Gravitational Potential and Kinetic Energy 1.1

A Level

P P P

In the absence of air resistance, use the equations in the notes page to derive expressions for:

Part A Speed on the ground for a dropped object

the speed v_1 at the ground if an object was dropped from h_0.

The following symbols may be useful: `E_GP, E_K, E_T, eta, g, h_0, h_1, m, v_0, v_1`

Part B Speed for an object with initial speed v_0

the speed v_1 at a height h_1 if an object had speed v_0 at h_0.

The following symbols may be useful: `E_GP, E_K, E_T, eta, g, h_0, h_1, m, v_0, v_1`

Part C Greatest height starting from the gound

the greatest height h_1 for an object projected up from the ground with speed v_0.

The following symbols may be useful: `E_GP, E_K, E_T, eta, g, h_0, h_1, m, v_0, v_1`

Part D Greatest height reached starting from h_0

the greatest height h_1 for an object projected up from a height h_0 with speed v_0.

The following symbols may be useful: `E_GP, E_K, E_T, eta, g, h_0, h_1, m, v_0, v_1`

Part E Greatest height after a bounce

the greatest height h_1 above a hard surface reached by an object dropped from a height h_0 if the efficiency of the bounce is η.

The following symbols may be useful: `E_GP, E_K, E_T, eta, g, h_0, h_1, m, v_0, v_1`

Part F Speed after a bounce

the speed v_1 just after a bounce from a hard surface if the speed just before was v_0.

The following symbols may be useful: `E_GP, E_K, E_T, eta, g, h_0, h_1, m, v_0, v_1`

Gravitational Potential and Kinetic Energy 1.10

A Level

P P P

How high would a ball bounce if it struck an $\eta = 0.75$ surface at $13\,\mathrm{m\,s^{-1}}$?

Gravitational Potential and Kinetic Energy 1.7

A Level
P P P

A worker at ground level throws a $2.2\,\mathrm{kg}$ drinks bottle upwards to a thirsty colleague $3.2\,\mathrm{m}$ above the ground. It just reaches him, but he fails to catch it, and it falls into an excavated trench $1.6\,\mathrm{m}$ below ground level.

Part A Initial speed of bottle

At what speed did the worker need to throw the bottle if she threw it from the waist, $1.0\,\mathrm{m}$ above the ground?

Part B Impact speed

How fast was it moving when it struck the base of the trench?

Gravitational, Elastic and Kinetic Energy 2.1

A Level

P P P

In the absence of air resistance, use the equations in the notes page to derive expressions for

Part A The total energy

Derive an expression for the total energy, E_T, in terms of x and v.

The following symbols may be useful: `E_B, E_EP, E_GP, E_T, g, k, m, v, x, x_B, y`

Part B The value of x where the forces balance

Derive an expression for the value of x where the forces balance (we will call this x_B).

The following symbols may be useful: `E_B, E_EP, E_GP, E_T, g, k, m, v, x, x_B, y`

Part C $E_\mathrm{GP} + E_\mathrm{EP}$ at the point where the forces balance

Derive an expression for $E_\mathrm{GP} + E_\mathrm{EP}$ at the point where the forces balance (we will call this E_B).

The following symbols may be useful: `E_B, E_EP, E_GP, E_T, g, k, m, v, x, x_B, y`

Part D The greatest value of x

Derive an expression for the greatest value of x if you hold the mass at $x = 0$ and let go.

The following symbols may be useful: `E_B, E_EP, E_GP, E_T, g, k, m, v, x, x_B, y`

Part E $E_{\mathrm{GP}} + E_{\mathrm{EP}}$ in terms of $y = x - x_{\mathrm{B}}$

Derive an expression for the value of $E_{\mathrm{GP}} + E_{\mathrm{EP}}$ in terms of $y = x - x_{\mathrm{B}}$.

The following symbols may be useful: `E_B, E_EP, E_GP, E_T, g, k, m, v, x, x_B, y`

Gravitational, Elastic and Kinetic Energy 2.2

A Level

P P P

Calculate E_{GP}, E_{EP}, E_{K} and E_{T} for a $2.5\,\text{kg}$ mass when $x = 0.055\,\text{m}$ and $v = 0.25\,\text{m}\,\text{s}^{-1}$ if $k = 600\,\text{N}\,\text{m}^{-1}$.

Part A Calculate E_{GP}

Calculate E_{GP} for a $2.5\,\text{kg}$ mass when $x = 0.055\,\text{m}$ and $v = 0.25\,\text{m}\,\text{s}^{-1}$ if $k = 600\,\text{N}\,\text{m}^{-1}$.

