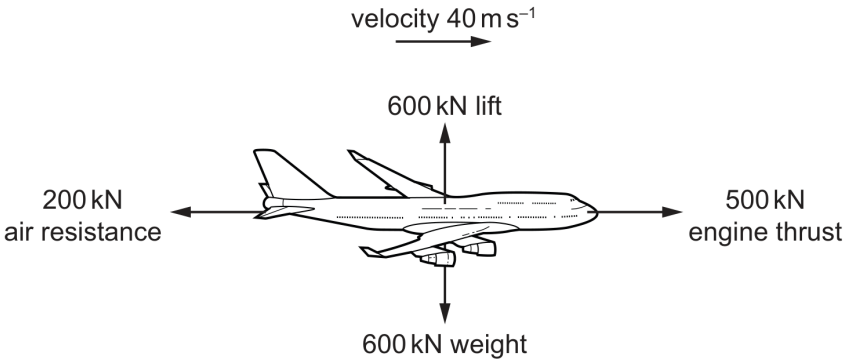
Unit 5: Work, energy and power:

Subunit 5.2: Gravitational potential energy and kinetic energy:

Topical Question No: 1

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

Topical Question No: 2

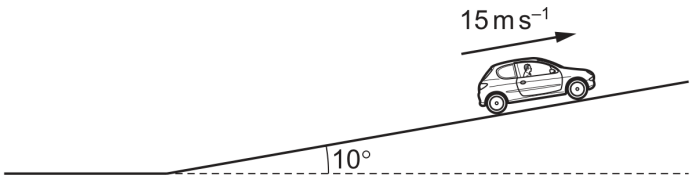
16 A man is running in a straight line.

What is an approximate value of his kinetic energy?

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

Topical Question No: 3

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.

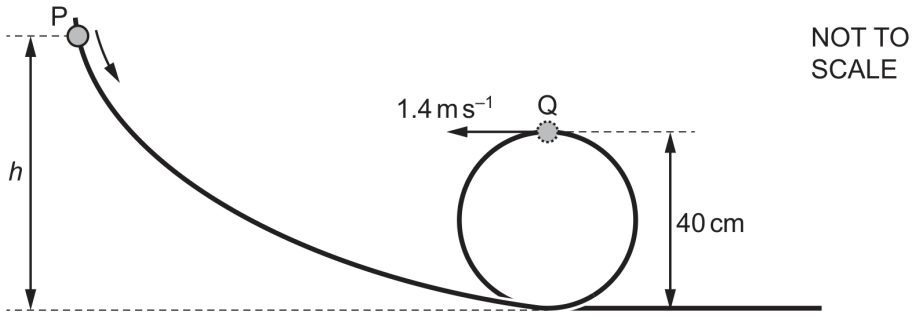


What is the useful output power of the car's engine?

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

Topical Question No: 4

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.

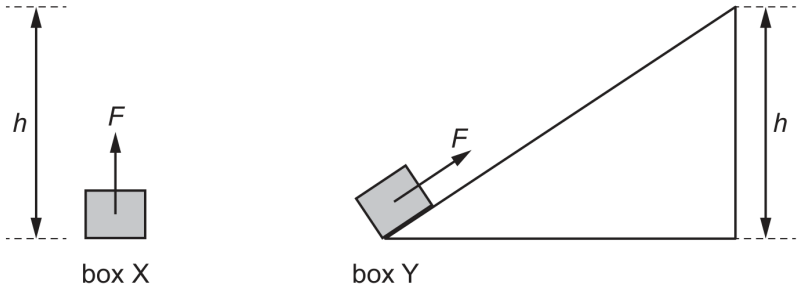
What is the height *h* from which the bead is released?

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

Topical Question No: 5

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.

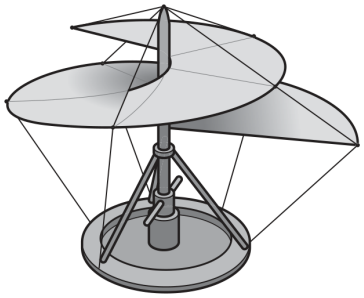
B Both boxes gain the same amount of gravitational potential energy but more work is done by the force acting on box Y than by the force acting on box X.

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.

Topical Question No: 6

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.



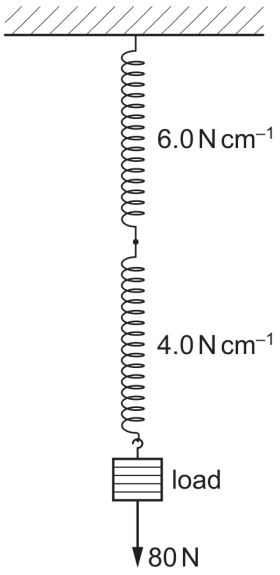
The machine and the pilot together have a total mass of 120 kg.

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

Topical Question No: 7

20 A spring has a spring constant of 6.0 N cm^{-1}. It is joined to another spring whose spring constant is 4.0 N cm^{-1}. A load of 80 N is suspended from this composite spring.

