2025 Sec 3 Physics Chapter 8 Work, Energy and Power

Answers to Examples and Exercises

1 Energy

Example 8.1.1

$E_k = ½(0.520)\ 5^2 =$ <u>6.5 J</u>

Example 8.1.2

$E_P = mgh = 30\text{ N} \times 3.0\text{ m} =$ <u>90 J</u>

2 Principle of Conservation of Energy

Example 2.1

(a) Initially the stone had maximum energy in the gravitation potential store which was transferred to its kinetic store.

Word equation: increase in k.e. = decrease in g.p.e. OR gain in k.e. = loss in g.p.e

$½mv^2 – 0 = mgh$

$v^2 = 2gh$; v = <u>22 m s^{-1} (2sf)</u>

(b) Initially the ball had maximum energy in the kinetic store which was transferred to its gravitational potential store when it reached its maximum height.

Word equation: increase in g.p.e = decrease in k.e. OR gain in g.p.e = loss in k.e.

$mgh = ½mv^2 – 0$

$h = ½\ (15^2) \div 10 = 11.25$ m = <u>11 m (2sf)</u>

Exercise 1

1 Energy

1. Decrease in height = 3.0 sin 30° = 1.5 m; Loss in G.P.E. = (mg)h = 30x1.5 = 45 J

2. (a) <u>2</u> times. (b) <u>4</u> times.

3. $E_k = ½mv^2 = ½\ (1.2)\ (0.25^2) = 0.0375$ J = <u>0.038 J (2sf)</u>

4. Change in $E_K = ½mv_1^2 – ½mv_2^2 = ½\ (0.42)\ (20.0^2) - ½\ (0.42)\ (5.0^2) = 84 – 5.25 = 79$ J

2 Principle of Conservation of Energy

5. (a) K.E. = ½ mv^2 = ½ (0.200) $(12.0)^2$ = 14.4 J

   (b) Initial K.E. of stone = 14.4 J; Initial G.P.E. of stone = 0 J
   Total = 14.4 J
   As stone travels upwards, K.E. of the stone is converted to G.P.E. of the stone. At the max height, K.E. of the stone = 0 J
   G.P.E. gained = mgh = (0.200)(10)(5.2) = 10.4 J
   Total = 10.4 J
   Decrease in energy = Loss in energy while travelling through air
   = 14.4 J – 10.4 J = 4.0 J

6. No. The car accelerates, therefore energy in the kinetic store increases. The car goes up a hill, therefore, the energy in the gravitational potential store also increases. Thus, they are not conserved. The additional energy was converted from the chemical potential store from the fuel supplied to the car.

3 Work

Example 3.1

1. (a) Work done = 20 J (b) Work done = 0 J (c) Work done = (10 cos 30°) (2.0) = 17 J

2. Work done = F x d = 50 N x 0.40 m = 20 J

3. Minimum work done = energy converted to g.p.e = mgh = 3.2 x 10 x 5.0 = 160 J

Exercise 2

1 (a) Yes, work done by shopper on the trolley. Work is done through the pushing force exerted by the shopper on the trolley through a horizontal distance. This work is done against frictional force on the trolley.
  (b) Yes, work done by gravity on the boy. Work is done through the weight of the boy, exerted by Earth on the boy, through a distance down the slope. The work done converts gravitational potential energy to kinetic energy of the boy.
  (c) No, the pillar did not move.
  (d) Yes, work done by gravity on the marble. Work is done through the weight of the marble, exerted by Earth on the marble through a vertical distance. The work done converts gravitational potential energy to kinetic energy of the marble.

2. Work done = 50 N x 2.5 m = 125 J = 130 J (2 sf)

3. Increase in K.E. of man = 0J (constant speed)
   Increase in G.P.E. of man = (60)(10)(80 sin30°) = 24 000 J
   Work done by man = Increase in G.P.E. = 24 000 J

   The energy is converted from stored (chemical) energy to G.P.E.

