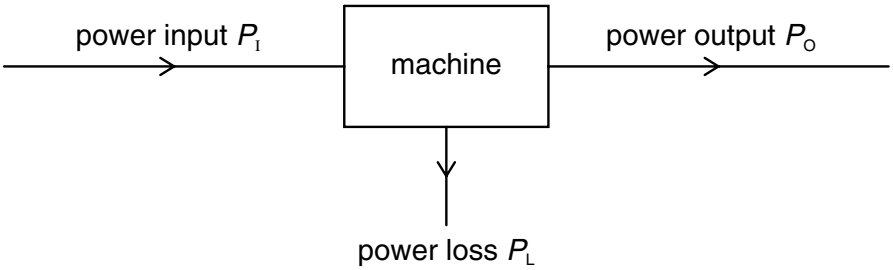
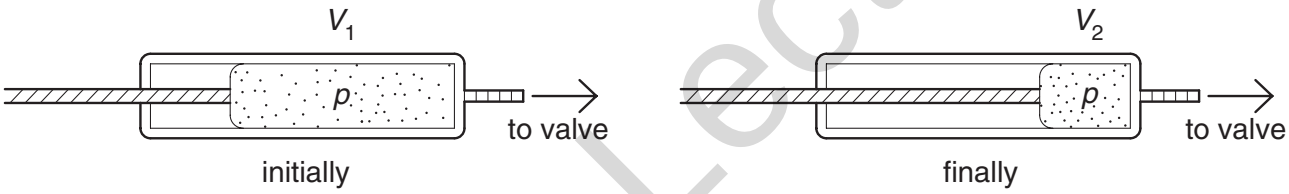
1 Power is transferred through a machine as shown.



What is the efficiency of the machine?

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

2 Air in a bicycle pump is forced through a valve at a constant pressure p. In one stroke of the pump the volume of air in the pump chamber is reduced from V_1 to V_2.



What is the work done on this air in one stroke of the pump?

A $\frac{p(V_1 + V_2)}{2}$

B $p(V_1 + V_2)$

C $p(V_1 - V_2)$

D pV_1

3 Car X is travelling at half the speed of car Y. Car X has twice the mass of car Y.

Which statement is correct?

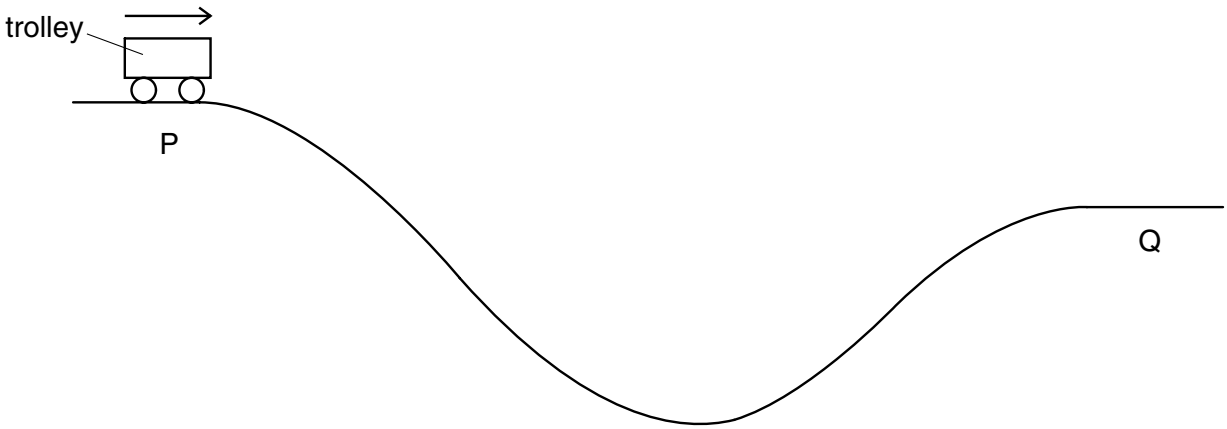
A Car X has half the kinetic energy of car Y.

B Car X has one quarter of the kinetic energy of car Y.

C Car X has twice the kinetic energy of car Y.

D The two cars have the same kinetic energy.

4 A trolley runs from P to Q along a track. At Q its potential energy is 50 kJ less than at P.



At P, the kinetic energy of the trolley is 5 kJ. Between P and Q the work the trolley does against friction is 10 kJ.

What is the kinetic energy of the trolley at Q?

A 35 kJ

B 45 kJ

C 55 kJ

D 65 kJ

5 To travel at a constant speed, a car engine provides 24 kW of useful power. The driving force on the car is 600 N.

At what speed does it travel?

