Work, Energy and Power

(Past Year Topical Questions 2010-2015)

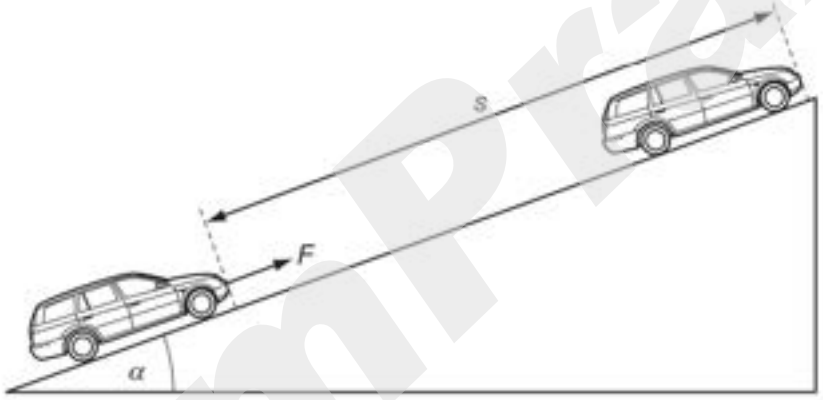
May/June 2010 (11)

15 A force of 1000 N is needed to lift the hook of a crane at a steady velocity. The crane is then used to lift a load of mass 1000 kg at a velocity of 0.50 $m\,s^{-1}$.

How much of the power developed by the motor of the crane is used in lifting the hook and the load? Assume that the acceleration of free fall g is equal to 10 $m\,s^{-2}$.

A 5.0 kW **B** 5.5 kW **C** 20 kW **D** 22 kW

16 A constant force F, acting on a car of mass m, moves the car up the slope through a distance s at constant velocity v. The angle of the slope to the horizontal is α.



Which expression gives the efficiency of the process?

A $\frac{mgs\sin\alpha}{Fv}$ **B** $\frac{mv}{Fs}$ **C** $\frac{mv^2}{2Fs}$ **D** $\frac{mg\sin\alpha}{F}$

May/June 2010 (12)

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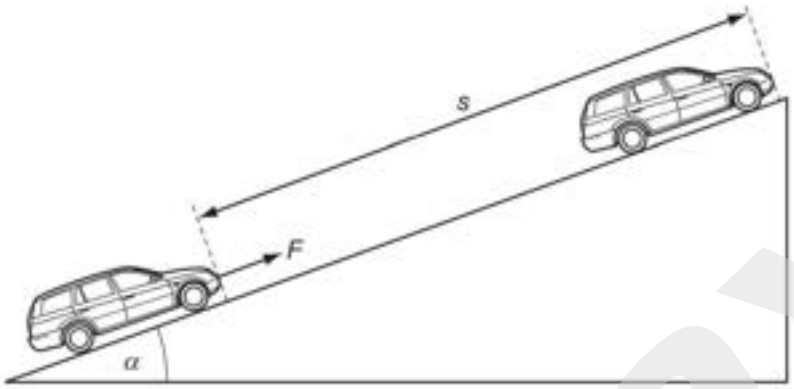

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How much of the power developed by the motor of the crane is used in lifting the hook and the load? Assume that the acceleration of free fall g is equal to $10\,m\,s^{-2}$.

A 5.0 kW **B** 5.5 kW **C** 20 kW **D** 22 kW

October/November 2010 (11)

16 What is the internal energy of a system?

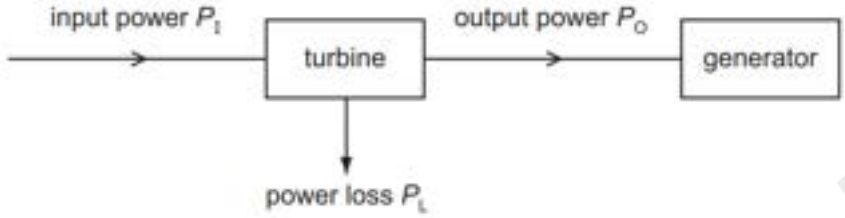
A the amount of heat supplied to the system

B the energy of the atoms of the system

C the total kinetic energy of the system

D the total potential energy of the system

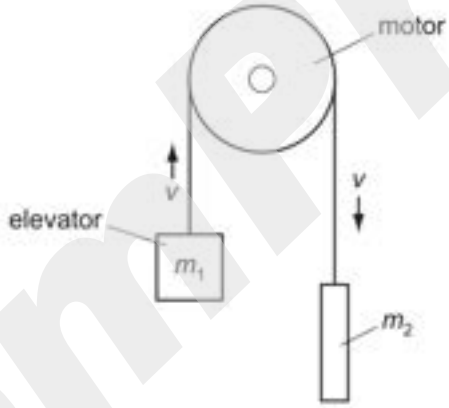
17 A steam turbine is used to drive a generator. The input power to the turbine is P_I and the output power P_O. The power loss in the turbine is P_L, as shown below.



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** $\frac{P_O}{P_I}$

18 The diagram shows a lift system in which the elevator (mass m_1) is partly counterbalanced by a heavy weight (mass m_2).



At what rate does the motor provide energy to the system when the elevator is rising at a steady speed v? (g = acceleration of free fall)