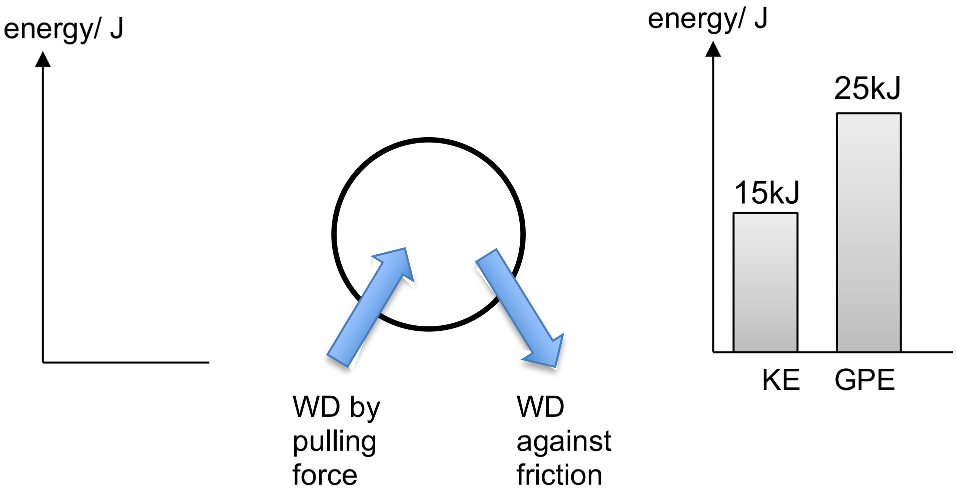
4. (a) WD = 8 x 8 = 64 J; Gain in energy of block = 64 J.
(b) The work done is converted to kinetic energy.

5.

(a) (i) WD by pulling force = 1800 N x 50.0 m = 90 000 J = 90.0 kJ
(ii) WD against friction = 1000 N x 50.0 m = 50 000 J = 50.0 kJ
(iii) WD against gravity = 5000 N x 3.0 m = 15 000 J
(iv) P.E. gained by block = WD against gravity = 15 000 J

(b) (i) Use your answers in (a) above to complete the table below.

	Initial Energy / J	**Work / J**	**Final Energy / J**
	G.P.E.= 0 J K.E. = 0 J	By pulling force = 90.0 kJ Against friction = 50.0 kJ	G.P.E.= 15.0 kJ K.E. = 40.0 – 15.0 = 25.0 kJ
Total	**0 J**	**90.0 – 50.0 = 40.0 kJ**	**40.0 kJ**



*KE = energy in the kinetic store;
*GPE = energy in the gravitational potential store

Using principle of conservation of energy,
form an equation of the energy change of the block.

WD done by pulling force - WD against friction
=
Block gains in G.P.E. and K.E. of the object.

(iii)

Input: Energy is transferred mechanically by the 1800 N force acting over 50.0m.

Energy store of the block: Energy gain in the gravitational potential store(GPE) and kinetic energy(KE) store of the block

Internal energy store of the surroundings: Energy is transferred to the internal store of the slope/surroundings due to the thermal energy loss due to friction and transferred by propagation of mechanical sound waves through air.

4 Power

Example 4.1

Power = $\frac{\text{Work done}}{\text{Time taken}} = \frac{500 \times 10 \times 10}{25} = 2000\text{W}$

Exercise 3

1. Time = work done / Power = (1000 × 10 × 20) / 25000 = 8.0 s

2. Gain in KE = ½ (60) $(7.6)^2$ = 1732.8 J
   Useful Power developed = 1732.8 / 0.9 = 1925.33 = <u>1930 W</u> (3 s.f.)

3. (a) Lowest KE = ½mv^2 = ½(1500) 11000^2 = <u>9.1×10^{10} J</u>

   (b) Average power = gain in KE ÷ t = 9.1×10^{10} ÷ 10(60) = <u>1.5×10^8 W</u>

5 Efficiency

Example 5.1

Output power = $\frac{\text{Work done}}{\text{Time taken}} = \frac{Fxd}{t}$ = F v = mgv = 1000 x 10 x 1.5 = 15 kW

Efficiency = $\frac{\text{output power}}{\text{input power}} \times 100\% = \frac{15}{20} \times 100\% = 75\%$

Exercises

1. Efficiency = 3840 /4500 × 100% = <u>85 % (2 s.f.)</u>

2. Efficiency = 70% = output power /input power x 100%
   Input power = (550 × 0.20)/70 × 100 = <u>157 W = 160 W (2 s.f.)</u>