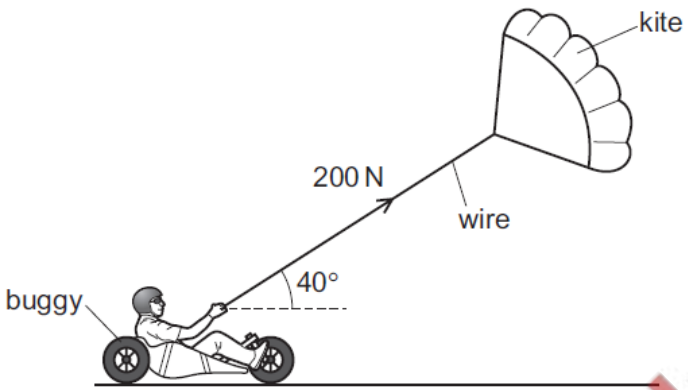
Work, Energy and Power – 2023 June AS Physics 9702

1. June/2023/Paper_ 9702/11/No.16

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

2. June/2023/Paper_ 9702/11/No.17

A ball is thrown vertically upwards from the surface of the Earth.

Which statement describes the energy of the ball as it rises through the air?

A The kinetic energy of the ball decreases as the gravitational potential energy decreases.

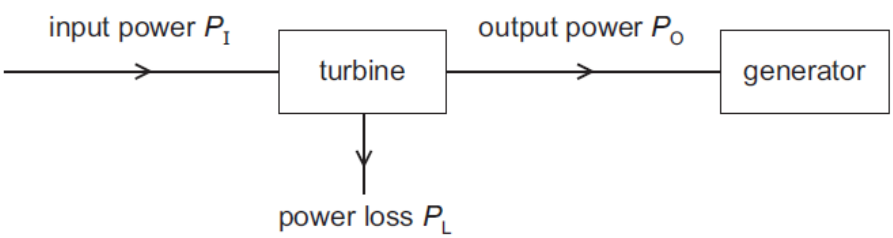
B The kinetic energy of the ball decreases as the gravitational potential energy increases.

C The kinetic energy of the ball increases as the gravitational potential energy decreases.

D The total energy of the ball increases.

3. June/2023/Paper_ 9702/12/No.15

A steam turbine is used to drive a generator. The input power to the turbine is P_I and the output power is P_O. The power loss in the turbine is P_L, as shown.



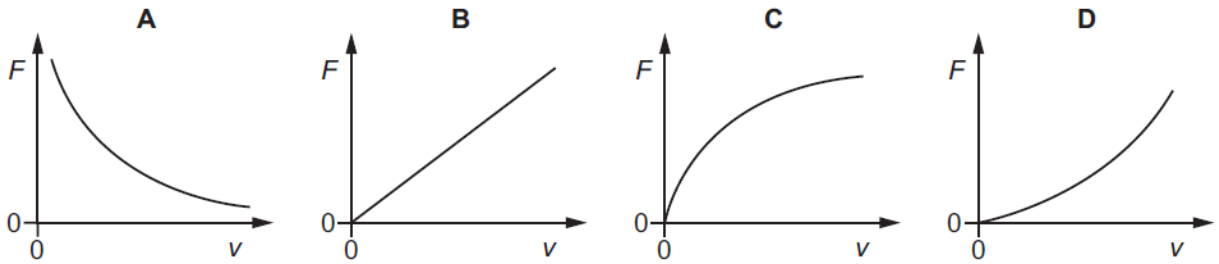
What is the efficiency of the turbine?

A $\frac{P_L}{P_O}$ **B** $\frac{P_I}{P_O}$ **C** $\frac{P_L}{P_I}$ **D** $\frac{P_O}{P_I}$

4. June/2023/Paper_ 9702/12/No.16

A variable force is applied to ensure that a constant power is supplied to a train.

