Unit 7. Forces and mass

Circle the correct answer:

1. Newton's first law is also called:

   a) The law of force   b) the law of motion c) the law of inertia

2. Which of the following expresses Newton's second law?

   a) F = ma   b) Fg = G $(m^1 m^2) / r^2$ c) p = mv

3. Which of the following expresses Newton's third law?

   a) Acceleration is always accompanied by a force.
   b) Every action force is accompanied by an equal and opposite reaction force.
   c) Objects tend to remain at rest or in motion at a constant speed.

4. Which quantity measures the amount of matter in an object?

   a) Mass   b) weight   c) force

5. Which is the SI unit for weight?

   a) kg   b) N   c) g   d) (kg)(m) / s

6. Newton's law of universal gravitation can be applied

   a) only to very massive objects
   b) only to objects in outer space
   c) only to objects near Earth's surface
   d) to any two objects with mass

7. What kind of force opposes the relative motion of two contacting surfaces?

   a) normal force   b) gravitational force   c) friction

8. Explain the difference between static friction and kinetic friction

Newtown's Laws

1. A 1520 kg car accelerates at a rate of 1.5 m/s^2. What is the force on the car?
Answer: 2280 N (2.28 x 10^3 N)

2. A 5.22 x 10^7 kg cruise ship is moving at its top speed as it comes into port. The ship then undergoes acceleration equal to -0.357 m/s^2 until it comes to rest at its anchorage. What is the net force acting on the ship as it slows down?
Answer: - 1.86 x 10^7 N

3. A catcher in a professional baseball game exerts a force of -65 N to top the ball. If the baseball has a mass of 0.145 kg, what is the ball's acceleration as it is being caught? Answer: - 448 m/s^2

4. A stone is dropped from rest. What is its speed a) after 1 s, b) after 2 s, c) after 5 s. Answer: a) 10 m/s   b) 20m/s   c) 50m/s

5. A stone is thrown downwards at 20 m/s. What is the speed a) after 1 s, b) after 2s, c)after 5 s. Answer: a) 30 m/s   b) 40m/s   c) 70m/s

6. We let an object fall from a height of 45 m. Determine the time it takes to reach the floor and the velocity it has at the moment of hitting the floor; g = 10 m/s^2.
Answer: a) 3 s   b) 30 m/s

7. We throw an object vertically upwards with an initial velocity of 108 km/h. How long (time in seconds) will it take to reach its maximum height? What would be the value of this maximum height? g = 10 m/s^2.
Answer: a) 3 s   b) 30 m/s

8. We throw a stone from a bridge with an initial velocity of 18 km/h, and it takes 2 s to reach the surface of the water. Calculate: a) the velocity of the stone as it hits the water, b) the height of the bridge, and c) the velocity of the stone after half a second of being thrown; g = 10 m/s^2.
Answer: a) 25 m/ s   b) 30 m   c) 10 m/s

9. Determine the initial velocity of a ball which falls from a balcony, knowing that it takes 1.5 s to reach the ground with a final velocity of 108 km/h. What is the height of the balcony? What is the velocity of the ball after 1 second, from the time it falls from the balcony?   g = 10 m/s^2.
. Answer: a) 15 m/ s   b) 33,75 m   c) 25 m/s

Force Weight (mass and weight)

1. Work out the weights of each of the masses below, assuming that g= 10m/s^2. a) 2 kg, b) 5.5 kg, c) 0.4 kg, d) 28 kg.
 Answer: a) 20 N   b) 55 N   c) 4 N   d) 280 N

2. An object weighs 125 N in a place where the acceleration caused by gravity is 10 m/s^2. What is the mass of the object? What is the object's weight in a place where the acceleration caused by gravity is 9.65 m/s^2?

3. What would be the acceleration of a 28 tonne lorry if it takes 100 seconds to speed up from 36 km/h to 54 km/h. And what would be the force exerted by the lorry?
    Answer: a) 0.05 m/s^2 b) 1400 N

4. The same force is applied to two different objects. The resulting acceleration of the first object is 1.8 m/s^2 and of the second object is 9.8 m/s^2. Explain which of the two objects have the greatest mass.
    Answer: object 1 must have the greatest mass. The acceleration of an object is directly proportional to the force applied and inversely proportional to the mass of the object, and as the same force is being applied to both objects, the more massive one will result in a smaller or lesser acceleration

Hooke's Law:

1. A spring has a constant of 2 N/m and a length of 40 cm without a load on it.
    a) Calculate the extension produced to the spring by a load of 0.4N.
    b) Calculate the load we need to stretch it   600 mm.
2. We have a spring holding a 400 g object. The constant of the spring is 10.5 N/m Such force is stretching the spring to a length of 40 cm. Determine the length of the spring without the object hanging from it.   g = 10 m/s^2.
3. We have a bag hung from a spring with 18 identical marbles. The mass of each marble is 3 grams, and the spring's constant is 0.25 N/m.
    a) determine the deformation of the spring and
    b) determine the final length of the spring if the initial length was 60 cm.
    g = 10 m/s^2.

The Law of Universal Gravitation:

1. Calculate the mass of the Earth, assuming that the Earth is a perfect sphere with a diameter of 12.6 × 10^6 m and the value of acceleration caused by gravity is 9.85 m/s^2.   G = 6,7 ×10^{-11} N m^2/kg^2.
2. Two objects of equal mass are separated by 10 mm. They attract each other with a force of 1.34 N. What is the mass of each object?
    G = 6,7 ×10^{-11} N m^2/kg^2.
3. The weight of a person on planet Earth is 784 N. What will his weight be on the Moon? Lunar mass = 7.34 ×10^{22} kg. Lunar radius = 1.74 × 10^6 m. g$_{earth}$ = 9.8 m