Work, Energy & Power

TOPIC QUESTIONS (1)

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

Time Allowed : 1Hour 10Min

1. A mass is raised vertically. In time t, the increase in its gravitational potential energy is Ep and the increase in its kinetic energy is Ek.
What is the average power input to the mass?

A $(E_p - E_k)t$ C $\frac{E_p - E_k}{t}$

B $(E_p + E_k)t$ D $\frac{E_p + E_k}{t}$

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

What is the power developed by the boat?

A ½ Fv **B** Fv **C** ½ Fv^2 **D** Fv^2

3. What is the expression used to define power?

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

B energy x time taken

C force x velocity

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

4. A ball is thrown vertically upwards.

Neglecting air resistance, which statement is correct?

A The kinetic energy of the ball is greatest at the greatest height attained.
B By the principle of conservation of energy, the total energy of the ball is constant throughout its motion.
C By the principle of conservation of momentum, the momentum of the ball is constant throughout its motion.
D The potential energy of the ball increases uniformly with time during the ascent.

5. 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

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

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

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

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

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

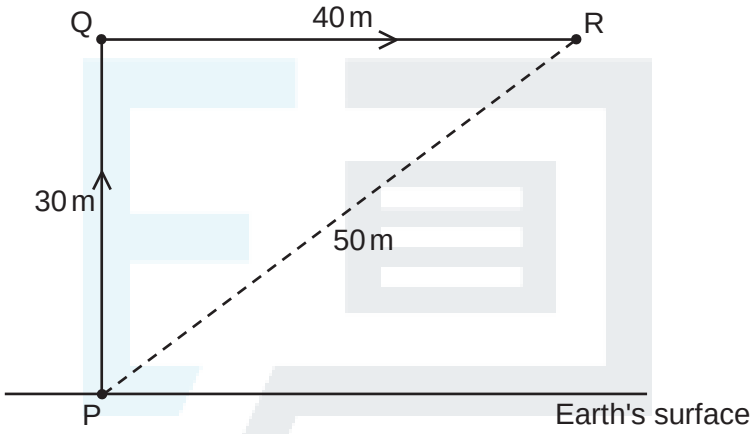
A 7 % B 8 % C 92 % D 93 %

8. A motorist travelling at 10 m s^{-1} can bring his car to rest in a braking distance of 10 m.

In what distance could he bring the car to rest from a speed of 30 m s^{-1} using the same braking force?

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

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



How much potential energy does the stone gain?

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

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

    What is the kinetic energy of the car?

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

11. A car travelling with speed 28 m s^{-1} leaves a motorway on an exit road. The end of the exit road is22 m higher than the motorway.

    If only the force of gravity is considered, what will be the speed of the car at the end of the exit road?

    A 7.3 m s^{-1} B 19 m s^{-1} C 21 m s^{-1} D 24 m s^{-1}

12. A piston in a gas supply pump has an area of 400 cm^2 and it moves a distance of 25 cm duringone 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

13. A transformer has the following input and output.

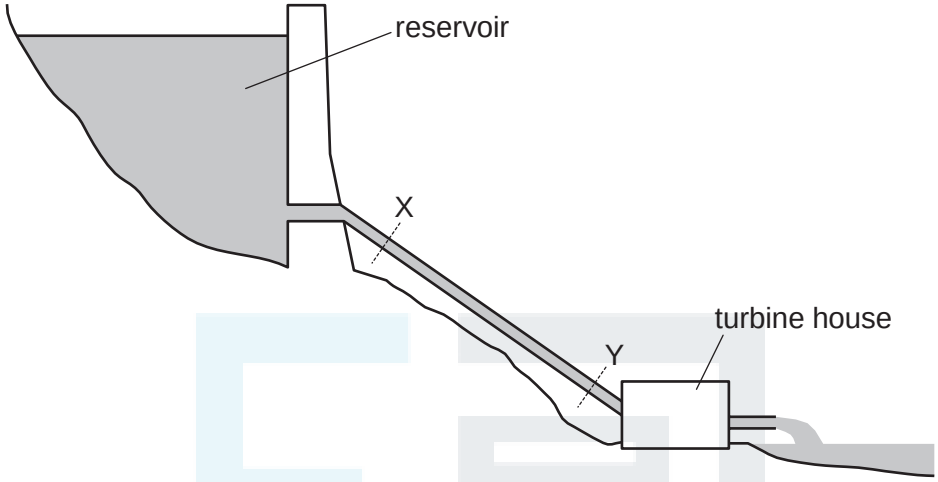
	potential difference / V	current / A
input	11 000	28
output	240	1200

What is the efficiency of the transformer?

