**Continuity of Learning - Part 01**

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| **Name:** |  | **Group:** |  |

The purpose of this block of learning is to try to get you grounded in the Science & Principles as they apply to **Basic Mechanics** and the relationship between **force**, **work**, **energy** and **power**. It covers: -

* **Step 1** What is meant by **mass** and **weight**
* **Step 2** The principles of basic mechanics as they apply to **levers**, **gears** and **pulleys**
* **Step 3** The relationship between **force**, **work**, **energy**, **power** and **efficiency and**
* **Steps 1 - 3** Carrying out relevant **calculations** of all of the above

This sheet contains a study plan with **Steps** that must be followed in the order laid out; skipping steps or undertaking them in the wrong order **will not help at all**.

References for research and study including the **Heinemann Text Book B, Chapter ELTK 08** and YouTube video links, are shown below each answer box.

**Step 1** We need to understand the difference between **Weight** and **Mass**

1. Give a definition for each of the two quantities:

|  |  |  |
| --- | --- | --- |
| **Quantity** | **Definition** | |
| **Mass** |  | |
| **Weight** |  | |
| **References:**   * **Text Book B Chapter ELTK 08 pages 213 & 246** | | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) |

1. What are the **Symbols** and **Units** associated with **Weight** and **Mass**?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Quantity** | **Quantity Symbol** | **Unit** | | **Unit Symbol** |
| **Mass** |  |  | |  |
| **Weight** |  |  | |  |
| **References:**   * **Text Book B Chapter ELTK 08 pages 213 & 246** | | | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) | |

1. Which formula links **Force** (weight) and **Mass**?

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) **1:22** |

**Step 1 (continued)**

1. On earth what is the value generally accepted for the **Force due to Gravity** at sea level?

(answer to 1 d.p.)

|  |  |  |
| --- | --- | --- |
| **Value** | | **Units** |
|  | |  |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) **1:45** | | |

1. Calculate the **Force** of an object with a mass of 2kg and an acceleration of 9.81 m/s2 ?

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) **1:22** |

1. Calculate the **Weight** of an object with a mass of 500g and an acceleration of 25 m/s2 ?

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) **1:22** |

1. Calculate the **Weight** of an object on Earth that has a Weight of 160 N on the Moon?

(Use values of 9.81 m/s2 and 1.6 m/s2 respectively)

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) **1:22** |

1. What is the **Mass** of an object on the Moon that has a mass of 10kg on Earth?

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [Weight, Force, Mass & Gravity](https://www.youtube.com/watch?v=U78NOo-oxOY) **1:22** |

**Step 2a** We need to understand how **levers** let us use a small force to apply a larger force to an object.

1. With the aid of a diagram, give one example of each of the three classes of lever.

For each label the diagram with the **Fulcrum** (Pivot) **Force** (Effort) and **Load**.

|  |  |  |
| --- | --- | --- |
| **Class** | **Example** | |
| **I** |  | |
| **II** |  | |
| **III** |  | |
| **References:**   * **Text Book B Chapter ELTK 08 pages 247- 248** | | * **YouTube videos:** [Types of levers](https://www.youtube.com/watch?v=J2Nt_rRa3JY) |

1. Identify the **Class of lever** for the following items (First, Second, or Third)

|  |  |  |
| --- | --- | --- |
| **Item** | | **Class of Lever** |
| **Sack Trucks** | |  |
| **Crowbar** | |  |
| **Wheel Barrow** | |  |
| **Tweezers** | |  |
| **References:**   * **Text Book B Chapter ELTK 08 pages 247- 248** | | * **YouTube videos:** [Types of levers](https://www.youtube.com/watch?v=J2Nt_rRa3JY) | |

**Step 2b** We need to understand how **gears** let us change **speed** and/or **direction** of rotation, and to gain **mechanical advantage**.

