Exam Mechanics (1): AESB1320-T, 17.04.2014, 09:00 – 12:00

This exam consists from 5 multiple-choice problems (each has value of 6 points with a total of 5x6=30 points) and 5 open problems (each has a value of 12 points with a total of 5x12=60 points). Some important expressions, basic laws and specific physical quantities are given in list of formulas. During exam, you can only use: a pen, a calculator, supporting drawing tools and English dictionary. For each question, please use a separate page. Please provide always detailed derivations – not only the final answers. Do not forget to write your student number and your name on EACH page !
Please feel free to provide your additional explanations (if you prefer) in Dutch.

Multiple-Choice Exam Questions ***(each question 6 points: 2 for correct answer and 4 for explanation).***

1) A girl of mass 62 kg throws a ball of mass 0.4 kg against a wall. The ball strikes the wall horizontally with a speed of 27 m/s, and it bounces back with this same speed. The ball is in contact with the wall 0.05 s. What is the average force exerted on the wall by the ball?

A) 16,740 N B) 66,960 N C) 430 N D) 33,480 N E) 220 N

2) Halley's comet orbits the Sun in an elliptical orbit. Its distance from the Sun ranges from 8.75×10^{10} m to 5.26×10^{12} m. Its minimum speed is 908 m/s. What is its maximum speed?

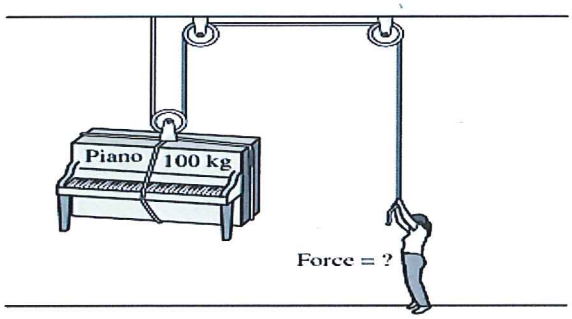
A) 5.46×10^4 m/s B) 2.33×10^3 m/s C) 3.12×10^5 m/s D) 6.55×10^4 m/s E) 7.06×10^5 m/s

3) A block is on a frictionless table, on Earth. The block accelerates at 1.2 m/s^2 when a 50 N horizontal force is applied to it. The block and table are set up on the Moon. The acceleration due to gravity at the surface of the Moon is 1.62 m/s^2. A horizontal force, equal in magnitude to the weight of the block on Earth, is applied to the block when it is on the Moon. The acceleration transmitted to the block is closest to:

A) 8 m/s^2 B) 4 m/s^2 C) 10 m/s^2 D) 6 m/s^2 E) 2 m/s^2

4) A 15-kg crate sliding at 4.0 m/s comes to rest due to friction.
The work done by friction during this process is -60 J. [TRUE or FALSE]

5) A piano mover raises a 100-kg piano at a constant rate using a frictionless pulley system, as shown below. With roughly what force is the mover pulling down on the rope?



A) 2000 N B) 250 N C) 1000 N D) 500 N E) Depends on the velocity!

The open exam problems (each question 12 points). Please use the symbol notation as long as possible. Replace the numerical values only at the very end. You can get additional (bonus) points by applying and using IDEA solving strategy (2 points per exam problem). Take care about the proper units and proper number of required significant (decimal) points.

6) A biologist looking through a microscope sees a bacterium at: $\vec{r}_1 = (2.2\vec{i} + 3.7\vec{j} - 1.2\vec{k})\mu m$. After 6.2 sec, it is at $\vec{r}_2 = (4.6\vec{i} + 1.9\vec{k})\mu m$.
Find: (a) averaged bacterium velocity (expressed in unit vectors) and (b) its average speed.

7) Children sled down a 41-m-long hill inclined at 25^0. At the bottom, the slope levels out. If the coefficient of friction is 0.12, how far do the children slide on the level ground?

8) A block of weight 4.5 N is launched up a 30^0 inclined plane 2.0 m long by a spring with k=2.0 kN/m and maximum compression of 10 cm. The coefficient of kinetic friction is 0.50. Does the block reach the top of the incline? If so, how much kinetic energy does it have there? If not, how close to the top, along the incline, does it get?

9) A satellite is in an elliptical orbit around Earth at altitudes ranging from 230 to 890 km. At its highest point, it is moving at 7.23 km/s. How fast is it moving at its lowest orbital point?

10) A 14-kg projectile is launched at 380 m/s at a 55^0 angle to the horizontal. At the peak of its trajectory it collides with a second projectile moving horizontally, in the opposite direction, at 140 m/s. The two stick together and land 9.6 km horizontally downrange from the first projectile's launch point. Find the mass of the second projectile.