1. A volume is measured to be 52 m$^3$. This volume in m$^3$ is
   A. $5.2 \times 10^3$ m$^3$.
   B. $5.2 \times 10^1$ m$^3$.
   C. $5.2 \times 10^{-1}$ m$^3$.
   D. $5.2 \times 10^{-8}$ m$^3$.

   **Markscheme**
   D

   **Examiners report**
   [N/A]

2. The masses and weights of different objects are independently measured. The graph is a plot of weight versus mass that includes error bars.

   These experimental results suggest that the
   A. measurements show a significant systematic error but small random error.
   B. measurements show a significant random error but small systematic error.
   C. measurements are precise but not accurate.
   D. weight of an object is proportional to its mass.

   **Markscheme**
   A

   **Examiners report**
   As the weights of different objects are plotted against the corresponding masses of those objects, it is expected that the data plotted would yield a best fitting straight line that passed through the origin. Given that the best fitting line for the data plotted is straight but does not pass through the origin and that the uncertainty bars are small, it is indicated that the measurements show a significant systematic error but a small random error.
3. The best estimate for the time it takes light to cross the nucleus of the hydrogen atom is

A. $10^{-23}$ s.  
B. $10^{-20}$ s.  
C. $10^{-15}$ s.  
D. $10^{-7}$ s.

Markscheme
A

Examiners report
[N/A]

4. The length of each side of a sugar cube is measured as 10 mm with an uncertainty of ±2 mm. Which of the following is the absolute uncertainty in the volume of the sugar cube?

A. ±6 mm$^3$  
B. ±8 mm$^3$  
C. ±400 mm$^3$  
D. ±600 mm$^3$

Markscheme
D

Examiners report
A majority of candidates clearly had not translated the absolute uncertainties into percentages.

5. Which of the following is equivalent to the joule?

A. N m$^2$  
B. N m$^{-2}$  
C. kg m s$^{-2}$  
D. kg m$^2$s$^{-2}$

Markscheme
D

Examiners report
[N/A]

6. An object falls for a time of 0.25 s. The acceleration of free fall is 9.81 m s$^{-2}$. The displacement is calculated. Which of the following gives the correct number of significant digits for the calculated value of the displacement of the object?

A. 1  
B. 2  
C. 3  
D. 4
7. Two lengths, \(a\) and \(b\), are measured to be \(51 \pm 1 \text{ cm}\) and \(49 \pm 1 \text{ cm}\) respectively. In which of the following quantities is the percentage uncertainty the largest? 

A. \(a + b\)  
B. \(a - b\)  
C. \(a \times b\)  
D. \(\frac{a}{b}\) 

Markscheme
B
Examiners report
[N/A]

8. Which of the following will reduce random errors in an experiment? 

A. Using an instrument having a greater precision  
B. Checking the calibration of the instrument used  
C. Checking for zero error on the instrument used  
D. Repeating readings

Markscheme
D
Examiners report
[N/A]

9. A body accelerates from rest with a uniform acceleration \(a\) for a time \(t\). The uncertainty in \(a\) is 8% and the uncertainty in \(t\) is 4%. The uncertainty in the speed is 

A. 32%.  
B. 12%.  
C. 8%.  
D. 2%.

Markscheme
B
10. What is the order of magnitude of the mass, in kg, of an apple? [1 mark]
   A. $10^{-3}$
   B. $10^{-1}$
   C. $10^{+1}$
   D. $10^{+3}$

**Markscheme**
B

11. Which of the following is a fundamental SI unit? [1 mark]
   A. Ampere
   B. Joule
   C. Newton
   D. Volt

**Markscheme**
A

12. The graph shows the relationship between two quantities $p$ and $q$. The gradient of the graph is $r$ and the intercept on the $p$ axis is $s$. [1 mark]

Which of the following is the correct relationship between $p$ and $q$?
   A. $p = sq+r$
   B. $p = rq+s$
   C. $p = rq-s$
   D. $p = rs+q$
The acceleration of free fall $g$ is determined by the relationship $g = \frac{4\pi^2 l}{t^2}$. The uncertainty in the value of $l$ is 2% and the uncertainty in the value of $t$ is 5%. What is the uncertainty in $g$?

A. 3%
B. 7%
C. 8%
D. 12%

**Markscheme**

D

**Examiners report**

Response B proved to be a popular distracter, particularly at SL, with candidates failing to spot that squaring the time doubles its uncertainty.

The sides of a square are measured to be $5.0 \pm 0.2$ cm. Which of the following gives the area of the square and its uncertainty?

