2023 Sec 3 Physics Work, Energy, Power Assignment 8

Answers

Note:

- When applying the principle of conservation of energy, use this approach:
  1. write down the word equation (including types of energy & change of energy)
  2. write down the corresponding equations using symbols
  3. simplify the equation before substitution of numerical values
  4. evaluate the answer (units, s.f., magnitude, sign)

1. **(a)** Gain in GPE = mgh = 500 x 10 x 12 = **60 000 J**

(b) Power developed = Work done by crane/ time taken
= 60 000 J / 60 s
= 1000 W

(c)

$$\text{Efficiency} = \frac{\text{energy gained by load (output)}}{\text{energy supplied to crane (input)}} \times 100\ \%$$

$$\text{Energy supplied} = \frac{100\ \%}{60\ \%} \times 60\,000\ \text{J}$$

$$= 100\,000\ \text{J}$$

2.

(a) $v = u + at = 2.0\ (4.0) = 8.0\ \text{m s}^{-1}$

work done by car = gain in K.E. + gain in G.P.E.
= $(\frac{1}{2}\ mv^2 - 0) + mgh$
= 16 000 J + 60 000 J
= 76 000 J(2sf)

(b) Work done by car = Work done by thrust force
= (thrust force) x distance travelled by car = F x d

Distance travelled by car, $s = ut + \frac{1}{2}\ at^2 = \frac{1}{2}\ (2)\ (4.0)^2 = 16$ m
Therefore, 76 000 = (thrust force) (16)
Thrust force = 4800 N (2sf)

OR $s = v_{av}\ t = \frac{1}{2}\ (u+v)\ t$

Note: cannot apply F = ma, where F is net force!

3. **Approach using Conservation of Energy**

(a) Work done by resistive force against bullet = loss in KE of bullet

$F \times d = \frac{1}{2} mv^2$

$F \times 0.23 = \frac{1}{2} (0.015)\ 410^2$

Average force, F = 5500 N (2sf)

OR Approach using Kinematics/Dynamics

Deceleration: $v^2 = u^2 + 2as$ ➔ a?

Resistive force = $F_{net} = ma$

(b) Thermal energy = $85\% \times \frac{1}{2} mu^2$

$= 85\% \times \frac{1}{2} (0.015)\ 410^2$

= 1100 J (2sf)

4. (a)

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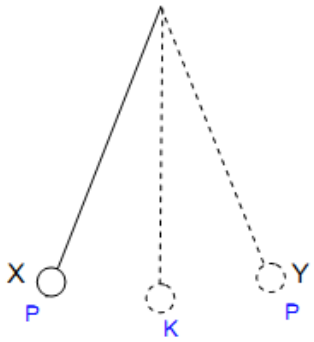

(b) X' is at a greater height compared to X, which means that the pendulum starts with greater GPE, which will be converted to KE at the lowest point.

Thus, the maximum KE attained increases.

OR

For the same period, the larger angle of displacement is travelled by the pendulum in the same time. Hence, the speed at the lowest point is higher, so there is a larger maximum k.e. at the lowest point.

(c) Position M. When the pendulum is at a **vertical** height midway between X' and the lowest point of the pendulum, its KE is equal to its PE.

Assumption: g.p.e. of pendulum at the lowest point is zero.

Note: M is the mid-point in the vertical height. This is not the same as half the angle of swing.

Refer simulation: https://phet.colorado.edu/en/simulation/pendulum-lab

(d)There is negligible energy loss to the surroundings.