A 2.5 $m\,s^{-1}$

B 4.0 $m\,s^{-1}$

C 25 $m\,s^{-1}$

D 40 $m\,s^{-1}$

6 Which of the following expressions **defines** power?

A force x distance moved in the direction of the force

B force x velocity

C work done ÷ time taken

D work done x time taken

7 What is the expression used to **define** power?

A $\frac{\text{energy output}}{\text{energy input}}$

B energy x time taken

C force x velocity

D $\frac{\text{work done}}{\text{time taken}}$

8 A ball is thrown vertically upwards.

Neglecting air resistance, which statement is correct?

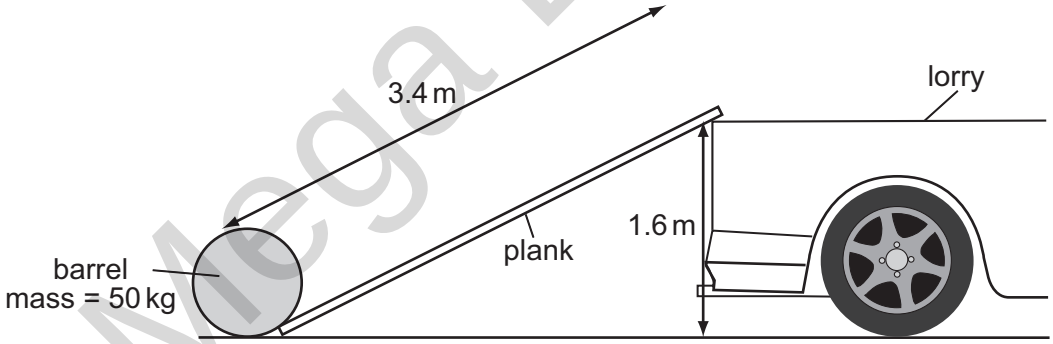
A The kinetic energy of the ball is greatest at the greatest height attained.

B By the principle of conservation of energy, the total energy of the ball is constant throughout its motion.

C By the principle of conservation of momentum, the momentum of the ball is constant throughout its motion.

D The potential energy of the ball increases uniformly with time during the ascent.

9 A barrel of mass 50 kg is loaded onto the back of a lorry 1.6 m high by pushing it up a smooth plank 3.4 m long.



What is the minimum work done?

A 80 J **B** 170 J **C** 780 J **D** 1700 J

10 What is the internal energy of an object?

A It is the energy associated with the object's movement through space.

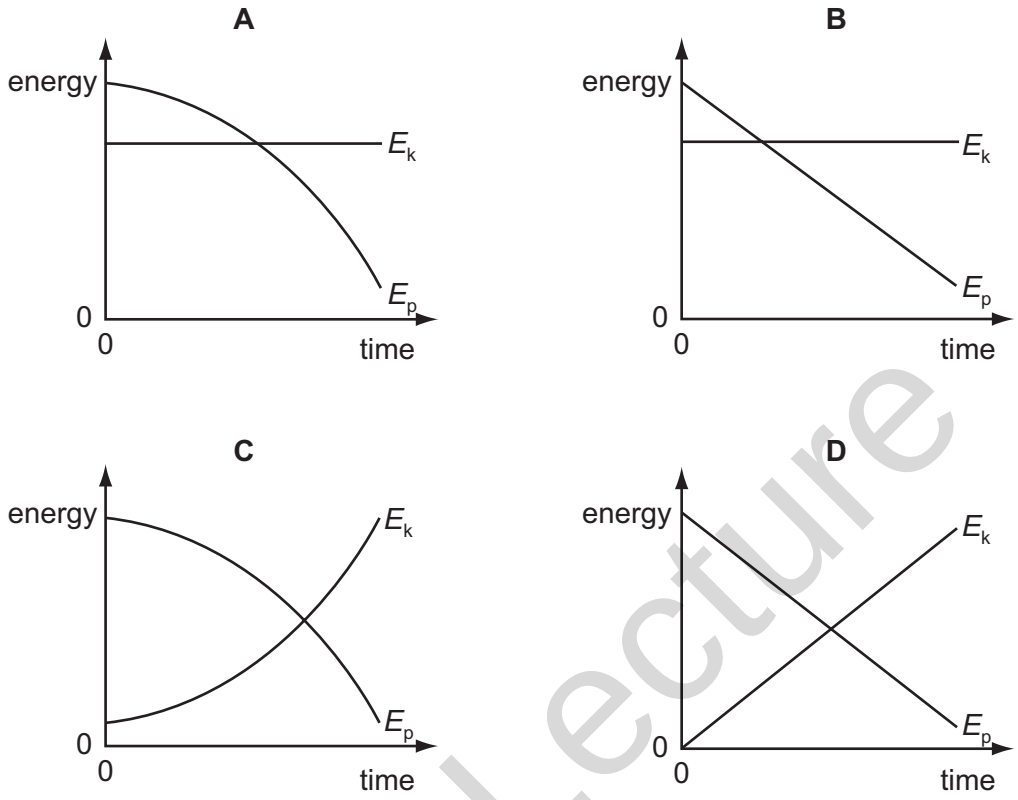
B It is the energy associated with the random movement of the molecules in the object.

