Chapter 5 - Work, Energy and Power Solution

<u>MCQ</u>

Q1 **Ans: D**

Work done on the ball = Change in P.E. + K.E.

= 3 x 9.81 x 1.5 + ½ x 3 x 10^2

= 194.1 J

Q2 **Ans : B**

By C.O.E.

$E_{ki} = E_{kf} + W_{dissipated}$

OR

Loss in K.E. = Energy dissipated as heat

½ x 1600 x v^2 = 500 x 10^3 J

v = 25 m s^{-1}

Q3 **Ans: C**

Work done by F = Gain in G.P.E.

F x 1 = 5 x 9.81 x 0.5

F = 24.5 N = 25 N (approx)

Q4 **Ans : C**

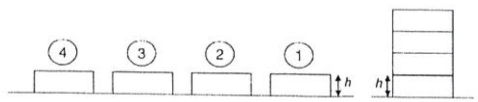
Total Work Done by the force = 80 x 10 = 800 J

Work done by friction = 60 x 10 = 600 J = Thermal Energy

Total Work Done by force = K.E. + Work done by friction

Therefore, K.E. = 800 – 600 = 200 J

Q5 **Ans: D**



Work done to lift block 1 = 0
Work done to lift block 2 on block 1 = mgh
Work done to lift block 3 on block 1 & 2 = mg(2h) = 2 mgh
Work done to lift block 4 on block 1 & 2 & 3 = mg(3h) = 3 mgh
Total work done to stack the blocks = 0 + mgh + 2 mgh + 3 mgh = 6 mgh

Q6 **Ans: A**

Since the pulley is smooth, there is not energy lost due to the friction at the pulley. When mass M moves down a distance x, mass m will also move up a distance x.

Work done against friction by mass m = Fx

Q7 **Ans: A**

By. C.O.E. on mass m,

$E_{ki} + E_{pi} = E_{kf} + E_{pf}$

OR

Loss in K.E. = Gain in P.E.

$\frac{1}{2} m v^2 = m g h$

$v^2 \alpha h$

$\frac{v_1^2}{v_2^2} = \frac{h_1}{h_2}$

$\frac{v^2}{(\frac{1}{2}v)^2} = \frac{h}{h_2} \Rightarrow h_2 = \frac{1}{4}h$

Q8 **Ans: C**

By C.O.E. and since air resistant is negligible,
From 0 to h,
Loss in E_K = Gain in P.E. = mgs ,
Thus E_K vs s is a straight line where as s increases , E_K decreases.
At h, E_K = 0
After h, Gain in E_K = Loss in P.E. = mgs
Thus E_K vs s is also a straight line where as s increases after h , E_K increases

Q9 **Ans : A**

$$\text{Power} = \frac{\text{work done}}{\text{time}}$$
$$= \frac{\text{force x displacement in the direction of the force}}{\text{time}}$$
$$= \text{force x } \frac{\text{displacement in the direction of the force}}{\text{time}}$$
$$= \text{force x velocity}$$

Q10 **Ans : C**

Useful output power = Fv = 400 x 9.81 x $\left(\frac{1200}{2 \times 60}\right)$

Useful output power = 39 240 W

$$\text{Efficiency} = \frac{\text{Useful Output Power}}{\text{Total Input Power}}$$

Total Input Power = 39 240 / 0.8 = 49 050 W or 49 kW

Short Structured Questions Solutions

Q1 If the father-in-law execute the bungee jump, by C.O.E.

Loss in P.E. = E.P.E. in cord
mgh = $\frac{1}{2}kx^2$
95 x 9.81 x 41 = ½ x k x $(41 - 30)^2$
k = 631.5 N m^{-1}

Now, applying a force of 380.0 N on the bungee cord, using
F = kx'
x' = 380 / 631.5 → 0.602 m

