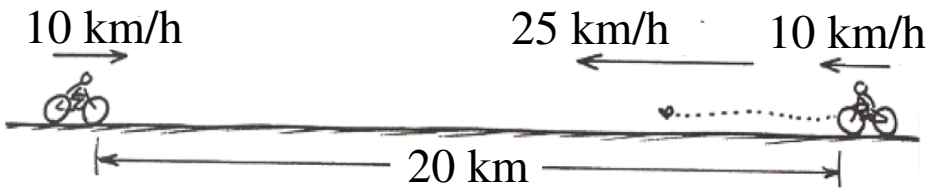
On-line contest questions 2015

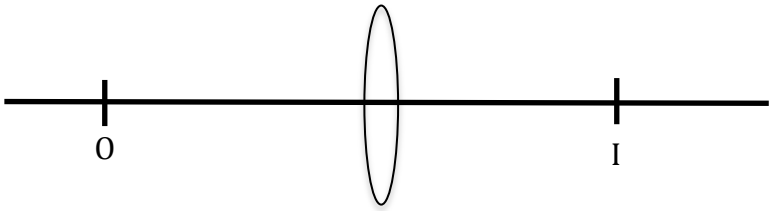
1) Two cyclists travel at a uniform speed of 10 km/h toward each other. At the moment when they are 20 km apart, a bee flies from the front wheel of one of the bikes at a uniform speed of 25 km/h (relative to the ground, not the bike) directly to the wheel of the other bike. It touches it and instantaneously turns around and returns at the same speed to the first bike, etc. -- successive trips becoming shorter and shorter until the bikes collide and squash the bee. What was the total distance travelled by the bee?



A 20 km B 25 km C 35 km D 50 km

2) A convex lens is situated so that it produces a real image at position "I" of a real object at position "O", as in the diagram. A plane mirror (reflective on both sides and larger than the lens) is inserted vertically between the lens and position I, just in front of position I. How many real images are there now?

A. zero
B. one
C. two
D. three



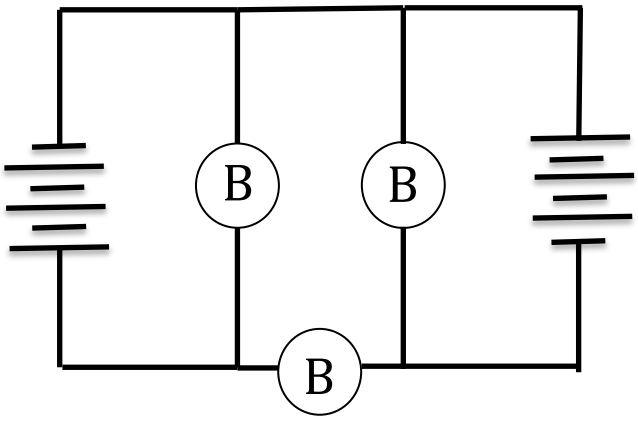
3) The circuit below contains two identical batteries and three identical light bulbs (B). If the current through the light bulb furthest to the left is I, then the current passing through the battery furthest to the right is …

A I

B 2 I

C 3 I

D 4 I



4) Tim Horton's is the most popular coffee chain in Canada. If all the Tim Horton's coffee cups consumed in a year in Canada, with lids on, were stacked vertically, how high would the stack be?

A 10 km
B 100 km
C 1000 km
D 10,000 km

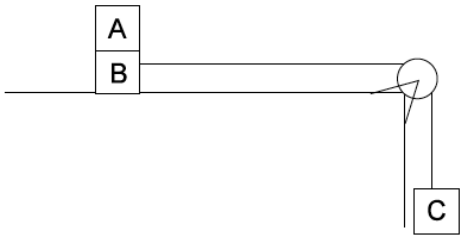
5) A rope of length *L* and mass *M* hangs from a ceiling. If the bottom of the rope is given a gentle wiggle, a wave will travel to the top of the rope. As the wave travels upward, its speed …

A increases
B decreases
C stays the same
D can't be determined

6) Three identical blocks form the system shown below. Blocks B and C are connected by a string over a pulley. Block A sits on top of block B. There is no frictional force between block B and the surface of the table but there is friction between the blocks. When released, block A remains on top of block B with no slipping.

Let W be the weight of each block, T be the tension in the string, and F be the frictional force acting on block A while the system is in motion. How do the magnitudes of the forces compare?

A W > T > F
B W > T = F
C W = T = F
D W = T but F can't be compared without knowing the coefficient of friction



7) A wooden cube (mass m and cross-sectional area A on a side) floats in a container of water (density ρ). If the block is pressed down a bit and then released, it oscillates under the influence of the buoyancy force, which depends on how much of the block is underwater and gravity (g). Which of the following could be an expression for the oscillation frequency?

A $\sqrt{\frac{\rho g}{m}}$ B $\sqrt{gA}$ C $\sqrt{\frac{mg}{\rho A}}$ D $\sqrt{\frac{\rho g A}{m}}$

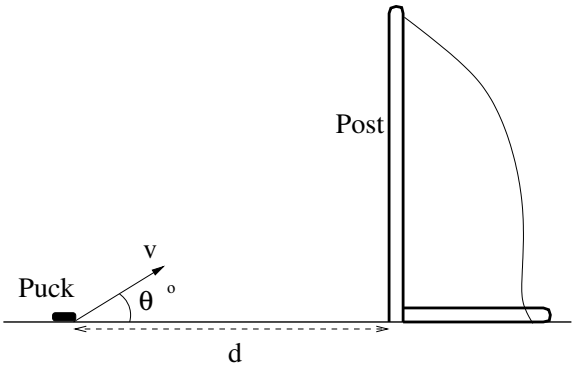
8) A hockey puck is struck at an angle of θ degrees upward from the ice surface at a speed v towards the goal a distance d away. It strikes the goal post in a perfectly elastic collision, ricochets and lands back on the ice. The goal post does not move. At what approximate speed does the puck strike the ice surface?

A v

B $v - \sqrt{2gd\sin(\theta)}$

C $v\ \sin(\theta)$

D $\sqrt{2gd\tan(\theta)}$



9) A package is dropped from an airplane traveling horizontally at constant speed. One second later a second package is dropped. Which of the following is an accurate statement? [Assume air resistance is negligible]

A The distance between the two packages will remain constant as they fall.
B The distance between the two packages will steadily increase as they fall.
C The second package hits the ground more than one second after the first hits.
D The horizontal distance between the two packages will increase as they fall.

10) A heavy ball attached to a string is swung in a vertical circle at a constant speed v, as depicted in the diagram. The centre of the circle is at a height h above the ground. When the ball is at the location shown, with the string horizontal, the string breaks and the ball flies off. Location A is directly under the ball when the string breaks. Where does the ball land?

A Location A

B Location B, a distance $v\sqrt{\frac{h}{g}}$ from A

C Location C, a distance $v\sqrt{\frac{2h}{g}}$ from A

D Impossible to determine without more information