Model Assignment

Issued June 2010

OCR Level 3 Principal Learning – Diploma in Engineering

Unit F564: Scientific Principles and Applications for Engineers

Please note:

This OCR model assignment may be used to provide evidence for the unit identified above. Alternatively, centres may 'tailor' the assignment within permitted parameters (see 'Notes for Teachers'). It is the centre's responsibility to ensure that any adaptations made to this assignment allow learners to meet all the assessment criteria and provide sufficient opportunity for learners to demonstrate achievement across the full range of marks.

The OCR administrative codes associated with this unit are:

- Unit entry code F564
- Certification code H811

The Ofqual accreditation numbers associated with this unit are:

- Unit accreditation number T/501/1905
- Qualification accreditation number (QAN) 500/2400/0

This OCR model assignment remains live for the life of this qualification.

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OCR Level 3 Principal Learning – Diploma in Engineering

Unit F564 Scientific Principles and Applications For Engineer

For assessment you will undertake **ten** tasks which will cover the Learning Outcomes.

Task	Learning Outcomes
1	**1** Forces and Motion and **2** Kinematics
2	**3** Dynamics and **4** Force, Work and Power
3	**5** Deformation of solids and **17** Properties of Materials
4	**6** Electricity
5	**10** Gravitational Fields, **11** Electric Fields and **12** Capacitors
6	**13** Electromagnetism and **14** Electromagnetic Induction
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8	**18** Electronics
9	**7** Quantum Physics, **8** Electromagnetic Waves and **9** Waves
10	**19** Chemical Reactions and **20** Organic Compounds and functional groups

Each task will be marked out of 30 marks giving a total of 300 marks for this unit.

Model Assignment brief for the learner
Team manufacturing challenge

When carrying out the ten tasks you must consider and employ appropriate Health and Safety measures which include:

- Care for yourself and others in a laboratory or workshop situation
- Follow safety procedures and instructions
- Wear appropriate clothing
- Maintain a safe place of work

- Check that health, safety and hygiene procedures are in operation
- Use all laboratory components, tools and equipment correctly during practical activities

You will need to reference specific safety issues for the individual experiments which might be in addition to the generic ones listed above. For each task you should have a folder of evidence preferably in a booklet which includes:

- a title
- a brief description of the experiment and each of the stages involved
- a thorough explanation of the theory behind the experiment including answers to individual questions
- a detailed list of equipment used
- labelled diagrams to show equipment used and systems clearly represented
- a detailed description of the methods used to conduct the experiment including accurate details of safety procedures
- experiment results with record of readings taken and calculations made
- analysis of results which should be presented in the most appropriate form e.g. tabular, graphical or pictorial
- a detailed statement regarding the degree of accuracy and how uncertainties were dealt with
- final comments and conclusions including suggestions for modifications or improvements that could be considered if the experiment was to be repeated

- photographic evidence or video evidence or other forms of evidence to show that the experiments had taken place

Read through all of the tasks carefully, so that you know what you will need to do to complete this assignment.

Tasks

Task 1: Force, motion and kinematics

Force is one of the fundamental concepts of engineering. All of us are aware of a feeling when we push or pull something. More abstract ideas can be built on this idea, through experiment and careful consideration of the task to follow. The relationship between forces and motion comes to mind easily, so experiments are available that show a variety of ways of measuring position and time. These measurements lead to concepts of speed, velocity, momentum and acceleration.
On a building site a tower crane is often used to lift containers off vehicles. The crane will have a single hook and two slings. As the cost of slings increases with their strength, it is important to use as low a cost sling as possible, bearing in mind the safety of the lifting process. Calculations based on the maximum weight and size of the load will help this decision. It is vital that the load is equally distributed in the container and this should be specified in the orders placed on suppliers. It might be useful if definite lifting points were marked on the load, with the points too close together there would be instability and with them a long way apart the strength of the sling would need to be greater.

kinematics can be useful to work out realistic values for products going through design stages, although the product may not be produced yet we can gain a fairly accurate idea as what to expect from it.

When designing a new car, force, motion and kinematics all have to be taken into account.

This task will fulfil all of the requirements for learning outcomes one and two.

Assessment Criteria 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6.

(a) Describe the difference between scalar and vector quantities

(b) Two forces, of 6.0 N and 10.0 N, act at a point and are inclined at 60^0 to one another. Find graphically the magnitude and direction of the resultant

(c) Calculate the resultant of a 25 N force and a 10 N force both acting in a perpendicular direction

(d) Find the horizontal and vertical components of a 150 N force which acts up to the right at 60^0 to the horizontal

(e) A 6.0 N weight is attached to a light string which is then tied 0.3 m from one end of a second string of length 0.8 m. This string is suspended from two fixed points which are on the same horizontal line 0.60 m apart.

(f) Determine experimentally and graphically the angle between the two halves of the string?

(g) Define the terms displacement, speed, velocity and acceleration

(h) Show, distance travelled, displacement, speed, velocity and acceleration using a graphical method

(i) Determine, experimentally, the distance travelled by determining the area under a speed – time graph

(j) Determine, experimentally, velocity by using the gradient of a displacement – time graph

(k) Determine, experimentally, speed by using the gradient of a distance – time graph

(l) Determine, experimentally, acceleration by using the gradient of a velocity – time graph

Your evidence must include:

- answers to questions a, b, c, d, f, g **(AC 1.1, 1.2, 1.3, 1.4, 2.1, 2.2)**
- the presentation of experimental results, for part e, h, i, j, and k in the agreed format that can be found in the section "Learner information" **(AC 1.1, 1.2, 1.3, 1.4)**

Task 2: Dynamics, force, work and power

Dynamics is the branch of engineering concerned with the forces that change or produce the motions of bodies.

Work is done whenever force is applied through a distance. Only the component of the force parallel to the motion does work. For example, if a rope is tied to a load and the load pulled along a floor, some of the force is pulling upward on the load, and some is pulling in the direction that the load is moving. Force is therefore the capacity to do work or cause physical change and power is a measure of how quickly work can be done.

When designing a new car, many things have to be considered. Once the target customer has been identified and the style established, probably the fuel economy of the vehicle is the next most important consideration. The power of the engine will have to be based on many factors, the weight of the vehicle, the aerodynamics, the various frictional forces to be overcome, the intended performance of the car and so on. All these considerations have an influence on each other and so an engineer will have to make many calculations on the speeds and accelerations needed, the distances to be travelled on a single tank of fuel and many of the forces involved in movement.

