$$\frac{5\,km}{h} = \frac{5(1000)}{3600} = 1.39\,\frac{m}{s}$$

Examples:

1. Find the kinetic energy of a 50 – kg object that travels at 5 km/h.

G: $v = 1.39$ m/s
$m = 50$ kg

R: $KE = ?$ [J]

A: $KE = \frac{1}{2} m v^2$

S: $KE = \left(\frac{1}{2}\right)(50)(1.39)^2$
$= 48$ J

S: Object's kinetic energy is 48 J

2. How fast does a 10g marble move if it has 50 J of kinetic energy?

G: $KE = 50$ J
$m = 10g = 0.010$ kg

R: $v = ?$

A: $KE = \frac{1}{2} m v^2$

$\frac{KE}{\frac{1}{2}m} = v^2$,

$v = \sqrt{\frac{KE}{\frac{1}{2}m}}$

S: $v = \sqrt{\frac{50}{\left(\frac{1}{2}\right)(0.01)}}$
$= 100\,\frac{m}{s}$

S: the marble moves with 100 m/s.

3. a) Find the mass of an object that moves at 25km/h and has kinetic energy of 1500J.

G: $KE = 1500$ J
$v = 25$ km/h $= \frac{25(1000)}{3600} = 6.94\,\frac{m}{s}$

R: $m = ?$ [kg]

A: $KE = \frac{1}{2} m v^2$

$\frac{KE}{\frac{1}{2}v^2} = m$

S: $m = \frac{1500}{\frac{1}{2}(6.94)^2} = \frac{1500}{24.11}$
$=$ kg $\boxed{62.3\text{ kg}}$

S: Object has mass of 62.3 kg.

b) What is the object's weight? What assumptions do you make?

Weight $= m \cdot g$
$= (62.3)(9.8)$

assume on Earth

4. What work was needed to stop an 8.0-kg object that originally moved with speed of 20 m/s?

G: $v_i = 20$ m/s
$v_f = 0$ m/s
$m = 8.0$-kg

R: $W = ?$ [J]

A: $W = \Delta KE$

S: $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$= \frac{1}{2}(8)(0)^2 - \frac{1}{2}(8)(20)^2$
$= 0 - 1600$ J
$W = -1600$ J

S: Work done is -1600 J.

Note: negative work because we need the object to slow down (stop)

Note: Friction always does negative work.

5. What is the potential energy of a 2.5 kg rock that lies on a 300m high cliff?

G: $h = 300$ m
$m = 2.5$ kg
$g = 9.8$ m/s^2

R: $PE = ?$ [J]

A: $PE = mgh$

S: $PE = (2.5)(9.8)(300)$
$= 7350$ J

S: Rock has potential energy of 7350 J.

6. What is the potential energy of a person whose weight is 784 N and they on top of a CN Tower? (350 m)

G: weight = 784 N
$h = 350$ m

mg = weight

R: $PE = ?$ [J]

A: $PE = mgh$

S: $PE = (784)(350)$
$= 2.7 \times 10^5$ J

S: The person's potential energy is 2.7×10^5 J.

7. What is the mass of an object that is at rest in a room on the tenth floor of a hotel and their total energy is 25 000J?

Assume that each floor is 6 m high and the street level is the reference level.

G: $h = (6m)(10) = 60m$
$PE = 25\,000\ J$

R: $m = ?$

A: $PE = mgh$
$m = \frac{PE}{gh}$

S: $m = \frac{25\,000}{(9.8)(60)}$
$= 42.5\ kg$

S: The object is about 43kg.

8. What is the total mechanical energy of a 1200-kg car that stopped on a cliff that is 80 m above the sea level?

G: $m = 1200\ kg$
$h = 80m$
$g = 9.8\ m/s^2$

R: $E_{TOT} = ?\ [J]$

A: $E_{TOT} = PE + KE$

S: $= mgh + \frac{1}{2}mv^2$
$= (1200)(9.8)(80) + (\frac{1}{2})(1200)(0)$
$= 940800\ J = 9.4 \times 10^5\ J$

S: Total mechanical energy is $9.4 \times 10^5\ J$

9. How much does the total mechanical energy of the car from question 8 changed if it now moves with average speed of 65 km/h on the road that is 120 m above the sea level?

$65 \frac{km}{h} = 18.1 \frac{m}{s}$

$E_{TOT} = PE + KE$
$= mgh + \frac{1}{2}mv^2$
$= (1200)(9.8)(120) + \frac{1}{2}(1200)(18.1)^2$
$= 1,411,200 + 196,566$
$= 1.6 \times 10^6\ J$

$\therefore E_{TOT}$ is higher by $6.7 \times 10^5\ J$.

Possible answers:

10. What is your total mechanical energy when you drive to school?

G: $m = 60\ kg$

$v = 50\ km/h = 13.9\ \frac{m}{s}$

assume: driving @ the reference level ⇒ $PE = 0\ J$

R+A $E_{TOT} = PE + KE$

S: Total mechanical energy is $5.8 \times 10^3\ J$

S: $E_{TOT} = KE$

$= \frac{1}{2}(60)(13.9)^2$

$= 5.8 \times 10^3\ J$

11. What is your total mechanical energy when you walk home from school?

G: $m = 60\ kg$

$v \doteq 5\ km/h = 1.4\ m/s$

S: Total mechanical energy is 59 J.

R: E_{TOT}

A: $E_{TOT} = PE + KE$

Assuming: reference level is the street

S: $= 0 + \frac{1}{2} m v^2$

$= \frac{1}{2}(60)(1.4)^2$

$= 59\ J$

12. What is your mechanical energy when you are sitting in the physics class? What did you choose as the reference level?

G: $m = 60\ kg$

$h = 0\ m$ (reference level the floor)

⇒ $E_{TOT} = 0\ J$

if $h = 8\ m$

$E_{TOT} = PE$

$= mgh$

$= (60)(9.8)(8)$

$= 4704\ J$