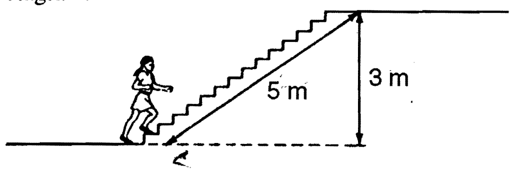
TOPIC 7 Energy, Work and Power

1 A girl weighing 400 N takes 4 s to run up the stairs shown in the diagram.

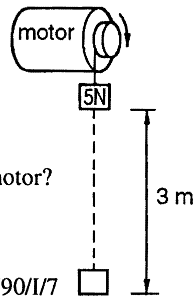


How much potential energy does she gain?

A 120 J
B 200 J
C 400 J
D 1200 J
E 2000 J

J90/I/8

2 An electric motor is used to lift a 5 N load through 3 m as shown in the diagram. The total amount of electrical energy used by the motor is 27 J.



What amount of energy is wasted by the motor?

A 9 J
B 12 J
C 15 J
D 22 J
E 27 J

N90/I/7

3 What are the main energy changes in a hydroelectric power station?

A electrical → kinetic → heat
B heat → electrical → kinetic
C kinetic → light → electrical
D kinetic → potential → light
E potential → kinetic → electrical

N90/I/8; N92/I/8

4 Which of the following quantities is calculated by multiplying force by distance?

A acceleration
B power
C pressure
D velocity
E work

J91/I/8

5 A ball of mass 0.2 kg is thrown to a height of 15 m.

What is the change in its gravitational potential energy? (g = 10 N/kg)

A 0.3 J
B 3.0 J
C 7.5 J
D 30 J
E 75 J

J91/I/9

6 A boy pushes a toy cart along a level road and then lets it go.

As the cart is slowing down, the biggest energy change is from

A chemical to heat.
B chemical to kinetic.
C heat to kinetic.
D kinetic to chemical.
E kinetic to heat.

N91/I/9

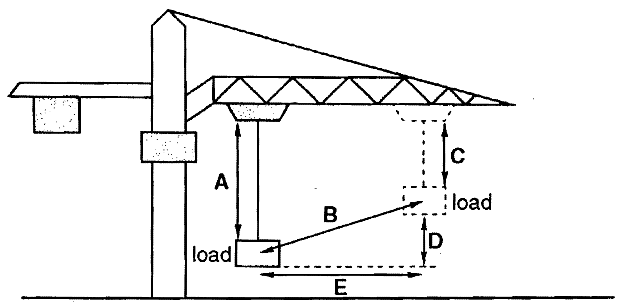
7 A tennis ball is dropped on to a hard, smooth, horizontal surface. The ball bounces up and down through the air. The height of each bounce gradually decreases until the ball stops moving.

During the motion of the ball,

A the kinetic energy of the ball is constant.
B the potential energy of the ball is constant.
C the sum of the kinetic and potential energies of the ball is constant.
D the total energy of the ball, ground and air is constant.

J92/I/7; N95/I/8

8 A crane moves its load diagonally, as shown in the diagram.



By which distance must the weight of the load be multiplied in order to find the increase in gravitational potential energy of the load?

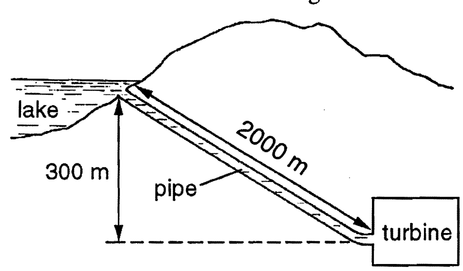
J92/I/8

9 An electric motor can lift a weight of 2000 N through a height of 10 m in 20 s. What is the power of the motor?

A 10 W
B 1000 W
C 2000 W
D 4000 W
E 400 000 W

J92/I/9

10 The turbine of a hydro-electric power station is built below the level of a lake as shown in the diagram .



How much potential energy does 500 kg of water lose as it falls down the pipe to the turbine? (The acceleration of free fall is 10 m/s^2.)

A 5 000 J
B 150 000 J
C 1 000 000 J
D 1 500 000 J
E 10 000 000 J

N93/I/8

11 An electric motor lifts a weight of 2 N through a height of 5 m in 4 s.

What is the power developed?

A	1.6 W	**C**	10 W	
B	2.5 W	**D**	40 W	J94/I/9

12 A crane lifts a load of 6000 N through a vertical distance of 15 m in 30 s.

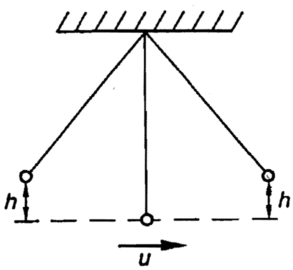
What is the average power during this operation?

