AP Physics - C

Dam Busters!

Name: KEY

Fill in the following blanks as you watch the video.

The ______________ bomber would be used to drop the bombs.

Water ______________ the spreading out of the explosive force but it __________ the dam if it is between the dam and the explosive.

The best angle of entry for the bombs is < __________ above the horizontal.

A ______________ ball bounces the farthest.

A smooth ball will travel ______________ the distance of the ______________ ball.

Using the diagrams below, sketch the airflow around a dimpled ball and a smooth ball.

After moving down along the dam underwater, the bomb will explode due to the pressure at a depth of ________ ft.

The bombers were to release the bombs from a height of ______________ ft.

__________ goggles were used to simulate moonlight.

The test bomb's ______________ ______________ was its Achilles' heel.

It was experimentally determined that it was best to drop the bombs from a height of __________ ft.

When the bomber was exactly 60 ft above the water, two ______________ projected downward from the aircraft would just touch.

On May 16th, __________ the squadron was briefed for the mission.

The cylindrical bombs were to spin at a rate of ______________ rpm.

____________ of the six planes returned safely after the mission.

____________ of the dams targeted were destroyed.

Problems:

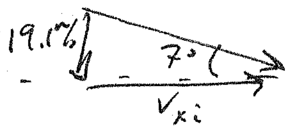
1. If the planes are 18.3 m above the water calculate the time it will take for the bomb to strike the water the first time.

$\Delta y = \frac{1}{2} a_y t^2 + \cancel{v_{yi} t}^{\,0} \rightarrow t = \sqrt{\frac{2\Delta y}{a_y}} = \sqrt{\frac{2(18.3)}{10}} = \boxed{1.91\,s}$

2. Calculate the vertical component of the bomb's velocity just before striking the water for the first time.

$v_{yf} = \cancel{v_{yi}}^{\,0} + a_y t = 10(1.91) = \boxed{19.1\,m/s}$

3. The angle at which the bomb must strike the water is to be 7°. Calculate the plane's horizontal velocity required to achieve this angle.



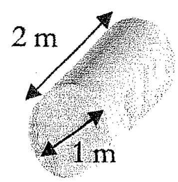
$\tan 7^\circ = \frac{19.1}{v_{xi}} \rightarrow v_{xi} = \frac{19.1}{\tan 7^\circ} = \boxed{156\ m/s}$

4. The 5080.0 kg bomb is to be spun at a rate of 500 revolutions per minute.

   a. Convert the rotational speed into rad/s.

   $500\ \frac{rev}{min}\left(\frac{2\pi\ rad}{rev}\right)\left(\frac{1\ min}{60\ s}\right) = \boxed{52.4\ rad/s}$

   b. If the bomb is a cylinder with dimensions shown to the right, calculate its rotational inertia (assume uniform density).



   $I = \frac{1}{2}mR^2 = \frac{1}{2}(5080)(0.5)^2 = \boxed{635\ kg \cdot m^2}$

   c. If the bomb takes 1.3 minutes to spin up to full speed, calculate the net torque acting on it.

   $t = 1.3\ min = 78\ s$

   $\omega_f = \omega_i + \alpha t \rightarrow \alpha = \frac{\omega_f - \omega_i}{t} = \frac{52.4}{78} = 0.67\ rad/s^2$

   $\tau = I\alpha$

   $\tau = I\alpha = (635)(0.67) = \boxed{427\ N \cdot m}$

   d. Assume that the force to speed up the bomb is applied tangentially to the edge. Calculate the necessary force.

   $\tau = rF_\perp \rightarrow F_\perp = \tau / r = \frac{427}{0.5} = \boxed{854\ N}$

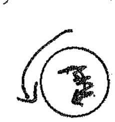
   e. Calculate the rotational KE of the bomb when it is spinning at full speed.

   $KE = \frac{1}{2}I\omega^2 = \frac{1}{2}(635)(52.4)^2 = \boxed{871{,}779\ J}$

   f. Calculate the minimum power motor necessary to spin up the bomb.

   $P = \frac{Energy}{time} = \frac{871779}{78} = 11177\ Watts = \boxed{11.2\ kW}$

5. If the plane is moving toward the right, sketch on the diagram below the direction it should rotate.



6. What is the relative speed between the lower edge of the bomb and the water surface just before impact?

   $2 \times v_{xi} =$