This task will fulfil all of the requirements for learning outcomes three and four.

Assessment Criteria 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11

(a) State the equations of motion

(b) A motor vehicle with a velocity of 20 ms^{-1} accelerates at 5 ms^{-2} for 20 s. Calculate the final velocity and the distance travelled

(c) A vehicle starts from rest and accelerates at a rate of 4 ms^{-2} for a distance of 1500 m. Calculate the final velocity

(d) Explain what is meant by the term 'mass of a body'

(e) Calculate the density of a material of mass 200 g and volume 20 cm^3

(f) Determine, experimentally, the density of a material of your choice

(g) Define the term ‘newton’

(h) Calculate the force that produces an acceleration of 20 ms^{-2} in a mass of 8 kg

(i) Determine, experimentally, the relationship between the acceleration and force

(j) Explain what is meant by the term ‘weight’

(k) Calculate the weight of a body having a mass of 75 kg given that the acceleration due to gravity is 9.81 ms^{-2}

(l) Determine, experimentally, the measurement of acceleration due to gravity

(m) Explain what is meant by the term ‘centre of gravity’

(n) Experimentally, locate the centre of gravity of a number of bodies

(o) Explain what is meant by ‘moment of a force’, ‘torque’ and ‘a system in equilibrium’

(p) Determine the moment of a force when a force of 30 N is acting on the end of a beam 3 m long and acting at right angles to the beam

(q) Carry out an experiment to determine the effects of moments on a beam

(r) Define the term ‘pressure’

(s) A force of 150 N is acting on an area of 0.75 m^2. Find the pressure acting on the surface

(t) A rectangular storage tank has a base of length 3 m and width 2 m. If the pressure acting on the base of the tank is 18 kn/m^2 determine the force involved

(u) Define the term ‘joule’

(v) Calculate the work done when a mass of 8 kg is lifted to a height of 15 m. Take the acceleration of gravity to be 9.81 ms^{-2}

(w) Explain what is meant by the term (a) kinetic energy and (b) potential energy

(x) Calculate the kinetic energy of (i) a 2 kg trolley travelling at 3 ms^{-1}, (ii) a 4 g bullet travelling at 500 ms^{-1}, (iii) a 400 kg vehicle travelling at 60 kmh^{-1}

(y) A 50 g steel ball falls from a height of 1.8 m on to a metal plate and rebounds to a height of 1.25 m. Find (i) the potential energy before the fall, (ii) kinetic energy as it hits the plate, (iii) velocity on hitting the plate, (iv) kinetic energy as it leaves the plate on the rebound, (v) velocity of rebound.

(z) Take the acceleration of gravity to be 9.81 ms^{-2}

(aa) Use a trolley to carry out an experiment to show the change of potential energy to kinetic energy

(bb) Explain the relationship between power, work done and time (cc) Define the term 'watt'

(dd) A force of 200 N moves a block through a distance of 25 m. Determine (i) work done (ii) power developed if the movement takes 40 s

Your evidence must include:

- answers to questions a, b, c, d, e, g, h, j, k, m, o, p, r, s, t, u, v, w, x, y, aa, bb, cc (**AC 3.1, 3.2, 3.3, 3.5, 3.6, 3.7, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11)**

- the presentation of experimental results, for part f, i , l, n, q, z in the agreed format that can be found in the section "Learner information" (**AC 3.3, 3.4, 3.6, 4.1, 4.3, 4.8, 4.9)**

Task 3: Deformation of solids and properties of solid

Is it possible to imagine a world without materials – probably not. Materials are part of our everyday life.

We know that a car manufacturer has been producing a hatchback model for some years. The increasing demand for convertibles has given design teams a project of converting existing models into attractive and exciting drop head coupé models.

A lot of the strength in the bodywork of the hatchback is in having a continuous roof, so with that removed how can the new car remain strong?

Decisions need to be taken, by engineering designers, as to where to add strengthening bars to the vehicle as a possible solution. Materials need to be considered for strength, elasticity and so on. The forces involved need to be assessed as well as the cost of the materials and their ability to be worked into the shapes needed.

All these considerations need to be made as well as the requirement for a low centre of gravity for stability, a good power to weight ratio for exciting performance and good fuel economy.

The engineering design team have a lot of work to do!

This task will fulfil all of the requirements for learning outcomes five and seventeen.

Assessment Criteria 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 17.10, 17.11

(a) Conduct an experiment, using a brittle material, a ductile material and a polymeric material to investigate

- Hooke's law

- Stress and how stress is related to force

- Strain and how strain is related to extension

(b) Conduct an experiment, using a brittle material, a ductile material and a polymeric material to investigate

- Force related to extension
- Ultimate tensile stress
- Strain energy

(c) Explain, in terms of the separation of atoms in a solid material, elastic deformation and how can this be used to explain Hooke's Law

(d) Explain, why that the resultant force between two atoms in a crystal is the vector sum of an attractive force and a repulsive force

(e) Explain, with the aid of a sketch what is meant by the term equilibrium separation

(f) Explain, in terms of slip, plastic deformation

(g) Explain why plastic deformation happens more easily when dislocations are present in a solid material

(h) Explain the difference between the drift velocity and root mean square (r.m.s.) speed of an electron which forms part of an electric current in a solid

(i) Describe, with the aid of sketches, the band theory for the conduction of electrons in metals

(j) Calculate the electric current in a solid when the number of conduction electrons per unit volume is 8.5×10^{28} , drift velocity is 8×10^{-7} ms^{-1}, charge on the electron is 1.6×10^{-19} C and the cross-sectional area of the conductor is 1×10^{-3} m^2.

(k) Explain what is meant by a super-conducting material and explain the use of such a material in strong magnets

(l) Explain what is meant by the term Hall voltage

(m) Calculate the Hall Voltage in a conductor when the magnetic flux density is 2 mT, electron drift velocity of 8×10^{-7} ms^{-1} and the thickness of the material is 0.2 mm

(n) Describe the macroscopic magnetic properties of ferromagnetic materials using the domain theory

Your evidence must include:

- answers to questions c, d, e, f, g, h, i, j, k, l, m, n (**AC 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 17.10, 17.11)**
- the presentation of experimental results, for part a and b in the agreed format that can be found in the section "Learner information" (**AC 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7)**

Task 4: Electricity

Imagine a world without electricity – no computers, no electronic games, no phones, no lights, no refrigerators. It's pretty hard — electricity underpins almost everything we do.
But, from the small diesel generator to the giant nuclear power station, the underlying principles are remarkably straightforward as you will find out in this task.