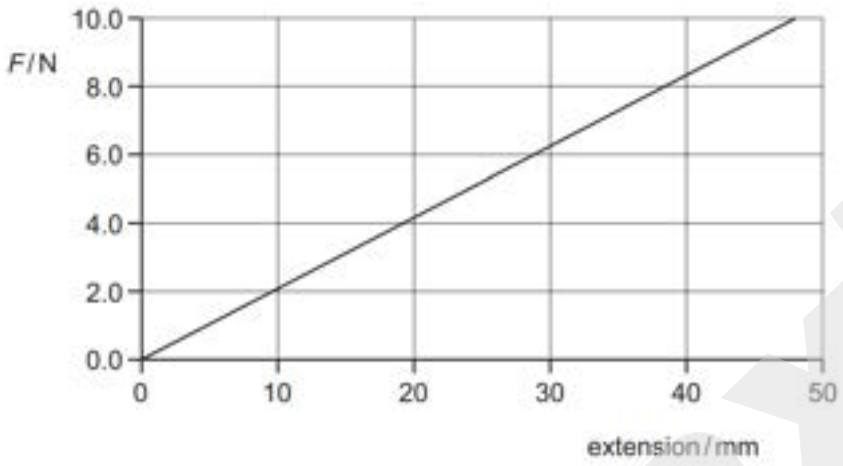
A $\frac{1}{2} m_1 v^2$

B $\frac{1}{2} (m_1 - m_2) v^2$

C $m_1 g v$

D $(m_1 - m_2) g v$

21 The graph shows how force depends on extension for a certain spring.

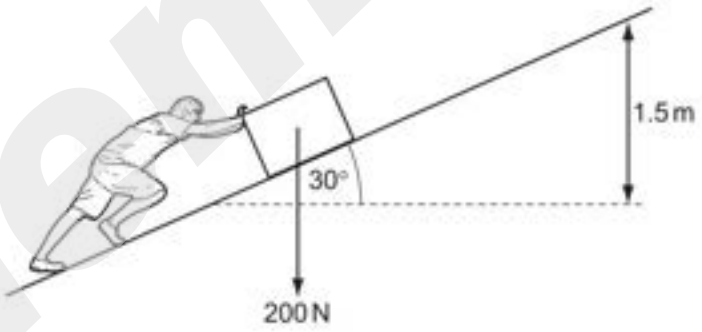


What is the energy stored in the spring when the extension is 30 mm?

A 0.095 J **B** 0.19 J **C** 0.25 J **D** 0.95 J

October/November 2010 (12)

14 A box of weight 200 N is pushed so that it moves at a steady speed along a ramp, through a height of 1.5 m. The ramp makes an angle of 30° with the ground. The frictional force on the box is 150 N while the box is moving.



What is the work done by the person?

A 150 J **B** 300 J **C** 450 J **D** 750 J

15 A raindrop of mass m is falling vertically through the air with a steady speed v. The raindrop experiences a retarding force kv due to the air, where k is a constant. The acceleration of free fall is g.

Which expression gives the kinetic energy of the raindrop?

A $\frac{mg}{k}$ **B** $\frac{mg^2}{2k^2}$ **C** $\frac{m^3g^2}{k^2}$ **D** $\frac{m^3g^2}{2k^2}$

16 The kinetic energy of a vehicle of mass 1000 kg is 4.5×10^5 J. It is stopped by applying a constant braking force of 6000 N.

What is its stopping distance?

A 37 m **B** 75 m **C** 150 m **D** 300 m

17 What are units of work, energy and power?

	work	energy	power
A	J	Nm	J
B	Js^{-1}	J	Js^{-1}
C	Nm	Nm	W
D	Nm	W	W

20 The pressure at sea level is approximately 100 000 Pa. The density of sea water is 1030 $kg\,m^{-3}$.

What is the approximate pressure 80 m below the surface of the sea?

A 100 000 Pa **B** 180 000 Pa **C** 800 000 Pa **D** 900 000 Pa

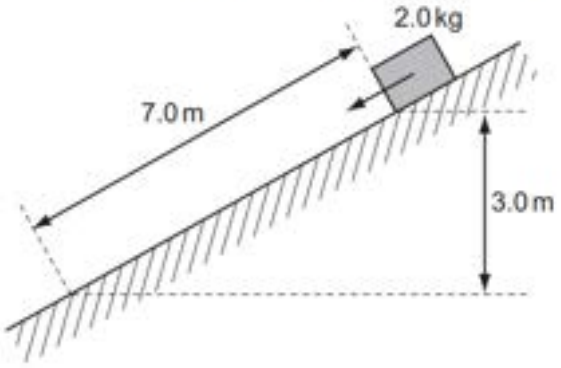
May/June 2011 (11)

14 A steel sphere is dropped vertically onto a horizontal metal plate. The sphere hits the plate with a speed u, leaves it at a speed v, and rebounds vertically to half of its original height.

Which expression gives the value of $\frac{v}{u}$?

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

15 A block of mass 2.0 kg is released from rest on a slope. It travels 7.0 m down the slope and falls a vertical distance of 3.0 m. The block experiences a frictional force parallel to the slope of 5.0 N.



What is the speed of the block after falling this distance?

A $4.9\,ms^{-1}$ **B** $6.6\,ms^{-1}$ **C** $8.6\,ms^{-1}$ **D** $10.1\,ms^{-1}$

16 A man has a mass of 80 kg. He ties himself to one end of a rope which passes over a single fixed pulley. He pulls on the other end of the rope to lift himself up at an average speed of $50\,cm\,s^{-1}$.

What is the average useful power at which he is working?

A 40 W **B** 0.39 kW **C** 4.0 kW **D** 39 kW

17 A body travelling with a speed of $10\,m\,s^{-1}$ has kinetic energy 1500 J.

If the speed of the body is increased to $40\,m\,s^{-1}$, what is its new kinetic energy?

A 4500 J **B** 6000 J **C** 24 000 J **D** 1 350 000 J

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May/June 2011 (12)

18 An electric motor produces 120 W of useful mechanical output power. The efficiency of the motor is 60 %.

Which row is correct?

	electrical power input / W	waste heat power output / W
A	72	48
B	192	72
C	200	72
D	200	80

19 A hammer with 10 J of kinetic energy hits a nail and pushes it 5.0 mm into a plank.

Both the hammer and nail come to rest after the collision.

What is the average force that acts on the nail while it moves the 5.0 mm?

A 0.050 N **B** 2.0 N **C** 50 N **D** 2000 N

20 The diagram shows two vessels, P and Q, both with sides inclined at 45°.

Vessel P tapers outwards and vessel Q tapers inwards, as shown.

Both vessels contain a liquid. The depth of the liquid in the vessels is the same. The liquid in vessel P is twice as dense as the liquid in vessel Q.

What is the ratio $\frac{\text{pressure due to the liquid on the base of P}}{\text{pressure due to the liquid on the base of Q}}$?

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

21 Two solid substances P and Q have atoms of mass M_P and M_Q respectively. They have n_P and n_Q atoms per unit volume.

The density of P is greater than the density of Q.

What **must** be correct?

A $M_P > M_Q$

B $n_P > n_Q$

C $M_P n_P > M_Q n_Q$

D $\frac{M_P}{n_P} > \frac{M_Q}{n_Q}$

October/November 2011 (11)

16 The diagram shows a particle X, with kinetic energy E_k, about to collide with a stationary particle Y. Both particles have the same mass.

After colliding, X and Y travel onwards together as a single larger particle.

How much kinetic energy is lost in the collision?

A 0 **B** $\frac{E_k}{4}$ **C** $\frac{E_k}{2}$ **D** $\frac{3E_k}{4}$

17 The first column in the table gives four examples of work being done. The second column gives more detail of the action.

