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Kinematics

1. A girl rides a bike and travels 12 km in a quarter an hour. Calculate her speed in $km.h^{-1}$ and $m.s^{-1}$ **Sol: 48 $km.h^{-1}$; 13,3 $m.s^{-1}$**

2. Ana needs 45 minutes to arrive to her high school, which is 3 km far away from her home. She stays at school for five hours and she comes back to home walking for an hour. Plot the graph s/t y v/t and calculate her speed in each phase **Sol: 4 $km.h^{-1}$; 3 $km.h^{-1}$**

3. A car travels at 72 $km.h^{-1}$ through a road. Calculate the time required for the car to cover a distance of 100 km. Express the speed in $m.s^{-1}$ and the distance travelled in 10 minutes **Sol: 83´20´´; 20 m/s; 12 km**

4. Speed limits in UK are 30, 50 and 70 miles per hour. Convert these limits in $km.h^{-1}$ and $m.s^{-1}$. A mile is equal to1609 m **Sol: 48, 80 & 112 $km.h^{-1}$**

5. A car starts from rest and accelerates uniformly to 120 $km.h^{-1}$ in 8 seconds. Determine the acceleration and the distance covered **4,17 m/s^2; 133 m**

6. A tile falls down from the top of a building 30 m above the ground. Calculate the time required for the tile to arrive to the ground and its speed **Sol: 2,47 s; 24,3 m/s**

7. A driver who is moving at 20 $m.s^{-1}$ notices a huge rock on the road, and he needs 10 s to stop his car. Calculate his acceleration and the travelled distance **Sol: - 2 m/s^2; 100 m**

8. A bike starts accelerating at a rate of1.5 $m.s^{-2}$, covering 40 m. Then it continues moving at the same speed for 10 s. Finally, it slows down and it stops covering 15 m. Determine the final speed of the first stage, the total time taken and the distance. Plot the graph v/t **Sol: 10,95 m/s, 20 s, 164,5 m**

9. A vehicle starts from rest accelerating uniformly at a rate of 3 $m.s^{-2}$ for 5 s. Then it continues moving uniformly for 10 s. Finally, it slows down until rest for 3 s. Determine the speed of each stage and the total distance travelled **Sol: 15 m/s; 210 m**

10. Pilar is driving at 90 $km.h^{-1}$ and she notices a traffic jam at a distance of 80 m. Calculate the acceleration required to avoid crushing against the cars. What is the time taken along the motion? **Sol: 3.9 $m.s^{-2}$; 6,4 s**

11. A 100 m-runner starts accelerating uniformly at 4 $m.s^{-2}$ and he reaches his maximal speed after 3 seconds. Then he keeps running at the same speed until the end of the race. Calculate the terminal speed and the time required for him to finish the race **Sol: 12 m/s; 9,83 s**

12. Maria throws vertically upwards a stone at 25 $m.s^{-1}$. Calculate the maximal height reached by the particle and the speed when it is 20 m above the ground **Sol: 31,9 m; 15,2 $m.s^{-1}$**

13. A brick falls down from the top of a building which is 250 m high. First it accelerates uniformly, but it reaches a limit speed after 5 s. Then it keeps its speed until the ground. Determine the total time required for the stone to arrive to the ground. Plot the graph v/t and s/t

14. A centrifuge spins at a rate of 800 rpm. Determine frequency and period of the motion. Calculate its angular speed, and velocity and centripetal acceleration of a point placed at 30 cm from the centre **Sol: 0,075 s; 25,1 m/s; 2105 m/s^2**

15. A car engine spins at a rate of 2400 rpm. Find the period and frequency of the motion. Determine the angular speed and the velocity and centripetal acceleration of a point placed 10 cm from the centre o **Sol: 0,025 s; 251 rad/s; 25 $m.s^{-1}$; 6250 m/s^2**

Kinematics

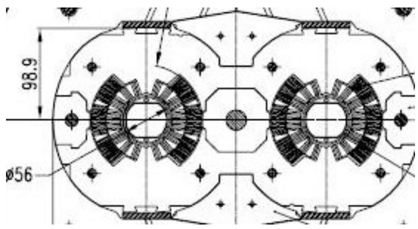
16. Carmen drops a stone into a narrow well. The stone falls down and she hears the echo 3 seconds later. Determine the depth of the well if the speed of the sound is 340 $m.s^{-1}$
Sol: 41 m

17. An aeroplane starts from rest accelerating at 3.2 ms^{-2}. Calculate the speed when it takes off if it has covered a distance of 1700 m. What is the time taken for the plane to take off?
Sol: 104 $m.s^{-1}$; 32,6 s

18. Gravity on the Moon is 1,67 $m.s^{-2}$. Calculate the time taken for a feather to fall down a height of 1.5 m, as it was carried out by Apollo15 crew. Compare this time with the time taken on Earth **Sol: 1,34 s; 0,55 s**

19. A proton at rest needs 20 minutes to reach the speed of light ($c = 3.10^8$ $m.s^{-1}$) to access in the tunnel of LHC, in Geneva. Calculate the average acceleration of a proton, and the total distance travelled **Sol: $3,64.18^8$ km**

20. Protons in LHC complete 11245 revolutions per second. Calculate their angular velocity and period. Determine their centripetal acceleration if the tunnel is 26.5 km long and compare it with gravity **Sol: 90 μs; 70650 $rad.s^{-1}$**



21. A proton at LHC falls down due to gravity. The diameter of the pipe is 56 mm, as it is shown in the cross section. Calculate the time taken for the proton to go out of the pipe and the number of cycles covered
Sol: 76 ms; 850 revolutions

22. A wheel turns at a rate of 120 rpm. Find the period and frequency of the motion. Determine the angular speed and the velocity and centripetal acceleration of a point placed 10 cm from the centre **Sol: 0,5 s; 2 Hz; 12,6 $rad.s^{-1}$; 1,26 $m.s^{-1}$; 15,8 $m.s^{-2}$**

23. Alfredo throws his mother´s watch vertically upwards from her flat´s window, placed at 25 m height and measures 5 seconds until the watch reaches to the ground. Determine the initial velocity of the watch and its speed when it is smashed on the street. What is the maximal height reached by the watch along the experiment? **Sol: 29,5 $m.s^{-1}$; - 19,5 $m.s^{-1}$; 44,4 m**

24. A computer´s hard disk drive turns at 720 rpm and its radius is 9 cm long. Calculate its period and frequency; its angular velocity; and its velocity and acceleration at the edge of the disk **Sol: 0,083 s; 12 Hz; 75,4 $rad.s^{-1}$; 6,8 $m.s^{-1}$; 511 m,s^{-2}**

25. A carousel turns at 12 rpm. Determine the period of the motion. Calculate the velocity and acceleration of a passenger who is placed at 3 m far away from the centre

26. An engineer is designing the runway for an airport. Of the planes that will use the airport, the lowest acceleration rate is likely to be 3 m/s^2. The take-off speed for this plane will be 65 m/s. Assuming this minimum acceleration, what is the minimum allowed length for the runway? **Sol: 704 m** © physicsclassroom.com

27. A tractor has two kinds of wheels, whose diameters are 60 and 130 cm. Assuming that the tractor is moving at 30 km/h, calculate period and frequency for each wheel and the accelerations at a point placed at the edge of the wheel
Sol: 0,226 s; 0,49 s; 4,42 Hz; 2,0 Hz; 231 and 107 $m.s^{-2}$

28. A nickel falls down from the top of a skyscraper at 350 m above the ground. Calculate the time for the penny to arrive to the street. Then it is embed into a lump of moist clay at a depth of 10 cm. Calculate the acceleration and the time taken to stop
Sol: 8,45 s; 34300 $m.s^{-2}$; 2,4 ms