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

14. 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.

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

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

16. When a horizontal force *F* is applied to a frictionless trolley over a distance *s*, the kinetic energyof 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?

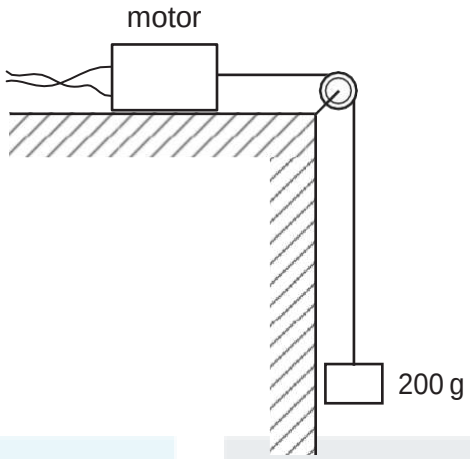
A 16 J B 20 J C 32 J D 64 J

17. 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

18. 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?

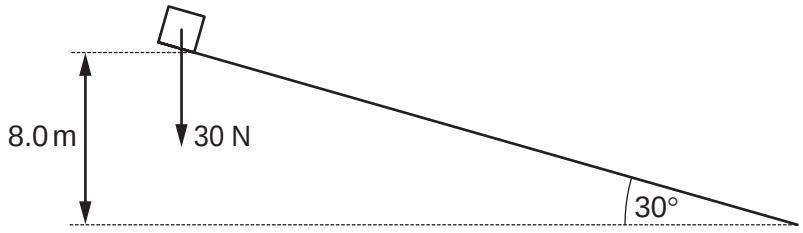
A 0.59 s B 0.85 s C 1.2 s D 2.7 s

19. 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*

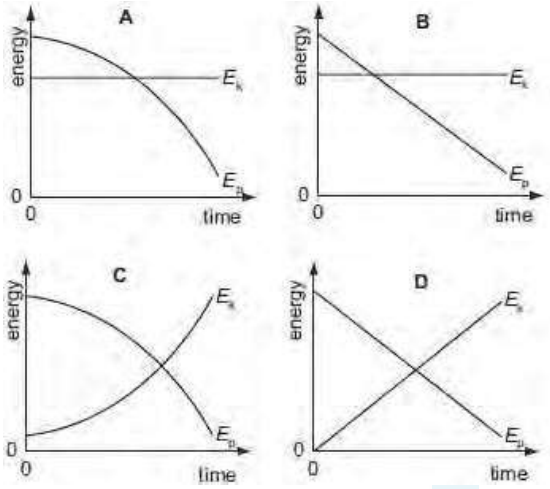
20. A box of weight 30 N is released from rest on a ramp that is at an angle of 30° to the horizontal. The box slides down the ramp so that it falls through a vertical distance of 8.0 m. A constant frictional force of 10 N acts on the box while it is moving.



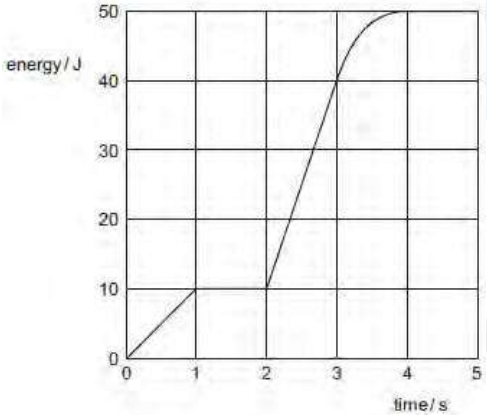
What is the kinetic energy of the box after falling through this distance?

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

21. A steel ball is falling at constant speed in oil. Which graph shows the variation with time of the gravitational potential energy Ep and the kinetic energy Ek of the ball?