This task will fulfil all of the requirements for learning outcome six

Assessment Criteria 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20

(a) Explain what is meant by the terms (i) electric current (ii) coulomb (iii) electron flow and current flow and (iv) potential difference

(b) A 20 Ω resistor is connected across a 6 V supply for 100 s. Calculate (i) current, (ii) charge passed, (iii) power and (iv) energy converted

(c) For a metallic conductor kept at constant temperature, a filament lamp and a semiconductor, conduct an experiment to show the relationship between current and potential difference for each component. Explain how your results relate to Ohm's Law

(d) Define the terms (i) resistance (ii) resistivity. A coil is wound with 500 turns of wire, the mean length of each turn being 100 mm. The cross-sectional area of the wire is 0.2 mm^2. The coil is connected to 10 V supply giving a current of 0.5 A. Calculate (i) coil resistance, (ii) resistivity of the wire

(e) The element of a heater has a resistance of 30 Ω and is supplied by 230 V. If the cost of electrical energy is 20 p/kWh determine (i) power absorbed, (ii) energy used for 4 s (iii) cost of energy used

(f) Draw a graph showing the variation of resistance with temperature of a pure resistor and of a negative temperature coefficient thermistor

(g) Explain the difference between potential difference and electromotive force

(h) Three resistors of value 2 Ω, 4 Ω and 6 Ω are connected in series across a 12 V supply and negligible internal resistance. Draw a circuit diagram; include a voltmeter to measure the electromotive force. Calculate (i) total circuit resistance, (ii) total current, (iii) potential difference across each resistor

(i) Four resistors of value 4 Ω, 8 Ω, 12 Ω and 24 Ω are connected in parallel across a 24 V dc supply. Draw a circuit diagram. Calculate (i) total circuit resistance, (ii) current through each resistor, (iii) total current drawn from the supply

(j) Draw magnetic field patterns caused by a current in a long straight conductor, a flat circular coil and a long solenoid

(k) Define the term 'flux density'

(l) A conductor 0.8 m long carries a current of 50 A at right angles to a magnetic field. If the force on the wire is 6 N determine the flux density of the magnetic field

(m) Explain, with the aid of a sketch, how to use Fleming's left-hand rule to predict the direction of forces acting on two long, straight parallel current-carrying conductors

Your evidence must include:

- answers to questions a, b,, d, e, f, g, h, i, j, k, l, m, n (**AC 6.1, 6.2, 6.3, 6.4, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20)**

- the presentation of experimental results, for part c in the agreed format that can be found in the section "Learner information" (**AC 6.5)**

Task 5: Gravitational fields, Electric Fields and Capacitors

The general theory of relativity is the geometric theory of gravitation published by Albert Einstein in 1915. It is the current description of gravitation in modern science and engineering circles. It unifies special relativity and Newton's law of universal gravitation, and describes gravity as a geometric property of space and time.

Engineers are still working on the original Einstein theories.

When engineers map the three-dimensional flow of a river around a bridge pier, or of wind around the wing of an airplane, they use streamlines, lines that trace the flow of particles of water or air.

Magnetic field lines similarly describe the structure of magnetic fields in three dimensions.

Magnetic field lines were introduced by Michael Faraday (1791-1867) who named them "lines of force." Faraday was one of the great discoverers in electricity and magnetism, responsible for the principles by which electric generators and transformers work, as well as for the foundations of electrochemistry. An electric field can be thought of as a region where a force is produced on an electric charge by the presence of other charges nearby.

The invention of the capacitor varies somewhat depending on who you ask. There are records that indicate a German scientist named Ewald Georg von Kleist invented the capacitor in November 1745. Several months later Pieter van Musschenbroek, a Dutch professor at the University of Leyden came up with a very similar device in the form of the Leyden jar, which is typically credited as the first capacitor. Capacitors are used in many electrical and electronic devices and are still being employed by designers today. Some uses of the capacitor, based on the insulation used in their construction, are listed:

Air - Often used in radio tuning circuits

Mylar - Most commonly used for timer circuits like clocks, alarms and counters Glass - Good for high voltage applications

Ceramic - Used for high frequency purposes like antennas, X-ray and MRI machines

Super capacitor - Powers electric and hybrid cars

This task will fulfil all of the requirements for learning outcomes ten, eleven and twelve.

Assessment Criteria 10.1, 10.2, 10.3, 10.4, 11.1, 11.2, 11.3, 11.4, 12.1, 12.2, 12.3, 12.4, 12.5

(a) Experimentally determine the gravitational constant G with the gravitational torsion balance (using the Cavendish method)

(b) Conduct an experiment to show that on the surface of the earth, the magnitude of g is approximately constant and equal to the acceleration of free fall

(c) Calculate the force between two point masses of 2 kg and 4 kg being 1.5 m apart. The universal gravitational constant is 6.67×10^{-11} N m^2 kg^{-2}

(d) Calculate the magnitude of the earth's gravitational field strength at a point 2000 km above the surface of the earth. You may need to use some or all of the following constants: Mass of earth, M = $6{\cdot}0 \times 10^{24}$ kg Radius of earth, R = 6400km G = $6{\cdot}7 \times 10^{-11}$ Nm^2 kg^{-2}

(e) A charge of + 1.6×10^{-19} C has a force of 4×10^{-15} N exerted on it when it is placed at a certain point in a radial electric field. Calculate the electric field strength

(f) Calculate the electrostatic force between a proton (charge +1.6×10^{-19} C) and an electron (charge -1.6×10^{-19} C) in an hydrogen atom if their separation is 5×10^{-11} m. Take the permittivity of free space to be 8.85 10^{-12} $C^2N^{-1}m^{-2}$

(g) Two point charges of + 1.6×10^{-19} C and – 1.6×10^{-19} C are placed at a distance of 12×10^{-3}m. Determine the electric field strength at the mid-point between the charges. Take the permittivity of free space to be 8.85 10^{-12} $C^2N^{-1}m^{-2}$

(h) A 10 μF capacitor has two plates separated by a dielectric 2.5 mm thick. When connected to a d.c. supply it is charged with 0.005 C. Calculate (i) the supply voltage, (ii) electric field strength in the dielectric, (iii) energy stored

