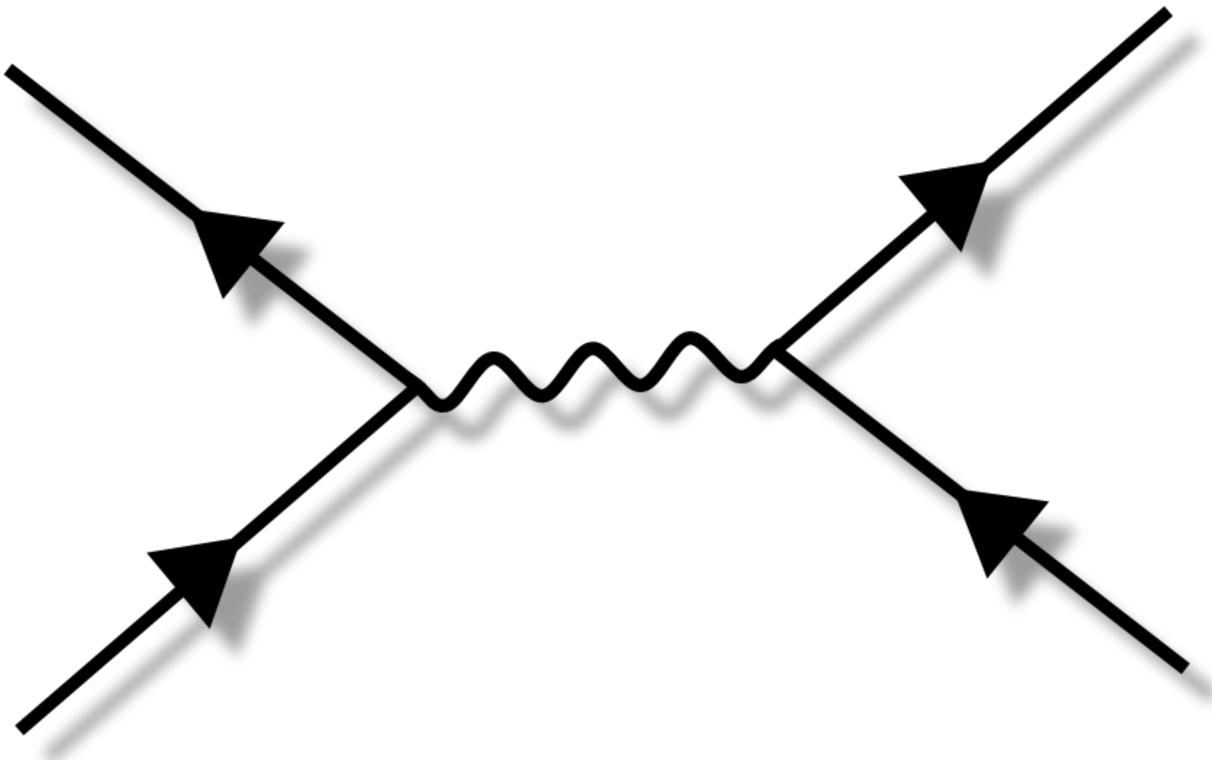

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1st September

1. **Complete** the following mega table:

	Quantity	Symbol	Unit
a.	Activity		
b.	Angular frequency		
c.	Angular velocity		
d.	Atomic mass unit		
e.	Avogadro constant		
f.	Boltzmann constant		
g.	Capacitance		
h.	Decay constant		
i.	Electric field strength		
j.	Electric potential		
k.	Gravitational constant		
l.	Gravitational potential		
m.	Half-life		
n.	Magnetic field strength		
o.	Magnetic flux		
p.	Magnetic flux density		
q.	Molar gas constant		
r.	Nucleon number		-
s.	Number of molecules		-
t.	Number of moles		-
u.	Number of primary turns (transformer)		-
v.	Number of secondary turns (transformer)		-
w.	Permittivity of free space		
x.	Relative permittivity		-
y.	Time period		
z.	Time constant		

2nd September

1 2 3

1. Write down the **value** and **units** for the following:

   a. Gravitational constant

   b. Gravitational field strength on the surface of the Earth

   c. Mass of the Earth

2. Explain how something can be **accelerating** while at a constant **speed**. Give an example in your answer.

3. Define what is meant, in physics, by:

   a. A **field**

   b. A **magnetic** field

   c. A **gravitational** field

   d. An **electric** field

3rd September

1 2 3

1. Write down the **value** and **units** for the following:

    a. Gravitational constant

    b. Permittivity of free space

    c. Elementary charge

2. State the **force** that provides the centripetal force responsible for circular motion in the following examples:

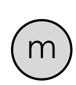
    a. The **Earth** orbiting the Sun

    b. A **rubber bung** being swung round on a string

    c. A **motorbike** going round a roundabout

3. The gravitational field around an object with mass can be represented by radial field lines.

    Draw at least eight field lines (with arrows) around this point mass and explain how the field lines represent the direction and strength of the force experienced by a mass in the field.



4th September

1 2 3

1. Write the following angles in **radians**, leaving your answer in its exact form (e.g. π/4):
   a. 360˚
   b. 180˚
   c. 90˚
   d. 30˚

2. State the **force** that provides the centripetal force responsible for circular motion in the following examples:
   a. The **Sun** orbiting Saggitarius A*, the black hole at the centre of the Milky Way
   b. A **cyclist** riding anti-clockwise on the sloped banks of a velodrome
   c. A **Supermarine Spitfire Mk Vb** flying in a horizontal circle

3. **Draw** the Earth's gravitational field at ground level.

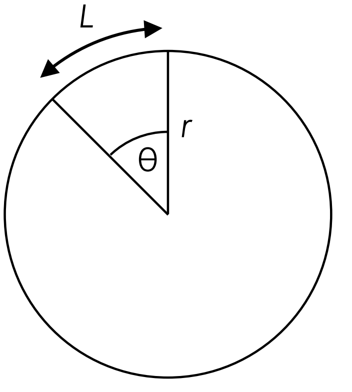
   Explain what the field lines represent in terms of Earth's gravitational field strength at its surface.

5th September

1 2 3

1. Write the following angles in **degrees**:
   a. 1.00 rad
   b. 2π rad
   c. π/2 rad
   d. π/3 rad

2. The circumference of a circle's radius, r, is given by $c = 2\pi r$.



   a. Write an expression for the **length** of an arc, *L*, subtended by an angle, θ, given in **degrees**
   b. Write an expression for the **length** of an arc, *L*, subtended by an angle, θ, given in **radians**

3. a. State **Newton's law of gravitation** in words
   b. Write the equation for calculating the size of the **gravitational force** of attraction between two objects
   c. Calculate the **gravitational force** of attraction, due to Earth's gravity, on someone with a mass of 88.5 kg

$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

$m_{Earth} = 5.97 \times 10^{24}$ kg

$r_{Earth} = 6370$ km

   d. Use the equation $W = mg$ to calculate the **weight** of the person

$g = 9.81$ N kg^{-1}

6^{th} September

1 2 3

1. Write the following angles in **radians**:
   a. 57.3˚
   b. 18.6˚
   c. 302˚
   d. 451˚

2. Calculate the linear **speed** of an object that travels in a circle, with a radius of 2.8 m, through an angle of 2.9 rad in a time of 10 s.

3. The equation to calculate the size of the gravitational field strength at a point is given by:

$$g = GM / r^2$$

   a. Use this to calculate **g** on the **surface** of the Earth

$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

$m_{Earth} = 5.97 \times 10^{24}$ kg

$r_{Earth} = 6370$ km

   b. Calculate the gravitational field strength of the **Moon** at its surface

$m_{Moon} = 7.35 \times 10^{22}$ kg

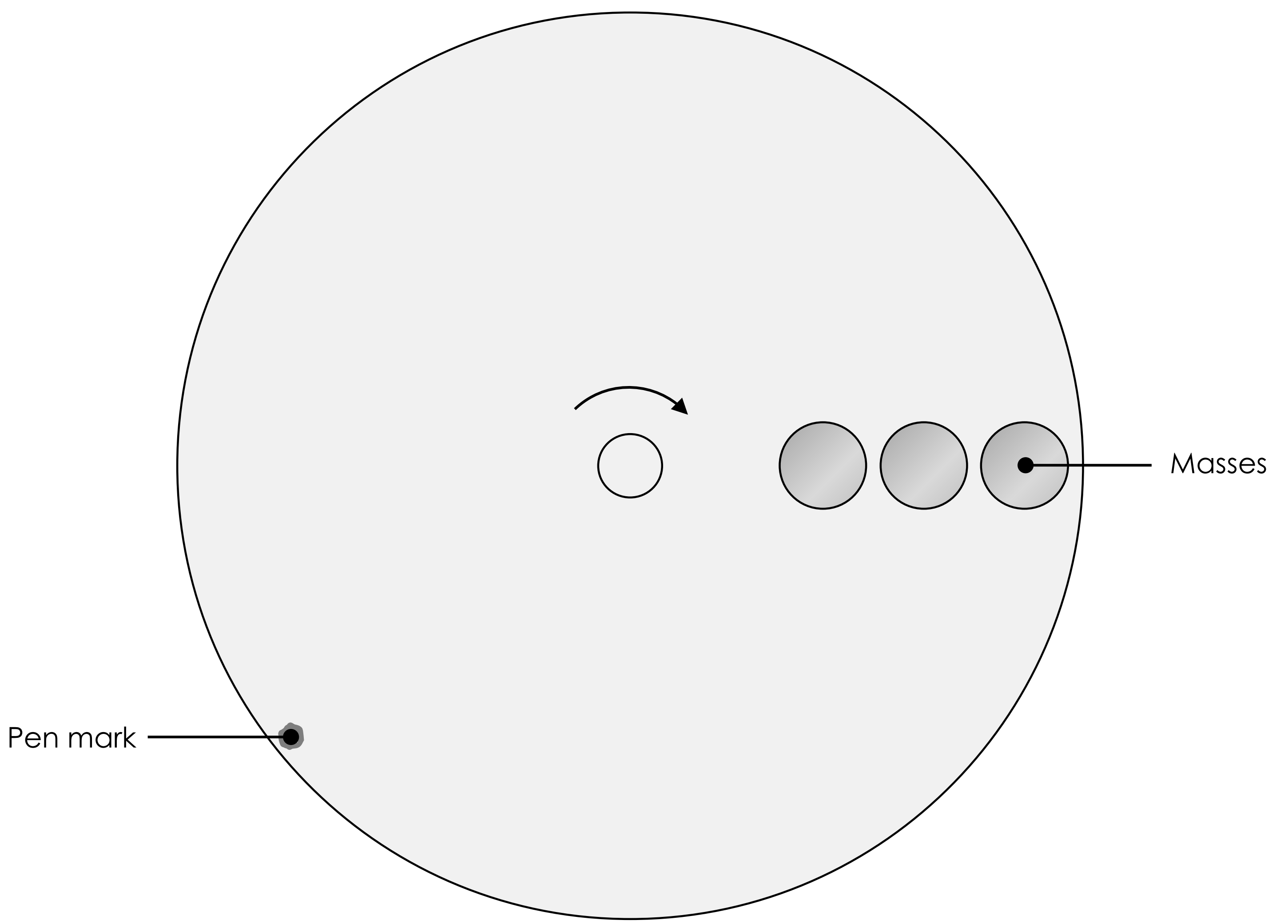
$r_{Moon} = 1740$ km

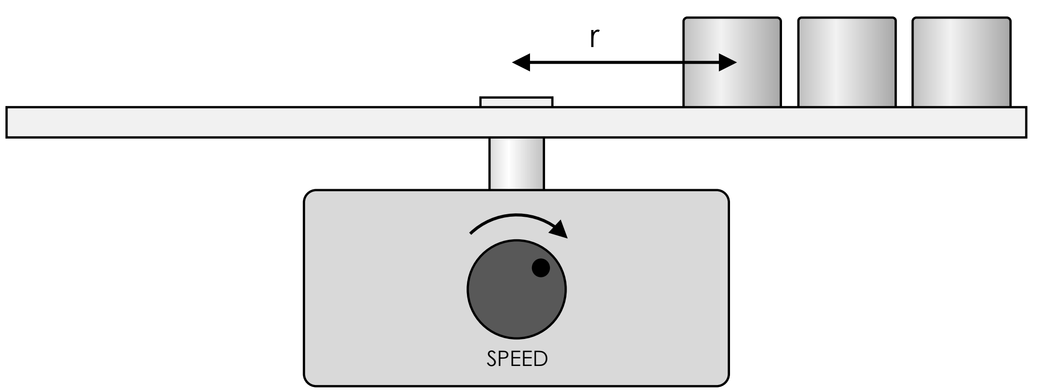
   c. Find the **ratio** of the gravitational field strengths of the Moon and Earth

7th September

1. An investigation is carried out to examine the forces acting on objects as they move in a circular path.

   A rotating turntable, show below, has small 50 g masses placed at different points. The speed of the motor is adjusted until a mass starts moving outwards and falls off the turntable.





