Measurement-practice-MC [64 marks]

1. A student wants to determine the angular speed ω of a rotating object.   *[1 mark]*
    The period T is 0.50 s ±5 %. The angular speed ω is

    $$\omega = \frac{2\pi}{T}$$

    What is the percentage uncertainty of ω?

    A. 0.2 %

    B. 2.5 %

    C. 5 %

    D. 10 %

2. A student models the relationship between the pressure *p* of a gas and its *[1 mark]*
    temperature *T* as $p = x + y$T.

    The units of *p* are pascal and the units of *T* are kelvin. What are the fundamental
    SI units of x and y?

	x	y
A.	$kg\,m^{-1}s^{-2}$	$kg\,m^{-1}s^{-2}K^{-1}$
B.	$kg\,m^{-1}s^{-2}$	K^{-1}
C.	K	$kg^{-1}m\,s^{-2}K^{-1}$
D.	K	K^{-1}

3. A student measures the radius R of a circular plate to determine its area. *[1 mark]* The absolute uncertainty in R is ΔR.

   What is the **fractional** uncertainty in the area of the plate?

   A. $\frac{2\Delta R}{R}$

   B. $\left(\frac{\Delta R}{R}\right)^2$

   C. $\frac{2\pi\Delta R}{R}$

   D. $\pi\left(\frac{\Delta R}{R}\right)^2$

4. What is the unit of electrical potential difference expressed in fundamental SI units? *[1 mark]*

   A. kg m s^{-1} C^{-1}

   B. kg m^2 s^{-2} C^{-1}

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

   D. kg m^2 s^{-1} A

5. An object has a weight of 6.10×10^2 N. What is the change in gravitational potential energy of the object when it moves through 8.0 m vertically? *[1 mark]*

   A. 5 kJ

   B. 4.9 kJ

   C. 4.88 kJ

   D. 4.880 kJ

6. A student is verifying the equation   *[1 mark]*

$$x = \frac{2\lambda Y}{z}$$

The percentage uncertainties are:

Quantity	Uncertainty
λ	±10%
Y	±0.05%
z	±5%

What is the percentage uncertainty in x?

A. 5 %

B. 15 %

C. 25 %

D. 30 %

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7. A proton has momentum 10^{-20} N s and the uncertainty in the position of   *[1 mark]*
the proton is 10^{-10} m. What is the minimum **fractional** uncertainty in the
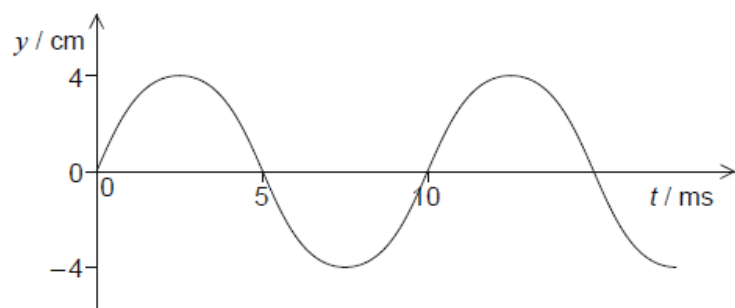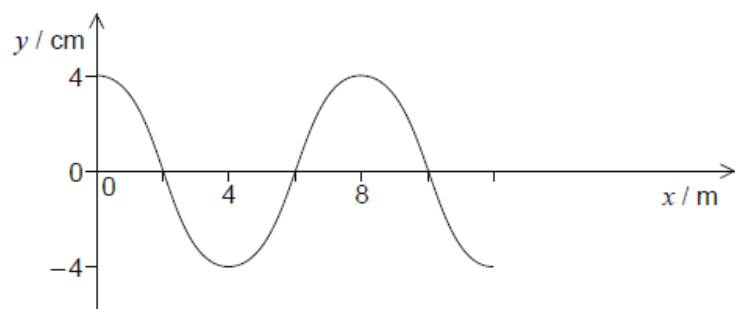momentum of this proton?