(i) For a capacitor, discharging through a resistor, conduct an experiment, to investigate the relationship between

1. potential difference with time

2. current with time

(j) An 8 μF capacitor is connected in series with a 50 kΩ resistor across a 120 V d.c. supply. When fully charged the capacitor is disconnected from the supply and is then discharged through the resistor. Calculate (i) time constant of the circuit, (ii) charge of the capacitor after 0.8 s, (iii) the magnitude of the current when the time is twice the time constant, (iv) magnitude of the discharge voltage when the time is twice the time constant

Your evidence must include:

- answers to questions c, d, e, f, g, h, j (**AC 10.1, 10.3, 11.1, 11.2, 11.3, 11.4, 12.1, 12.2, 12.4, 12.5)**

- the presentation of experimental results, for part a, b and i in the agreed format that can be found in the section "Learner information" (**AC 10.2, 10.4, 12.3)**

Task 6: Electromagnetism and electromagnetic induction

The magnetic and electric fields found in hospital rooms and other locations need to be measured and precautions suggested by the engineering teams involved.

For example, merely walking around in an area of intense electrical field may well generate a worrying shock when an operator touches an earthed metal object.

Some form of shielding will be needed to protect from the electrical fields and metal detection devices installed to stop magnetic materials from being taken into the room.

An engineer's knowledge of properties of fields will be vital.

This task will fulfil all of the requirements for learning outcomes thirteen and fourteen.

Assessment Criteria 13.1, 13.2, 14.1, 14.2, 14.3, 14.4, 14.5

(a) Experimentally, determine the force acting on a current carrying conductor in a uniform magnetic field, with directions as stated in Fleming's left hand rule

(b) Use the kit provided to build a small electric motor. Conduct an experiment to measure the magnetic flux density using a Hall probe

(c) Conduct an experiment to show Faraday's law, Lenz's law and the direction and magnitude of an induced e.m.f

(d) Calculate the induced e.m.f. in a coil of 5000 turns which is linked with a magnetic flux which changes from 0.05 to 0.2 Wb in 2 s

Your evidence must include:

- answers to questions d (**AC 14.5)**
- the presentation of experimental results, for part a, b and c in the agreed format that can be found in the section "Learner information" (**AC 13.1, 13.2, 14.1, 14.2, 14.3, 14.4)**

Task 7: Thermal physics, nuclear atom and radioactivity

Many of us have been to a hospital for various forms of treatment. Some of you will have seen X-ray machines, magnetic resonance imaging (MRI) and a computerised tomography (CT) scanner. The X-ray machine is probably the most common and is used by radiographers to acquire an x-ray image of the inside of an object, as in medicine or non-destructive testing of materials. The MRI scans use strong magnetic fields and radio waves to produce a detailed image of the inside of the body. One of the main advantages of MRI is that, unlike X-rays, it does not involve exposing the body to radiation.

A CT scan stands for Computerised (Axial) Tomography scan. This means a scan that takes a series of X-rays and uses a computer to put them together. The scan is painless. The CT machine takes pictures of your body from different angles and gives a series of cross sections or 'slices' through the part of the body being scanned. A very detailed picture of the inside of the body can be built up in this way.

When we are ill the use of these machines is often vital. The problem of protecting the medical staff from the various emissions involved is paramount. A team of engineers will have to consider the various safety requirements needed. How far the medical staff can be separated from the patients, how radioactive emission and X-rays are absorbed by various materials and the intense magnetic fields that can be involved, will all have to be considered.

Many applications mentioned above involve heat in some form or other so we need to study thermal physics which is the combined study of thermodynamics, statistical mechanics, and kinetic theory. This umbrella-subject is typically designed for science students and functions to provide a general introduction to each of three core heat-related subjects. Other authors, however, define thermal physics loosely as a summation of only thermodynamics and statistical mechanics.

This task will fulfil all of the requirements for learning outcomes fifteen and sixteen.

Assessment Criteria 15.1, 15.2, 15.3, 15.4, 15.5, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9

(a) Explain what is meant by ‘the internal energy of a system’ and ‘thermodynamic scale’

(b) Conduct an experiment to measure the specific heat capacity of copper by the direct conversion of mechanical energy into heat energy

(c) Conduct an experiment to determine the form of a temperature-time graph for a substance which changes its state over a period of time. State on the graph the section that corresponds to sensible heat and latent heatCalculate the volume of 2 moles of an ideal gas at 20 C and a pressure of 1200 Pa, if the characteristic gas constant is 8.3 J $K^{-1}mol^{-1}$

(d) Explain the difference between nucleon mass number and proton atomic number. How can an element have different mass numbers?

(e) Describe the process of nuclear fission and nuclear fusion

(f) Conduct experiments

(j) to detect and identify the principal nuclear radiations

(j) to determine the half-life of a radioactive isotope

(g) A mass defect of 9 x 10^{-30} kg occurs in the decay of a radium nucleus. Calculate the energy released. The speed of light is 3 x 10^{8} ms^{-1}

(h) State (i) hazards of ionising radiation, (ii) safety precautions when handling, storing and disposing of radioactive materials

Your evidence must include:

- answers to questions a, d, e, g, h and i (**AC 15.1, 15.2, 15.5, 16.1, 16.3, 16.4, 16.6, 16.7, 16.8)**

- the presentation of experimental results, for part b, c and f in the agreed format that can be found in the section "Learner information (**AC 15.3, 15.4, 16.2, 16.5, 16.9)**

Task 8: Electronics

Operational amplifiers are among the most widely used electronic devices today, being used in a vast array of consumer, industrial, and scientific devices. Many standard IC op-amps cost only a few pence in moderate production volume; however some integrated or hybrid operational amplifiers with special performance specifications may cost over £25.00 in small quantities. Op-amps sometimes come in the form of macroscopic components, or as integrated circuit cells; patterns that can be reprinted several times on one chip as part of a more complex device.

There use in hospitals is extensive. The monitoring of a hospital patient's respiration, heart rhythms and circulation is increasingly important. A new portable device is needed to assist post-operative care in emergency field hospitals. All the inputs to such a device are at extremely low levels; detected optically, audibly or by electrical changes.

These inputs need electronic amplification to produce outputs that can be monitored both visually and by generating warning signals. Over and above these needs, an engineer will have to keep close watch on power requirements and the size of battery needed.

Electrical and electronic engineers are still today working on operational amplifiers to improve the services that hospitals and other consumers need.