7^{th} September

The speed of the turntable is adjusted until a 50 g mass starts sliding off. The speed is then kept constant as the time for ten complete rotations is recorded - a permanent marker was used to make a mark on the outer part of the turntable to help with counting ten rotations.

The following data was recorded:

Starting distance from centre r / m	Time for ten complete rotations t_{10} / s	Time period for one rotation T / s	Velocity of mass when it started sliding v / m s^{-1}	Velocity² v^2 / m^2 s^{-2}
0.160	5.81			
0.120	4.92			
0.080	4.05			

a. In the table above, calculate the **time period** for one rotation

The instantaneous linear velocity can be calculated by using the equation: $v = 2\pi r / T$

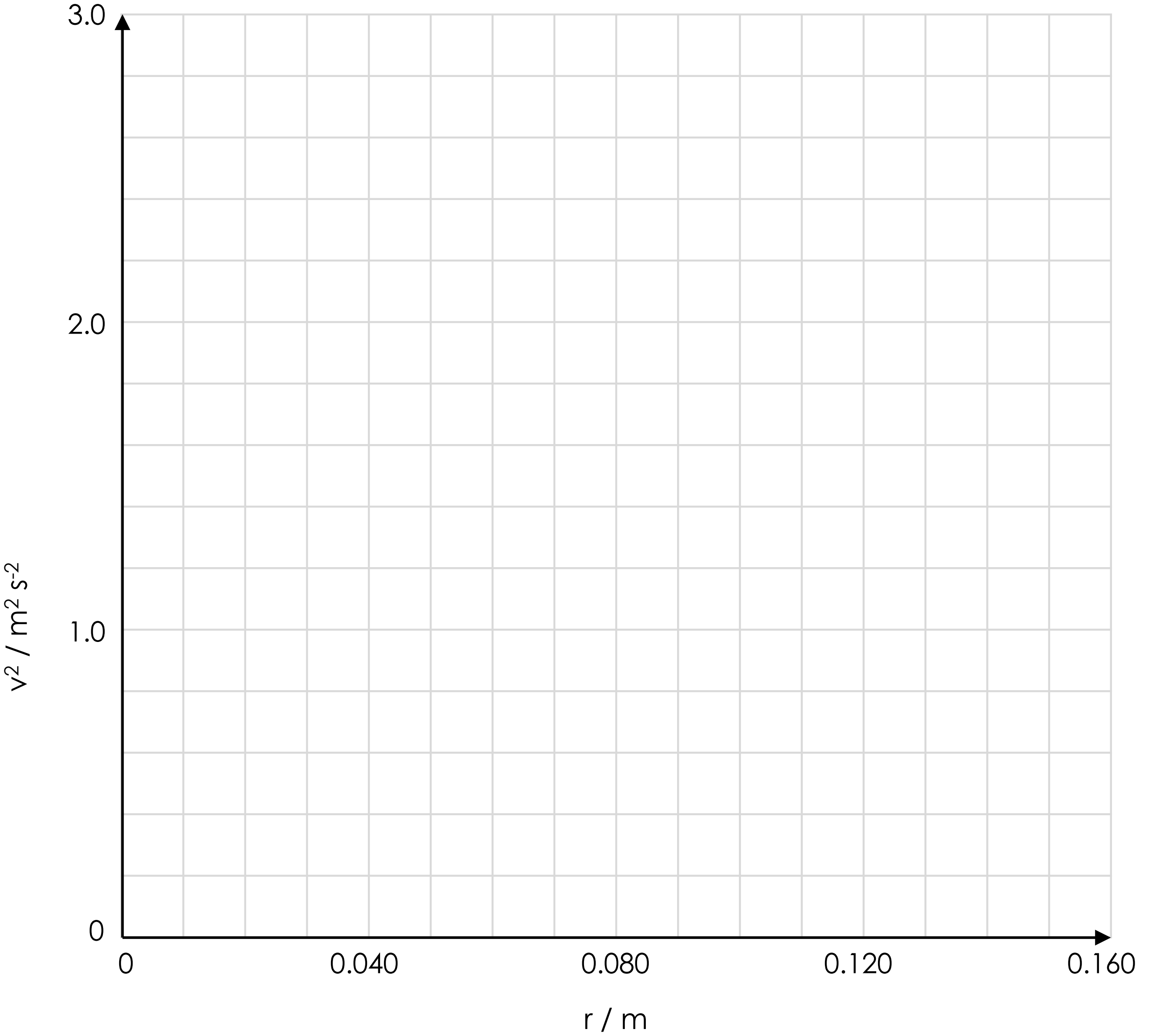
b. Calculate the **velocity** when each mass started sliding off the turntable

c. Finish the table with values for **velocity squared**

d. **Plot** a graph of v^2 against r

e. Describe the **relationship** between v^2 and r

7th September



The equation for the size of the centripetal force is: $F = mv^2 / r$

f. Explain why the mass starts to slide off the turntable as it gets **faster**

g. Use the gradient of your graph to calculate the size of the maximum **frictional force** between the turntable and the 50 g masses

8th September

1 2 3

1. Write down the **value** and **units** for the following:

   a. Gravitational constant

   b. Permittivity of free space

   c. Boltzmann constant

2. Angular speed (sometimes called angular velocity), ω, is similar to linear speed but instead of the distance travelled in a certain time it measures the angle moved through per unit time.

   Calculate the **angular speed** of the turntable in yesterday's question when it took 4.05 s to make ten complete rotations.

3. People often assume that astronauts aboard the International Space Station (ISS) have escaped Earth's gravitational field because they appear 'weightless'.

   Show that this isn't the case by calculating the **gravitational field strength** at this point, assuming the ISS orbits approximately 400 km above the Earth's surface.

9th September

1 2 3

1. Convert the following from revolutions per minute to **radians per second**:
   a. 60.0 rpm
   b. 1.00 rpm
   c. 140 rpm
   d. 24.4 rpm

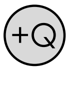
2. Calculate the **angular speed** of a car driving round about a roundabout at 30 mph. The radius of the roundabout is 11 m.

1.00 mile = 1609 m

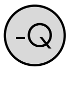
3. Electric fields around a point charge are very similar in shape to radial gravitational fields. However, gravity is always attractive whereas electric fields can be attractive and repulsive. The direction of electric field lines point in the direction of the force exerted on a test particle that is positively charged.

   Sketch the electric field around an isolated:

   a. **Positive** charge

   b. **Negative** charge

10^{th} September

1 2 3

1. Convert the following from radians per second to a frequency in **rpm**:
   a. 60.0 rad s^{-1}
   b. 1.00 rad s^{-1}
   c. 30π rad s^{-1}
   d. 64 rad s^{-1}

2. An object is travelling in a circular path at an angular speed of 0.71 rad s^{-1}.
   a. Write down the **relationship** between time period and frequency
   b. Calculate the **time** it takes to complete one full rotation
   c. Calculate the **frequency** of its rotation in Hz

3. Coulomb's law is similar in form to Newton's law of gravitation.
   a. State **Coulomb's inverse-square law** in words
   b. Write down the **equation** for Coulomb's law and state what each symbol represents
   c. Explain what **permittivity** means

11th September

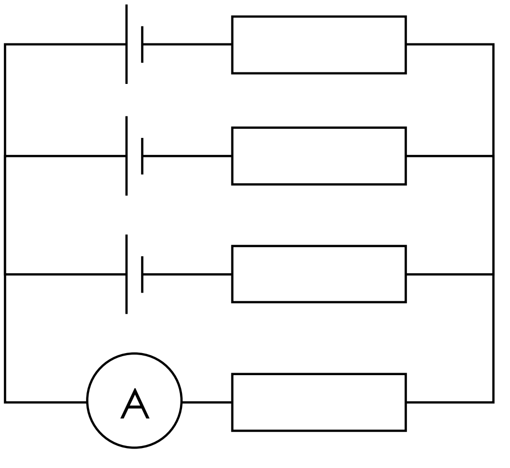
1 2 3

1. Calculate the **angular speed** of an object undergoing circular motion with a frequency of:
   a. 50 Hz

   b. 50 rpm

2. Three 1.5 V cells (of negligible internal resistance) are connected to four 10 Ω resistors as shown below.

   Calculate the reading on the **ammeter**.

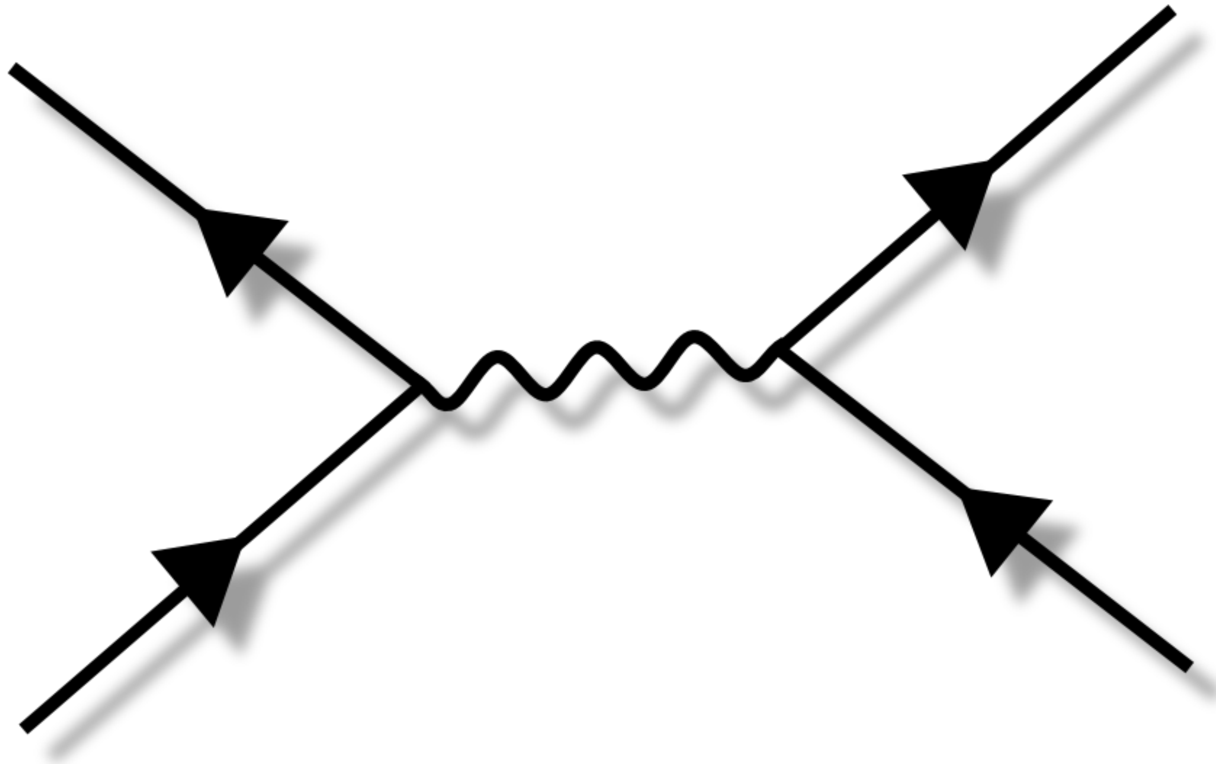


3. Using Coulomb's law, state the sign (+ or -) of the force between:
   a. Two **positive** charges

   b. Two **negative** charges

   c. Two **opposite** charges

   d. Describe which sign (+ or -) describes an attractive or repulsive force and the sign that should be used for any gravitational force



