Work, energy, and power

Business, Industries

Work, Energy, and Power

1. Is work done when you move a book from the top of the desk to the floor? Why? Yes. It is because the displacement of the book from the top of the desk to the floor and the force that is applied to the book is parallel with one another.
2. State the law of Conservation of Mechanical Energy in two ways? The law of conservation of energy states that energy may neither be created nor destroyed. Therefore the sum of all the energies in the system is constant. TMEinitial= TMEfinal.
3. Explain the basic ideas that govern the design and operation of a roller coaster. A roller coaster is operated and designed through the application of Physics. The law of Conservation of Energy governs the changes in a coaster's speed and height. Simply put, the higher an object is off the ground, the more potential energy it has - that is, potential to gain speed as it falls. As it falls toward the ground, that potential energy changes to kinetic energy, or energy of motion. The sum of the two types of energy is constant, but a roller coaster must maintain an adequate balance of potential and kinetic energies to deliver a thrilling ride.
4. An inefficient machine is said to “ waste energy”. Does this mean that energy is actually lost? Explain. Energy is never lost. An inefficient machine wastes energy by converting it to an unproductive state. A machine, such as amotor carengine has the primary task of converting the energy in the fuel to the motion of the car. It is unproductive because a large proportion of the fuel's chemical energy is dissipated

in the form of noise, heat, vibration, etc. so that only a small proportion is actually used for its prime purpose.

5. Is it possible for a simple machine to multiply both force and speed at the same time? Why? It is impossible for a simple machine to multiply both force and gain speed at the same time. It is because the gain in speed of a machine is the result of the exertion of a lot more force and therefore, does not take place at the same time. One best example is a bicycle crossing a steep hill that requires a greater force to be exerted to be able to gain speed.

B. Problems

1. Starting from rest, 5-kg slides 2. 5 m down a rough 30° incline. The coefficient of kinetic friction between the block and the incline is 0. Determine the work done by (a) the force of gravity; (b) the friction between the block and incline; (c) the normal force; and (d) the net force on the block. W= 5kg9. 8kgs2 W= 49 N.
    1. W= Fd W= Wsin30°(2. 5m) W= 49sin30°(2. 5m) W= 61. 25 J.
    2. W=-Fd W=-? kNd W=-(0. 4)(42. 44N)(2. 5m) W=-42, 44 J.
    3. W= 0 Normal force does not exert work because it is perpendicular to the displacement.
    4. WT= 49Nsin30°2. 5m-0. 442. 44N2. 5m+0 WT= 18. 81 J.
2. Car A has twice the mass of car B, but only half as much kinetic energy. When both cars increase their speed by 5m/s, then they have the same kinetic energy. What were the original speeds of the two cars? CAR A CAR B mass= 2mB mass= mB KEA= 12KEB KEB = KEB VA= 5ms VB = 5ms VA= 2KEAmA KEA= KEB VA= 2(12KEB)2mB

12mAv= 12mBv 2122mB5= 12mB5 VA= KEB2mB 10mB4= 5mB2 VB= KEBmB 5mB2= 5mB2.

3. A 400-g bead slides on a curved frictionless wire, starting from rest at point A. Find the speed of the bead at point B and point C. 400g? 1kg1000g= 0. 4 kg PEA= mgh PEA=(0. 4 kg)(9. 8)(5m) PEA= 19. 6 J PEB=(0. 4)(9. 8)(0) PEB= 0 J KEA= 12mv2= 120. 4kg02= 0 J TME= PEA+KEA= 19. 6 J+0 J= 19. 6 J KEB= TME-PEB= 19. 6-0= 19. 6 J KEB= 12mvB2 19. 6 J= 120. 4 kgVB2 VB= 39. 2 J0. 4 lg= 9. 90 m/s PEC= mgh=(0. 4)(9. 8ms22m= 7. 84 J KEC= TME-PEC= 19. 6 J-7. 84 J= 11. 76 J KEC= 12mv2C 11. 76= 120. 4kg) (v2C Vc= 23. 2 J0. 4 kg= 76. 67 m/s.
4. A tandem (two-person) bicycle team must overcome a force of 34 lbs. to maintain a speed of 30 ft. /s. Find the power required per rider, assuming they contribute equally. Express your answer in horsepower. F= 34 lb F1= 17 lb= F2 P1= F1v= 17 lb30fts= 510 ftlbs? 1hp550 ftlbs= 0. 93 hp P2= F1v= 17 lb30fts= 510 ftlbs? 1hp550 ftlbs= 0. 93 hp.
5. A pump is required to lift 200 L of water per minute from a well 10 m deep and eject it with a speed of 20m/s.