Part B Calculate E_{EP}

Calculate E_{EP} for a $2.5\,\text{kg}$ mass when $x = 0.055\,\text{m}$ and $v = 0.25\,\text{m}\,\text{s}^{-1}$ if $k = 600\,\text{N}\,\text{m}^{-1}$.

Part C Calculate E_{K}

Calculate E_{K} for a $2.5\,\text{kg}$ mass when $x = 0.055\,\text{m}$ and $v = 0.25\,\text{m}\,\text{s}^{-1}$ if $k = 600\,\text{N}\,\text{m}^{-1}$.

Part D Calculate E_{T}

Calculate E_{T} for a $2.5\,\text{kg}$ mass when $x = 0.055\,\text{m}$ and $v = 0.25\,\text{m}\,\text{s}^{-1}$ if $k = 600\,\text{N}\,\text{m}^{-1}$.

Gravitational, Elastic and Kinetic Energy 2.3

A Level

P P P

Calculate x_B (the extension of the spring at the equilibrium point) for a $100\,\mathrm{N}$ weight hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring.

Physics. You work it out.

Home Physics Gravitational, Elastic and Kinetic Energy 2.4

Gravitational, Elastic and Kinetic Energy 2.4

A Level

P P P

This question is about the system shown in the Example in the notes page.

A $60\,\mathrm{kg}$ bungee jumper falls $12\,\mathrm{m}$ before their bungee is taut. $k = 200\,\mathrm{N\,m^{-1}}$.

Calculate the speed of the bungee jumper when,

Part A The bungee has stretched $5.0\,\mathrm{m}$

Calculate the speed of bungee jumper when the bungee has stretched $5.0\,\mathrm{m}$.

Part B The bungee becomes slack on the way up

Calculate the speed of bungee jumper when the bungee becomes slack on the way up.

Gravitational, Elastic and Kinetic Energy 2.5

A Level

Fill in the missing entries in the table below. This describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$. You calculated x_B in question 2.3.

x	v	E_K	E_GP	E_EP	$E_\mathrm{EP} + E_\mathrm{GP}$	E_T	$y = x - x_\mathrm{B}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
1.0	(a)	(b)	(c)	(d)	(e)	0.0	(f)
2.0	(g)	(h)	(i)	(j)	(k) $= E_\mathrm{B}$	0.0	0.0
3.0	(l)	(m)	(n)	(o)	(p)	0.0	(q)
4.0	(r)	(s)	(t)	(u)	(v)	0.0	(w)

Part A Find v (a)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_K	E_GP	E_EP	$E_\mathrm{EP} + E_\mathrm{GP}$	E_T	$y = x - x_\mathrm{B}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
1.0	(a)	(b)	(c)	(d)	(e)	0.0	(f)

Find v (a).

Part B Find E_{K} (b)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
1.0	(a)	(b)	(c)	(d)	(e)	0.0	(f)

Find E_{K} (b).

Part C Find E_{GP} (c)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
1.0	(a)	(b)	(c)	(d)	(e)	0.0	(f)

Find E_{GP} (c).

Part D Find E_{EP} (d)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
1.0	(a)	(b)	(c)	(d)	(e)	0.0	(f)

Find E_{EP} (d).

Part E Find $E_{\text{EP}} + E_{\text{GP}}$ (e)

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
1.0	(a)	(b)	(c)	(d)	(e)	0.0	(f)

Find $E_{\text{EP}} + E_{\text{GP}}$ (e).

Part F Find y (f)

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
1.0	(a)	(b)	(c)	(d)	(e)	0.0	(f)

Find y (f).

Part G Find v (g)

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
2.0	(g)	(h)	(i)	(j)	(k) $= E_{\text{B}}$	0.0	0.0

Find v (g).

Part H Find E_{K} (h)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\mathrm{EP}} + E_{\mathrm{GP}}$	E_{T}	$y = x - x_{\mathrm{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
2.0	(g)	(h)	(i)	(j)	(k) $= E_{\mathrm{B}}$	0.0	0.0

Find E_{K} (h).

Part I Find E_{GP} (i)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\mathrm{EP}} + E_{\mathrm{GP}}$	E_{T}	$y = x - x_{\mathrm{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
2.0	(g)	(h)	(i)	(j)	(k) $= E_{\mathrm{B}}$	0.0	0.0

Find E_{GP} (i).

Part J Find E_{EP} (j)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\mathrm{EP}} + E_{\mathrm{GP}}$	E_{T}	$y = x - x_{\mathrm{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
2.0	(g)	(h)	(i)	(j)	(k) $= E_{\mathrm{B}}$	0.0	0.0

Find E_{EP} (j).

