Review Problem Set

Gravitation Questions

Newton's law of Universal gravitation: $F_{grav} = \frac{m_1 m_2 G}{d^2}$.

Acceleration g near surface of a planet of mass M_p, radius R_p: $g = \frac{M_p G}{R_p^2}$.

- Be able to say by what factor the gravitational force between two objects increases or decreases due to a factor change in their separation or their masses.
- Be able to say by what factor the weight of an object increases or decreases due to a factor change in the mass of a planet or the object's distance from the planet's center.

1. Mass m_1 exerts a gravitational force F on mass m_2. If the separation of the masses is doubled, keeping everything else the same, what will the new force on m_2 be?

2. Mass m_1 exerts a gravitational force F on mass m_2. If both of the masses are doubled, keeping their separation the same, what will the new force on m_2 be?

3. Assume that the earth suddenly shrank to half its present diameter but that its mass remained unchanged. Under these circumstances, the weight of a person standing on its surface would be: A) four times as great, B) twice as great, C) the same, D) half as great, E) one-quarter as great.

4. Assume that your weight on earth is W. If you were standing on the surface of a planet whose diameter and mass were each twice that of the earth, what would your weight on this planet be?

5. Assume that your weight on earth is W. If you were standing on the surface of a planet whose diameter and mass were each half that of the earth, what would your weight on this planet be?.

6. Assume that your weight on earth is W. If you were standing on the surface of a planet whose diameter were half that of the earth and whose mass were twice that of the earth, what would your weight on this planet be?

7. Assume that your weight on earth is W If you were standing on the surface of a planet whose mass were half that of the earth and whose diameter were twice that of the earth, what would your weight on this planet be?

8. Let g = the acceleration of a falling object near the surface of the earth. Planet X has twice the mass of the earth and twice the radius of the earth. What would be the acceleration of a freely falling object on the surface of X ?

9. Let g = the acceleration of a falling object near the surface of the earth. When a falling meteoroid is at a height above the earth's surface equal to twice the earth's radius, its acceleration in m/s^2 is:
   A) g/9, B) g/4, C) g/3, D) g/2, E) g.

10. Astronauts in a space capsule orbiting the earth 100 mi above its surface are frequently characterized as being *weightless* because they are so far from the earth that their gravitational attraction to the earth is negligible. This characterization is: A) true, B) false.

11. A pencil of mass m is located on the surface of the earth. The gravitational force of the moon on the pencil as compared with the gravitational force of the pencil on the moon is: A) smaller, B) larger, C) the same.

Energy Questions

Work = $F_{//} \times d$.

Potential Energy PE = mgh.

Kinetic Energy KE = $\frac{1}{2}mv^2$.

- Be able to say when positive, negative, or zero work is done by a force.
- Know that sliding friction does negative work.
- Be able to say when the gravitational potential energy of a particle increases, decreases, or remains constant, and by what factor, if its mass and/or height change by a given factor.
- Be able to say what happens to the kinetic energy of an object if its mass and/or velocity change by a given factor.
- For an object released and allowed to slide on a track with hills and valleys, be able to say when the PE and KE are greatest and least.
- Be able to compare the kinetic energies of different objects given their respective masses and velocities (like in the H.W. problem in the text).
- Know the work-energy principle: "The work done by all forces on a system equals the change in kinetic energy of that system."
- Know the conditions for which the mechanical energy of a system is conserved: The energy of a system is conserved only if all work done on that system is by gravity (no other forces doing work).

12. When does a force do no mechanical work on an object?
13. When does a force do positive mechanical work on an object?
14. When does a force do negative mechanical work on an object?
15. What are the conditions for which the mechanical energy of a system is conserved?
16. State the work-energy principle.
17. When an object slides on a stationary frictional surface, does the force of friction do positive, negative, or no work? Explain your answer.
18. When the mass of an object moving with fixed speed doubles, by what factor does its KE change?
19. When the velocity of an object moving with fixed mass doubles, by what factor does its KE change?
20. When the height of an object of fixed mass doubles, by what factor does its PE change?
21. When the mass of an object of fixed height doubles, by what factor does its PE change?

Questions on the Atom

- Given the symbol of an element El, be able to say how many protons and neutrons in its nucleus ($^{p+n}El_p$).
- Know that the number of electrons in a neutral atom is equal to the number of protons in its nucleus.
- Be able to draw the electron-dot diagram of an element given its symbol. Note that the first, second, and third electron shells contain a maximum of 2, 8, and 8 electrons, respectively.

22. The element, Chlorine, is designated by the symbol $^{35}Cl_{17}$. How many protons *p* and neutrons does Chlorine have?
23. Draw the electron-dot diagram for Chlorine $^{35}Cl_{17}$.
24. Draw the electron-dot diagram for Neon $^{20}Ne_{10}$.

Answers

1. $F/4$
2. $4F$

3. A

4. $W/2$

5. $2W$

6. $8W$

7. $W/8$

8. g/2

9. A (at a height of two earth radii, the meteoroid is three earth radii from the earth's center).

10. B. At 100 mi above the surface of the earth, astronauts weigh practically the same as at the surface, but the astronauts are accelerating toward the earth at the same rate as is their space capsule. Therefore, they float in the capsule (like the water in the teapot swung over the teacher's head at the minimum speed for the water not to fall out).

11. C (Newton's third law).

12. Either when the object is stationary or when the force is perpendicular to the object's motion.

13. When the force is parallel to the direction of the motion.

14. When the force is opposite to the direction of the motion.

15. The energy of a system is conserved only if all work done on that system is by gravity (no other forces doing work).

16. The work done by all forces on a system equals the change in kinetic energy of that system.

17. Negative work because the force of sliding friction is always opposite to the direction of the motion.

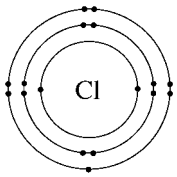
18. 2

19. 4

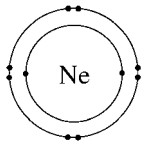
20. 2

21. 2

22. $p = 17$, $n = 18$

23. 

Chlorine 17e⁻

24. 

Neon 10e⁻