1. What is the ratio (speed multiplier) where the Driver Gear has 50 teeth and the Driven Gear has 10 teeth?

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| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 248** | * **YouTube videos:** [GEARS - the Basics](https://www.youtube.com/watch?v=uz436Ixbl-I) |

1. What is the mechanical advantage (speed multiplier) where the Driven Gear has a circumference of 300cm and the Driver Gear has a circumference of 30cm

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 248** | * **YouTube videos:** [GEARS - the Basics](https://www.youtube.com/watch?v=uz436Ixbl-I) |

1. If the Driver gear is rotating at 160 rpm, what is the output speed?

|  |  |  |
| --- | --- | --- |
|  | |  |
| **References:**   * **Text Book B Chapter ELTK 08 page 248** | * **YouTube videos:** [GEARS - the Basics](https://www.youtube.com/watch?v=uz436Ixbl-I) | |

1. Using the following formula, calculate the Velocity Ratio of the example in c) above:

**Velocity ratio = number of teeth on the driven gear**

**number of teeth on the driver gear**

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 248** | * **YouTube videos:** [GEARS - the Basics](https://www.youtube.com/watch?v=uz436Ixbl-I) |

**Step 2c** We need to understand how **pulleys** enable us to gain **mechanical advantage**.

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| --- | --- | --- |
|  | 1. What downward force on the rope is required to lift the 100N load (approximately 10kg) shown? | |
| **References:**   * **Text Book B Chapter ELTK 08 pages 249-251** | | * **YouTube videos:** [Pulleys and Mechanical Advantage](https://www.youtube.com/watch?v=6GuldysCVjI) |

|  |  |  |
| --- | --- | --- |
|  | 1. Explain the advantage of pulley system B over pulley system A | |
| **References:**   * **Text Book B Chapter ELTK 08 pages 249-251** | | * **YouTube videos:** [Pulleys and Mechanical Advantage](https://www.youtube.com/watch?v=6GuldysCVjI) |

1. What is the mechanical advantage (speed multiplier) where the Driven Gear has a circumference of 300cm and the Driver Gear has a circumference of 30cm

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 248** | * **YouTube videos:** [GEARS - the Basics](https://www.youtube.com/watch?v=uz436Ixbl-I) |

**Step 3a** We need to understand the **relationship** between **Force**, **Work done**, **Energy** and **Power**.

We have already established that **Force** is a push or pull that acts on an object and is in **N**ewtons.

**Reminder**: At sea level a mass of **1 kg** will exert a **Force** of **9.81** **N (F** = **m** × **a) : (F = 1 × 9.81)**.

1. What is the S.I. Unit and Symbol used to measure **Energy and Work done** in physics?

|  |  |
| --- | --- |
| **Unit** | **Symbol** |
|  |  |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [What is a Joule?](https://www.youtube.com/watch?v=BYpZSdSEk4A) |

1. What is the definition of a **Joule**?

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [What is a Joule?](https://www.youtube.com/watch?v=BYpZSdSEk4A) **1:30** |

1. What is the formula used to calculate the amount of **Work done** when an object is moved?

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [What is a Joule?](https://www.youtube.com/watch?v=BYpZSdSEk4A) **2:45 – 7:15** |

1. Calculate the amount of **Work done** when lifting a 20kg reel of cable 2m.

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [What is a Joule?](https://www.youtube.com/watch?v=BYpZSdSEk4A) **8:00** |

1. A site hoist raises a 150kg load 20m. Calculate the **Work done** in kiloJoules (**kJ**).

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253** | * **YouTube videos:** [What is a Joule?](https://www.youtube.com/watch?v=BYpZSdSEk4A) **8:00** |

**Step 3b** We need to understand that **Energy** is what is required to get the **Work done**, whereas **Power** is what is required to get the **Work done** in a certain **time**.

1. Give a **definition** for both **Potential energy** and **Kinetic energy**.

|  |  |
| --- | --- |
| Potential energy is | |
| Kinetic energy is | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253 -255** | * **YouTube videos:** [Kinetic and Potential Energy](https://www.youtube.com/watch?v=eBsU9DVa7ws) |

1. Give an **electrical related example** for a source of **Potential energy** and **Kinetic energy**.

|  |  |
| --- | --- |
| A potential energy source | |
| A kinetic energy source | |
| **References:**   * **Text Book B Chapter ELTK 08 page 253 -255** | * **YouTube videos:** [Kinetic and Potential Energy](https://www.youtube.com/watch?v=eBsU9DVa7ws) |

1. **Power** is the rate of work done and is in Joules per second. What other more common unit is used by electrical engineers?

