Gravity Bounds

The acceleration due to gravity experienced by any mass close to the surface of the earth can be calculated using the following formula:

$$g = \frac{GM}{r^2}$$

G is the gravitational constant, M is the mass of the earth and r is the radius of the earth.

The mass of the earth is $5.97 \times 10^{24}\ kg$, to 3 significant figures.
The radius of the earth is $6371000\ m$, to the nearest $1000\ m$.
The gravitational constant, G, is 6.67×10^{-11} to 3 significant figures.

1. Using the values given above, calculate g.

Taking the values given above, g is equal to: __________ms^{-2}

2. By taking into account the precision of the measurements given, and considering upper and lower bounds, find the range of possible values g could take.

The greatest possible value of g is: __________ms^{-2}

The least possible value of g is: __________ms^{-2}

3. Using the upper and lower bounds you have now found for the value of g, write down the value for g, rounding to an appropriate degree of accuracy.

g is __________ms^{-2} correct to __________ $significant\ figures$

Gravity Bounds SOLUTIONS

The acceleration due to gravity experienced by any mass close to the surface of the earth can be calculated using the following formula:

$$g = \frac{GM}{r^2}$$

G is the gravitational constant, M is the mass of the earth and r is the radius of the earth.

The mass of the earth is $5.97 \times 10^{24}\ kg$, to 2 significant figures.
The radius of the earth is $6371000\ m$, to the nearest $1000\ m$.
The gravitational constant, G, is 6.67×10^{-11} to 3 significant figures.

1. Using the values given above, calculate g.

$$g = \frac{(6.67 \times 10^{-11}) \times (5.97 \times 10^{24})}{6371000^2}$$

Taking the values given above, g is equal to: 9.81036023452388 ms^{-2}

2. By taking into account the precision of the measurements given, and considering upper and lower bounds, find the range of possible values g could take.

$$5.965 \times 10^{24} \leq m < 5.975 \times 10^{24}$$

$$6370500 \leq r < 6371500$$

$$6.665 \times 10^{-11} \leq G < 6.675 \times 10^{-11}$$

$$\frac{G_L m_L}{(r_U)^2} \leq g < \frac{G_U m_U}{(r_L)^2}$$

The greatest possible value of g is: 9.8274793416876 ms^{-2}

The least possible value of g is: 9.79325869624054 ms^{-2}

3. Using the upper and lower bounds you have now found for the value of g, write down the value for g, rounding to an appropriate degree of accuracy.

$$\mathbf{9.7932 \ldots \leq g < 9.8274 \ldots}$$

All values within this range round to 9.8 to 2 s.f.,
but to 3 s.f. they are no longer the same.

g is 9.8 ms^{-2} correct to 2 *significant figures*

Note: This gives an error interval of $9.75 \leq g < 9.85$ which contains the calculated interval.