Which row is **not** correct?

	example	detail
A	a girl dives from a diving board into a swimming pool	work is done by the girl against gravity as she falls
B	a man pushes a car along a level road	work is done by the man against friction
C	an electron is accelerated towards a positively-charged plate	work is done on the electron by the electric field of the plate
D	a piston is pushed outwards as a gas expands	work is done on the atmosphere by the gas

18 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

19 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

October/November 2011 (12)

15 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 2*F* is applied to the trolley over a distance of 2*s*, what will the original kinetic energy of 4 J become?

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

16 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

17 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%

May/June 2012 (11)

16 A concrete cube of side 0.60 m and uniform density 2.0×10^3 kg m^{-3} is lifted 5.0 m vertically by a crane.

What is the change in potential energy of the cube?

A 2.2 kJ **B** 21 kJ **C** 59 kJ **D** 450 kJ

17 The force resisting the motion of a car is taken as being proportional to the square of the car's speed. The magnitude of the force at a speed of 20 m s^{-1} is 800 N.

What effective power is required from the car's engine to maintain a steady speed of 40 m s^{-1}?

A 32 kW **B** 64 kW **C** 128 kW **D** 512 kW

18 The data below are taken from a test of a petrol engine for a motor car.

power output	150 kW
fuel consumption	20 litres per hour
energy content of fuel	40 MJ per litre

Which expression will evaluate the efficiency of the engine?

A $\dfrac{150\times10^{3}}{40\times10^{6}\times20\times60\times60}$

B $\dfrac{150\times10^{3}\times60\times60}{20\times40\times10^{6}}$

C $\dfrac{150\times10^{3}\times40\times10^{6}\times20}{60\times60}$

D $\dfrac{150\times10^{3}\times20}{40\times10^{3}\times60\times60}$

19 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 in the object.

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

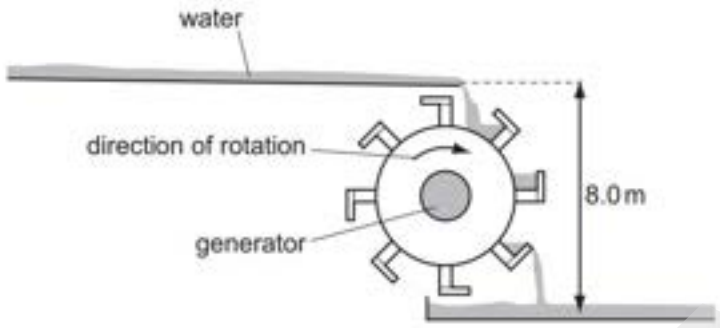
May/June 2012 (12)

17 Initially, four identical uniform blocks, each of mass *m* and thickness *h*, are spread on a table.

How much work is done on the blocks in stacking them on top of one another?

A 3*mgh** **B** 6*mgh** **C** 8*mgh** **D** 10*mgh*

18 The diagram shows the design of a water wheel which drives a generator to produce electrical energy. The flow rate of the water is 200 kg s^{-1}. The generator supplies a current of 32 A at a voltage of 230 V.



Ignoring any changes in kinetic energy of the water, what is the efficiency of the system?

A 14 % **B** 16 % **C** 22 % **D** 47 %

19 A car engine exerts an average force of 500 N in moving the car 1.0 km in 200 s.

What is the average power developed by the engine?

A 2.5 W **B** 2.5 kW **C** 100 kW **D** 100 MW

May/June 2012 (13)

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B $\dfrac{150\times10^{3}\times60\times60}{20\times40\times10^{6}}$

C $\dfrac{150\times10^{3}\times40\times10^{6}\times20}{60\times60}$

D $\dfrac{150\times10^{3}\times20}{40\times10^{3}\times60\times60}$

October/November 2012 (11)

18 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

19 A piston in a gas supply pump has an area of 600 cm^2 and it moves a distance of 40 cm during one 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 1.2×10^{2} J **B** 1.2×10^{4} J **C** 1.2×10^{6} J **D** 1.2×10^{8} J

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

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

A 1.0×10^{6} J **B** 2.0×10^{6} J **C** 1.0×10^{9} J **D** 2.0×10^{9} J

21 Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 500 kg s^{-1}. The reservoir 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 %

October/November 2012 (12)

19 A piston in a gas supply pump has an area of 500 cm^2 and it moves a distance of 30 cm during one 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

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

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

A 1.7×10^8 J **B** 3.4×10^8 J **C** 1.7×10^9 J **D** 3.4×10^9 J

21 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 %

22 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 $\frac{PS}{NMJ}$ **B** $\frac{PSN}{MJ}$ **C** $\frac{NMJ}{PS}$ **D** $\frac{NM}{PSJ}$

October/November 2012 (13)

19 A piston in a gas supply pump has an area of 400 cm^2 and it moves a distance of 25 cm during one stroke.

The pump moves the gas against a fixed pressure of 3000 Pa.

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

A 30 J **B** 3.0×10^3 J **C** 3.0×10^5 J **D** 3.0×10^7 J

20 A transformer has the following input and output.

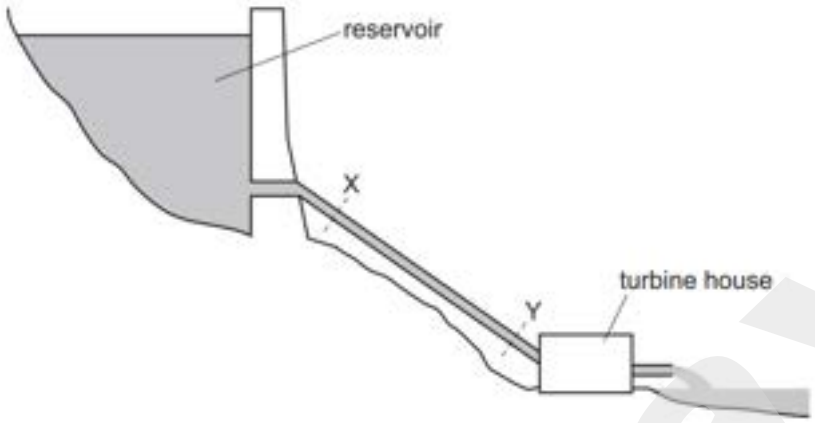
	potential difference / V	current / A
input	11 000	28
output	240	1200

What is the efficiency of the transformer?

A 0.94 % **B** 1.0 % **C** 11 % **D** 94 %

21 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 the reservoir, through the pipe and through the turbines at a constant rate.



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.

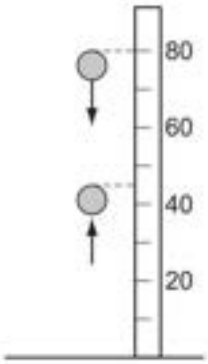
B It loses gravitational potential energy and gains elastic potential energy.

