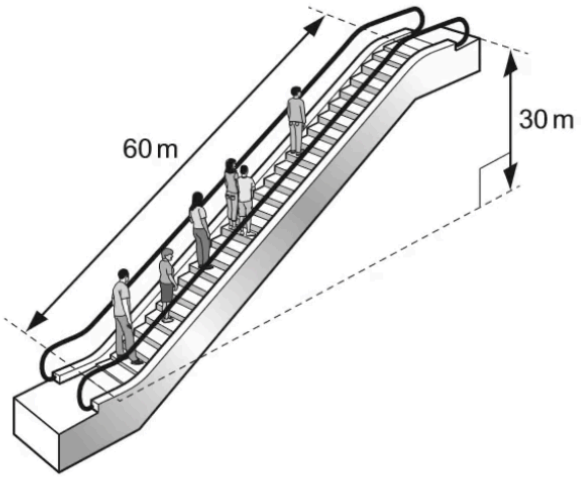
1.

An escalator is 60 m long and lifts passengers through a vertical height of 30 m, as shown.



To drive the escalator against the forces of friction when there are no passengers requires a power of 2.0 kW.

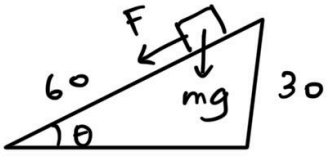
The escalator is used by passengers of average mass 60 kg and the power to overcome friction remains constant.

How much power is required to drive the escalator when it is carrying 20 passengers and is travelling at 0.75 m s^{-1}?

A 4.4 kW **B** 6.4 kW **C** 8.8 kW **D** 10.8 kW

Ans: B

Method 1 : energy



$\theta = \sin^{-1}\left(\frac{30}{60}\right) = 30°$

$mg = 60 \times 9.81 \times 20$

$F = 60 \times 9.81 \times 20 \times \sin 30$

$= 5886\,N$

$P = Fv$

$= 5886 \times 0.75 = 4414.5\,W$

* add P when no passengers !!

$4414.5 + 2000 = 6414.5\,W$

Method 2 : force

$t = \frac{s}{v} = \frac{60}{0.75} = 80\,s$ to cover journey

$W = mgh = 60 \times 9.81 \times 20 \times 30$

$P = \frac{W}{t} = \frac{60 \times 9.81 \times 20 \times 30}{80} = 4414.5$

$+ 2000$

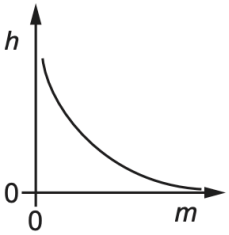
6414.5

2.

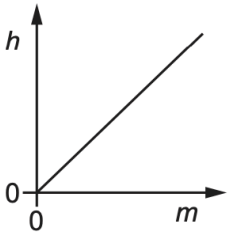
Objects with different masses are placed on the horizontal surface of a table. The objects are then raised to different heights above the table. The gain in gravitational potential energy of each object is the same.

Which graph best shows the variation of the height *h* of the objects above the table with their mass *m*?

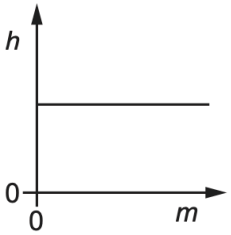
A



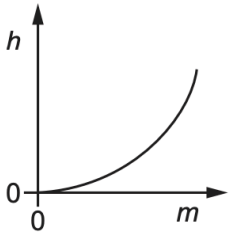
B



C



D



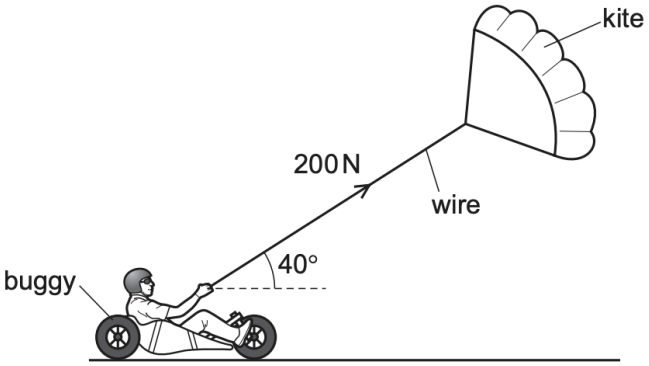
Ans: A

- mgh = k
- h = k/mg

- Thus h is inversely proportional to m; A = inversely proportional graph

3.

