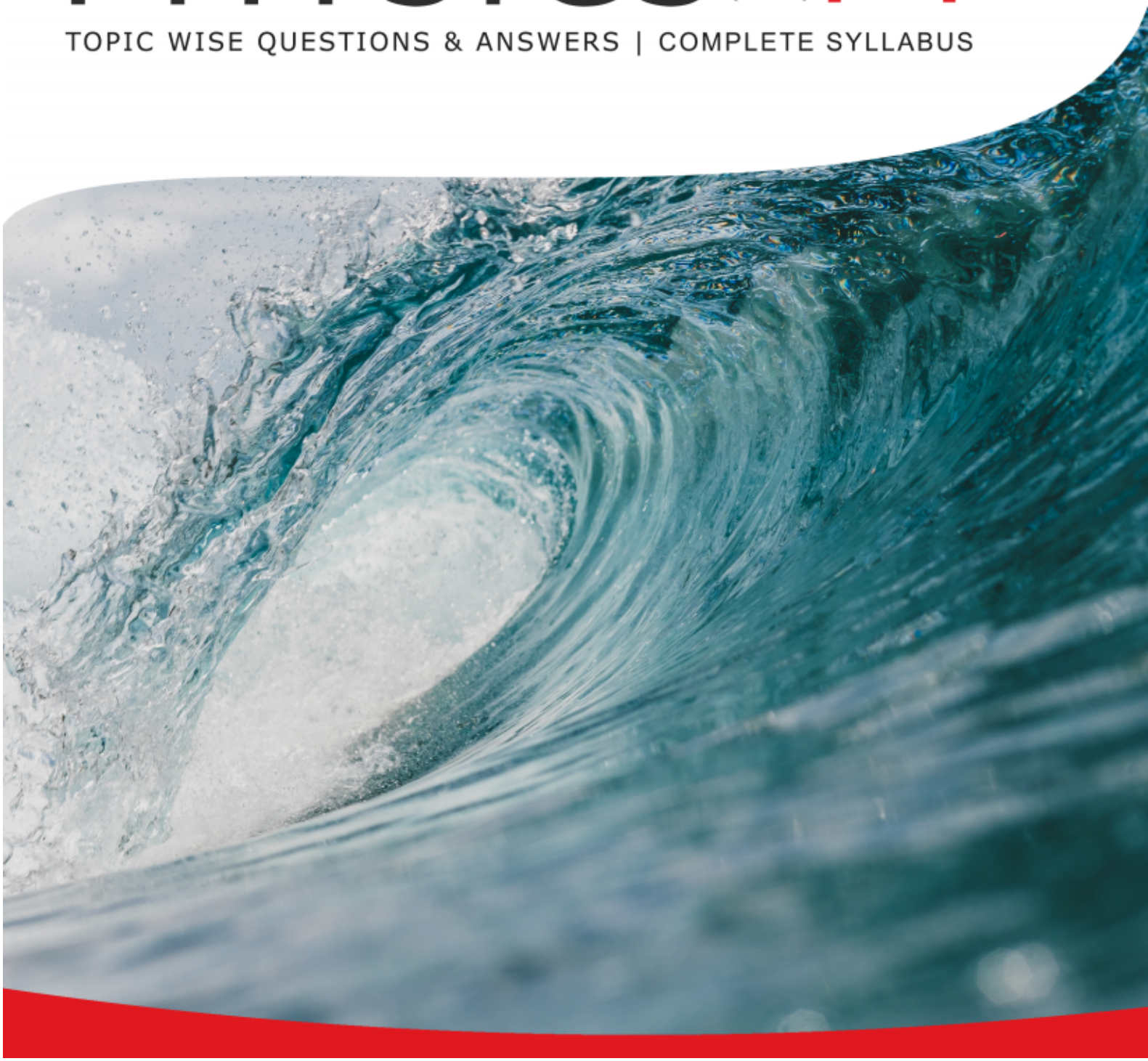
Cambridge International AS & A Level

PHYSICS (9702) P1

TOPIC WISE QUESTIONS & ANSWERS | COMPLETE SYLLABUS



PapaCambridge

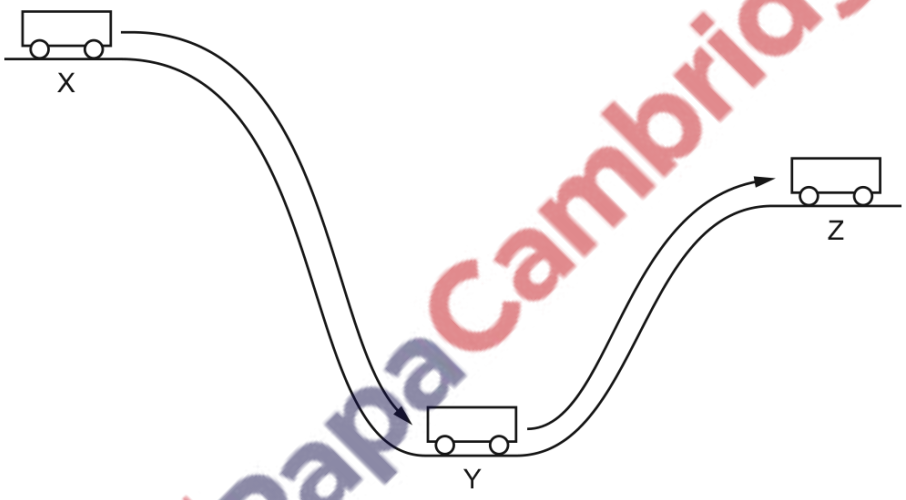
Chapter 6

Work, energy and power

6.1 Energy conversion and conservation

499. 9702_s20_qp_13 Q: 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	PE → KE	KE → PE
B	PE → KE	KE → PE + heat
C	PE → KE + heat	KE → PE
D	PE → KE + heat	KE → PE + heat

key
PE = potential energy
KE = kinetic energy

500. 9702_m19_qp_12 Q: 15

Which statement best represents the principle of conservation of energy?

A Energy cannot be used faster than it is created.

B The supply of energy is limited, so energy must be conserved.

C The total energy in a closed system is constant.

D The total energy input to a system is equal to the useful energy output.

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501. 9702_s19_qp_13 Q: 15

Which statement about the principle of conservation of energy is correct?

A Energy conversion helps to conserve energy sources.

B Energy is conserved only in systems with an efficiency of 100%.

C The supply of energy is limited so energy should be conserved.

D The total amount of energy in a closed system is constant.

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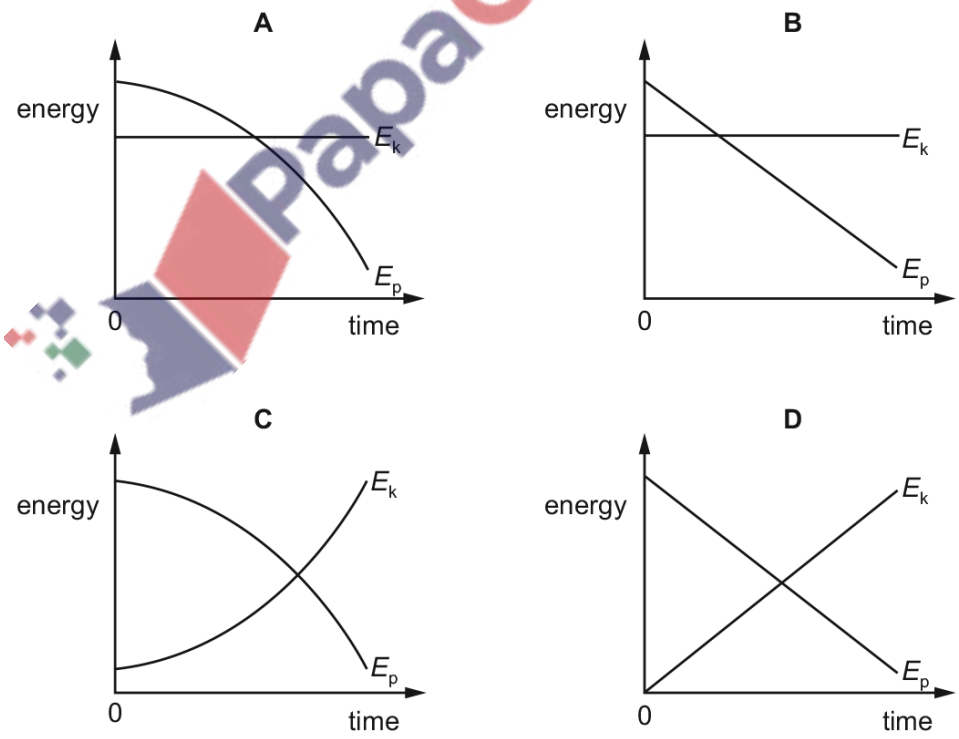
502. 9702_w19_qp_13 Q: 16

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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503. 9702_w18_qp_11 Q: 14

A rocket is fired upwards.

As it accelerates upwards after leaving the launch pad, which forms of energy are changing?

A chemical energy, gravitational potential energy and kinetic energy

B chemical energy and gravitational potential energy only

C chemical energy and kinetic energy only

D gravitational potential energy and kinetic energy only

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504. 9702_w18_qp_12 Q: 15

A bungee jumper on a platform over a river is attached to an elastic rope that is 20 m long when unstretched. He falls towards the river and his lowest point is 30 m below the platform.

The initial gravitational potential energy of the jumper is transferred to other forms during the jump.

Which other forms of energy do the jumper and rope have when the jumper has fallen half-way and when he is at the lowest point of his jump?

	half-way	lowest point
A	kinetic energy and elastic potential energy	kinetic energy and elastic potential energy
B	kinetic energy and elastic potential energy	elastic potential energy only
C	kinetic energy only	kinetic energy and elastic potential energy
D	kinetic energy only	elastic potential energy only

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505. 9702_s17_qp_11 Q: 15

A man climbs slowly at a steady speed to the top of a ladder.

What is the **main** energy transfer taking place for the man as he climbs?

A chemical potential to gravitational potential

B chemical potential to kinetic

C kinetic to gravitational potential

D thermal (heat) to kinetic

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506. 9702_w17_qp_13 Q: 15

A ball is thrown vertically upwards. Air resistance is negligible.

Which statement is correct?

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

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

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

D The potential energy of the ball increases at a constant rate during its ascent.

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507. 9702_s16_qp_12 Q: 16

A parachutist is falling at constant (terminal) velocity.

Which statement is **not** correct?

A Gravitational potential energy is converted into kinetic energy of the air.

B Gravitational potential energy is converted into kinetic energy of the parachutist.

C Gravitational potential energy is converted into thermal energy of the air.

D Gravitational potential energy is converted into thermal energy of the parachutist.

