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|  **Subject Science - Year 9 Medium Term Plan/SOW** | **The Academy of St Francis of Assisi** |
| **P1** | **Title : P1 Conservation and dissipation of energy** | **Number of lessons in sequence** | **10 lessons**  |
| **Overarching Curricular Goals (Aims)**  | **By the end of this unit students will:** Students will develop their understanding of energy and energy transfer from Key Stage 3. This includes the development of an energy stores model and the processes, such as forces and electrical currents, through which energy can be transferred. They will know how to measure the work done by a force acting over a distance and how this concept can be used to analyse energy changes in gravitational stores, through lifting and falling, and elastic potential stores during stretching using the relevant mathematical relationships. They will also gain an understanding of conservation of energy through changes in the gravitational, kinetic, and elastic stores. They will understand that energy is dissipated during transfers such as those caused by friction or electrical heating and this leads to the idea of efficiency during different energy changes and its calculation. They will be able to apply the concept of efficiency to the selection of electrical devices. Students will be able to link the rate of energy transfer in different systems to the concept of power and how this power rating can be used to determine total energy change over time. | **Links to National Curriculum****Links to & building upon prior learningIncluding KS2 if Yr7** | **Students at KS3 build on their knowledge and skills from KS2 by learning about:****Energy****Changes in systems*** Energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change
* Comparing the starting with the final conditions of a system and describing increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions
* Using physical processes and mechanisms, rather than energy, to explain the intermediate steps that bring about such changes.

**Students at KS4 build on their knowledge and skills from KS3 by learning about:**Energy* Energy changes in a system involving heating, doing work using forces, or doing work using an electric current: calculating the stored energies and energy changes involved.
* Power as the rate of transfer of energy.
* Conservation of energy in a closed system, dissipation.
* Calculating energy efficiency for any energy transfers.
* Renewable and non-renewable energy sources used on Earth, changes in how these are used.

**Students at KS5 build on their knowledge and skills from KS4 by learning about:**Energy* Calculation of work done for constant forces, including force not along the line of motion
* Calculation of exchanges between gravitational potential energy and kinetic energy
* Principle of conservation of energy
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| **Outcomes/****Success Criteria** | **Knowledge Learners will:** * A system is an object or group of objects.
* There are changes in the way energy is stored when a system changes.
* Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed.
* Dissipated energy is often classed as being wasted.
* When a force causes an object to move through a distance work is done on the object.
* A force does work on an object when the force causes a displacement of the object.
* work done = force × distance (moved along the line of action of the force)
* work done W in joules, (J) force F in newtons (N) and distance s in metres (m)
* One joule of work is done when a force of one newton causes a displacement of one metre.
* 1 joule = 1 newton metre.
* Work done against the friction causes a rise in the temperature of the object.
* When an object its raised above ground level it gains gravitational potential energy.
* g.p.e. = mass × gravitational field strength × height
* Gravitational potential energy Ep in joules, J; Mass m in kilograms, kg;
* Gravitational field strength g in newtons per kilogram, N/kg; Height h in metres.
* Kinetic energy is stored in moving object.
* Kinetic energy = 0.5 × mass × (speed)2 [Ek = ½ m v2].
* Kinetic energy, Ek, in joules, J; Mass, m, in kilograms, kg; Speed, v, in metres per second, m/s.
* Elastic potential energy is stored in a stretched objects.
* Elastic potential energy = 0.5 × spring constant × (extension)2 [Ee = ½ k e].
* Elastic potential energy, Ee, in joules, J; spring constant, k, in newtons per metre, N/m;
* Extension, e, in metres, m
* The energy efficiency is the amount of useful energy transferred.

Efficiency = useful output energy transfer ÷ total input energy transfer* Power the rate at which energy is transferred or the rate at which work is done.
* Power = energy transferred ÷ time
* Power = work done ÷ time
* Power, P, in watts, W; energy transferred, E, in joules, J;
* Time, t, in seconds, s; work done, W, in joules, J
* An energy transfer of 1 joule per second is equal to a power of 1 watt.
* Efficiency = useful power output ÷ total power input

**Skills: Learners will:** * *Describe all the changes involved in the way energy is stored when a system changes.*
* *Calculate the changes in energy involved when a system is changed.*
* Describe with examples, how in all system changes energy is dissipated, so that it stored in less useful ways. This energy is often described as being ‘wasted’.
* Describe the energy transfer involved when work is done.
* Calculate the changes in energy involved when a system is changed by work done by forces
* Use calculations to show on a common scale how the overall energy in a system is redistributed when the system is changed.
* Calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level.
* Describe with examples where there are energy transfers in a closed system, that there is no net change to the total energy.
* Explain ways of reducing unwanted energy transfers, for example, through lubrication and the use of thermal insulation.
* Describe ways to increase the efficiency of an intended energy transfer.
* Comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.
* Compare the efficiency of appliances.
* Describe ways to increase the efficiency of energy transfers.
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| **2/3 tier vocabulary.** | **Differentiation/Scaffolding/Support.** | **Stretch and challenge opportunities in class, enrichment and home learning.** | **Opportunities for wider reading/Listening/watching.** |
| closed systemconservation of energy dissipated energy efficiency Hooke’s Lawinput energy power spring constantuseful energy wasted energy work **Oracy:** ACE questioning Targeted Q and ADiscussion activities  | **Knowledge Support:** * Key facts.
* Knowledge organisers.