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12th September

1 2 3

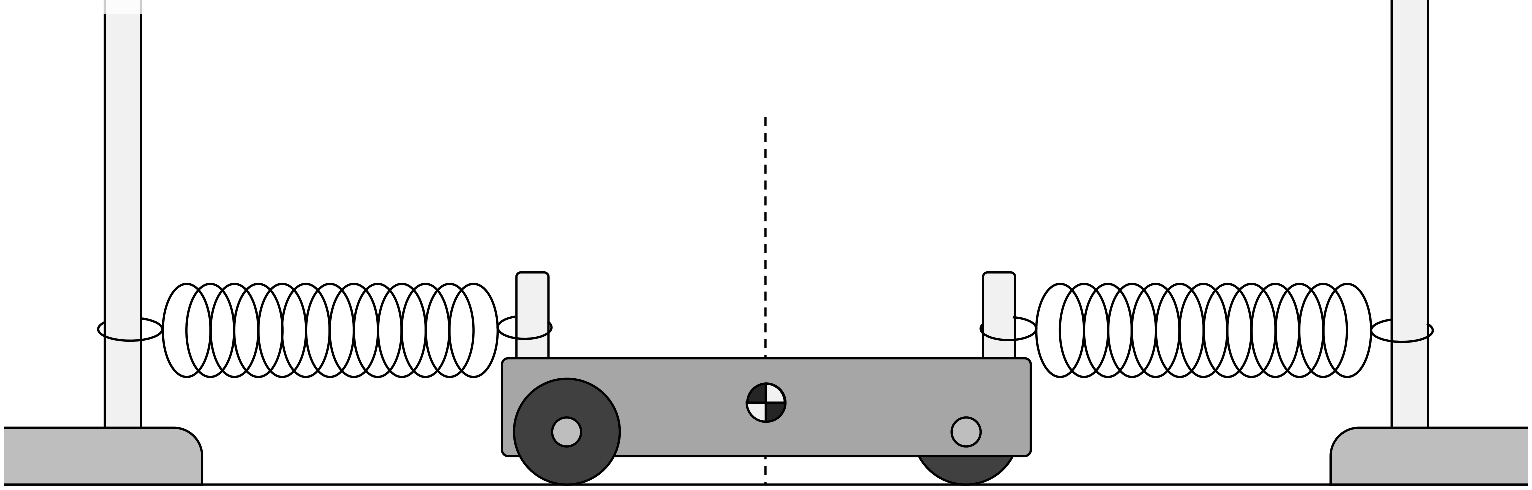
1. **Differentiate** y with respect to x for the following*:
   a. $y = x$
   b. $y = x^2$
   c. $y = x^3$

2. A radio-controlled aircraft takes 49 s to travel in a circle of radius 80 m.
   Calculate its:
   a. **Frequency**
   b. **Angular** speed
   c. **Linear** speed

3. Calculate:
   a. The **electrostatic force** between a proton and an electron that are 1.0×10^{-11} m apart
   b. The **gravitational force** between a proton and an electron that are 1.0×10^{-11} m apart
   c. The **ratio** between the electrostatic and gravitational force between them

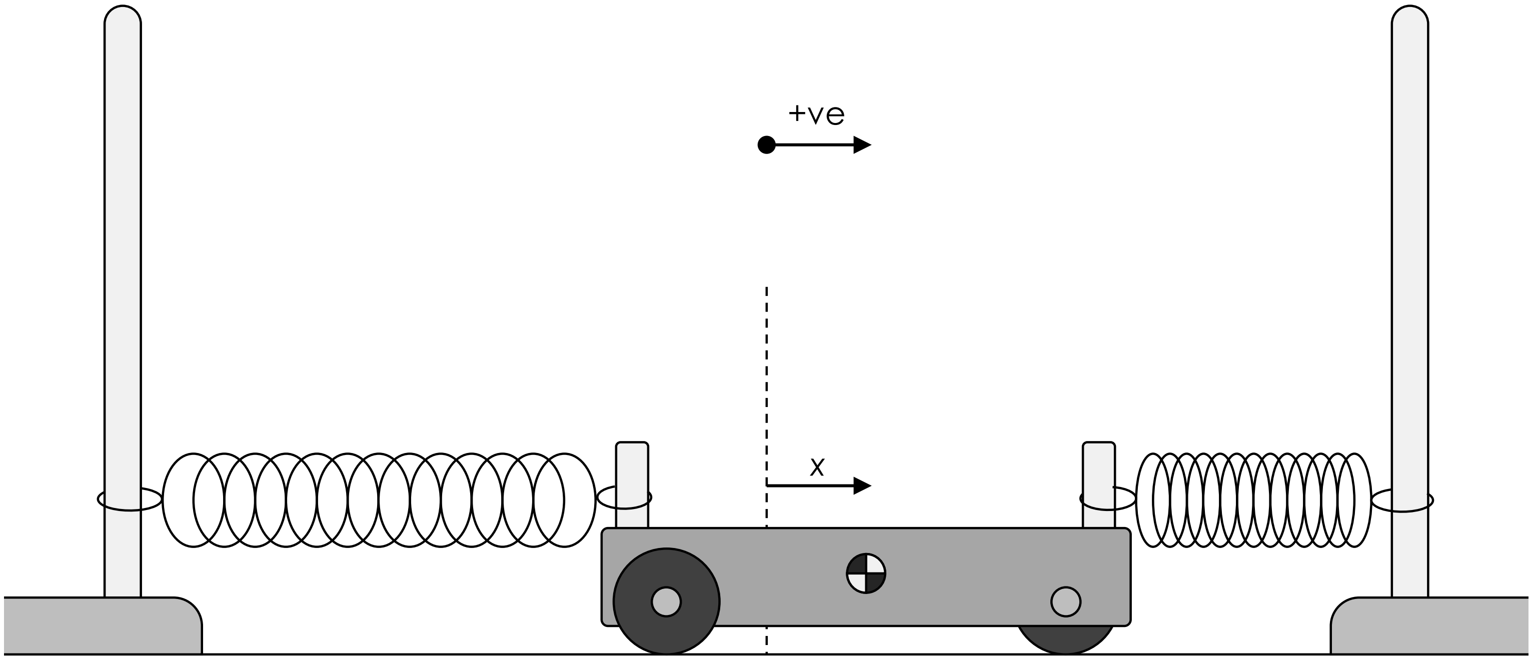
* Differentiation and integration are not requirements for the A Level Physics course. But they are incredibly useful and may be familiar to you from A Level Maths – and they are essential if you're considering Physics or Engineering at university.

13th September



1. A wooden trolley is connected to two identical springs which are attached to two retort stands held firmly in place, as shown above.

   The trolley is then displaced to the right by a displacement x, as shown below.



   a. At the instant the trolley is released, state the direction of the **resultant force** on it

   b. State the direction that the trolley would initially **accelerate** in

   c. As the positive displacement from the central point decreases, describe how the acceleration of the trolley **changes**

   d. Once the trolley moves to the left of the initial rest position, state the direction of the **acceleration** of the trolley

13th September

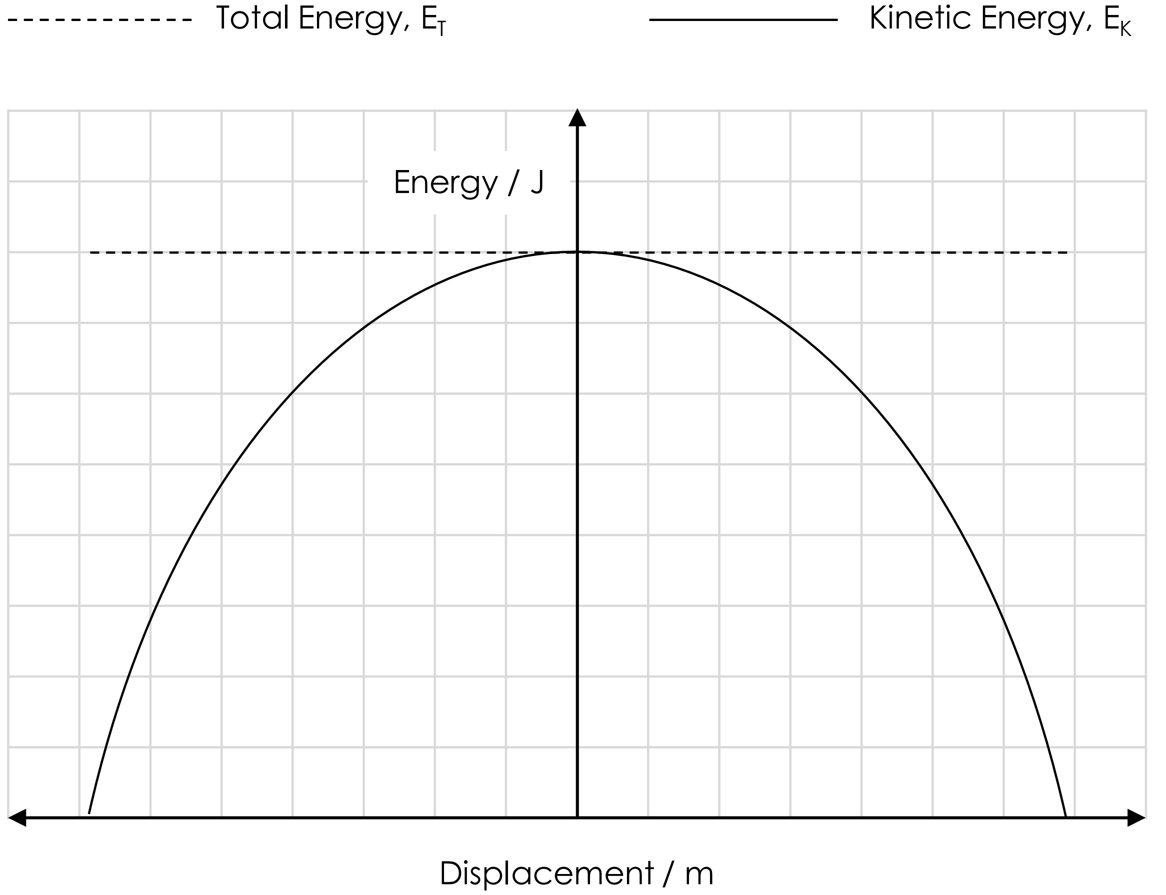
e. When the trolley is pulled to the right and about to be released, describe how the energy of the system is **stored** and state the **equation** used to calculate this

f. State the value of the displacement where the **kinetic energy** of the trolley is at a **maximum** value

Once the trolley is released it oscillates about the central rest position.

Below is a graph showing how the energy is related to the displacement of the trolley. The total energy of the system, E_T, is constant (assuming no losses to the surroundings due to friction and air resistance) and the kinetic energy, E_K, has been plotted.

g. Sketch a line to show how the **energy** described in part e. changes with respect to displacement



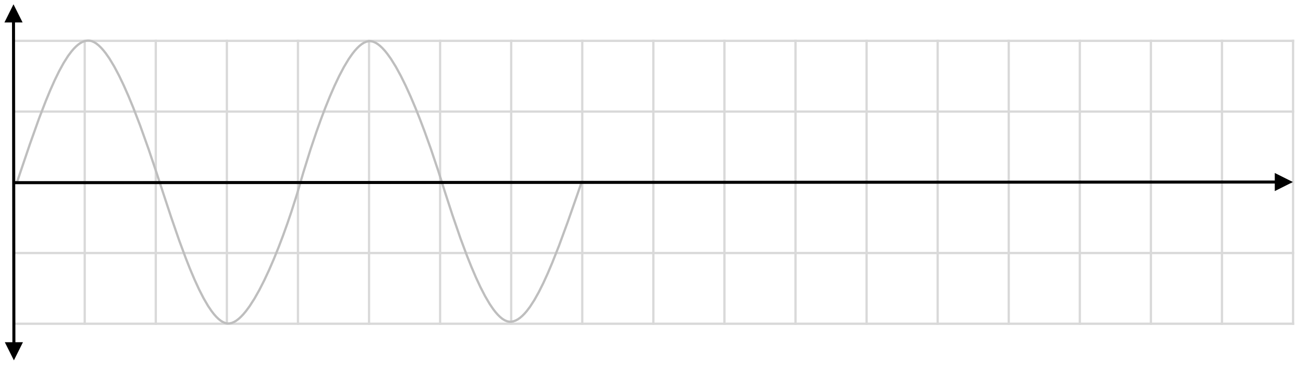
14th September

1 2 3

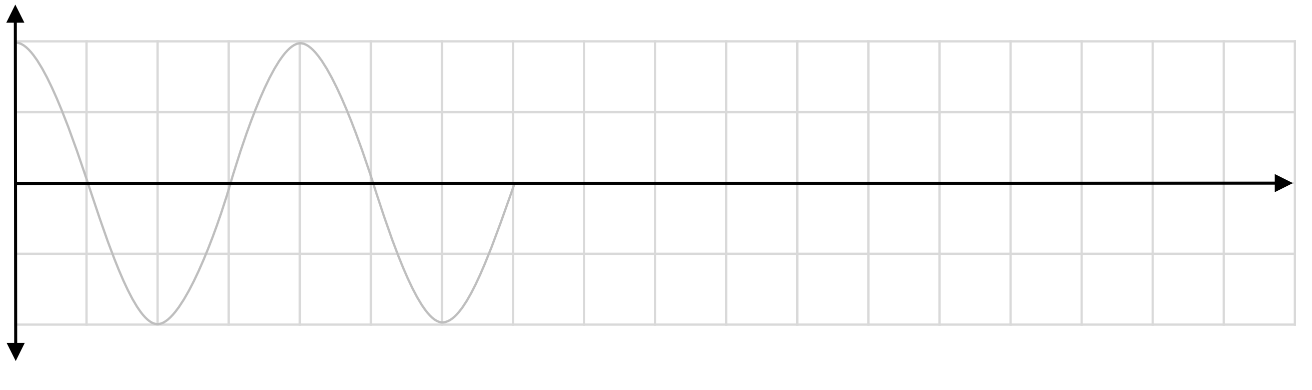
1. **Differentiate** y with respect to x for the following:
   a. $y = \sin x$
   b. $y = \cos x$
   c. $y = -\sin x$

2. By selecting a suitable equation from your data book, calculate the **centripetal acceleration** of an object travelling at:
   a. A linear speed of 7.7 m s^{-1} around a circle with radius 1.2 m
   b. An angular speed of 0.95 rad s^{-1} around a circle with a diameter of 700 mm

3. Sketch a **sinusoidal** curve on the axes below:
   a.



   b.