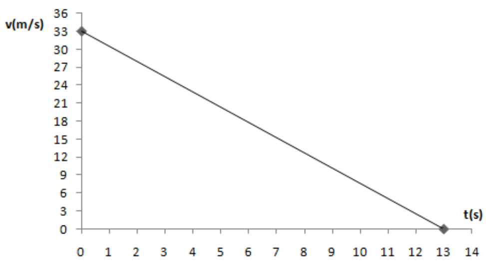
Kinematics

29. A stone falls down from the edge of a cliff, which is 650 m above the sea level. First it accelerates uniformly for 6 seconds until it reaches its terminal speed. Then it continues its path and arrives to the surface of water. Finally, it starts to slow down due to the water friction and it stops after 0,5 s. Determine the acceleration of each stage, the total time taken for the stone to complete the motion and the total distance. Plot a graph of velocity versus time **Sol: 14,5 s; 665 m;**

30. The blades of a wind turbine complete a whole circumference in five seconds. Determine the frequency of the motion and its angular speed. Considering that the length of the blades is 50 m, determine the linear velocity and acceleration at the edge of the blades
Sol: 0,2 Hz; 62,8 m.s^{-1}; 79 m.s^{-2}

31. *Furius Baco* is a roller coaster placed in Port Aventura. First of all, its train speeds up, reaching 135 km/h in 3.5 s. Then it covers 400 m keeping at the same speed. Finally, it slows down steadily until it stops. Its total ride length is 850 m. Determine its maximal speed, the total time taken for the train to cover a ride and its different accelerations. Plot a graph of the variation of speed with time **Sol: 25,7 s**

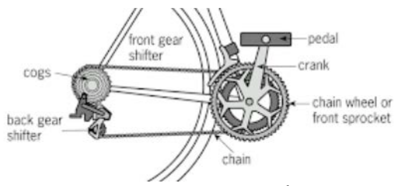
32. A wheel of a car, which has 25 cm of radius is moving a 125 km/h. Determine its centripetal acceleration. Calculate its angular speed. What is the frequency and period of its circular motion? **Sol: 4820 m.s^{-2}; 139 rad.s^{-1}; 22 Hz; 0,045 s**



33. A driver, who is moving at 33 m/s along a road, suddenly notices a rock on the road and slows down to avoid crashing. The graph shows the variation of speed with time. Calculate its acceleration and the distance covered until he stops. Determine the required acceleration if the rock was placed at 150 m of distance.
Sol: - 2,5 m.s^{-2}; 215 m; 3,6 m.s^{-2}

33. *Shanghai Tower* elevator is the fastest one all over the world. First it accelerates for 16 seconds until it reaches 72 km.h^{-1}. Then it keeps moving at the same rate covering 200 m. Finally, it slows down and reaches to the top of the building, which is 540 m above the ground. Determine the total time taken for the lift until it stops. Calculate its different accelerations. Plot a graph of the variation of speed with time **Sol:**

34. Bikes have two gears, the chain wheel and the cog, whose diameters are, respectively, 20 and 4 cm. A cyclist turns his pedal at 75 rpm. Calculate its angular speed. Determine the velocity and acceleration of the chain. Determine the frequency of the cog and the velocity of the bike´s wheel, whose radius is 30 cm



Sol: 7,85 rad.s^{-1}; 1,57 m.s^{-1}; 12,3 m.s^{-2}; 375 rpm=6,25 Hz; 11,8 m.s^{-1}

35. A canoeist starts moving through a river and accelerates for 10 seconds, reaching to 25 km/h. Determine force applied by his paddle, considering his mass is 85 kg Then, he keeps moving at the same rate, covering 160 m. Finally, he slows down and stops at the end of his ride, which is 275 m long. Determine the time taken for the canoeist to arrive to the finish line and his maximal speed **Sol:**

36. A hard drive disk (HDD) turns at 7200 rpm. Determine its period and its angular speed. How many revolutions does it complete when it works for 0.15 s? Considering that its radius is 2.7 cm, determine its linear velocity and acceleration at the edge of the disk
Sol: 8,3 ms; 754 rad.s^{-1}; 20 m.s^{-1}; 15350 m.s^{-2}

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Dynamics

1. A spring stretches 5 cm when a 20 N force is applied upon it. Determine the constant of the spring of the spring and the extension produced by 37 N **Sol: 400 $N.m^{-1}$; 9,25 cm**

2. When a 100 g body is hanged at the end of a spring, we observe an extension of 4 cm. Determine the constant of the spring and the force needed to stretch 7.5 cm
Sol: 24,5 $N.m^{-1}$; 1,84 N

3. A spring is stretched from 10 to 16 cm when a force of 3 N is applied to it. Determine the constant of the spring and the force needed to get a length of 30 cm
Sol: 50 $N.m^{-1}$; 10 N

4. A car, which has 800 kg, starts from rest. Its engine applies a force equal to 1500 N to the wheels and its coefficient of friction is 0.1. Draw the free body diagram of the car. Calculate its acceleration and the distance travelled and its velocity after 10 s
Sol: 0,895 $m.s^{-2}$; 44,75 m; 8,95 $m.s^{-1}$

5. Ines wants to move a wardrobe, whose mass is 90 kg, applying a horizontal force equal to 500 N. If coefficient of friction between wood and floor is 0,3, draw a diagram of forces applied to it and calculate the acceleration of the body. What is the time taken to move it along 2 m and its final velocity? **Sol: 2,62 $m.s^{-2}$; 1,24 s; 3,2 $m.s^{-1}$**

6. An astronaut weighs 750 N on the Earth. What is his weight on the Moon, if a body falls down on the Moon at 1,6 m/s^{-2}? **Sol: 122 N**

7. A car which has 1200 kg slows down from 130 $km.h^{-1}$ to 80 $km.h^{-1}$ along 150 m. Calculate its acceleration, the force of friction applied upon it and the coefficient of friction between its tyres and the road **Sol: 2,7 $m.s^{-2}$; 3240 N; 0.27**

8. Compare the force needed for a 3 kg-body to get an acceleration equal to 0,5 m/s^{-2}:
a) if we want to move it on a non-friction horizontal surface
b) if we want to move it on a horizontal surface which applies a force of friction which is 40 N
c) if we want to pull it vertically upwards **Sol: 1,5 N; 41,5 N; 30,9 N**

9. A body, which has 5 kg, is placed on a horizontal surface. The coefficient of friction is 0.1. Calculate the minimal force needed to move it. What happens when a 3 N force is applied upon the body? What is the acceleration of the motion if a 15 N force is applied to it? **Sol: 4,9 N; - ; 2,02 $m.s^{-2}$**

10. David stands up on a scale placed in his elevator. The measurement of the scale is 70 kg. Find the mass measured
a) if the elevator starts from rest vertically upwards at 2 $m.s^{-2}$ b) rise up uniformly at 3 $m.s^{-1}$
c) slows down at 1 $m.s^{-2}$ **Sol: 84,3 kg; 70 kg; 62,8 kg**

11. A box, which has 2 kg, is hanged at the end of a wire. Determine the force which is needed to move the object a) vertical upwards at 1 $m.s^{-1}$
b) vertically downwards at 2 $m.s^{-1}$ c) vertically upwards with an acceleration 3 $m.s^{-2}$
d) vertically downwards with an acceleration 1 $m.s^{-2}$ **Sol: 19,6 N; 19,6 N; 25,6 N; 17,6 N**

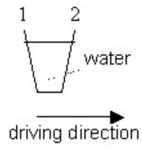
12. An object of 250 g turns at 30 rpm. Determine the centripetal force considering its radius is equal to 50 cm **Sol: 1,23 N**

13. The 30 cm-wheel of a bike turns at 480 rpm. Determine its period and frequency. Find the acceleration of a point at the edge of the wheels and the force applied upon the tyre, which has 100 g **Sol: 0,125 s; 8 Hz; 758 $m.s^{-2}$; 75,8 N**

Dynamics

14. A carousel turns at 15 rpm. Find its period and frequency. Determine the acceleration and force applied upon a 35 kg-child who is placed at 3 m from the centre
Sol: 4 s; 7,4 m.s^{-2}; 259 N

15. A bus is moving along a straight stretch of a road. The bus driver, named Ray, has a cup of water resting on the dashboard. Suddenly Ray has to slam on the brakes. What is most likely to happen to the water in the cup? A. The water will stay horizontal. B. The water will spill over side 1 C. The water will spill over side 2 D. The water will spill but you cannot tell if it will spill at side 1 or side 2. **(PISA tests)**