C It loses gravitational potential energy and gains kinetic energy.

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

May/June 2013 (11)

17 A solid rubber ball has a diameter of 8.0 cm. It is released from rest with the top of the ball 80 cm above a horizontal surface. It falls vertically and then bounces back up so that the maximum height reached by the top of the ball is 45 cm, as shown.



If the kinetic energy of the ball is 0.75 J just before it strikes the surface, what is its kinetic energy just after it leaves the surface?

A 0.36 J **B** 0.39 J **C** 0.40 J **D** 0.42 J

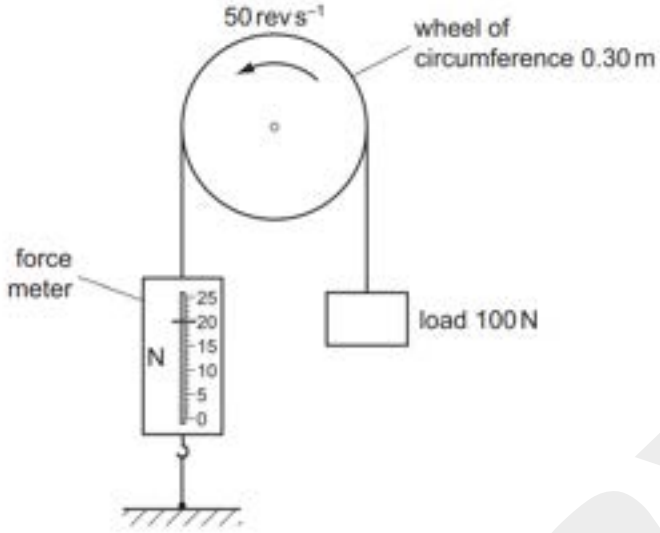
18 A wind turbine has blades that sweep an area of 2000 m^2. It converts the power available in the wind to electrical power with an efficiency of 50%.

What is the electrical power generated if the wind speed is 10 $m\,s^{-1}$? (The density of air is 1.3 $kg\,m^{-3}$.)

A 130 kW **B** 650 kW **C** 1300 kW **D** 2600 kW

19 The diagram shows a wheel of circumference 0.30 m. A rope is fastened at one end to a force meter. The rope passes over the wheel and supports a freely hanging load of 100 N. The wheel is driven by an electric motor at a constant rate of 50 revolutions per second.

When the wheel is turning at this rate, the force meter reads 20 N.



What is the output power of the motor?

A 0.3 kW **B** 1.2 kW **C** 1.8 kW D 3.8 kW

May/June 2013 (12)

15 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 its ascent.

16 A bow of mass 400 g shoots an arrow of mass 120 g vertically upwards. The potential energy stored in the bow just before release is 80 J. The system has an efficiency of 28%.

What is the height reached by the arrow when air resistance is neglected?

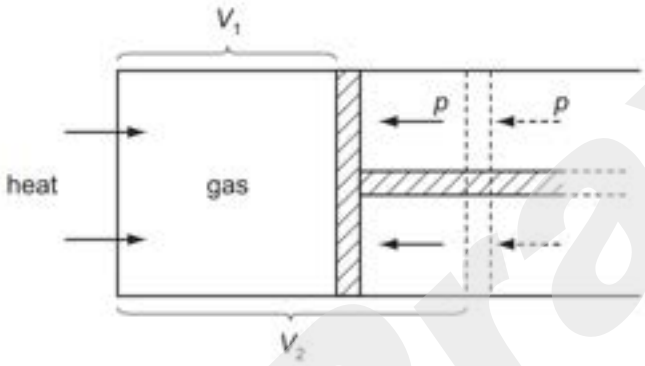
A 4 m **B** 19 m **C** 187 m **D** 243 m

17 A train on a mountain railway is carrying 200 people of average mass 70 kg up a slope at an angle of 30° to the horizontal and at a speed of 6.0 m s^{-1}. The train itself has a mass of 80 000 kg. The percentage of the power from the engine which is used to raise the passengers and the train is 40 %.

What is the power of the engine?

A 1.1 MW **B** 2.8 MW **C** 6.9 MW **D** 14 MW

18 A gas is enclosed inside a cylinder which is fitted with a frictionless piston.



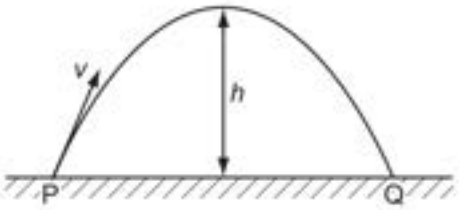
Initially, the gas has a volume V_1 and is in equilibrium with an external pressure p. The gas is then heated slowly so that it expands, pushing the piston back until the volume of the gas has increased to V_2.

How much work is done by the gas during this expansion?

A $p(V_2 - V_1)$ **B** $\frac{1}{2}p(V_2 - V_1)$ **C** $p(V_2 + V_1)$ **D** $\frac{1}{2}p(V_2 + V_1)$

May/June 2013 (13)

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



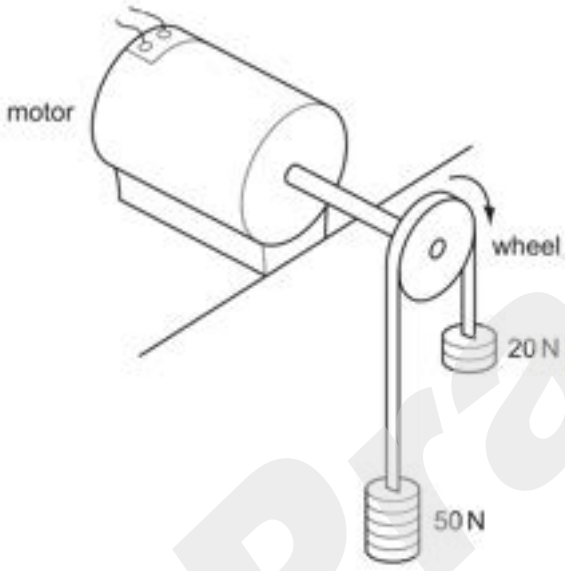
Air resistance is considered negligible. The acceleration of free fall is g.

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** $2mgh$

16 The diagram shows an arrangement used to find the output power of an electric motor.

The wheel attached to the motor's axle has a circumference of 0.5 m and the belt which passes over it is stationary when the weights have the values shown.