(a) How much work is done per minute in lifting the water? (b) How much in giving its kinetic energy? What horsepower engine is needed if it is 80% efficient?

1. W= mgh+12mv2= 200kg? 0m? 9. 81kgm2+12? 200kg? 20ms2= 59620Js= 993. 67J/min
2. W= 12mv2= 12200kg20ms2= 40000 J

3. HP= 59620js? 0. 8? 746js= 99. 899 hp

Linear Momentum

1. Which has greater momentum, a ten-wheeler truck at rest, or a moving motorcycle? Why? A moving motorcycle has greater momentum than the truck. A truck at rest has zero momentum because an object has to be moving in order to have momentum.
2. How does impulse differ from force? Impulse is the product of force and the time interval of the application of force; while force is just a factor that affects an object’s impulse when it is at motion.
3. Why is it incorrect to say that impulse equals momentum? It is not right to say that impulse is equal to momentum because the impulse is the measure of the change in momentum and therefore an object with constant and non-changing momentum has zero impulses.
4. What is the function of seatbelts and airbags in an automobile? The function of seatbelts and airbags in an automobile is to increase the time of a force to reach its destination, which results in a lesser impact of objects that can collide to a passenger and therefore will have a higher chance for his/her life to be saved.
5. Distinguish between an elastic collision and inelastic collision. Inelastic collision, the momentum, and the kinetic energy are conserved; and its coefficient of restitution is equal to one. However an inelastic collision, the kinetic energy is not conserved and the coefficient of restitution is zero.

B. Problems

1. Does a 10, 000-kg truck have a speed of 100 km/h? (a) what is its momentum? What speed must a 5, 000-kg truck attain in order to have (b) the same momentum? (c) the same kinetic energy?
    1. P= mv= 10000 kg27. 78ms= 2. 78? 105kg? m/s.
    2. P= mv 2. 78? 105kg? ms5000kg= 5000 kgv5000 kg v= 55. 6 m/s.
    3. KE= 12mv2 KE= 121000027. 782 KE= 3. 86? 106J KE= 12mv2 3. 86? 106J= 125000kgv2 v= 7. 72? 106J500kg v= 39. 29 m/s .
2. A car is stopped for a traffic signal. When the light turns green, the car accelerates, increasing its speed from 0 to 60 km/h in 0. 8 s. What are the magnitudes of the linear impulse and the average total force experienced by a 70-kg passenger in the car during the time the car accelerates? J= m? v J=(70 kg)(16. 67ms) J= 1166. 9 kg? m/s J= Ft= Jt F= 1166. 9 kg? ms0. 8s= 1458. 63 N.
3. A 5-g object moving to the right at 20cm/s makes an elastic head-on collision with a 10-g object that is initially at rest. Find (a) the velocity of each object after the collision and (b) the fraction of the initial kinetic energy transferred to the 10-g object. PT= PT' mAvA+mBvB= mAvA'+mBvB' 5g20cms+10g0= 5g-vA'+(10g)(vB') 100=-5vA+10vB' 20=-vA+2vB' 20=-vB+20 +2vB' vB'= 0 cm/s e=(vB'-vA')/(vA-vB) 1=(vB'-vA')/(20 cm/s-0cm/s) 20= vB'-vA' vA'= vB'-20 vA'= 0-20 vA'=-20 cm/s.
4. After a completely inelastic collision between two objects of equal mass m, each having initial speed v, the two move off together with speed v/3. What was the angle between their initial directions? P1x +

P2x = Pfx = Pf, P1y+P2x = 0. 2mv cos? = 2mv/3, cos? = 1/3, ? = 70. 5o. The angle between their initial directions is 2? = 141 °.

5. 5. A stone whose mass is 100 g rest on a frictionless horizontal surface. A bullet of mass 2. 5 g, traveling horizontally at 400 m/s, strikes the stone and rebounds horizontally at night angles to its original direction with a speed of 300 m/s. (a) Compute the magnitude and direction of the velocity of the stone after it is struck. (b) Is the collision perfectly elastic? a.) Assume that the bullet is traveling in the positive x-direction and that the stone has components of velocity vx and vy after the collision. Equating momentum before and after in these directions. 0. 0025 kg x 400ms= 0. 1 kg vx vx = 10 m/s 0. 1 vy= 0. 0025 x 300 vy = 7. 5 m/s Magnitude of velocity = v(102+7.) = 10. 37 m/s Angle = tan-1(vy/vx) = 36. 87 deg to the x-axis b.) No.