16. A car is turning at 90 km/h along a curve whose radius is 100 m. Determine the coefficient of friction required for the car to take the curve, considering that the force of friction is responsible of the motion and the mass of the car is 800 kg **Sol: 0,64**

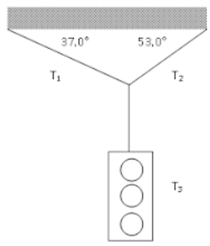
17. A body of 3 kg is placed on a flat surface, which has a coefficient of friction equal to 0,15. Calculate the force required to move the object considering
a) the force is parallel to the surface b) the force makes an angle of 45º to the baseline
Sol: 4,4 N; 5.4 N

18. A body of 2 kg is placed on a ramp, which makes 45º to the ground. The coefficient of friction between the surface and the object is 0,2. Calculate the acceleration of the body. What is the force required to pull the object upwards? **Sol: 5,5 m.s^{-2}; 16,6 N**

19. A body which has a mass equals to 3 kg is placed on a tilted ramp which makes an angle of 30º to the ground The coefficient of friction is 0.1. Determine the acceleration of the body. Calculate the force required to pull the body upwards. **Sol: 4.05 m.s^{-2}; 17.2 N**

20. A bird, which has a mass of 550 g, is placed at a string, which is tilted 20º because of its weight. Calculate the tension of the string **Sol: 7,9 N**

21. A traffic light hangs from the end of two strings of different length, as shown in the diagram below. The mass of the traffic light is 85 kg, ar the string makes angles of 37º and 53 º to the horizontal. Calculate the forces applied along both strings **Sol: 666 N & 500 N**



22. Paula and Guillermo are holding a rod, which is 3 m long. Find the force applied by them to transport a 100 kg load when it is placed at 1 metre away from Guillermo. Where must they place the load so that Paula holds a fourth of the load? **Sol: 327 N / 653 N; 0,75 m**

23. Ana and Javier are sitting on a seesaw, which is 3 metres long, and stands on its centre. Their masses are 35 and 65 kg respectively. Determine the point where Javier must sit to balance the seesaw, considering Ana sits at the end **Sol: 0,81 m**

24. A rocket of 1200 kg is thrown to the space. The friction force of the atmosphere is 6500 N. Calculate the force required to pull it upwards at 2 m/s^2 vertically upwards. Determine the force applied by its engine when it is rising up at 6 m/s. **Sol: 20700 N; 18300 N**

Gravitation

1. The mass of the Moon is $7{,}36.10^{22}$ kg and its radius, $1{,}74.10^{6}$ m. Determine gravity on the Moon. Compare the distance covered by a stone in a second on the Earth and on the Moon. $G = 6.67.10^{-11}\ N.m^{2}.kg^{-2}$ **Sol: 4,9 and 0,81 m**

2. Saturn has a mass 95,2 times greater than the Earth´s and its radius is 9.47 times greater. Find its gravity **Sol: 1.06.g: 10.4 m.s^{-2}**

3. The first satellite, Sputnik I, was launched in 1957. Its period was 96 minutes and it revolved at an average height equal to 570 km. Calculate its velocity, considering that the radius of the Earth is 6370 km. Imagine that it could be stopped by a meteorite and started to fall down to the Earth. Calculate its velocity, considering that friction is negligible **Sol: 7.6 km.s^{-1}; 3340 m.s^{-1}**

4. Determine the point between the Earth and the Moon which has no gravity. Their masses are $5.98.10^{24}$ and $7{,}36.10^{22}$ kg respectively and the distance is $3{,}84.10^{8}$ m **Sol: 3,45.10^{8} m**

5. Sunlight rays take 8.31 minutes to arrive to the Earth. Considering that speed of light is 3.10^{8} m.s^{-1} determine the angular velocity of the Earth, its linear velocity and acceleration Find the mass of the Sun **Sol: 2.10^{-7}rad.s^{-1}; 30 km.s^{-1}; 0.006 m.s^{-2}; 2.10^{30} kg**

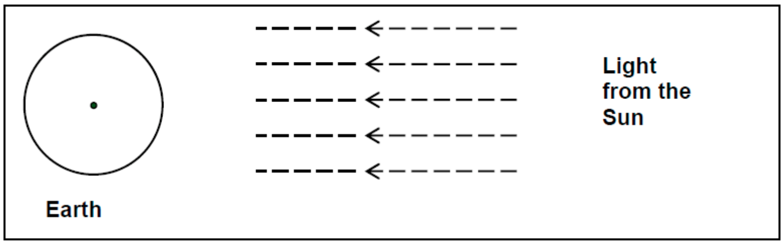
6. Calculate the mass and density of Mercury, considering that its radius is 2440 km and gravity on its surface, 3.7 m.s^{-2}. Determine the high jump record in Mercury, considering that the actual record on Earth is 2,45 m **Sol: 3,3.10^{23} kg; 5400 kg.m^{-3}**

7. Determine gravity on Jupiter, considering that its mass is $1{,}9.10^{27}$ kg and its radius is 69900 km. What is its density? **Sol: 26 m.s^{-2}; 1300 kg.m^{-3}**

Today, as the Northern Hemisphere celebrates its longest day, Australians will experience their shortest. In Melbourne, Australia, the Sun will rise at 7:36 am and set at 5:08 pm, giving nine hours and 32 minutes of daylight.
Compare today to the longest day of the year in the Southern Hemisphere, expected on 22 December, when the Sun will rise at 5:55 am and set at 8:42 pm, giving 14 hours and 47 minutes of daylight.
The President of the Astronomical Society, Mr Perry Vlahos, said the existence of changing seasons in the Northern and Southern Hemispheres was linked to the Earth's 23-degree tilt

8. Which statement explains why daylight and darkness occur on Earth?
A The Earth rotates on its axis. B The Sun rotates on its axis.
C The Earth's axis is tilted. D The Earth revolves around the Sun. **(PISA tests)**

9. In the Figure light rays from the Sun are shown shining on the Earth.



Suppose it is the shortest day in Melbourne. Show the Earth's axis, the Northern Hemisphere, the Southern Hemisphere and the Equator on the Figure. Label all parts of your answer. **(PISA tests)**

Gravitation

10. On 8 June 2004, the planet Venus could be seen passing in front of the Sun when viewed from many places on Earth. This is called a "transit" of Venus and happens when its orbit takes Venus between the Sun and Earth. The previous transit of Venus occurred in 1882 and another is predicted to occur in 2012.
Below is a picture of the transit of Venus in 2004. A telescope was pointed at the Sun and the image projected onto a white card

Why was the transit observed by projecting the image onto a white card, rather than by looking directly through the telescope?

A. The Sun's light was too bright for Venus to show up.
B. The Sun is big enough to see without magnification.
C. Viewing the Sun through a telescope may damage your eyes.
D. The image needed to be made smaller by projecting it onto a card **(PISA tests)**

11. When viewed from Earth, which one of the following planets can be seen in transit across the face of the Sun at certain times?
A Mercury B Mars C Jupiter D Saturn **(PISA tests)**

12. Determine gravity on the surface of Titan, the largest moon of Saturn, considering its mass is $1{,}35.10^{23}$ kg and its radius is 2575 km. Titan takes 16 days to complete its orbit around Saturn and its distance to this planet is 1250 thousands of kilometres. Calculate its speed and acceleration What is the force applied by Saturn to Titan?
Sol: 1,36 m.s^{-2}; 5700 m.s^{-1}: 0,026 m.s^{-2}; 3,5.10^{21} N

13. Mercury has a mass equals to $3{,}29.10^{23}$ kg and its radius is 2440 km. Determine gravity of Mercury on its surface. Considering it takes 88 days to complete a revolution around the Sun and its average distance to the sun is 58 millions of km, determine its velocity and its acceleration **Sol: 3,7 m.s^{-2}; 48000 m.s^{-1}; 0,04 m.s^{-2}**