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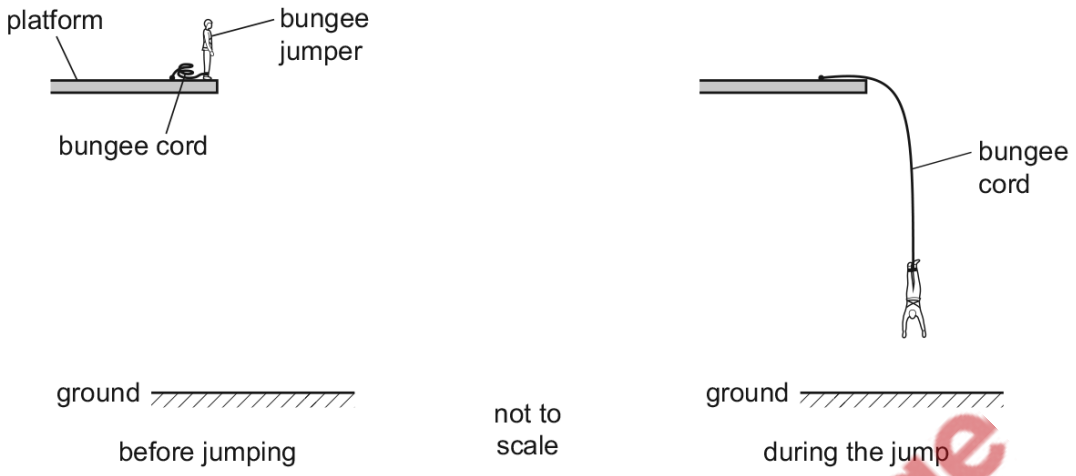
508. 9702_s16_qp_13 Q: 16

A bungee jumper jumps from a platform and is decelerated by an elastic bungee cord, as shown.



When the jumper makes the jump, his initial gravitational potential energy is converted into his kinetic energy and into elastic potential energy in the cord.

At which part of the jump are all three types of energy non-zero?

A on the platform before the jump

B on the way down before the cord has started to extend

C on the way down as he decelerates

D at the bottom of the jump when he is stationary

6.2 Work and efficiency

509. 9702_m20_qp_12 Q: 14

A cylinder contains a volume of $0.012\,m^3$ of gas at a pressure of $1.0 \times 10^5\,Pa$.

400 J of work is done on this gas, with its pressure remaining constant throughout.

What is the final volume of the gas?

A $0.0040\,m^3$ **B** $0.0080\,m^3$ **C** $0.016\,m^3$ **D** $0.020\,m^3$

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510. 9702_m20_qp_12 Q: 16

A sledge of mass 50 kg sits on a snowy surface. It is pulled horizontally for 10 m against a frictional force of 200 N, then it is pulled horizontally across ice for 10 m. There is no friction between the ice and the sledge. It is lifted up vertically by 1 m and finally carried back at a constant speed to where it started.

During which stage of its journey is most work done on the sledge?

A being carried back 20 m at constant speed

B being lifted up 1 m

C being pulled 10 m across ice

D being pulled 10 m across snow

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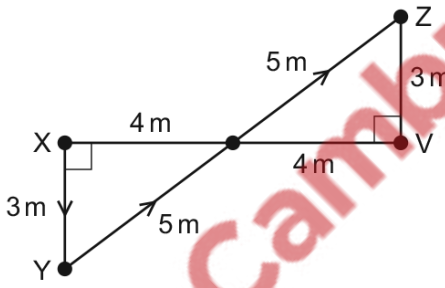
511. 9702_m20_qp_12 Q: 17

An object is moved in a vertical plane from X to Y, and then from Y to Z, as shown in the diagram.



The distances between various points are indicated on the diagram.

Lines XY and VZ are vertical.

The object weighs 20 N.

How much gravitational potential energy does the object gain by moving from X to Z?

A 60 J **B** 120 J **C** 140 J **D** 260 J

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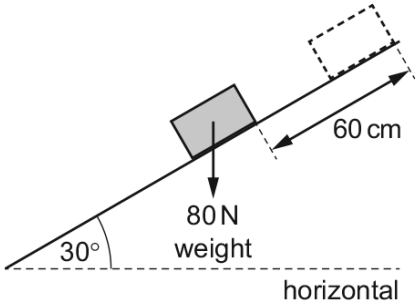
512. 9702_s20_qp_11 Q: 17

A block of weight 80 N is pushed a distance of 60 cm up a slope inclined at 30° to the horizontal. There is a frictional force of 25 N between the block and the surface of the slope.



What is the work W_g done against the gravitational force and the work W_f done against the frictional force?

	W_g / J	W_f / J
A	24	7.5
B	24	15
C	48	7.5
D	48	15

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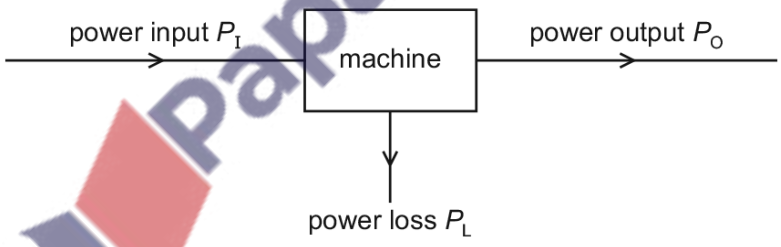
513. 9702_s20_qp_11 Q: 19

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

---

514. 9702_s20_qp_12 Q: 14

During an interval of time, fuel supplies energy X to a car.

Some of this energy is converted into kinetic energy as the car accelerates.

The rest of the energy Y is lost as thermal energy.

What is the efficiency of the car?

A $\frac{X}{X-Y}$ **B** $\frac{Y}{X-Y}$ **C** $\frac{X-Y}{X}$ **D** $\frac{X-Y}{Y}$

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515. 9702_s20_qp_12 Q: 15

In which situation is work done on an object?

A The object slides with a constant velocity along a horizontal frictionless surface in a vacuum.

B A person holds the object at arm's length and at a fixed height above the ground.

C A person pushes the object up a frictionless ramp.

D The stationary object floats partially submerged in water.

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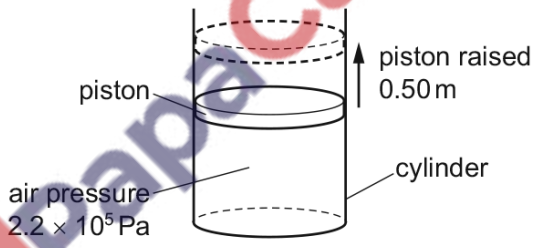
516. 9702_s20_qp_13 Q: 17

A cylinder is heated, causing the air inside to expand at a constant pressure of 2.2×10^5 Pa.



The expansion of the air causes the piston to rise through a vertical distance of 0.50 m, doing 11 kJ of work. Frictional forces are negligible.

What is the cross-sectional area of the piston?

A $1.0 \times 10^{-4}\,m^2$

B $2.5 \times 10^{-2}\,m^2$

C $5.0 \times 10^{-2}\,m^2$

D $1.0 \times 10^{-1}\,m^2$

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517. 9702_s19_qp_11 Q: 8

A positive charge of 2.6×10^{-8} C is in a uniform electric field of field strength 300 000 V m^{-1}.

How much work must be done on the charge in order to move it a distance of 4.0 mm in the opposite direction to the direction of the field?

A 3.1×10^{-5} J

B 2.0×10^{-3} J

C 3.1×10^{-2} J

D 2.0 J

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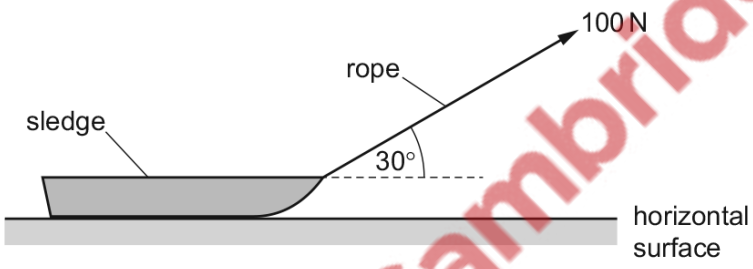
518. 9702_s19_qp_11 Q: 17

A rope is attached to a sledge and a boy uses the rope to pull the sledge along a horizontal surface with a constant velocity. The tension in the rope is 100 N and the rope is held at 30° to the horizontal.



How much work does the boy do on the sledge when he pulls it a distance of 5.0 m along the surface?

A 250 J **B** 290 J **C** 430 J **D** 500 J

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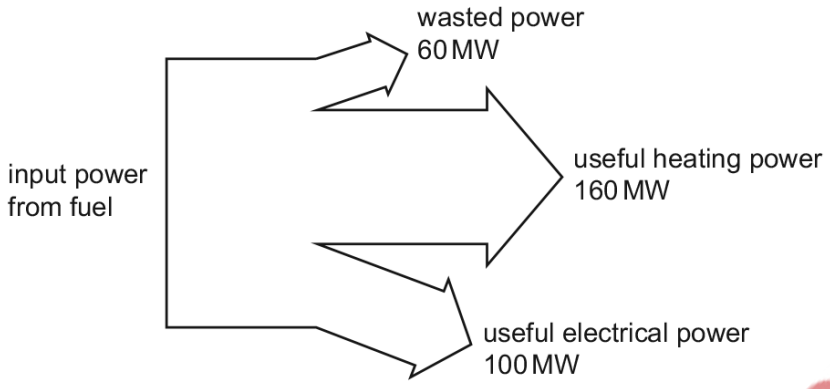
519. 9702_s19_qp_12 Q: 17

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



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

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

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520. 9702_w19_qp_11 Q: 15

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

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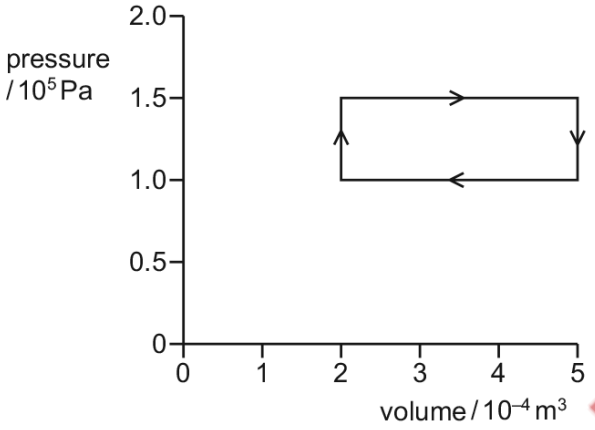
521. 9702_w19_qp_11 Q: 16

A fixed amount of a gas undergoes a series of changes to its pressure and volume.

In two of the changes, no work is done by or on the gas. In one change work is done by the gas on its surroundings. In another change work is done on the gas by its surroundings.



During the change when work is done on the gas by its surroundings, how much work is done on the gas?

A 15 J **B** 25 J **C** 30 J **D** 45 J

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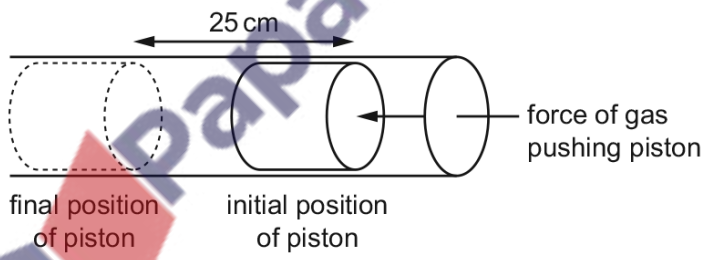
522. 9702_w19_qp_12 Q: 14

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

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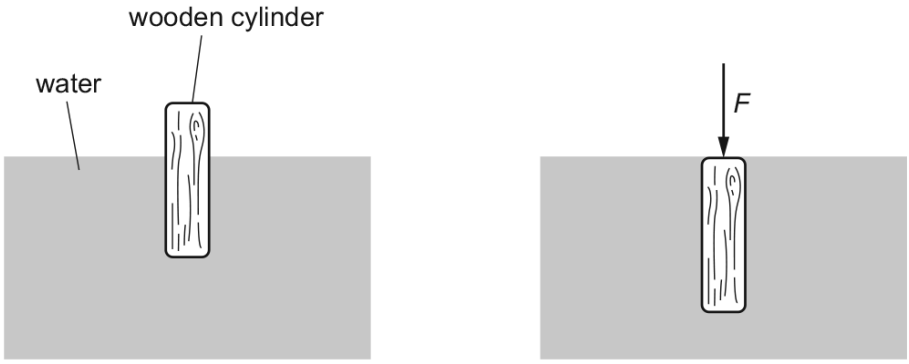
523. 9702_w19_qp_12 Q: 16

A wooden cylinder floats partially submerged in a bath of water. A force F is applied to the cylinder until it is just fully submerged.



