towards the north because it is actually pointing towards a south pole of the earth’s magnetic field. |
| State the principle on which the definition of the ampere is based. | A current-carrying conductor in a magnetic field experiences a force. |
| How are electrons accelerated in a cathode ray tube? | By a large potential difference. |
| A kaon consists of a strange quark and an up anti-quark. What type of hadron is a kaon? | It is a meson. |

2006 **[Ordinary Level]**

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| A person pushed a car a distance of 15 m with a force of 500 N. Calculate the work done by the person. | Work = Force × distance = 500 × 15 = 7,500 J. |
| Which one of the following instruments can be used to measured the density of a liquid?  barometer hydrometer thermometer | hydrometer |
| What is friction? | Friction is a force which opposes the relative motion between two objects. |
| Give one example of a thermometric property. | Resistance / emf / voltage / colour / volume / length / pressure, etc. |
| Copy and complete in your answerbook the following diagram to show how a concave mirror forms an image of an object O, which is placed outside the focus F of the mirror. |  |
| Give one use of a spectrometer. | Measure wavelength of light / demonstrate spectra / chemical analysis, etc. |
| Name the electrical component represented in the diagram. | Variable resistor / rheostat |
| State Ohm’s law. | Ohm’s Law states that the current flowing through a conductor is directly proportional to the potential difference across it, assuming constant temperature. |
| Give one use of a capacitor. | Store charge / (radio) tuning / smoothing / store energy / flash camera, etc. |
| Give two properties of the electron. | Small mass, negative charge, orbits the nucleus, deflected by electric / magnetic fields, etc. |

**2006 [Higher Level]**

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| State Newton’s third law of motion. | Newton’s third law of motion states that if object A exerts a force on object B, B exerts a force on A which is equal in magnitude but opposite in direction. |
| Why is it easier to turn a nut using a longer spanner than a shorter one? | The distance from the fulcrum is greater therefore there is a greater turning effect. |
| The average value for the solar constant in Ireland is 1.2 × 102 W m–2.  What is the average energy falling normally on an area of 5 m2 of ground in Ireland in 1 minute? | Energy per minute on 5 m2 = energy *per second* on *1 m2* multiplied by the number of seconds, multiplied by the number of m2.  = (1.2 x 102)(60)(5) = 36,000 J |
| A sound wave is diffracted as it passes through a doorway but a light wave is not. Explain why. | For diffraction to occur the gap needs to be approximately the same width as the wavelength.  The width of a doorway is approximately the same as the wavelength of sound, but the wavelength of light is much, much smaller. |
| What is the Doppler effect? | The Doppler effectis the apparent change in the frequency of a wave due to the relative motion between the source of the wave and the observer. |
| An RCD is rated 30 mA. Explain the significance of this current. | The RCD trips the circuit at 30 mA or greater . |
| Why is Coulomb’s law an example of the inverse square law? | Because force is inversely proportional to distance squared. |
| Sketch a graph to show the variation of current with potential difference for a semiconductor diode in forward bias. |  |
| Describe the Bohr model of the atom. | A dense positively-charged nucleus with the negatively-charged electrons in orbit at discrete levels around it. |
| Name the three negatively charged leptons. | Electron (*e*) , muon (*μ*), tau (*τ* )  *{See page 48 of the Formula & tables book}* |

2005 **[Ordinary Level]**

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| State the principle of conservation of momentum. | In any collision between two objects, the total momentum before impact equals total momentum after impact, provided no external forces act on the system. |
| A car accelerates from 10 m s−1 to 30 m s−1 in 5 seconds. What is its acceleration? | v = u + at  a = ( v – u ) ÷ t   a = (30 – 10) ÷ 5   a = 4 m s-2. |
| Which one of the following is the unit of power?  joule kelvin kilogram watt | watt |
| Name two methods by which heat can be transferred. | Conduction, convection, radiation. |
| A wave motion has a frequency of 5 hz and a wavelength of 200 m.  Calculate the speed of the wave. | *f* = 5 Hz  ***λ*** = 200 m  ***c = f λ c*** = (5)(200)**=** 1000 m s−1 |
| Infrared radiation is part of the electromagnetic spectrum.  Name two other radiations that are part of the electromagnetic spectrum. | Radio waves, microwaves, infrared, (visible) light, ultraviolet, gamma rays, X-rays. |
| Name the electrical component represented in the diagram. | A diode. |
| List two safety devices that are used in domestic electric circuits. | Fuse, miniature circuit breaker, residual current device, earthing, bonding. |
| What is the photoelectric effect? | It is the emission of electrons from a metal due to electromagnetic radiation of a suitable frequency falling upon it. |
| Name a material used as shielding in a nuclear reactor. | Lead, concrete. |

