Work, Energy & Power

TOPIC QUESTIONS (2)

Level	A Level
Subject	Physics
Exam Board	CIE
Paper Type	Multiple Choice

Time Allowed : 1Hour 10Min

1. 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.
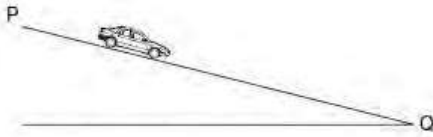
The magnitude of the change in the car's kinetic energy is ΔE_k. The magnitude of the change in its gravitational potential energy is ΔE_p. Which statement is correct?

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

2. An area of land is an average of 2.0m 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

3. A twig from a tree drops from a 200m 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 35ms^{-1} **B** 40ms^{-1} **C** 49ms^{-1} **D** 63ms^{-1}

4. A weight W hangs from a trolley that runs along a rail. The trolley moves horizontally through a distance p and simultaneously raises the weight through a height q.
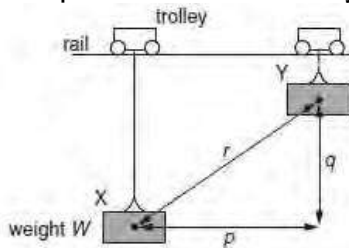
As a result, the weight moves through a distance r from X to Y. It starts and finishes at rest.
How much work is done on the weight during this process?

A Wp   **B** W(p + q)   **C** Wq   **D** Wr

5. A motorist travelling at 10ms^{-1} can bring his car to rest in a distance of 10 m.
If he had been travelling at 30ms^{-1}, in what distance could he bring the car to rest using the same braking force?

A 17 m **B** 30 m **C** 52 m **D** 90m

6. 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?

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A

B

C

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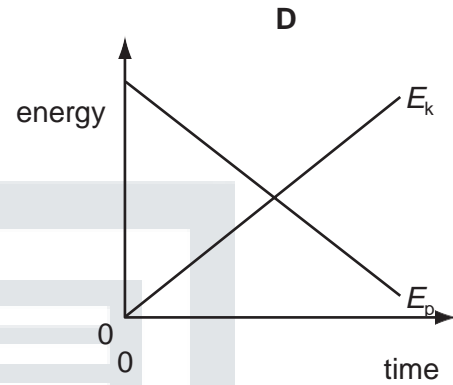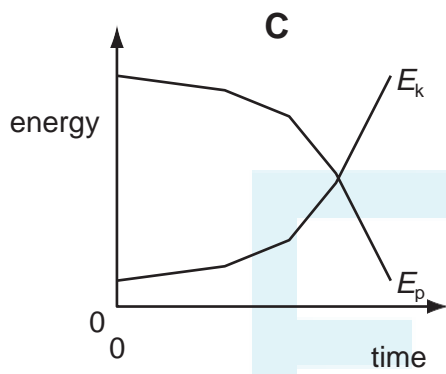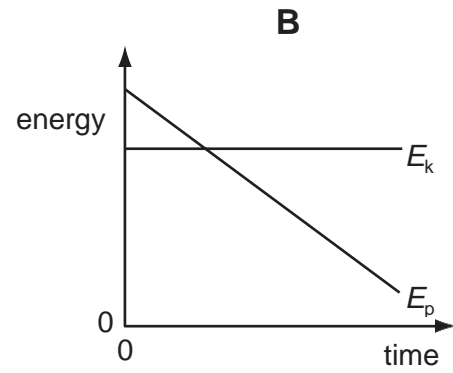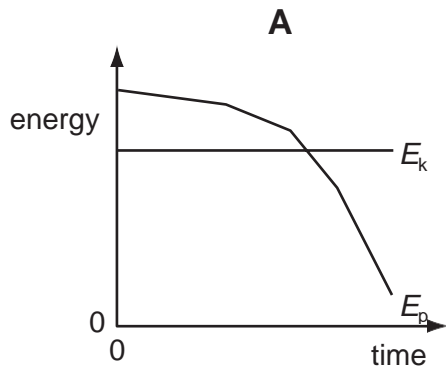
7. The total energy input E_{in} in a process is partly transferred to useful energy output U, and partly toenergy that is wasted W.

   What is the efficiency of the process?