Which statement is **not** correct?

A Some of the water gains gravitational potential energy.

B The cylinder loses gravitational potential energy.

C Work is done by force F on the cylinder.

D Work is done by the upthrust on the cylinder.

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524. 9702_w19_qp_13 Q: 15

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

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

How much work is done by the piston?

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

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525. 9702_w19_qp_13 Q: 18

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

The acceleration of free fall is g.

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

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

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526. 9702_m18_qp_12 Q: 15

An old-fashioned 60 W lamp converts 95% of its energy supply into heat. A 4.0 W modern lamp has the same power output of light as the old-fashioned lamp.

What is the efficiency of the modern lamp?

A 5.0% **B** 6.7% **C** 75% **D** 95%

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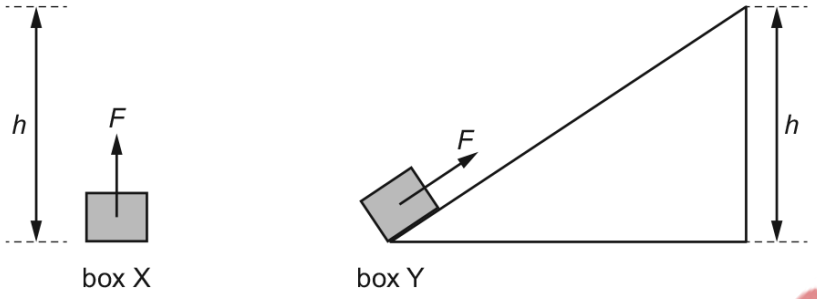
527. 9702_m18_qp_12 Q: 18

Two boxes X and Y have the same mass. Box X is lifted vertically through a height *h* by a force of magnitude *F*.

Box Y is pulled along a slope by a force of the same magnitude to reach the same height, as shown.



Which statement is correct?

A Both boxes gain the same amount of gravitational potential energy and the same amount of work is done by the two forces.

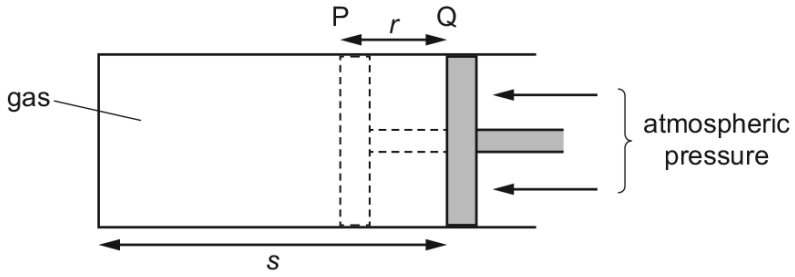
B Both boxes gain the same amount of gravitational potential energy but more work is done by the force acting on box Y than by the force acting on box X.

C Box Y gains less gravitational potential energy than box X because the weight of box Y is less than the weight of box X.

D Box Y gains more gravitational potential energy than box X as more work is done by the force acting on box Y than by the force acting on box X.

528. 9702_s18_qp_13 Q: 14

Gas is trapped inside a cylinder by a piston of cross-sectional area *A*. The piston is **not** frictionless.



The gas is heated and this causes it to expand, pushing back the piston through distance *r* from position P to position Q. The length of the gas column is then *s*.

Which expression represents the amount of work done by the gas against the atmosphere during this expansion?

A (atmospheric pressure) × *Ar*

B (atmospheric pressure) × *As*

C (pressure inside the gas) × *Ar*

D (pressure inside the gas) × *As*

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529. 9702_s18_qp_13 Q: 15

Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 510 kg s^{-1}. The reservoir is 280 m above the level of the turbine.

The electrical output from the generator driven by the turbine is a current of 205 A at a potential difference of 5800 V.

What is the efficiency of the system?

A 8.3% **B** 12% **C** 83% **D** 85%

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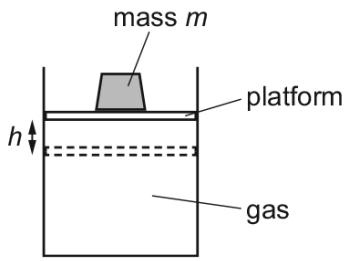
530. 9702_w18_qp_11 Q: 15

A mass m is on top of a platform that is supported by gas in a cylinder of cross-sectional area A, as shown.



The platform has negligible mass and can move freely up and down.

The gas is heated and expands so that the mass is raised through a height h. Atmospheric pressure is p.

What is the ratio $\frac{\text{gain in gravitational potential energy of the mass}}{\text{work done by the gas}}$?

A $\frac{mg}{pA}$ **B** $\frac{mg}{mg + pA}$ **C** $\frac{pA}{mg}$ **D** $\frac{mg - pA}{mg}$

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531. 9702_w18_qp_12 Q: 16

A cylinder contains a fixed mass of gas. The gas, at a constant pressure of 1.3×10^5 Pa, expands from a volume of 900 cm^3 to a volume of 1100 cm^3.

What is the work done by the gas during this expansion?

A 26 J **B** 130 J **C** 2600 J **D** 13 000 J

---

532. 9702_w18_qp_13 Q: 15

Which statement about energy is **not** correct?

A Energy is never lost but it may be transferred between different forms.

B In an inelastic collision, the total energy is constant.

C The efficiency of a system is the ratio of the useful energy output to the total energy input.

D When a machine does work, friction reduces the total energy.

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533. 9702_w18_qp_13 Q: 17

On a planet, a gravitational force F acts on a mass of 6.0 kg. The mass is moved by force F a distance of 30 m in the direction of the gravitational field. The work done by the field is 450 J.

What is the force F on the mass and what is the acceleration of free fall g on the planet?

	F/N	g/m s^{-2}
A	0.067	0.011
B	0.067	0.40
C	15	2.5
D	15	90

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534. 9702_m17_qp_12 Q: 16

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

What is the efficiency of the process?

A $\frac{U}{E_{in}} \times 100\%$

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

C $\frac{U}{W} \times 100\%$

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

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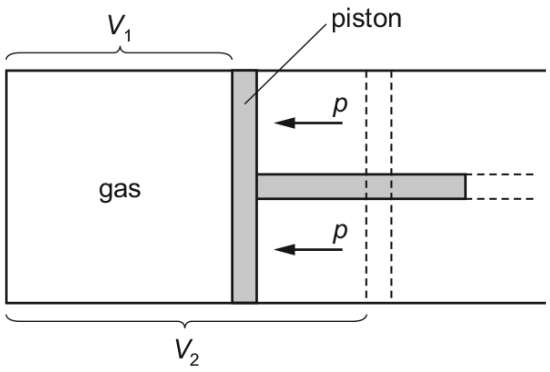
535. 9702_m17_qp_12 Q: 17

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 the external pressure p. The gas is then heated slowly so that it expands at constant pressure, 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** $\frac{1}{2}p(V_2 + V_1)$

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536. 9702_s17_qp_11 Q: 16

During an interval of time, fuel supplies energy X to a car.

Some of this energy is converted into kinetic energy as the car accelerates.

The rest of the energy Y is lost as thermal energy.

What is the efficiency of the car?

A $\frac{X}{X-Y}$ **B** $\frac{Y}{X-Y}$ **C** $\frac{X-Y}{X}$ **D** $\frac{X-Y}{Y}$

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537. 9702_s17_qp_11 Q: 17

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

How much useful 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** $2.0 \times 10^9\,\text{J}$

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538. 9702_s17_qp_12 Q: 17

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 $3.4 \times 10^6\,J$ **B** $6.8 \times 10^6\,J$ **C** $3.4 \times 10^9\,J$ **D** $6.8 \times 10^9\,J$

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539. 9702_s17_qp_13 Q: 14

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 the gravitational field 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

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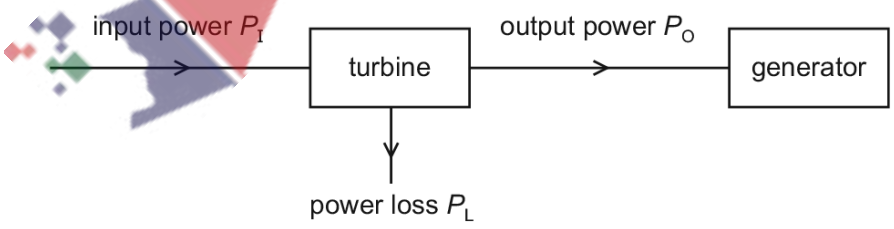
540. 9702_s17_qp_13 Q: 15

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

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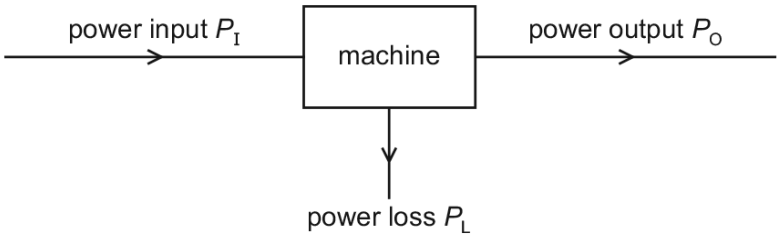
541. 9702_w17_qp_11 Q: 16

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

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542. 9702_w17_qp_11 Q: 17

A piston in a gas supply pump has an area of 400 cm^2. The pump moves the gas against a fixed pressure of 3000 Pa.

During part of its stroke, the piston moves a distance of 25 cm in one direction. How much work is done by the piston during this movement?

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

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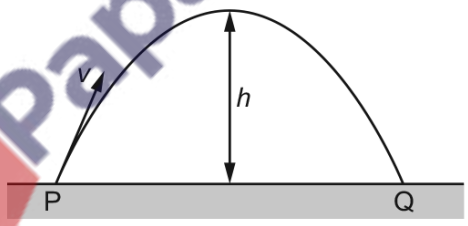
543. 9702_w17_qp_12 Q: 16

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



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

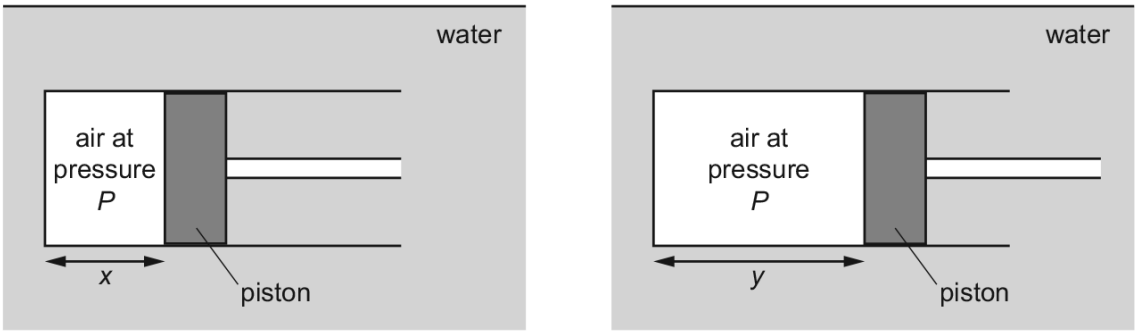
What is the **total** work done by the gravitational force on the ball during its flight from P to Q?