This task will fulfil all of the requirements for learning outcome eighteen.

Assessment Criteria 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9

(a) Explain, why the transmission of digital signals give a better result than the transmission of analogue signals

(b) In a domestic radio what is meant by the terms (i) amplitude modulation, (ii) frequency modulation and (iii) bandwidth

(c) Conduct an experiments to investigate

- the gain of an inverting amplifier

- a summing amplifier

- the gain of a non-inverting amplifier

Your evidence must include:

- answers to questions a and b (**AC 18.1, 18.2, 18.3, 18.4)**
- the presentation of experimental results, for part c and f in the agreed format that can be found in the section “Learner information (**AC 18.5, 18.6, 18.7, 18.8, 18.9)**

Task 9: Quantum Physics, Electromagnetic Waves and Waves

Quantum Physics at a glance may seem like just another strange theory, it contains many clues as to the fundamental nature of the universe and is more important then even relativity in the grand scheme of things. Furthermore, it describes the nature of the universe as being much different then the world we see. As Niels Bohr said, "Anyone who is not shocked by quantum theory has not understood it”.

Musical instruments make sounds by being forced to generate sound waves. All objects have a natural resonant frequency, which allows us to differentiate the sound of a guitar from that of a violin, for example. The way the original vibration is generated and then amplified gives us the distinctive sounds.

All objects have this ability but in some cases this resonance causes a problem. The Millennium Bridge over the River Thames in London became unstable when people walked across it (the Romans had the same problem when their legions were marching over bridges).

Car designers have to be careful that the engine sounds or the frequency that the tyres hit joints in motorway surfaces do not force the bodywork to vibrate at its natural frequency causing unpleasant sounds to be produced (as buzzes or hums). The engineer will have to test for these problems at various engine/car speeds.

This task will fulfil all of the requirements for learning outcomes seven, eight and nine.

Assessment Criteria 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 8.1, 8.2, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7

(a) Conduct an experiment to verify the quantum nature of light by investigating the photoelectric effect of light. Information must be provided about (i) photons and waves, (ii) Planck constant, (iii) work function energy and (iv) threshold frequency

(b) Calculate the photon energy of yellow light whose wavelength is 550 nm. (h = 6.626 x 10^{-34} Js and c = 3 x 10^{8} ms^{-1}

(c) The work function for lithium is 4.6 x 10^{-19} J. Calculate (i) the lowest frequency of light that will cause photoelectric emission, (ii) the maximum energy of the electrons emitted when light of 7.3 x 10^{14} Hz is used?

(d) Calculate the de Broglie wavelength of a 0.20kg ball moving at $15ms^{-1}$

(e) Describe the features of the electromagnetic spectrum

(f) State the orders of magnitude of the wavelengths of the principal radiations from radio waves to gamma rays

(g) Conduct an experiment to investigate reflection, refraction and interference in the following:

1. transverse waves in ropes and springs

2. longitudinal waves in ropes and springs

3. ripple tank waves

(h) The speed of sound in a metal is 1000 m s^{-1}. Calculate the wavelength if the frequency is 2 kHz?

(i) Explain what is meant by 'polarisation' as a phenomenon associated with transverse waves

(j) With the help of diagrams, explain the terms displacement, amplitude, phase difference, frequency and wavelength

Your evidence must include:

- answers to questions b, c, d, e, f, h, i (**AC 7.8, 8.1, 8.2, 9.3, 9.4, 9.7)**

- the presentation of experimental results, for part a and g in the agreed format that can be found in the section "Learner information (**AC 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 9.1, 9.2, 9.5, 9.6)**

Task 10: Chemical reactions, Organic compounds and functional groups

A chemical reaction is the process in which substances are changed into different ones, with different properties, as distinct from changing position or form. Chemical reactions involve the rupture or rearrangement of the bonds holding atoms together. The total mass and number of atoms of all reactants equals those of all products, and energy is almost always consumed or liberated. The speed of reactions varies. Understanding their mechanisms lets chemical engineers alter reaction conditions to optimize the rate or the amount of a given product; the reversibility of the reaction and the presence of competing reactions and intermediate products complicate these studies. Reactions can be syntheses, decompositions, or rearrangements, or they can be additions, eliminations, or substitutions. Organic Chemistry is a discipline which involves chemical engineers studying the structure, properties, composition, reactions, and preparation of carbon based compounds, hydrocarbons, and their derivatives. These compounds may contain any number of other elements, including hydrogen, nitrogen, oxygen, the halogens as well as phosphorus, silicon and sulphur. Organic compounds are structurally diverse, and the range of application of organic compounds is enormous. They form the basis of, or are important constituents of many products, such as plastics, drugs, petrochemicals, food, explosives, paints, to name but a few and, with very few exceptions, they form the basis of all earthly life processes. In organic chemistry, functional groups are specific groups of atoms within molecules that are responsible for the characteristic chemical reactions of those molecules. The same functional group will undergo the same or similar chemical reactions regardless of the size of the molecule it is a part of. Combining the names of functional groups with the names of the parent alkanes generates a powerful systematic nomenclature for naming organic compounds. Chemical engineers are still finding that chemicals are a blessing and a curse. When a new drug is developed and people are cured from a particular disease this is good news. However, for example, when a dangerous, but useful chemical, is accidentally let escape into the atmosphere this is bad news. Chemical engineers will still be employed for a long time to come.

This task will fulfil all of the requirements for learning outcomes nineteen and twenty.

Assessment Criteria 19.1, 19.2, 19.3, 19.4, 19.5, 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7

(a) Conduct an experiment for (i) an oxidation chemical reaction, (ii) a reduction reaction

(b) Use the examples of the Groups 1, 7 and 0 from the Periodic Table of Elements to explain how patterns in chemical properties can be used to predict reactions

(c) State five factors that can affect the rate of a reaction and explain why (i) some adhesives are sold in two tubes (ii) a mixture of chlorine and methane reacts in sunlight but does not react in the dark (iii) lumps of coal are difficult to set alight

(d) Conduct an experiment to measure temperature changes in four reactions, and classify the reactions as exothermic or endothermic

(e) Conduct experiments to determine the pH value for a number of solutions

(f) 5.00g of NaOH are dissolved to make 1.00 dm^3 of solution. What is the concentration of H^+? ($8x10^{-14}$ mol. dm^{-3}

(g) Use a molecule model to build up molecules with different structures.