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

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

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

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

8. 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 $450\,kJ$

9. 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 untilthe lowest point of the jump is reached (position 3).

position 1

position 2
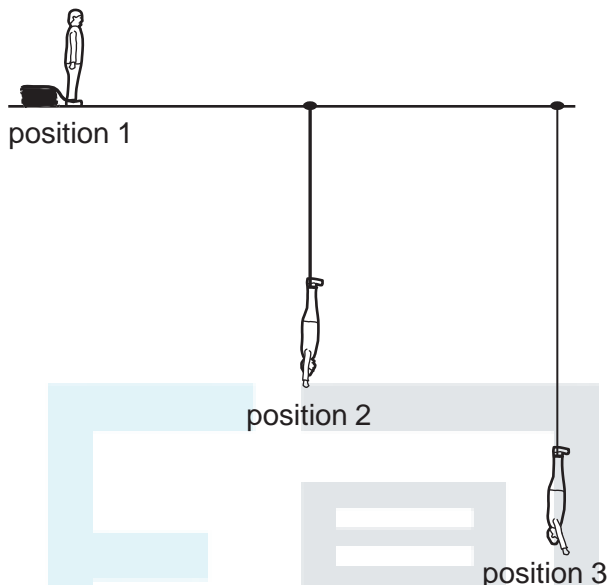
position 3

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

10.   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

11.   A piston in a gas supply pump has an area of 500 cm^2 and it moves a distance of 30 cm duringone stroke.

The pump moves the gas against a fixed pressure of 4000 Pa.

How much work is done by the piston during one stroke?

A   60 J   B 6.0×10^3 J   C 6.0×10^5 J   D 6.0×10^7 J

12. A railway engine accelerates a train of total mass 1200 tonnes (1 tonne = 1000 kg) from rest to aspeed of 75 m s^{-1}.

How much useful work must be done on the train to reach this speed?

A 1.7×10^6 J   B 3.4×10^6 J   C 1.7×10^9 J   D 3.4×10^9 J

13. A crane is being used to lift containers off a ship. One container has a mass of 14 000 kg and is being lifted vertically with a speed of 3.2 m s^{-1}.

The electric motor being used to supply the power to lift the container is using a current of 240 A at a potential difference of 2200 V.

What is the efficiency of the system?

A   8.1 %   B   8.5 %   C   48 %   D   83 %

14. Trains supply coal to a power station. The table below gives quantities describing the operation of the power station.

	symbol	unit
power station output	P	W
number of trains per day	N	
mass of coal on a train	M	kg
energy from 1 kg of coal	J	J
number of seconds in one day	S	

Which expression gives the efficiency of the power station?

A $\dfrac{PS}{NMJ}$ B $\dfrac{PSN}{MJ}$ C $\dfrac{NMJ}{PS}$ D $\dfrac{NM}{PSJ}$

15. What leads to the conclusion that the movement of molecules is random?

   A   evaporation of water at room temperature

   B   conduction of electricity in water

   C   convection currents in air

   D   motion of dust particles in air

16. A fisherman lifts a fish of mass 250 g from rest through a vertical height of 1.8 m. The fish gains a speed of $1.1 \, \text{m s}^{-1}$.

   What is the energy gained by the fish?

   A   0.15 J   B   4.3 J   C   4.4 J   D   4.6 J

17. Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of $500 \, \text{kg s}^{-1}$. Thereservoir is 300 m above the level of the turbine.

   The electrical output from the generator driven by the turbine is 200 A at a potential difference of 6000 V.

   What is the efficiency of the system?

   A   8.0%   B   8.2%   C   80%   D   82%

18. Which of the following is a statement of the principle of conservation of momentum?

   A   Momentum is the product of mass and velocity.

   B   In an elastic collision, momentum is constant.

   C   The momentum of an isolated system is constant.

   D   The force acting on a body is proportional to its rate of change of momentum.

19. The gas in an engine does work on a piston of cross-sectional area $80 \, \text{cm}^2$. The pressure on thepiston has a constant value of $4.6 \times 10^5 \, \text{Pa}$.
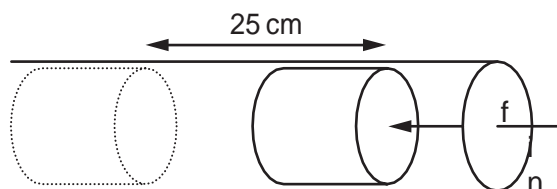
al positionof piston

initial position of piston

force of gas pushing piston

How much work is done by the gas on the piston when it moves through a distance of 25 cm?

