**Move It! Teachers' Notes - read more about Connect on the web at: *www.nms.ac.uk/connect***

**Move It!** explores transport, friction and forces and the environmental impact of our travel choices. Pupils can experience F1 racing in our full-size racing car simulator , see the world's oldest steam locomotive and a real F1 car.

**Table 1 – Move It key objects**

| Key object | Description | Background information |
|---|---|---|
| Autogyro | Autogyros are small aircraft that were designed to be used like cars.<br><br>The Weir W-2 autogyro in the Connect Gallery was designed and built in Scotland. It first flew in 1934. | An autogyro (also called a gyroplane or gyrocopter) is an aircraft that resembles a helicopter and combines flight principles from both helicopters and planes.<br><br>Like a helicopter it has a spinning rotor to provide lift. But helicopter rotors are powered by an engine; the rotors of an autogyro spin because of the movement of air past the rotors. They operate in a similar way to Sycamore seed pods that have 'two wings'. As the seed pod starts to fall, it begins to spin. The air movement over the wings keeps them spinning and creates lift, raising the seed pod. Therefore the seed pod stays in the air longer than it would if it had no wings.<br><br>Like an aeroplane, the autogyro needs a separate power source to propel the aircraft forward. Usually an engine-powered propeller is used. As the autogyro is propelled forward, the air moving over the aircraft spins the rotor, which provides the lift. They are more manoeuvrable, can fly slower, take off and land in smaller spaces than planes; they can fly faster than helicopters and, if the engine fails, their rotor continues spinning until the aircraft is on the ground.<br><br>The autogyro made it on to the big screen in the Bond film "You Only Live Twice". The yellow autogyro 'Little Nellie', designed by Q, was heavily fortified with arms. Autogyros are still being developed, and could become a form of everyday transport in the future. |

| Key object | Description | Background information |
|---|---|---|
| Formula One Car | This Stewart-Ford car was raced in the 1998 Grand Prix season. The Stewart team was set up by Scottish three-time World Motor Racing Champion Sir Jackie Stewart and his son Paul. | Formula One racing (also know as Grand Prix racing) is based around a worldwide series of races on purpose-built tracks or closed-off streets. Based on European Grand Prix motor racing of the 1920s and 30s the first Formula One drivers championship was held in 1950.<br><br>Jackie Stewart, a three times World Motor Racing Champion, was born in Dumbartonshire in 1939. Jackie Stewart's racing career was celebrated by Robbie Williams in his song “Supreme”.<br><br>Formula One racing cars are a very different shape to normal cars because they are designed to go much faster. For example, the tyres are much wider and slicker (less ridges) than normal tyres. This is to increase the contact between the tyre and the road. Friction between the road and a car’s tyres is necessary to keep the car on the road, especially when travelling at high speeds.<br><br>Streamlining lowers the air resistance -- that is, the amount of friction between the air particles flowing over the car and the car's surface. Like friction between the tyres and the road, air resistance slows cars down. However, an F1 car uses air resistance to keep it pushed down onto the track because it is travelling so fast. The shape of the front wing is designed partly to maximize downforce on the car, improving control between the car and the track.<br><br>The design of an F1 car is carefully balanced to maximise the benefits of friction and air resistance without being slowed down by them too much. |
| Wylam<br><br>Dilly Locomotive | This is one of the world’s two oldest surviving locomotives. It was built in 1813 and was used to pull coal along the Wylam Wagonway to the river, near Newcastle upon Tyne. | A locomotive is a railway vehicle that provides the power to move the train along the tracks. Wylam Dilly is one of the first railway locomotives, which were powered by steam from burning wood, then later by steam from coal or petroleum.<br><br>Steam engines use the heat produced from burning fuel to heat water in a boiler. The water boils, producing steam that expands, pushing against a piston or turbine. The movement of the piston is used to turn wheels or drive machinery. Steam turbines are still used today for electrical power generation. |