C It is the energy due to the attractions between the molecules within the object.

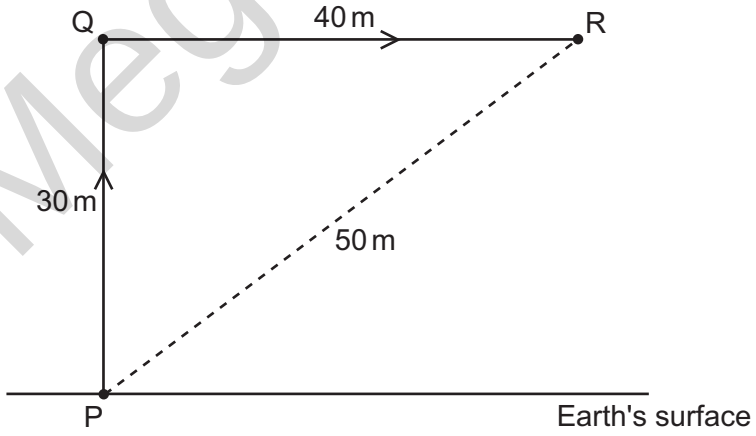
D It is the sum of all the microscopic potential and kinetic energies of the molecules.

11 A steel ball is falling at constant speed in oil.

Which graph shows the variation with time of the gravitational potential energy E_p and the kinetic energy E_k of the ball?



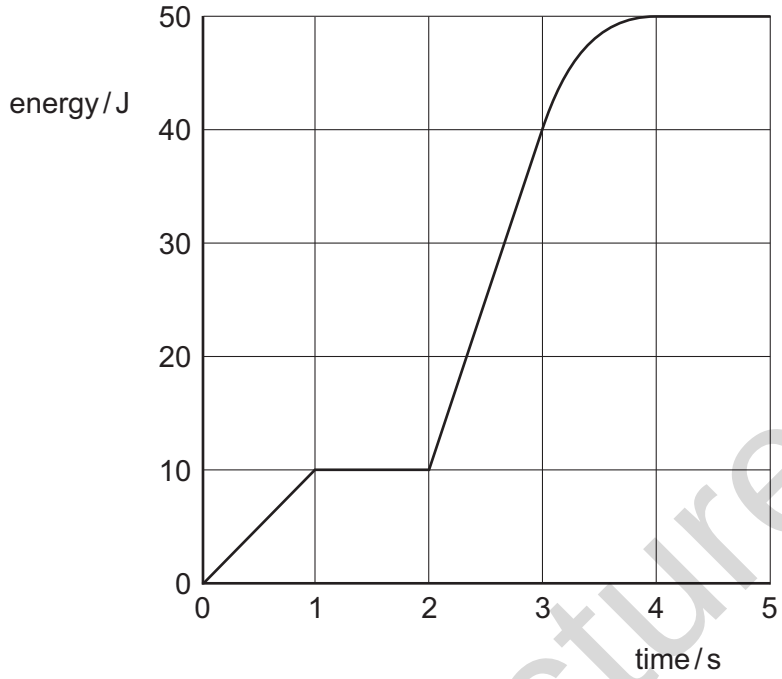
12 A stone of weight 4.0 N in the Earth's gravitational field is moved from P to Q and then to R along the path shown.



How much potential energy does the stone gain?

A 120 J **B** 200 J **C** 280 J **D** 1200 J

13 An electrical generator is started at time zero. The total electrical energy generated during the first 5 seconds is shown in the graph.



What is the maximum electrical power generated at any instant during these first 5 seconds?

A 10 W **B** 13 W **C** 30 W **D** 50 W

14 A concrete cube of side 0.50 m and uniform density 2.0 x 10^3 kg m^{-3} is lifted 3.0 m vertically by a crane.

What is the change in potential energy of the cube?

A 0.75 kJ **B** 7.4 kJ **C** 29 kJ **D** 470 kJ

15 In perfectly elastic collisions between two atoms, it is always true to say that

A the initial speed of one atom will be the same as the final speed of the other atom.

B the relative speed of approach between the two atoms equals their relative speed of separation.

C the total momentum must be conserved, but a small amount of the total kinetic energy may be lost in the collision.

D whatever their initial states of motion, neither atom can be stationary after the collision.

