ENERGY

# ~~Gravity and Circle~~s Packet

**Problems:** **On a separate sheet of paper, show your starting equation(s), show your work and box your answer.**

**5 points each:**

- **Starting equation (1 point)**
- **Work and correct answer (3.5 points)**
- **Boxed answer w/correct units (0.5 points)**

1. (II) A box of mass 5.0 kg is accelerated by a force across a floor at a rate of $2.0\,\mathrm{m/s^2}$ for 7.0 s. Find the net work done on the box.

$v = v_0 + at = 14\,\frac{m}{s}$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(5)(14)^2 = 490\,J$

$W = \Delta KE = 490\,J$

2. (I) How much work must be done to stop a 1250-kg car traveling at $105\,\mathrm{km/h}$?

$105\,\frac{km}{h}\left(\frac{1\,h}{3600\,s}\right)\left(\frac{1000\,m}{1\,km}\right) = 29.2\,\frac{m}{s}$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(1250)(29.2)^2 = 5.32\times10^5\,J$

$W = \Delta KE = -5.32\times10^5\,J$

3. (I) A spring has a spring stiffness constant, *k*, of $440\,\mathrm{N/m}$. How much must this spring be stretched to store 25 J of potential energy?

$PE_s = \frac{1}{2}kx^2$

$25 = \frac{1}{2}(440)x^2$

$x = 0.337\,m$

4. (I) By how much does the gravitational potential energy of a 64-kg pole vaulter change if his center of mass rises about 4.0 m during the jump?

$PE_g = mgh = (64)(9.8)(4) = 2509\,J$

5. (II) A vertical spring (ignore its mass), whose spring stiffness constant is $950\ \mathrm{N/m}$, is attached to a table and is compressed down 0.150 m. (*a*) What upward speed can it give to a 0.30-kg ball when released? (*b*) How high above its original position (spring compressed) will the ball fly?

$PE_g = mgh$

$KE = \frac{1}{2}mv^2$

$PE_s = \frac{1}{2}kx^2$

a) $PE_s = KE$

$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

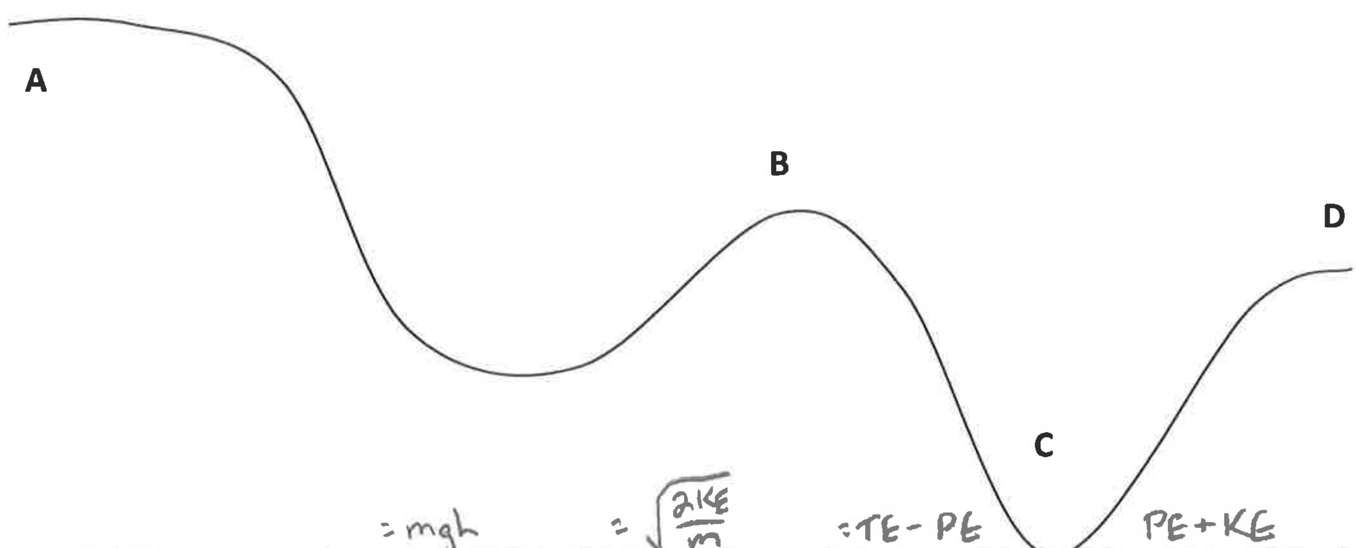
$\frac{1}{2}(950)(.15)^2 = \frac{1}{2}(.30)v^2$