A	200 W	**C**	3000 W	
B	400 W	**D**	120000 W	N94/I/9

13 Which example best illustrates the conversion of electrical energy to chemical energy?

A melting a fuse
B charging an accumulator
C starting a car
D generating hydro-electric power N94/I/10

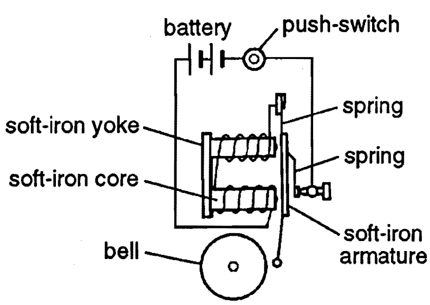
14 A pendulum bob of mass *m*, attached to a light string, is released from rest at a height *h* above its lowest point. The speed of the bob at its lowest point is *u*.



What will be the kinetic energy of the bob when it reaches a height *h* on the other side?

A	zero	**C**	$\frac{1}{2}mu^2$	
B	mgh	**D**	mu^2	J95/I/8

15 The diagram shows an electric door bell.



Which energy changes take place after the push-switch is pressed?

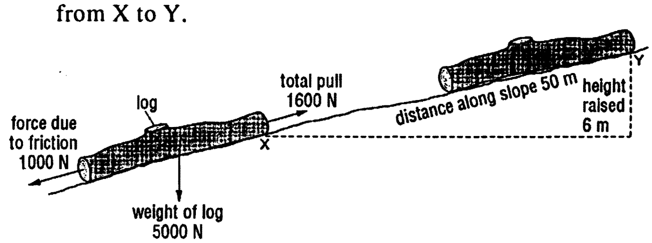
A	chemical →	electrical →	kinetic →	sound
B	chemical →	kinetic →	electrical →	sound
C	electrical →	chemical →	kinetic →	sound
D	kinetic →	chemical →	electrical →	sound

N95/I/9

16 From which source would the release of energy be affected by a change in the Earth's gravitational field?

A chemical
B geothermal
C hydroelectric
D nuclear N96/I/10

17 The diagram shows a log being pulled up an earth slope from X to Y.

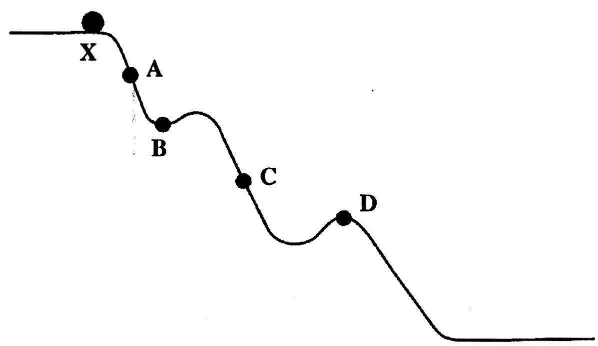


How much work is done against friction?

A	6 000 J	**C**	50 000 J	
B	9 600 J	**D**	80 000 J	J97/I/9

18 A ball, starting at point **X**, rolls down the hill shown in the diagram.

At which point does the ball have half of its maximum kinetic energy? (Ignore friction.)



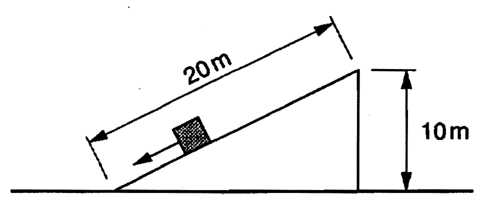
N97/I/9

19 A dry-battery can deliver 3000 J of energy to a small 2 W electric motor before the battery is exhausted.

For how many minutes does the motor run?

A 1500 minutes
B 100 minutes
C 50 minutes
D 25 minutes N97/I/11

20 A block of mass 2 kg slides from rest through a distance of 20 m down a frictionless slope, as shown.



What is the kinetic energy of the block at the bottom of the slope?

[The acceleration of free fall is 10 m/s^2.]

A 20 J
B 40 J
C 200 J
D 400 J

J93/I/9; J98/I/8

21 A windmill is used to raise water from a well. The depth of the well is 5 m. The windmill raises 200 kg of water every day.

What is the useful power extracted from the wind? (g = 10 N/kg)

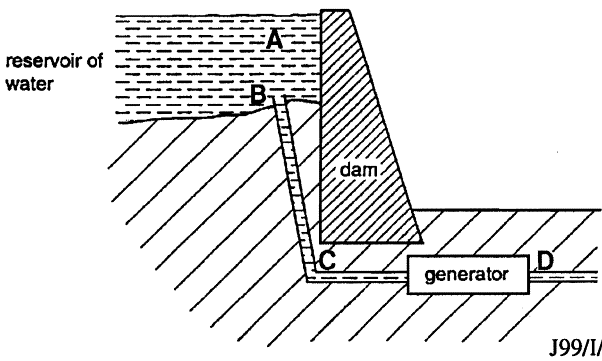
A $\frac{200 \times 10 \times 4}{5}$ W **C** $\frac{200 \times 10}{5 \times 24}$ W

B $\frac{200 \times 10 \times 5}{24 \times 60 \times 60}$ W **D** $\frac{200 \times 5}{24 \times 60}$ W

N98/I/10

22 The diagram shows part of a hydroelectric power station.

At which point does water have most potential energy?