14. Venus has a mass of $4{,}87.10^{24}$ kg and its diameter is 12100 km. Calculate gravity on the surface of Venus. Considering it takes 225 days to complete a revolution and its distance to the Sun is 108 millions of kilometres, calculate its speed and acceleration. Determine the force applied by the Sun to Venus and the mass of the sun
Sol: 8,9 m.s^{-2}; 34,9 km.s^{-1}; 0,11 m.s^{-2}; 5,5.10^{22} N; 1,98.10^{30} kg

15. Chang´e 1 was a chinese spacecraft, which was launched in 2007 and arrived to the Moon, where It was orbiting at a height of 200 km. Calculate gravity of the Moon at this orbit, considering the mass of the Moon is $7{,}36.10^{22}$ kg and its radius, $1{,}74.10^{6}$ m. Determine the speed of this spacecraft. In 2009, it has finished a 3D map of the surface of the Moon, so it was crashed into the surface of the Moon. Calculate the velocity at which it hit on the surface of the Moon, considering its average acceleration was 1,5 m.s^{-2}
Sol: 1,3 m.s^{-2}; 1590 m.s^{-1}; 1770 m.s^{-1}

Pressure

1. What is the pressure applied by a skier which has 80 kg on the snow if the area of his boot is 250 cm^2? Compare this pressure with the pressure applied by the area of his skis, which is 3200 cm^2 **Sol: 15680 Pa; 2450 Pa**

2. Compare the pressure exerted by a 1500 kg-car, which is acting on its 4 wheels, with the pressure applied by a motorcycle, which has 300 kg. The area of each wheel is 50 and 20 cm^2, respectively **Sol: 735 kPa; 735 kPa**

3. What is the pressure acting on a submarine submerged at a depth of 500 m? What is the force required to open a hatchway whose radius is 20 cm?
Density of sea water: 1030 $kg.m^{-3}$ **Sol: 5,05 MPa; 634 kN**

4. In 1648 Pascal carried out an experiment to check that air pressure explained the height of a column of mercury in Torricelli´s barometer. He climbed up the Puy de Dôme and observed a pressure whose height was 84 mm Hg shorter than the one at the bottom of the mountain. Calculate its height, considering that the average density of air is 1,2 g/l
Sol: 950 m

5. What is the pressure that a sunk ship has to stand at a depth of 100 m? What is the force required to open a door which is 2 m high and 80 cm wide?
Density of sea water is 1030 $kg.m^{-3}$ Sol: 1009 kPa; 1615 kN

6. An open U-shaped tube contains water (ρ = 1000 kg/m^3). We fill one of the ends with an immiscible liquid whose density is 900 kg/m^3. When the system is at equilibrium the column of this liquid is 8.0 cm high. What is the difference of height between both columns of fluid? **Sol: 8 mm**

7. A body weighs 150 N, but its weight immersed in water is 100 N and immersed in another liquid, 111. Determine the density of the body and density of the fluid. Density of water: 1000 $kg.m^{-3}$ **Sol: 3000 $kg.m^{-3}$; 780 $kg.m^{-3}$**

8. A submarine is submerged at depth of 20 m. Determine the force required to open its hatchway whose diameter is 1 m. ρ_{water} = 1025 $kg.m^{-3}$ **Sol: 158 kN**

9. A wood block has 800 g and its sides are 12, 9 and 8 cm, respectively. Does it float in water, whose density 1000 $kg.m^{-3}$? **Sol: yes; 800 cm^3**

10.- An ice cube whose side is 5 cm has a mass equal to 110 g. Does it float in water? What is the immersed volume? Density of water 1000 $kg.m^{-3}$ **Sol: si; 110 cm^3**

11.- An ice cylinder has a height of 20 cm and its radius is 5 cm. Determine the height which is above the sea level when it floats. Densities of sea water and ice are, respectively, 1030 and 900 $kg.m^{-3}$ **Sol: 2,5; 17,5 cm**

12. What is the force required to keep a wood board completely immersed in water? Density of wood is 750 $kg.m^{-3}$ and its dimensions 50x40x10 cm. ρ_{water}=1000 $kg.m^{-3}$ **Sol: 49 N**

13. A cubic block of wood, which has a side equal to 10 cm floats in water, and it has 2 cm out of water. Determine the mass we have to place on the cube to immerse it completely in the fluid. **Sol: 200 g**

14. What is the force applied to the disk brake, which has an area equal to 100 cm^2, when we apply a 5 N force to the pedal which affects to an area equals to 0,5 cm^2? **Sol: 1000 N**

15. What is the force exerted by a hydraulic Jack which has an area equals to 500 cm^2, when we apply a 15 N to an area equals to 10 cm^2? **Sol: 750 N**

Pressure

16. Charles Darwin travelled around the Earth for 5 years on board of "Beagle". He stopped in Valparaiso and crossed the Andes range to collect stones samples. Near Portillo he tried to boil potatoes for dinner

> *Hence the potatoes, after remaining for some hours in the boiling water, were nearly as hard as ever. The pot was left on the fire all night, and next morning it was boiled again, but yet the potatoes were not cooked. I found out this, by overhearing my two companions discussing the cause, they had come to the simple conclusion, "that the cursed pot [which was a new one] did not choose to boil potatoes*." The Voyage of the Beagle, chapter 15, 1839 © http://infidels.org

Explain why the potatoes were "as hard as ever" after an overnight boiling. Suggest an alternative method for boiling potatoes on the top of a mountain

17. Trees have to pump water from the edge of their roots to the leaves. Determine the pressure, which has to be exerted to lift the water from the ground to a height equals to 25 m and the force applied on a drop of water whose radius is 1 mm

Sol. 245 kPa; 0,77 N

18. Which one is heavier, a tone of straw or a tone of iron? Compare their buoyant force in air. Densities (kg.m^{-3}): air: 1.3; iron: 7900; straw: 150 **Sol: 1,6 N; 85 N**

19. An aerostatic balloon, which has a radius 3 m, is filled with helium. Considering the basket of the balloon and its passenger have a mass of 120 kg, explain whether the balloon lifts or remains on the ground. What is its acceleration? Determine the time taken for the balloon to reach to a height of 100 m and its final speed. Calculate the total pressure at this height, considering pressure at the ground is 94 kPa. Density of air at STP is 1,22 g/l

Sol: it lifts; 1,47 m.s^{-2}; 11,7 s; 17 m.s^{-1}; 92,8 kPa

20. A ball of aluminum, which has a radius equal to 1 cm and a mass of 11 g is dropped into water. Determine its buoyant force and explain whether it floats or sinks, considering density of water is 1020 kg /m^3. When it is immersed, it accelerates for one second and then it reaches to its maximal speed. Determine its acceleration. Calculate the time taken for the ball to reach to the bottom of swimming pool at a depth of 6 m if it starts from rest.

Sol: 0,042 N; it sinks; 6 m.s^{-2}; 1,5 s

21. What is the pressure applied to a scuba diver, who is immersed at a depth of 60 m? What is the force required if he wants to remove his goggles, which have an area equal to 10 cm^2? Density of sea water: 1030 kg/m^3 **Sol: 605 kPa; 605 N**

22.