A man sits on a buggy that is pulled along by a wire attached to a kite. The wire is at an angle of 40° to the horizontal and has a constant tension of 200 N. The man and buggy travel a distance of 20 m along a straight horizontal path. The wire and the path of the buggy are in the same vertical plane.



What is the work done by the tension force on the man and buggy?

A 2.6 kJ **B** 3.1 kJ **C** 3.4 kJ **D** 4.0 kJ

Ans: B

W = Fd; use the horizontal component of F.

4.

A boat moves at a constant velocity *v* through still water.

A constant drag force *F* acts on the boat.

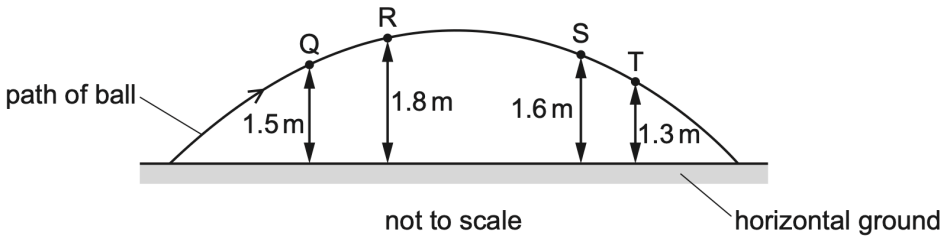
What is the power used by the boat to move through the water?

A $\frac{1}{2}Fv$ **B** Fv **C** $\frac{1}{2}Fv^2$ **D** Fv^2

Ans: B

5.

A ball is projected into the air from horizontal ground and follows the path shown in the diagram.



At points Q, R, S and T, the ball has kinetic energies E_Q, E_R, E_S and E_T respectively. The heights above the ground of these four points are shown.

Air resistance is negligible.

Which difference in kinetic energies is the smallest?

A $E_Q - E_S$ **B** $E_S - E_R$ **C** $E_T - E_Q$ **D** $E_T - E_R$

Ans: A

Smallest difference in KE = smallest change in height between the 2 points

6.

The battery of a small tablet computer is initially uncharged. It is connected to a constant 10 W power supply for 2.0 hours to charge the battery.

The efficiency of the charging process is 80%.

What is the total energy stored in the battery?

A 1.6×10^1 J **B** 1.6×10^3 J **C** 5.8×10^4 J **D** 5.8×10^6 J

Ans: C

total E input = $10 \times 2 \times 60 \times 60 = 72000$

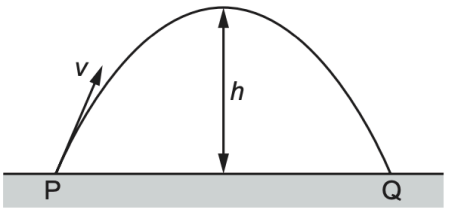
useful E used = energy stored in battery

$\Rightarrow \frac{x}{72000} \times 100 = 80 \Rightarrow x = 57600$

$= 5.8 \times 10^4$ J

7.

A ball of mass m is thrown up to height h in air with an initial velocity v, as shown.



Air resistance is negligible. The acceleration of free fall is g.

What is the **total** work done by the gravitational force on the ball during its flight from P to Q?

A zero **B** $\frac{1}{2}mv^2$ **C** mgh **D** $2mgh$

Ans: A

- Gravitational force only acts in the vertical direction
- Since vertical displacement is 0, Fd = 0, so work is 0

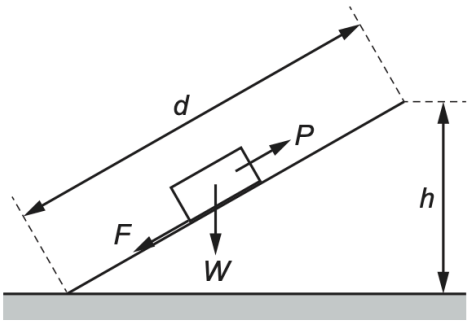
8.

A box of weight W is pulled by a force P along a slope.

The length of the slope is d, and the box rises a height h.

The frictional force between the box and the slope is F.

The diagram shows the directions of the forces.



The purpose of the slope is to raise the box vertically.

Which expression gives the efficiency of the slope?

A $\frac{Fd}{Wh}$ **B** $\frac{Pd}{Wh}$ **C** $\frac{Wh}{Fd}$ **D** $\frac{Wh}{Pd}$

Ans: D

- Useful work = mgh = Wh
- Total work = Pd