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



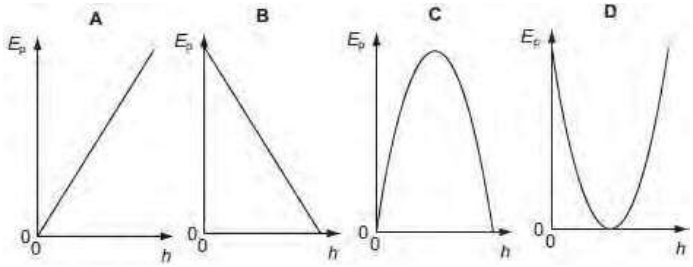
23. What is the maximum electrical power generated at any instant during these first 5 seconds?

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

24. A concrete cube of side 0.50 m and uniform density 2.0 x 10^3 kgm^{-3} is lifted 3.0 m vertically by a crane. What is the change in potential energy of the cube?
A 0.75 kJ B 7.4 kJ C 29 kJ D 470 kJ

25. A car with a total mass of 1400 kg is travelling at 30 m s What is the kinetic energy of the car?
A kJ B 42 kJ C 630 kJ D 1260 kJ

. An object is thrown into the air. Which graph shows how the potential energy Ep of the object varies with height h above the ground?



26. A concrete cube of side 0.50 m and uniform density 2.0×10^3 kg m^{-3} is lifted 3.0 m vertically by acrane.

What is the change in potential energy of the cube?

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

27. 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

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

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

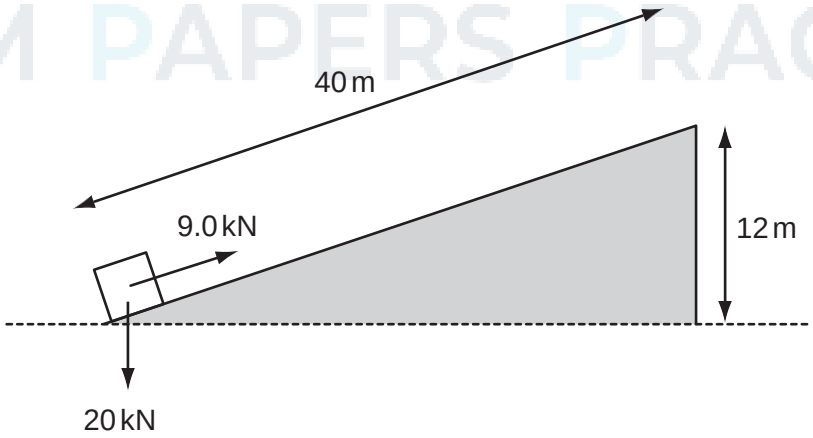
A 240 J B 300 J C 540 J D 840 J

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

What is the approximate time achieved in the speed trial?

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

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



How much of the work done is dissipated as heat?

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

31. 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

32. An Olympic athlete of mass 80 kg competes in a 100 m race.

What is the best estimate of his mean kinetic energy during the race?

A 4×10^2 J B 4×10^3 J C 4×10^4 J D 4×10^5 J

33. 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 $\frac{3E_k}{4}$

34. The first column in the table gives four examples of work being done. The second column givesmore 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

35. 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.

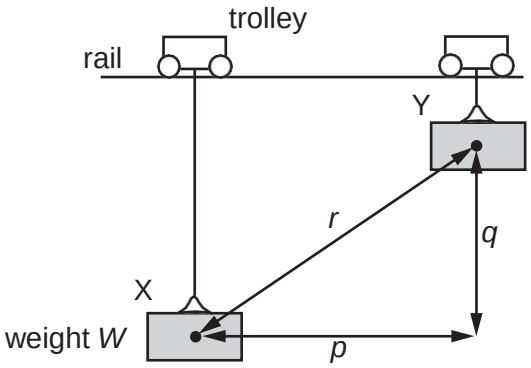
What is the kinetic energy of the trolley at Q?

A 35 kJ B 45 kJ C 55 kJ D 65 kJ

36. 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

37. 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.