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

---

544. 9702_w17_qp_13 Q: 17

A horizontal cylinder of cross-sectional area A is fitted with a frictionless piston and contains air at pressure P. It is immersed in hot water and the length of the air column increases from x to y. The pressure P is constant.



Which equation represents the work done by the trapped air during this process?

A PAy **B** $-PAy$ **C** $PA(y-x)$ **D** $-PA(y-x)$

---

545. 9702_m16_qp_12 Q: 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?

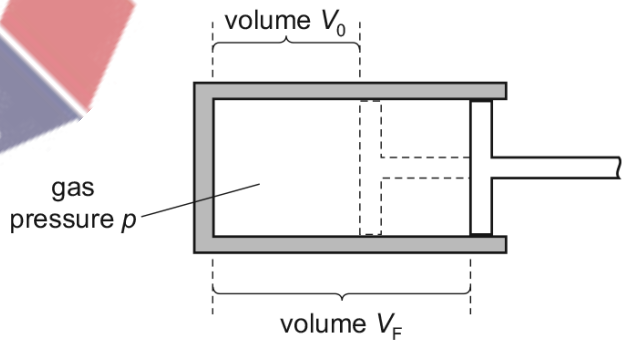
A 1.8% **B** 5.6% **C** 22% **D** 55%

---

546. 9702_s16_qp_11 Q: 16

Some gas in a cylinder is supplied with thermal energy q.

The gas does useful work in expanding at constant pressure p from volume V_0 to volume V_F, as shown.



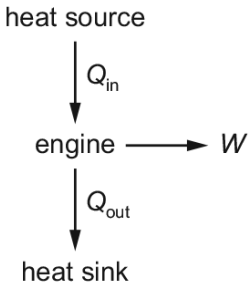
Which expression gives the efficiency of this change?

A $\frac{pV_0}{q}$ **B** $\frac{V_F}{V_0 q}$ **C** $\frac{p(V_F - V_0)}{q}$ **D** $\frac{(V_F - V_0)}{V_0 q}$

---

547. 9702_w16_qp_11 Q: 18

An engine transforms thermal energy into mechanical work. The engine takes in thermal energy Q_{in} from a heat source and gives out thermal energy Q_{out} to a heat sink, producing useful work W.



What is the efficiency of this engine?

A $\frac{W}{Q_{in}+Q_{out}}$ **B** $\frac{W}{Q_{in}-Q_{out}}$ **C** $\frac{W}{Q_{in}}$ **D** $\frac{W}{Q_{out}}$

---

548. 9702_w16_qp_11 Q: 20

Which condition must apply for the work done by an expanding gas to be $p\Delta V$, where p is the pressure of the gas and ΔV is its change in volume?

A No thermal energy must be supplied to the gas.

B The expansion must be at a constant rate.

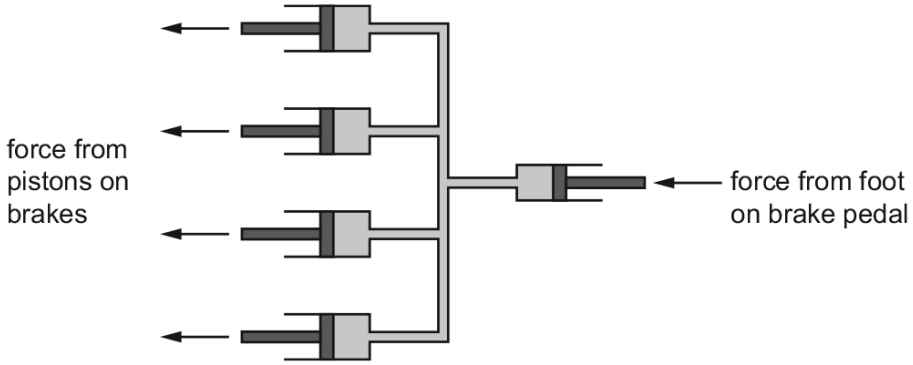
C The pressure must be constant.

D The temperature of the gas must be constant.

---

549. 9702_w16_qp_12 Q: 16

The diagram shows the brake system of a car.



The pipes are filled with incompressible liquid. When a force is applied to the brake pedal, the pressure in the liquid increases and applies a force to each of the four wheels.

The area of the piston connected to the brake pedal is 8 cm^2.

The area of each piston connected to the brakes is 12 cm^2.

A force of 800 N is applied by the foot to the brake pedal.

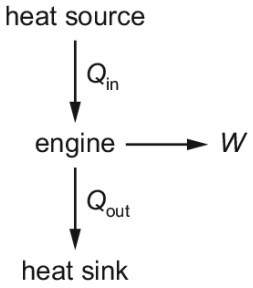
What is the force applied to each brake?

A 300 N **B** 530 N **C** 1200 N **D** 4800 N

---

550. 9702_w16_qp_13 Q: 18

An engine transforms thermal energy into mechanical work. The engine takes in thermal energy Q_{in} from a heat source and gives out thermal energy Q_{out} to a heat sink, producing useful work W.



What is the efficiency of this engine?

A $\frac{W}{Q_{in} + Q_{out}}$ **B** $\frac{W}{Q_{in} - Q_{out}}$ **C** $\frac{W}{Q_{in}}$ **D** $\frac{W}{Q_{out}}$

---

551. 9702_w16_qp_13 Q: 20

Which condition must apply for the work done by an expanding gas to be $p\Delta V$, where p is the pressure of the gas and ΔV is its change in volume?

A No thermal energy must be supplied to the gas.

B The expansion must be at a constant rate.

C The pressure must be constant.

D The temperature of the gas must be constant.

---

552. 9702_s15_qp_11 Q: 16

A team of nine dogs can pull a sledge with a combined force of 800 N at a speed of $1.5\,m\,s^{-1}$ for 360 minutes.

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

A 4.8×10^4 J **B** 4.3×10^5 J **C** 2.9×10^6 J **D** 2.6×10^7 J

---

553. 9702_s15_qp_12 Q: 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.

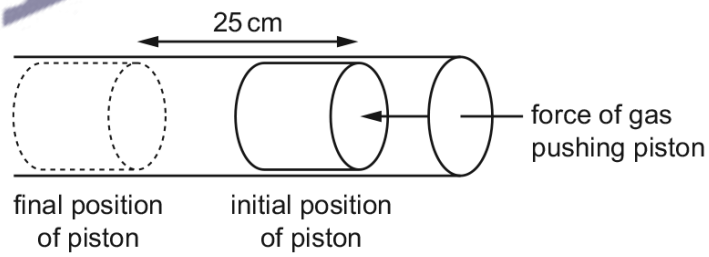
What is the efficiency of the system?

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

---

554. 9702_s15_qp_13 Q: 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

6.3 Potential energy and kinetic energy

555. 9702_m20_qp_12 Q: 15

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.

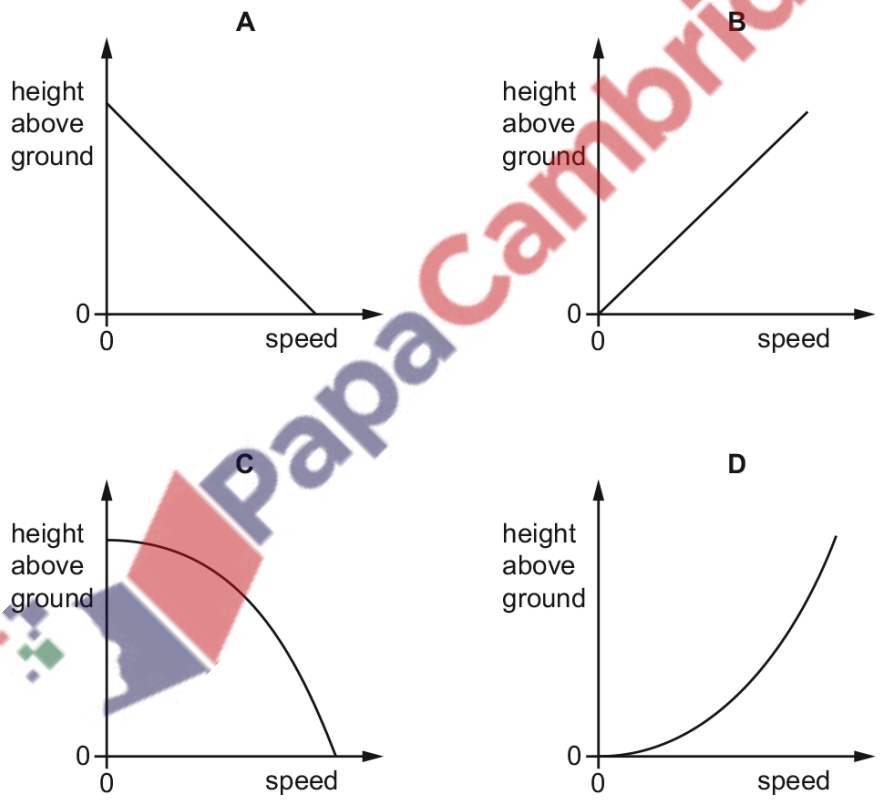
D The total energy of the ball increases.

---

556. 9702_s20_qp_11 Q: 18

A ball is dropped from rest and falls towards the ground. Air resistance is negligible.

Which graph shows the variation with speed of the height of the ball above the ground?



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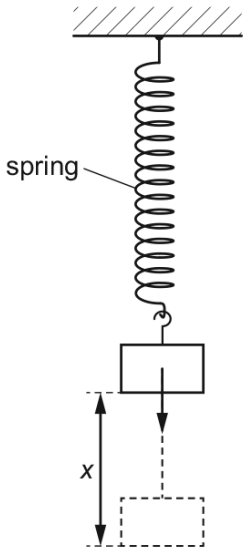
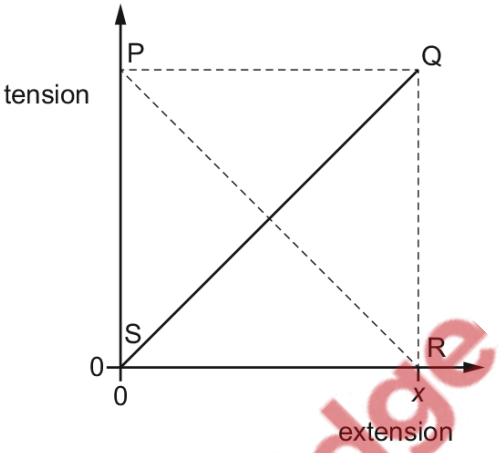
557. 9702_s20_qp_12 Q: 16

A spring is attached at one end to a fixed point. A mass is then hung from the other end of the spring. The spring has extension x when the system is in equilibrium.





The variation of the tension in the spring with its extension is shown on the graph.

Which statement is correct?

A Area SPR represents the energy stored in the spring which cannot be recovered.

B Area SPQR represents the energy stored in the spring which can be recovered.

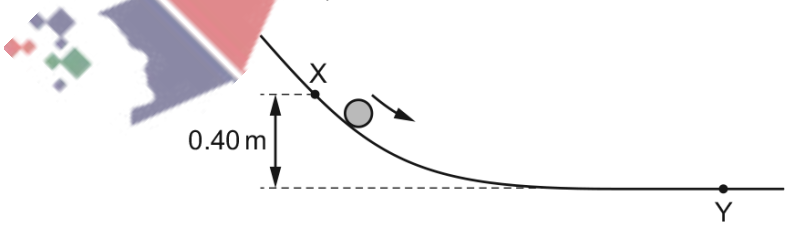
C Area SPQ represents the loss of gravitational potential energy of the mass due to the extension of the spring.

