

R2019_1 [15 marks]

1. An object is positioned in a gravitational field. The measurement of 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? [1 mark]
- A. 3 %
 - B. 6 %
 - C. 12 %
 - D. 27 %

Markscheme

C

2. What is a correct value for the charge on an electron? [1 mark]
- A. $1.60 \times 10^{-12} \mu\text{C}$
 - B. $1.60 \times 10^{-15} \text{mC}$
 - C. $1.60 \times 10^{-22} \text{kC}$
 - D. $1.60 \times 10^{-24} \text{MC}$

Markscheme

C

3. A stone falls from rest to the bottom of a water well of depth d . The time t 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. [1 mark]
- What is the absolute uncertainty in d ?
- A. ± 0.2 m
 - B. ± 1 m
 - C. ± 2 m
 - D. ± 4 m

Markscheme

D

4. Light of wavelength 400nm is incident on two slits separated by $1000\mu\text{m}$. 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 [1 mark]
- A. 0.16Mm .
 - B. 0.16km .
 - C. 0.16m .
 - D. 0.16mm .

Markscheme

B

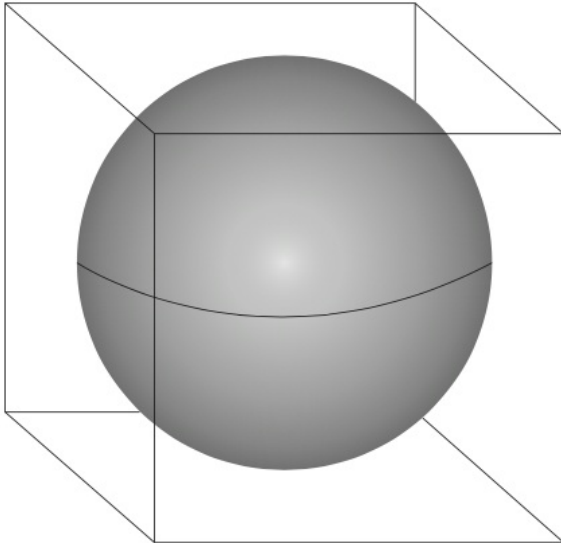
5. A car moves north at a constant speed of 3m s^{-1} for 20s and then east at a constant speed of 4m s^{-1} for 20s . What is the average speed of the car during this motion? [1 mark]
- A. 7.0m s^{-1}
 - B. 5.0m s^{-1}
 - C. 3.5m s^{-1}
 - D. 2.5m s^{-1}

Markscheme

C

6. A sphere fits inside a cube.

[1 mark]



The length of the cube and the diameter of the sphere are 10.0 ± 0.2 cm.

What is the ratio $\frac{\text{percentage uncertainty of the volume of the sphere}}{\text{percentage uncertainty of the volume of the cube}}$?

- A. $\frac{3}{4\pi}$
- B. 1
- C. 2
- D. 8

Markscheme

B

7. What is the unit of energy density?

[1 mark]

- A. J kg^{-1}
- B. $\text{J kg}^{-1} \text{ m}^3$
- C. J mol^{-1}
- D. J K^{-1}

Markscheme

A

8. Which of the following expresses the watt in terms of fundamental units?

[1 mark]

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

Markscheme

D

9. Which of the following expresses the units of capacitance in terms of fundamental units?

[1 mark]

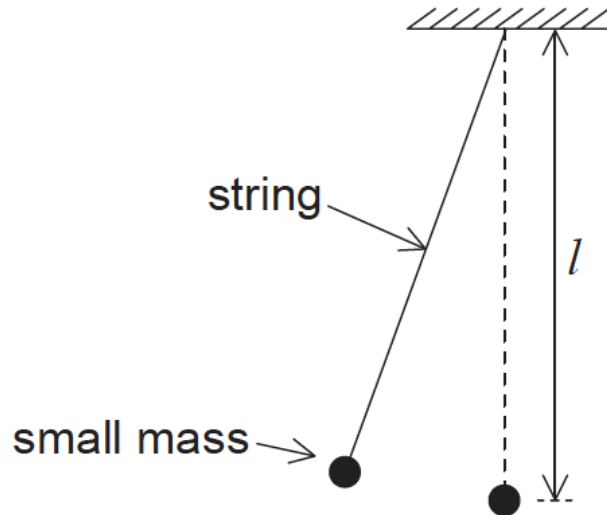
- A. $\text{s}^4 \text{A}^2 \text{m}^{-2} \text{kg}^{-1}$
- B. $\text{s}^2 \text{Am}^{-2} \text{kg}^{-1}$
- C. $\text{s}^4 \text{A}^2 \text{m}^{-2}$
- D. $\text{s}^2 \text{Am}^{-2}$

Markscheme

A

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]

Markscheme

fractional uncertainty in $l = \frac{1}{880}$ **or** 0.00114 } (both needed)
and fractional uncertainty in $T = \frac{1}{19}$ **or** 0.0526; } (accept percentage, or fraction here
- allow candidate to quote $\frac{2}{19}$
directly if added correctly later)
fractional uncertainty in $g = (2 \times 0.0526 + 0.00114) = 0.106$; } (accept percentage,
do not accept fraction)

11. Which of the following is a fundamental unit? [1 mark]
- A. Ampere
 - B. Coulomb
 - C. Ohm
 - D. Volt

Markscheme

A

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%

Markscheme

C

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%

Markscheme

C

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%

Markscheme

D

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