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Energy, work & heat

1. A pump lifts water from the ground to a 50 m^3-tank, which is placed 30 m higher. What is the work required to fill the tank? What is the power of the engine, considering it takes half an hour to fill the tank? **Sol: 14700 kJ; 8166 W**

2. An elevator rises up from the ground to the top of a building which is 15 m high. Find the work done by the weight, considering that its mass is 1500 kg and it lifts four people who have 60 kg. What is the power of the engine if it takes 15 s to cover the distance?
Sol: 256 kJ; 17 kW

3. Find the power of a car engine, considering it takes 10 seconds to accelerate from rest to 110 km/h. The mass of the car is 1500 kg. Convert the power to HP **Sol: 70 kW; 95 HP**

4. A roller coaster car starts form rest at a height of 20 m and slides down along an incline ramp. Determine its speed at a height of 15 m. What is its velocity when it arrives to the ground? Calculate the height at which its velocity is 15 m/s **Sol: 9,9 m/s; 19,8 m/s; 8,5 m**

5. A ball spins along the slope of a hill which has no friction. Consider it starts from rest at 50 metres high. What is the velocity at 20 metres high? What is its velocity when it arrives at the ground? What is the height where its speed is 20 m/s? **Sol: 24 m/s; 31,3 m/s; 29,6 m**

6. An iron ball of 50 g is thrown at 90 km/h from the top of a building whose height is 100 m. Determine its velocity when its height is 40 m. Calculate the height at which it falls down at 50 m/s. Consider that it hits the ground and 90 % of its energy is converted into heat. How much does its temperature increase? Specific heat capacity of iron is 440 J/kg.K
Sol: 42,4 m/s; 4,4 m; 2,6º C

7. A 600 grams brick at 500º C is immersed in a container which has 100 liters of water at 15º C. Determine the temperature of the system when it achieved its thermal equilibrium. Specific heat capacities of brick and water are 840 y 4180 J/kg.K respectively Sol: **15,6º C**

8. Determine the quantity of heat required to warm a room whose sides are 4 and 3 m long and its height is 2,5 m from 15º to 22 º C. Consider that density of air is 1,2 kg/m^3 and its specific heat capacity is 1012 J.kg^{-1}.K^{-1} . What is the time taken for a 2500 W heating system to warm the room? **Sol: 255 kJ; 1min 42 s**

9. An 1 kg-iron rod at 800º C is cooled in a bath filled with 50 liters of water at 15º C. Determine the temperature at thermal equilibrium, considering that specific heat of iron and water are 440 y 4180 J/kg.K respectively **Sol: 16,6º C**

10. A 2 kW-electric kettle is used to boil water at 15º C. What is the time taken for the kettle to boil one liter of water? What is the time required to vaporize all the water? Specific heat capacity: 4180 J.kg^{-1}.K^{-1}. Latent heat of vaporization: 2260 kJ.kg^{-1} **Sol:2 min 57 s; 19 min**

11. What is the energy released if a 50 g drop of mercury falls down from a table which is 80 cm high to the ground? Consider that all the heat is absorbed by the drop. What is the increase of temperature of the mercury drop? Specific heat capacity: 139,5 J/kg.K
Sol: 0,392 J; 0,06º C

12. A brake system of a car slows down its motion by means of friction forces upon the brake disc. Determine the change of temperature of the brake disc when a 1200 kg car at 120 km/h stops. Consider that the brake system absorbs 15 % of the heat produced and its mass is 10 kg and its specific heat capacity is 800 J.kg^{-1}.K^{-1} **Sol: 12,5º C**

13. What is the quantity of heat released when a 100 g ball of lead falls down from a balcony which is at 40 m above the ground? Consider that 90 % of the heat is absorbed by the ball. Determine the change of temperature. Specific heat capacity 129 J/kg.K
Sol: 39.2 J; 2,7º C

Energy, work & heat

14. Determine the temperature at thermal equilibrium after adding two ice rocks which have 25 cm^3 at - 10º C to a 200 cm^3 -glass filled with water at a 35º C. Density of ice: 900 $kg.m^{-3}$: Specific latent heat: 4180 $J.kg^{-1}.K^{-1}$; Latent heat fusion: 334 $kJ.kg^{-1}$ **Sol: 12,1º C**

15. We mix 2 kg of water at 60º C and 1 kg at 0º C. Find the temperature at thermal equilibrium. Determine the temperature at equilibrium considering we mix the same amount of water with 1 kg of ice at 0º C. **Sol: 40º C, 13,3º C**

16.- Peter is working on repairs to an old house. He has left a bottle of water, some metal nails and a piece of timber inside the boot of his car. After the car has been out in the sun for three hours, the temperature of the car reaches 40 ºC. What happens to the object in the car? Do they have the same temperature? Do you think later on water will begin to boil? **PISA 2012**

17. A ball falls down from a height of 2 metres, bounces at the ground and arrives to a point placed at 1,25 m. Determine the speed when it arrives to the ground and the speed after it bounces. What is the force applied by the ground, considering the bounce takes 1cs? Determine the energy lost after the bounce and the change of temperature, considering 75 % of this energy is converted into heat. Mass of the ball: 250 g;
Specific heat capacity plastic 100 J/kg.K **Sol: 6,26 $m.s^{-1}$; 4,95 $m.s^{-1}$; 280 N; 1,84 J; 0,055 K**

18. For drinks during the day, Peter has a cup of hot coffee at a temperature about 90º C and a cup of mineral water of about 5º C. The cups are of identical size and type and the volume of each drink is the same. Peter leaves the cups sitting in a room where the temperature is about 20º C. What are the temperature of the coffee and the mineral water likely to be after 10 minutes?
A: 70 and 10 ºC B. 90 and 5º C C: 70 and 25º C D. 20 and 20º C **PISA 2015**

19. Water storage of Canal Isabel II at *Santa Engracia* St. was designed to supply water in Madrid. It is 36 m high and its capacity is 125 m^3. Determine the water pressure at the top of a building which is 10 m high. What is the power of its pumps, considering it takes six hours to fill the storage completely? Calculate the velocity of the water at the top of the building
Sol: 255 kPa; 2 kW; 22,6 $m.s^{-1}$

20. Amaya Valdemoro, a Spanish basket player, threw the ball at 35 km/h from a point at 2 m of height. Determine its velocity when she scored, considering the basket is at 3,15 m. What is the maximal height which the ball could reach? Determine the change of temperature of the ball, considering it lost 35 % of its energy after bouncing to the floor.
Specific heat capacity of rubber is 2010 J/kg.K **Sol: 8,8 $m.s^{-1}$; 5,1 m; 0,012º C**

21. Determine the percentage of an iceberg volume, which is above the sea level, considering that the densities of ice and sea water are, respectively, 900 and 1025 $kg.m^{-3}$. Determine the change of temperature in 200 ml of water at 35º after melting an ice rock of 25 cm^3. Latent heat of melting: 334 kJ/kg; Specific heat capacity: 4180 J/kg.K **Sol: 87,8 %**

22. An iodine piece, which has a mass of 50 g, is thrown from the top of *Hotel Bali* building in Benidorm, which is 186 m above the ground, at 10 m/s. What is the speed of the drop when its height is 100 m?. Determine the height where its speed is 40 m/s. Calculate the amount of iodine converted into gas when it hits to the ground, considering that 75% of its energy is used for the phase change. Latent heat of sublimation: 224 $kJ.kg^{-1}$
Sol: 42,2 $m.s^{-1}$; 109,5 m; 6,3 g

23. A 200 g ball, which has a mass of 200 g, is thrown at a speed equals to 15 m/s from a point which is 25 m high. Calculate its mechanical energy. Determine its velocity when it is 10 m high and when it reaches to the ground. Determine its change of temperature considering 75 % of its energy is converted into heat. Specific heat capacity: 2000 $J.kg^{-1}.K^{-1}$
Sol: 71,5 J; 22,8 $m.s^{-1}$; 26,7 $m.s^{-1}$; 0,13º C

Waves & light

1. A source emits monochromatic light which has a wavelength in vacuum equals to 6.10^{-7} m (red coloured). Consider that light travels through water, which has a refractive index equals to 1.34. Determine its frequency, speed and wavelength in water
Sol: 5.10^{14} Hz; $2{,}24.10^{8}$ m/s; 447 nm

2. A monochromatic ray of light passes from a medium which has a refractive index equals to 1.58 to a different one whose index equals to 1.23. The ray of light makes an angle of 15º to the normal the boundary between these two media. Determine the angle of refraction and the critical angle for these two media **Sol: 19º 25´; 51º**

3. A beam of light consists of two different rays: a blue one, which has a wavelength equals to 450 nm and a red one, whose wavelength equals to 650 nm. Determine the frequency of each colour, considering that speed of light is 3.10^{8} $m.s^{-1}$. Consider that the beam hits into a flat surface and its angle of incidence is 30º, determine the angle which makes the reflected blue and red rays. Determine the angle which makes the refracted blue ray to the red one. Refractive index of glass for the blue and red rays are, respectively, 1,55 and 1,40. **Sol: $6{,}7.10^{14}$ and $4{,}61.10^{14}$ Hz; 0º; 2º 6´**

4. A ray of light travels through the air and hits on a surface of water, making an angle of 30º. What is the angle which makes the reflected ray to the refracted one? Consider that the ray travels from the water to the air, what is the critical angle at which total reflection occurs? Refractive index of water is 4/3. **Sol: 128º; 48º 35´**

5. An optic prism whose refractive index is 1,5 is immersed in water. Its section is an isosceles right triangle. A ray of light hits perpendicularly on of the cathetus of the triangle. Explain either total reflection occurs or not. What is the emerged ray direction?