A 9.2×10^2 J   B 9.2×10^4 J   C 9.2×10^6 J   D 9.2×10^8 J

20. A loaded aeroplane has a total mass of 1.2×10^5 kg while climbing after take-off. It climbs at an angle of 23° to the horizontal with a speed of 50 m s^{-1}. What is the rate at which it is gaining potential energy at this time?

   A 2.3×10^6 J s^{-1}

   B 2.5×10^6 J s^{-1}

   C 2.3×10^7 J s^{-1}

   D 2.5×10^7 J s^{-1}

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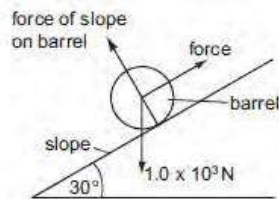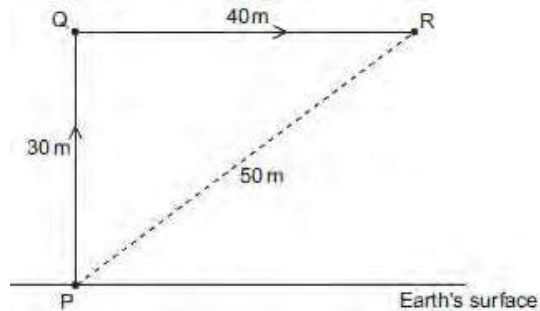

A force is applied to the barrel to move it up the slope at constantspeed. The force is parallel to the slope.
What is the work done in moving the barrel a distance of 5.0 m upthe slope?
A 1.0×10^4J   B 2.5×10^3J
C 4.3×10^3J   D 5.0×10^3J

22. A stone of weight 4.0 N in the Earth's gravitational field is movedfrom 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

23. 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 2.5m and the man has a mass of 80 kg.
What is the approximate gain in the man's gravitational potentialenergy during the climb?
A 1200 J   B 2000 J   C 4800 J   D 12 000 J

24. In many old-style filament lamps, as much as 93 J of energyis emitted as thermal energy for every 7 J of energy emitted as light.
What is the efficiency of the lamp, as the percentage of electricalenergy converted to light energy?
A 7 %   B 8 %   C 92 %   D 93 %

25.   Which expression defines power?

EXAM PAPERS PRACTICE

A force × distance moved in the direction of the force
B force × velocity
C work done ÷ time taken
D work done × time taken

26.   What is the expression used to define power?

A.   energy output
        energy input

B   energy x time taken

C   force x velocity
      work done

D   ────────
    time taken

27. 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 constantthroughout its motion.

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

28. 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.

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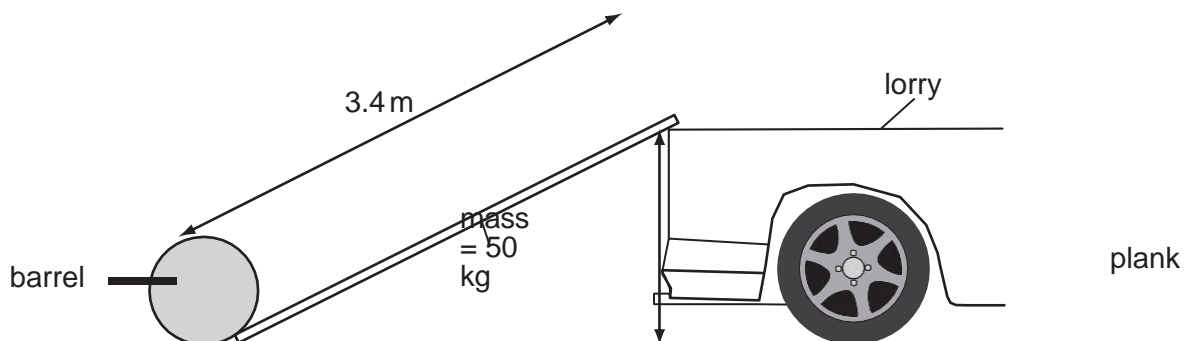
1.6 m

What is the minimum work done?