D Area SQR represents the elastic potential energy stored in the spring.

---

558. 9702_s20_qp_13 Q: 18

A ball slides down a curved track, as shown.



Point X is at a height of 0.40 m above point Y. The speed of the ball at point X is 2.5 m s^{-1}.

Frictional forces are negligible.

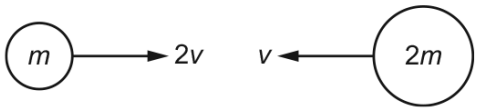
What is the speed of the ball at point Y?

A 2.8 m s^{-1} **B** 3.2 m s^{-1} **C** 3.8 m s^{-1} **D** 14 m s^{-1}

---

559. 9702_m19_qp_12 Q: 10

Two balls, of masses m and $2m$, travelling in a vacuum with initial velocities $2v$ and v respectively, collide with each other head-on, as shown.



After the collision, the ball of mass m rebounds to the left with velocity v.

What is the loss of kinetic energy in the collision?

A $\frac{3}{4}mv^2$ **B** $\frac{3}{2}mv^2$ **C** $\frac{9}{4}mv^2$ **D** $\frac{9}{2}mv^2$

---

560. 9702_s19_qp_11 Q: 18

The kinetic energy E_k of an object of mass m moving at speed v is given by the equation shown.

$$E_k = \frac{1}{2}mv^2$$

Which equation is **not** used in the derivation of this equation?

A $F = ma$ **B** $s = vt$ **C** $v^2 = u^2 + 2as$ **D** $W = Fs$

---

561. 9702_s19_qp_12 Q: 16

A parachutist is falling at constant (terminal) velocity.

Which statement is **not** correct?

A Gravitational potential energy is converted into kinetic energy of the air.

B Gravitational potential energy is converted into kinetic energy of the parachutist.

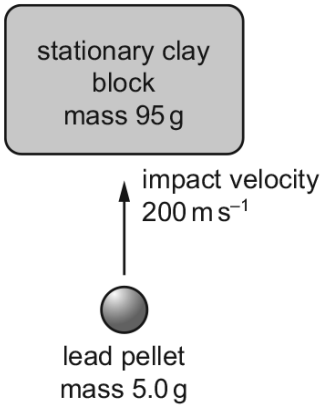
C Gravitational potential energy is converted into thermal energy of the air.

D Gravitational potential energy is converted into thermal energy of the parachutist.

---

562. 9702_s19_qp_13 Q: 17

A lead pellet is shot vertically upwards into a clay block that is stationary at the moment of impact but is able to rise freely after impact.



The mass of the pellet is 5.0 g and the mass of the clay block is 95 g.

The pellet hits the block with an initial vertical velocity of 200 m s^{-1}. It embeds itself in the block and does not emerge.

How high above its initial position will the block rise?

A 5.1 m **B** 5.6 m **C** 10 m **D** 100 m

---

563. 9702_s19_qp_13 Q: 18

On the surface of a planet, 30 J of work is done against gravity to raise a mass of 1.0 kg through a height of 10 m.

How much work must be done to raise a mass of 4.0 kg through a height of 5.0 m on this planet?

A 15 J **B** 60 J **C** 120 J **D** 200 J

---

564. 9702_w19_qp_11 Q: 17

An object travelling with a speed of 10 m s^{-1} has kinetic energy 1500 J.

The speed of the object is increased to 40 m s^{-1}.

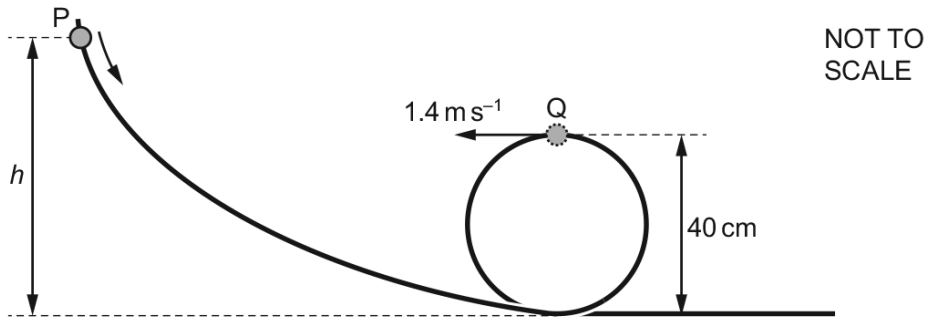
What is the new kinetic energy of the object?

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

---

565. 9702_m18_qp_12 Q: 16

A bead is released from rest at point P and slides along a wire, as shown.



The track loops around and forms a vertical circle of diameter 40 cm. At point Q, the bead has a speed of 1.4 m s^{-1}.

Air resistance and friction on the wire are negligible.

What is the height *h* from which the bead is released?

A 0.30 m **B** 0.40 m **C** 0.50 m **D** 0.60 m

---

566. 9702_s18_qp_11 Q: 15

A cannon-ball of mass 3.50 kg is fired at a speed of 22.0 m s^{-1} from a gun on a ship at a height of 6.00 m above sea level.

The total energy of the cannon-ball is the sum of the gravitational potential energy relative to the surface of the sea and the kinetic energy.

What is the total energy of the cannon-ball as it leaves the gun?

A 206 J **B** 641 J **C** 847 J **D** 1050 J

---

567. 9702_s18_qp_12 Q: 18

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

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

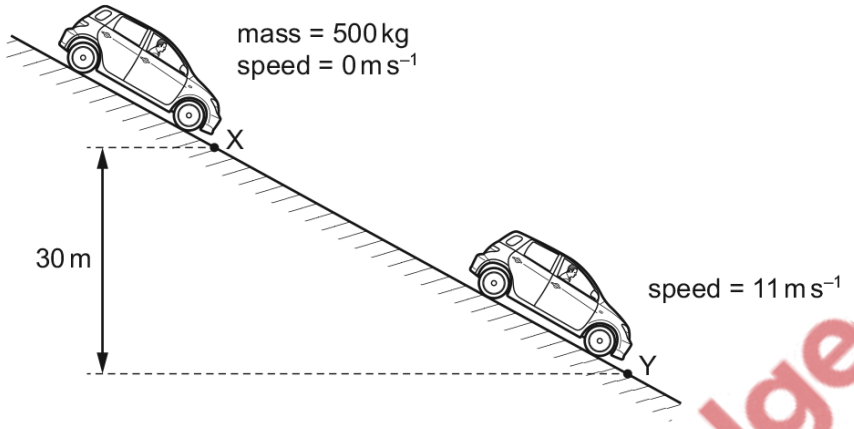
A $\frac{1}{2^2}$ **B** $\frac{1}{2}$ **C** $\frac{1}{\sqrt{2}}$ **D** $1 - \frac{1}{\sqrt{2}}$

---

568. 9702_s18_qp_12 Q: 19

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}.

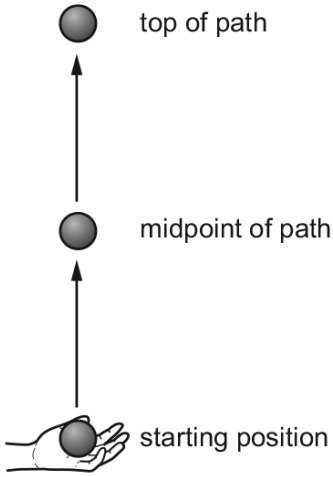


What is the energy dissipated by frictional forces when the car moves from X to Y?

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

569. 9702_s18_qp_13 Q: 16

A ball is thrown vertically up into the air. It rises to the top of its path before beginning to fall vertically downwards.



Assume that the gravitational potential energy of the ball is zero at its starting position.

Which statement about the ball is **not** correct?

A As it rises, its kinetic energy is transferred to gravitational potential energy.

B At the midpoint of its path, its gravitational potential energy is equal to its initial kinetic energy.

C At the top of its path, its kinetic energy is zero.

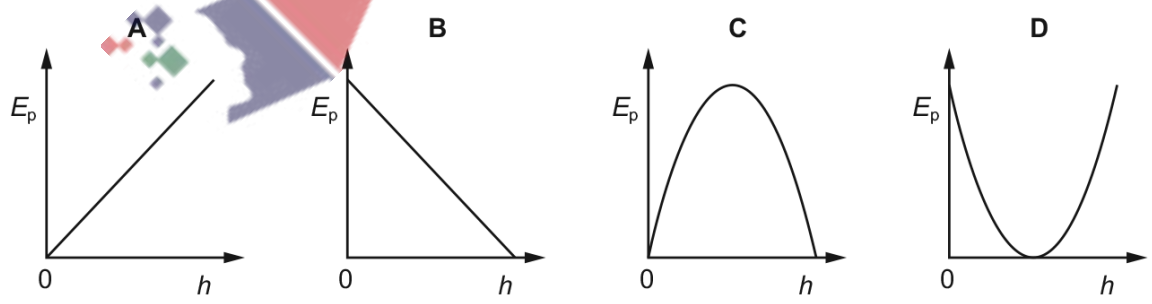
D At the top of its path, its total energy is less than its initial total energy.

---

570. 9702_w18_qp_12 Q: 17

An object is thrown into the air.

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



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571. 9702_s17_qp_12 Q: 15

A cyclist is travelling at a constant speed up a hill. The frictional force resisting the cyclist's motion is 8.0 N.

The cyclist uses 450 J of energy to travel a distance of 20 m.

What is the increase in the gravitational potential energy of the cyclist?

A 160 J **B** 290 J **C** 440 J **D** 610 J

---

572. 9702_s17_qp_12 Q: 16

A stone of mass m falls from rest at the top of a cliff of height h into the sea below. Just before hitting the sea the stone has speed v.

What is the average force of air resistance acting on the stone during its fall?

A mg **B** $\frac{m(v^2 - 2gh)}{h}$ **C** $m\left(g - \frac{v^2}{2h}\right)$ **D** $m\left(gh - \frac{v^2}{2}\right)$

---

573. 9702_w17_qp_11 Q: 15

The derivation of the pressure equation $\Delta p = \rho g \Delta h$ uses a number of relationships between quantities.

Which relationship is **not** used in the derivation of this equation?

A density = $\frac{\text{mass}}{\text{volume}}$

B potential energy = mass × acceleration of free fall × height

C pressure = $\frac{\text{force}}{\text{area}}$

D weight = mass × acceleration of free fall

---

574. 9702_w17_qp_11 Q: 18

A stone is projected vertically upwards from the ground at an initial speed of 15 m s^{-1}. Air resistance is negligible.

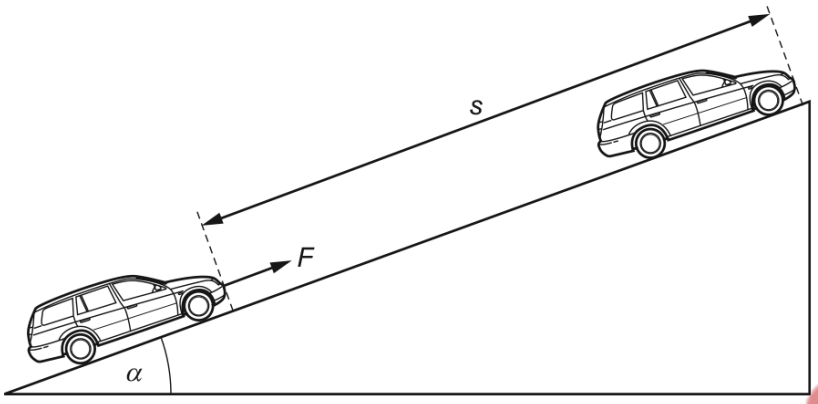
What is the maximum height reached by the stone?