16 The diagram shows the masses and velocities of two trolleys about to collide.

After the impact they move off together.

What is the total kinetic energy of the trolleys after the collision?

A 1.3 J **B** 12 J **C** 18 J **D** 19 J

17 Which expression **defines** power?

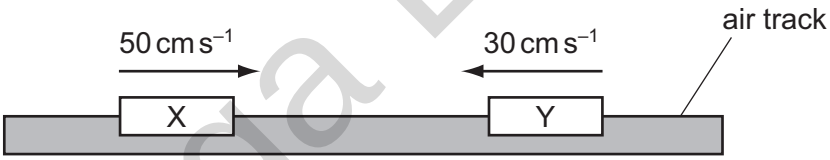
A force × distance moved in the direction of the force

B force × velocity

C work done ÷ time taken

D work done × time taken

18 Two equal masses X and Y are moving towards each other on a frictionless air track as shown. The masses make an elastic collision.



Which row gives possible velocities for the two masses after the collision?

	velocity of X	velocity of Y
A	zero	20 cm s^{-1} to the right
B	10 cm s^{-1} to the right	10 cm s^{-1} to the right
C	20 cm s^{-1} to the left	zero
D	30 cm s^{-1} to the left	50 cm s^{-1} to the right

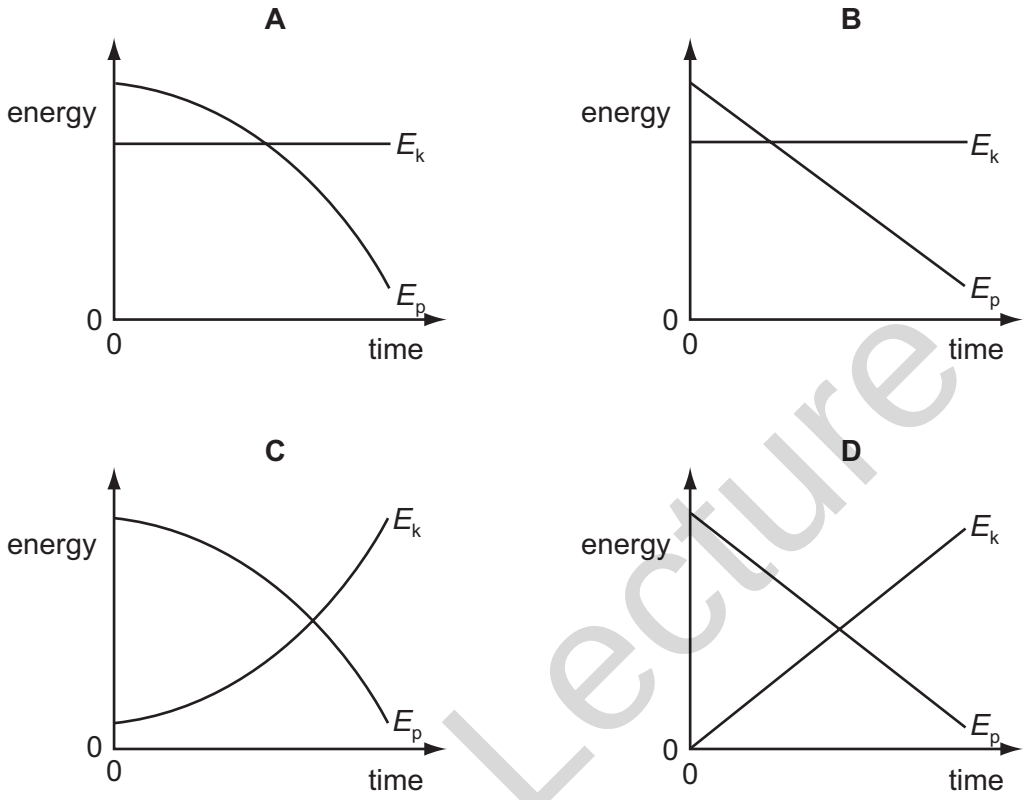
19 A boat moving at constant speed v through still water experiences a total frictional drag F.

What is the power developed by the boat?

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

20 A steel ball is falling at constant speed in oil.

Which graph shows the variation with time of the gravitational potential energy E_p and the kinetic energy E_k of the ball?



21 The total energy input E_{in} in a process is partly transferred to useful energy output U, and partly to energy that is wasted W.

What is the efficiency of the process?