A. 5×10^{-25}

B. 5×10^{-15}

C. 5×10^{-5}

D. 2×10^{4}

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8. What is the unit of power expressed in fundamental SI units?   *[1 mark]*

A. $kg\,m\,s^{-2}$

B. $kg\,m^2\,s^{-2}$

C. $kg\,m\,s^{-3}$

D. $kg\,m^2\,s^{-3}$

9. The graphs show the variation of the displacement y of a medium with distance x and with time t for a travelling wave. [1 mark]

What is the speed of the wave?

A. $0.6 \, \text{m s}^{-1}$

B. $0.8 \, \text{m s}^{-1}$

C. $600 \, \text{m s}^{-1}$

D. $800 \, \text{m s}^{-1}$

10. The length of the side of a cube is $2.0 \, \text{cm} \pm 4\,\%$. The mass of the cube is $24.0 \, \text{g} \pm 8\,\%$. What is the percentage uncertainty of the density of the cube? [1 mark]

A. $\pm 2\,\%$

B. $\pm 8\,\%$

C. $\pm 12\,\%$

D. $\pm 20\,\%$

11. A student measures the radius r of a sphere with an absolute uncertainty *[1 mark]* Δr. What is the fractional uncertainty in the volume of the sphere?

A. $\left(\frac{\Delta r}{r}\right)^3$

B. $3\frac{\Delta r}{r}$

C. $4\pi\frac{\Delta r}{r}$

D. $4\pi\left(\frac{\Delta r}{r}\right)^3$

12. What is the best estimate for the diameter of a helium nucleus? *[1 mark]*

A. 10^{-21} m

B. 10^{-18} m

C. 10^{-15} m

D. 10^{-10} m

13. Which is a unit of force? *[1 mark]*

A. J m

B. J m^{-1}

C. J m s^{-1}

D. J m^{-1} s

14. How many significant figures are there in the number 0.0450? *[1 mark]*

A. 2

B. 3

C. 4

D. 5

15. An object is positioned in a gravitational field. The measurement of *[1 mark]* gravitational force acting on the object has an uncertainty of 3 % and the uncertainty in the mass of the object is 9 %. What is the uncertainty in the gravitational field strength of the field?

A. 3 %

B. 6 %

C. 12 %

D. 27 %

16. The diagram shows an analogue meter with a mirror behind the pointer. *[1 mark]*
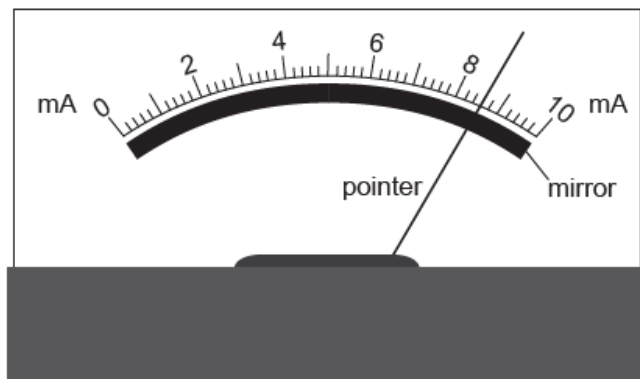
What is the main purpose of the mirror?