**Reading support**:* Explicit vocabulary delivery
* Glossary of terms
* Visualizer to support whole class reading.
* Keyword discussion and annotation.

**Skills support:** * Support sheets
* Practical guidance sheets.
* Practical scaffolding.
* Demonstrations and discussions.
* Writing frames.
 | Stretch and challenge embedded into every lesson (see Powerpoints)**Home learning / enrichment** <https://www.freesciencelessons.co.uk/gcse-physics-paper-1/energy/>**Scholarship:****Go Further** * Entropy and the heat death of the universe
 | GCSE Science<https://www.gcsesciencerevision.com/physics/energy>Work, Power and Energy<https://youtu.be/w4QFJb9a8vo>Primrose kitten AQA Energy revision <https://youtu.be/tDkBhy-Y1Z8>Primrose kitten AQA Energy Q and A<https://youtu.be/q5CwATii6OA>Conservation of Energy | Physics – Wonders of Life<https://youtu.be/nbXXFtF8Lzs>The sun's energy on earth - Wonders of the Solar System<https://youtu.be/c17t_Pf8vI4> |

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| **Unit Title** | **Sequence of learning Lesson title, theme, big question.** |  **Key concepts/outcomes/knowledge and skills.**  | **Assessment/ including specific content/ knowledge/skills tested.** **Green=assess/Blue=improve**  | **HWK. Add** **Hyperlink****To be in books clearly marked** | **Furthering Cultural Capital.****&****Opportunities for reading** | **Recall of prior or future topics –**  | **Lesson resources including or hyperlink to supporting websites/resources/books/texts & individual lessons.** **5xT+L essentials to be included in individual lessons,** |
|  1 | **P1.1 Changes in energy stores** | **Aiming for Grade 4 LOs:*** State some examples of energy stores.
* State the processes that can transfer energy from one store to another.
* Identify changes in some energy stores using simple examples.

**Aiming for Grade 6 LOs:*** Describe a wide range of energy stores in different contexts.
* Describe changes in energy stores in terms of the process that causes the change.
* Use quantitative descriptions of changes in energy stores.

**Aiming for Grade 8 LOs:*** Describe the nature of energy stores in detail including the relationship between objects.
* Explain factors that affect the size of changes in energy stores.
* Represent energy changes graphically, accounting for changes in all stores.
 | **Key questions**1. How can energy be stored?
2. How can energy be transferred?
3. Describe the changes in energy stores that happen when an object falls.
4. Describe the energy transfers that happen when a falling object hits the ground without bouncing back.
 | **Energy Podcast**FoundationHigher**Student book**Changes in energy stores |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**Practical**: Energy circus.**PowerPoint:** Changes in energy stores **Printed resources:**Energy circus  |
|  2 | **P1.2 Conservation of energy** | **Aiming for Grade 4 LOs:*** State that energy is conserved in any transfer.
* State that energy is dissipated (is no longer useful) when it heats the environment.
* Investigate the energy transfers in a pendulum and a bungee.

**Aiming for Grade 6 LOs:*** Apply the law of conservation of energy in straightforward situations.
* Describe the changes in energy stores explaining why energy ceases to be useful.
* Describe the energy changes in a range of experiments and account for energy dissipation to the surroundings.

**Aiming for Grade 8 LOs:*** Apply the law of conservation of energy to explain why forces cause hating effects.
* Describe closed systems and the changes to energy stores within them using the principle of conservation energy.
* Evaluate in detail experiments to investigate energy changes.
 | **Key questions**1. What is conservation of energy?
2. What is a closed system?
3. Describe the changes to energy stores in a closed system.
* Retrieval questions
* Conservation of energy in action
* Investigating pendulums
* Bungee jump
 | **Energy Podcast**FoundationHigher**Student book**Conservation of energy | **Go Further** * Entropy and the heat death of the universe
 |  | **Knowledge organisers**Energy**Retrieval questions**P1**Practical**: Bungee jump**PowerPoint:** Conservation of energy **Printed resources:**Bungee jumpConservation of energy in actionInvestigating pendulumsExtension / optional: Falling cup cakes |
|  3 | **Lesson P1.3 Energy and work** | **Aiming for Grade 4 LOs:**State that energy is measured in joules (J).Calculate the work done by a force.Measure the work done by a force experimentally.**Aiming for Grade 6 LOs:*** Describe the action of frictional forces on objects and the associated heating effect.
* Use the equation for work done to calculate distances or size of forces.
* Use repeat values to measure the work done by a force experimentally.