J99/I/7

23 A tennis ball is dropped on to a horizontal surface. As the ball bounces up and down, the height of each bounce gradually decreases.

During the motion of the ball,

A the kinetic energy of the ball is constant.
B the potential energy of the ball is constant.
C the sum of the kinetic and potential energies of the ball is constant.
D the total energy of the ball, ground and air is constant.

N99/I/9

24 A car accelerates up a hill.

What happens to its kinetic energy and to its potential energy?

	kinetic energy	potential energy
A	decreases	increases
B	increases	decreases
C	increases	increases
D	unchanged	decreases

J2000/I/8

25 The results table is produced by a student studying the 'work done' in moving an object.

force used	distance moved	'workdone'
110	10	1100

Units are missing from each column.

What should they be?

	force	distance	workdone
A	F	D	W
B	kg	m	kg/m
C	m	kg	N
D	N	m	J

J2000/I/10

26 The power output of a lamp is 6 W.

How much energy does the lamp give out in 2 minutes?

A 3 J **C** 120 J
B 12 J **D** 720 J

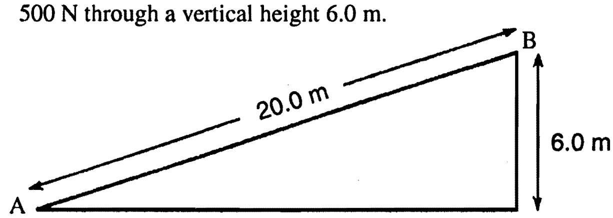
N2000/I/9

27 What can be used as the unit of energy?

A newton per metre
B volt ampere
C volt per coulomb
D watt second

N2000/I/39

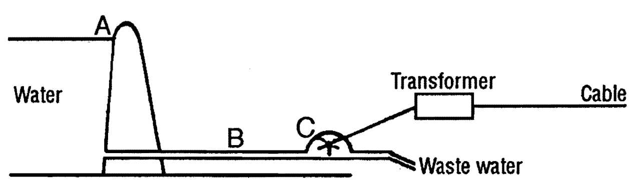
28 Calculate the work done in lifting a mass whose weight is 500 N through a vertical height 6.0 m.



The mass can be raised to the same height by pulling it from A to B up the ramp of length 20.0 m, shown in the diagram. If the surface of the ramp is sufficiently smooth for friction between the surface and the mass to be neglected, calculate the force acting parallel to AB required to pull the mass up the ramp at a constant speed.

J79/I/4

29 The diagram shows the essential features of a hydroelectric installation.



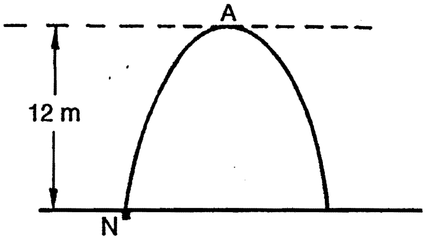
State the form of the energy of the water

(i) at A, (ii) at B.

What transformations of energy occur in the generator at C?

N79/I/10

30 The diagram illustrates the path of the water from a fountain, after it emerges from the nozzle N.



(a) Considering the stream of water as a series of drops, state what type of energy each drop possesses when it leaves N, and describe the transformation of energy which occurs as each drop rises to A.

(b) Given that one drop of water has a mass of 0.001 kg, how much work is transferred in raising each drop from the level of N to the level of A? [Take the acceleration of free fall to be 10 m/s^2.]

(c) 1000 such drops emerge from the nozzle per second. What is the minimum power of the pump required to drive the fountain?

(d) Indicate on the diagram a possible path of the water when a strong steady wind blows horizontally from left to right. N79/II/1

31 Taking the force of gravity to be 10 N/kg, calculate the work done against gravity by a person of mass 80 kg in walking up a flight of 12 steps each of which is 200 mm high.

What becomes of this work? J80/I/2

32 State the form in which an accumulator stores energy.

Into what forms is the energy converted when the accumulator is used to

(a) light a lamp,

(b) operate an electric motor in order to start a motor car engine? J80/I/9

33 Find the work done in raising a mass of 2.0 kg through a vertical distance of 0.75 m. Take g, the acceleration of free fall, to be 10 m/s^2.

What is the minimum power of a motor which will do this amount of work in 3.0 s? N80/I/3

34 Water, which flows over a weir at a rate of 900 kg/s, takes 1.5 s to fall *vertically* into the stream below.

(a) (i) What is the speed with which the falling water hits the stream?