**2005 [Higher Level]**

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| A container contains 5.0 kg of water. If the area of the base of the container is 0.5 m2. Calculate the pressure at the base of the container due to the water.  (acceleration due to gravity = 9.8 m s–2) | The force corresponds to the weight *mg*.   P = 98 Pa |
| State Boyle’s law*.* | Pressure is inversely proportional to volume for a fixed mass of gas at constant temperature |
| What is the thermometric property of a thermocouple? | emf |
| An object O is placed 30 cm in front of a concave mirror of focal length 10 cm. How far from the mirror is the image formed? |  *v* = 15 cm = 0.15 m |
| A capacitor of capacitance 100 μF is charged to a potential difference of 20 V.  What is the energy stored in the capacitor? | E = ½CV2  E = ½(100 × 10-6)(20)2  = 0.02 J |
| Draw a sketch of the magnetic field due to a long straight current-carrying conductor. | unit 4 compass |
| A pear-shaped conductor is placed on an insulated stand as shown.  Copy the diagram and show how the charge is distributed over the conductor when it is positively charged. | Place charges on the conductor but ensure that they are more concentrated at the pointed end. |
| Explain why high voltages are used in the transmission of electrical energy. | High voltages result in smaller currents therefore less energy is lost as heat. |
| How are electrons produced in an X-ray tube? | Thermionic emission occurs at the heated cathode. |
| Name the fundamental force of nature that holds the nucleus together. | The strong nuclear force. |

2004 **[Ordinary Level]**

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| A student holds a metal ball 2 m above the ground. The mass of the ball is 5 kg.  Calculate the potential energy of the ball. | Ep = mgh = 5 × 9.8 × 2 = 98 J. |
| Explain the term thermometric property. | A thermometric property is a property that changes measurably with temperature. |
| Give one application of the Doppler effect. | Speed gun, measuring red shift, ultrasonic scanners, used to study blood flow, used to study heart beat, etc. |
| Name two primary colours of light. | Red, blue, green |
| Which one of the following is not part of the electromagnetic spectrum?  sound waves microwaves ultraviolet radiation | Sound waves |
| Name the electrical component represented in the diagram. | A capacitor |
| Name two safety devices that are used in domestic electric circuits. | Fuse, miniature circuit breaker, residual current device / RCD, earthing, etc. |
| A conductor of length 50 cm is carrying a current of 5 A.  It is placed at right angles to a magnetic field of flux density 3 T.  Calculate the force on the conductor. | F = B I l  F = 3 × 5 × 0.5 = 7.5 N |
| Which one of the following is emitted from a metal surface when suitable light shines on the metal?  protons neutrons electrons atoms | Electrons |
| What is nuclear fission? | Nuclear fission is the break-up of a large nucleus into two smaller nuclei with the release of energy (and neutrons). |

**2004 [Higher Level]**

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| Two forces are applied to a body, as shown.  What is the magnitude of the resultant force acting on the body? | R2 = F12 + F22  R2 = 52 +122  R = 13 N |
| A can of height 10 cm is submerged in water.  What is the difference in pressure between the top and bottom of the can?  Density of water = 1000 kg m–3 | Change in pressure ΔP = (ρ)(g)(Δh)  = (1000)(9.8)(0.1)  = 980 Pa |
| Explain the term thermometric property. | A thermometric property is a property that changes measurably with temperature. |
| The sound intensity doubles as a person approaches a loudspeaker.  What is the increase in the sound intensity level? | 3 dB |
| Two converging lenses, each with a focal length of 10 cm, are placed in contact.  What is the power of the lens combination? | *f* = 10 cm = 0.1 m P1 = 10 m-1 P2 = 10 m-1  PTotal = P1 + P2 = 20 m-1 |
| What is meant by polarisation of waves? | A polarized wave is one which vibrates in one plane only. |
| Identify two hazards caused by static electricity. | Electric shock / explosion in flour mills /explosion when fuelling aircraft/ damage to electronic devices / electrical storm / static cling, etc. |
| The activity of a radioactive isotope decays to 1/16th of its original value after 36 years.  What is the half-life of the isotope? | 1 → ½ → ¼ → 1/8 → 1/16  It takes 4 half-lives to get from the original amount to 1/16th of the original.  4 half-lives took 36 years, so one half-life must be 9 years.  Answer: 9 years |
| Give one use of the earth’s magnetic field. | Navigation, protective layer around the earth which deflects dangerous cosmic rays. |
| Give the quark composition of the neutron. | Up, down, down. |