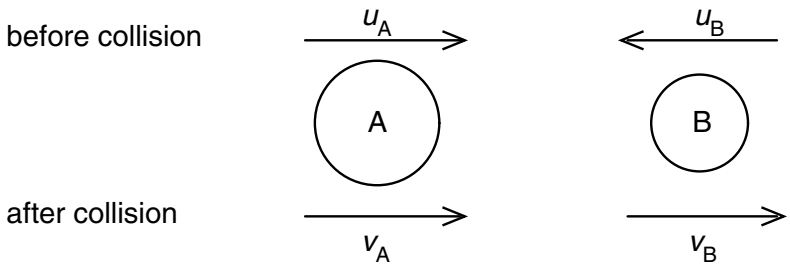
A $\frac{U}{W} \times 100\,\%$

B $\frac{W}{E_{in}} \times 100\,\%$

C $\frac{U}{E_{in}} \times 100\,\%$

D $\frac{U+W}{E_{in}} \times 100\,\%$

22 Two spheres A and B approach each other along the same straight line with speeds u_A and u_B. The spheres collide and move off with speeds v_A and v_B, both in the same direction as the initial direction of sphere A, as shown below.



Which equation applies to an elastic collision?

A $u_A + u_B = v_B - v_A$

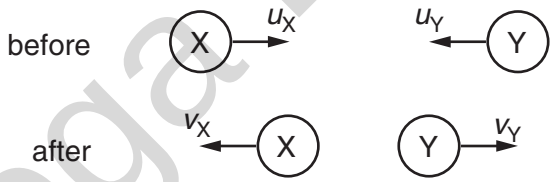
B $u_A - u_B = v_B - v_A$

C $u_A - u_B = v_B + v_A$

D $u_A + u_B = v_B + v_A$

23 Two balls X and Y approach each other along the same straight line and collide elastically.

Their speeds are u_X and u_Y respectively. After the collision they move apart with speeds v_X and v_Y respectively. Their directions are shown on the diagram.



Which of the following equations is correct?

A $u_X + u_Y = v_X + v_Y$

B $u_X + u_Y = v_X - v_Y$

C $u_X - u_Y = v_X + v_Y$

D $u_X - u_Y = v_X - v_Y$

24 Which of the following is an expression for power?

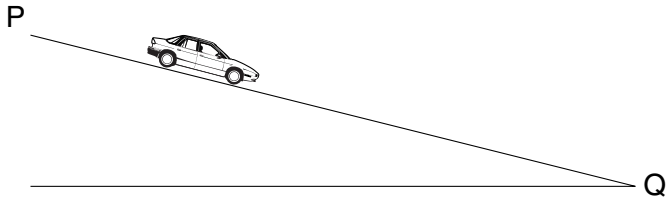
A energy x time

B force x displacement

C force x velocity

D mass x velocity

25 A car driver adjusts the pressure on a car's brakes so that the car travels at constant speed down a hill from P to Q.



The magnitude of the change in the car's kinetic energy is ΔE_k. The magnitude of the change in its gravitational potential energy is ΔE_p.

Which statement is correct?

A $\Delta E_k > \Delta E_p$ **B** $\Delta E_k = \Delta E_p$ **C** $\Delta E_p > \Delta E_k > 0$ **D** $\Delta E_k = 0$

26 An area of land is an average of 2.0 m below sea level. To prevent flooding, pumps are used to lift rainwater up to sea level.

What is the minimum pump output power required to deal with 1.3×10^9 kg of rain per day?

A 15 kW **B** 30 kW **C** 150 kW **D** 300 kW

27 A twig from a tree drops from a 200 m high cliff on to a beach below. During its fall, 40% of the twig's energy is converted into thermal energy.

What is the speed with which the twig hits the beach?

A $35\ m\ s^{-1}$ **B** $40\ m\ s^{-1}$ **C** $49\ m\ s^{-1}$ **D** $63\ m\ s^{-1}$

28 A mass is raised vertically. In time t, the increase in its gravitational potential energy is E_p and the increase in its kinetic energy is E_k.

What is the average power input to the mass?

A $(E_p - E_k)t$

B $(E_p + E_k)t$

C $\frac{E_p - E_k}{t}$

D $\frac{E_p + E_k}{t}$

29 The kinetic energy of a particle is increased by a factor of 4.

By what factor does its speed increase?

A 2 **B** 4 **C** 8 **D** 16

30 A horizontal force of 90 N is used to push a box across a horizontal floor. The frictional force on the box is 50 N.

What is the gain in kinetic energy of the box when it is moved through a distance of 6.0 m?