A. To provide extra light when reading the scale

B. To reduce the risk of parallax error when reading the scale

C. To enable the pointer to be seen from different angles

D. To magnify the image of the pointer

17. What is a correct value for the charge on an electron? *[1 mark]*

A. 1.60×10^{-12} μC

B. 1.60×10^{-15} mC

C. 1.60×10^{-22} kC

D. 1.60×10^{-24} MC

18. What is the unit of electrical energy in fundamental SI units? *[1 mark]*

A. $kg\ m^2\ C^{-1}\ s$

B. $kg\ m\ s^{-2}$

C. $kg\ m^2\ s^{-2}$

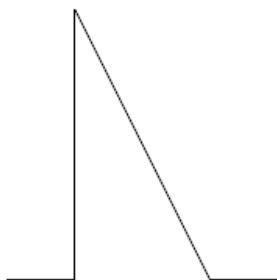D. $kg\ m^2\ s^{-1}\ A$

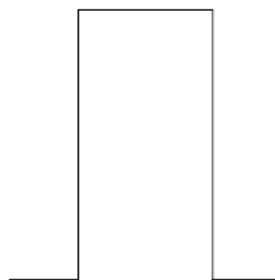19. Two pulses are travelling towards each other. [1 mark]
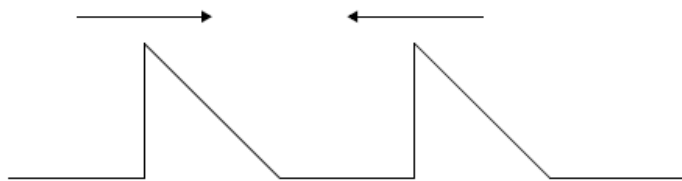
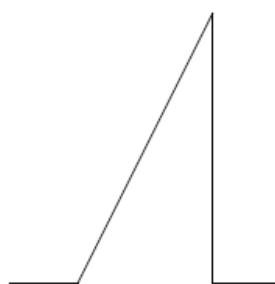What is a possible pulse shape when the pulses overlap?

A.

B.

C.

D.

20. A stone falls from rest to the bottom of a water well of depth d. The time t [1 mark]
taken to fall is 2.0 ±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. ± 0.2 m

B. ± 1 m

C. ± 2 m

D. ± 4 m

21. A boy jumps from a wall 3m high. What is an estimate of the change in   [1 mark]
momentum of the boy when he lands without rebounding?

A. $5×10^0$ kg m s⁻¹

B. $5×10^1$ kg m s⁻¹

C. $5×10^2$ kg m s⁻¹

D. $5×10^3$ kg m s⁻¹

22. Light of wavelength 400nm is incident on two slits separated by 1000μm. *[1 mark]*
The interference pattern from the slits is observed from a satellite
orbiting 0.4Mm above the Earth. The distance between interference maxima as
detected at the satellite is

A. 0.16Mm.
B. 0.16km.
C. 0.16m.
D. 0.16mm.

23. A sphere fits inside a cube. *[1 mark]*
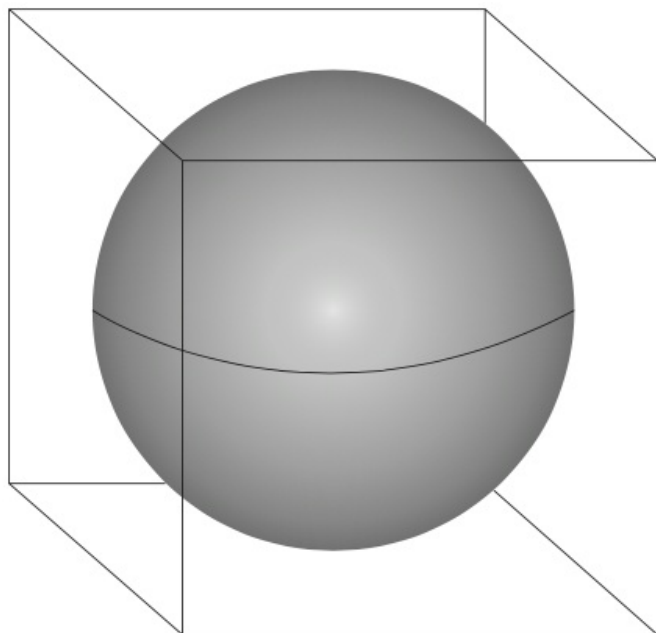
The length of the cube and the diameter of the sphere are 10.0±0.2cm.

What is the ratio $\dfrac{percentage\,uncertainty\,of\,the\,volume\,of\,the\,sphere}{percentage\,uncertainty\,of\,the\,volume\,of\,the\,cube}$?