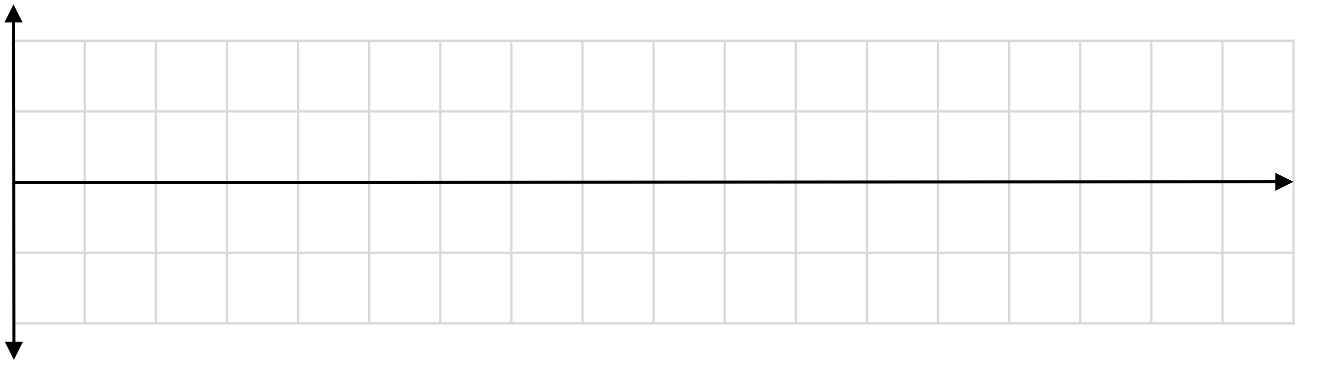
15th September

1 2 3

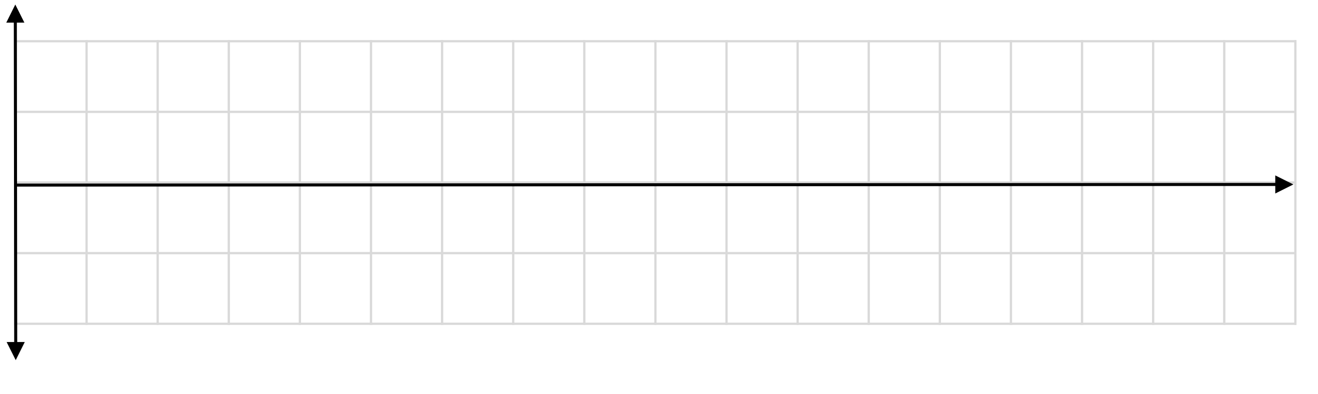
1. **Differentiate** y with respect to x for the following (where A and B are constants):
   a. $y = A\cos x$
   b. $y = A\sin x$
   c. $y = \sin Bx$

2. a. Define **simple harmonic motion**
   b. Describe **three examples** from everyday life that undergo simple harmonic motion

3. Sketch the following curve on the axes below:
   a. $y = \sin x$



   b. $y = \cos x$

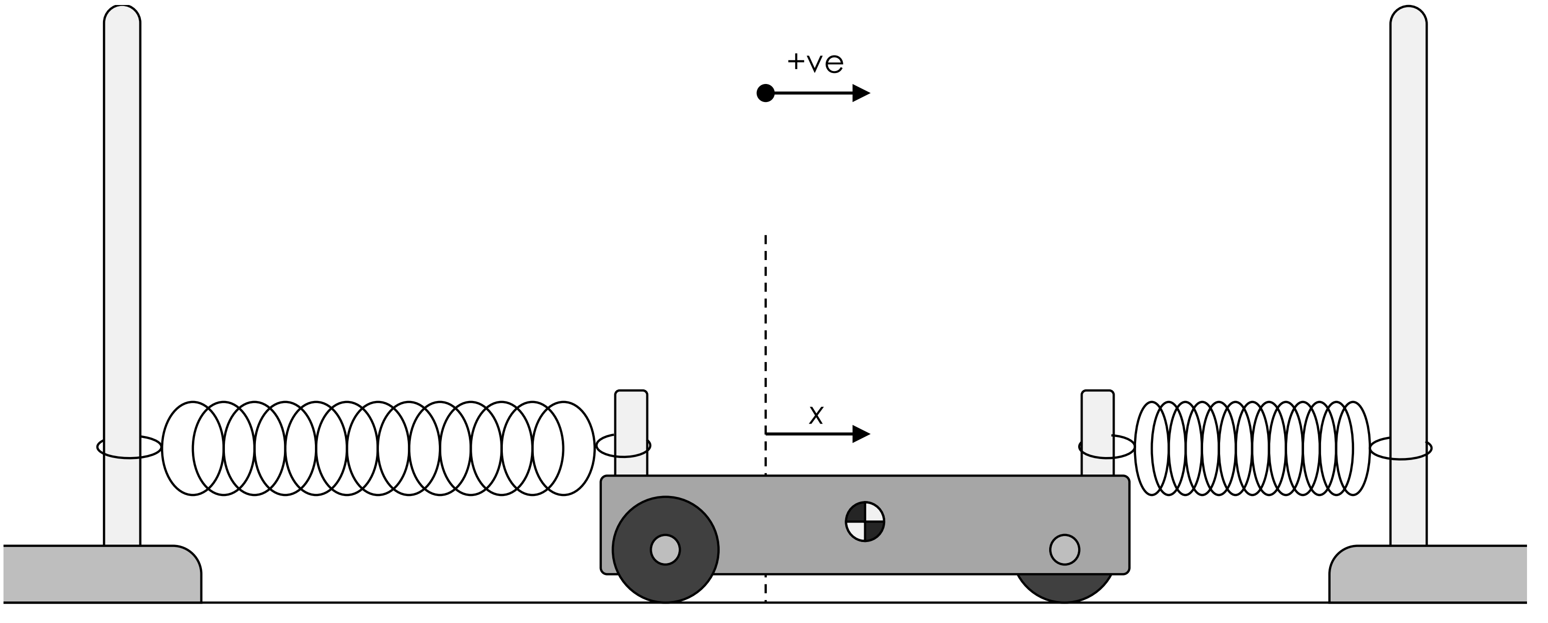


16th September

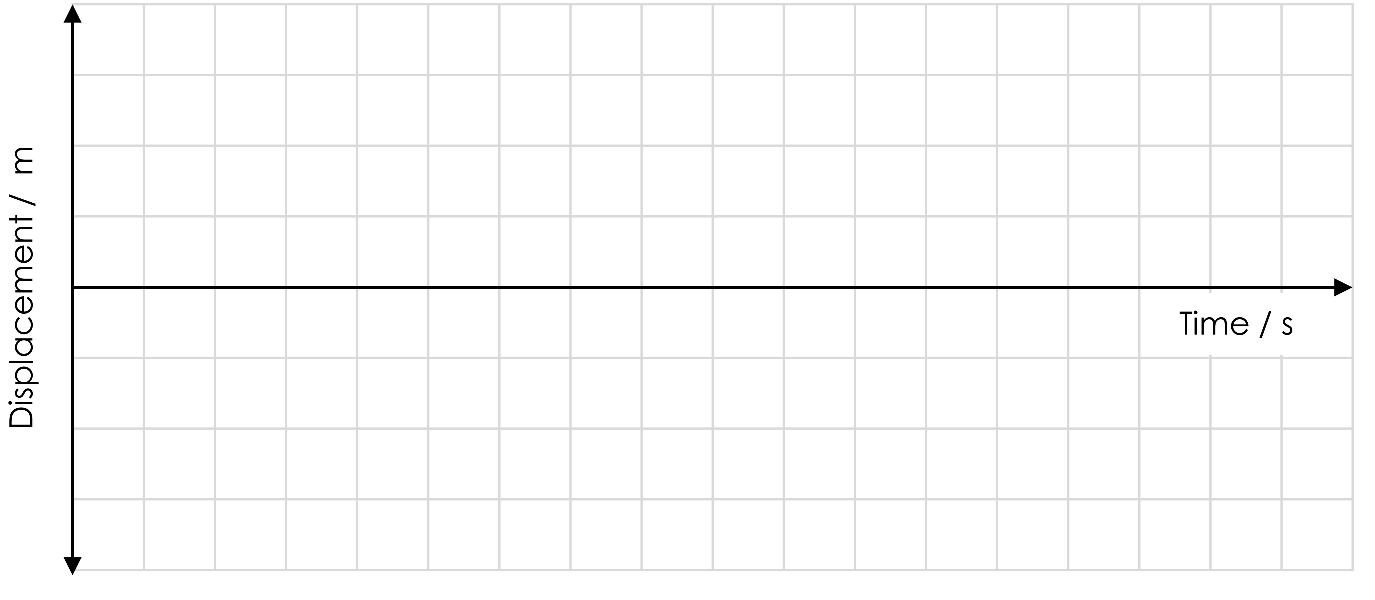
1 2

1. **Differentiate** y with respect to x for the following:
   a. $y = A \sin Bx$
   b. $y = A \cos Bx$
   c. $y = - A \sin Bx$