$v = 8.44\ \frac{m}{s}$

b) $\frac{1}{2}(950)(.15)^2 = (0.30)(9.8)h$

$h = 3.64\ m$

6. (II) A roller coaster (500 kg) starts from rest at a height of 15 m. Find its total energy, its potential energy, its kinetic energy and its speed at each of the locations indicated.




| Position | Height | Potential Energy ($= mgh$) | Velocity ($= \sqrt{\frac{2KE}{m}}$) | Kinetic Energy ($= TE - PE$) | Total Energy ($PE + KE$) |
|---|---|---|---|---|---|
| A | 15 m | 73,500 | 0 | 0 | 73,500 |
| B | 10 m | 49,000 | 9.9 | 24,500 | 73,500 |
| C | 0 m | 0 | 17 | 73,500 | 73,500 |
| D | 5 m | 24,500 | 14 | 49,000 | 73,500 |

7. (II) Electric energy units are often expressed in the form of "kilowatt-hours." (a) Show that one kilowatt-hour (kWh) is equal to (b) If a typical family of four uses electric energy at an average rate of 520 W, how many kWh would their electric bill be for one month, and (c) how many joules would this be? (d) At a cost of $0.12 per kWh, what would their monthly bill be in dollars? Does the monthly bill depend on the rate at which they use the electric energy?

a) $1\,kW \cdot hr \left(\frac{1000\,W}{1\,kW}\right)\left(\frac{3600\,s}{1\,hr}\right)$

$= 3.6 \times 10^6\,J$

c) $1.35 \times 10^9\,J$

d) $44.93

b) $E = Pt = 520\,W\left(\frac{1\,kW}{1000\,W}\right)\left(\frac{24\,hrs}{day}\right)\left(\frac{30\,day}{1\,month}\right) = 374\,kWhr$

8. (II) A driver notices that her 1150-kg car slows down from 85 km/h to 65 km/hr in about 6.0 s on the level when it is in neutral. Approximately what power (watts and hp) is needed to keep the car traveling at a constant 75 km/hr?

$\Delta v = 20\,\frac{km}{hr} = 5.56\,\frac{m}{s}$

$P = \frac{\Delta E}{t} = \frac{\frac{1}{2}(1150)(5.56)^2}{6} = 2963\,W = 3.97\,hp$

9. (II) How much work can a 3.0-hp motor do in 1.0 h?

$W = Pt = (3\,hp)\left(\frac{746\,W}{1\,hp}\right)(1\,hr)\left(\frac{3600\,s}{1\,hr}\right)$

$W = 8.06 \times 10^6\,J$

10. (II) A shot-putter accelerates a 7.3-kg shot from rest to 14 m/s If this motion takes 1.5 s, what average power was developed?

$P = \frac{\Delta E}{t} = \frac{\Delta KE}{t} = \frac{\frac{1}{2}(7.3)(14)^2}{1.5} = 477\,W$

11. (II) A pump is to lift 18.0 kg of water per minute through a height of 3.60 m. What output rating (watts) should the pump motor have?

$P = \frac{\Delta E}{t} = \frac{\Delta PE}{t} = \left(18\,\frac{kg}{min}\right)\left(9.8\,\frac{m}{s^2}\right)(3.60\,m)\left(\frac{1\,min}{60\,sec}\right) = 10.6\,Watts$