5. Work, Energy and Power

5.2 Gravitational potential energy and kinetic energy

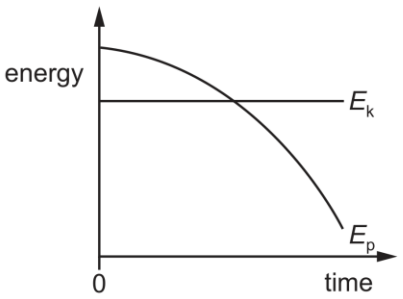
Paper 1

Question Paper

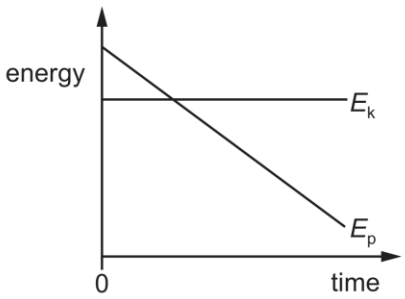
1 A steel ball is falling at constant speed in oil.

Which graph shows the variation with time of the gravitational potential energy E_p and the kinetic energy E_k of the ball?

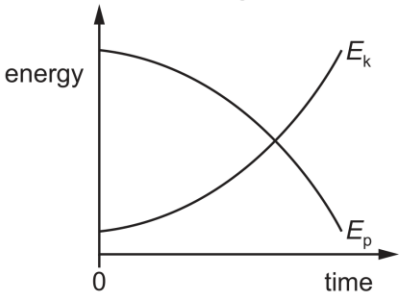
A



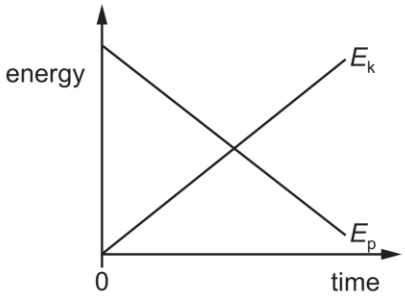
B



C



D



2 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

3 A mass of 28 g is raised vertically upwards through a distance of 4.6 m.

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

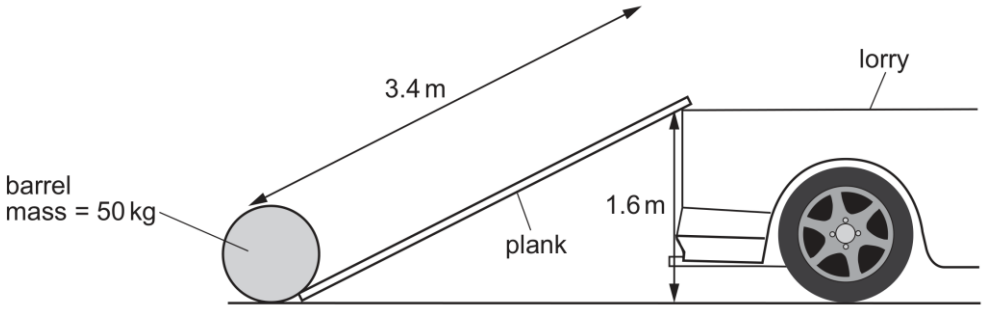
A 0.13 J **B** 1.3 J **C** 130 J **D** 1300 J

4 A car of mass 1200 kg has momentum 18 000 kg m s^{-1}.

What is the kinetic energy of the car?

A 4.65 kJ **B** 6.57 kJ **C** 135 kJ **D** 270 kJ

5 A barrel of mass 50 kg is loaded onto the back of a lorry 1.6 m high by pushing it up a frictionless plank 3.4 m long.

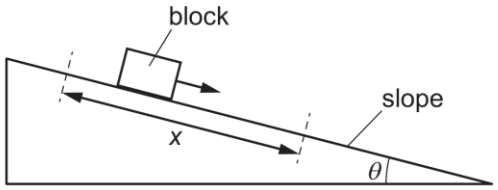


What is the minimum work done?

A 80 J **B** 170 J **C** 780 J **D** 1700 J

6 A block is released from rest and slides a distance x down a straight slope.

The slope is at an angle θ to the horizontal.



The slope is frictionless and air resistance is negligible.

The acceleration of free fall is g.

Which expression gives the final speed of the block?