2. A trolley connected to two springs oscillates from side to side.

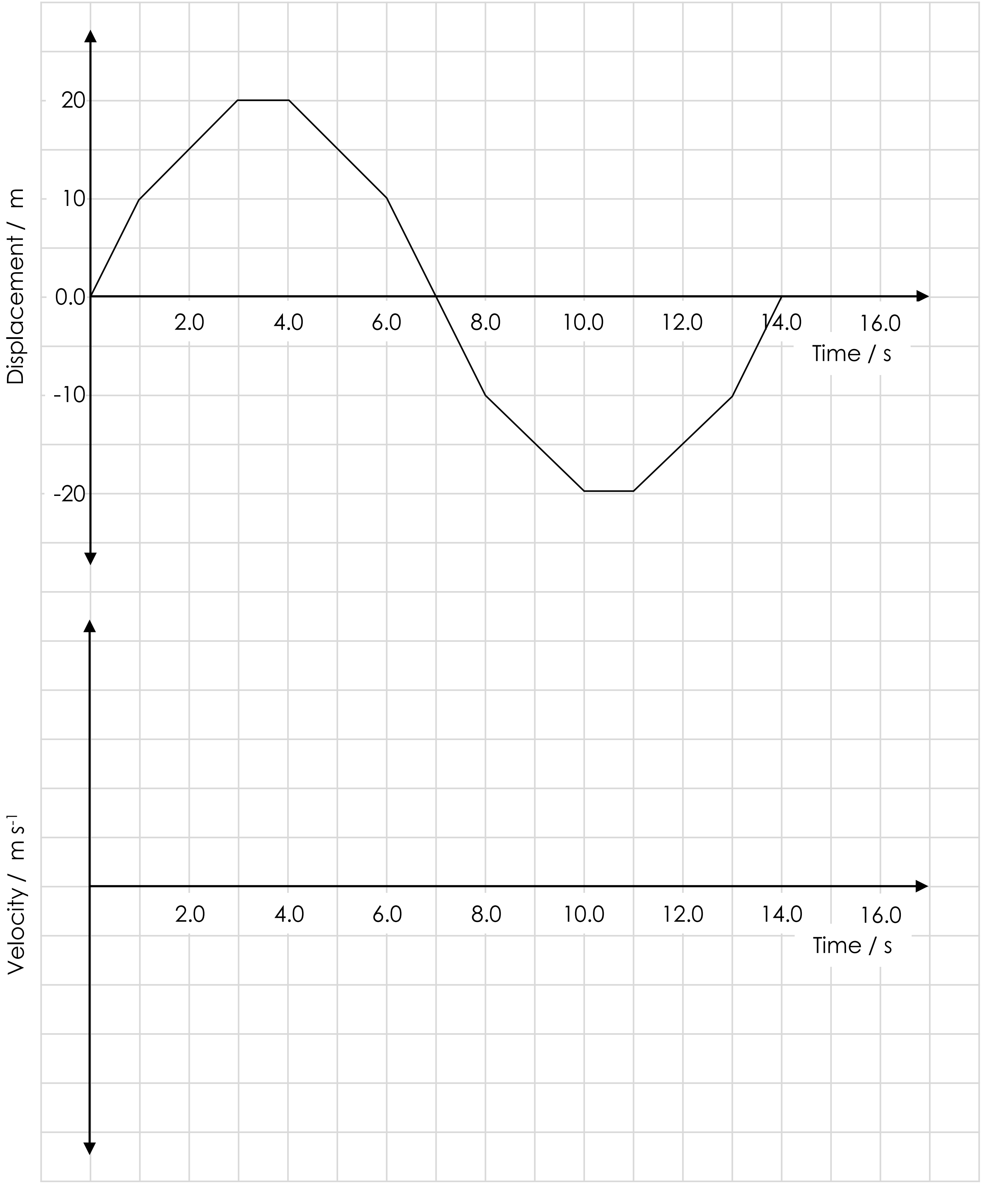


Sketch a **displacement-time** graph for the trolley from the moment it is released in the position above.



16th September

3. Plot the corresponding **velocity-time** graph to this displacement-time graph.



17th September

1 2

1. **Differentiate** the following with respect to t:

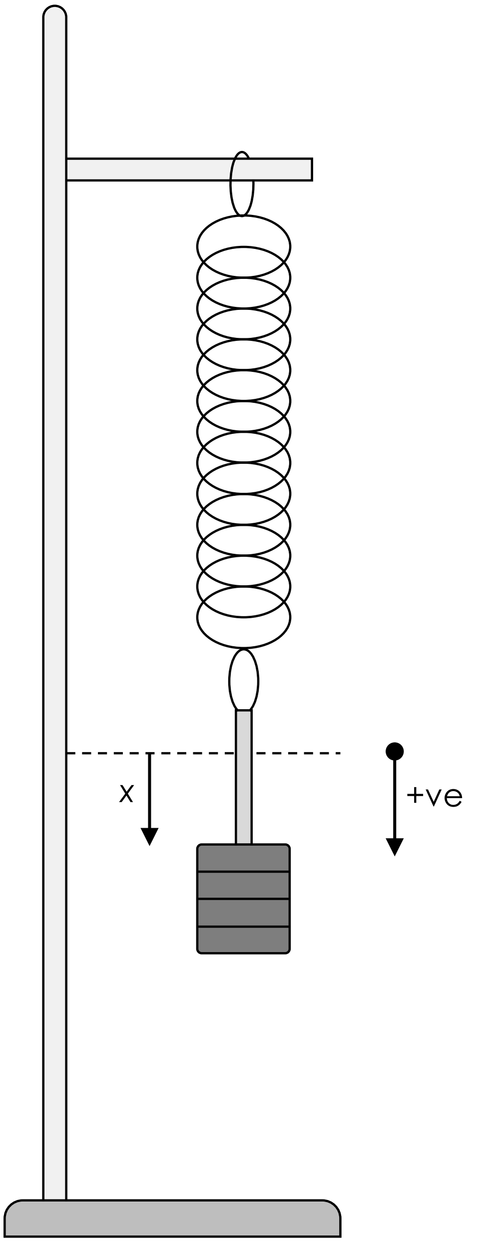
   a. $x = A \cos Bt$

   b. $v = -A \sin Bt$

2. A mass is hung from the end of a spring.

   a. State the **two forces** acting on the mass when it is resting in its equilibrium position

   b. State **two factors** that determine the initial extension of the spring

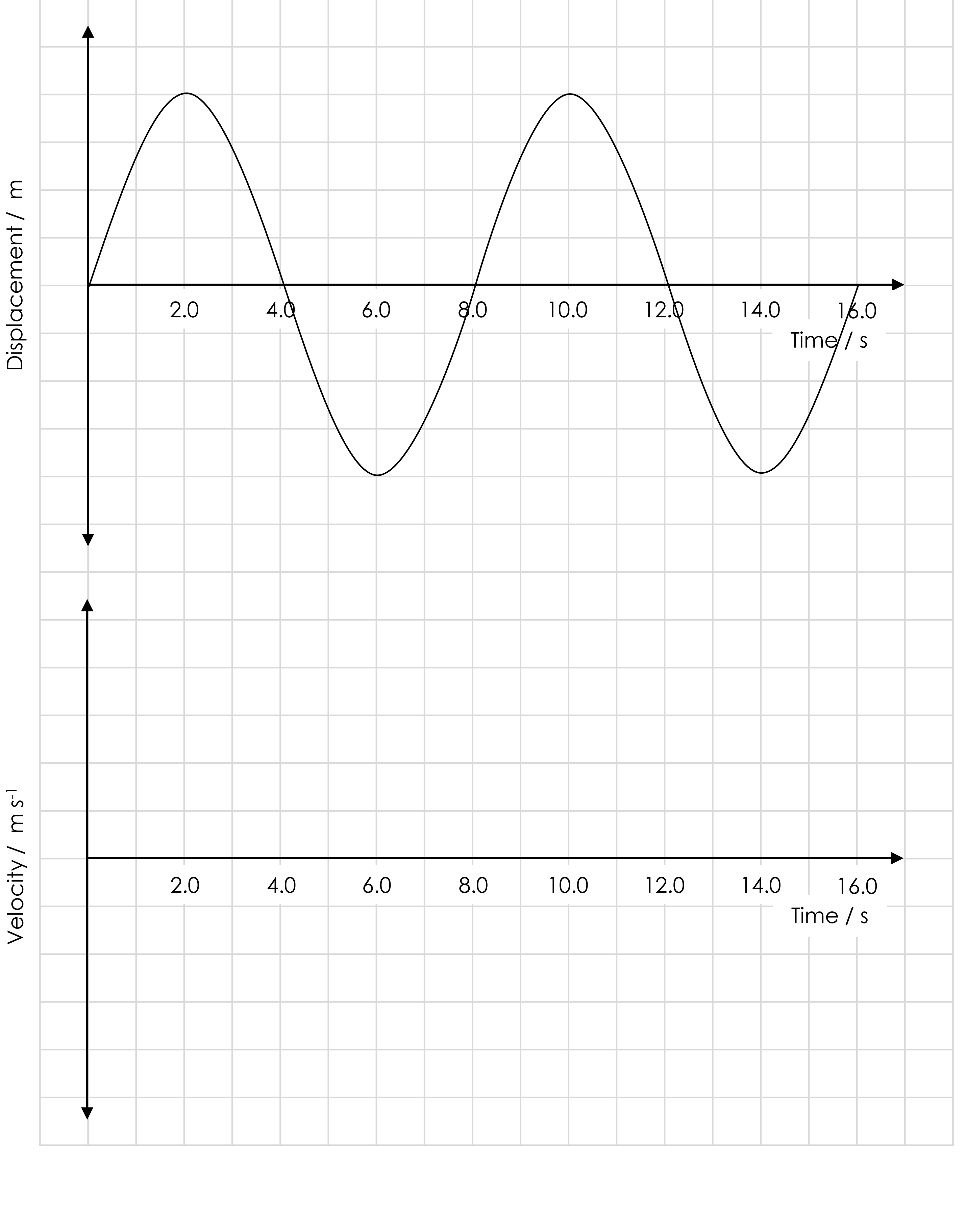


The mass is pulled down through a displacement, *x*, and released so it oscillates up and down.

   c. Sketch the shape of a **displacement-time** graph for the mass from the time it first passes its equilibrium position

17th September

3. Sketch the shape of the corresponding **velocity-time** graph to this displacement-time graph.



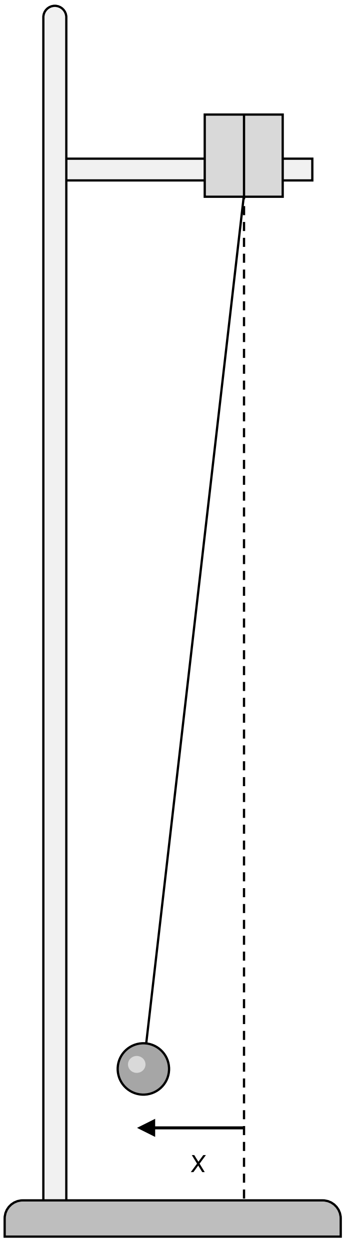
18th September

1 2

1. **Differentiate** the following with respect to t:

   a. $x = A\cos\omega t$

   b. $v = -\omega A\sin\omega t$



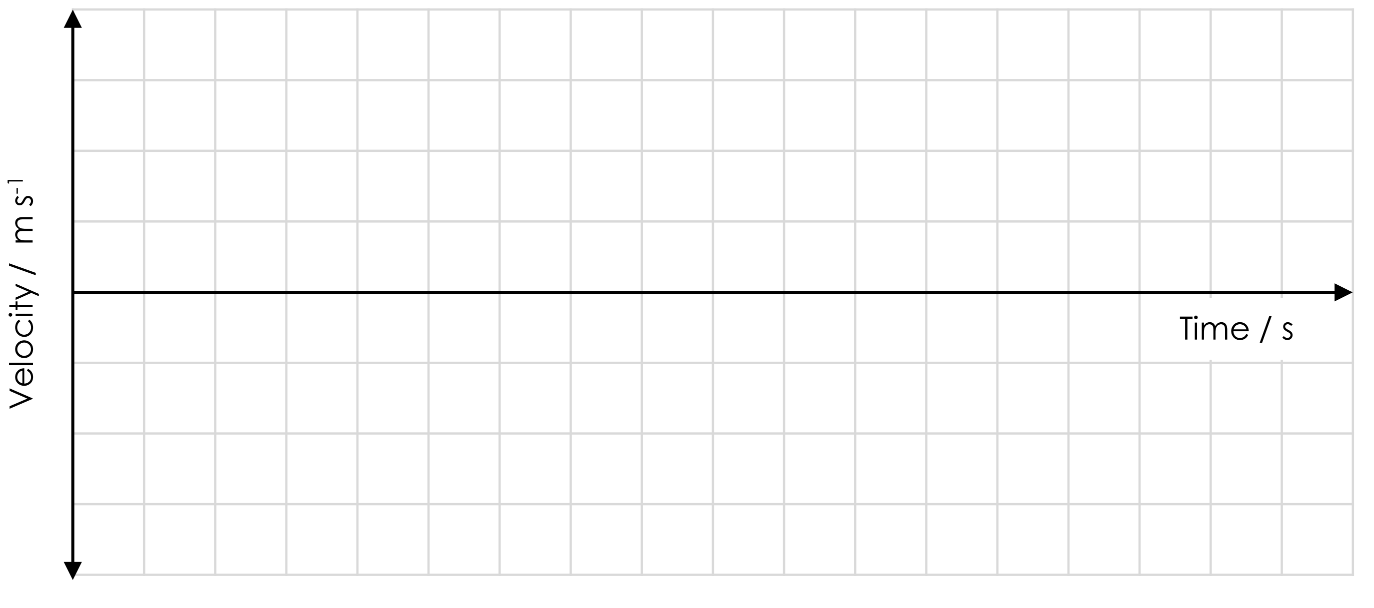
2. A pendulum is hung from the end of a string.

   a. State the **two forces** acting on the pendulum bob when it is resting in its equilibrium position

   The bob is pulled through a displacement x and released so it oscillates from side to side.