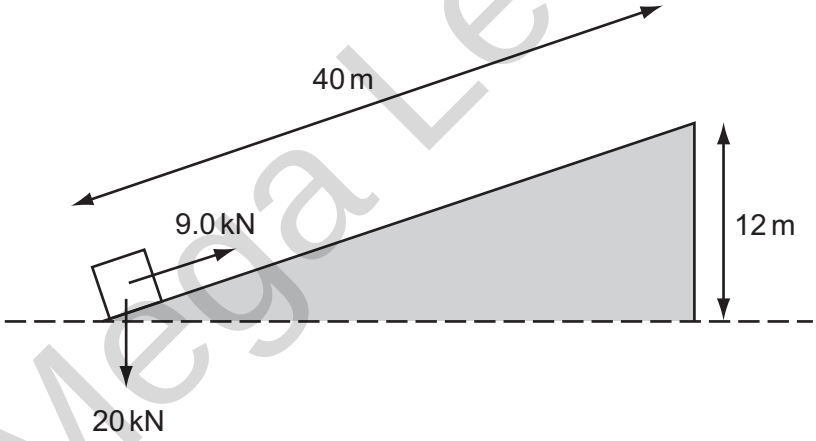
A 240 J **B** 300 J **C** 540 J **D** 840 J

31 A cyclist is capable of generating an average power of 3.0 kW during a 4.0 km speed trial. His aerodynamic suit and position on the cycle reduce resistive forces to 180 N.

What is the approximate time achieved in the speed trial?

A 140 s **B** 240 s **C** 1300 s **D** 2200 s

32 A constant force of 9.0 kN, parallel to an inclined plane, moves a body of weight 20 kN through a distance of 40 m along the plane at constant speed. The body gains 12 m in height, as shown.



How much of the work done is dissipated as heat?

A 120 kJ **B** 240 kJ **C** 360 kJ **D** 600 kJ

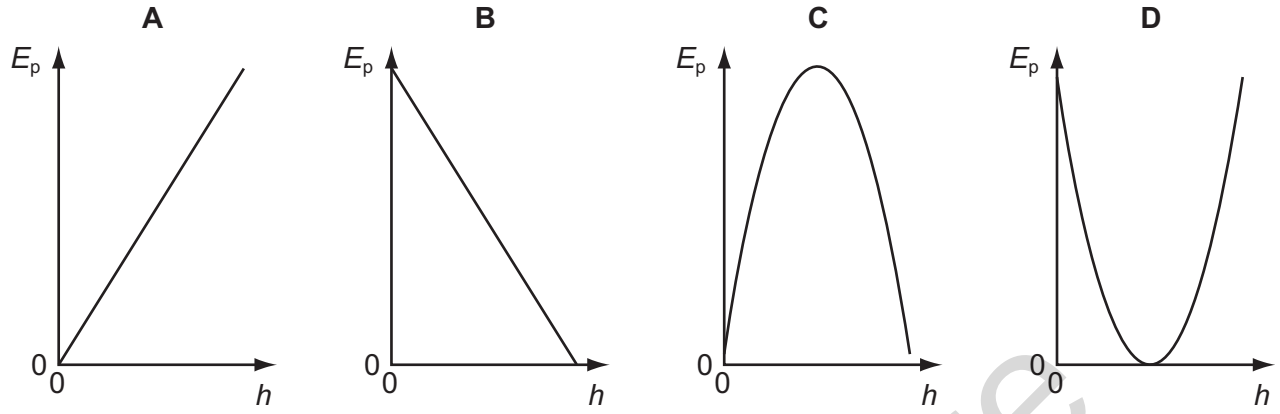
33 A car with a total mass of 1400 kg is travelling at 30 m s^{-1}.

What is the kinetic energy of the car?

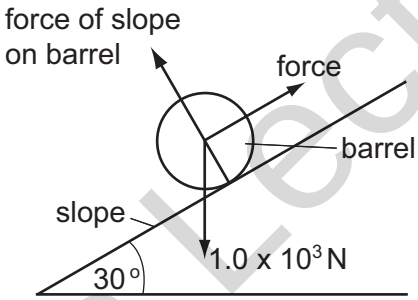
A 21 kJ **B** 42 kJ **C** 630 kJ **D** 1260 kJ

34 An object is thrown into the air.

Which graph shows how the potential energy E_p of the object varies with height h above the ground?



35 The diagram shows a barrel of weight 1.0×10^3 N on a frictionless slope inclined at 30 ° to the horizontal.



A force is applied to the barrel to move it up the slope at constant speed. The force is parallel to the slope.

What is the work done in moving the barrel a distance of 5.0 m up the slope?

A 1.0×10^4 J **B** 2.5×10^3 J **C** 4.3×10^3 J **D** 5.0×10^3 J

36 In many old-style filament lamps, as much as 93 J of energy is emitted as thermal energy for every 7 J of energy emitted as light.

What is the efficiency of the lamp, as the percentage of electrical energy converted to light energy?

A 7 % **B** 8 % **C** 92 % **D** 93 %

37 To get to his office from the entrance of the building, a man has to walk up six flights of stairs. The height of each flight is 2.5 m and the man has a mass of 80 kg.

What is the approximate gain in the man's gravitational potential energy during the climb?

