P 9.2.1 Gravity

Practicals and Examples

1.1 Define **weight** as the force on an object due to a gravitational field

Example: Find gravitational acceleration on the surface of the moon, given mass is 7.36×10^{22} kg and radius is 1740 km.

$$g = \frac{GM}{d^2}$$

$$= \frac{6.67 \times 10^{-11} \times 7.36 \times 10^{22}}{(1740000)^2}$$

$$= 1.62\ ms^{-2}$$

Example: Find the force of attraction between two 700 kg balls placed 10 metres away from their centres.

$$F = G\frac{m_1 m_2}{d^2}$$

$$= \frac{6.67 \times 10^{-11} \times 700 \times 700}{10^2}$$

$$= 3.2683 \times 10^{-7}\ N$$

1.2 Explain that a change in **gravitational potential energy** is related to **work done**

See page 11 PiF

1.3 Define **gravitational potential energy** as the work done to move an object from a very large **distance** away to a point in a gravitational field

See page 11, 12 PiF

1.P1 Perform an investigation and gather information to determine a **value for acceleration due to gravity** using pendulum motion or computer-assisted technology and identify **reason for possible variations from the value 9.8ms^{-2}**

- Retort stand, swing a 20 g mass on a 1 metre string, with 10 oscillations
- Period (seconds) measured and the formula $T = 2\pi\sqrt{\frac{l}{g}}$ (T = period (s), l = length (m), g = acceleration (ms^{-2}))
    - i.e. $g = \frac{4\pi^2 l}{T^2}$ *or* $\boldsymbol{g = \frac{kl}{T^2}}$
- Different lengths produced different times and an average was taken
- Accuracy: human reaction time for stopwatch, 10 oscillations to increase accuracy
- Validity: value of g affected by **altitude, spinning Earth**

1.P2 Gather secondary information to **predict the value of acceleration due to gravity on other planets**

- Data gathered from online sources
- Measured using $g = G\frac{m_{planet}}{r_{planet}^2}$ (see 1.1)
- See page 6 PiF

1.P3 Analyse information using the expression: $\boldsymbol{F = mg}$ to determine the **weight force for a body on Earth** and for the same body on other planets

$$F = mg$$

F = force/weight (N), m = mass (g), g = gravitational acceleration (9.8ms^{-2} on Earth)

- Use $F = mg$ to find the weight of objects on different planets when given its mass and acceleration due to gravity of that planet
- See page 7 PiF