- Chain – propane, butane, pentane and hexane.
- Branched Chain – methyl propane, methyl butane, 2methyl pentane and 2,3-dimethyl hexane
- Ring – cyclohexane and benzene

(h) Explain the difference between aliphatic and aromatic compounds

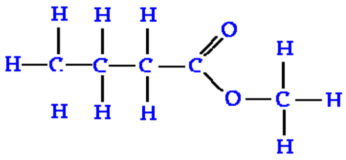
(i) State the functional groups of (i) phenols, (ii) phenylamines and (iii) carboxylic acids

(j) Draw structures of

- phenol and 2,4,6-tribromophenol
- phenylamine ($phNH_{2)}$, N-methyl phenylamine ($phNHCH_3$) and N-methyl-N-ethyl phenylamine (phN(CH3) C_2H_5)
- phenyl carboxylic acid (phCOOH) and 2,4,6-trimethyl carboxylic acid. State functional group of phenyl carboxylic acids.

In each case highlight the functional groups and state the “type” of compound next to each structure.

(k) For each of following structure:
- highlight the functional groups and state the “type” of the compound.
- state if each structure is aliphatic or aromatic
- give each compound its IUPAC name.

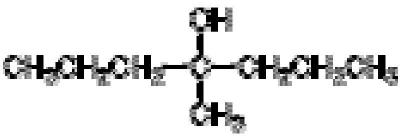


Functional group:______________________________

Type of compound: ______________________________

Aliphatic or aromatic ? ______________________________

IUPAC name: ____

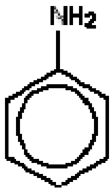


Functional group: ______________________________

Type of compound: ______________________________

Aliphatic or aromatic? ______________________________

IUPAC name: ____



Functional group: ______________________________

Type of compound: ______________________________

Aliphatic or aromatic? ______________________________

IUPAC name: ____

(l) Conduct an experiment to investigate Friedel-Crafts Alkylation Reaction

Your evidence must include:

- answers to questions b, c, e, f, g, h, i, j **(AC 19.2, 19.3, 20.1, 20.2, 20.3, 20.4, 20.5)**

- the presentation of experimental results, for part a, d and k in the agreed format that can be found in the section “Learner information (**AC 19.1, 19.4, 19.5, 20.6, 20.7)**

Model Assignment: Presenter Information

OCR Level 3 Principal Learning – Diploma in Engineering

Unit F564 Scientific Principles and Applications for Engineer

Presenters must refer to the unit specification and the section on controlled assessment in the OCR Level 3 Principal Learning in Engineering centre handbook for more information on task setting, taking and marking.

This model assignment has been developed to comply with the levels of control for task setting, taking and marking for this unit.

It is suggested that for each task a booklet is provided which contains a front sheet with candidate name etc, the questions and a space for the answers. There should also be sufficient room and maybe headings for the experiments to be written up. At the end of the booklet there could be included a marking grid. It is intended that the booklet be helpful so that when a particular assessment criteria has been dealt with the learner can answer the appropriate questions. The booklet should also save time because the learner will not have to write out each question.

It is important for the presenter to realise that for each task, only one mark sheet is used. This means that if there is more than one experiment involved then a global mark must be entered at the appropriate band

Centres must carry out a review or ‘internal standardization’ to ensure that marks awarded by different presenters are accurate and consistent across all learners entered for the unit from that centre.

If centres are working together in a consortium, you must carry out internal standardisation of marking across the consortium.

Where controlled assessments are internally assessed and externally moderated, the centre must standardize marking to make sure that all learners at the centre have been marked to the same standard. One person should be appointed within the centre to be responsible for internal standardization for each specification. This person should sign the Centre Declaration Sheet to confirm that internal standardization has taken place. For Principal Learning, this person will normally be the domain assessor. Where centres are working within a consortium, they must standardize the marking within each unit across the consortium.

In marking work, presenters should pay close attention to the requirements of the unit specification. and note that it is their responsibility to award marks for work in accordance with the marking criteria specified in the awarding body’s unit specification. Presenters must show clearly how the marks have been awarded in relation to these marking criteria. The centre’s marks must reflect the relative attainment of all the learners.

Annotation

Guidance given in the OCR unit specification on providing evidence to support the marks awarded must be followed.

Useful random references:

http://newton.ex.ac.uk/teaching/resources/fyo/phy1110/manuscripts/me10.pdf

http://www.egglescliffe.org.uk/physics/gravitation/bifilar/bif.html

Mechanics qs http://www.saburchill.com/physics/questions/quest012.html

Electric fields http://www.antonine-education.co.uk/physics_a2/module_4/Topic_9/topic_9.htm#Question%206.

http://www.science.uwaterloo.ca/~cchieh/cact//c120/emwave.html

http://www.iop.org/activity/education/Projects/Teaching%20Advanced%20Physics/Atomic%20and%20Nuclei/Quantum%20physics/file_5008.doc

http://www.webcalc.net/calc/0218_debroglie.php

http://www.s-cool.co.uk/alevel/physics/progressive-waves/progressive-waves.html

http://www.iop.org/activity/education/Projects/Teaching%20Advanced%20Physics/Vibrations%20and%20Waves/Progressive%20waves/page_4488.html

http://www.iop.org/activity/education/Projects/Teaching%20Advanced%20Physics/Vibrations%20and%20Waves/Progressive%20waves/file_4219.doc

http://highergrades.com/chemistry-tutorials.html?gclid=CPjWlLqfvZ8CFSBk4wodpy1v0Q

http://chemistry.about.com/od/chemistryexperiments/Chemistry_Experiments.htmhttp://uk.yhs.search.yahoo.com/avg/search?fr=yhs-avg&type=yahoo_avg_hs2-tb-web_uk&p=experiments%20for%20chemical%20reactions

http://www.practicalchemistry.org/experiments/exothermic-or-endothermic,72,EX.html

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A2-level Physics OCR A Revision Guide
Coordination Group Publications Ltd

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Study Notes for Technicians - Physical Science and Physics
McGraw-Hill

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Force and Motion
Perfection Learning

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Newnes

Bird J (2007)
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Pratley John B (1998)
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Arnold

Hannah J (1998)
Applied Mechanics
Pearson

Ashby F and Jones DRH (2005)
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Dover

Pierce JR (2006)
Almost All About Waves
Dover

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› Visit Amazon's John R. Pierce Page
Find all the books, read about the author, and more.
See search results for this author
Are you an author? Learn about Author Central