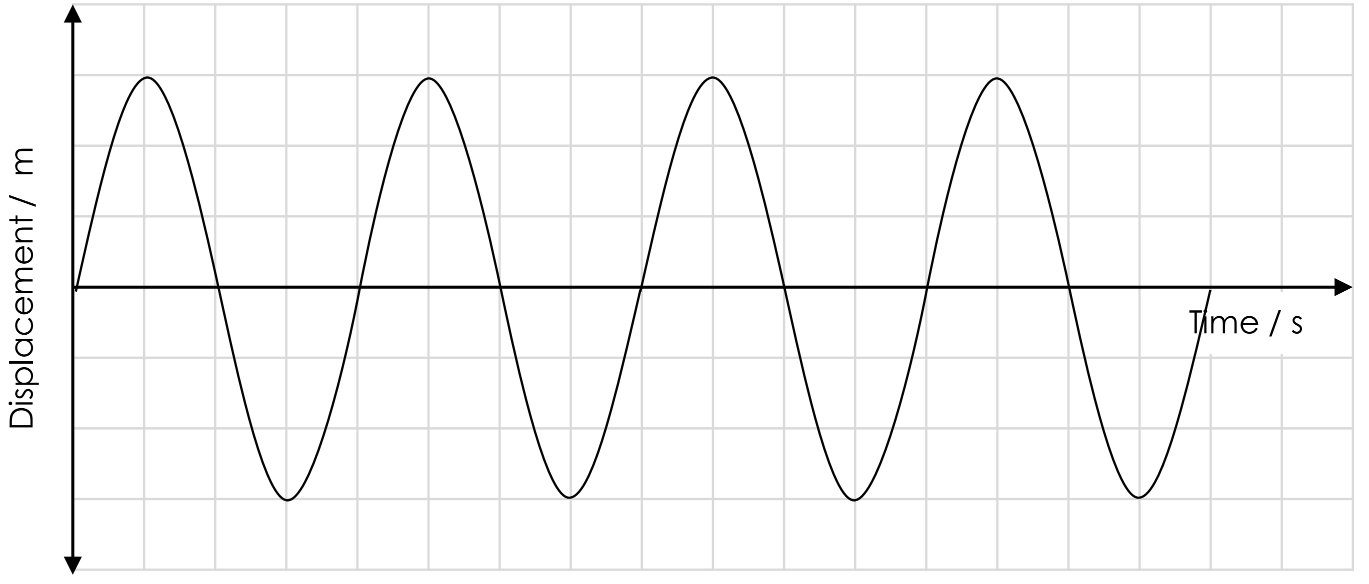
   b. Describe what provides the **resultant force** on the bob causing it to accelerate

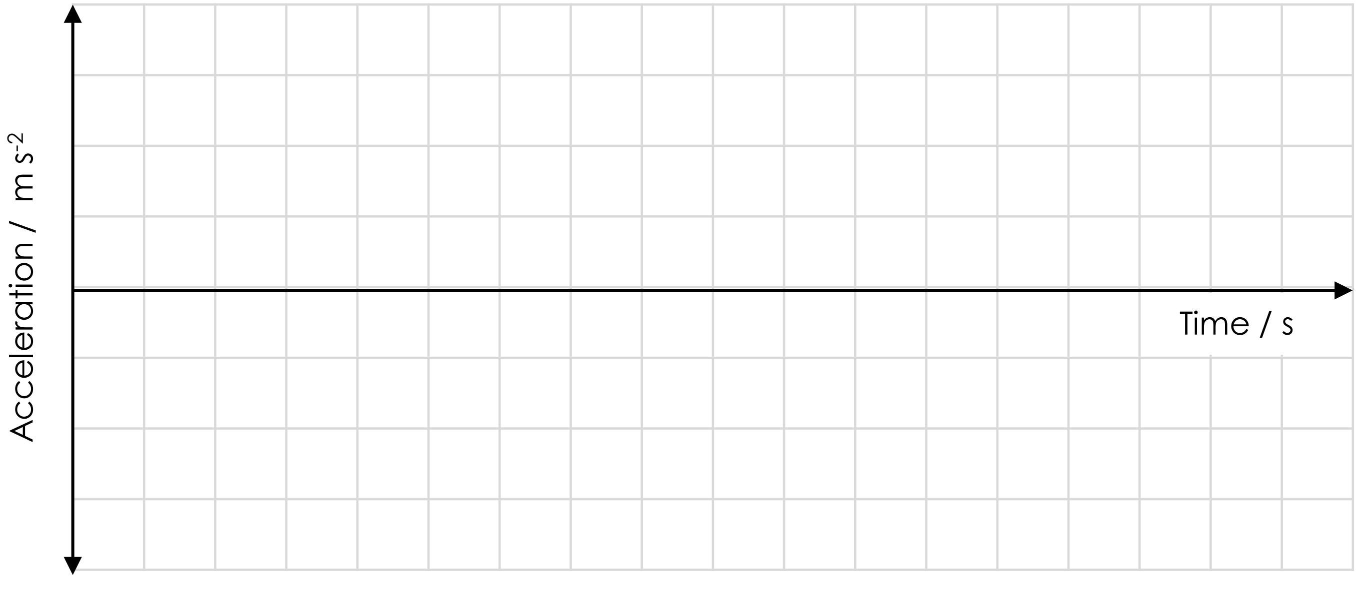
   c. Sketch the shape of a **velocity-time** graph for the pendulum from the moment it is released



18th September

3. Sketch the shape of the corresponding **velocity-time** and **acceleration-time** graphs to this displacement-time graph.



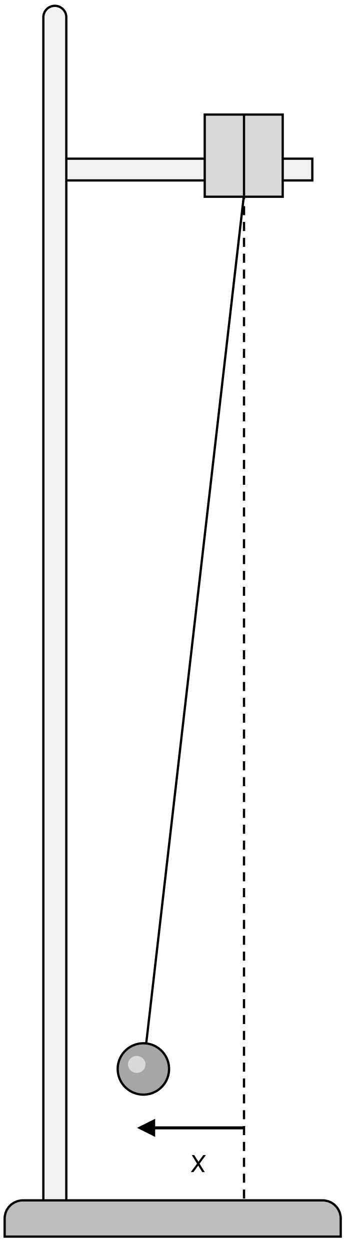


19th September

1. A simple pendulum is set up with a 50 g mass on a thread.

   The length of the pendulum, *L*, should be 400 mm.

   a. Describe how an **accurate** measurement of *L* could be taken



   The bob is displaced exactly 30 mm to the left and then released.

   b. Describe how this distance of 30 mm could be reliably **repeated** so the pendulum is released from exactly the same point each time

   c. State the effect on the **time period** if the pendulum was released from an initial amplitude of 10 mm rather than 30 mm

   d. Describe the **energy transfers** that take place as it oscillates from side to side

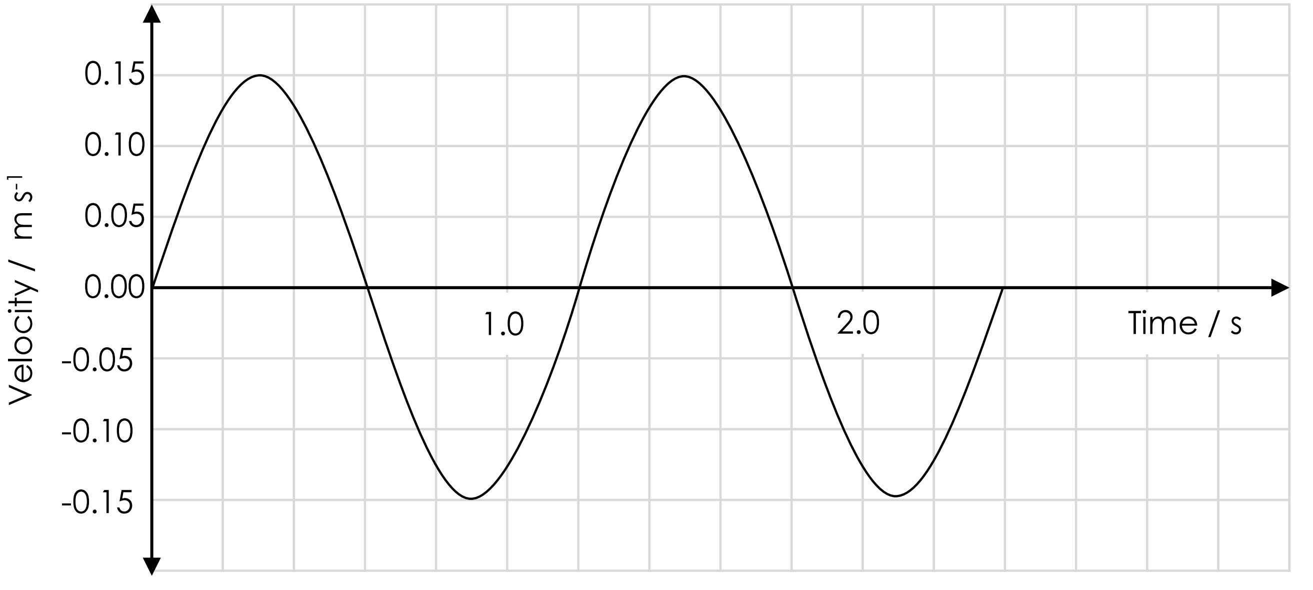
   The time for ten oscillations is recorded as 12.62 seconds.