A. $\dfrac{3}{4\pi}$

B. 1

C. 2

D. 8

24. A swimming pool contains 18×10^6 kg of pure water. The molar mass of *[1 mark]*
water is 18gmol^{-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^{33}

25. Which of the following is a derived unit?   *[1 mark]*
    A.   Mole
    B.   Kelvin
    C.   Coulomb
    D.   Ampere

26. What is the unit of energy density?   *[1 mark]*
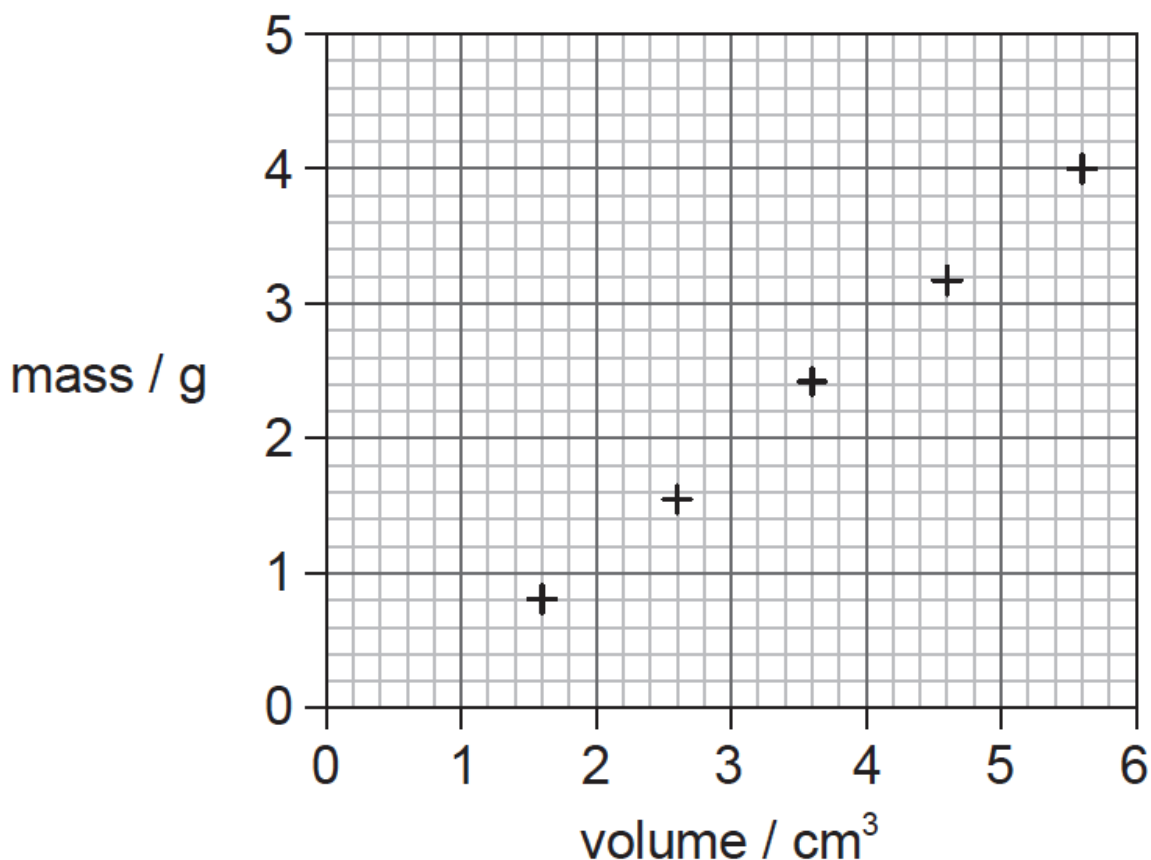   A. $J\,kg^{-1}$
    B. $J\,kg^{-1}\,m^3$
    C. $J\,mol^{-1}$
    D. $J\,K^{-1}$

27. Which of the following expresses the watt in terms of fundamental units? *[1 mark]*
    A. $kg\,m^2\,s$
    B. $kg\,m^2\,s^{-1}$
    C. $kg\,m^2\,s^{-2}$
    D. $kg\,m^2\,s^{-3}$

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

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

	Systematic errors	Random errors
A.	small	small
B.	small	large
C.	large	small
D.	large	large

29. Which of the following expresses the units of capacitance in terms of fundamental units? [1 mark]

A. $s^4 A^2 m^{-2} kg^{-1}$

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

C. $s^4 A^2 m^{-2}$

D. $s^2 A m^{-2}$

This question is about the flow of liquids.