A 0.76 m **B** 11 m **C** 23 m **D** 110 m

---

575. 9702_w17_qp_12 Q: 17

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



What is the ratio $\frac{\text{gravitational potential energy gained by car}}{\text{work done by force } F}$?

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

---

576. 9702_w17_qp_12 Q: 18

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.

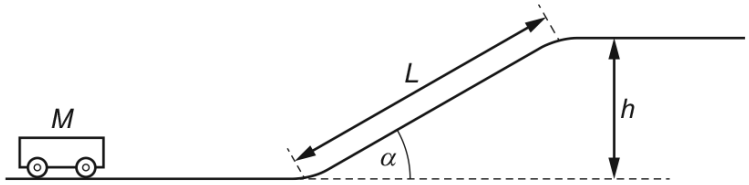
C Car X has twice the kinetic energy of car Y.

D The two cars have the same kinetic energy.

---

577. 9702_w17_qp_13 Q: 18

A trolley rolls along a horizontal surface and then travels up a slope before reaching a second horizontal surface. The slope is of length *L*. The trolley has mass *M*. The slope is at an angle α to the horizontal surface. The second horizontal surface is at height *h* above the first surface.



Assume negligible frictional forces. The acceleration of free fall is known.

In order to determine the minimum initial velocity of the trolley for it to reach the top of the slope, which additional values are needed?

A *h* and *M* **B** *M*, *L* and *h* **C** α, *L*, *M* **D** *h* only

---

578. 9702_m16_qp_12 Q: 16

A man is running in a straight line.

What is an approximate value of his kinetic energy?

A 10 J **B** 100 J **C** 1000 J **D** 10 000 J

---

579. 9702_s16_qp_11 Q: 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 approximate average force that acts on the nail while it moves through 5.0 mm?

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

---

580. 9702_s16_qp_12 Q: 17

A boy on a bicycle starts from rest and rolls down a hill inclined at 30° to the horizontal.

The boy and bicycle have a combined mass of 25 kg.

There is a frictional force of 30 N, which is independent of the velocity of the bicycle.

What is the kinetic energy of the boy and the bicycle after rolling 20 m down the slope?

A 1850 J **B** 2450 J **C** 3050 J **D** 3640 J

---

581. 9702_s16_qp_13 Q: 17

An object of mass 0.30 kg is thrown vertically upwards from the ground with an initial velocity of 8.0 $m s^{-1}$. The object reaches a maximum height of 1.9 m.

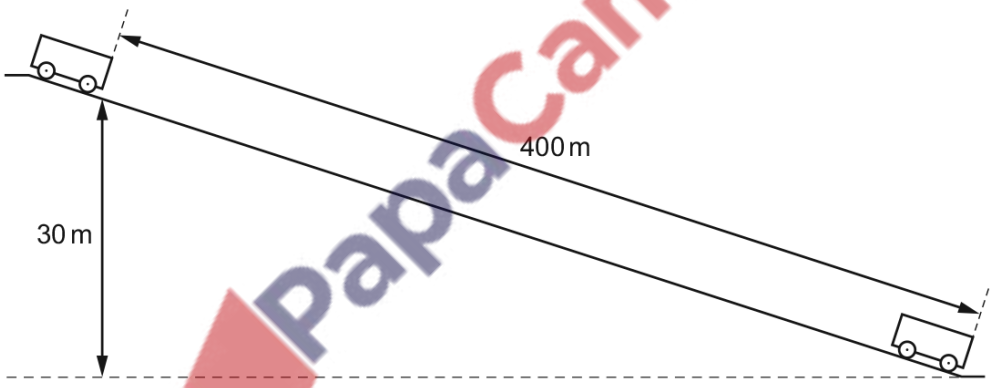
How much work is done against air resistance as the object rises to its maximum height?

A 4.0 J **B** 5.6 J **C** 9.6 J **D** 15 J

---

582. 9702_w16_qp_11 Q: 19

A truck of mass 500 kg moves from rest at the top of a section of track 400 m long and 30 m high, as shown. The frictional force acting on the truck is 250 N throughout its journey.



What is the final speed of the truck?

A 14 $m s^{-1}$ **B** 24 $m s^{-1}$ **C** 31 $m s^{-1}$ **D** 190 $m s^{-1}$

---

583. 9702_w16_qp_12 Q: 18

On the surface of a planet, 30 J of work is done against gravity to raise a mass of 1.0 kg through a height of 10 m.

How much work must be done to raise a mass of 4.0 kg through a height of 5.0 m on this planet?

A 15 J **B** 60 J **C** 120 J **D** 200 J

---

584. 9702_w16_qp_12 Q: 19

The speed of a car increases from $10\,m\,s^{-1}$ to $15\,m\,s^{-1}$ and its kinetic energy increases by E_1.

Later, the speed of the car increases from $15\,m\,s^{-1}$ to $25\,m\,s^{-1}$ and its kinetic energy increases by E_2.

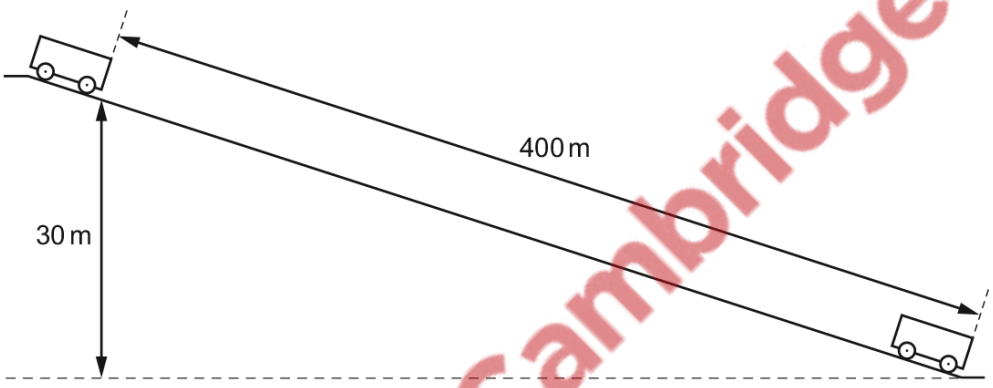
What is the ratio $\frac{E_2}{E_1}$?

A 1.6 **B** 2.6 **C** 3.2 **D** 4.0

---

585. 9702_w16_qp_13 Q: 19

A truck of mass 500 kg moves from rest at the top of a section of track 400 m long and 30 m high, as shown. The frictional force acting on the truck is 250 N throughout its journey.



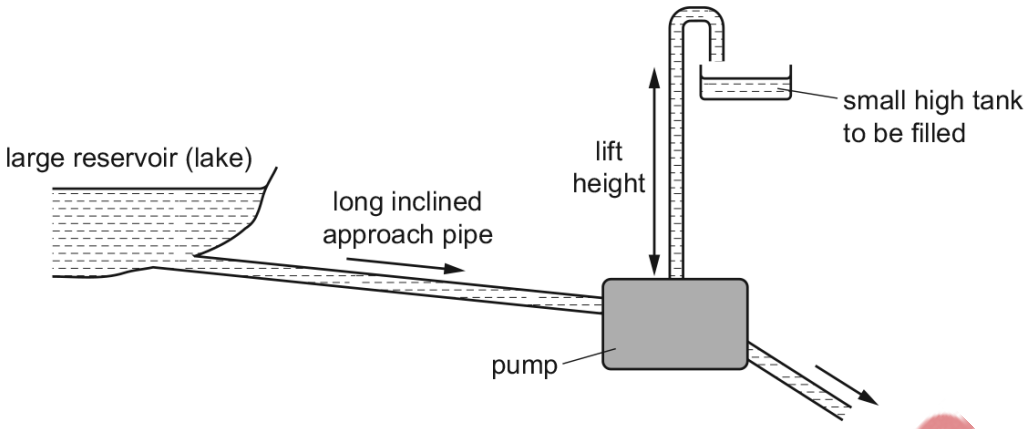
What is the final speed of the truck?

A $14\,m\,s^{-1}$ **B** $24\,m\,s^{-1}$ **C** $31\,m\,s^{-1}$ **D** $190\,m\,s^{-1}$

---

586. 9702_s15_qp_11 Q: 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.

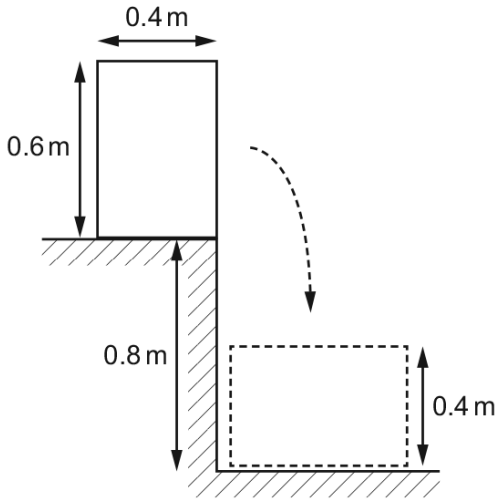
The efficiency of the pump is 10%.

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

587. 9702_s15_qp_12 Q: 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.

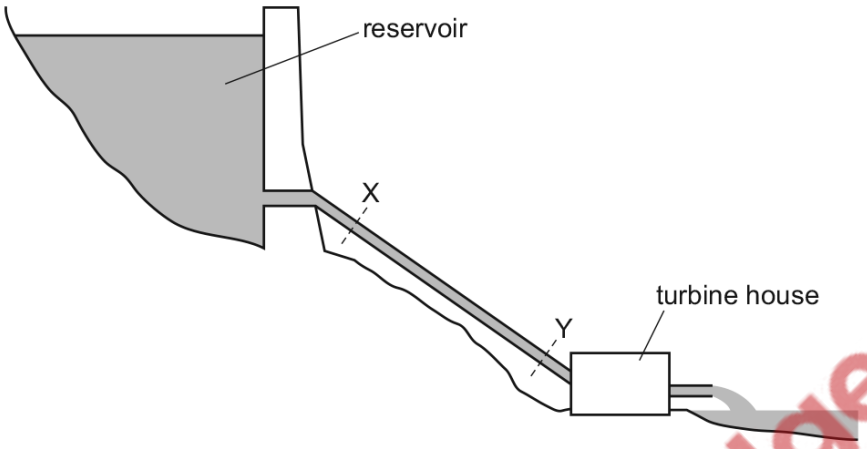
What is the change in gravitational potential energy of the block?

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

588. 9702_s15_qp_12 Q: 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.

---

589. 9702_s15_qp_12 Q: 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

---

590. 9702_s15_qp_13 Q: 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 $2.3 \times 10^6\,J\,s^{-1}$

B $2.5 \times 10^6\,J\,s^{-1}$

C $2.3 \times 10^7\,J\,s^{-1}$

D $2.5 \times 10^7\,J\,s^{-1}$

---

591. 9702_s15_qp_13 Q: 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 $2F$ is applied to the trolley over a distance of $2s$, what will the original kinetic energy of 4.0 J become?