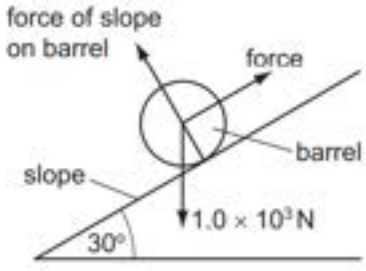


If the wheel is making 20 revolutions per second, what is the output power of the motor?

A 300 W **B** 500 W **C** 600 W **D** 700 W

October/November 2013 (11)

17 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 2.5×10^3 J **B** 4.3×10^3 J **C** 5.0×10^3 J **D** 1.0×10^4 J

18 A car travelling on a level road at a steady $20\,m\,s^{-1}$ against a constant resistive force develops a power of 40 kW.

What is the magnitude of the resistive force?

A 200 N **B** 800 N **C** 2000 N **D** 4000 N

19 A turbine at a hydroelectric power station is situated 30 m below the level of the surface of a large lake. The water passes through the turbine at a rate of $340\,m^3$ per minute.

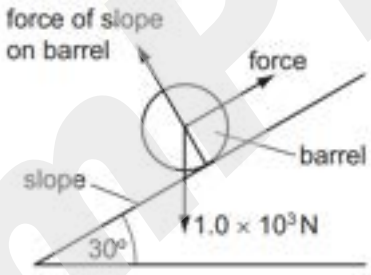
The overall efficiency of the turbine and generator system is 90%.

What is the output power of the power station? (The density of water is $1000\,kg\,m^{-3}$.)

A 0.15 MW **B** 1.5 MW **C** 1.7 MW **D** 90 MW

October/November 2013 (12)

17 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 2.5×10^3 J B 4.3×10^3 J **C** 5.0×10^3 J **D** 1.0×10^4 J

18 A car travelling on a level road at a steady $20\,m\,s^{-1}$ against a constant resistive force develops a power of 40 kW.

What is the magnitude of the resistive force?

A 200 N **B** 800 N **C** 2000 N **D** 4000 N

19 A turbine at a hydroelectric power station is situated 30 m below the level of the surface of a large lake. The water passes through the turbine at a rate of 340 m^3 per minute.

The overall efficiency of the turbine and generator system is 90%.

What is the output power of the power station? (The density of water is 1000 $kg\,m^{-3}$.)

A 0.15 MW **B** 1.5 MW **C** 1.7 MW **D** 90 MW

October/November 2013 (13)

17 The pump of a water pumping system uses 2.0 kW of electrical power when raising water. The pumping system lifts 16 kg of water per second through a vertical height of 7.0 m.

What is the efficiency of the pumping system?

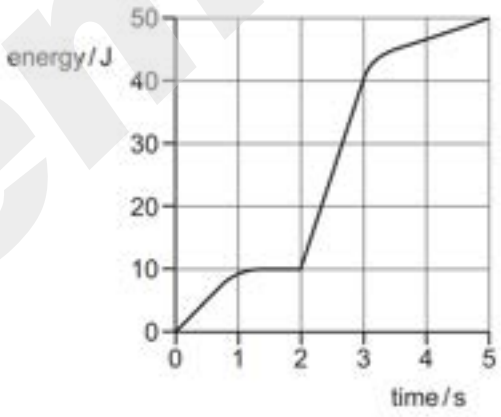
A 1.8% **B** 5.6% **C** 22% **D** 55%

18 A body travelling with a speed of 20 $m\,s^{-1}$ has kinetic energy E_k.

If the speed of the body is increased to 80 $m\,s^{-1}$, what is its new kinetic energy?

A $4E_k$ **B** $8E_k$ **C** $12E_k$ **D** $16E_k$

19 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?

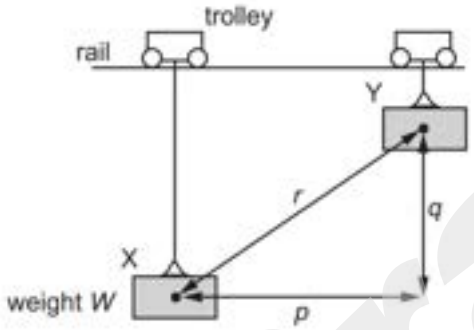
A 10 W **B** 13 W **C** 30 W **D** 50 W

May/June 2014 (11)

14 What is the average power output of a laser that can deliver 0.20 J of energy in 10 ns?

A 2 nW **B** 20 mW **C** 200 kW **D** 20 MW

15 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*

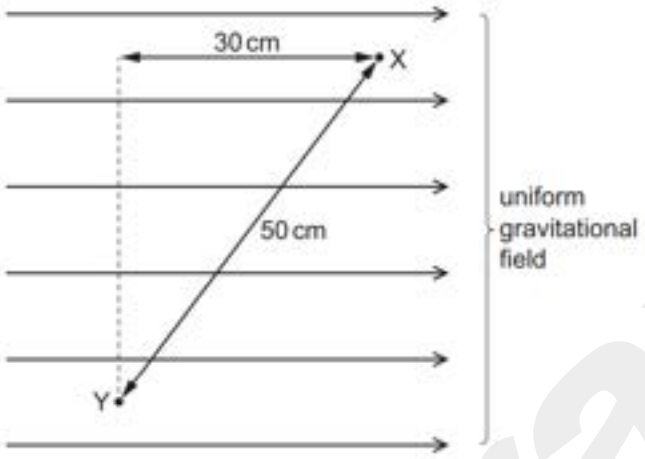
16 The engine of a car exerts a force of 600 N in moving the car 1.0 km in 150 seconds.

What is the average output power of the engine?

A 4.0 W **B** 4.0 kW **C** 90 kW **D** 90 MW

May/June 2014 (12)

14 A mass at point X inside a uniform gravitational field experiences a gravitational force of 0.200 N. It has 1.00 J of gravitational potential energy.



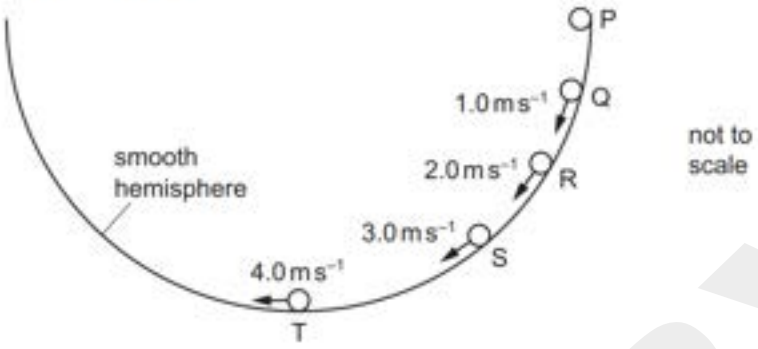
The mass is then moved to point Y.

