Student #: _____ Student Name: _____

Grade 12 Physics Class 7: Gravitational Field

_____ 1. A planet moves faster in its orbit

(a) when it is farthest from the Sun.
(b) the greater its mass.
(c) when it is in opposition.
(d) the farther it is from it's satellites.
(e) when it is nearer the Sun.

_____ 2. Kepler's first law says that the planets move in elliptical orbits with the sun at one focus of the ellipse. What is at the other focus?

(a) Empty space.
(b) The Earth
(c) The Moon.
(d) Your Grade 12 Physics teacher.
(e) The planet in question.

_____ 3. If a planet has an average distance from the sun (semi-major axis of its orbit) of 4 astronomical units, what is the period of its orbit? Hint: Use Kepler's third law.

(a) 1 year
(b) 4 years
(c) 64 years
(d) 12 years
(e) 8 years

_____ 4. The Earth and the moon apply a gravitational force to each other. Which of the following statements is true?

(a) Earth applies a greater force on the moon than the moon exerts on Earth.
(b) Earth applies a smaller force on the moon than the moon exerts on Earth.
(c) Earth applies a force on the moon, but the moon does not exert a force on Earth.
(d) Earth does not apply a force on the moon, but the moon exerts a force on Earth.
(e) The force Earth applies to the moon is equal and opposite to the force the moon applies to Earth.

_____ 5. Two masses exert a gravitational force F on each other. If one of the masses is doubled, and the distance between the masses is tripled, the new force between them is

(a) $6F$
(b) $2F/3$
(c) $2F/9$
(d) $3F/2$
(e) $4F/9$

_____ 6. What can be said about a satellite as it orbits the Earth at a constant speed? *Select two answers.*

(a) The satellite's velocity is constant.
(b) The satellite experiences acceleration towards the centre of the orbit.
(c) There is an unbalanced force on the satellite.
(d) The satellite experiences acceleration away from the centre of the orbit.
(e) The satellite experiences a constant acceleration.

_____ 7. The Earth is at an average distance of $1\,\text{AU}$ from the Sun and has an orbital period of $1\,\text{year}$. Jupiter orbits the Sun at approximately $5\,\text{AU}$. About how long is the orbital period of Jupiter?

(a) 1 year
(b) 2 years
(c) 5 years
(d) 11 years
(e) 125 years

_____ 8. When you shoot a cannonball upwards from the surface of the Earth with less than escape velocity, what will happen?

(a) It will slow down, but will not fall back to Earth.
(b) It will keep moving at a constant speed and not fall back to Earth.
(c) It will slow down and eventually fall back to Earth.
(d) It will speed up as it moves away from Earth.

_____ 9. I throw a baseball up the air and watch its motion. Which stays constant?

(a) Its total energy.
(b) Two of the other answers are correct.
(c) Its kinetic energy.
(d) Its gravitational potential energy.
(e) None of the other answers are correct.

_____ 10. Newton discovered that gravity can be described as:

(a) A spring-like connection between any two masses.
(b) A universal attraction between masses which gets stronger with distance.
(c) A force which is independent of the masses of the objects involved.
(d) An attraction between like electrical charges.
(e) A universal attraction between any two masses, which falls off as the square of their distance.

11. If the force of gravity between a book of mass $0.50\,\text{kg}$ and a calculator of $0.100\,\text{kg}$ is 1.5×10^{-10} N, how far apart are they?

12. Using Newton's law of universal gravity, find the location from Earth where the gravitational forces of Earth and the Moon balanced. (Requires solving a quadratic equation.)

13. Mercury is the planet that is closest to the Sun. It has a mass of 3.285×10^{23} kg and a radius of 2.440×10^{6} m.
    (a) What is the maximum speed of a satellite in a *circular* orbit around Mercury?
    (b) If the satellite is to stay in an elliptical orbit around Mercurcy, what orbital speed must it not allow to exceed? In which part of the orbit will the maximum speed occur?

14. A communications satellite is in geosynchronous orbit above Earth's equator.
    (a) What is the orbital period in seconds?
    (b) What is the satellite's orbital speed?
    (c) What is the altitude of the satellite?

15. A $1.00 \times 10^2\,\text{kg}$ space probe is in a circular orbit, $25\,\text{km}$ above the surface of Titan, a moon of Saturn. If the radius of Titan is $2575\,\text{km}$ and its mass is $1.346 \times 10^{23}\,\text{kg}$, determine the space probe's:
    (a) Orbital speed
    (b) Orbital period
    (c) Orbital kinetic energy
    (d) Orbital gravitational potential energy
    (e) Total orbital energy
    (f) Binding (escape) energy
    (g) Additional speed required for the space probe to break free from Titan

16. A $550\,\text{kg}$ satellite launched upward from Earth's surface reaches an orbit at a height of $6000\,\text{km}$. Find:
    (a) its change in gravitational potential energy
    (b) its orbital kinetic energy
    (c) its initial kinetic energy

    (Hint: gain in U_g is loss in K)

17. Two $2.0 \times 10^4\,\mathrm{kg}$ meteorites from outer space are headed towards Earth at $2.1\,\mathrm{km/s}$. One is headed straight for Earth's centre, while the other is on a path that will come within $8500\,\mathrm{km}$ of Earth's centre. Find the speed of

    (a) the first meteorite when it strikes Earth, and
    (b) the second meteorite at its closest approach.
    (c) Will the second meteorite ever return to Earth's vicinity?

18. As a member of the 2240 Olympic Committee, you are considering a new sport: asteroid jumping. On Earth, world-class high jumpers routinely clear $2\,\mathrm{m}$. Your job is to make sure athletes jumping from asteroids will return to the asteroid. Make the simplifying assumption that asteroids are spherical, with an average density of $2.5 \times 10^3\,\mathrm{kg/m^3}$. For safety, make sure that even a jumper capable of $3\,\mathrm{m}$ on Earth will return to the surface. What do you report for the minimum asteroid diameter?