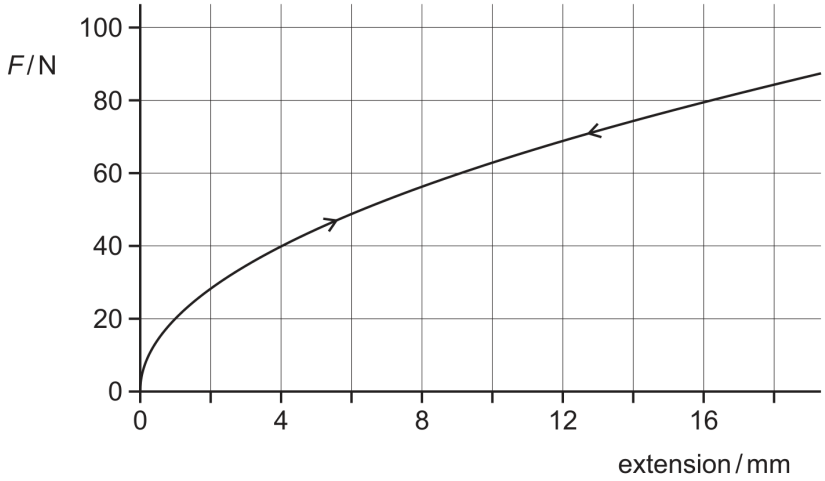


What is the extension of this composite spring?

A 8.0 cm **B** 16 cm **C** 17 cm **D** 33 cm

Topical Question No: 8

21 The graph shows the extension of a sample of a type of rubber as different loads *F* are applied and then gradually removed.



What is the best estimate of the strain energy in the rubber when a load of 80 N is applied?

A 0.40 J **B** 0.64 J **C** 0.88 J **D** 1.3 J

Topical Question No: 9

20 A wire is stretched by applying increasing values of force *F*. For each value of force applied, the extension *x* is recorded. A force–extension graph is plotted from the data obtained.

Which statement about the area under the graph **must** be correct?

A It can be calculated as $\frac{1}{2}Fx$.

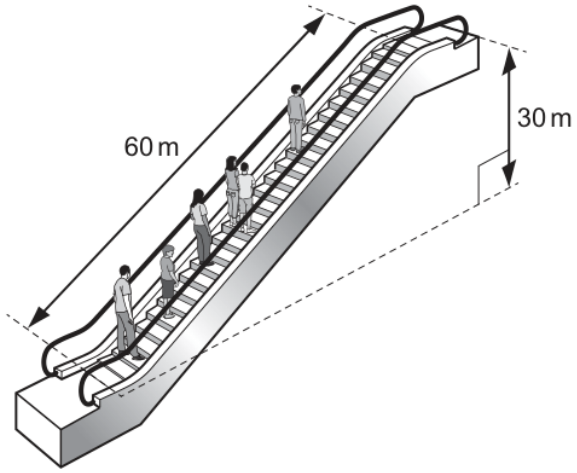
B It is the elastic potential energy stored in the stretched sample.

C It is the work done in stretching the sample.

D It would be the same for any wire of the same material.

Topical Question No: 10

16 An escalator is 60 m long and lifts passengers through a vertical height of 30 m, as shown.



To drive the escalator against the forces of friction when there are no passengers requires a power of 2.0 kW.

The escalator is used by passengers of average mass 60 kg and the power to overcome friction remains constant.

How much power is required to drive the escalator when it is carrying 20 passengers and is travelling at 0.75 m s^{-1}?

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

Topical Question No: 11

17 A rock of mass 40 kg is released from rest from a height of 20 m above the surface of a planet.

The rock has a kinetic energy of 32 kJ when it hits the surface of the planet. The planet does not have an atmosphere.

What is the weight of the rock on the surface of the planet?

A 1.6 N **B** 390 N **C** 1.6 kN **D** 64 kN

Topical Question No: 12

17 A projectile of mass 0.25 kg is at a height of 30 m above horizontal ground and travelling at a speed of 15 m s^{-1}. A short time later, it is at a height of 35 m above the horizontal ground and travelling at a speed of 5.0 m s^{-1}.

How much work is done against air resistance during this time?

A 0 J **B** 13 J **C** 25 J **D** 37 J

Topical Question No: 13

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

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

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

Space for working

Topical Question No: 14

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

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

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

Topical Question No: 15

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

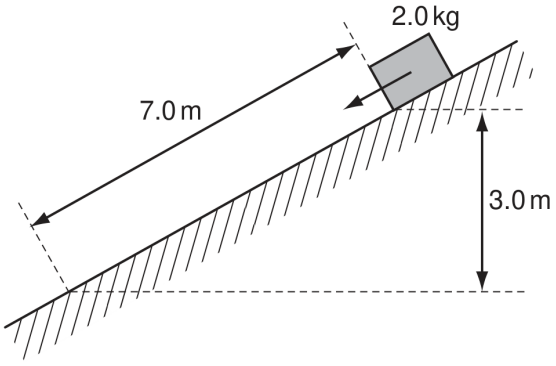
Which expression gives the value of $\frac{v}{u}$?