A student carries out an experiment to investigate how the rate of flow R of water through a narrow tube varies with the pressure difference across the tube. The pressure difference is proportional to the height h shown in the diagram. The student measures h in cm with a metre ruler. R is obtained by measuring the volume of water collected in a measuring cylinder in a time of 100s.
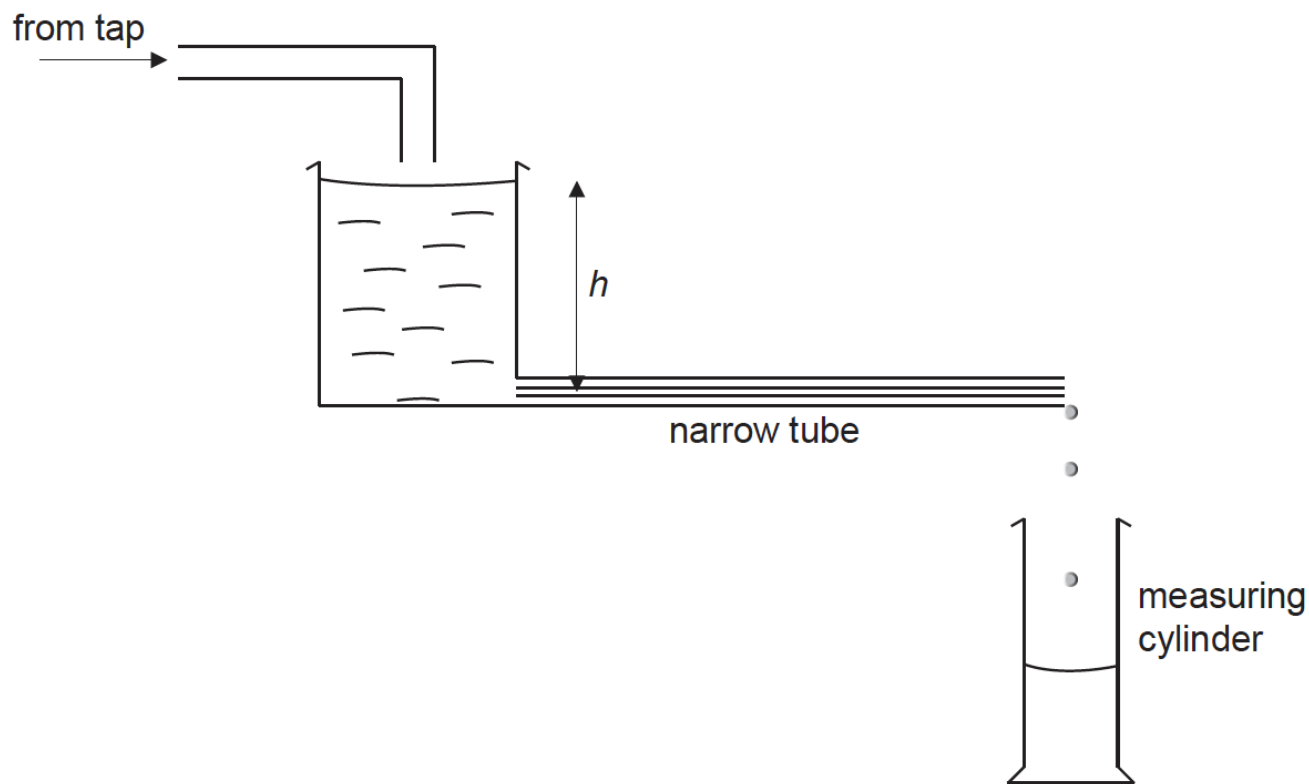
30a. The student enters the data on a spreadsheet and produces the graph [5 marks] and trend line shown below.
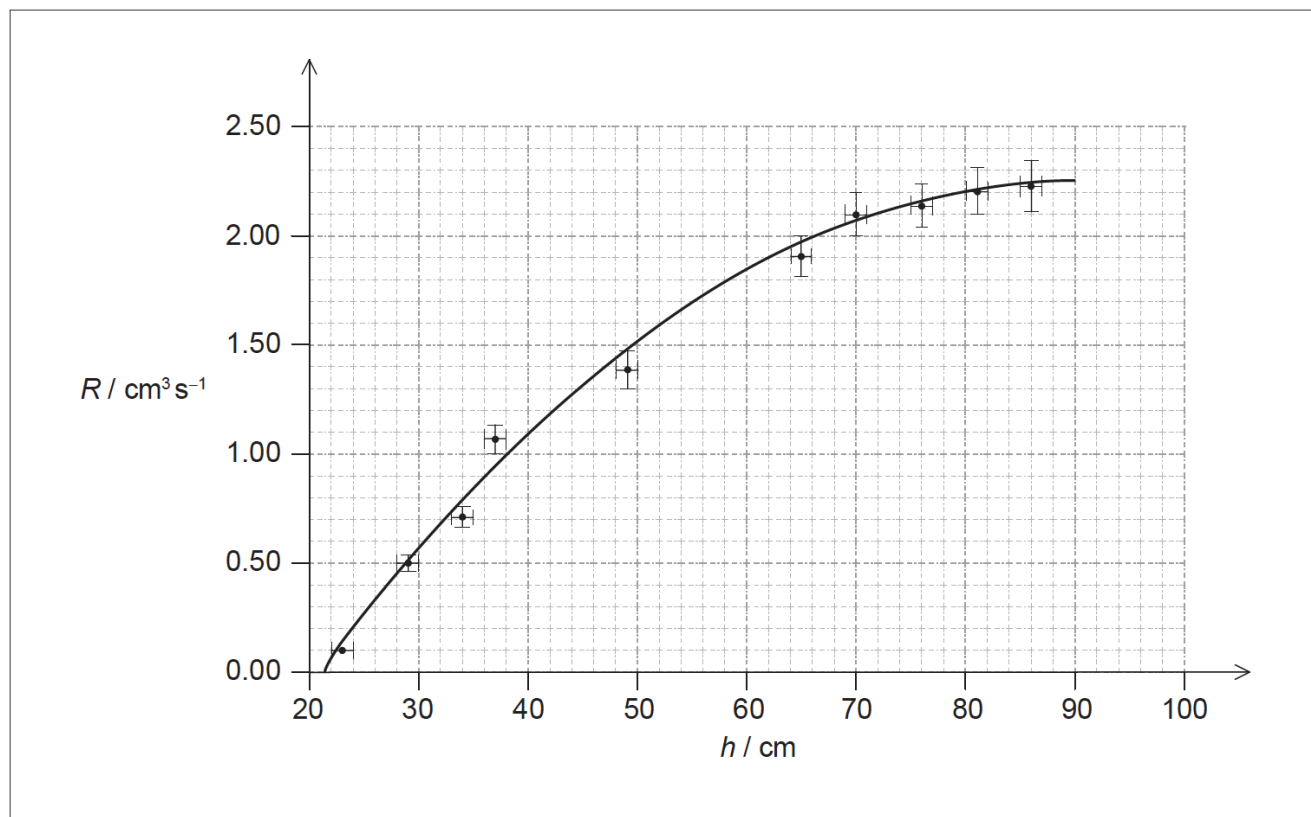
The data point for $h = 57$cm, $R = 1.70$cm^{3}s^{-1} has not been shown on the graph. The student estimates the uncertainties in all values of h to be ± 1cm and the uncertainties in the values of R to be $\pm 5\%$.

