Teacher(s)		**Subject group and discipline**	**Sciences – Physics**		
Unit title	**2 How do forces and matter interact?**	**MYP year**	4	**Unit duration (hrs)**	

Inquiry: Establishing the purpose of the unit

Key concept	**Related concept**	**Global context**
Relationships	**Interaction**	**Identities and relationships**

Statement of inquiry

By identifying ***relationships*** of ***similarity and difference*** we understand how force and matter ***interact***.

Inquiry questions

Factual— What forces are there? How strong are different forces? What is the strongest force? What is the weakest force?

Conceptual— How do forces and matter interact? How far do forces reach? Where do forces begin and where do they end? What holds the Universe together? What stops the Universe from collapsing in on itself?

Debatable— Is any force more important than others across the Universe? Can we control natural forces?

Objectives	**Summative assessment**	
	Outline of summative assessment task(s) including assessment criteria:	**Relationship between summative assessment task(s) and statement of inquiry:**
A: All strands	Criterion A: Knowing and understanding – *Activity: Analysing gravitational fields* Criterion A: Knowing and understanding – *Levelled summative assessment problems*	The task in the DL resources is modified to allow for summative assessment of Criterion A to levels 7–8. The task requires students to interpret data on variation in gravitational field strength from NASA's GRACE satellite. Levelled problems designed to test knowledge and understanding
D: All strands	Criterion D: Reflecting on the impacts of science – *Activity: Recycling – a win–win for the planet*	Evaluating the use of electromagnetic fields to collect metals in recycling plants, and the impact of metal recycling

Approaches to learning (ATL)
Critical-thinking skills: evaluate evidence and arguments interpret data draw reasonable conclusions and generalizations use models and simulations to explore complex systems and issues identify trends and forecast possibilities **Information literacy skills:** organize and analyse data using digital tools

Action: Teaching and learning through inquiry

Content	Learning process
All students should: **Recall** the names of the four 'fundamental' forces **State** that force is measured in newtons **Interpret** a range of examples for each of the four fundamental forces **Analyse** the four fundamental forces in terms of strength and distance of action **Apply** the reciprocal nature of distance–strength relationships to explain observations **Outline** that matter is both kept together and kept apart by electrostatic attraction and repulsion *Some students could:* **Recall** that strength of force fields is usually proportional to $1/r^2$ **Outline** the significance of the relative sizes of the gravitational and	**Learning experiences and teaching strategies** • ***Activity: A forces smorgasbord*** (pp. 24–25) In pairs or individually – in the circus of activities, students make preliminary observations of the different types of force and familiarise themselves with their properties. These ideas may already be somewhat familiar to those who have studied forces before, so the activities have been chosen to be unfamiliar in context. • **DYNAMIC LEARNING Activity: A forces smorgasbord – observation sheet** • **DYNAMIC LEARNING Interactive activity: Properties of fundamental forces** • ***Activity: Observing the form of magnetic fields*** (p. 27) In pairs or individually – students use iron filings to visually observe the extent and form of a force field. This is a simple experiment which may be familiar, although the effect on the field of the interaction of poles is not often dealt with earlier in science programmes. • **DYNAMIC LEARNING Demonstration: Observing electrical fields (teacher notes)** This teacher demonstration requires the use of an EHT supply and suitable oil as a dielectric medium. With care, students can observe that the charge-carrying particles (pepper, pollen or similar) orientate along electric field lines, which form the same shape as those observed between attracting magnetic poles. • ***Activity: Measuring Earth's gravitational field strength*** (pp. 30–31) In pairs or individually – this simple experiment with Newton meters aims to introduce the concept of gravitational field strength, and to define the concept of *weight* in terms of gravitational force acting on a mass. It also provides the data for introducing the technique of best-fit line and the idea of a linear relationship, and of gradient/slope. Finally the evaluation prompts students to relate their experiment evaluations to the *quality* of the data obtained, rather than to other kinds of evaluation encountered in

Coulomb constants	other subject areas. • **DYNAMIC LEARNING Activity: Measuring Earth's gravitational field strength (student sheet)** • **DYNAMIC LEARNING Activity: Measuring Earth's gravitational field strength (teacher notes and assessment rubric)** • ***Activity: Analysing gravitational fields*** (p. 32) In pairs or individually – this is a visual interpretation task looking at an image of Earth's gravitational field taken by the GRACE satellite. It encourages students to synthesize what they have learnt about gravitational field and mass, while also challenging the idea that gravitational field is uniform across the surface of the Earth. It then extends to the less familiar context of different planets with different gravitational field strengths. • **DYNAMIC LEARNING Activity: Analysing gravitational fields (student sheet)** This student resource has hi-res whole-Earth and '3D geoid' versions of the GRACE mappings for comparison. The questions on this task sheet allow for summative assessment of the activity. • **DYNAMIC LEARNING Activity: Analysing gravitational fields (teacher notes and assessment rubric)** • ***Activity: Lift off! Analysing the variation of gravitational field strength with distance*** (pp. 33–34) Individually – this is a data analysis exercise that gives students the opportunity to explore the inverse-square relationship for *g* with distance *r* from a mass, and then to evaluate the experimental method in terms of the quality of the data. • **DYNAMIC LEARNING Activity: Lift off! Analysing the variation of gravitational field strength with distance (student spreadsheet)** This spreadsheet provides data enabling students to model Earth's gravitational field. • ***Activity: Modelling force fields*** (p. 35) Individually – the activity allows students to infer the asymptotic relationship with distance. • **DYNAMIC LEARNING Activity: Modelling force fields (student spreadsheet)** This spreadsheet provides data enabling students to model an electric field and a gravitational field. Students can alter values of charge, mass or distance and the model plots the field variation for 100

	points from the centre of the force field to the distance desired. • ***ACTIVITY: Recycling – a win-win for the planet*** (p. 36) Individually – the 'Impacts of Science' activity on metals recycling is designed to promote reflection on the real-life applications of electromagnetic fields. • **DYNAMIC LEARNING Activity: Recycling – a win–win for the planet (teacher notes and assessment rubric)** • **DYNAMIC LEARNING Interactive activity: Finding the gradient** • ***Summative problems*** (pp. 37–38) • **DYNAMIC LEARNING Solutions to summative problems**
	Formative assessment ***Activity: Measuring Earth's gravitational field strength*** and ***Activity: Lift off! Analysing the variation of gravitational field strength with distance*** provide opportunities for formative assessment of Criterion C, although not all strands. ***Activity: Analysing gravitational fields*** as given in the book provides for formative assessment to levels 3–4 in Criterion A. ***Activity**: **Modelling force fields*** might be a useful opportunity, as an extension task, to develop students' IT media literacy skills through writing their own spreadsheet, or making their own graphs from the computed data, rather than using the spreadsheet model provided.
	Differentiation The content is developed through group- or pair-based discussion activities, allowing for students to support each other. Use of simple visible thinking techniques is made to provide variety in learning modes. Task sheets for the experimental investigations provide scaffolding and writing frames to structure the investigation and guide students through the experiment investigation cycle. The summative problems are levelled, but each problem contains parts that can be accessed at the lower

	levels of achievement. Key/access vocabulary is highlighted for English language learners. The chapter includes a range of activities from relatively straightforward observational tasks through to a complex culminating laboratory task and modelling exercise. The teacher notes give task-adapted rubrics with information on how each activity addresses each of the strands within a learning objective to each level of achievement.
Resources	
PowerPoint presentation: **DYNAMIC LEARNING Building blocks presentation** for Chapter 2	

Reflection: Considering the planning, process and impact of the inquiry

Prior to teaching the unit	During teaching	After teaching the unit