Rutherford Schools Physics Project: Website Dynamics Questions

2 AS - I

Exercise 1: A toboggan is sliding down a hillside with a uniform acceleration. The resultant force acting on the toboggan:

a) is zero.

b) is constant.

c) increases uniformly with time.

d) decreases uniformly with time.

e) is proportional to the displacement from a fixed point.

Adapted with permission from UCLES, A Level Physics, November 1987, Paper 1, Question 1.

Exercise 2: Which of the following pairs contains one vector quantity and one scalar quantity?

a) Displacement : Acceleration

b) Force : Kinetic Energy

c) Momentum : Velocity

d) Power : Speed

e) Work : Potential Energy

Used with permission from UCLES, A Level Physics, November 1987, Paper 1, Question 3.

Exercise 3: Two masses, X and Y, are moving directly towards one another along a line. The momentum of X before the collision is 20 kg m s^{-1} and the momentum of Y before the collision is 12 kg m s^{-1}. After the collision, the masses move in opposite directions and the momentum of X is 2 kg m s^{-1}. What is the magnitude of the momentum of Y?

a) 6 kg m s^{-1}

b) 8 kg m s^{-1}

c) 10 kg m s^{-1}

d) 30 kg m s^{-1}

e) 34 kg m s^{-1}

Used with permission from UCLES, A Level Physics, November 1988, Paper 1, Question 4.

Exercise 4: A ball is fired vertically upwards with a given velocity. Neglecting air resistance, which one of the following statements is correct?

a) The kinetic energy of the ball is a maximum at the maximum height attained.

b) In accordance with the principle of conservation of energy, the total energy of the ball is constant throughout the motion.

c) In accordance with the principle of conservation of momentum, the total momentum of the ball is constant throughout the motion.

d) The ball travels equal distances during equal periods of time during both ascent and descent.

e) The potential energy of the ball increases uniformly with time during ascent.

Used with permission from UCLES, A Level Physics, June 1986, Paper 1, Question 4.

Exercise 5: A rock is resting on a horizontal sheet of ice and acted on by two forces of magnitudes 15 N and 20 N, in perpendicular directions North and East respectively. The friction between the rock and the ice is negligible.

a) The rock accelerates at 4.0 ms^{-2}; find the direction in which it moves. What is the mass of the rock?

b) The forces continue to act so that the rock moves in a straight line for 6.0 s. Calculate the velocity acquired by the rock in this time, and also the distance it has travelled.

Adapted with permission from UCLES, O Level Physics, June 1979, Paper 2, Question 3.

Exercise 6: A cube of polystyrene and a small cube of lead, each of mass 0.2 kg are released together from rest and fall down a deep well with water at the bottom. The lead cube is found to take 4.0 s to reach the water surface.

a) Calculate the speed with which the lead cube hits the water, and also the depth of the well to the water's surface.

b) The polystyrene cube takes 6.0 s longer to hit the water. Find the upward force, assumed constant, that must be acting on the polystyrene and explain why it is reasonable to assume it does not affect the lead.

Adapted with permission from UCLES, O Level Physics, June 1978, Paper 1, Question 1.

Exercise 7: Calculate the work done against gravity by a person of mass 80 kg in walking for 102 m along a path going up a hill of uniform gradient 1 in 5. What happens to this energy?

Hint: A gradient of 1 in 5 means that for every 5 m horizontally, 1 m is gained in vertical height. It is also called a slope of 20%.

Adapted with permission from UCLES, O Level Physics, June 1980, Paper 1, Question 2.

Exercise 8: A bullet of mass m moving horizontally with velocity u meets a block of wood of mass M approaching with velocity U and remains embedded in it. Show that the loss of kinetic energy is

$$\frac{1}{2}\frac{Mm(u+U)^2}{M+m}.$$

Hint: Momentum, $\underline{\boldsymbol{p}} = m\underline{\boldsymbol{v}}$, is always conserved in collisions; the total before a collision equals the total after, taking care of the directions.

Used with permission from UCLES, Higher School Certificate Mathematics, June 1950, Paper 3, Question 3.

Exercise 9:

a) A lift, of mass m, is travelling downwards at a speed u. It is brought to rest by a constant acceleration over a distance h.

   i. What is the tension, T, in the lift cable when the lift is stopping?

   ii. What is the work done by the tension whilst stopping the lift?

b) A lift, of mass m, is travelling upwards at a speed u. It is brought to rest by a constant acceleration over a distance h.

   i. What is the tension, T, in the lift cable when the lift is stopping?

   ii. What is the work done by the tension whilst stopping the lift?

NB: For the website, we are planning to have these two questions alternate at random. When a student clicks on the question he could receive either part a) or part b).

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Exercise 10: Two particles P and Q, of masses $2m$ and m respectively, are joined by a light inextensible string and rest on a smooth horizontal plane, with the string slack. The particle P is projected in a horizontal direction, directly away from Q, with speed u.

a) Find the loss in kinetic energy when the string becomes taut.

b) Calculate the impulse (which is equal to the change in momentum) that acts on the particle Q.

Used with permission from UCLES, A Level Mathematics, Syllabus C, June 1986, Paper 2, Question 1.