A 1200 J **B** 2000 J **C** 4800 J **D** 12 000 J

38 An electric railway locomotive has a maximum mechanical output power of 4.0 MW. Electrical power is delivered at 25 kV from overhead wires. The overall efficiency of the locomotive in converting electrical power to mechanical power is 80 %.

What is the current from the overhead wires when the locomotive is operating at its maximum power?

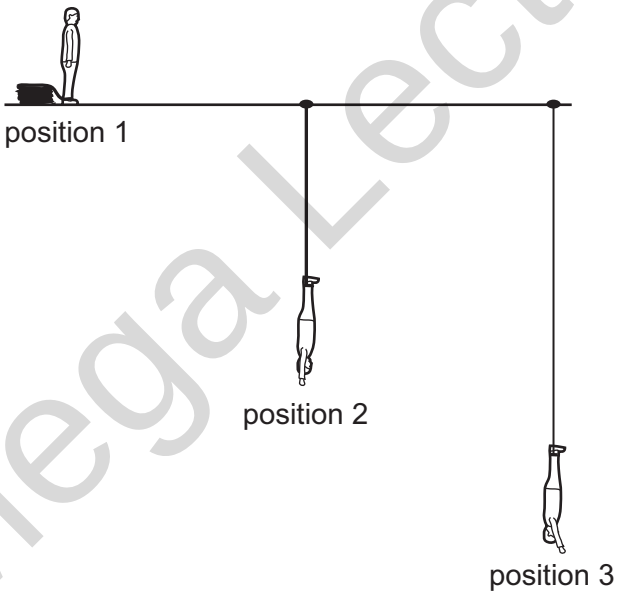
A 130 A **B** 160 A **C** 200 A **D** 250 A

39 A car of mass 1000 kg first travels forwards at 25 m s^{-1} and then backwards at 5 m s^{-1}.

What is the change in the kinetic energy of the car?

A 200 kJ **B** 300 kJ **C** 325 kJ **D** 450 kJ

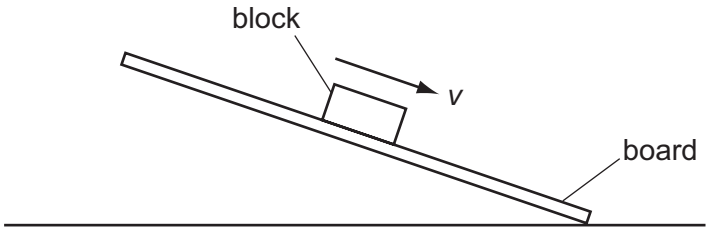
40 When bungee jumping, a student starts with maximum gravitational potential energy (position 1), then falls freely until the rope fully unwinds (position 2), after which the rope starts to stretch until the lowest point of the jump is reached (position 3).



What are the kinetic and elastic potential energies at position 3?

	kinetic energy	elastic potential energy
A	maximum	maximum
B	maximum	minimum
C	minimum	maximum
D	minimum	minimum

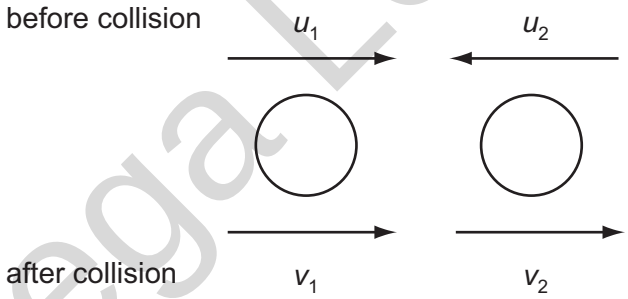
41 A wooden block rests on a rough board. The end of the board is then raised until the block slides down the plane of the board at constant velocity *v*.



Which row describes the forces acting on the block when sliding with constant velocity?

	frictional force on block	resultant force on block
A	down the plane	down the plane
B	down the plane	zero
C	up the plane	down the plane
D	up the plane	zero

42 Two spheres approach each other along the same straight line. Their speeds are u_1 and u_2 before collision, and v_1 and v_2 after collision, in the directions shown below.



Which equation is correct if the collision is perfectly elastic?