(ii) What is the height through which the water falls?

(b) Calculate

(i) the *weight* of water falling over the weir in 5.0 s.

(ii) the work which has been done on this weight of water when it hits the stream below the weir.

(c) Calculate the power of the *falling* water at the instant it hits the stream.

(d) State the energy transformations which occur as the water falls from the weir into the stream below.

[Take the acceleration of free fall to be 10 m/s^2 (10 N/kg).

J81/II/1

35 *(a)* State the meanings of the terms *work* and *power*.

(b) The front of a lorry may be regarded as a flat vertical plane of area 7.0 m^2 . The average pressure due to air resistance, perpendicular to the front of the lorry, is 400 N/m^2 when the speed of the lorry is 25 m/s.

Calculate the force, due to air resistance, acting on the front of the lorry when it is travelling at 25 m/s.

(c) Calculate the power dissipated in overcoming the air resistance when the lorry is travelling at 25 m/s.

(d) What happens to the energy lost by the lorry in maintaining its speed against this resistance?

N81/II/1

36 Calculate the work done in lifting a sphere of weight 80 N through a vertical height of 2.0 m from the floor.

The sphere is released, falls to the floor and then rebounds to a height of about 1.8 m above the floor. Account for the failure of the sphere to reach the original height of 2 m.

J82/I/3

37 A boy of mass 50 kg runs up a flight of steps in 4.0 s. There are 20 steps each of height 0.25 m. Calculate the average power he develops.

[Take the weight of 1 kg to be 10 N.] N82/I/3

38 A large stone, mass 2.0 kg, is projected horizontally at 40 m/s from the top of a cliff over the see and hits the water after 4.0 s.

(a) Taking the acceleration of free fall as 10 m/s^2, calculate

(i) the vertical velocity of the stone just before it hits the water,

(ii) the height of the cliff-top above the sea.

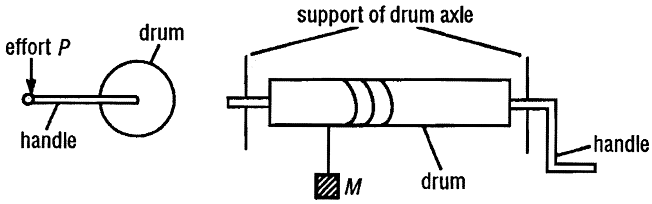
(b) The *rate* at which the stone loses potential energy increases as the stone nears the water. Why is this?

(c) Determine, by means of a scale diagram or otherwise, the direction in which the stone is moving just before it hits the water.

(d) On hitting the water, the stone slows down. State, with a reason, what happens to the kinetic energy it loses.

N82/II/1

39 *(b)* The diagram below illustrate a winch. An effort *P* is applied to the handle as shown and, as the handle turns, a rope is wound round the drum, so raising the mass *M*.



Given that the circumference of the circle in which the effort moves is 1.5 m and that the length of the handle is three times the radius of the drum, calculate how far the mass M rises when the effort moves through one revolution.

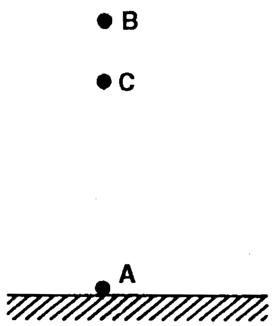
An effort of 10 N, applied to the handle, raises a mass of 2.2 kg. Calculate

(i) the energy gained by the mass when the drum turns through one revolution,

(ii) the work done by the effort during this revolution.

Suggest reasons why these two quantities are not equal. [Take the weight of 1 kg as 10 N.] N82/II/7*(b)*

40 A ball originally at position **A** is raised to position **B**.



What type of energy is gained by the ball?

The ball is released and falls. Into what form has this energy been converted just before it reaches the ground at **A**?

After one bounce, the ball rises only to the height of point **C** on the diagram. Account for this in terms of the energy conversions involved. N83/I/3

41 An empty lift is counterbalanced by a heavy piece of metal. Some people of combined mass 350 kg enter the lift and operate it. The lift rises 50 m in 60 s. Calculate

(a) the work done in raising the people,

[Take the weight of 1 kg to be 10 N.]

(b) the power required to do this. J84/I/3

42 In one type of clock the gradual falling of a mass provides energy to maintain the swinging of a heavy pendulum and to operate the clock mechanism.

In a particular clock of this type, the mass (0.60 kg) falls 0.40 m in 24 h. Calculate

(a) the weight of the mass,

(b) the energy provided in 24 h by the failing mass,

(c) the power generated.

[Take the weight of 1 kg to be 10 N.]

Draw a labelled sketch graph to show how, during two complete and successive swings, the potential energy of the pendulum changes with height above the lowest point of its path. Start the graph at an instant when the potential energy is greatest.