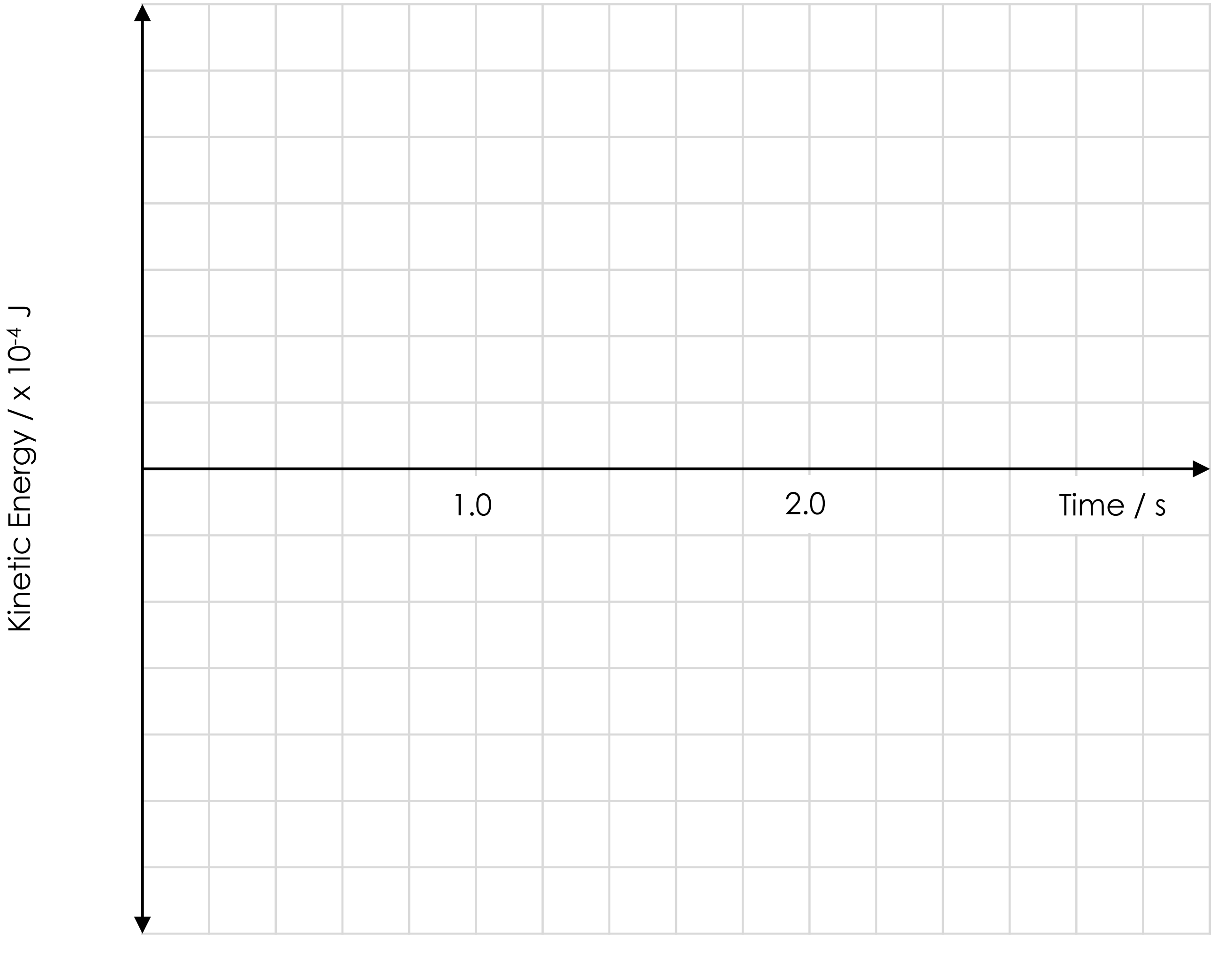
   e. Calculate a sensible value for the **percentage uncertainty** in the time period for one oscillation

19th September

The velocity-time graph of the pendulum as it undergoes simple harmonic motion is shown below.

f. Sketch the shape of the corresponding **kinetic energy-time** graph with suitable values





20th September

1 | 2 | 3

1. Determine the **result** that should be recorded for ‘g’ and calculate the **percentage uncertainty** in the data:

g / N kg^{-1}	9.7	8.6	9.2	10.6	10.2

2. The volume of an atomic nucleus is proportional to the number of nucleons in it (if the nucleons are modelled as incompressible spherical particles).

   Write the **proportionality relationship** between:

   a. The mass, m, and the nucleon number, A

   b. The nuclear radius, R, and the mass, m

   c. The nuclear radius, R, and the nucleon number, A

3. Define:

   a. **Electric** potential

   b. **Gravitational** potential

   c. An **equipotential**

21st September

1 2 3

1. A micrometer (giving readings with an absolute uncertainty of ± 0.01 mm) is used to measure the diameter of a copper wire. This gives a value of 0.42 mm.

   Calculate the **percentage uncertainty** in this measurement and suggest how a **more accurate** value could be recorded.

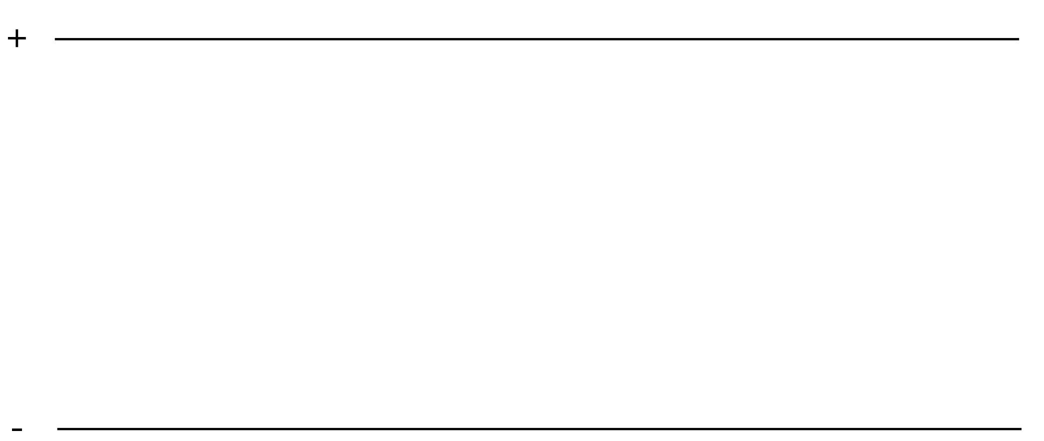
2. The proportionality constant between nuclear radius, R, and nucleon number, A, is called R_0* and is approximately 1.2 fm, where: $R = R_0 A^{1/3}$

   a. State what ‘**f**’ represents in ‘fm’

   b. Explain what $\mathbf{R_0}$ represents

   c. Calculate the **radius** of a carbon-12 nucleus

3. Draw the **electric field lines** between two parallel plates that have a potential difference across them.



* R_0 can also have the symbol r_0

22nd September

1 2 3

1. Measurements were taken to investigate a piece of copper wire. Calculate the **percentage uncertainty** in the calculated value of **resistivity**:

Quantity	Percentage Uncertainty
Resistance	2.1 %
Length	0.2 %
Diameter	4.3 %

2. For a nucleus of **oxygen-16**, calculate:

Atomic mass unit = 1.661×10^{-27} kg

R_0 = 1.2 fm

   a. Its radius

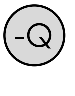
   b. Its volume

   c. Its mass

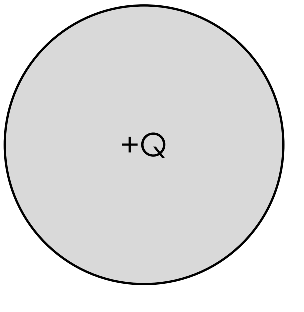
   d. Its density

3. Sketch the **electric field** around an isolated:

   a. **Point** charge



   b. Charged **sphere**



23rd September

1 2 3

1. The following values were recorded:

Quantity	Value	Percentage Uncertainty
Potential Difference / V	1.0	10 %
Current / A	0.20	5.0%

Calculate the **resistance**, including its **uncertainty**.

2. For a nucleus of **uranium-235**, calculate:
   a. Its radius
   b. Its volume
   c. Its mass
   d. Its density

3. Sketch the **electric field** between these shapes:

24th September

1 2 3

1. The following values were recorded:

Quantity	Value	Uncertainty
Potential Difference / V	3.0	± 0.1
Current / A	0.22	± 0.01

Calculate the **electrical power**, including its **uncertainty**.

2. State the **density** of:

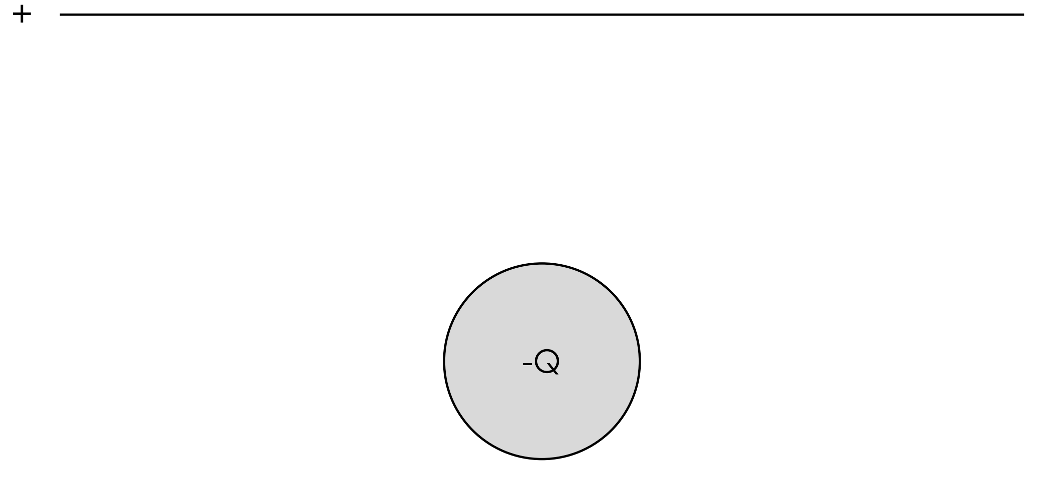
a. An iodine-131 nucleus

b. An americium-241 nucleus

c. A hydrogen nucleus

d. A proton

3. Sketch the **electric field** between a positive plate and negative sphere:



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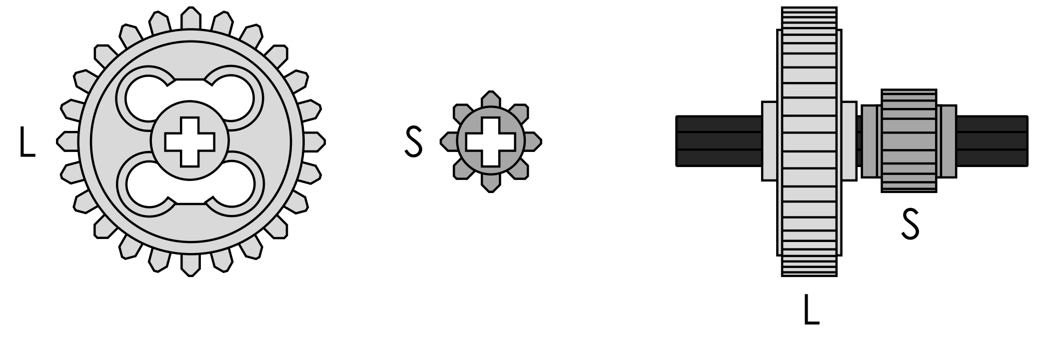
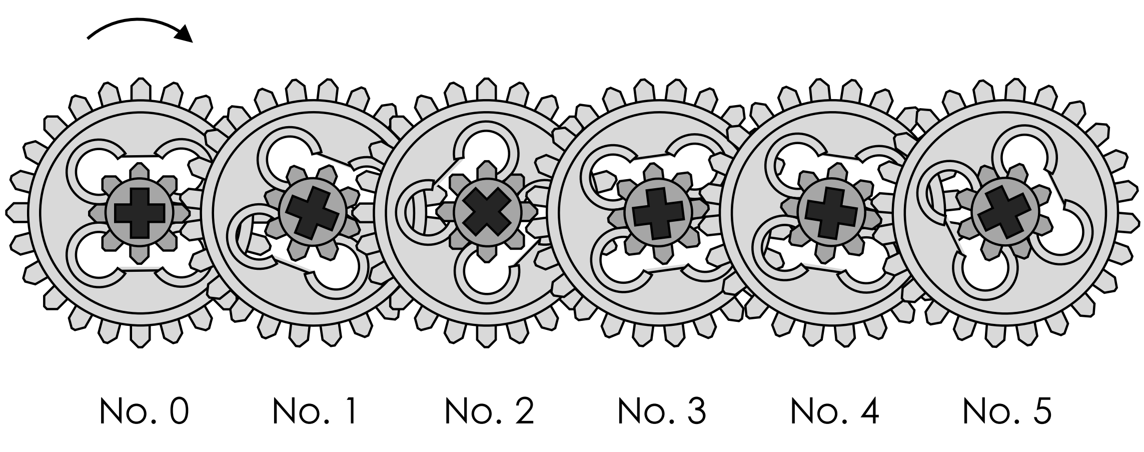
25th September

1

1. A large cog (L) is connected to a small cog (S) on a rigid axle, as shown below.



A series of these are set up, where the small cog meshes with the large cog of the adjacent gear.