A $u_1 - u_2 = v_2 + v_1$

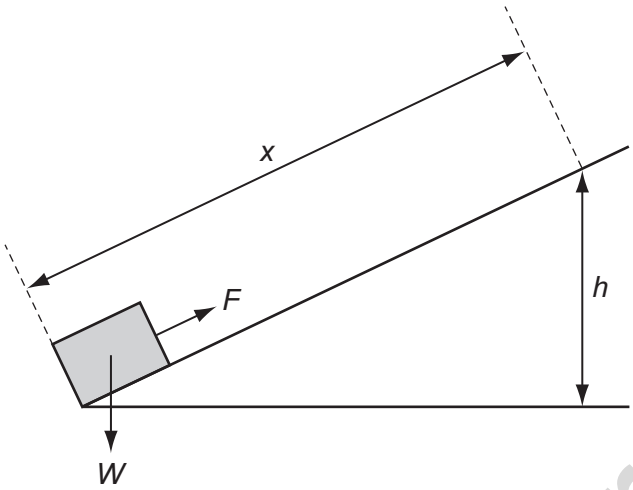
B $u_1 - u_2 = v_2 - v_1$

C $u_1 + u_2 = v_2 + v_1$

D $u_1 + u_2 = v_2 - v_1$

43 A block of weight *W* is pulled up a rough slope by a force *F*.

When the block has moved a distance *x* along the slope, it has risen height *h*.

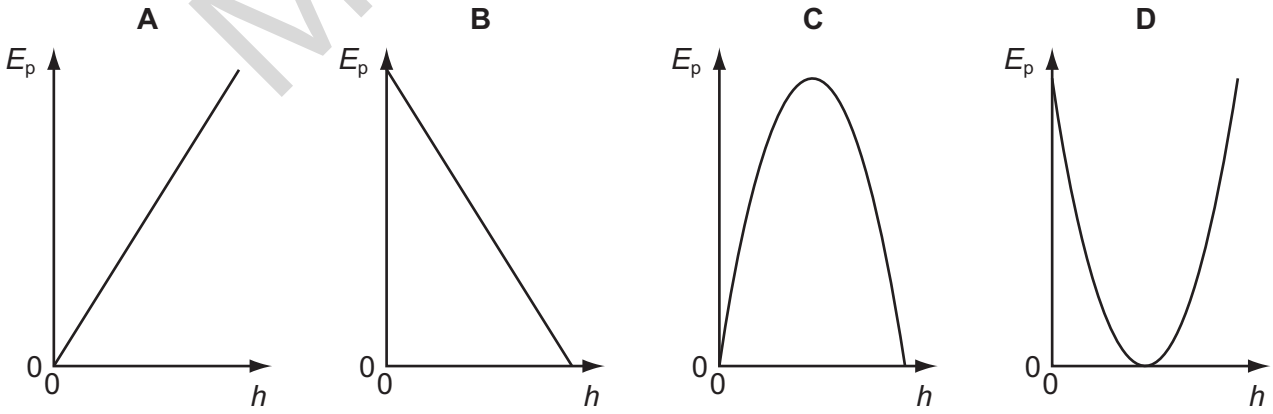


Which expressions give the amount of work done on the block and the amount of gravitational potential energy gained by the block?

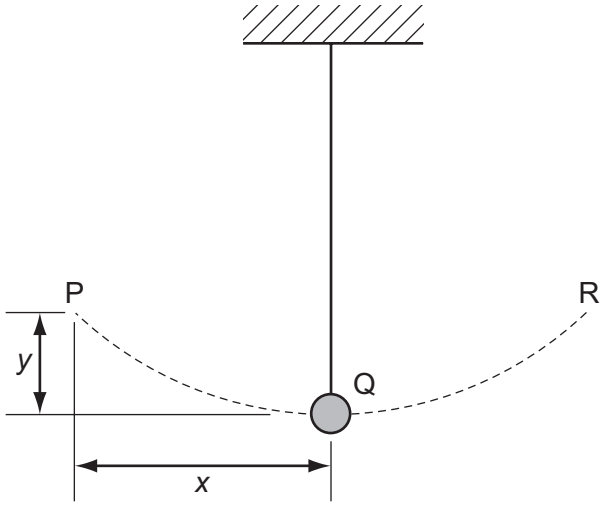
	work done	gravitational potential energy
A	*Fx*	*Wh*
B	*Fh*	*Wx*
C	*Wx*	*Fh*
D	*Wh*	*Fx*

44 An object is thrown into the air.

Which graph shows how the potential energy E_p of the object varies with height *h* above the ground?



45 A pendulum bob oscillates between P and R.



Assuming the gravitational potential energy lost in moving from P to Q is converted into kinetic energy, what is the speed of the bob at Q?

A $\sqrt{2gx}$ **B** $2gx$ **C** $\sqrt{2gy}$ **D** $2gy$

46 Which operation involves the greatest mean power?

A a car moving against a resistive force of 0.4 kN at a constant speed of 20 m s^{-1}

B a crane lifting a weight of 3 kN at a speed of 2 m s^{-1}

C a crane lifting a weight of 5 kN at a speed of 1 m s^{-1}

D a weight being pulled across a horizontal surface at a speed of 6 m s^{-1} against a frictional force of 1.5 kN