A. $25.0 \pm 0.2$ cm$^2$
B. $25.0 \pm 0.4$ cm$^2$
C. $25 \pm 2$ cm$^2$
D. $25 \pm 4$ cm$^2$

**Markscheme**

C

**Examiners report**

A number of candidates opted for B. Candidates appeared to have added the absolute uncertainty rather than adding the relative uncertainty as the approximation for finding the uncertainty in multiplication.

The radius of a sphere is measured with an uncertainty of 2%. What is the uncertainty in the volume of the sphere?

A. 2%
B. 4%
C. 6%
D. 8%

**Markscheme**

C
16. The force of air resistance $F$ that acts on a car moving at speed $v$ is given by $F = kv^2$ where $k$ is a constant. What is the unit of $k$? [1 mark]

A. kg m$^{-1}$  
B. kg m$^{-2}$s$^{-2}$  
C. kg m$^{-3}$  
D. kg m$^{-2}$s$^{-2}$

**Markscheme**
A

**Examiners report**

Consideration of units leads to C. It is not necessary to know the formula for the volume of a sphere.

17. Which of the following is a unit of energy? [1 mark]

A. kg m$^{-1}$s$^{-1}$  
B. kg m$^{-2}$s$^{-2}$  
C. kg m$^{-2}$  
D. kg m$^{-3}$s$^{-1}$

**Markscheme**
B

**Examiners report**

[N/A]

18. The volume $V$ of a cylinder of radius $R$ and height $H$ is given by $V = \pi R^2 H$. The volume of the cylinder was measured with an uncertainty of 10% and the height was measured with an uncertainty of 6%. What is the uncertainty in the radius of the cylinder? [1 mark]

A. 1%  
B. 2%  
C. 4%  
D. 8%

**Markscheme**
D

**Examiners report**

When calculating uncertainties a distinction must be made between what is measured and what is calculated. The calculated should be made the subject of the formula before proceeding.
19. Which of the following is a fundamental unit?
   A. Ampere
   B. Coulomb
   C. Ohm
   D. Volt

   **Markscheme**
   A

   **Examiners report**
   [N/A]

20. Which of the following expresses the watt in terms of fundamental units?
   A. kg m$^2$ s
   B. kg m$^2$ s$^{-1}$
   C. kg m$^2$ s$^{-2}$
   D. kg m$^2$ s$^{-3}$

   **Markscheme**
   D

   **Examiners report**
   [N/A]
The graph shows a set of experimental results to determine the density of oil. The results have systematic errors and random errors. [1 mark]

Using the information on the graph, what can be said about the measurements used to find the density of oil?

<table>
<thead>
<tr>
<th></th>
<th>Systematic errors</th>
<th>Random errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>small</td>
<td>small</td>
</tr>
<tr>
<td>B</td>
<td>small</td>
<td>large</td>
</tr>
<tr>
<td>C</td>
<td>large</td>
<td>small</td>
</tr>
<tr>
<td>D</td>
<td>large</td>
<td>large</td>
</tr>
</tbody>
</table>

**Markscheme**

C

**Examiners report**

[N/A]
22. Which of the following is a derived unit?
   A. Mole  
   B. Kelvin  
   C. Coulomb  
   D. Ampere

**Markscheme**

C

**Examiners report**

[N/A]

23. A sphere fits inside a cube. The length of the cube and the diameter of the sphere are 10.0±0.2cm. What is the ratio ?

   A. \( \frac{3}{4\pi} \)  
   B. 1  
   C. 2  
   D. 8

**Markscheme**

B

**Examiners report**

[N/A]
A swimming pool contains $18 \times 10^6$ kg of pure water. The molar mass of water is $18$ gmol$^{-1}$. What is the correct estimate of the number of water molecules in the swimming pool?

A. $10^4$
B. $10^{24}$
C. $10^{25}$
D. $10^{26}$

**Markscheme**

D

**Examiners report**

[N/A]

Which of the following is a scalar quantity?

A. Velocity
B. Momentum
C. Kinetic energy
D. Acceleration

**Markscheme**

C

**Examiners report**

[N/A]

A stone falls from rest to the bottom of a water well of depth $d$. The time $t$ taken to fall is $2.0 \pm 0.2$ s. The depth of the well is calculated to be $20$ m using $d = \frac{1}{2}at^2$. The uncertainty in $a$ is negligible.

What is the absolute uncertainty in $d$?

A. $\pm 0.2$ m
B. $\pm 1$ m
C. $\pm 2$ m
D. $\pm 4$ m

**Markscheme**

D

**Examiners report**

[N/A]

Which is a vector quantity?

A. Pressure
B. Electric current
C. Temperature
D. Magnetic field

**Markscheme**

[N/A]
28. How many significant figures are there in the number 0.0450? 

A. 2 
B. 3 
C. 4 
D. 5 

Markscheme

B 

Examiners report 

[N/A]