(i) On the graph, draw the missing data point.

(ii) On the graph, draw the vertical error bar for this data point.

(iii) Comment on why the trend line is not a perfect match for the data.

(iv) Explain why the student's estimate of a 5% uncertainty in all values for R is unlikely to be correct.

30b. The student estimates that the uncertainty in timing 100s is ± 1s. Using *[4 marks]* the data on the graph, deduce the absolute uncertainty in the volume of water collected when $R = 2.1$cm^{3}s^{-1}.

31. Which of the following is a fundamental unit? *[1 mark]*

A. Ampere

B. Coulomb

C. Ohm

D. Volt

32. The maximum acceleration a_{max} of an oscillator undergoing simple   *[1 mark]*
    harmonic motion (SHM) has a percentage uncertainty of 12%. The
    amplitude x_0 of the oscillation has a percentage uncertainty of 20%. If $k = \sqrt{\dfrac{a_{max}}{x_0}}$

    what is the percentage uncertainty in the constant k?

    A. 4%

    B. 8%

    C. 16%

    D. 32%

33. The radius of a sphere is measured with an uncertainty of 2%. What is the *[1 mark]*
    uncertainty in the volume of the sphere?
    A. 2%
    B. 4%
    C. 6%
    D. 8%

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

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

35. 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 s^{-2}
   D. kg m^2 s^{-1}

36. The volume V of a cylinder of radius R and height H is given by $V = \pi R^2 H$. *[1 mark]*
    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?

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

37. The sides of a square are measured to be 5.0 ± 0.2 cm. Which of the following gives the area of the square and its uncertainty? [1 mark]

A. 25.0 ± 0.2 cm²
B. 25.0 ± 0.4 cm²
C. 25 ± 2 cm²
D. 25 ± 4 cm²

38. The length of the side of a cube is 10.0 ±0.3cm. What is the uncertainty in the volume of the cube? [1 mark]

A. ±0.027 cm³

B. ±2.7 cm³

C. ±9.0 cm³

D. ±90 cm³

39. 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]
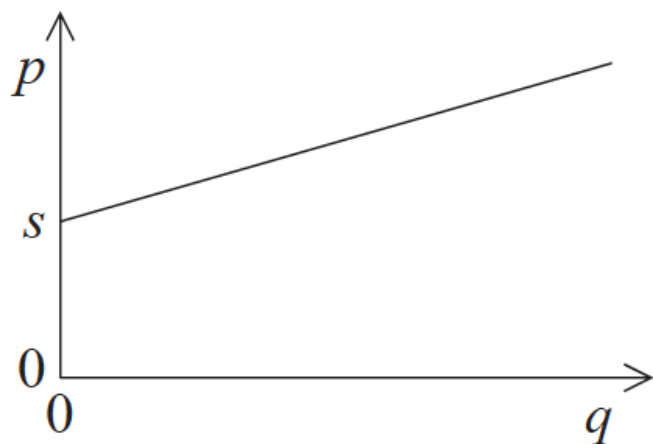
Which of the following is the correct relationship between p and q?

A. $p = sq+r$
B. $p = rq+s$
C. $p = rq-s$
D. $p = rs+q$

40. Aiming for the centre of a target, an archer fires arrows which produces a *[1 mark]* pattern of hits as shown below.
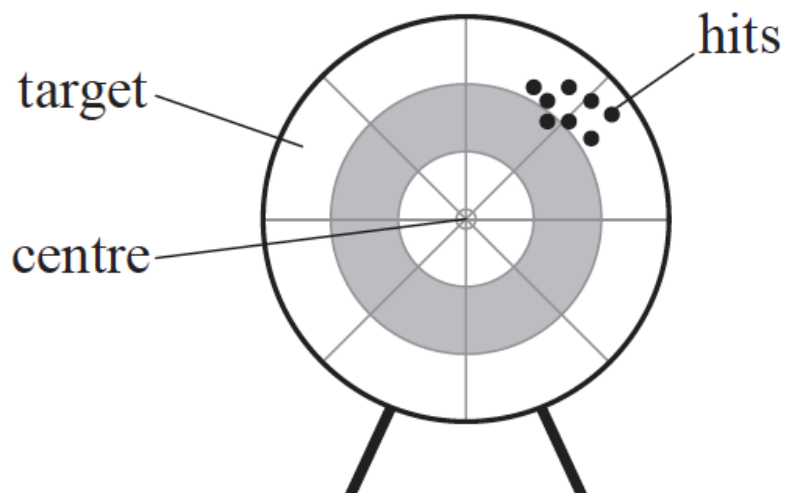
The pattern suggests the presence of

A. random and systematic uncertainties.
B. random uncertainties but no systematic uncertainties.
C. systematic uncertainties but no random uncertainties.
D. neither random nor systematic uncertainties.