On the same axes, draw a second labelled graph to show how, during the same interval of time, the kinetic energy of the pendulum changes with height above the lowest point of its path.

*A falling mass drives a small generator used to supply current to a circuit. Describe, with the aid of a circuit diagram, how the power output of the generator could be determined. Why would you expect this output to be less than the power developed by the failing mass? N84/II/8

43 A steady force of 6.0 N is applied horizontally to a body of mass 4.0 kg, which is initially at rest. In the 2.0 s during which the force is applied, the mass moves 3.0 m in the direction of the force. Assuming that there is no resistance to the motion, find

(a) the work done by the force,

(b) the resulting kinetic energy of the body,

(c) the resulting velocity of the body. J85/I/1

44 An athlete throws a javelin of mass 0.80 kg so that its centre of gravity is raised from a height 2.0 m above ground level at the moment of release, to a maximum height of 14.0 m during its flight.

Calculate the energy to lift it against gravity to this height. (The force of gravity on 1 kg is 10 N.)

Explain why the energy with which the javelin leaves the athlete's hand is considerably greater than the energy calculated above. N85/I/3

45 In a crash test a car of mass 1500 kg containing a dummy is driven into a rigid barrier at a speed of 15 m/s. The recorded results showed that the interval between the first contact with the barrier and the car coming to rest was 0.12 s.

(a) Calculate the average deceleration of the car over the 0.12 s.

(b) Find the retarding force, assumed to be constant, acting on the car.

(c) One of the man-shaped dummies used in the above test was strapped in place with a safety belt. The dummy was found to have moved forward 0.25 m against the force exerted by the belt. Given that the kinetic energy of the dummy just before impact was 7870 J, calculate the average force which acted on the dummy as it was stopping.

(d) Explain why it is an advantage for anyone riding in the car to be brought to rest steadily over this distance of 0.25 m rather than abruptly. J86/II/1

46 A bricklayer lifts 12 bricks each weighing 20 N a vertical height of 1.2 m in 30 s and places them at rest on a wall.

Calculate

(i) the work done,

(ii) the average power needed. N87/I/2

47 A boy of mass 30 kg runs up a flight of stairs to a floor which is at a height of 5.5 m in 6.0 s. Taking the weight of 1 kg to be 10 N, calculate

(i) the work done by the boy against gravity, [2]

(ii) the average power developed by the boy. [2]
N88/I/2

48 Fig. 1 shows one form of diving-board used at swimming pools. The board is pivoted at **F**. A woman of weight 640 N stands still with her centre of gravity directly above a point 1.8 m from **F** as shown. A spring **S** holds the diving-board in a horizontal position.

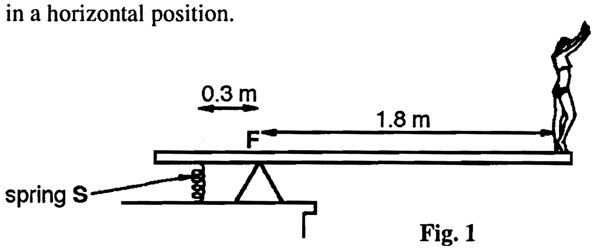


Fig. 1

(a) (i) Calculate the moment of the weight of the woman about **F**.

(ii) Assuming that the distance between the spring **S** and the point **F** is 0.3 m, calculate the force exerted by the spring to balance the weight of the woman.

(iii) Draw on the diagram an arrow to show the direction of the force exerted by the spring on the diving-board. [4]

(b) The woman allows herself to fall from the end of the board, and when her centre of gravity has fallen through 2.5 m from rest, her speed is 7.0 m/s.

(i) Assuming that the woman falls with uniform acceleration, calculate the time taken for her speed to reach 7.0 m/s.

(ii) Calculate the work done on the woman by the force of gravity.

(iii) Calculate the average rate at which work is done on the woman by the force of gravity. [6]
J89/II/1

49 *(b)* Students investigating the performance of a small d.c. motor used the arrangement shown in Fig. 2. As the output shaft turns, the thread wraps itself evenly around the shaft and the load is raised at a constant speed.

The following measurements were made during the experiment.

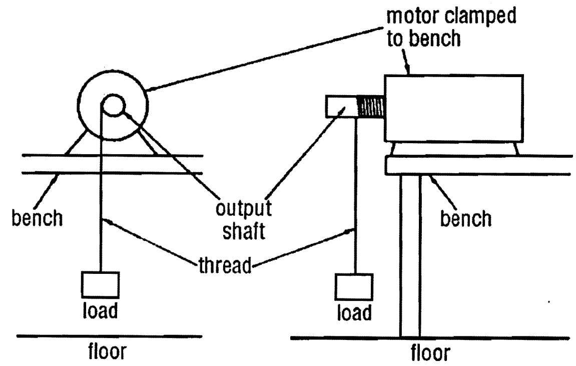


Fig. 2

Diameter of output shaft = 10.0 mm

Mass of load = 0.50 kg

Time taken to raise load through a height of 1.20 m = 5.0 s.