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 255** | * **YouTube videos:** [Energy, Work and Power](https://www.youtube.com/watch?v=pDK2p1QbPKQ) **2:30** |

1. Give a formula for **Power** (watts) that includes the following: **Power**, **Force**, **Distance** and **Time**

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 255** | * **YouTube videos:** [Energy, Work and Power](https://www.youtube.com/watch?v=pDK2p1QbPKQ) **2:30** |

**Step 3b continued**

1. A Tower crane lifts a load of 1000kg a vertical distance of 40m in 20 seconds. Calculate the power output of the crane motor.

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 255** | * **YouTube videos:** [Energy, Work and Power](https://www.youtube.com/watch?v=8jC8AzyuiwM) **8:50** |

1. Energy is the amount of work done and is in Joules. What other more common unit is used by electricity supply companies?

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 286** | * **YouTube videos:** [Power v Energy](https://www.youtube.com/watch?v=b6l2XYwP-v0) **1:30** |

1. Calculate the **Energy** (kilowatt/hours) consumed by a 22kW motor running for 45 minutes.

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 255** | * **YouTube videos:** [Energy, Work and Power](https://www.youtube.com/watch?v=pDK2p1QbPKQ) **2:30** |

1. Calculate the **Energy** (kilowatt/hours) consumed by a 60W pump motor running for 24 hours.

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 255** | * **YouTube videos:** [Energy, Work and Power](https://www.youtube.com/watch?v=pDK2p1QbPKQ) **2:30** |

**Step 3c** Electric motors will state the **Output Power** usually in **Watts** but occasionally in **Horsepower**.

This is the Power that can be produced at the motor shaft (**NOT** the Input Power)

1. Give the equivalent power for each of the following motor **Output Powers**:

|  |  |
| --- | --- |
| **S.I. Units** | **Imperial Units** |
| **370 W** |  |
|  | **1 H.P** |
| **2.2kW** |  |
|  | **15 H.P** |
| **22 kW** |  |
| **References:**   * **YouTube videos:** [Motor Horsepower v Watts](https://www.youtube.com/watch?v=h4vdcLDlU_I) | |

Electric motors will not state the **Input Power** of the motor but this can be calculated.

1. What is the basic formula used to calculate the amount of **Power** taken by a load?

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| --- | --- |
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| **References:**   * **Text Book B Chapter ELTK 08 page 283** | * **YouTube videos:** [Calculating Power in an Electrical Circuit](https://www.youtube.com/watch?v=9omx07AKH5Q) |

1. Calculate the amount of **Power** taken by a 230V motor where the current drawn is 9.6 Amps?

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 283** | * **YouTube videos:** [Calculating Power in an Electrical Circuit](https://www.youtube.com/watch?v=9omx07AKH5Q) |

1. Calculate the amount of **Power** taken by a 400V motor where the current drawn is 25 Amps?

|  |  |
| --- | --- |
| **Show formula used and working out** | |
| **References:**   * **Text Book B Chapter ELTK 08 page 283** | * **YouTube videos:** [Calculating Power in an Electrical Circuit](https://www.youtube.com/watch?v=9omx07AKH5Q) |

**Step 3c continued**

No electric motor is 100% **Efficient**, meaning there are **losses** between the Input Power and the Output Power.

1. Give a formula for Efficiency that includes the following: **Efficiency**, **Input Power**, **Output Power**.

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 256** | * **YouTube videos:** [Efficiency](https://www.youtube.com/watch?v=7hcv_mxcA-g) |

1. A 750 W, 110 V motor draws a current of 9 A from the supply. Determine the efficiency

of this motor.

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 256** | * **YouTube videos:** [Efficiency](https://www.youtube.com/watch?v=7hcv_mxcA-g) |

1. A 3 kW, 240 V motor draws a current of 10 A from the supply. Determine the efficiency

of this motor.

|  |  |
| --- | --- |
|  | |
| **References:**   * **Text Book B Chapter ELTK 08 page 256** | * **YouTube videos:** [Efficiency](https://www.youtube.com/watch?v=7hcv_mxcA-g) |