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

30. 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.
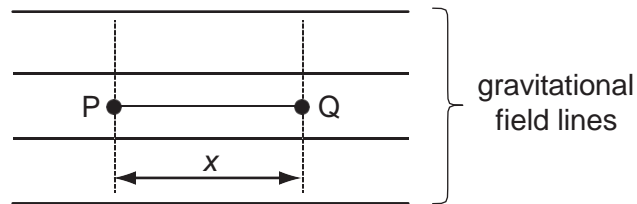
What is the average power input to the mass?

A $(E_p - E_k)t$

B $(E_p + E_k)t$

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

D $\dfrac{E_p + E_k}{T}$

31. An electric motor is required to produce 120 W of mechanical output power. The efficiency of the motor is 80 %.

Which row is correct?

	electrical power input to motor / W	waste heat output from motor / W
A	120	24
B	120	96
C	150	30
D	150	120

32.   A mass *m* is situated in space in a uniform gravitational field.

When the mass moves through a displacement *x*, from P to Q, it loses an amount of potential energy *E*.

Which row correctly specifies the magnitude and the direction of the acceleration due to the gravity in this field?

	magnitude	direction
A	$\dfrac{E}{mx}$	→
B	$\dfrac{E}{mx}$	←
C	$\dfrac{E}{x}$	→
D	$\dfrac{E}{x}$	←

33. When a horizontal force F is applied to a frictionless trolley over a distance s, the kinetic energy of the trolley changes from 4 J to 8 J.

   If a force of $2F$ is applied to the trolley over a distance of $2s$, what will the original kinetic energy of 4 J become?

   A   16 J   B   20 J   C   32 J   D   64 J

34. The kinetic energy of a vehicle of mass 1000 kg is 4.5×10^5 J. It is braked with a total constant braking force of 6000 N.

   What will be its stopping distance?
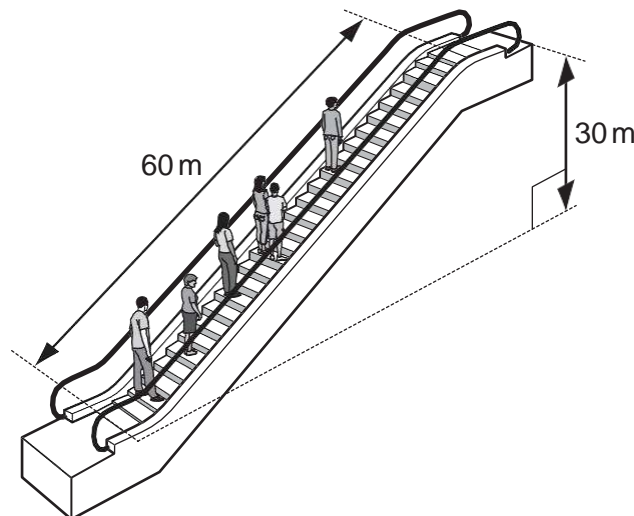
   A   37 m   B   75 m   C   150 m   D   300 m

35. In many old-style filament lamps, as much as 92 J of energy is emitted as thermal energy for every 8 J of energy emitted as light.

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

   A   8 %   B   9 %   C   91 %   D   92 %

36. 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 $0.75\,\mathrm{m\,s^{-1}}$?

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

37. A uniform solid cuboid of concrete of dimensions 0.50 m × 1.20 m × 0.40 m and weight 4000 N rests on a flat surface with the 1.20 m edge vertical as shown in diagram 1.