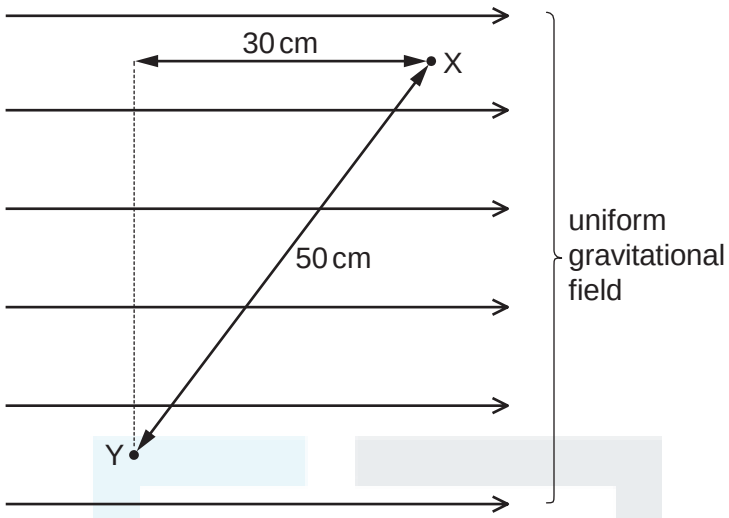
How much work is done on the weight during this process?

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

38. 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

39. 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.



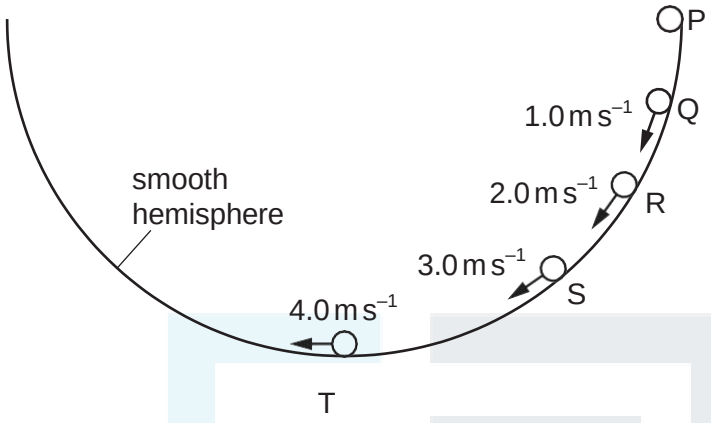
The mass is then moved to point Y.

What is its new gravitational potential energy?

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

40. A small mass is placed at point P on the inside surface of a smooth hemisphere. It is thenreleased 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 $\frac{E}{4}$?

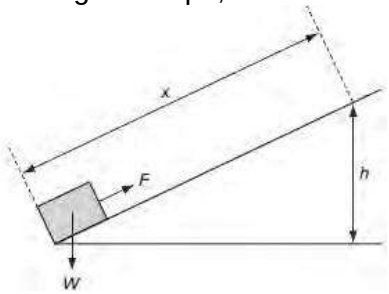
A Q

B R

C S

D none of these

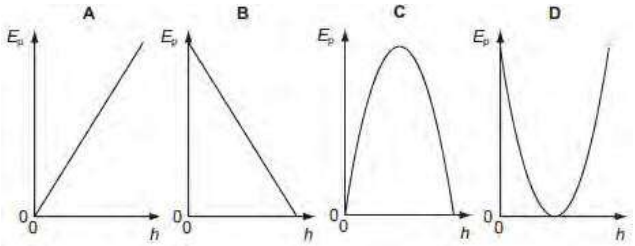
41. A block of weight W is pulled up a rough slope by a force F. When the block has moved a distance x along the slope, it has risenheight h.



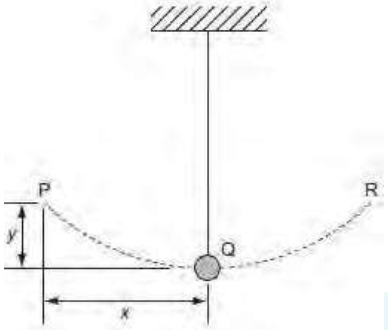
Which expressions give the amount of work done on the block andthe amount of gravitational potential energy gained by the block?

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

42. An object is thrown into the air. Which graph shows how thepotential energy Ep of the object varies with height h above the ground?



43. A pendulum bob oscillates between P and R.



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

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

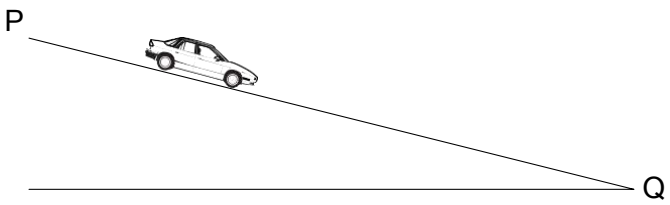
44. Which operation involves the greatest mean power?