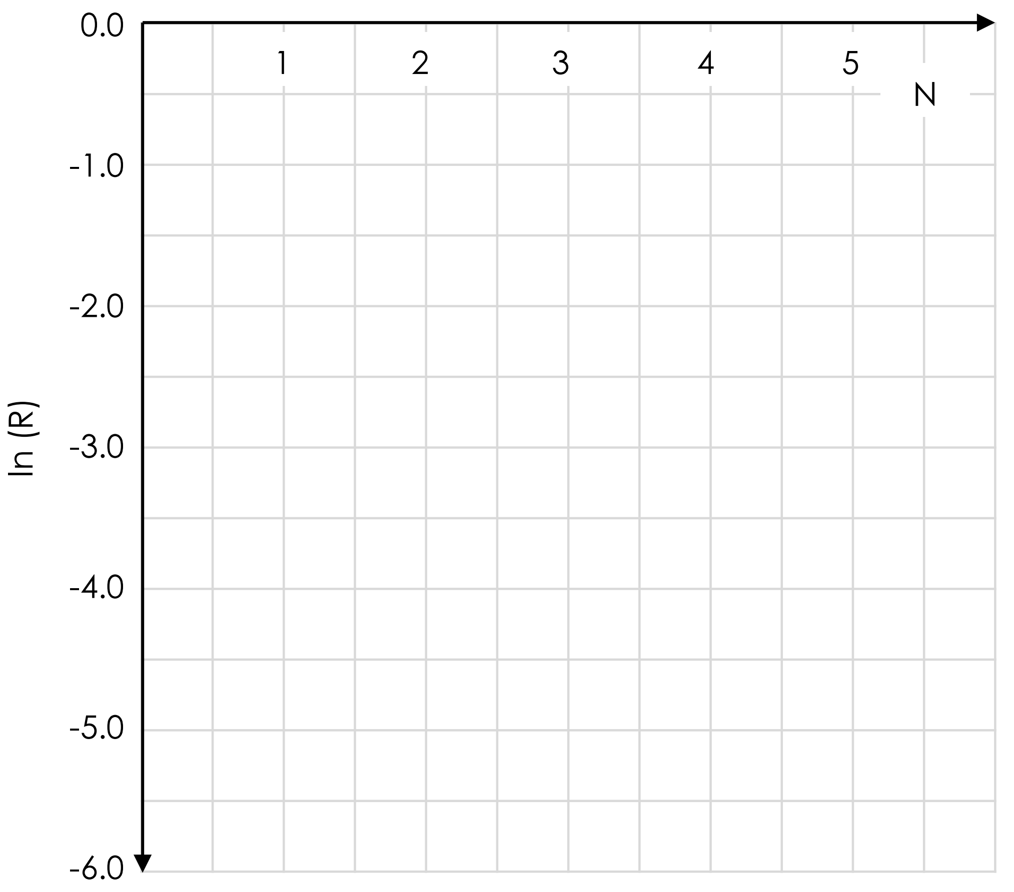
a. When cog No. 0 rotates through one complete rotation, state how many **degrees** cog No. 1 turns through

b. Complete the **table** with value of R and ln (R)

Cog No. (N)	Number of Rotations (R)	ln (R)
0	1.0	0.00
1		
2		
3		
4		
5		

25^{th} September

c. Plot the data on the graph below and calculate the **gradient** of the line of best fit



d. Explain the **significance** of the constant gradient and why this is seen when a graph of the natural log of R is plotted against N

e. Calculate $\mathbf{e^{-gradient}}$ and describe how this is related to the **ratio** of the two cogs that are connected on the axle

f. If a series of one hundred of these gears were set up, how many **rotations** would cog No. 99 have to make to rotate cog No. 0 by one turn

26th September

1 2

1. The equation for the centripetal acceleration is:

   ① $a = v^2 / r$

   The tangential velocity can be calculated using:

   ② $v = \omega r$

   a. **Square** both sides of equation ②

   b. Substitute your answer to part a. into equation ① and write an **expression** for the centripetal acceleration in terms or ω and r

2. For an object oscillating with simple harmonic motion, its displacement at time t can be calculated using the equation:

   $$x = A \cos \omega t$$

   This applies when the displacement at t = 0 is its maximum amplitude.

   a. Define **velocity**

   b. **Differentiate** the above equation with respect to **time**

   c. Define **acceleration**

   d. **Differentiate** your answer to part b. with respect to **time**

   e. **Compare** your answer to part d. to the original equation for x

27^{th} September

1 2

1. The velocity of a body orbiting a planet of mass *M* can be written as:

   ① $v^2 = GM / r$

   The speed of an orbiting body travelling in a circular path is:

   ② $v = 2\pi r / T$

   a. **Square** both sides of equation ②

   b. **Equate** equation ① and your answer to part a.

   c. **Rearrange** the equation to make T^2 the subject

2. For an object oscillating with simple harmonic motion, its displacement at time t can be calculated using the equation:

   $$x = A \sin \omega t$$

   This applies when the displacement at t = 0 is its equilibrium position.

   a. Define **simple harmonic motion**

   b. **Differentiate** the above equation with respect to **time**

   c. **Differentiate** your answer to part b. with respect to **time**

   d. **Compare** your answer to part c. to the original equation for x

28th September

1 2

1. The equation for the kinetic energy of a moving particle is:

   ① $E_k = ½ mv^2$

   The electric potential energy between two charges is:

   ② $E_p = qQ / 4\pi\varepsilon_0 r$

   a. **Equate** equations ① and ② for when the kinetic and potential energies are equal

   b. **Rearrange** the equation to make ***r*** the subject

2. Plot a graph showing the **displacement** of an object undergoing SHM, with an amplitude of 5.0 cm and time period of 1.2 s, if the displacement can be described with the equation:

   $x = A \sin \omega t$

29th September

1 2

1. The equation for the kinetic energy of a moving object of mass *m* is:

   ① $E_k = \frac{1}{2} mv^2$

   The gravitational potential energy between two masses is:

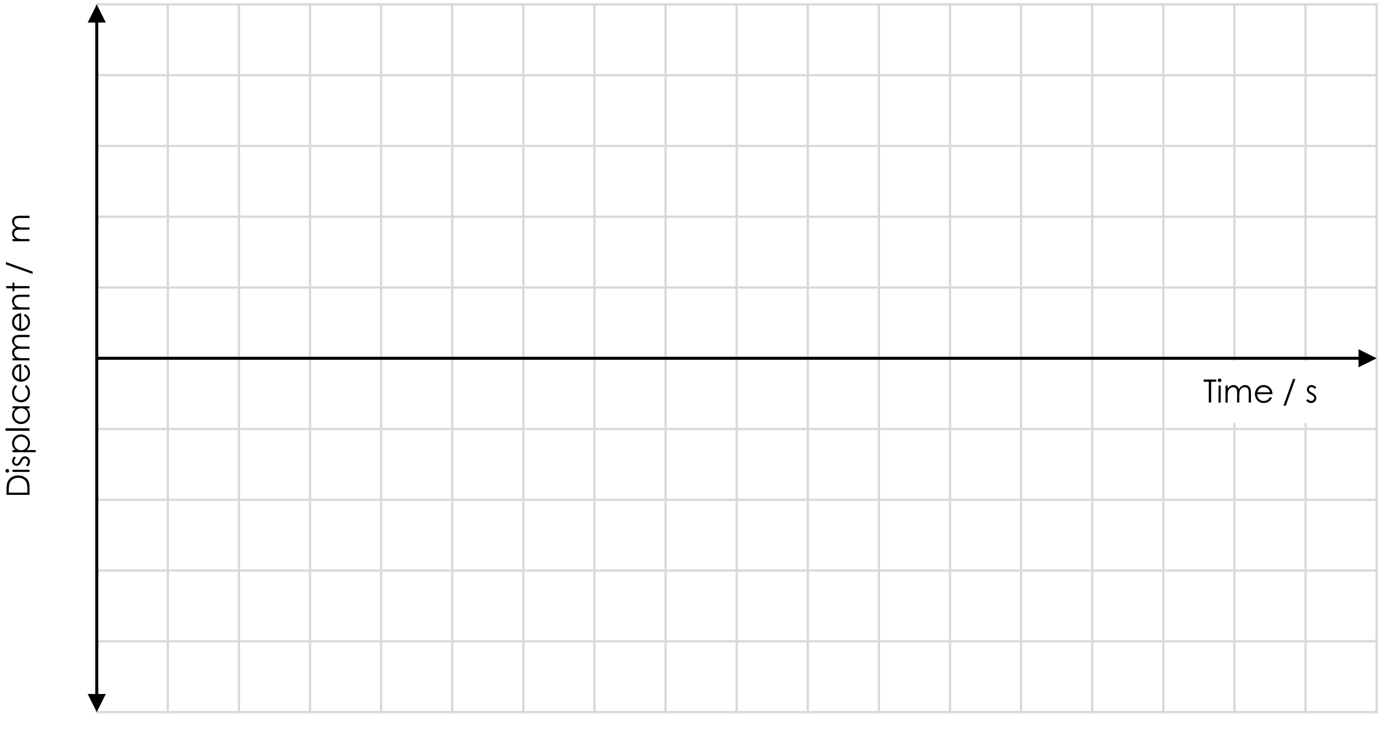
   ② $E_p = GmM / r$

   a. **Equate** equations ① and ② for when the kinetic and potential energies are equal

   b. **Rearrange** the equation to make ***v*** the subject

2. Plot a graph showing the **displacement** of an object undergoing SHM, with an amplitude of 40 mm and a frequency of 0.625 Hz, if the displacement can be described with the equation:

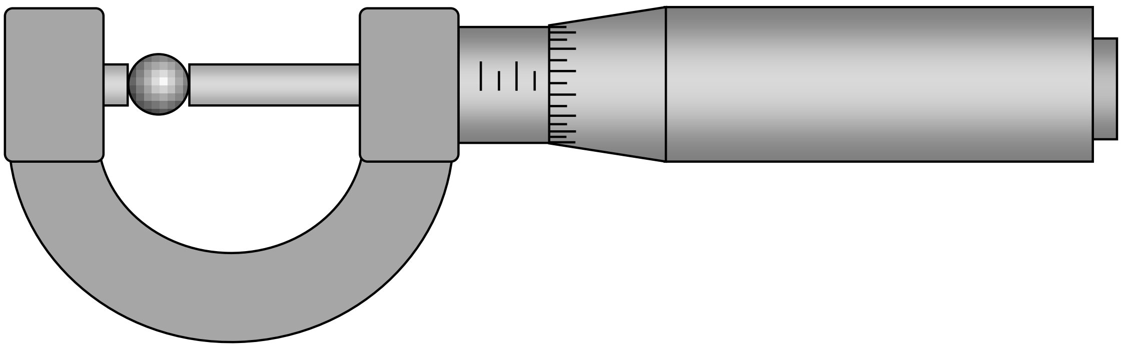
$$x = A \cos \omega t$$

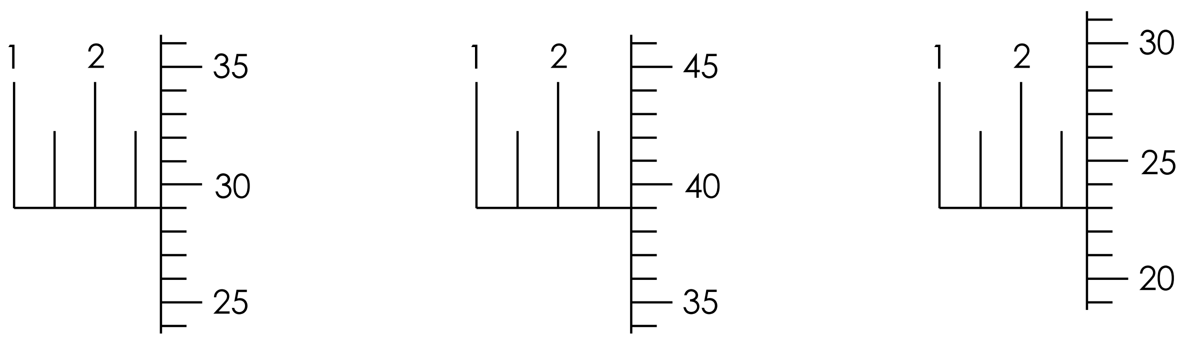


30th September

1

1. A micrometer is used to measure the diameter of a ball bearing. Three readings are taken to ensure that the ball is spherical.





Calculate the:

a. Mean **diameter** in mm

b. **Absolute uncertainty** in the diameter

c. **Percentage uncertainty** in the diameter

d. **Volume** in m^3

e. **Percentage uncertainty** in the volume

f. **Uncertainty** in the volume

September REVIEW

See how much progress you have made and identify any areas you are not confident with at this time.

A Level Physics Content	Red	Amber	Green
I can draw the **gravitational field lines** around a point mass and for a uniform field			
I can draw the **electric field lines** around a point charge, for a uniform field and between charges			
I can convert between **radians** and **degrees**			
I can **differentiate** functions with sin and cos			
I can calculate the centripetal acceleration of objects undergoing **circular motion**			
I can sketch displacement, velocity, and acceleration-time graphs for **simple harmonic motion**			
Any other comments:			

ANSWERS

Check your work with the short answers in the back of this book.

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