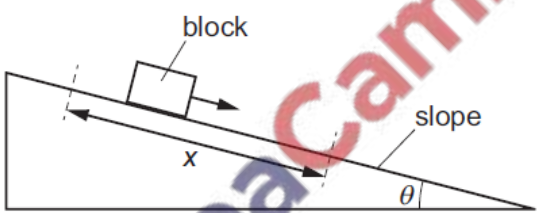
Which graph best shows the variation of the force F applied with the velocity v of the train?



5. June/2023/Paper_ 9702/12/No.17

A block is released from rest and slides a distance x down a straight slope.

The slope is at an angle θ to the horizontal.



The slope is frictionless and air resistance is negligible.

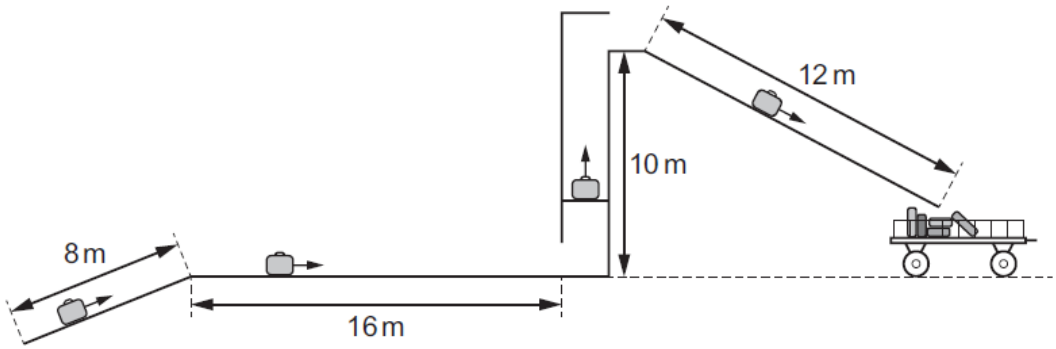
The acceleration of free fall is g.

Which expression gives the final speed of the block?

A $\sqrt{\frac{gx \sin\theta}{2}}$ **B** $\sqrt{2gx \sin\theta}$ **C** $\sqrt{2gx}$ **D** $2gx \sin\theta$

6. June/2023/Paper_ 9702/13/No.15

An airport has a mechanical system for moving luggage. The system uses a horizontal conveyor belt, a sloping conveyor belt, a lift and a frictionless slide. A suitcase is moved around the airport using this system.



Resistive forces opposing the motion of the suitcase are negligible.

For which movement of the suitcase is the net work done on the suitcase greatest?

A moving the suitcase a distance of 8 m at a constant speed up the sloping conveyor belt

B moving the suitcase a distance of 16 m at a constant speed along the horizontal conveyor belt

C moving the suitcase a distance of 10 m at a constant speed vertically upwards on the lift

D moving the suitcase a distance of 12 m at increasing speed downwards on the slide

7. June/2023/Paper_ 9702/13/No.16

A car moves along a horizontal road with a constant velocity v against a resistive force F.

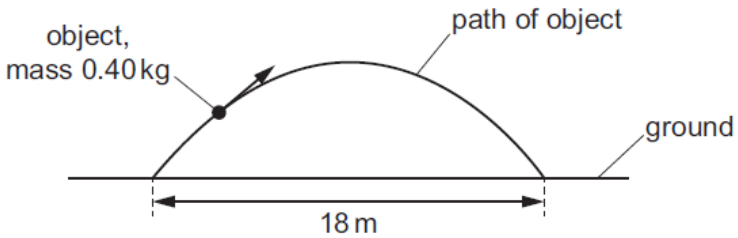
The engine of the car has an efficiency of 25%.

What is the input power to the engine?

A $\frac{Fv}{4.0}$ **B** $\frac{4.0}{Fv}$ **C** $4.0Fv$ **D** $\frac{4.0F}{v}$

8. June/2023/Paper_ 9702/13/No.17

An object of mass 0.40 kg is projected into the air and follows a curved path above horizontal ground.