6. A scuba diver switchs on a torch under the water, whose refractive index of refraction is 1,33. The ray of light travels upwards and makes 40º to the normal. What is the refraction angle? What is the angle of incidence at which the light cannot emerge from water? **Sol: 58º 45´; 48º 45´**

7.- A red ray of light which travels through the air has a wavelength equals to 650 nm. When it hits the boundary between two media, it becomes 500 nm. Determine the frequency of red light and the refractive index of the second medium. Consider that the ray of light makes an angle of 0º to the perpendicular, what is the angle of refraction of the second medium? Consider that the ray of light reverses its direction and travels from the second medium to the air, what is the critical angle? **Sol: 1,3; $4{,}6.10^{14}$ Hz; 22º 37´**

8. A ray of light whose wavelength in vacuum is 650 nm hits from air to the end of an optical fiber making an angle θ to the axis of the fiber. The fiber has a refractive index equals to 1,46 and its sheathing 1,44. What is the wavelength of light inside the fiber? What is the maximal angle at which total reflection occurs? Sol: 439 nm; 20º

9. Consider a monochromatic ray of light, whose wavelength in vacuum is 600 nm. This ray hits from air to the flat surface of a fish tank, making an angle of 30º. Determine the angle of refraction of glass, considering that its refractive index is 1,5 and the direction of propagation through water. Determine the wavelength of light in water, considering that the index of refraction of water is 1,33 **Sol: 19º 28´; 22º; 451 nm**

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Atomic structure & chemical bond

1. Determine the group and period of the elements whose atomic number are shown as follows: 15, 20, 35 y 55. What are their most frequent oxidation numbers?

2. Determine the electron structure of the following elements according to their place in the periodic table: potassium, aluminium, tin and bromine. What are their most frequent oxidation numbers?

3. Based on the following atomic numbers: Z = 7, Z = 13 y Z = 15, which elements are in the same group? Which elements do share the same period?

4. Write the electron structure of the elements whose atomic numbers are 4, 11, 17 and
33. Determine the group of each element, showing which are metals or nonmetals. What are their most frequent oxidation numbers?

5. A valence shell electron structure is $4s^2$ $4p^3$. According to this, determine its place in the periodic table. Determine its atomic number and state the most frequent oxidation numbers of the element

6. Elements A, B, C y D have atomic numbers 3, 10, 20 and 35, respectively. Write the electron structures of each one and show its place in the periodic table

7. Determine which of the following statements are true or false and give a reasoned answer
   a) the structure $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s$ $3d^1$ is the ground state of an atom
   b) the electronic configuration $1s^2$ $2s^2$ $2p^7$ $3s^1$ doesn´t exist
   c) the structures $1s^2$ $2s^2$ $2p^6$ $3s^1$ $3p^1$ and $1s^2$ $2s^2$ $2p^1$ $2d^1$ $3s^2$ are two different configurations of the same atom
   d) the configuration $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s$ $3d^1$ refers to an alkaline-earth element

8. Given the elements which have the following atomic numbers: 19, 23 and 48: write their electron structures; explains if the element (Z =30) is placed in the same group or period of the others

9. Write the electronic configuration in the ground state of the following atoms or ions: N^{3-}, Mg^{2+}, Cl^-, K y Fe. Which species are isoelectronic?

10. Write Lewis structures for the following molecules: PF_3, CH_2O and N_2. Nitrogen and phosphorus are in the group 15; carbon in the 14, oxygen in 16 and fluorine in the 17

11. Write Lewis structure for the following molecules: CH_3Cl (chloroform), NH_3, HNO_2 and H_2CO_3. Carbon is in group 14 and nitrogen in 15

12. Write Lewis structure for the following molecules: CO_2, SO_3, BF_3 and SO_2. Carbon is in group 14, nitrogen in 15 and sulphur in 16

Nomenclature of Inorganic Chemistry

	Formula	Stoichiometric compositional	Traditional / oxidation number
1	SbH_3		
2	CdO		
3	AsF_5		
4	SrO_2		
5	B_2H_6		
6	Na_2SO_3		
7	H_2Se		
8	$PbCl_2$		
9	Cu_2O		
10	$KMnO_4$		
11	$MoBr_2$		
12	$Fe(OH)_3$		
13	$(NH_4)_2S_2O_7$		
14	Ag_2S		
15	$Zn(ClO_3)_2$		
16	$LiClO$		
17	H_2SiO_3		
18	$Ca(OH)_2$		
19	WF_6		
20	$Hg(NO_2)_2$		
21			Manganese (II) chloride
22			Rubidium phosphate
23		Platinum diiodide	
24			Gold (III) oxide
25			Nickel (II) hydride
26			Strontium nitrate
27		Boron trifluoride	
28		Lead dihydroxide	
29			Iron (II) sulphate
30		Potassium tetraoxidochlorate	
31		Cobalt trichloride	
32			Antimony (V) oxide
33			Aluminium hydroxide
34			Hydrochloric acid
35		Silicon tetrahydride	
36			Bromous acid
37			Sodium carbonate
38			Ammonium chromate
39			Mercury (I) sulphide
40		Paladium dioxide	

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Nomenclature of Inorganic Chemistry: binary compounds

	Formula	Stoichiometric compositional	Traditional / oxidation number
1	PH_3		
2	MgO		
3	PF_5		
4	BaO_2		
5	N_2O_4		
6	Na_2S		
7	H_2S		
8	PbH_2		
9	CuI_2		
10	KBr		
11	$MnCl_2$		
12	Fe_2O_3		
13	NH_4Cl		
14	AgF		
15	ZnF_2		
16	Li_2O		
17	SiO_2		
18	CaH_2		
19	CoF_3		
20	HgH_2		
21			Platinum (II) chloride
22			Rubidium oxide
23		Tellurium diiodide	
24			Gold (III) fluoride
25			Nickel (II) sulphide
26			Strontium oxide
27		Boron triiodide	
28		Dilead trioxide	
29			Iron (II) sulphide
30		Potassium bromide	
31		Cobalt dichloride	
32			Arsenic (III) oxide
33			Chromium (VI) oxide
34			Hydrochloric acid
35		Germanium tetrahydride	
36			Mercury (II) oxide
37			Sodium fluoride
38			Ammonium bromide
39			Arsane
40		Tin dioxide	

Nomenclature of Inorganic Chemistry (II)

	Formula	Stoichiometric name	Traditional / oxidation number
1	$BaCl_2$	---	
2	H_2SO_2		(T)
3	CO		---
4	CH_4	---	
5	$Pb(NO_3)_2$	---	(T)
6	K_2S	---	
7	SrO_2	---	
8	HIO	---	(T)
9	CoH_3	---	
10	$MgCO_3$		(T)
11	H_2SeO_4		(T)
12	BeF_2	---	
13	H_2S	---	(T)
14	$Cd(IO_4)_2$		
15	PtO_2	---	
16	$Sn(OH)_4$	---	
17	H_2SiO_3		(T)
18	Cs_2SO_3		(T)
19	$Al(BrO_3)_3$		(T)
20	HNO_2		(T)
21	Sb_2O_3		---
22	$CuOH$	---	
23	$AsCl_5$		---
24	H_2CrO_4		(T)
25	$KMnO_4$		(T)
26		Dibromine heptaoxide	
27			Sodium perchlorate
28		---	Bismuth (III) hydroxide
29		---	Gold (I) hydride
30		tetrahydrogen (tetraoxidosilicate)	
31			Titanium (IV) oxide
32		Phosphorus tricloride	
33		Hydrogen(dioxidoiodate)	
34		Lead tetrakis(trioxidoiodate)	
35		Phosphane	
36			Magnesium hydroxide
37			Aluminium iodide
38			Hydrochloric acid
39		Dimercury dicloride	
40			Nitric acid
41			Nickel (II) sulfate
42			Iron (III) carbonate
43			Barium oxide
44			Platinum (IV) sulfide
45			Hydroselenic acid
46			Silver phosphate
47			Lithium borate
48		Sodium oxoiodate	
49		Antimony pentafluoride	
50			Ammonium dichromate