Calculate each of the following quantities, assuming that the thickness of the thread can be ignored and that the gravitational force acting on a mass of 1 kg is 10.0 N.

(i) The change in potential energy of the load as it is raised through a height of 1.20 m.

(ii) The useful power of the motor.

(iii) The number of revolutions of the shaft required to raise the load through 1.20 m.

(iv) The speed of rotation of the output shaft in revolutions per second. [7]
N90/II/9*(b)*

50 *(a)* A petrol-driven car accelerates from rest to its cruising speed along a straight level road.

(i) State the principal energy changes in the car and in its surroundings.

(ii) The car now climbs a slope with no change of speed. Explain whether the rate of petrol consumption will increase, stay the same or decrease. [5]

(b) Stone is raised from the floor of a quarry as shown in Fig. 3.

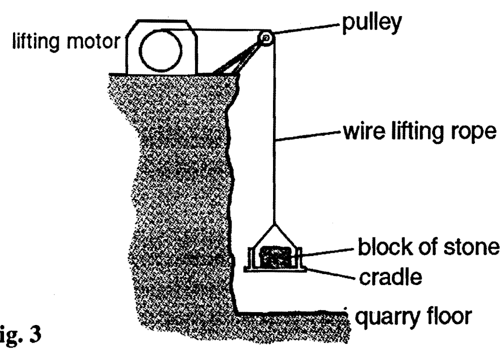


Fig. 3

The circumference of the pulley wheel is 1.35 m and the mass of the lifting cradle is 40 kg. A block of stone of mass 600 kg is raised at constant speed through a height of 27 m in a time of 3.0 minutes. The gravitational force exerted on a mass of 1.0 kg may be assumed to be 10 N.

Calculate

(i) the number of revolutions of the pulley during the lifting,

(ii) the speed of the stone and the cradle,

(iii) the combined weight of the stone and the cradle,

(iv) the tension in the lifting rope,

(v) the output power of the motor assuming that the friction at the pulley is negligible. [10]

N92/II/9

51 *(a)* (i) Define *work* and give the name and symbol for an SI unit in which it is measured.

(ii) Define *power* and give the name and symbol for an SI unit in which it is measured. [4]

(b) A student of mass 60 kg runs up a flight of stairs of height 4.0 m in a time of 3.0 s. Calculate, assuming that the gravitational force on a mass of 1.00 kg is 10.0 N,

(i) the student's gain in potential energy,

(ii) the useful power developed by the student in climbing the stairs. [3]

N96/II/3

52 A ball moves upwards as shown in Fig. 4. The ball rises from its initial position at **J** to its maximum height at **K**, hits the ground again at **L**, bounces a few times and rolls to rest at **M**.

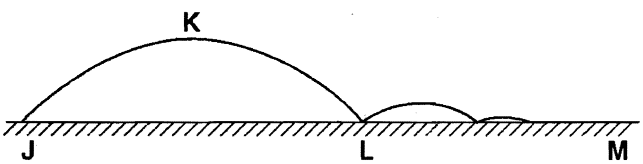


Fig. 4

(a) State the principal energy changes of the ball

(i) between **J** and **K**,

(ii) between **K** and **L**,

(iii) between **L** and **M**. [5]

(b) At **M**, the ball has less energy than it had at **J**. What has happened to the energy it has lost? [2]

J97/II/2

53 Fig. 5.1 shows a gate which closes automatically after use. A heavy stone is attached by chains **JK** and **KL** to the top bar of the gate and to the top of a nearby vertical post.

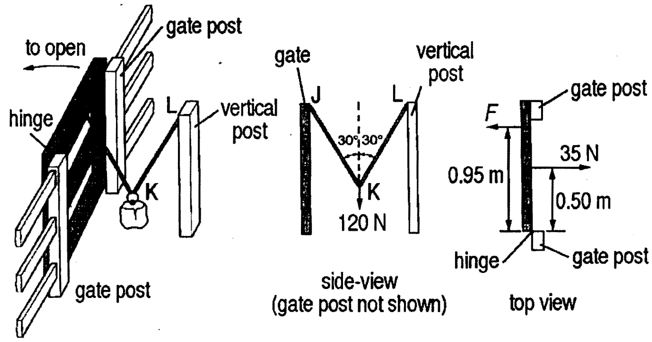


Fig. 5.1 **Fig. 5.2** **Fig. 5.3**

Opening the gate raises the stone; when the gate is released, the force exerted by the chain **JK** closes the gate.

The weight of the stone is 120 N.

(a) On average, the stone is raised through a height of 0.14 m when the gate is opened.

(i) Calculate the gain in potential energy of the stone when the gate is opened.