The object takes a time of 1.5 s to move along its path. The object lands a horizontal distance of 18 m from its initial position. Air resistance is negligible.

What is the kinetic energy of the object at its maximum height?

A 0 J **B** 2.4 J **C** 11 J **D** 29 J

(c) The string is cut so that the spring extends upwards. This causes the beam to rotate and launch the block into the air. The block reaches its maximum height and then falls back to the ground.

Fig. 2.2 shows part of the path of the block in the air shortly before it hits the horizontal ground.

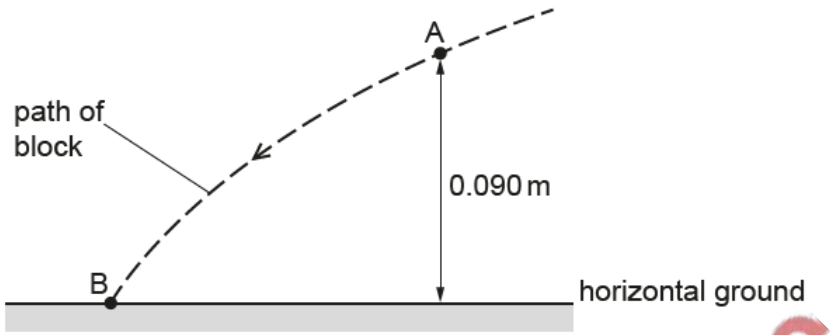


Fig. 2.2 (not to scale)

The block is at a height of 0.090 m above the ground when it passes through point A. The block has a kinetic energy of 0.044 J when it hits the ground at point B.
Air resistance is negligible.

(i) Calculate the decrease in the gravitational potential energy of the block for its movement from A to B.

decrease in gravitational potential energy = ... J [2]

(ii) Use your answer in **(c)(i)** and conservation of energy to determine the speed of the block at point A.

speed = ... $m s^{-1}$ [3]

(iii) By reference to the force on the block, explain why the horizontal component of the velocity of the block remains constant as it moves from A to B.

.....

..... [1]

(iv) The block passes through point A at time t_A and arrives at point B at time t_B.

On Fig. 2.3, sketch a graph to show the variation of the magnitude of the vertical component v_Y of the velocity of the block with time t from $t = t_A$ to $t = t_B$.
Numerical values of v_Y are not required.

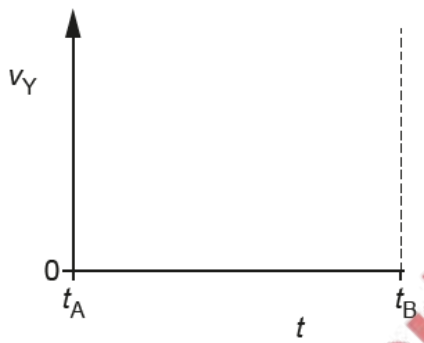


Fig. 2.3

[1]

(c) The beam in **(b)** rotates when the string is cut and the small block of weight 2.4 N is projected through the air. Fig. 2.2 shows the last part of the path of the block before it hits the ground at point Y.

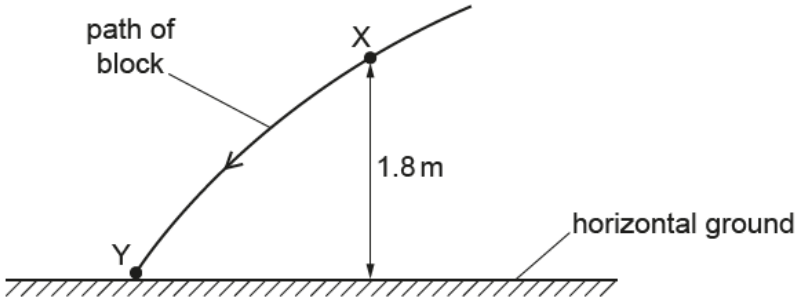


Fig. 2.2 (not to scale)

At point X on the path, the block has a speed of 3.4 m s^{-1} and is at a height of 1.8 m above the horizontal ground. Air resistance is negligible.