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

6.4 Power

592. 9702_m20_qp_12 Q: 18

A car travels at a constant speed of 25 m s^{-1} up a slope. The wheels driven by the engine exert a forward force of 3000 N. The total force due to air resistance and friction is 2100 N. The weight of the car has a component down the slope of 900 N.

What is the rate at which thermal energy is dissipated?

A zero **B** 2.3×10^4 W **C** 5.3×10^4 W **D** 7.5×10^4 W

---

593. 9702_s20_qp_12 Q: 17

An escalator in an underground station has 25 people standing on it and is moving with a speed of 4.3 m s^{-1}. The average mass of a person is 78 kg and the angle of the escalator to the horizontal is 40°.

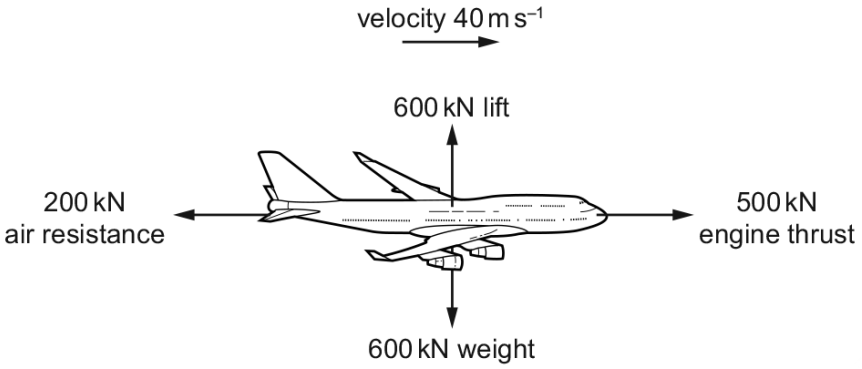
What is the minimum power required to lift these people?

A 5.4 kW **B** 6.4 kW **C** 53 kW **D** 63 kW

---

594. 9702_s20_qp_13 Q: 19

The force diagram shows an aircraft accelerating. At the instant shown, the velocity of the aircraft is $40\,m\,s^{-1}$.



At which rate is its kinetic energy increasing?

A 2.4 MW **B** 8.0 MW **C** 12 MW **D** 20 MW

---

595. 9702_m19_qp_12 Q: 17

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

What is the ratio $\frac{\text{power output}}{\text{power input}}$?

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

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

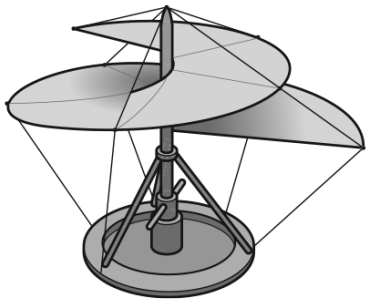
C $\frac{150\times10^3\times40\times10^6\times20}{60\times60}$

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

---

596. 9702_m19_qp_12 Q: 18

Leonardo da Vinci proposed a flying machine that would work like a screw to lift the pilot into the air. The 'screw' is rotated by the pilot.



The machine and the pilot together have a total mass of 120 kg.

Which useful output power must the pilot provide to move vertically upwards at a constant speed of 2.5 $m\,s^{-1}$?

A 48 W **B** 300 W **C** 470 W **D** 2900 W

---

597. 9702_s19_qp_11 Q: 19

A grasshopper of mass 0.12 g jumps vertically. It uses its back legs over a time of 0.020 s to jump, leaving the ground with a velocity of 3.0 $m\,s^{-1}$.

What is the average power developed by the legs of the grasshopper?

A 9.0×10^{-3} W **B** 1.8×10^{-2} W **C** 2.7×10^{-2} W **D** 37 W

---

598. 9702_s19_qp_12 Q: 19

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

---

599. 9702_s19_qp_13 Q: 16

A student can run or walk up the stairs to her classroom.

Which statement describes the power required and the gravitational potential energy gained while running up the stairs compared to walking up them?

A Running provides more gravitational potential energy and uses more power.

B Running provides more gravitational potential energy and uses the same power.

C Running provides the same gravitational potential energy and uses more power.

D Running provides the same gravitational potential energy and uses the same power.

---

600. 9702_w19_qp_11 Q: 18

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 useful output power of the engine?

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

---

601. 9702_w19_qp_12 Q: 15

A power station using coal as fuel has an average power output of 3000 MW. Coal is supplied by 20 trains each day. The efficiency of the station in converting the thermal energy released from the coal to electrical energy is 26%.

A mass of 1.0 kg of coal will release 33 MJ of thermal energy when burnt.

Which mass of coal does each train bring?

A 2.5×10^4 kg **B** 6.3×10^4 kg **C** 1.5×10^6 kg **D** 3.0×10^7 kg

---

602. 9702_w19_qp_12 Q: 17

The motor of a crane lifts a load of mass 600 kg. The load rises vertically at a constant speed of 12 m per minute.

What is the useful power output of the motor?

A 0.12 kW **B** 1.2 kW **C** 7.2 kW **D** 71 kW

---

603. 9702_w19_qp_13 Q: 14

Trains supply coal to a power station. The table shows quantities describing the operation of the power station.

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

Which expression gives the efficiency of the power station?

A $\frac{PS}{NME}$ **B** $\frac{PSN}{ME}$ **C** $\frac{NME}{PS}$ **D** $\frac{NM}{PSE}$

---

604. 9702_w19_qp_13 Q: 17

The maximum useful output power of a car travelling on a horizontal road is P. The total resistive force acting on the car is kv^2, where v is the speed of the car and k is a constant.

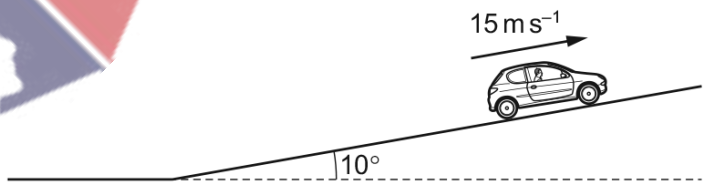
Which equation is correct when the car is travelling at maximum speed?

A $v^3 = \frac{P}{k}$ **B** $v^2 = \frac{P}{k}$ **C** $v = \left(\frac{P}{k}\right)^2$ **D** $v = \left(\frac{P}{k}\right)^3$

---

605. 9702_m18_qp_12 Q: 14

A car of mass 1100 kg is travelling at a constant speed of 15 m s^{-1} up a slope inclined at 10° to the horizontal. The combined frictional forces acting on the car are directed down the slope and are equal to $\frac{W}{5}$, where W is the weight of the car.



What is the useful output power of the car's engine?

A 28 kW **B** 32 kW **C** 60 kW **D** 190 kW

606. 9702_m18_qp_12 Q: 17

A small diesel engine uses a volume of $1.5 \times 10^4\,cm^3$ of fuel per hour to produce a useful power output of 40 kW. It may be assumed that 34 kJ of energy is transferred to the engine when it uses $1.0\,cm^3$ of fuel.

What is the rate of transfer from the engine of energy that is wasted?

A 102 kW **B** 142 kW **C** 182 kW **D** 470 kW

---

607. 9702_s18_qp_11 Q: 14

A train of mass 3.3×10^6 kg is moving at a constant speed up a slope inclined at an angle of 0.64° to the horizontal. The engine of the train is producing a useful output power of 14 MW.

Assume that there are no frictional forces opposing the motion of the train.

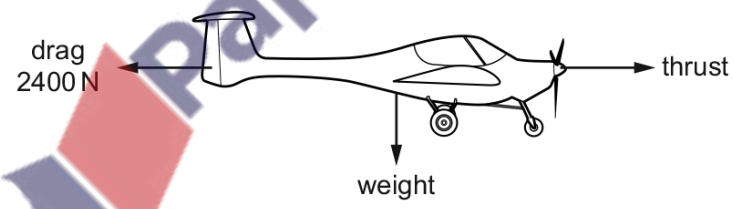
What is the speed of the train?

A $0.43\,m\,s^{-1}$ **B** $4.2\,m\,s^{-1}$ **C** $39\,m\,s^{-1}$ **D** $380\,m\,s^{-1}$

---

608. 9702_s18_qp_11 Q: 16

An aircraft travels at a constant velocity of $90\,m\,s^{-1}$ in horizontal flight. The diagram shows some of the forces acting on the aircraft.



The mass of the aircraft is 2000 kg.

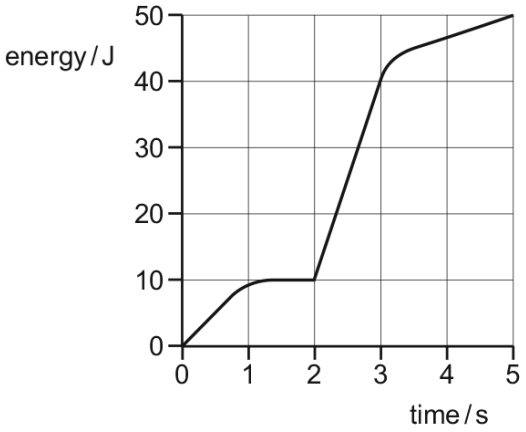
What is the power produced by the thrust force?

A 1.8×10^5 W **B** 2.2×10^5 W **C** 1.8×10^6 W **D** 2.0×10^6 W

---

609. 9702_s18_qp_11 Q: 17

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

---

610. 9702_s18_qp_12 Q: 16

In 'normal driving conditions', an electric car has a range of 150 km. This uses all of the 200 MJ of 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 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

---

611. 9702_s18_qp_13 Q: 17

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

What is the power needed to lift the hook and the load?

A 4.9 kW **B** 5.4 kW **C** 20 kW **D** 22 kW

---

612. 9702_w18_qp_11 Q: 17

The force resisting the motion of a car is proportional to the square of the car's speed. The magnitude of the force at a speed of 20.0 m s^{-1} is 800 N.

What useful output power is required from the car's engine to maintain a steady speed of 40.0 m s^{-1}?

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

---

613. 9702_w18_qp_12 Q: 18

A car of mass 1800 kg accelerates along a horizontal road so that its speed increases from 20 m s^{-1} to 25 m s^{-1} in a time of 5.4 s.

What is the average useful power output of the car's engine?

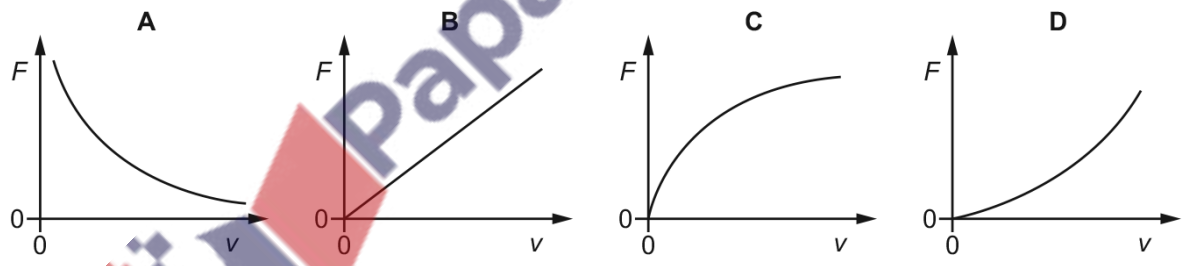
A 4.2 kW **B** 38 kW **C** 120 kW **D** 1100 kW

---

614. 9702_w18_qp_12 Q: 19

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?



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615. 9702_w18_qp_13 Q: 16

An electric kettle is rated as having an input power of 1.50 kW and an efficiency of 65.0%.

The kettle is switched on for 2.00 minutes.

How much energy is transferred to the water in the kettle?

