SOLUTIONS

Miscellaneous Year 10 Physics Problems

1. It is 2.00 m from the top to bottom of a skateboard half pipe.

a) A 60.0 kg skateboarder has how much potential energy at the top of the pipe?

$E_p = mgh$

$= 60 \times 9.8 \times 2$

$= 1176\ J$

b) What is the velocity of the skateboarder at the bottom of the pipe?

E_k at bottom = E_p at top

$\frac{1}{2}mv^2 = 1176$ $\quad v = \sqrt{\frac{1176 \times 2}{60}} = 6.26\ m/s$

2. A 90.00 kg weightlifter lifts 125.00 kg from the ground to 2.050 m above his head in 0.4500 s.

a) What force must the lifter apply to do this?

$W = Fs \therefore F = W/s$ $\quad W = \Delta E = mgh = 125 \times 9.8 \times 2.05 = 2511\ J$

$F = 2511/2.05 = 1225\ N$

b) What work does the lifter do to do this?

$W = \Delta E = mgh = 125 \times 9.8 \times 2.05 = 2511\ J$

c) If the lifter walks around the stage for 3.00m while trying to retain his balance. What extra work has he done?

Q.1 None.

Work is only achieved if force is in same direction as motion.

d) How much power did the lifter develop to lift the weights?

$P = E/t = \frac{2511}{0.46} = 5580\ J/s$ or W.

3. A stunt driver drives a 1000 kg car with a horizontal velocity of 33.00 m/s off a 25.0 m cliff into a river.

a) What is the kinetic energy of the car at the top of the cliff?

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

$= \frac{1}{2} \times 1000 \times 33^2$

$= 54,450\ J$

b) What is the kinetic energy of the car just before it hits the water?

E_p at top = $mgh = 1000 \times 9.8 \times 25 = 24,500\ J$

E_p turned into E_k and added to previous E_k.

Total $E_k = 54,450 + 24,500 = 29\,945\ J$

c) What is the total energy of the car half way down the cliff?

Energy must be conserved. Total energy is found at the bottom when it is all kinetic.

The total energy ($E_k + E_p$) must be the same everywhere. 29 945J.

4. A student built rocket of 175 g is fired upwards. The engine burns for 3.00 s and the rocket is at 65.0 m when the engine stops burning.

a) What is the weight of the rocket?

$W = mg = 0.175 \times 9.8 = 1.71\ N$

b) What is the gain in potential energy of the rocket?

$E_p = mgh$

$= 0.175 \times 9.8 \times 65$

$= 112\ J$

c) What is the power of the rocket engine?

$P = E/t$

$= 112/3 = 3.73\ J/s$ or W.

d) Why are these calculations only estimates?

No air resistance has been included.

5. You step on the brake pedal for 2.5 s as you near a corner. This applies a retarding force of 810 N to slow the 250.0 kg go-cart. If the initial speed of the cart is 16.5 m/s, what is the cart's final velocity?

$t = 2.5s$

$F = -810N$*

$m = 250kg$

$u = 16.5m/s$

$v = ?$

$F = ma \therefore a = F/m$

$= -810/250 = -3.24\ m/s^2$

$v = u + at$

$= 16.5 + (-3.24)2.5$

$= 8.4\ m/s$

* Negative as is a retarding force

6. A 40.0 kg astronaut travels from Earth to Mars. The acceleration due to gravity on the Earth's surface is 9.80 ms^{-2} whereas on Mars it is only 3.72 ms^{-2}.

a) Compare the mass of the astronaut on Earth with her mass on Mars,

Same, mass does not depend on gravity.

b) Compare the weight of the astronaut on Earth with her weight on Mars,

$W_E = mg = 40 \times 9.8 = 392N$

$W_m = m \times 3.72 = 40 \times 3.72 = 149N$

c) It takes a certain force to accelerate the astronaut at 2.0 ms^{-2} while she is on earth. What force on Mars would accelerate her at the same rate?

Net force = $F - 149 = ma$

$F = 40 \times 2 + 149$

$F = 229\ N$

7. A child throws a 0.200 kg stone down into a river from a 12.0 m high bridge. If the stone's initial speed is 10.0 ms^{-1}, what is the stone's kinetic energy as it hits the water?

Energy at top = $E_p + E_K$

$= mgh + \frac{1}{2}mv^2$

$= 0.2 \times 9.8 \times 12 + \frac{1}{2} \times 0.2 \times 10^2 = 33.5J$

At river, all energy is kinetic.

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

$v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2 \times 33.5}{0.2}} = 18.3\ m/s$