2003 **[Ordinary Level]**

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| What is the momentum of an object with a mass of 5 kg travelling at 10 m s-1? | Momentum = mass × velocity  = 5 × 10 = 50 kg m s-1. |
| State Boyle’s law. | For a fixed mass of gas, pressure is inversely proportional to volume, assuming temperature is constant. |
| Name a renewable source of energy. | Solar, wind, tidal, hydro, biomass |
| The temperature of a body is 300 K.  What is its temperature in degrees Celsius? | 300 – 273.15 = 26.85 0C. |
| Name two methods by which heat can be transferred. | Conduction, convection and radiation. |
| Give one difference between light waves and sound waves. | Light waves are transverse; sound waves are longitudinal  Light waves can be polarised; sound waves cannot be polarised  Light waves travel through vacuum; sound waves cannot travel through |
| Describe the image that is formed in a concave mirror when an object is placed inside the focus, as shown in the diagram. | The image is virtual, magnified and upright. |
| State one energy conversion that takes place in an electrical generator. | Kinetic to electric |
| What is a transformer used for? | To increase or decrease voltage. |
| Give two properties of the electron. | Small mass, negative charge, orbits the nucleus. |

**2003 [Higher Level]**

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| State Hooke’s law. | 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. |
| What is the relationship between the acceleration due to gravity *g* and the distance from the centre of the earth? | *g* is inversely proportional to d2 |
| The diagram shows forces of 5 N applied to a water tap.  Calculate the moment of the couple (torque) on the tap. | Moment = force × distance  = 5 × 0.06  = 0.3 N m |
| Which wave phenomenon can be used to distinguish between transverse waves and longitudinal waves? | Polarisation |
| Sound intensity level can be measured in dB or dB(A).  What is the difference between the two scales? | The dB(A) gives extra weighting to the frequencies which the human ear is most sensitive to. |
| Calculate the critical angle for diamond.  The refractive index of diamond is 2.4. | n = 2.4  sin C = 0.417  C = *C* = 24.62° |
| What is the purpose of a miniature circuit breaker (MCB) in an electric circuit? | It behaves as a fuse and breaks the circuit when too large a current flows. |
| What is the photoelectric effect? | It is the emission of electrons from the surface of a hot metal due to electromagnetic radiation of a suitable frequency shining on it. |
| What is meant by nuclear fusion? | Nuclear fusion is the combining of two small nuclei to form one large nucleus with the release of energy. |
| Give one contribution made to Physics by either Paul Dirac or Nicholas Callan. | Dirac predicted antimatter. |

2002 **[Ordinary Level]**

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| What is friction? | Friction is a force which opposes the relative motion between two objects. |
| A car of mass 800 kg is travelling at 10 m s-1. What is its kinetic energy? | Ek = ½mv2  E = ½ 800 × 102  E = 40,000 J |
| In the following table, match the scientist in the first column with the law in the second column. | A = 2, B = 3, C = 1 |
| What is the effect of increasing the U-value of a structure? | It means that the heat conductivity of the structure is increased. |
| What physical quantity is measured in decibels? | Sound intensity level |
| A lens has a power of +50 m-1.  What type of lens is it and what is its focal length? | P = 1/f f = 1/P f = .02 m. It is a converging (convex) lens. |
| What is meant by a thermometric property? | A thermometric property is any physical property that changes measurably with temperature. |
| Give an example of the Doppler effect. | The pitch of moving sound source changes as it goes past. |
| What is the purpose of a miniature circuit breaker (MCB) in an electrical circuit? | To prevent current overload |
| A pear-shaped conductor is placed on an insulated stand as shown.  The conductor is given a positive charge.  Copy the diagram and show how the charge is distributed over the conductor. |  |

**2002 [Higher Level]**

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| A particle travels at a constant speed of 10 m s-1 in a circle of radius 2 m.  What is its angular velocity? | v = r     = 5 rad s-1 |
| Give the equation that defines temperature on the Celsius scale. | T (0C) = T(K) – 273.15 |
| The solar constant is 1.35 kW m-1.  What is the average amount of energy falling normally on each square metre of the earth’s atmosphere in one year? (one year = 3.16 × 10 7s) | 1350 Joules of energy falls on each m2 in a second.  So in *one year* the number of Joules that falls = (1.35 × 103)(3.16 × 107) = 4.27 ×1010Joules |
| What is the Doppler effect? | The Doppler effectis the apparent change in the frequency of a wave due to the relative motion between the source of the wave and the observer. |
| Define sound intensity. | Sound Intensity is defined as power per unit area. |
| A diffraction grating has 200 lines per mm.  What is the value of d in the diffraction grating formula nλ = d sin θ ? | d = 5 × 10-6 m. |
| How much energy is stored in a 100 μF capacitor when it is charged to a potential difference of 12 V? | E = ½ CV2 = ½ (100 × 10-6)(12)2 = 7.2 × 10-3 J |
| What is the purpose of a residual current device (RCD) in an electrical circuit? | It acts as a safety device by breaking the circuit if there is a difference between the live and the neutral in a circuit. |
| A current-carrying conductor experiences a force when placed in a magnetic field.  Name two factors that affect the magnitude of the force. | Magnetic flux density, current and length. |
| What is meant by nuclear fission? | Nuclear fission is the break-up of a large nucleus into two smaller nuclei with the release of energy and neutrons. |