A 0.975 kJ **B** 117 kJ **C** 180 kJ **D** 277 kJ

---

616. 9702_w18_qp_13 Q: 18

A girl of mass 50 kg runs up a flight of 20 steps in 7.0 seconds. Each step is 25 cm high.

What is the useful average output power provided by the girl to climb the flight of steps?

A 18 W **B** 36 W **C** 350 W **D** 2500 W

---

617. 9702_m17_qp_12 Q: 19

A car of mass 1400 kg is travelling on a straight, horizontal road at a constant speed of 25 m s^{-1}. The output power from the car's engine is 30 kW.

The car then travels up a slope at 2° to the horizontal, maintaining the same constant speed.

What is the output power of the car's engine when travelling up the slope?

A 12 kW **B** 31 kW **C** 42 kW **D** 65 kW

---

618. 9702_s17_qp_11 Q: 18

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.

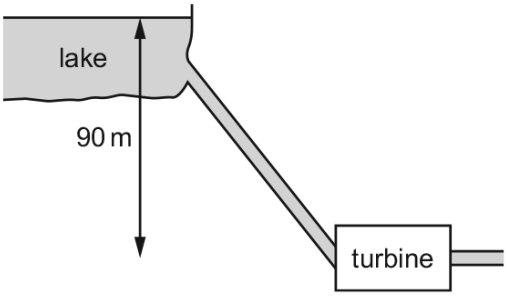
What is the average power input to the mass?

A $(E_p - E_k)t$ **B** $(E_p + E_k)t$ **C** $\frac{E_p - E_k}{t}$ **D** $\frac{E_p + E_k}{t}$

---

619. 9702_s17_qp_11 Q: 19

Water flows from a lake into a turbine that is a vertical distance of 90 m below the lake, as shown.



The mass flow rate of the water is 2400 kg min^{-1}. The turbine has an efficiency of 75%.

What is the output power of the turbine?

A 26 kW **B** 35 kW **C** 1.6 MW **D** 2.1 MW

---

620. 9702_s17_qp_12 Q: 18

What is a correct derivation of the equation relating power, force and velocity?

A power = $\frac{\text{work done}}{\text{time taken}}$ and work done = force × displacement

so power = $\frac{\text{force} \times \text{displacement}}{\text{time taken}}$

so power = force × velocity

B power = $\frac{\text{work done}}{\text{time taken}}$ and work done = force × distance

so power = $\frac{\text{force} \times \text{distance}}{\text{time taken}}$

so power = force × velocity

C power = $\frac{\text{work done}}{\text{time taken}}$ and work done = $\frac{\text{force}}{\text{displacement}}$

so power = $\frac{\text{force}}{\text{displacement}}$ × time taken

so power = $\frac{\text{force}}{\text{velocity}}$

D power = $\frac{\text{work done}}{\text{time taken}}$ and work done = $\frac{\text{force}}{\text{distance}}$

so power = $\frac{\text{force}}{\text{distance}}$ × time taken

so power = $\frac{\text{force}}{\text{velocity}}$

---

621. 9702_s17_qp_13 Q: 17

A constant force pushes a block along a horizontal frictionless surface. The block moves from rest through a fixed distance.

What is the relationship between the final speed v of the block and its mass m?

A $\sqrt{v} \propto \frac{1}{m}$ **B** $v \propto \sqrt{m}$ **C** $v \propto \frac{1}{\sqrt{m}}$ **D** $\sqrt{v} \propto m$

---

622. 9702_w17_qp_11 Q: 3

An ion is accelerated in a vacuum by a series of electrodes. A graph of the power supplied to the ion is plotted against time.

What is represented by the area under the graph between two times?

A the average force on the ion

B the change in kinetic energy of the ion

C the change in momentum of the ion

D the change in velocity of the ion

---

623. 9702_w17_qp_11 Q: 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

---

624. 9702_w17_qp_12 Q: 19

During refuelling, a petrol car receives 50 litres of fuel in 90 seconds. The petrol has 34 MJ of energy per litre.

For an electric car to receive the same amount of energy in the same time from a 230 V supply, what is the minimum current required?

A 2700 A **B** 8.2×10^4 A **C** 7.4×10^6 A **D** 6.6×10^8 A

---

625. 9702_w17_qp_13 Q: 16

A car of total mass 1560 kg is travelling with a constant speed of 32 m s^{-1}. The driving force provided by the car is 680 N. The kinetic energy of the car is 800 kJ and its momentum is 50 000 N s.

Which two items of data could be used to calculate the useful power output of the car?

A driving force and momentum

B kinetic energy and mass

C mass and momentum

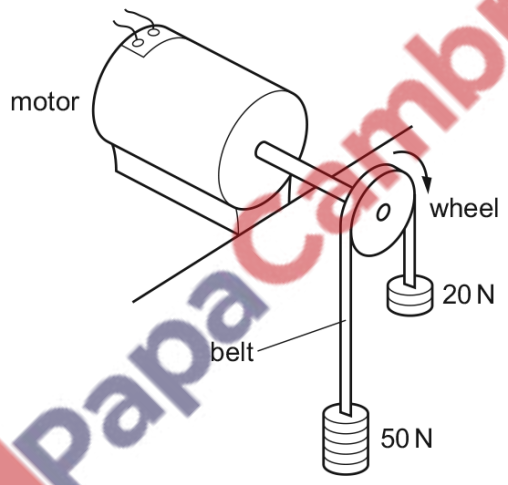
D speed and driving force

---

626. 9702_w17_qp_13 Q: 19

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.



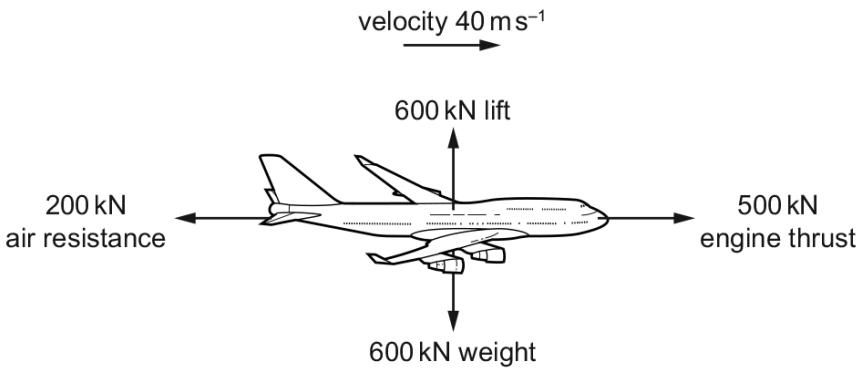
When the wheel is making 20 revolutions per second, what is the output power of the motor?

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

---

627. 9702_m16_qp_12 Q: 15

The force diagram shows an aircraft accelerating. At the instant shown, the velocity of the aircraft is 40 m s^{-1}.



At which rate is its kinetic energy increasing?

A 2.4 MW **B** 8.0 MW **C** 12 MW **D** 20 MW

---

628. 9702_s16_qp_11 Q: 17

The power P required to move an object through a medium at constant speed depends on the speed v and the resistive force F acting on the object.

The resistive force F also depends on the speed v.

Which row shows a possible relationship between speed v, resistive force F and power P?

	resistive force F	power P
A	proportional to v	constant
B	proportional to v	proportional to v
C	proportional to v^2	proportional to v^2
D	proportional to v^2	proportional to v^3

---

629. 9702_s16_qp_11 Q: 18

Which amount of energy is **not** 2400 J?

A the decrease in gravitational potential energy of a body of mass 60 kg when it moves vertically downwards through 40 m near the Earth's surface

B the energy transferred in 15 s by a machine of power 160 W

C the kinetic energy of a body of mass 12 kg moving at a speed of 20 m s^{-1}

D the work done by a gas expanding against a constant external pressure of 120 kPa when its volume increases by 0.020 m^3

---

630. 9702_s16_qp_12 Q: 18

An escalator in an underground station has 250 people standing on it and is moving with a velocity of 4.3 m s^{-1}. The average mass of a person is 78 kg and the angle of the escalator to the horizontal is 40°.

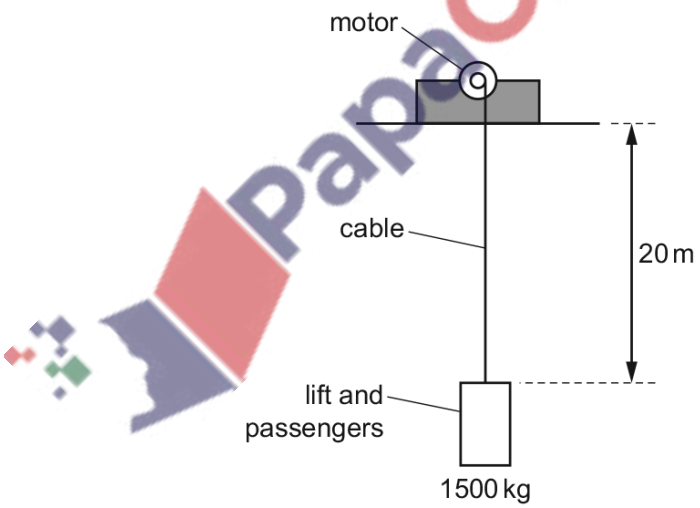
What is the minimum power required to lift these people?

A 54 kW **B** 64 kW **C** 530 kW **D** 630 kW

---

631. 9702_s16_qp_12 Q: 19

An electric motor operating a lift has an output power of 20 kW.



The lift and passengers have a combined mass of 1500 kg. The motor raises the lift through a distance of 20 m.

How long does it take?

A 6 s **B** 15 s **C** 30 s **D** 60 s

---

632. 9702_s16_qp_13 Q: 18

A racing car has an output power of 300 kW when travelling at a constant speed of 60 m s^{-1}.

What is the total resistive force acting on the car?

A 5 kN **B** 10 kN **C** 50 kN **D** 100 kN

---

633. 9702_w16_qp_11 Q: 17

A hydroelectric power station uses the gravitational potential energy of water to generate electrical energy.

In one particular power station, the mass of water flowing per unit time is 1.5×10^5 kg s^{-1}. The water falls through a height of 120 m.

The electrical power generated is 100 MW.

What is the efficiency of the power station?

A 5.6% **B** 43% **C** 57% **D** 68%

---

634. 9702_w16_qp_12 Q: 20

A car travels at a constant speed of 25 m s^{-1} up a slope. The wheels driven by the engine exert a forward force of 3000 N. There is a drag force due to air resistance and friction of 2100 N. The weight of the car has a component down the slope of 900 N.

What is the rate at which thermal energy is dissipated?

A zero **B** 2.3×10^4 W **C** 5.3×10^4 W **D** 7.5×10^4 W

---

635. 9702_w16_qp_13 Q: 17

A hydroelectric power station uses the gravitational potential energy of water to generate electrical energy.

In one particular power station, the mass of water flowing per unit time is 1.5×10^5 kg s^{-1}. The water falls through a height of 120 m.

The electrical power generated is 100 MW.

What is the efficiency of the power station?

A 5.6% **B** 43% **C** 57% **D** 68%

---

636. 9702_s15_qp_11 Q: 17

Which statement is correct?

A A ball lands on the ground and bounces. The kinetic energy changes sign, because the ball changes direction.

B A car drives up a slope at a steady speed. The power generated by the engine equals the potential energy gained per unit time.

C An electric heater can be 100% efficient.

D It is impossible for momentum to be conserved in a collision.

---

637. 9702_s15_qp_11 Q: 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