0.40 m

1.20 m

0.50 m

0.50 m

diagram 1

0.40 m

0.50 m

1.20 m
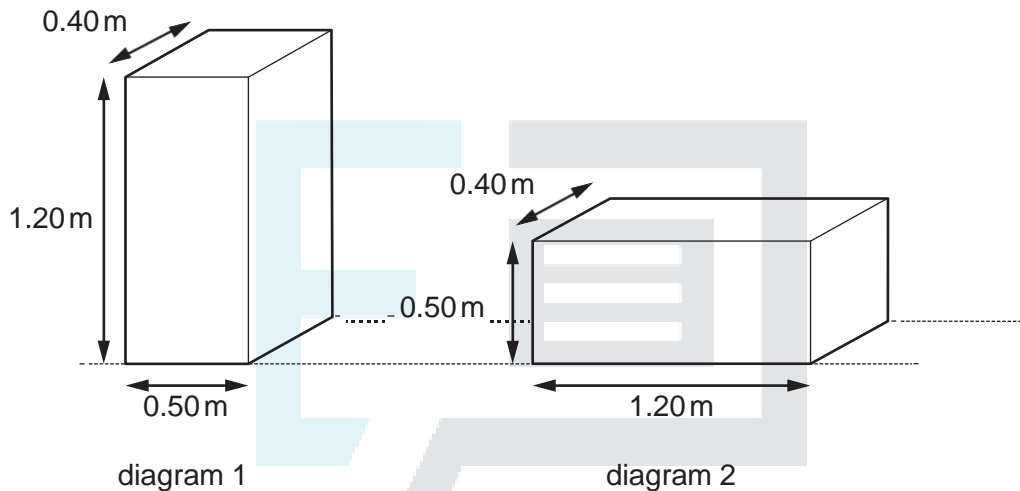
diagram 2

What is the minimum energy required to roll the cuboid through 90° to the position shown in diagram 2 with the 0.50 m edge vertical?

A   200 J   B   400 J   C   1400 J   D   2600 J

38. An electric motor has an input power P_{in}, useful output power P_{out} and efficiency η.

input power P_{in}	→	electric motor of efficiency η	→	output power P_{out}

power lost
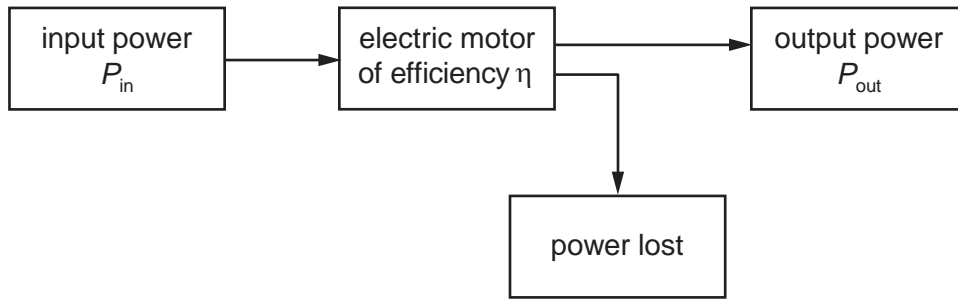
How much power is lost by the motor?

A ηP_{in} B $\left(\dfrac{1}{\eta}-1\right)P_{in}$ C ηP_{out} D $\left(\dfrac{1}{\eta}-1\right)P_{out}$

39. A ball drops onto a horizontal surface and bounces elastically.

What happens to the kinetic energy of the ball during the very short time that it is in contact with the surface?

A   Most of the kinetic energy is lost as heat and sound energy.

B   The kinetic energy decreases to zero and then returns to its original value.

C   The kinetic energy remains constant because it is an elastic collision.

D   The kinetic energy remains constant in magnitude but changes direction.

40. The diagram shows a barrel of weight $1.0 \times 10^3 \, \text{N}$ on a frictionless slope inclined at $30°$ to thehorizontal.
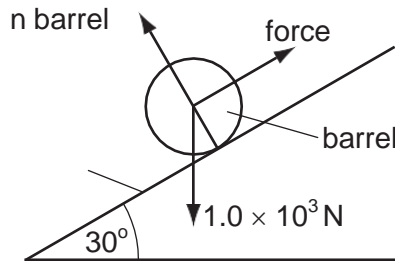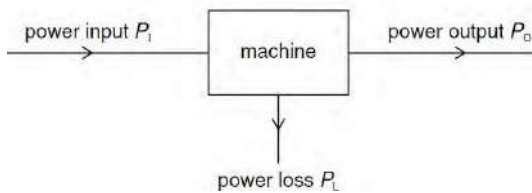

A force is applied to the barrel to move it up the slope at constant speed. The force is parallel to the slope.

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

A $2.5 \times 10^3 \, \text{J}$ B $4.3 \times 10^3 \, \text{J}$ C $5.0 \times 10^3 \, \text{J}$ D $1.0 \times 10^4 \, \text{J}$
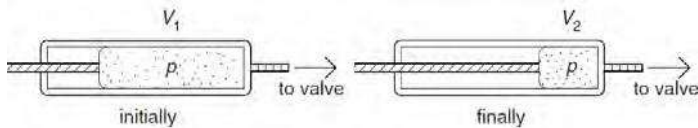
41.   Power is transferred through a machine as shown.

What is the efficiency of the machine?