Vibrations and Waves
Fullerton

Someda CG (1998)
Electromagnetic waves
Chapman and Hall

Ellse M and Honeywill C (2004)
Electricity and thermal physics
Nelson Thornes

Johnson K (2006)
Physics for you
Nelson Thorne

Jason Z (2009)
Force and Motion
Johns Hopkins University Press

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Hodder Wayland

Doherty JJJ (2008)
Kinematics and Dynamics
Bibliolife

Wilson CE (2003)
Kinematics and Dynamics of Machinery
Pearson

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www.metacafe.com/tags/Kinematics/page-3
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Organic Chemistry (5th Edition)
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Organic Chemistry, Fourth Edition : Structure and Function
Freeman

Hornback JM (2006)
Organic Chemistry (with Organic Chemistry Now)
Brooks Cole

Pavia DL et al (2005)
Introduction to Organic Laboratory Techniques : A Small-Scale Approach (Brooks/Cole Laboratory Series for Organic Chemistry)
Thomson Books

McMurry JE (2010)
Fundamentals of Organic Chemistry
Cenage Learning

Harwood LM et al (2003)
Experimental organic chemistry: standard and microscale
Blackwell

The Operational Amplifier
IC Operational Amplifiers is the SN741. This experiment uses a 741 as a simple audio-frequency amplifier. 741 Op Amps come in a variety of packages. ...
www.st-andrews.ac.uk/~www_pa/.../experiment/.../expt6.html

The Basic Op Amp Inverter
The basic 741 op amp includes a means of balancing out these offsets so as to minimize their effects. We'll see how this works in the next experiment in ...
www.play-hookey.com/.../experiments/basic_op_amp_inverter.html

Gayakwad (2008)
Op-Amps & Linear Integrated Circuits, 4th/ed.
Pearson

Experiment 13: Radioactivity
File Format: PDF/Adobe Acrobat - Quick View
Experiment 13: Radioactivity. Pre-lab questions ... counters, cloud chamber, small radioactive sources, ruler, sheets of paper, book. 13.3 Background ...
www.barransclass.com/phys1050/manual/P1050lab_S10_13.pdf

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New Central Book Agency

Ellse M and Honeywill C (2000)
Electricity and thermal physics
Nelson

Heckert PA (2008)
Understanding Faraday's Law - Electromagnetic Induction from Changing Magnetic Flux
Suite 101
Platt C (2009)
Make Electronics
O'Reilly Medi

LAB SAFETY
SAFETY REGULATIONS: Occupational Safety and Health Act of 1970 (OSHA); School District Policies; Professional Liability; Contributory Negligence (even if ...
www.csun.edu/science/ref/laboratory/safety/safety.html

Guidance on using this model assignment

1 General

1.1 OCR model assignments are available to download free of charge from our website: www.ocr.org.uk

1.2 OCR model assignments are intended to be used for formal summative assessment of learners and assessment must be conducted under controlled conditions. The OCR centre handbook for this qualification gives full information on controlled assessment. There is also guidance on what controlled assessment means in the context of this model assignment in the next section 'Notes for teachers'.

1.3 This assignment has been designed to meet the full assessment requirements of the unit. Learners will need to take part in a planned learning programme that covers the underpinning knowledge, understanding and skills of the unit.

2 Before carrying out the assignment

2.1 Learners should be provided with a copy of the *Learner Information* section of this assignment or the centre adapted model assignment.

2.2 It is not anticipated that learners will need to carry out any preparations prior to undertaking the assessment tasks, such as collating resources to use in the assessment, but if you do ask your learners to do so you please be aware that there is no time limit for this.

3 Producing evidence

3.1 Each learner must produce individual and authentic evidence for each task within the assignment.

3.2 Centre staff may give support and guidance to learners. This support and guidance should focus on checking that learners understand what is expected of them. It is not acceptable for presenters to provide model answers or to work through answers in detail. For advice on giving feedback to learners on the work they have produced for assessment consortia/centres should refer to JCQ document *Instructions for conducting controlled assessment.*

3.3 Learners may use information from any relevant source to help them with producing evidence for the tasks.

3.4 Learners must be guided on the use of information from other sources to ensure that confidentiality is maintained at all times.

3.5 Under each task we have specified what evidence the learner is expected to produce, but it is important to note that if it is possible to generate the evidence in a variety of formats (so that the learner is free to use the format that is most appropriate for them.

The section 'Evidence Summary' at the back of the model assignment will guide you on evidence and formats for evidence.

4 Presentation of work

4.1 Centres wishing to submit digital evidence in the form of an e-portfolio should refer to the appendix in the Principal Learning centre handbook on guidance for the production of electronic assessment.

4.2 Centres may wish to discourage learners from excessive use of plastic wallets for presentation of their evidence as this may hinder the assessment process. Instead centres may wish to encourage learners to present their work so that it is easily accessible, eg spiral bound, stapled booklet, treasury tag.

For more guidance on production and presentation of work please refer to the section on Internal Assessment in the OCR Principal Learning centre handbook.

Instructions on controlled assessment for this model assignment

Introduction to the Tasks

This model assignment has been developed to comply with the levels of control for task setting, taking and marking for this unit.

Centres should refer to the section on internal assessment in the OCR Level 3 Principal Learning in Engineering centre handbook for more information on task setting, taking and marking.

These guidance notes should be used in conjunction with the unit specification and OCR Principal Learning centre handbook.

Controls for Task Setting

The level of control for task setting is limited. This means that centres can use this model assignment without adaptation or it can be adapted in line with the scope of permitted model assignment modification section in this document (see section below).

Alternatively, consortia may develop their own assessment tasks and this OCR model assignment acts as an exemplar therefore helping to establish the standard expected of a controlled assessment activity. **All consortia designed assignments must be quality assured before being used for assessment,** consortia must ensure that model assignments they design are appropriate for their intended use and match the requirements of the unit(s).

There is further information on task setting in the OCR Level 3 Principal Learning in Engineering centre handbook.

Controls for Task Taking

Under the process of task taking, levels of control are set for the key aspects in assessment of supervision, time, resources and collaboration.

Supervision control

The level of control for supervision is medium, this means that learners will complete the majority of work for assessment under direct presenter supervision but it is acceptable for some aspects of exploration to be outside the direct supervision of the presenter (the presenter must be able to authenticate all work carried out by the learner). It is also acceptable for assessment to take place outside the classroom but presenters must exercise continuing supervision to ensure essential compliance with health and safety requirements as well as being able to authenticate the learner's work. For this model assignment the following aspects could be undertaken outside of the direct supervision of the presenter:

- Library research
- Researching the internet.