Nomenclature of oxoacids & oxosalts

	Formula	Stoichiometric name	Traditional
1	$Ba(ClO_2)_2$		
2	H_4SiO_4		
3	$Fe_2(CO_3)_3$		
4	$Cu(ClO_4)_2$		
5	$Pb(NO_3)_2$		
6	K_2SO_3		
7	$Sr(BO_2)_2$		
8	HIO		
9	$Co(MnO_4)_3$		
10	$MgSO_2$		
11	H_2CrO_4		
12	$BeSO_4$		
13	HPO_3		
14	$Sn(IO_4)_2$		
15	$PtCr_2O_7$		
16	$Pb(NO_3)_4$		
17	H_3BO_3		
18	Cs_3PO_4		
19	$Al(ClO_3)_3$		
20	$AuNO_2$		
21	$Ag_4P_2O_7$		
22	$Bi_2(SO_4)_3$		
23	$HgClO$		
24	H_3PO_3		
25	$K_2Cr_2O_7$		
26			Sodium perclorate
27			Bismuth (III) phosphate
28			Gold (I) nitrate
29			Silver carbonate
30			Titanium (IV) sulphate
31		Lead tetrakis(trioxidoiodate)	
32			Calcium chlorate
33			Magnesium borate
34			Tin (II) nitrite
35			Strontium hypochlorite
36			Aluminium sulphite
37		tetrahydrogen(tetraoxidosilicate)	
38			Iron (II) manganate
39			Nickel (III) metasilicate
40			Lithium hyposulphite
41			Cessium chromate
42			Zinc bromite
43			Platinum (IV) dichromate
44		Hydrogen(dioxidoiodate)	
45			Ammonium disulphate
46			Barium metaphosphate
47			Potassium permanganate
48			Mercury (II) bromate
49			Diphosphoric acid
50			Cadmium periodate

Chemical reactions

1. Find the number of molecules of carbon dioxide and number of atoms of oxygen contained in a sample of 0.5 kg of carbon dioxide.
Atomic masses: carbon: 12, oxygen: 16 **Sol: 6,8.10^{24} molecules; 1,37.10^{25} atoms**

2. Determine the number of molecules of ammonia and number of atoms of hydrogen in 100 g of ammonia. What is its volume at 720 mm Hg and 35º C?
Sol: 3,54.10^{24} molecules; 106.10^{25} atoms, 157 L

3. A tennis ball contains about 40 g of sulphur hexafluoride. What is the number of moles of gas stored in the ball? What is the pressure of the gas considering its volume is 300 cm^{-3} at 20º C? **Sol: 0,27 moles; 21 at**

4. A butane (C_4H_{10}) gas cylinder contains 5 kg of gas. Determine the number of moles of butane and the number of molecules within the cylinder. What is the volume occupied by the gas when it is released at 700 mm Hg and 20 º C?
Sol: 86,2 moles; 5,2.10^{25} molecules; 2250 L

5. We solve 30 g of sodium chloride in 200 ml of solution. Calculate its molar concentration. What is the new molarity when we add half a litre of water?
Sol: 2,56 M; 0,68 M

6. What is the mass of copper (II) sulphate pentahydrate ($CuSO_4.5H_2O$) required to prepare 1.5 l of solution 10^{-3} M? **Sol: 0,37 g**

7. What is the mass of nitric acid required to prepare 600 ml of a solution 0,6 M?
Sol: 0,36 moles = 22 g

8. Magnesium hydride reacts with water and yields magnesium hydroxide and molecular hydrogen. Write and balance the chemical equation. Consider we throw 20 grams of magnesium hydride into water. What is the number of moles and molecules of water required for the reaction? What is the mass of magnesium hydroxide produced in the reaction? What is the volume of hydrogen, measured at 15º C and 730 mm Hg released in the reaction? **Sol: 1,54 moles; 9,63.10^{23} molecules; 44,6 g; 38 l**

9. Calcium hydride reacts with water and yields calcium hydroxide and hydrogen. Write and balance the chemical equation. Consider we throw 25 grams of calcium hydride into water. What is the number of moles and molecules of water required for the reaction? What is the mass of calcium hydroxide produced in the reaction? What is the volume of hydrogen, measured at STP, released in the reaction?
Sol: 1,2 moles; 7,2.10^{23} molecules; 44 g; 27 L

10. Calcium carbide, CaC_2, reacts with water and yields calcium hydroxide and ethyne (C_2H_2). Write and balance the chemical equation. Calculate the mass of water required to produce 200 g of ethyne. What is the volume occupied by ethyne gas at 25º C and 0,97 at? **Sol: 277,2 g; 193.8 L**

11. Sodium carbonate reacts with hydrochloric acid and produces carbon dioxide, sodium chloride and water. Determine the volume of a solution of hydrochloric acid 0,6 M required to react with 4.2 g of sodium carbonate. **Sol: 132 mL**

12. Consider the combustion of 10,4 litres of acetylene (ethyne, C_2H_2) at STP. Determine the volume of oxygen at STP required to complete its combustion. What is the volume of air required for the reaction, measured at 17º C y 700 mm? Air consists of 20 % of oxygen and 80 % of nitrogen **Sol: 26 L; 150 L**

Chemical reactions

13. The combustion of 3 tons of anthracite (coal) which has 3 % of sulphur impurity, released to the atmosphere sulphur dioxide. Determine the mass of sulphur dioxide released and its volume at STP **Sol: 180 kg; 63 m^3**

14. A commercial solution of hydrogen peroxide contains 3 % of solute and its density is 1,03 g.cm^{-3}. Determine its molar concentration. Hydrogen peroxide produces water and oxygen. Write and balance the chemical equation. What is the volume of oxygen, measured at STP, released after the reaction of 100 ml of solution? **Sol: 0.9 M; 1 l**

15. Determine the density of chlorine at 30º C and 700 mm Hg **Sol: 2,63 g/L**

16. Determine the mass and the number of molecules of butane, C_4H_{10}, stored in a gas cylinder whose volume is 20 l at 2 at and 20º C **Sol: 95 g; 10^{24}**

17. Since *Cumbre vieja* volcano in la Palma started its eruption on September, 19th, 2021, it released 10665 t of sulphur dioxide per day. Determine the number of moles of sulphur dioxide and the volume of the cloud of gas expelled to the atmosphere, at 745 mm of Hg and 21º C. Calculate the pressure inside the volcano, considering that it occupied 117 millions of liters at 800º C before it was released
Sol: 1,66.10^8 moles; 4100 millions of liters; 125 atm

18. A balloon filled with helium has a volume of 500 L. Determine the number of moles of helium and its mass, considering it is at 22º C and 0,96 at. What is its volume when it lifts to a height at which air is at 0,85 at and 12º C? **Sol: 6,7 M;**

19. A solution of glycerin ($C_3H_8O_3$) has 56 % of solute and its density is 1,1 g/cm^3. Determine its molar concentration **Sol: 6,7 M; 56,1 y 43,9 %**

20. A five litre iron container is filled with air, which has 21 % of oxygen and 79 % of nitrogen, at 239º C and 0.1 at. Considering that all the oxygen reacts with iron to produce iron (II) oxide, determine the mass of iron (II) oxide produced in the reaction. Determine the final pressure in the container and the temperature required to reach a pressure equals to 0,1 at **Sol: 0,36 g; 0,079 at; 650 K**

21. The combustion of 3 g of anthracite (coal) produces 5,3 l of carbon dioxide measured at STP. Determine the mass of carbon in the sample and its mass percentage **Sol: 2,83 g; 94,6 %**

22. The roasting of zinc sulphide with hot oxygen produces zinc oxide and sulphur dioxide. What is the mass of sulphur dioxide produced by the roasting of 50 g of zinc sulphide? What is the volume of oxygen required measured at 1 at and 160º C? **Sol: 32,9 g; 27.3 L**

