# R2019_1 *[15 marks]*

1. An object is positioned in a gravitational field. The measurement of gravitational force *[1 mark]* 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 %

2. 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

3. A stone falls from rest to the bottom of a water well of depth *d*. The time t taken to fall is *[1 mark]* 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

4. Light of wavelength 400nm is incident on two slits separated by 1000µm. The *[1 mark]* 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.

5. A car moves north at a constant speed of 3m s $^{-1}$ for 20s and then east at a constant *[1 mark]* speed of 4m s^{-1} for 20s. What is the average speed of the car during this motion?

    A. 7.0m s^{-1}
    B. 5.0m s^{-1}
    C. 3.5m s^{-1}
    D. 2.5m s^{-1}

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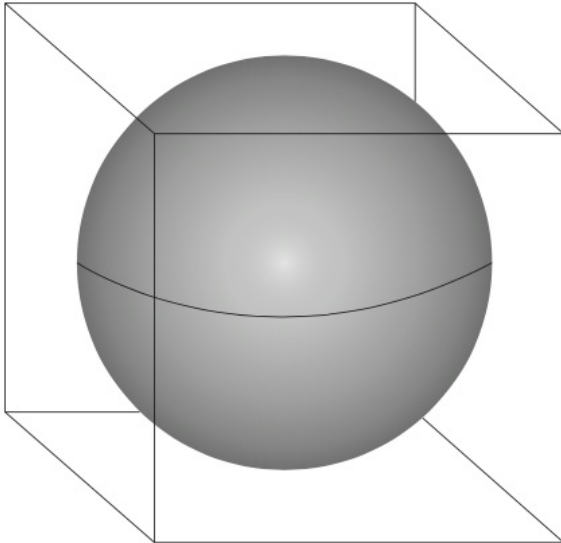
The length of the cube and the diameter of the sphere are 10.0±0.2cm.

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

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

B. 1

C. 2

D. 8

7. 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}

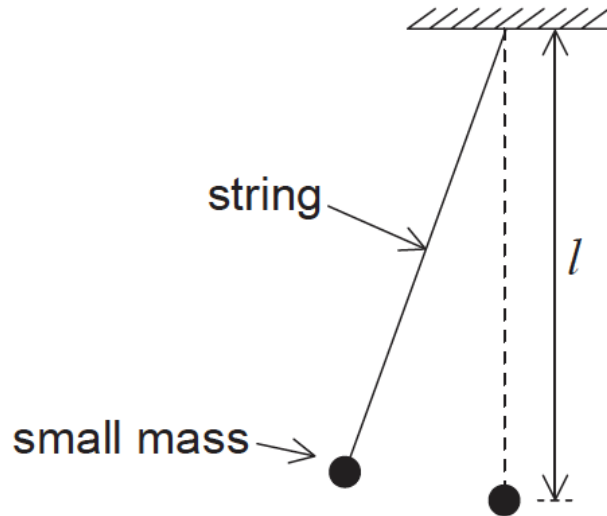8. Which of the following expresses the watt in terms of fundamental units? *[1 mark]*

A. kg m^2 s

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

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

D. kg m^2 s^{-3}

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

Data analysis question.

A simple pendulum of length *l* consists of a small mass attached to the end of a light string.

The time *T* taken for the mass to swing through one cycle is given by

$$T = 2\pi \sqrt{\frac{l}{g}}$$

where *g* is the acceleration due to gravity.

10. A student measures *T* for one length *l* to determine the value of *g*. Time $T = 1.9s \pm 0.1s$ and length $l = 0.880m \pm 0.001m$. Calculate the fractional uncertainty in *g*. [2 marks]

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

   A. Ampere

   B. Coulomb

   C. Ohm

   D. Volt

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

    A. 4%

    B. 8%

    C. 16%

    D. 32%

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

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

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