*Choose & browse a section*

Methods

Helps with general questions / reasonings

Experiments

Helps with questions regarding experimental setups and data collection

Essential Knowledge

The bare minimum that you’d need to know for each unit in this paper

Formula Sheet

For reference

Past Papers

Browse all WCH13 past papers!

# Methods

## Criticizing & Opinions

### Criticizing data

Point out inconsistent features that otherwise would be done in an experiment, such as:

1. Same significant figure
2. Continuous increment
3. Large range of values
4. Large sets of results (>5)
5. Repeat experiments for mean

### Safety of use of material, given property

Interpret meaning of property, then find value of property in which might pose a threat to safety

### Why graph should be a straight line, given equation

1. Rearrange & compare equation to
2. Identify gradient and y-intercept

## Measurement

### Calculating mean

Identify & exclude anomalies not within and take mean value

### Measuring devices

Long / short stationary length: Meter rule () / digital calipers () / micrometer ()

Distance between movements: Video camera and suitable length measuring device for same position on object

Temperature: Thermometer (if water bath, then measure temperature of water)

Mass: Balance

### Determining value

1. Use a suitable device
2. Measure related variables
3. Use correct formula
4. Repeat to find mean

Volume: Measuring cylinder

Time: Stop watch / light gates

Voltage: Voltmeter parallel to electrical component

Current: Ammeter in series

Angle: Protractor

### Measuring methods

Radius: Measure diameter then divide by 2

Density: Measure mass and volume, then divide

Acceleration: Measure distance travelled, time taken,

### Common questions

**Conducting measurements**

* Why is measuring device suitable: Much less resolution compared to measurement, low % uncertainty
* Accurate length measurement: Measuring device

Readings in different positions (as object might not be uniform)

Ensure measurement at widest point

Take mean

Reduce systematic error

* Why digital measuring device: Less % uncertainty, higher resolution, no parallax error

**Measuring accuracy**

* Why reduce % uncertainty: uncertainty in measuring device constant, larger measurement 🡪 lower % uncertainty
* Why accurate: Low % difference between value and constant value
* Which is greater source of uncertainty: Calculate all uncertainties and compare

### Common uncertainties

|  |  |  |
| --- | --- | --- |
| *Uncertainty* | *Causes* | *Solution* |
| Zero error | ~Mass | Zero balance before measurement *or*  Subtract y-var with value of error |
| Parallax error | ~Length | Ensure measuring device is at eye-level |
| Uncertain position | \* | Repeat and calculate mean value |
| Non-monochromatic light | Range of wavelengths | Use monochromatic light |
| Extrapolated data point | \* | Take measurements at regions around data point |

## Measuring device operation

|  |  |
| --- | --- |
|  |  |
| *Reading vernier calipers: 3.34cm* | *Reading micrometer: 17.9mm* |

### Using light gates to determine velocity

1. Measure length of moving object

## Changing variables

* Temperature of electrical comp: Water bath
* Potential difference on electrical comp: Variable resistor in series

### Finding point at which variable stops behaving normally

1. Keep finding more values
2. Identify point at which graph curves
3. Take smaller increments

### Determining value from graph

Use a large triangle to determine gradient

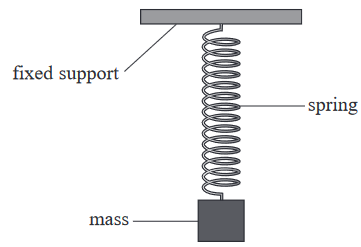
# Experiments

## Extension of spring – Material

### Obtaining data

Concept:

Measurement: Measure initial length & length with load, subtract 🡪 extension

Measuring device: Ruler ensured eye-level to reduce parallax

Accuracy: Different masses for different values

### Finding stiffness

Concept:

Value: Gradient of linear section

## Vibrating string – Frequency

### Main sources of uncertainty

* Location of nodes
* Parallax error for length
* Zero error for mass

## Light beam – Refractive index

To denser medium: bends towards normal

To less dense medium: bends away from normal

### Common questions

* Why monochromatic light: Single , different , more accurate measurement of

## Pasted image 20220312174509Electron diffraction grating – Wave nature

### Common questions

* How pattern provide evidence: e- experienced interference, which is a wave property

## Circuits – Electrical component properties

### Setup

1. Variable power supply / resistor
2. Ammeter in series
3. Voltmeter connected in parallel with electrical component

### Obtaining data

Record I for V, take smaller intervals at positions where graph curves.

# Essential knowledge

## Unit 1

Friction can be actively measured when the velocity not 0

## Unit 2

### Pasted image 20220312165433Viscosity

### Stiffness constant

A measure of how difficult it is to stretch a given object.

* Stiffness for a material is constant for an object
* The stiffness changes per material & shape

### Pasted image 20220312170528F-Δx graph

* The **area** under the graph is the **elastic strain energy**
* The **slope** of the graph is the **stiffness constant**
* The **area between loading and unload lines** is the **work done →** permanently deform

## Unit 3

Only waves can show **Interference** and **Diffraction**

The angle of incidence and refraction are **taken from the normal**

### Interference

* **Constructive** - whole number wavelength difference - in phase
* **Destructive** - 0.5 wavelength difference - out of phase

### Total internal reflection

Only occurs when and

## Unit 4

#### Distribution of current in circuits

Series: Constant

Parallel:

#### Distribution of potential difference in circuits

Series:

Parallel: Constant

# Formula sheet

s = (u+v)t \* 0.5 [-a]

v = u + at [-s]

s = ut + 1/2at² [-v]

v² = u² + 2as [-t]

F = ma

W = mg

p = mv [p: momentum]

v = s / t [@ a = 0]

ΔW = F \* Δs [Work done J]

KE = 1/2mv2 [J]

GPE = mgΔh [Gravitational potential J]

P = E / t = W / t [W]

Efficiency = Useful out / Total in

ρ = m / V [ρ: density]

F = 6(pi)ηrv [η: viscosity] [stroke's law] [v: terminal velocity]

ΔF = k Δx [Δx: extension][k: stiffness constant][hooke's law]

ΔEelastic = 1/2 FΔx

E = σ / ε [Young modulus]

σ = F / A [Stress]

ε = Δx / x [Strain]

v = fλ [Transverse wave speed]

v = sqrt(T/μ) [Wave speed on string] [T: Tension] [μ: kg m²]

I = P / A [Intensity of radiation] [A: Area m²]

nsinθ = nsinθ [Snell's law]

n = c / v

sinC = n⁻¹ [Critical angle]

nλ = dsinθ [d: slit width] [n: index of fringe] [θ: angle to fringe] [d = 1 / num of gratings]

V = W / Q = E / Q [Potential difference] [Q: charge]

V = IR

P = VI = I²R = V² / R

W = VIt [Work done J]

R = ρl / A [ρ: Resistivity] [l: length]

I = ΔQ / Δt [Q: charge]

I = nAve [A: Area m2] [n: density of electron]

E = hf

hf = Φ + 1/2mv² [Φ: work function] [v: maximum velocity]

λ = h / p [λ: de broglie wavelength]

## Mathematical methods

|  |  |
| --- | --- |
|  |  |