(1) In physics, the potential energy \( p \) of an object varies directly with the mass of the object \( m \) times the height of the object \( h \) times a constant \( g \).

(a) Write the expression for potential energy.

Answer: \( p = mgh \)

(b) An object that weighs 55 kilograms and is at a height of 121 meters above sea level has a potential energy value of 65285.55 joules. Determine the value of the constant, \( g \).

Answer: \( g = 9.81 \)

(c) Write an equation to express the height of this object in terms of its potential energy, assuming that its mass remains constant at 55 kilograms.

Answer: \( h = \frac{p}{539.55} \)

(2) Gravity exists between any two objects with mass, not just when planets are involved. In physics, the force of gravity \( F \) is given by the following equation:

\[
F = \frac{GMm}{r^2}
\]

where \( G \) is a constant, \( M \) is the mass of the one object, \( m \) is the mass of the other object, and \( r \) is the distance between both objects. Suppose Jon Snow is celebrating his birthday with a large chocolate cake. Jon weighs 77 kilograms, and the cake weighs 2.3 kilograms. When Jon is 0.3 meters away from the cake, he feels a force of gravity equal to \( 1.3125 \times 10^{-7} \) newtons.

(a) What type of relation exists between gravitational force \( F \) and the distance between Jon and his cake \( r \)? (i.e.- direct or indirect variation?)

Answer: Indirect Variation

(b) Determine the value of the gravitational constant, \( G \), with the information given.

Answer: \( G = 6.67 \times 10^{-11} \)

(c) Jon wants to share some of his cake with Daenerys. Write an equation to express the distance between Daenerys and the cake \( r \) in terms of the gravitational force \( F \), assuming the cake’s mass stays the same and with the knowledge that Daenerys weighs 52 kilograms.

Answer: \( r = \frac{0.0000893}{\sqrt{F}} \)