41. The acceleration of free fall g is determined by the relationship $g = \frac{4\pi^2 l}{t^2}$. *[1 mark]*

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%

42. What is the correct SI unit for momentum? *[1 mark]*

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

43. 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}

44. Which of the following is a fundamental SI unit? [1 mark]

   A. Ampere
   B. Joule
   C. Newton
   D. Volt

45. The resistive force F acting on a sphere of radius r travelling with speed v [1 mark] through a liquid is given by the equation

$$F = 6\pi\eta r v$$

   where η is a constant. What are the SI units of η?

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

46. A small object is attached to a string and rotated in a circle of constant [1 mark] radius in a horizontal plane. The tension T in the string is measured for different speeds v. Which of the following plots should give a straight-line graph?

   A. T against v

   B. T^2 against v

   C. T against v^2

   D. T^2 against v^2

47. Which of the following contains one fundamental and one derived unit? [1 mark]

A.	ampere	kilogram
B.	ampere	coulomb
C.	joule	newton
D.	joule	coulomb

48. The current I through a resistor is measured with a digital ammeter to be [1 mark] 0.10 A. The uncertainty in the calculated value of I^2 will be

   A. 1 %.
   B. 2 %.
   C. 5 %.
   D. 20 %.

49. Which of the following will reduce random errors in an experiment?   *[1 mark]*

   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

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50. A body accelerates from rest with a uniform acceleration *a* for a time *t*.   *[1 mark]*
   The uncertainty in *a* is 8% and the uncertainty in *t* is 4%. The uncertainty
   in the speed is

   1. 32%.

   2. 12%.

   3. 8%.

   4. 2%.

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51. Which of the following is equivalent to the joule?   *[1 mark]*

   A. $\mathrm{N\,m^2}$

   B. $\mathrm{N\,m^{-2}}$

   C. $\mathrm{kg\,m\,s^{-2}}$

   D. $\mathrm{kg\,m^2 s^{-2}}$

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52. An object falls for a time of 0.25 s. The acceleration of free fall is   *[1 mark]*
   $9.81\ \mathrm{m\,s^{-2}}$. 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

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53. Two lengths, a and b, are measured to be 51 ± 1 cm and 49 ± 1 cm   *[1 mark]*
   respectively. In which of the following quantities is the percentage
   uncertainty the largest?

   A. $a + b$

   B. $a - b$

   C. $a \times b$

   D. $\frac{a}{b}$

54. The length of each side of a sugar cube is measured as 10 mm with an   *[1 mark]*
    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

55. A volume is measured to be 52 mm^3. This volume in m^3 is   *[1 mark]*

    A. 5.2×10^3 m^3.

    B. 5.2×10^1 m^3.

    C. 5.2×10^{-1} m^3.

    D. 5.2×10^{-8} m^3.

56. The masses and weights of different objects are independently measured.*[1 mark]*
    The graph is a plot of weight versus mass that includes error bars.
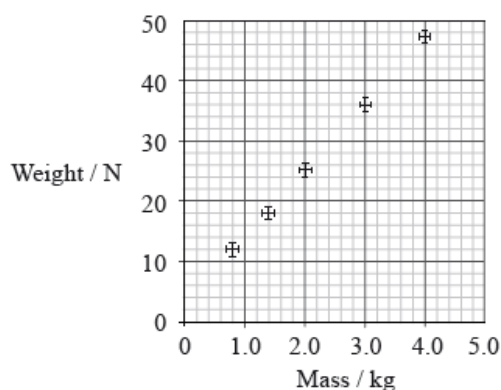
    These experimental results suggest that the

    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.