Hooke’s Law

1. What is Hooke’s Law? Hooke's law of elasticity is an approximation that states that the extension of a spring is in direct proportion with the load applied to it. Many materials obey this law as long as the load does not exceed the material's elastic limit. Materials for which Hooke's law is a useful approximation are known as linear-elastic or " Hookean" materials. Hookean materials are a necessarily broad term that may include the work of muscular layers of the heart. Hooke's law in simple terms says thatstressis directly proportional to strain. Mathematically, Hooke's law states that.
2. When is a material said to be elastic? A material is called elastic if the deformation produced in the body is completely recovered after the

removal of the load. For ideally elastic materials, a single-valued (linear) and time-independent relation exists between the forces and the deformations. Although it is hard to find an ideally elastic material, i. e. , A Hookean solid, most of the materials can be considered elastic at least for a specific range.

3. Which is more elastic, a rubber band, or spiral steel spring? Why? Spiral steel spring is more elastic than a rubber band because it has a greater elastic limit and ultimate strength than a rubber band because it has a greater elastic limit and ultimate strength than rubber.
4. What is the difference between the elastic limit of a material and its ultimate strength? Why are these concepts of special importance to construction engineers? Elastic limit is the maximum stress that can be applied to a material without being permanently deformed while ultimate strength is the stress required to cause an actual fracture to a material. These concepts are important to construction engineers because it gives them the idea of what materials are perfect for the construction and those that are fragile.
5. Which is more compressible, alcohol, or water? Why? Alcohol. It is because alcohol has higher compressibility and accepts a greater pressure than on the water.

B. Problems

1. A nylon rope used by mountaineers elongates. 5 m under the weight of an 80-kg climber. (a) If the rope is 50 m in length and 9 mm in diameter, what is the Young’s Modulus for this material? (b) If Polson’s ratio for nylon is 0. , find the change in diameter under this stress. a)

y= F? LoA? L y=(784N)(50m)Pi4. 5x10-32(1. 5 m) y= 4. 11x108 Pa b) ? tto=-?? LL0 ? t=-?? LtoLo=-0. 21. 59x10-3m50m=-5. 4? 10^-5.

2. The elastic limit of steel elevator cable is 2. 75x108 N/m2 Find the maximum upward acceleration that can be given a 900-kg elevator when supported by a cable whose cross-section is 3 cm2, if the stress is not to exceed ? of the elastic limit. Maximum stress allowed: 14(2. 75? 108= 6. 875? 104 Pa Force force this stress= stress? area= 6. 875? 104 x0. 0003= 20. 625 N= Fup Fup= mg+ma 20. 625= 900(9. 81)+900(a) a= 13. 11 m s-2. The deepest pint in the ocean is the Mariana trench, about11 km deep. The pressure at this depth is huge, about 1. 13? 108 Pa. (a) Calculate the change in volume of 1000 L of seawater carried from the surface to this deepest point in the Pacific Ocean. (b) The density of seawater at the surface is 1. 025g/cm.
3. Find its density at the bottom.
4. If the shear stress in steel exceeds 4x108 N/m2, the steel ruptures. Determine the shearing force necessary to (a) shear a steal bolt 1. 0 cm in diameter and (b) punch a 1. 0-cm diameter hole in steel plate 5mm thick. a.) FA= 4x108Nm2= F/R2 = F/*0. 1m2 F = 125663. 706143592N b.) FA= 4x108Nm2= F/2RT= F/2*0. 005 m*0. 005m F = 63, 000 N.
5. In the figure below, 103 kg uniform log hangs by two steel wires, A and B, both of diameters 2. 4 mm. initially, wire A was 2. 5 m long and 2. 0 mm shorter than wire B. The log is now horizontal. a) What are the tensions in wires A and b? Since the log is not moving: FA + FB –mg = 0 Since the log is horizontal: LA + DLA = LB + DLB = LA + l + DLB,

DLA = DLB + l, where l = 2 mm is the original difference in lengths between A and B. Which gives: b) What is the ratio of distance a and b?