A a car moving against a resistive force of 0.4 kN at a constant speed of 20 m s^{-1}
B a crane lifting a weight of 3 kN at a speed of 2 m s^{-1}
C a crane lifting a weight of 5 kN at a speed of 1 m s^{-1}
D a weight being pulled across a horizontal surface at a speed of 6 m s^{-1} against a frictional force of 1.5 Kn

45. The forward motion of a motor-boat is opposed by forces F which vary with the boat's speed v in accordance with the relation $F = k v^2$, where k is a constant. The effective power of the propellers required to maintain the speed v is P. Which expression relates k, P and v ?

A $k = \frac{P}{v}$ **B** $k = \frac{P}{v^2}$ **C** $k = \frac{P}{v^3}$ **D** $k = \frac{P}{v^4}$

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



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

Which statement is correct?

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

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

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

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

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

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

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

49. 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.

50. Trolley X, moving along a horizontal frictionless track, collides with a stationary trolley Y. The two trolleys become attached and move off together.

Which statement about this interaction is correct?

A Some of the kinetic energy of trolley X is changed to momentum in the collision. B Some of the momentum of trolley X is changed to kinetic energy in the collision. C Trolley X loses some of its momentum as heat in the collision.

D Trolley X shares its momentum with trolley Y but some of its kinetic energy is lost.

51. An electric motor produces 120 W of useful mechanical output power. The efficiency of the motoris 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

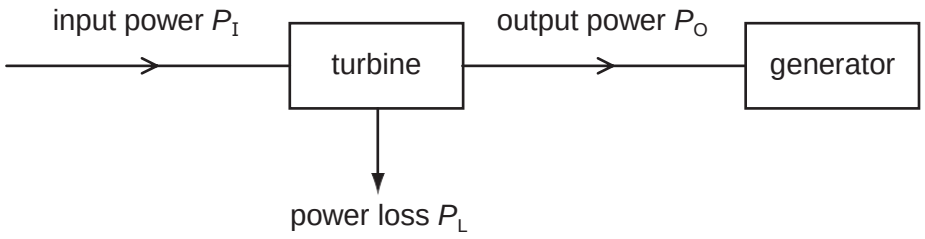
52. A hammer with 10 J of kinetic energy hits a nail and pushes it 5.0 mm into a plank.

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

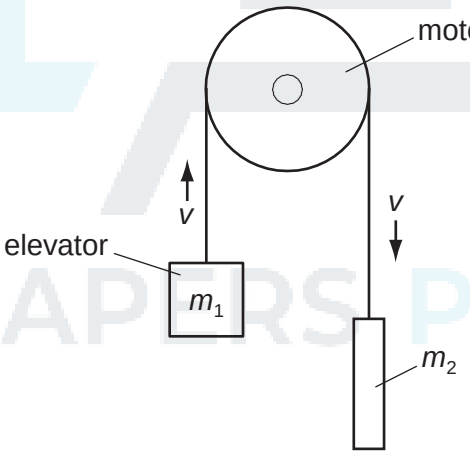
53. A steam turbine is used to drive a generator. The input power to the turbine is P_I and the outputpower P_O. The power loss in the turbine is P_L, as shown below.



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 $\frac{P_O}{P_I}$

54. The diagram shows a lift system in which the elevator (mass m_1) is partly counterbalanced by aheavy 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)