**Aiming for Grade 8 LOs:*** Use the principle of conservation of energy and forces to explain why objects become heated by frictional forces.
* Apply the equation for work done in a wide range of contexts.
* Evaluate in detail an experiment to measure work done, explaining why there is variation in the measurements.
 | **Key questions**1. What does work means in science?
2. How are work and energy related?
3. Recall the equation for work done.
4. What happens to work done to overcome friction?
 | **Energy Podcast**FoundationHigher**Student book** |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**Practical**: Doing work**PowerPoint:** Conservation of energy**Printed resources:** * Doing work (practical sheet)
* Work, energy, and power (student)
* Work energy and power (teacher)
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|  4 | **Lesson P1.4 Gravitational potential energy stores** | **Aiming for Grade 4 LOs:*** State the factors that affect the change in the gravitational potential energy store of a system.
* Calculate the gravitational potential energy store of a system using the weight of an object and its height.
* Measure the gravitational potential energy store changes in a system with a simple practical activity.

**Aiming for Grade 6 LOs:*** Describe the effect of a different gravitational field strength on the gravitational potential energy store changes of a system.
* Calculate the gravitational potential energy store of a system using the mass, gravitational field strength, and height.
* Describe energy changes that involve a heating effect as opposed to movement of an object.

**Aiming for Grade 8 LOs:*** Perform calculations using rearrangements of the gravitational potential energy store equations.
* Apply the gravitational potential energy store equations in a wide range of contexts.
* Account for all changes of energy during falls or increases in height, including heating effects.
 | **Key questions**1. What is gravitational potential energy?
2. What happens to the gravitational potential energy stores of an object when it moves up or down?
3. Explain why an object moving up has an increase in its gravitational potential energy store.
4. Why it is easier to lift an object on the Moon than on the Earth?
5. Recall the equation gravitational potential energy.
 | **Energy Podcast**FoundationHigher**Student book** |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**Practical**: Stepping up**PowerPoint:** Gravitational potential energy stores**Printed resources:** All work How high? |
|  6 and 7 | **Lesson P1.5 Kinetic and elastic stores** | **Aiming for Grade 4 LOs:*** State the factors that affect the size of a kinetic energy store of an object.
* State the factors that affect the elastic potential energy store of a spring.
* Describe energy changes involving elastic potential energy and kinetic energy stores.

**Aiming for Grade 6 LOs:*** Calculate the kinetic energy store of an object.
* Calculate the elastic potential energy store of a stretched spring.
* Investigate the relationship between the energy stored in a spring and the kinetic energy store of an object launched from it.

**Aiming for Grade 8 LOs:*** Perform calculations involving the rearrangement of the kinetic energy equation.
* Perform calculations involving the rearrangement of the elastic potential energy equation.
* Perform a wide range of calculations involving transfer of energy.
 | **Key questions**1. What does the amount of energy in a kinetic energy store depends on?
2. Recall the equation needed to calculate the amount of energy in a kinetic energy store.
3. What is an elastic potential energy store?
4. Describe how to calculate the energy in an elastic potential energy store.
 | **Energy Podcast**FoundationHigher**Student book**Kinetic and elastic stores |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**Practical**: Investigating kinetic energy stores.**Practical:** Investigating a catapult.**PowerPoint:**Kinetic and elastic stores**Printed resources** Kinetic objects.Calculation sheet energy transfersLiteracy KE and GPE |
|  8 | Lesson P1.6 Energy dissipation | **Aiming for Grade 4 LOs:*** Identify useful and wasted energy in simple scenarios.
* Describe energy dissipation in terms of heating the surroundings.
* Measure the frictional force acting on an object.

**Aiming for Grade 6 LOs:*** Analyse energy changes to identify useful and less useful energy transfers.
* Describe energy dissipation and how this reduces the capacity of a system to do work.
* Investigate the factors that affect frictional forces.

**Aiming for Grade 8 LOs:*** Use a wide range of energy stores and physical processes to decide on wasted and useful energy transfers.
* Apply the concept of energy dissipation in a wide range of scenarios.
* Evaluate in detail an experiment to measure the frictional forces acting on an object.
 | **Key questions**1. What is useful energy?
2. What is wasted energy?
3. What does dissipates mean?
4. What eventually happens to wasted energy?
 | **Energy Podcast**FoundationHigher**Student book**Energy dissipation |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**PowerPoint**: Energy dissipation**Practical:**Investigating friction.**Printed resources:**Useful or useless. |
| 9 | Lesson P1.7 Energy and efficiency | **Aiming for Grade 4 LOs:*** Describe an efficient transfer as one that transfers more energy by a useful process.
* State that the efficiency of an energy transfer is always less than 100%.
* Calculate the efficiency of a simple energy transfer.