What is its new gravitational potential energy?

A 0.90 J **B** 0.94 J **C** 1.06 J **D** 1.10 J

15 A small mass is placed at point P on the inside surface of a smooth hemisphere. It is then released from rest. When it reaches the lowest point T, its speed is $4.0\,m\,s^{-1}$.

The diagram (not to scale) shows the speed of the mass at other points Q, R and S as it slides down. Air resistance is negligible.



The mass loses potential energy E in falling from P to T.

At which point has the mass lost potential energy $\frac{E}{4}$?

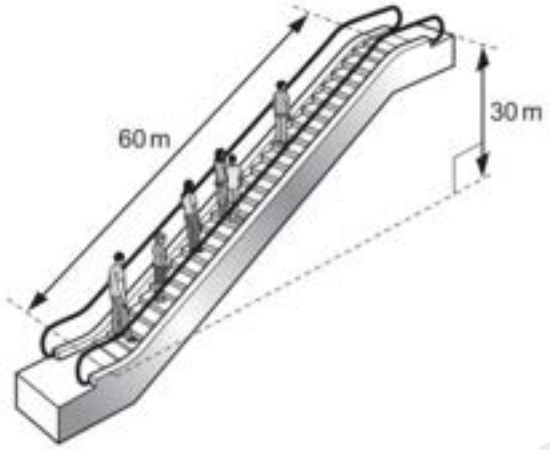
A Q

B R

C S

D none of these

16 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

May/June 2014 (13)

14 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.

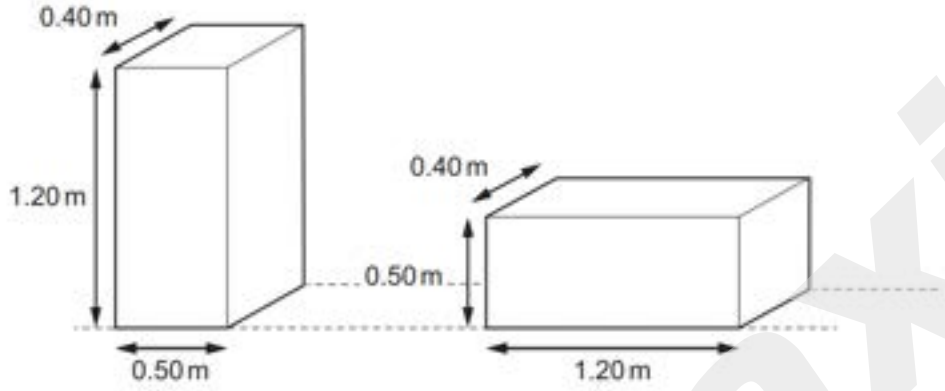
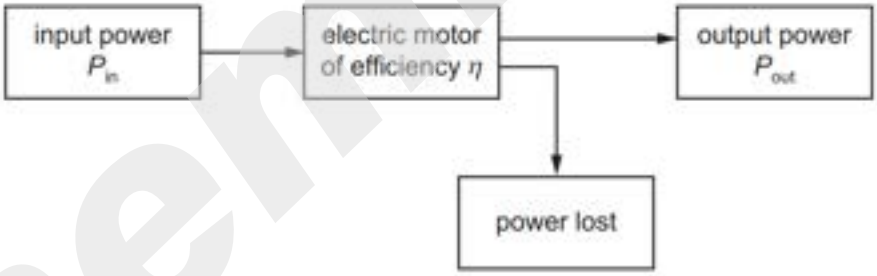


diagram 1 diagram 2

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

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



How much power is lost by the motor?

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

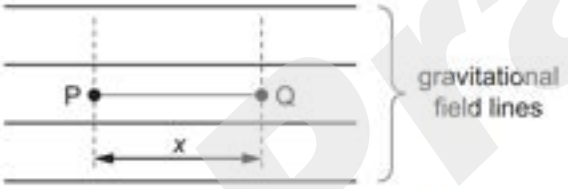
October/November 2014 (11)

13 A mass attached to the lower end of a spring bounces up and down.

At which points in the path of the mass do the gravitational potential energy of the mass (GPE), the elastic potential energy in the spring (EPE) and the kinetic energy of the mass (KE) have their highest values?

	GPE	EPE	KE
A	bottom	middle	top
B	bottom	top	middle
C	top	bottom	middle
D	top	bottom	top

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

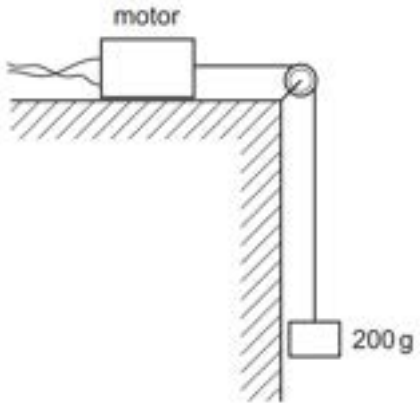


When the mass moves through a displacement *x*, from P to Q, it loses an amount of potential energy *E*.

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

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

15 A small electric motor is mounted on a bench, as shown. The motor is connected to a 6.0 V supply and the current in the motor is 0.50 A. The motor is 50% efficient.



What is the time taken to lift a mass of 200 g up through a height of 90 cm?

A 0.59 s **B** 0.85 s **C** 1.2 s **D** 2.7 s

16 A projectile is launched at 45° to the horizontal with initial kinetic energy *E*.

Assuming air resistance to be negligible, what will be the kinetic energy of the projectile when it reaches its highest point?

A 0.50*E* **B** 0.71*E* **C** 0.87*E* **D** *E*

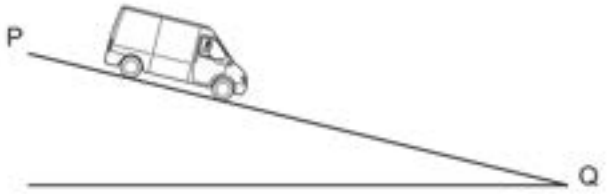
October/November 2014 (13)

17 A box of weight 30 N is released from rest on a ramp that is at an angle of 30° to the horizontal. The box slides down the ramp so that it falls through a vertical distance of 8.0 m. A constant frictional force of 10 N acts on the box while it is moving.

What is the kinetic energy of the box after falling through this distance?

A 80 J **B** 160 J **C** 240 J **D** 400 J

19 A van driver adjusts the force on a van's brakes so that the van travels at constant speed down a hill from P to Q.



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

Which statement is correct?