A $\sqrt{\frac{gx\sin\theta}{2}}$ **B** $\sqrt{2gx\sin\theta}$ **C** $\sqrt{2gx}$ **D** $2gx\sin\theta$

7 A builder holding a brick of mass 3000 g drops the brick on his foot.

What is a reasonable estimate of the change in gravitational potential energy of the brick?

A 30 J **B** 300 J **C** 3000 J **D** 30 000 J

8 When an object of mass m is raised through a vertical height Δh, the gain of its gravitational potential energy is ΔE_P.

ΔE_P and Δh are related by the equation

$$\Delta E_P = mg\Delta h,$$

where g is the acceleration of free fall.

The definition of which physical quantity is needed to derive this equation?

A acceleration

B momentum

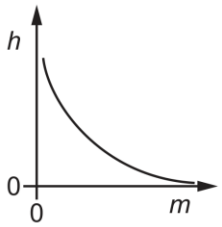
C power

D work done

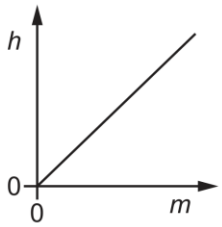
9 Objects with different masses are placed on the horizontal surface of a table. The objects are then raised to different heights above the table. The gain in gravitational potential energy of each object is the same.

Which graph best shows the variation of the height h of the objects above the table with their mass m?

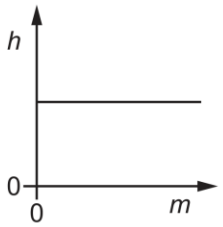
A



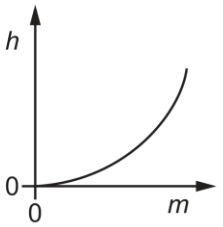
B



C



D



10 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** $v^2 = u^2 + 2as$

11 An alpha-particle has 2.2×10^{-13} J of kinetic energy.

What is the speed of the alpha-particle?

A $4.1 \times 10^6\,\text{m s}^{-1}$

B $5.8 \times 10^6\,\text{m s}^{-1}$

C $8.1 \times 10^6\,\text{m s}^{-1}$

D $1.2 \times 10^7\,\text{m s}^{-1}$

12 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.

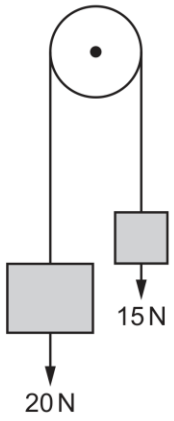
	height / m	change in gravitational potential energy
planet X	3	ΔE
planet Y	4	$4\Delta E$

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** $4g_X$

13 A pulley of radius 0.40 m supports weights of 20 N and 15 N by means of a thin string, as shown.



The weights are moved by slowly rotating the pulley clockwise through an angle of 60°.

What is the increase in the total gravitational potential energy of the weights?

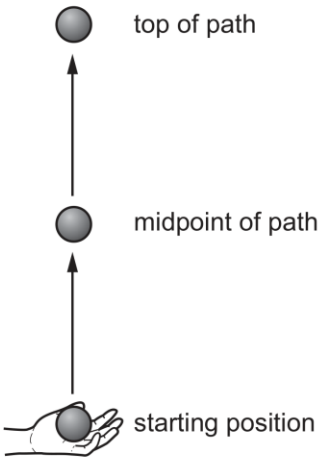
A 0.33 J **B** 2.0 J **C** 2.1 J **D** 15 J

14 A car of mass 1500 kg accelerates from an initial speed of 15 m s^{-1}. This acceleration causes the car to gain 3.0×10^5 J of kinetic energy.

What is the change in the speed of the car?

A 5.4 m s^{-1} **B** 10 m s^{-1} **C** 20 m s^{-1} **D** 25 m s^{-1}

15 A ball is thrown vertically upwards 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.

16 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.

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

A the decrease in gravitational potential energy of a mass of 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 mass of 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

18 The change in gravitational potential energy ΔE of an object of mass m when moving through height Δh near the surface of the Earth is given by the equation shown.

$$\Delta E = mg\Delta h$$

Which equation is needed as part of the derivation of this expression?