23. The reaction between 100 g of zinc and hydrochloric acid yields zinc chloride and hydrogen. What is the mass of hydrochloric acid required for the reaction? What is the volume of commercial solution 37 % of acid and density 1.18 g/ml required in the reaction? What is the mass of zinc chloride obtained? What is the volume of hydrogen at STP? **Sol: 111,6 g; 256 mL; 209 g; 34,2 L**

Chemical reactions

24. Aluminium combines to nitric acid and yields aluminium nitrate and hydrogen. Write and balance the chemical equation. Consider we want to solve 4.5 g of aluminium, Determine the volume of nitric acid solution, which is 69 % and whose density is 1,41 g/ml, required for solving 4,5 g of aluminium. What is the molar concentration of the solution? What is the volume of hydrogen released in the reaction, measured at 1 at and 23º C? **Sol: 32,4 mL; 15,4 M; 6,2 L**

25. When a 6,25 g piece of metal is treated with 250 ml of sulphuric acid solution 0,2 M, it is solved and yields hydrogen and metal sulphate. The reaction takes place until it stops bubbling, and the mass of metal which remains unsolved is 2,98 g. Determine the amounts of reactants required in the reaction and the formula of the metal sulphate, considering that the atomic mass of the metal is 65,4. Write and balance the chemical equation. What is the volume of hydrogen released in the reaction, measured at 700 mm and 27º C?. Determine the mass of the metal sulphate produced in the reaction **SOL:** 0,05 moles; MSO_4; 1,34 L;

26. Determine the mass of carbon dioxide that we have to release from a 25 l-container at 6 at and 20º C so as to reduce its pressure to 2 atm at the same temperature **Sol: 183 g**

27. A 84 litre propane cylinder is filled with 30 kg of gas. Considering its temperature is 27º C, determine the pressure of the gas contained in the cylinder. What is the density of propane at 20º C and 1 at? **Sol: 200 atm; 1,83 g.L^{-1}**

28. Commercial ammonia solution, used as a cleaning product, has 29 % and its density is 0,90 g/ml. Determine its molarity and the concentration in grams per litre
SOL: 15,5 M; 261 g.L^{-1}

29.

Atomic structure & chemical bond

1. Determine the group and period of the elements whose atomic number are shown as follows: 15, 20, 35 y 55. What are their most frequent oxidation numbers?

2. Determine the electron structure of the following elements according to their place in the periodic table: potassium, aluminium, tin and bromine. What are their most frequent oxidation numbers?

3. Based on the following atomic numbers: Z = 7, Z = 13 y Z = 15, which elements are in the same group? Which elements do share the same period?

4. Write the electron structure of the elements whose atomic numbers are 4, 11, 17 and 33. Determine the group of each element, showing which are metals or nonmetals. What are their most frequent oxidation numbers?

5. A valence shell electron structure is $4s^2\ 4p^3$. According to this, determine its place in the periodic table. Determine its atomic number and state the most frequent oxidation numbers of the element

6. Elements A, B, C y D have atomic numbers 3, 10, 20 and 35, respectively. Write the electron structures of each one and show its place in the periodic table

7. Determine which of the following statements are true or false and give a reasoned answer
   a) the structure $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$ is the ground state of an atom
   b) the electronic configuration $1s^2\ 2s^2\ 2p^7\ 3s^1$ doesn´t exist
   c) the structures $1s^2\ 2s^2\ 2p^6\ 3s^1\ 3p^1$ and $1s^2\ 2s^2\ 2p^5\ 2d^1\ 3s^2$ are two different configurations of the same atom
   d) the configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$ refers to an alkaline-earth element

8. Given the elements which have the following atomic numbers: 19, 23 and 48: write their electron structures; explains if the element (Z =30) is placed in the same group or period of the others

9. Write the electron structure of the atoms whose atomic number are 38, 53 and 84. Determine their group and period and the most frequent oxidation number

10. Write the electronic configuration in the ground state of the following atoms or ions: N^{3-}, Mg^{2+}, Cl^-, K y Fe. Which species are isoelectronic?

11. Write Lewis structures for the following molecules: PF_3, CH_2O and N_2. Nitrogen and phosphorus are in the group 15; carbon in the 14, oxygen in 16 and fluorine in the 17

12. Write Lewis structure for the following molecules: CH_3Cl (chloroform), NH_3, HNO_2 and H_2CO_3. Carbon is in group 14 and Nitrogen in 15

13. Write Lewis structure for the following molecules: CO_2, SO_3, BF_3 and SO_2. Carbon is in group 14, nitrogen in 15 and sulphur in 16

14. Draw the Lewis structures for the following molecules: PF_3, CH_2O and H_2O_2. Carbon, phosphorus and oxygen are placed in the groups 14, 15 and 16

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CONSEJERÍA DE EDUCACIÓN
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Organic nomenbclature

1. Give a fomula to the following subastances:

1.- 3,5-dimethyl-4-propyl-oct-1,6-diene
2.- 3-chlorocyclopentanone
3.- 3-oxobutanoic acid
4.- hex-4-enal
5.- 2-methylpropan-1-ol
6.- 3-aminobutanone
7.- butylhexylether
8.- ethanenitrile
9.- decanamide
10.- 1-chlorohept-1-en-3,6-diyne
11.- propyl 3-aminohexanoate
12.- 1,3-dihydroxipropanone
13.- 3-pentyn-1-ol
14.- 5-methoxyhex-2-ene
15.- 3-bromocyclopentene
16.- Calcium ethanoate
17.- 3-propyl-2,4-dimethylhexane
18.- Propanodioic acid
19.- 3-methylbutanonitrile
20.- hept-1,3-dien-5-yne
21.- ethyilbenzene
22.- 4-aminobutan-2-ol
23.- 1-ethylciclohexene
24.- ethandiamide
25.- non-3-en-1-ol
26.- 3,3-dipropyldec-1,5.7-triene
27.- butan-2,3-diol
28.- 4-aminopent-1,3-diene
29.- trichlorometane
30.- 2-aminopropanoic acid

2. Give a name to the following substances:

1.- CH_3-CH=CH-CH=CH_2
2.- CH_3-CH_2-CH_2-CH_2-COO-CH_2-CH_3

3.-  --CH_3
4.- CH_2=CH-CH=CH-CHO
5.- CH_3-CH_2-CHOH-CH_2OH
6.- CH_3-CH_2-CH_2-CH=CH-CH_2-C≡CH
7.- CH_2=CH-CH_2-CH_2-$CONH_2$
8.- CH_2=CH-CH_2-CO-CH_2-CH_3
9.- CH_3-CH_2-O-CH_2-CH_2-CH_2-CH_3
10.- CH_3-CH_2-CH_2-CH_2-CN

11.- CH_3-CH_2-CH_2-CH_2-  -CH_2-CH_3

12.- CH_3-CH_2-CH_2-CH_2-CHOH-CH_2-COOH
13.- CH_3-CH_2-CHCl-CH=CH_2
14.- CH≡C-CH=CH_2
15.-
16.- CH_3-CH_2-CHOH-CO-CH_3
17.- CH_3-CH_2-CH_2-CH_2-CH_2-COONa
18.- CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CHO
19.- CH_3-CH_2-C≡C-CH_3
20.- CH_3-CH_2-CH=CH-CH_2-CH_2-CH_2-CH_2-CH_2-$CONH_2$
21.- CH_2=CH-CH_2OH

22.- CH_3-  -CH_2-CH_3
23.- CH_3-CH_2-CH_2-CH_2-COO-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3

24.-  --NH_2
25.- CH_3-CH_2-CH_2-CH_2-CH=CH-CH=CH_2
26.- $CHBr_2$-CH_2-CH_3
27.- CH_2=CH-CH_2-O-CH_2-CH_2-CH_2-CH_3
28.- CH_3-CH_2-CH_2-CH_2-CH=CH-CH_2-CH_2-CH_3
29.- CHO-CH_2-CH_2-CH_2-CH_2-CHO
30.- CH_3-CH_2-CH_2-CH_2-CO-CH_2-COOH