**Aiming for Grade 6 LOs:*** Calculate the efficiency of a range of energy transfers.
* Use the law of conservation of energy to explain why efficiency can never be greater than 100%.
* Investigate the efficiency of a motor.

**Aiming for Grade 8 LOs:*** Describe design features that can be used to improve the efficiency of an energy transfer.
* Rearrange the efficiency equation to find input or total output energy.
* Evaluate in detail an efficiency investigation to justify conclusions.
 | **Key questions**1. What is meant by efficiency?
2. What is the maximum efficiency of any energy transfer?
3. How do machines waste energy?
4. How can energy transfers be made more efficient?
 | **Energy Podcast**FoundationHigher**Student book**Energy and efficiency |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**PowerPoint:**Energy and efficiency**Practical:** Investigating efficiency.**Printed resources:**Car efficiency.Energy and efficiency |
| 10 | Lesson P1.8 Electrical appliances | **Aiming for Grade 4 LOs:*** List some example electrical devices.
* Survey a range of electrical devices and their operation.
* Describe the energy transfers carried out by electrical devices.

**Aiming for Grade 6 LOs:*** Rank electrical devices in terms of their power.
* Compare mains-powered and battery-powered devices.
* Describe the processes that waste energy in electrical devices.

**Aiming for Grade 8 LOs:*** Compare electrical devices in terms of efficiency.
* Calculate the efficiency of an electrical device.
* Explain the operation of electrical devices in terms of forces and electric current.
 | **Key questions**1. How is energy supplied to your home?
2. Why are electrical appliances so useful?
3. Give examples of everyday electrical appliances and describe their uses.
4. Explain why it’s important that electrical appliance are efficient.
 | **Energy Podcast**FoundationHigher**Student book**Electrical appliances |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**PowerPoint:****Electrical appliances****Practical:** Everyday electrical devices.**Printed resources:**Making connections. |
| 11 | Lesson P1.9 Energy and power | **Aiming for Grade 4 LOs:*** State the unit of power as the watt and kilowatt.
* With support, rank electrical appliances in order of power.
* Identify ‘wasted’ and ‘useful’ energy transfers in electrical devices.

**Aiming for Grade 6 LOs**:* Calculate the energy transferred by an electrical device.
* Calculate the efficiency of a device from power ratings.
* Find the wasted power of a device.

**Aiming for Grade 8 LOs:*** Compare the power ratings of devices using standard form.
* Apply the efficiency equation in a range of situations, including rearrangement of the equation.
* Combine the electrical power equation with other equations to solve complex problems.
 | **Key questions**1. What is meant by power?
2. How can we calculate the power of an appliance?
3. How can we calculate the efficiency of an appliance in terms of power?
4. How can we calculate the power wasted by an appliance?
 | **Energy Podcast**FoundationHigher**Student book**Energy and power |  |  | **Knowledge organisers**Energy**Retrieval questions**P1**Practical:** Efficiency and power.**Maths skills:** Electrical energy.**Printed resources**Power to the kitchenBig numbersEnergy stores and transfers literacyEfficiency and power practical sheetWS: working with units |
| 12 | Lesson P1 Conservation and dissipation of energy checkpoint | **Aiming for Grade 4*** Name different types of energy store
* Do calculations involving gravitational potential energy, kinetic energy, elastic
* Potential energy, work done, power, and efficiency
* Describe the difference between efficient and inefficient devices in terms of dissipation

**Aiming for Grade 6*** Describe processes in terms of energy stores, and transfers
* Do calculations involving gravitational potential energy, kinetic energy, elastic
* Potential energy, work done, power, and efficiency; including changing the subject of an equation

**Aiming for Grade 8*** Describe processes in terms of energy stores
* Do calculations involving gravitational potential energy, kinetic energy, elastic
* Potential energy, work done, power, and efficiency; including changing the
* Subject of an equation
* Apply what they know about power and efficiency
 | **Summary questions**Self-assessed and improved**Practice questions**Self-assessed and improved**Check point quiz**Self-assessed**Checkpoint** Self-assessed**Checkpoint extension** Self-assessed  | **Energy Podcast**FoundationHigher**Student book**Summary questions**Student book** Practice questions |  |  | **Knowledge organisers**Energy**PowerPoint** Checkpoint**Printed resources**Summary questionsPractice questionsCheck point quizCheckpoint Checkpoint extension  |
| 13 | P1 Energy End of topic test |  | **Teacher assessed**  |  |  |  |  |