(ii) Assuming that frictional forces are negligible, determine the work done when opening the gate.

(iii) State what happens to the potential energy stored in the weight when the gate closes [6]

(b) When the gate is closed, each chain is at 30° to the vertical (Fig. 5.2). The plane containing the chains and the stone is at right angles to the gate (Fig. 5.3).

(i) The vector sum of the tensions in the chains is equal to the weight of the stone. Draw, to scale, a vector diagram showing these forces and use your diagram to determine the tension in each chain.

(ii) Because chain **JK** pulls at an angle to the horizontal, the horizontal force holding the gate closed is only 35 N, as shown in Fig. 5.3. Use the principle of moments and the data given in Fig. 5.3 to determine the minimum force F needed to start opening the gate. Assume that frictional forces in the hinge are negligible. [5]

(c) (i) State the *principle of moments.*

N97/II/9

54 A small hydro-electric power station is shown in Fig. 6.

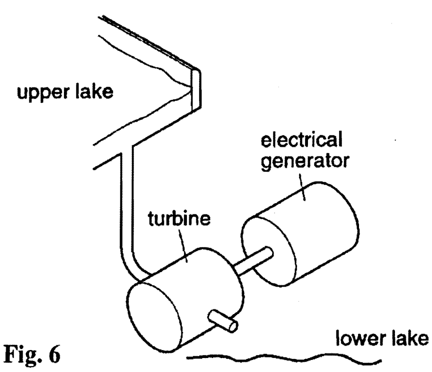
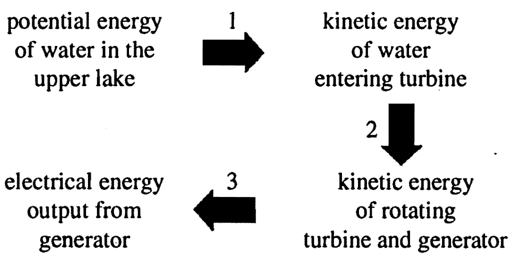


Fig. 6

Only 55% of the potential energy of the water in the upper lake is converted into electrical energy in the generator.

The useful energy changes which occur are as follows:



(a) At each change, some energy is lost. Describe, in detail and for each of the three changes, where this energy loss occurs and what other form of energy is produced. [5]

(b) The hydro-electric power station is used for one hour. During this hour, the level of water in the upper lake falls by 0.050 m. The area of the upper lake is 5000 m^2 and it is 80 m above the turbine. No additional water enters the lake.

Calculate

(i) the mass of water that leaves the lake in one hour, (the density of water is 1000 kg/ m^3),

(ii) the potential energy lost by the water in one hour, (take the gravitational force on a mass of 1 kg to be 10 N and assume that, on average, the water falls 80 m),

(iii) the electrical energy produced by the generator in one hour, (only 55% of the potential energy of the water becomes electrical energy),

(iv) the average electrical power produced by the generator during the hour. [8]

*(c) Calculate the maximum rise in temperature of the water that occurs if all the water leaving the upper lake in (b) falls directly into the lower lake, which is also 80 m below the upper lake. You should assume that all the potential energy of the falling water is converted into internal energy within this water. Take the specific heat capacity of water as 4200 J/(kg K). [2] J98/II/11

55

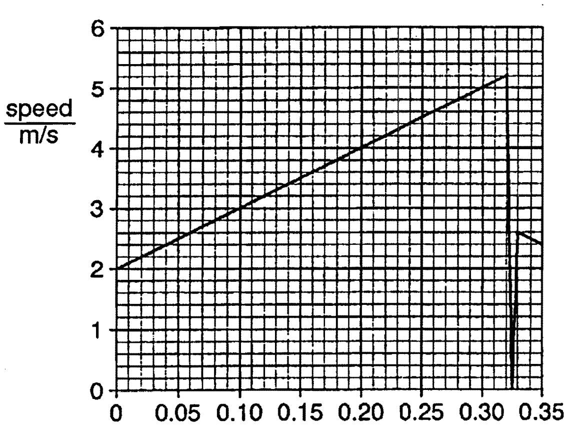


Fig. 7

Fig. 7 shows the variation with time t of the speed of a stone that is thrown vertically downwards. In this question, air resistance may be ignored.

The stone has mass 0.23 kg and leaves the thrower's hand at $t = 0$. It hits the ground at $t = 0.325$ s and rebounds with 50% of the speed with which it hit the ground.

(a) State the maximum speed of the stone. [1]

(b) Show, using data from Fig. 7, that the acceleration of free fall is 10 m/s^2. [2]

(c) Determine the speed of the stone just after it rebounds. [1]

(d) Calculate the loss of kinetic energy of the stone as it hits the ground and rebounds. [3]

J99/II/1

56 A toy car is given a **brief** initial push which sends it along a horizontal section of runway. The force of gravity then accelerates the car down the ramp which is shown in Fig. 8. In this question the only force due to friction that acts on the car is air resistance.