**Table 2 Interactive exhibits**

| Interactive | Description | Background information | Learning Outcomes |
|---|---|---|---|
| Air Track<br>(best for 6-12 yrs) | An air track and a model train track sit side by side. You can compare the tracks by pushing a train along each one. Can you work out why the air track train travels much further? | Engineers are continually innovating to enable us to travel further, faster and more efficiently. **Friction** is a force which opposes movement. Friction between the track and the train slows the train down and eventually stops it. Controlling friction increases the train's efficiency, enabling it to go faster and further for the same amount of energy.<br><br>Friction occurs when particles/surfaces rub against each other. Rough surfaces generate more friction than smooth surfaces because the rough surfaces catch on each other more. The air track puts a cushion of air between the track and the train which reduces friction between the two surfaces. If there was no friction, an object could continue to move forever. | Friction causes moving objects like trains to lose speed.<br><br>Without friction a moving object would continue to move forever (Newton's 1st law). |
| Design for Speed<br>(best for 8-14 yrs) | Design your own racing car. Test your design in a virtual 'wind tunnel' and then test drive the car. What is your speed score? And how easy is your design to control?<br><br>Remember, the fastest car doesn't always have the most. You need a combination of speed and control. | Engineers are continually innovating to enable us to travel further, faster and more efficiently.<br><br>**Friction** occurs when particles/surfaces rub against each other. Friction is a **force** which opposes movement. Rough surfaces generate more friction than smooth surfaces. Friction between the road and a car's tyres is necessary to keep the car on the road, especially when travelling at high speeds, but too much friction can slow the car down.<br><br>How streamlined a car is depends on its shape. The more rounded and smooth the outside of the car is the easier it is for air to flow over the car. This is called **streamlining**. Streamlining lowers the **air resistance** -- that is, the amount of friction between the air particles flowing over the car and the car's surface. The streamlining of an F1 car is mainly down to the front wing, the back wing and the way the air flows between these wings. The shape of the front wing is designed not only to maximize down force (and hence control between the car and the track) but also to direct airflow towards the rear. Note that the airflow underneath the car is just as important as the air going over the top. | Friction slows moving objects down.<br><br>Streamlining lowers air resistance.<br><br>Controlling friction and streamlining increases a car's efficiency, enabling it to go faster for the same amount of energy. |

| Interactive | Description | Background information | Learning Outcomes |
|---|---|---|---|
| F1 Test Drive<br>(best for 5-14 yrs) | This computer interactive lets you get behind the wheel of a Formula One car. You need to control it with the steering wheel and brake.<br>Being the fastest to get round the track isn't simply a question of pressing down on the accelerator and steering. Understanding the physics involved in driving helps to safely negotiate the track. | When your car is moving, the main **forces** acting on your car are the force moving it forward (engine power) which is opposed by **frictional** and **air resistance** forces. When your car is travelling at a constant speed, these forces acting on your car are **balanced**. When you are accelerating the engine power moving your car forward is greater than the frictional and air resistance forces. When your car slows down the forces opposing movement, including breaking, are greater than the force moving the car forward.<br>Understanding cornering is essential to winning. On the straights, the race is determined by the power of the engine and brakes. However, to negotiate the corners you need to master the 'traction circle', which depends on the frictional force between the tyres and the road. To make the most of the available tyre grip you need to use a combination of breaking, turning and acceleration. If you under-steer the front tyres loose their grip and the car runs wide. If you over-steer the back tyres lose their grip and the back end of the car skids and tries to overtake the front. To win the race, you need to balance control on the corners with speed on the straights. | Physics is not just a subject that you study in class.<br>To be a successful racing driver you need to know about physics, especially speed, acceleration and forces (including friction). |
| How Green Do You Travel?<br>(best for 7+ yrs) | How do you travel to school or work? How do you travel on holiday? See how you compare with other visitors and find out about how you can travel in a 'greener' way. | **Transport** affects the way we live and work and it affects the **environment** in which we live. Many forms of transport cause **pollution** and most produce **carbon dioxide** gas (a product of burning carbon-based fuel, e.g. petrol). Carbon dioxide is often called a **greenhouse** gas. Carbon dioxide in the Earth's atmosphere allows sunlight through the atmosphere (which warms up the Earth) but stops heat from escaping back out into space. Too much carbon dioxide and other greenhouse gases in the atmosphere means the Earth gets hotter and hotter – this is called **global warming**. Global warming may be responsible for changing weather patterns across the world.<br>Some methods of transport are more environmentally friendly than others (e.g. produce less carbon dioxide and other pollution). How we choose to travel can affect the amount of carbon dioxide we are responsible for in the atmosphere. | The way we use transport in our everyday lives affects the environment.<br>We have the power to make more 'environmentally friendly' personal choices or to put pressure on local and national government to supply more environmentally friendly options. |