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

Space for working

Topical Question No: 16

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



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

A 4.9 m s^{-1} **B** 6.6 m s^{-1} **C** 8.6 m s^{-1} **D** 10.1 m s^{-1}

Topical Question No: 17

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

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

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

Space for working

Topical Question No: 18

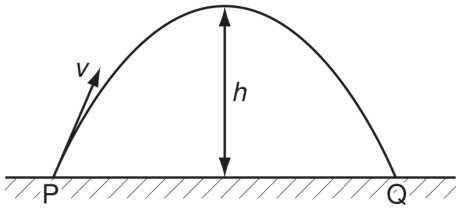
17 A body travelling with a speed of 10 m s^{-1} has kinetic energy 1500 J.

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

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

Topical Question No: 19

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



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

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

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

Topical Question No: 20

15 A spring of unextended length 40 mm is suspended from a fixed point. A load of 16 N is applied to the free end of the spring. This causes the spring to extend so that its final length is five times its original length. The spring obeys Hooke's Law.

What is the energy stored in the spring due to this extension?

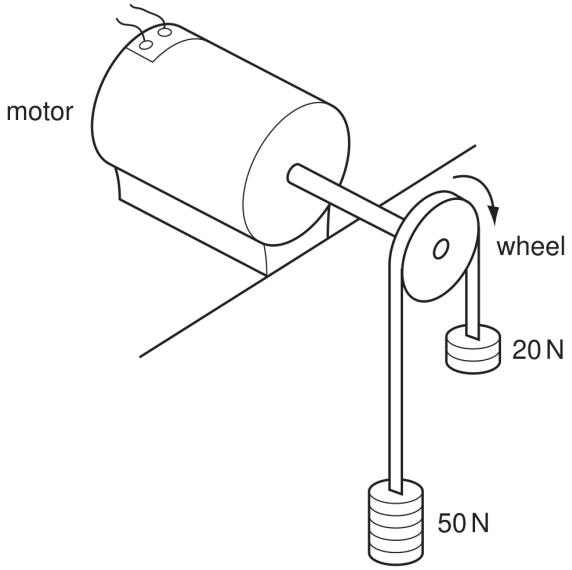
A 1.3 J **B** 1.6 J **C** 2.6 J **D** 3.2 J

Space for working

Topical Question No: 21

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

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



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

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

Topical Question No: 22

21 A spring is stretched over a range within which elastic deformation occurs. Its spring constant is 3.0 N cm^{-1}.

Which row, for the stated applied force, gives the correct extension and strain energy?

	force / N	extension / cm	strain energy / mJ
A	3.0	1.0	1.5
B	6.0	2.0	120
C	12.0	3.0	180
D	24.0	8.0	960

Topical Question No: 23

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

Topical Question No: 24

18 A student attempts to derive the formula for kinetic energy E_K. She begins by considering an object of mass m which is initially at rest. A constant force F applied to the object causes it to accelerate to final velocity v in displacement s. The kinetic energy gained by the object is equal to the work done on the object by the force F.

Which equation would the student **not** need in order to derive the formula for E_K?

A $F = ma$ **B** $W = Fs$ **C** $E = \frac{1}{2}Fs$ **D** $v^2 = u^2 + 2as$

Topical Question No: 25

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

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

Topical Question No: 26

17 A motor is used to lift a load vertically upwards.

The load has weight W.

The motor produces useful power output P.

The load is lifted at constant velocity v.

Which expression gives the time taken for the motor to lift the load vertically upwards through a distance d?

A $\frac{P}{Wd}$ **B** $\frac{Wv}{P}$ **C** $\frac{Wd}{P}$ **D** $\frac{Pv}{W}$

Topical Question No: 27

19 An object of mass m is dropped onto the surface of two planets, X and Y, which have no atmosphere.

The height from which the object is dropped and the change in gravitational potential energy of the object, for each planet, are given in the table.

	height / m	change in gravitational potential energy
planet X	3	ΔE
planet Y	4	$4\Delta E$

The acceleration of free fall near the surface of planet X is g_X.

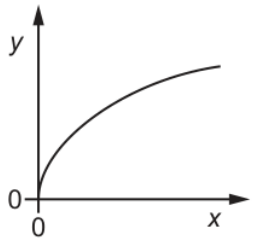
What is the acceleration of free fall near the surface of planet Y?

A $\frac{3}{4}g_X$ **B** $\frac{4}{3}g_X$ **C** $3g_X$ **D** $4g_X$

Topical Question No: 28

21 A wire is extended by different forces. The wire obeys Hooke's law.

A graph is plotted to show the variation of a quantity *y* with a quantity *x*.



What could *x* and *y* represent?

	x	*y*
A	elastic potential energy	extension
B	extension	force
C	force	extension
D	extension	elastic potential energy

Answer Key

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