A kinetic energy = $\frac{1}{2} \times$ mass $\times$ (speed)^2

B moment = force $\times$ distance

C weight = mass $\times$ acceleration of free fall

D work done = power $\times$ time

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

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

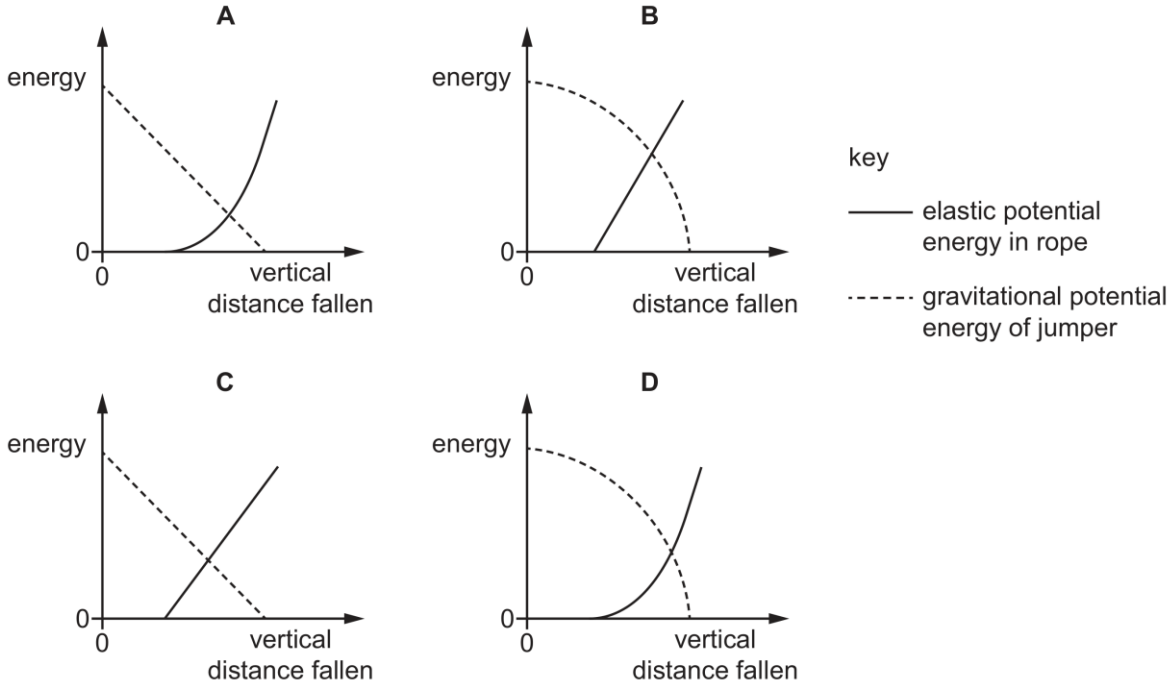
Which equation is **not** used in the derivation of this equation?

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

20 A bungee jumper jumps off a high bridge, when attached to it by a long elastic rope which obeys Hooke's law.

The gravitational potential energy of the jumper is measured relative to the lowest point reached by the jumper.

Which graph shows the variation of the gravitational potential energy of the jumper, and the elastic potential energy in the rope, with the vertical distance fallen from the top of the bridge?



21 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

22 The momentum of a car of mass m increases from p_1 to p_2.

What is the increase in the kinetic energy of the car?

A $\frac{(p_2^2 - p_1^2)}{2m}$ **B** $\frac{(p_2 - p_1)^2}{2m}$ **C** $\frac{p_2 - p_1}{2m}$ **D** $\frac{p_1 - p_2}{2m}$

23 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.

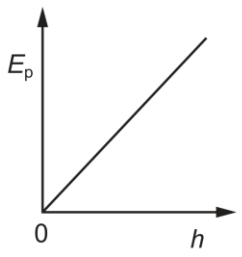
What is the total energy of the cannon-ball as it leaves the gun?

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

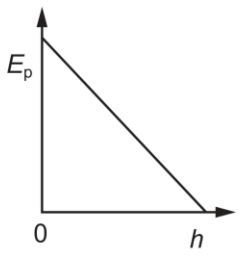
24 An object is thrown into the air.

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

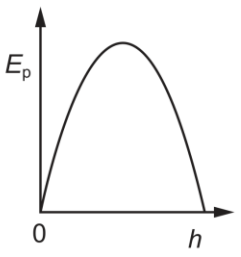
A



B



C



D