A $\dfrac{P_i}{P_o + P_L}$ B $\dfrac{P_L}{P_i}$ C $\dfrac{P_L}{P_o}$ D $\dfrac{P_o}{P_i}$

42.   Air in a bicycle pump is forced through a valve at a constantpressure 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 $\dfrac{p(V_1 + V_2)}{2}$ C $p(V_1 - V_2)$

B $p(V_1 + V_2)$ D pV_1

43.   A trolley runs from P to Q along a track. At Q its potentialenergy is 50 kJ less than at P.

At P, the kinetic energy of the trolley is 5 kJ. Between P and Qthe 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

44.   To travel at a constant speed, a car engine provides 24 kW of useful power. The driving force on the car is 600N. At what speed does it travel?
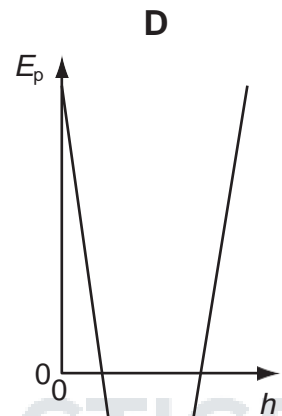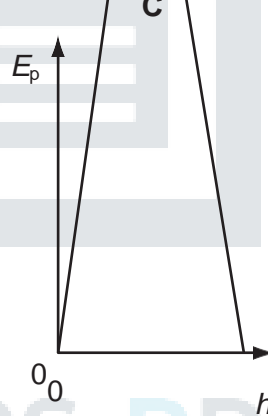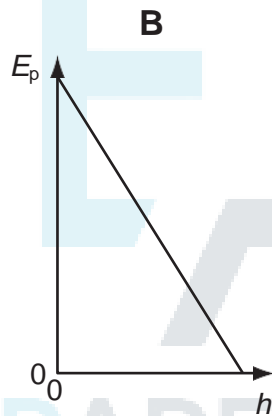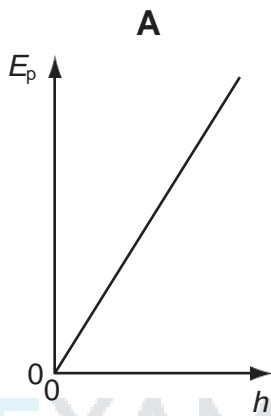
A 2.5ms^{-1} **B** 4.0ms^{-1} **C** 25ms^{-1} **D** 40ms^{-1}

45.   Which of the following is an expression for power?
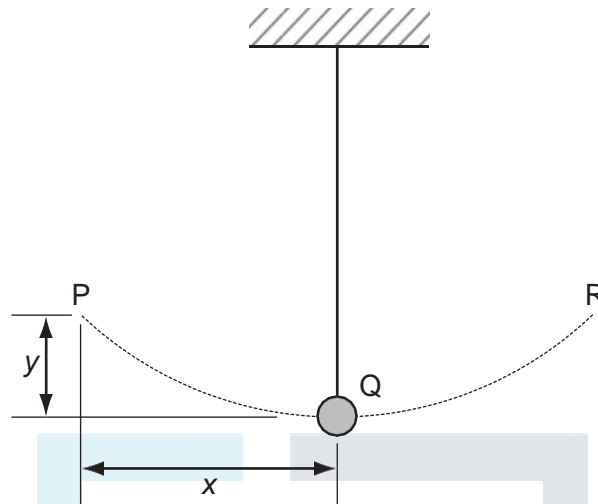
A energy x time   **B** force x displacement
C force x velocity   **D** mass x velocity

46.   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?

47. 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 $2gy$

48.   Which operation involves the greatest mean power?

• a car moving against a resistive force of 0.4 kN at a constant speed of $20\,\text{m s}^{-1}$

• a crane lifting a weight of 3 kN at a speed of $2\,\text{m s}^{-1}$

• a crane lifting a weight of 5 kN at a speed of $1\,\text{m s}^{-1}$

• a weight being pulled across a horizontal surface at a speed of $6\,\text{m s}^{-1}$ against a frictional force of 1.5 kN

49. What is a reasonable estimate of the average kinetic energy of an athlete during a 100 m racethat takes 10 s?

A   40 J   B   400 J   C   4000 J   D   40 000 J

50. Which quantities are conserved in an inelastic collision?

	kinetic energy	total energy	linear momentum
A	conserved	conserved	conserved
B	conserved	not conserved	not conserved
C	not conserved	conserved	conserved
D	not conserved	conserved	not conserved

51. A piston in a gas supply pump has an area of 600 cm^2 and it moves a distance of 40 cm duringone stroke. The pump moves the gas against a fixed pressure of 5000 Pa.