A $\Delta E_k > \Delta E_p$

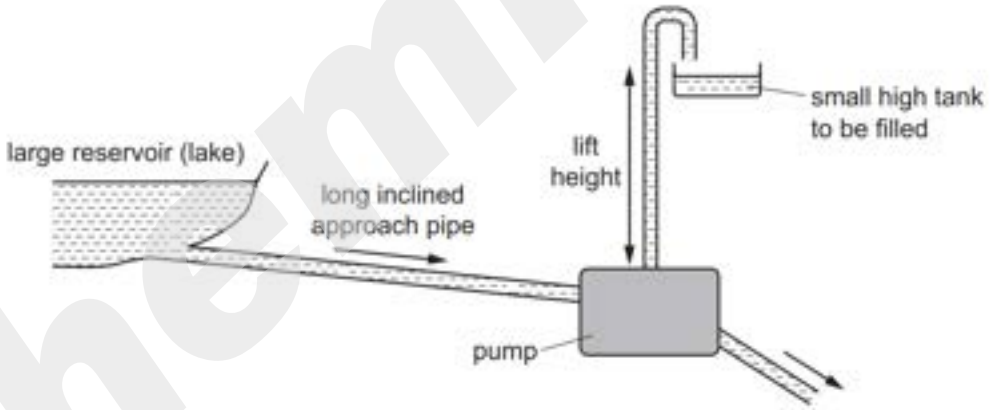
B $\Delta E_k = \Delta E_p$

C $\Delta E_p > \Delta E_k > 0$

D $\Delta E_k = 0$

May/June 2015 (11)

18 The diagram shows a pump called a hydraulic ram.



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

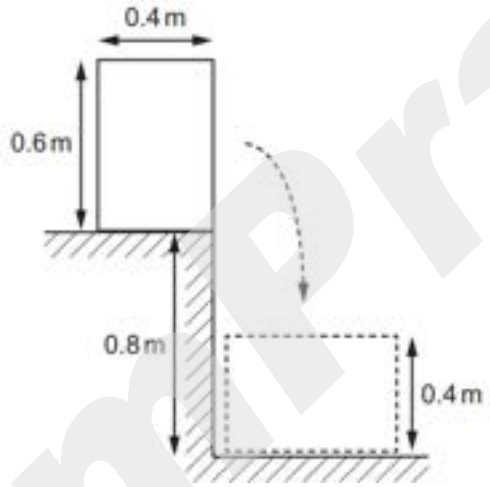
19 A conveyor belt is driven at velocity v by a motor. Sand drops vertically on to the belt at a rate of $m\,\text{kg}\,\text{s}^{-1}$.

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

May/June 2015 (12)

15 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.



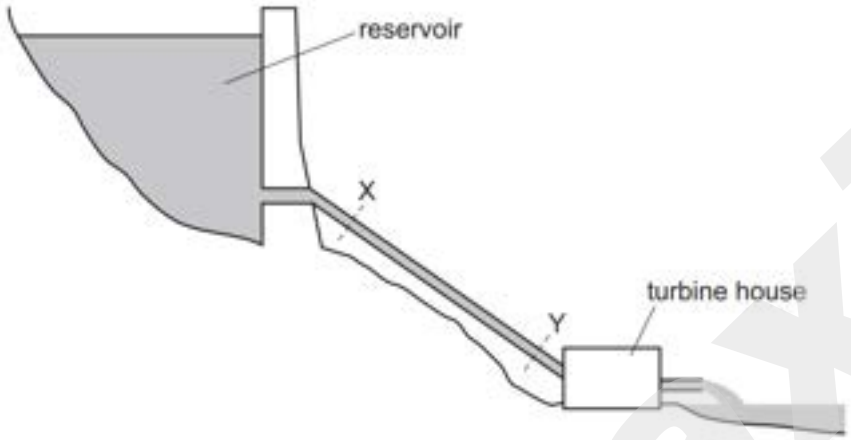
The block is knocked over the edge of the step and rotates through 90° before coming to rest with the 0.6 m edge horizontal.

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

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

16 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.

17 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 $m s^{-1}$.

What is the energy gained by the fish?

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

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

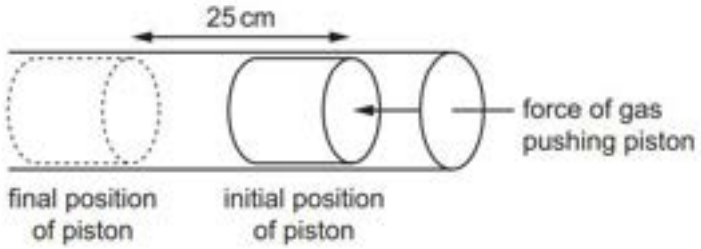
The electrical output from the generator driven by the turbine is 200 A at a potential difference of 6000 V.

What is the efficiency of the system?

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

May/June 2015 (13)

17 The gas in an engine does work on a piston of cross-sectional area 80 cm^2. The pressure on the piston has a constant value of 4.6×10^5 Pa.



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

18 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 $J\,s^{-1}$

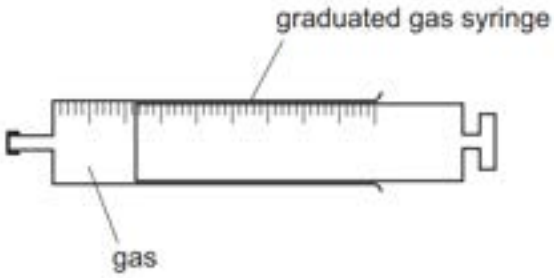
19 When a horizontal force *F* is applied to a frictionless trolley over a distance *s*, the kinetic energy of the trolley changes from 4.0 J to 8.0 J.

If a force of 2*F* is applied to the trolley over a distance of 2*s*, what will the original kinetic energy of 4.0 J become?

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

October/November 2015 (11)

15 A gas is contained inside a sealed syringe, as shown.



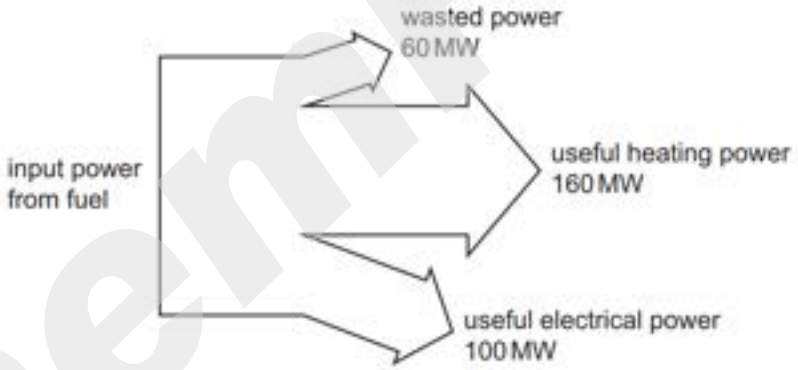
The volume of gas at room temperature is 2.0 cm^3.