(i) Calculate the decrease in the gravitational potential energy of the block for its movement from X to Y.

decrease in gravitational potential energy = ... J [2]

(ii) Use your answer to **(c)(i)** and conservation of energy to determine the kinetic energy of the block at Y.

kinetic energy = ... J [3]

(iii) State the variation, if any, in the direction of the acceleration of the block as it moves from X to Y.

..... [1]

(iv) The block passes point X at time t_X and arrives at point Y at time t_Y.

On Fig. 2.3, sketch a graph to show the variation of the magnitude of the horizontal component of the velocity of the block with time from t_X to t_Y.
Numerical values are not required.

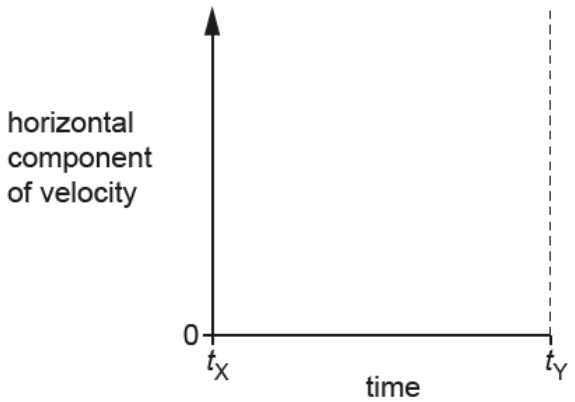


Fig. 2.3

[1]

11. March/2023/Paper_ 9702/12/No.16

A system with an efficiency of 74% wastes 230 W of power.

What is the useful output power of the system?

A 170 W **B** 310 W **C** 650 W **D** 880 W

12. March/2023/Paper_ 9702/12/No.17

A projectile of mass 0.25 kg is at a height of 30 m above horizontal ground and travelling at a speed of 15 m s^{-1}. A short time later, it is at a height of 35 m above the horizontal ground and travelling at a speed of 5.0 m s^{-1}.

How much work is done against air resistance during this time?

A 0 J **B** 13 J **C** 25 J **D** 37 J

13. March/2023/Paper_ 9702/22/No.2a(ii), (b)

A motor uses a wire to raise a block, as illustrated in Fig. 2.1.

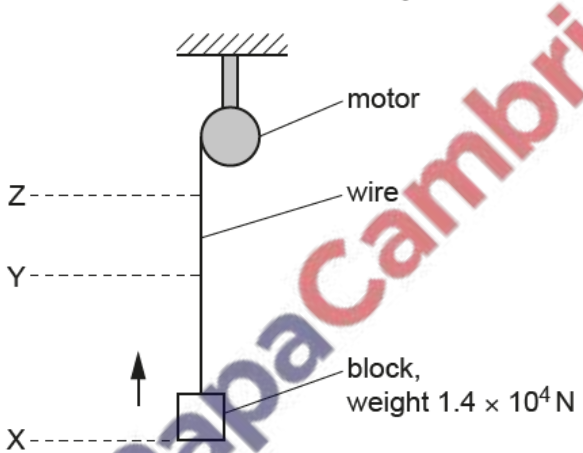


Fig. 2.1 (not to scale)

The base of the block takes a time of 0.49 s to move vertically upwards from level X to level Y at a constant speed of 0.64 m s^{-1}. During this time the wire has a strain of 0.0012. The wire is made of metal of Young modulus 2.2 × 10^{11} Pa and has a uniform cross-section.

The block has a weight of 1.4 × 10^4 N. Assume that the weight of the wire is negligible.

(ii) the increase in the gravitational potential energy of the block for the movement of its base from X to Y.

increase in gravitational potential energy = ... J [3]

(b) The motor has an efficiency of 56%.

Calculate the input power to the motor as the base of the block moves from X to Y.

input power = ... W [3]