How much work is done by the piston during one stroke?

A $1.2 \times 10^2 \text{ J}$ B $1.2 \times 10^4 \text{ J}$ C $1.2 \times 10^6 \text{ J}$ D $1.2 \times 10^8 \text{ J}$

52. A railway engine accelerates a train of total mass 800 tonnes (1 tonne = 1000 kg) from rest to aspeed of 50 m s^{-1}.

How much work must be done on the train to reach this speed?

A $1.0 \times 10^6 \text{ J}$ B $2.0 \times 10^6 \text{ J}$ C $1.0 \times 10^9 \text{ J}$ D $2.0 \times 10^9 \text{ J}$

53. Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 500 kg s^{-1}. Thereservoir is 300 m above the level of the turbine.

The electrical output from the generator driven by the turbine is 200 A at a potential difference of 6000 V.

What is the efficiency of the system?

A 8.0%   B 8.2%   C 80%   D 82%

54. What is the approximate kinetic energy of an Olympic athlete when running at maximum speed during a 100 m race?

A 400 J   B 4000 J   C 40 000 J   D 400 000 J

55. Two identical, perfectly elastic spheres have the same mass m. They travel towards each otherwith the same speed v along a horizontal frictionless surface.
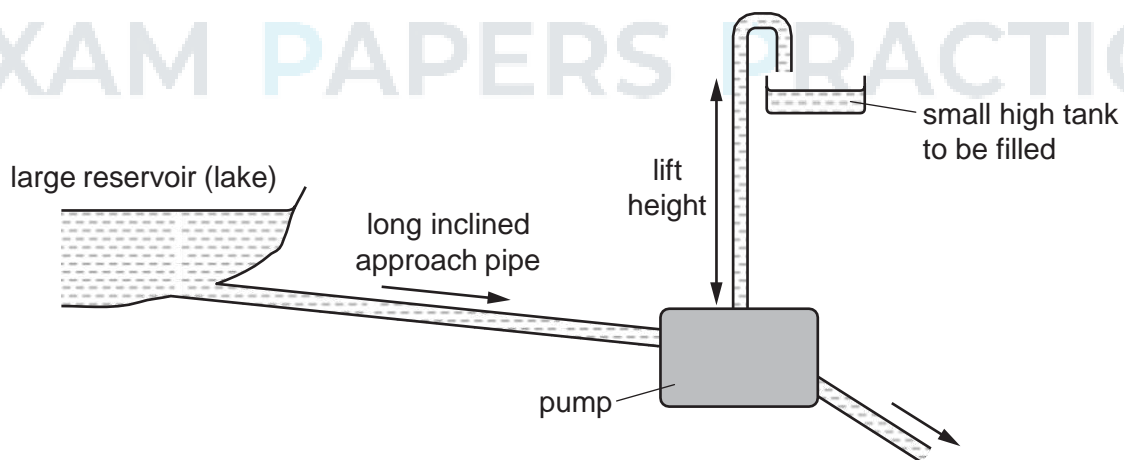

mass m mass m

speed v speed v
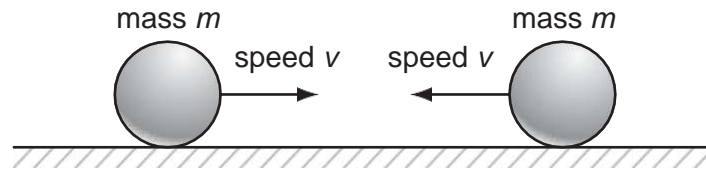
Which statement about the sum of the kinetic energies of the spheres is correct?

A   The sum of their kinetic energies before impact is zero.

B   The sum of their kinetic energies before impact is $\frac{1}{2} mv^2$.

C   The sum of their kinetic energies after impact is zero.

D   The sum of their kinetic energies after impact is mv^2.

56.   A team of nine dogs can pull a sledge with a combined force of $800\,N$ at a speed of $1.5\,m\,s^{-1}$ for360 minutes.

What is the average work done by each dog during this time?