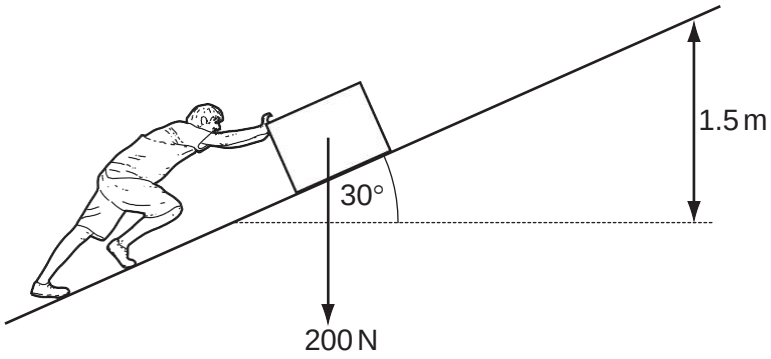
A $\frac{1}{2} m_1 v^2$

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

C $m_1 g v$

D $(m_1 - m_2) g v$

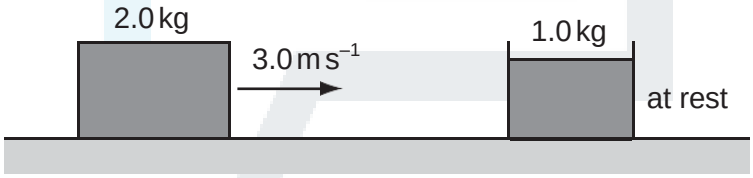
55. A box of weight 200 N is pushed so that it moves at a steady speed along a ramp, through a height of 1.5 m. The ramp makes an angle of 30° with the ground. The frictional force on the box is 150 N while the box is moving.



What is the work done by the person?

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

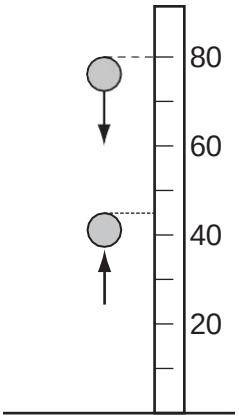
56. A 2.0 kg mass travelling at 3.0 m s^{-1} on a frictionless surface collides head-on with a stationary 1.0 kg mass. The masses stick together on impact.



How much kinetic energy is lost on impact?

A zero B 2.0 J C 2.4 J D 3.0 J

57. 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 maximumheight 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

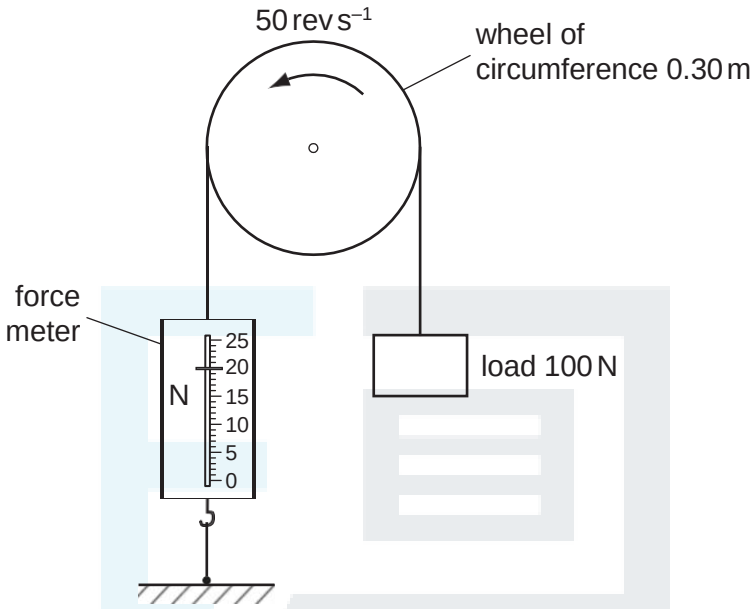
58. A wind turbine has blades that sweep an area of 2000 m^2. It converts the power available in thewind to electrical power with an efficiency of 50%.

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

59. 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.

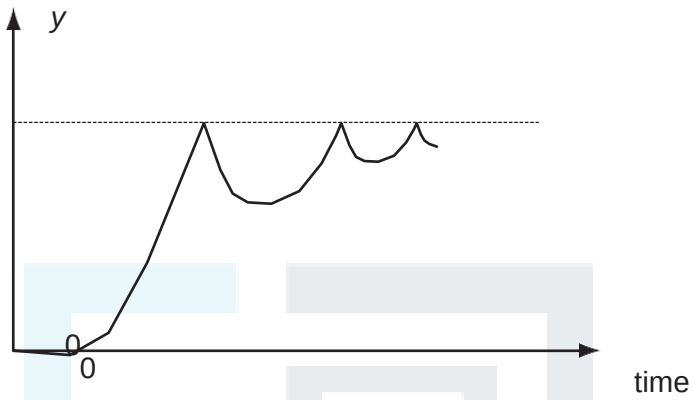
When the wheel is turning at this rate, the force meter reads 20 N.



What is the output power of the motor?

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

60. A ball is released from rest above a horizontal surface and bounces several times. The graph shows how, for this ball, a quantity y varies with time.



What is the quantity y ?

A acceleration B displacement C kinetic energy D velocity