Time control

The level of control for time is limited, this means that the overall time allocated for assessment is recommended to be 45 hours but consortia can decide how the time can be allocated between each part or individual task in the assessment.

For this model assignment we recommend that the time for each task is 4.5 hours giving a total of 45 hours.

This is only an approximation and will vary depending on the approach to each task and the overall context of the assignment.

Resource Control

The level of control for resource is limited; this means that consortia can determine which physical resources and information sources are appropriate for the assessment. Learners will need to be provided with the most appropriate materials and equipment to allow them full access to the marking criteria and for the ten experiments.

Learners should have access to:

- ICT equipment as appropriate for this model assignment
- PC and printer
- Necessary research materials
- Necessary recording information such as camcorders or cameras or tape recorders
- Learners may benefit from having access to the following as aides to presenting their evidence, depending on the format chosen (presentation, video, photographic records etc):
- Digital camera
- Camcorder
- Presentation software
- Standard operating procedures for equipment to be used.

Collaboration control

The level of control for collaboration is medium; where collaboration takes place the presenter must be sure each learner has produced evidence of their own contribution to each assessment criteria.

When learners are working in teams, presenters should ensure:

- that all team members have equal opportunity to evidence their skills, knowledge and understanding
- team composition, for example based on learners' preferred learning/reviewing styles

- the number of team members. Small groups of 3 to 6 learners could comprise a team
- monitoring the team as work progresses
- providing opportunity for practice/rehearsal and giving structured feedback
- If witness statements are used to support learners' evidence, these should be completed individually for each learner.

Controls for Marking

The level of control for task marking is medium. This means that learners' evidence is assessed and marks awarded by the centre assessor(s) using OCR marking grids provided in the unit and moderated by an OCR appointed moderator. (When marking learners' work, centres **must** use the descriptors provided within the unit.)

Centres should refer to the OCR Level 3 Principal Learning in Engineering centre handbook for further information on task marking and for a description of the key words used in the marking criteria.

When marking this assignment, presenters should start with the marking criteria within the unit and a 'best fit' approach should be applied to each assessment criterion.

Presenters must be confident that the work they mark is the learner's own. Although this does not mean that learners must be supervised throughout the completion of all work, presenters must employ sufficient checks whilst tasks are being completed to ensure learners are producing their own evidence.

Assessors' decisions should be quality assured across the centre through internal moderation. External moderation will take the form of postal moderation or e-moderation. For further information about internal and external moderation please refer to the section on Internal Assessment in the Principal Learning centre handbook.

Scope of permitted Model Assignment modification

The model assignment is very self-contained in its present form. The set of tasks form a coherent whole addressing all the Assessment Criteria.

No changes can be made to the following:

- the assessment criteria
- the level of control for task taking.

The model assignment can be changed in terms of:

- the learner's brief, which can be contextualised or amended to suit local needs. However, the scenario must still be set within a sector relevant context (one that links to the world of work) and have an engineering business purpose/objective and be engaging and motivating for the learners. For this unit the scenario must be an engineering context

- who the end user/client is and what their requirements are

- each specific task may be appropriately contextualised (consortia must ensure that learners have the opportunity to cover all assessment criteria through the tasks)

- links to other unit assignments

- the type of evidence required and the format it takes (providing the Assessment Criteria do not demand specific evidence or format)

- Timings given for each assessment task are only approximations and it is permissible to vary them depending on the approach taken to each task and the overall context of the assignment.

OCR has ensured that, in the language used and tasks and scenarios provided, we have avoided discrimination, bias and stereotyping and support equality and diversity. In the development of qualifications and assessments we use the guidance given in the Ofqual publication Fair access by design, notably this includes:

- using language and layout in assessment materials that does not present barriers to learners

- using stimulus and source materials in assessment materials (where appropriate) that do not present barriers to learners

- If consortia wish to adapt the model assignment we strongly advise that staff responsible for modifying the model assignment and quality assuring it refer to the publication *Fair access by design*.

If modifications are made to the model assignment it is up to the centre to ensure that all assessment criteria and marking criteria are adequately covered.

Evidence summary

This is a summary of the evidence the learner will be expected to produce in relation to this model assignment.

It is important to note that when completing this model assignment the tasks will require a specific format for the outcome and this will be clearly marked in the table.

Depending on the approach taken to the model assignments it may also be possible to demonstrate additional Personal, Learning and Thinking Skills (PLTS) coverage

Task Activity	Evidence prescribed for activity	Format of evidence	Assessment criteria (AC)
Tasks 1 Force, motion and kinematics	Answering questions and carrying out experiments	A folder of evidence	**AC** 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6.
Task 2 Dynamics, force, work and power	Answering questions and carrying out experiments	A folder of evidence	**AC** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11
Task 3 Properties of materials and deformation of solids	Answering questions and carrying out experiments	A folder of evidence	**AC** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 17.10, 17.11
Task 4 Electricity	Answering questions and carrying out experiments	A folder of evidence	**AC** 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.14, 6.15, 6.16, 6.17, 6.18, 6.19, 6.20
Task 5 Gravitational fields, electric fields and capacitors	Answering questions and carrying out experiments	A folder of evidence	**AC** 10.1, 10.2, 10.3, 10.4, 11.1, 11.2, 11.3, 11.4, 12.1, 12.2, 12.3, 12.4, 12.5
Task 6 Electromagnetism and electromagnetic induction	Answering questions and carrying out experiments	A folder of evidence	**AC** 13.1, 13.2, 14.1, 14.2, 14.3, 14.4, 14.5

Task 7 Thermal physics, nuclear atom and radioactivity	Answering questions and carrying out experiments	A folder of evidence	**AC** 15.1, 15.2, 15.3, 15.4, 15.5, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9
Task 8 Electronics	Answering questions and carrying out experiments	A folder of evidence	**AC** 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9
Task 9 Quantum physics, electromagnetic waves and waves	Answering questions and carrying out experiments	A folder of evidence	AC 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 8.1, 8.2, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7
Task 10 Chemical reactions, organic compounds and functional groups	Answering questions and carrying out experiments	A folder of evidence	**AC** 19.1, 19.2, 19.3, 19.4, 19.5, 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7