A $4.8 \times 10^4\,J$ B $4.3 \times 10^5\,J$ C $2.9 \times 10^6\,J$ D $2.6 \times 10^7\,J$

57. The diagram shows a pump called a hydraulic ram.

small high tank to be filled

lift height

large reservoir (lake)

long inclined approach pipe

pump

In one such pump the long approach pipe holds 500 kg of water. A valve shuts when the speed of this water reaches 2.0 m s^{-1} and the kinetic energy of this water is used to lift a small quantity of water by a height of $15\,m$.

The efficiency of the pump is 10%.

Which mass of water could be lifted $15\,m$?

A   0.15 kg   B   0.68 kg   C   1.5 kg   D   6.8 kg

58. A conveyor belt is driven at velocity v by a motor. Sand drops vertically on to the belt at a rate of $m\,\text{kg s}^{-1}$.
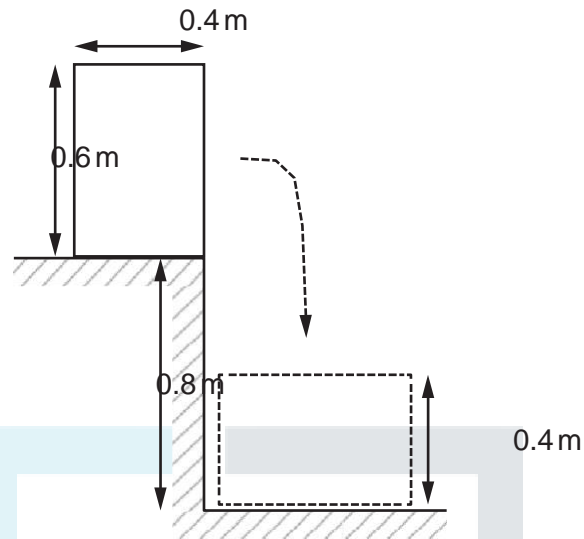
What is the additional power needed to keep the conveyor belt moving at a steady speed when the sand starts to fall on it?

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

59. A uniform solid block has weight 500 N, width 0.4 m and height 0.6 m. The block rests on the edge of a step of depth 0.8 m, as shown.
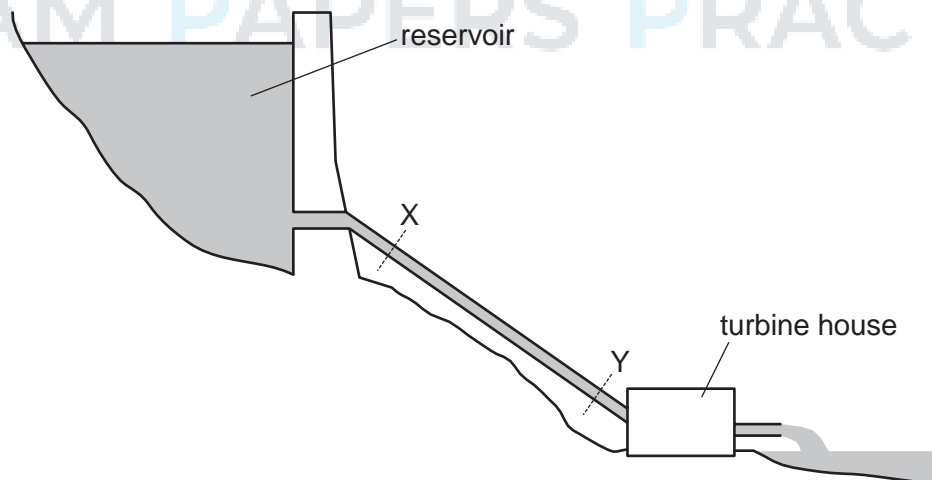

The block is knocked over the edge of the step and rotates through 90° before coming to rest with the 0.6 m edge horizontal.

What is the change in gravitational potential energy of the block?

A   300 J   B   400 J   C   450 J   D   550 J

60. The diagram shows a hydroelectric power station.

The reservoir is linked to the turbines by a pipe of uniform cross-sectional area.

Water flows from X to Y at constant speed. Which statement about the change of energy of the water as it moves from X to Y is correct?

A   It gains both gravitational potential energy and kinetic energy.

B It loses both elastic potential energy and kinetic energy.

C It loses both elastic potential energy and gravitational potential energy.

D It loses gravitational potential energy and gains elastic potential energy.