**Table 3 Move It: keywords, concepts and curricular links**

| Exhibit | Keywords and Concepts | Curricular Links | Renfrewshire Topics (Edinburgh) |
|---|---|---|---|
| Air Track<br>can be linked with:<br>Design for Speed<br>Wylam Dilly | Forces<br>Friction<br>Push and Pull | **Energy and Forces:** Forces and their effects<br>Level B – describe the effect that a push and pull can have on the direction, speed or shape of an object [ISE5-14 EF-B3.1].<br>Level C - Give some examples of friction. Explain friction in simple terms [ISE5-14 EF-C3.1/3. 2].<br>**Standard Grade Physics**<br>Unit 5: Transport<br>Section 2 Forces at work - Friction and movement | **P3 – Forces**<br>Describe the effect that a push and pull can have on the direction, speed or shape of an object.<br>Give some examples of friction.<br>Explain friction in simple terms. |
| Design for Speed<br>can be linked with:<br>Air Track<br>Formula One Car<br>F1 Test Drive | Air resistance<br>Forces<br>Friction<br>Streamlining | **Energy and Forces:** Forces and their effects<br>Level C - Give some examples of friction. Explain friction in simple terms. Describe air resistance in terms of friction [ISE5-14 EF-C3.1/C3.2/C3.3].<br>Level D – give examples of streamlining and explain how this lowers resistance [ISE5-14 EF-D3.1].<br>**Standard Grade Physics**<br>Unit 5: Transport<br>Section 2 Forces at work - Friction and movement | **P3 – Forces**<br>Give some examples of friction.<br>Explain friction in simple terms.<br>**P6 – Air Resistance & Gravity**<br>Describe air resistance in terms of friction.<br>Give examples of streamlining and explain how this lowers resistance. |

| Exhibit | Keywords and Concepts | Curricular Links | Renfrewshire Topics (Edinburgh) |
|---|---|---|---|
| F1 Test Drive<br>can be linked with:<br>Formula One Car<br>Design for Speed | Air resistance<br>Forces<br>Friction<br>Streamlining<br>"Balanced and unbalanced forces." | **Energy and Forces:** Forces and their effects<br>Level B - Describe the effect that a push and pull can have on the direction, speed or shape of an object [ISE5-14 EF-B3.1].<br>Level C - Give some examples of friction. Explain friction in simple terms. [Describe air resistance in terms of friction [ISE5-14 EF-C3.1/C3.2/C3.3].<br>Level E – Describe the effects of balanced and unbalanced forces [ISE5-14 EF-E3.1].<br>**Standard Grade Physics**<br>Unit 5: Transport<br>Section 2 Forces at work - Friction and movement | **P3 – Forces**<br>Describe the effect that a push and pull can have on the direction, speed or shape of an object.<br>Give some examples of friction.<br>Explain friction in simple terms.<br>**P6 – Air Resistance & Gravity**<br>Describe air resistance in terms of friction.<br>**S1 – Force and Gravity**<br>Balanced and unbalanced forces.<br>The conversion of chemical potential energy into kinetic/movement energy. |

| Exhibit | Keywords and Concepts | Curricular Links | Renfrewshire Topics (Edinburgh) |
|---|---|---|---|
| How Green Do You Travel?<br>can be linked with:<br>Autogyro<br>Formula One Car<br>World Energy: You're in charge!<br>Wylam Dilly | Carbon Dioxide<br>Environment<br>Global Warming<br>Greenhouse Gas<br>Pollution<br>Transport | **Technology:** Needs and how they are met<br>Level A – talk about some everyday needs and the things that are made to meet these [ISE5-14 KUT-A1.1]<br>Level C – suggest how people's needs differ. Suggest ways in which people can meet needs of other living things and the environment [ISE5-14 KUT-C1.1 & 3]<br>Levels D & E – explain how technological activity can affect the needs of people and the environment [ISE5-14 KUT-D1.4 & E1.4]<br>Skills – developing informed attitudes [e.g. DIAT-A3.2]<br>**People and place:** Human-physical interactions<br>Level F – explain why conservation of natural resources is important both in a local and global context [ISE5-14 PPL-F4.3].<br>**People in society:** Conflict and decision-making in society<br>Level D – describe the ways in which the media can affect personal decision-making [ISE 5-14 PS-D3.2].<br>Level E – identify ways that citizens can participate in decision-making through elections and pressure groups. Give examples of the ways in which local and national government make decisions that affect people's lives [ISE5-14 PS-E3.1].<br>Level F – explain the ways in which campaigners, media and pressure group activities influence public opinion [ISE5-14 PS-F3.1].<br>**Standard Grade Biology**<br>Topic 1: The Biosphere<br>Control and management | **P7 – Our Environment**<br>Describe examples of human impact on the environment that have brought about beneficial changes and examples that have detrimental effects. |