Atmospheric pressure is 101 kPa.

What is the work done by the gas when it is heated and expands to a volume of 6.0 cm^3?

A 404 μJ **B** 404 mJ **C** 404 J **D** 404 kJ

16 A combined heat and power (CHP) station generates electrical power and useful heat. The diagram shows the input and output for a CHP station.



What is the efficiency of the CHP station for producing useful power?

A 31% **B** 38% **C** 50% **D** 81%

17 In 'normal driving conditions', an electric car has a range of 150 km. This uses all of the 200 MJ energy stored in its batteries.

With the batteries initially fully charged, the car is driven 100 km in 'normal driving conditions'. The batteries are then recharged from a household electrical supply delivering a constant current of 13.0 A at a potential difference (p.d.) of 230 V.

What is the minimum time required to recharge the batteries?

A 0.95 hours

B 12.4 hours

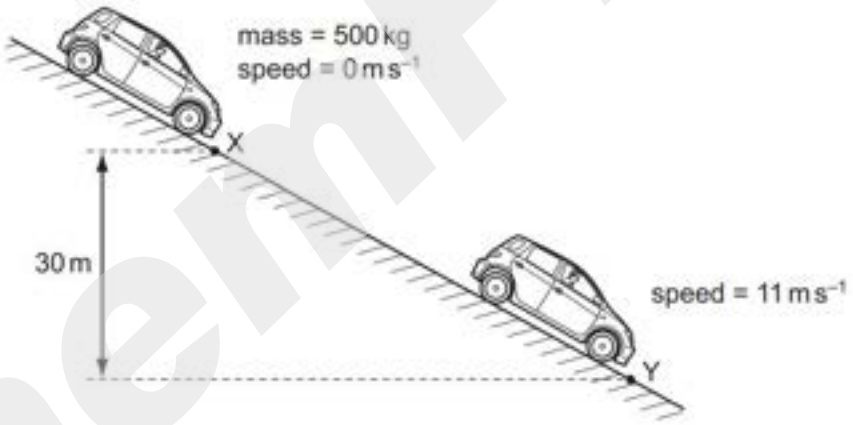
C 18.6 hours

D 27.9 hours

October/November 2015 (12)

16 A car of mass 500 kg is at rest at point X on a slope, as shown.

The car's brakes are released and the car rolls down the slope with its engine switched off. At point Y the car has moved through a vertical height of 30 m and has a speed of 11 m s^{-1}.



What is the energy dissipated by frictional forces when the car moves from X to Y?

A 3.0×10^4 J **B** 1.2×10^5 J **C** 1.5×10^5 J **D** 1.8×10^5 J

17 In which situation is **no** work done?

A The air in a bicycle tyre is released because of a puncture.

B A ball is dropped and falls to the ground.

C A box moves at constant speed across a smooth horizontal surface.

D A crane lifts a steel girder at constant speed.

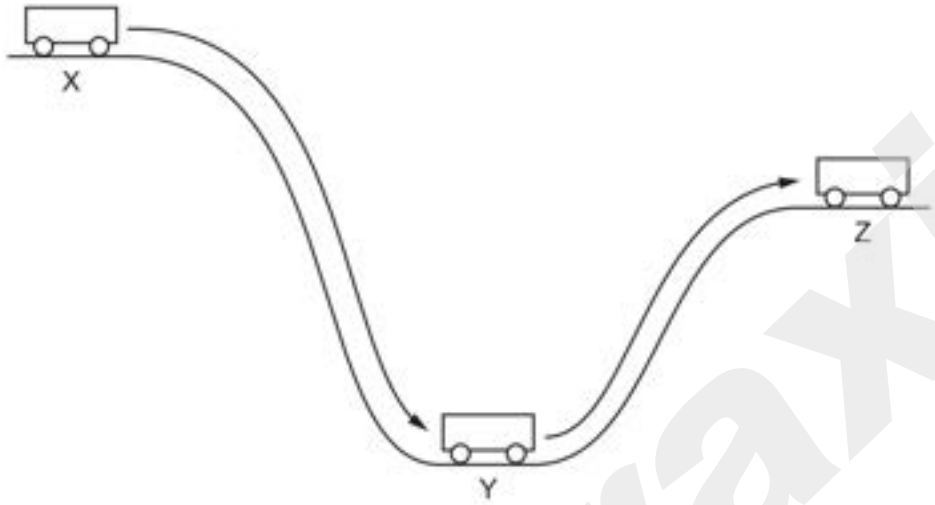
18 An electric railway locomotive has a maximum mechanical output power of 4.0 MW. Electrical power is delivered at 25 kV from overhead wires. The overall efficiency of the locomotive in converting electrical power to mechanical power is 80 %.

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

October/November 2015 (13)

16 A trolley starts from rest at X. It rolls down to Y and eventually comes to rest at Z.



Which row is a possible summary of the energy changes during this process?

	X to Y	Y to Z
A	p.e. → k.e.	k.e. → p.e.
B	p.e. → k.e.	k.e. → p.e. + heat
C	p.e. → k.e. + heat	k.e. → p.e.
D	p.e. → k.e. + heat	k.e. → p.e. + heat

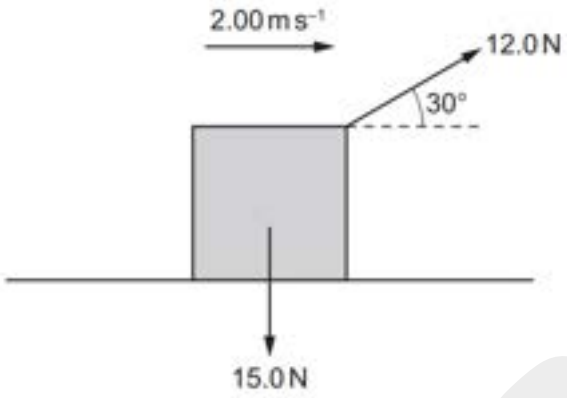
key

p.e. = potential energy

k.e. = kinetic energy

17 An object of weight 15.0 N is pulled along a horizontal surface at a constant velocity of 2.00 m s^{-1}.

The force pulling the object is 12.0 N at 30° to the horizontal, as shown.



What is the power used to move the object?

A 12.0 W **B** 20.8 W **C** 24.0 W **D** 30.0 W