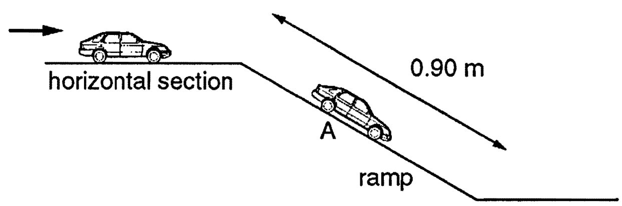


Fig. 8

(a) On Fig. 8, where the car is moving down the ramp at A, draw labelled arrows to show

(i) the direction of the force due to gravity on the car,

(ii) the direction of the force due to friction on the car. [1]

(b) State the effect that friction has on the motion of the car

(i) while the car is moving along the horizontal section,

(ii) while the car is accelerating down the ramp. [2]

(c) The length of the ramp is 0.90 m and the average force of friction is 0.11 N .

(i) Calculate the work done by the car against friction as it moves down the ramp.

work done = ...

(ii) The car has 0.30 J of kinetic energy at the top of the ramp and loses 0.50 J of potential energy as it moves from the top to the bottom of the ramp.

Calculate the kinetic energy of the car at the bottom of the ramp.

kinetic energy = ... [4]

N99/II/1

57 Fig. 9 shows the path of a ball thrown into the air.

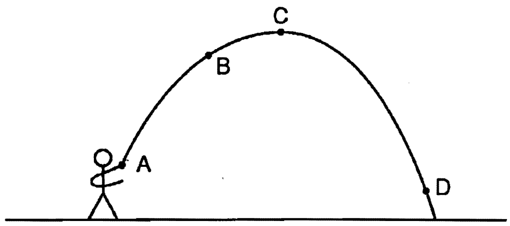


Fig. 9

(a) (i) State at which point A, B, C or D the ball travels the slowest.

(ii) Explain your choice in (i). You should write about the kinetic energy and the potential energy of the ball. [3]

(b) The mass of the ball is 0.20 kg. At point A, the ball has kinetic energy 2.5 J. Taking the gravitational force on a mass of 1.0 kg to be 10 N, calculate

(i) the weight of the ball,

weight = ...

(ii) the speed of the ball at point A.

speed = ... [4]

N2000/II/1

ANSWERS

1. **D**	2. **B**	3. **E**	4. **E**	5. **D**
6. **E**	7. **D**	8. **D**	9. **B**	10. **D**
11. **B**	12. **C**	13. **B**	14. **A**	15. **A**
16. **C**	17. **C**	18. **C**	19. **D**	20. **C**
21. **B**	22. **A**	23. **D**	24. **C**	25. **D**
26. **D**	27. **D**			

28. 3000 J; 150 N

29. (i) P.e. (ii) k.e. ; Ke → electrical energy

30. *(b)* 0.12 J *(c)* 120 W

31. 1920 J

33. 15 J ; 5 W

34. *(a)* (i) 15 m/s (ii) 11.25 m
(b) (i) 4500 kg (ii) 506 250 J
(c) 101 250 W

35. *(b)* 2800 N *(c)* 70 kW

36. 160 J

37. 625 W

38. *(a)* (i) 40 m/s (ii) 40 m

39. *(b)* 0.5 m (i) 11 J (ii) 15 J

41. *(a)* 7500 J *(b)* 2917 W

42. *(a)* 6 N *(b)* 2.4 J (c) 2.74×10^{-4} W

43. *(a)* 18.0 J *(b)* 18.0 J *(c)* 3.0 m/s

44. 96 J

45. *(a)* 125 m/s *(b)* 1.875×10^5 N *(c)* 31 480 N

46. (i) 288 J (ii) 96 W

47. (i) 1650 J (ii) 275 W

48. *(a)* (i) 1152 Nm (ii) 3840 N
(b) (i) $^5/_7$ s (ii) 1600 J (iii) 2240 W

49. *(b)* (i) 6 J (ii) 1.2 W
(iii) 38.2 (iv) 7.64 rps

50. *(b)* (i) 20 (ii) 0.15 m/s; (iii) 6400 N
(iv) 6400 N (v) 960 W

51. *(b)* (i) 2400 J (ii) 800 W

53. *(a)* (i) 16.8 J (ii) 16.8 J
(b) (ii) 18.4 N

54. *(b)* (i) 250 000 kg (ii) 2.0×10^8 J
(iii) 1.10×10^8 J (iv) 3.06 kW
(c) 0.19 K

55. *(a)* 5.2 m/s *(b)* 10 m/s^2
(c) 2.6 m/s *(d)* 2.33 J

56. *(c)* (i) 0.099 J (ii) 0.701 J

57. *(a)* (i) C
(b) (i) 2 N (ii) 5 m/s