Q2

$$P_{ave} = \frac{\text{Total Work done}}{\text{Total Time Taken}}$$

Work done to lift crate = mgh
= 30 x 9.81 x 0.9 = 265 J

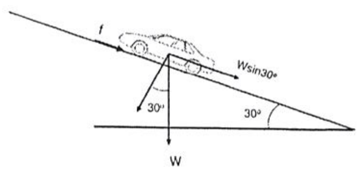
(a) $P_{ave} = \frac{265}{60} = 4.41$ W

For the P_{ave} = 0.5 hp = 0.5 x 746 W = 373 W , in 1 minute,
the no. of crates loaded = 373 / 4.41
= 84.6 per minute

(b) Now, P_{ave} = 100 W , in 1 minute,
the no. of crates loaded = 100 / 4.41
= 22.7 per minute

(c) Using an average weight of 75 kg of a person, the crate is at 40% of the weight of a person. Thus it is not possible for a person to perform work at this rate of 22.7 crates per min.

Q3



At the instant when a = 3 m s^{-1} and v = 20 m s^{-1} , resolving forces along the slope,

$\sum F = F_{engine} - W\sin 30^0 - f = ma$

$F_{engine} = ma + W\sin 30^0 + f$

$F_{engine} = 1200 \times 3 + 1200 \times 9.81 \times \sin 30^0 + 900$

$F_{engine} = 10386$ N

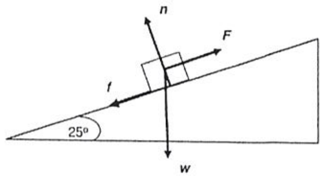
Power at that instant $= F_{engine}$ v

Power = 10386 x 20 = 2.1x10^5 W

= 210 kW

Long Structured Questions Solutions

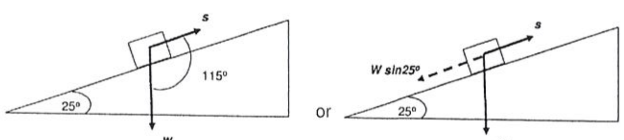
Q1 (a)



Since both $\vec{F}$ (force) and $\vec{s}$ (displacement) are in parallel direction work done on the suitcase by the force $\vec{F}$, W_F = 140 x 3.8

= 532 J

(b)



The directions of the displacement and gravitational force are shown above. work done on the suitcase by the gravitation force,

W_w = (wcos115°)s or (-wsin25°)s

= 20 x 9.81 x cos115° x 3.8 or (- 20 x 9.81 x sin 25° x 3.8)

= -315 J

(c) Since both ***n*** (normal force) and $\vec{s}$ (displacement) are in perpendicular direction,

work done on the suitcase by the normal force, W_n = 0 J

(d) Since both ***f*** (frictional force) and $\vec{s}$ (displacement) are in opposite direction, work done on the suitcase by the frictional force, W_f = - 50 x 3.8 = -190 J

(e) W_{total} = W_F + W_w + W_n + W_f

= 532 – 315 + 0 – 190

= 27 J

(f) Total Work done = Gain in K.E.

$\frac{1}{2} mv^2 = 27$

$v = \sqrt{\frac{2 \times 27}{20}} = 1.6$ m s^{-1}

Q2 (a) By C.O.E.

Gain in K.E. = Lost in G.P.E.

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

v^2 = 2 x 9.81 x 1

v = 4.4 m s^{-1}

(b) Energy stored in spring = Elastic P.E.

= $\frac{1}{2} kx^2$

= ½ x 225 x 0.2^2

= 4.5 J

(c) Initial Energy = G.P.E.

= mgh

= 2 x 9.81 x 1 = 19.6 J

Final Energy = Elastic P.E. = 4.5 J

Energy lost due to friction = 19.6 – 4.5

= 15.1 J

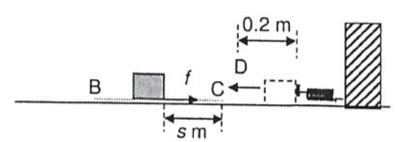
(d) Work done on the block by the average frictional force (f)

= Energy lost due to friction

f x 2 = 15.1 J

f = 7.6 N

(e)



Work done on the block by frictional force = Elastic P.E.

$f.s$ = $\frac{1}{2} kx^2$

7.6 x s = 4.5 J

$s = \frac{4.5}{7.6}$

= 0.6 m