Part K Find $E_{\mathrm{EP}} + E_{\mathrm{GP}}$ (k)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\mathrm{EP}} + E_{\mathrm{GP}}$	E_{T}	$y = x - x_{\mathrm{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
2.0	(g)	(h)	(i)	(j)	(k) $= E_{\mathrm{B}}$	0.0	0.0

Find $E_{\mathrm{EP}} + E_{\mathrm{GP}}$ (k).

Part L Find v (l)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\mathrm{EP}} + E_{\mathrm{GP}}$	E_{T}	$y = x - x_{\mathrm{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
3.0	(l)	(m)	(n)	(o)	(p)	0.0	(q)

Find v (l).

Part M Find E_{K} (m)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\mathrm{EP}} + E_{\mathrm{GP}}$	E_{T}	$y = x - x_{\mathrm{B}}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
3.0	(l)	(m)	(n)	(o)	(p)	0.0	(q)

Find E_{K} (m).

Part N **Find E_{GP} (n)**

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
3.0	(l)	(m)	(n)	(o)	(p)	0.0	(q)

Find E_{GP} (n).

Part O **Find E_{EP} (o)**

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
3.0	(l)	(m)	(n)	(o)	(p)	0.0	(q)

Find E_{EP} (o).

Part P **Find $E_{\text{EP}} + E_{\text{GP}}$ (p)**

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
3.0	(l)	(m)	(n)	(o)	(p)	0.0	(q)

Find $E_{\text{EP}} + E_{\text{GP}}$ (p).

Part Q **Find y (q)**

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_K	E_{GP}	E_{EP}	$E_{EP} + E_{GP}$	E_T	$y = x - x_B$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
3.0	(l)	(m)	(n)	(o)	(p)	0.0	(q)

Find y (q).

Part R **Find v (r)**

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_K	E_{GP}	E_{EP}	$E_{EP} + E_{GP}$	E_T	$y = x - x_B$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
4.0	(r)	(s)	(t)	(u)	(v)	0.0	(w)

Find v (r).

Part S **Find E_K (s)**

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_K	E_{GP}	E_{EP}	$E_{EP} + E_{GP}$	E_T	$y = x - x_B$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
4.0	(r)	(s)	(t)	(u)	(v)	0.0	(w)

Find E_K (s).

Part T Find E_{GP} (t)

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
4.0	(r)	(s)	(t)	(u)	(v)	0.0	(w)

Find E_{GP} (t).

Part U Find E_{EP} (u)

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
4.0	(r)	(s)	(t)	(u)	(v)	0.0	(w)

Find E_{EP} (u).

Part V Find $E_{\text{EP}} + E_{\text{GP}}$ (v)

The table describes the motion of a $100\,\text{N}$ weight ($m = 10.2\,\text{kg}$), hanging from a $k = 5000\,\text{N}\,\text{m}^{-1}$ spring, which is released from rest at $x = 0$.

x	v	E_{K}	E_{GP}	E_{EP}	$E_{\text{EP}} + E_{\text{GP}}$	E_{T}	$y = x - x_{\text{B}}$
$/\text{cm}$	$/\text{m}\,\text{s}^{-1}$	$/\text{J}$					$/\text{cm}$
4.0	(r)	(s)	(t)	(u)	(v)	0.0	(w)

Find $E_{\text{EP}} + E_{\text{GP}}$ (v).

Part W Find y (w)

The table describes the motion of a $100\,\mathrm{N}$ weight ($m = 10.2\,\mathrm{kg}$), hanging from a $k = 5000\,\mathrm{N\,m^{-1}}$ spring, which is released from rest at $x = 0$.

x	v	E_K	E_GP	E_EP	$E_\mathrm{EP} + E_\mathrm{GP}$	E_T	$y = x - x_\mathrm{B}$
$/\mathrm{cm}$	$/\mathrm{m\,s^{-1}}$	$/\mathrm{J}$					$/\mathrm{cm}$
4.0	(r)	(s)	(t)	(u)	(v)	0.0	(w)

Find y (w).

Gravitational, Elastic and Kinetic Energy 2.6

A Level

For the system in question 2.5, state or calculate

Part A x where the total potential energy is at a minimum

Calculate the value of x where the total potential energy is at a miniumum.

Part B The minimum total potential energy

Calculate the minimum total potential energy.

Part C The total potential energy

Calculate the total potential energy *relative to the minimum* when $y = 2.0\,\mathrm{cm}$.

Part D The energy required to stretch $2.0\,\mathrm{cm}$

Calculate the energy required to stretch a $k = 5000\,\mathrm{N\,m^{-1}}$ spring by $2.0\,\mathrm{cm}$.

Gravitational, Elastic and Kinetic Energy 2.7

A Level

C C C

This question is about the system shown in the Example in the notes page.

A $60\,\mathrm{kg}$ bungee jumper falls $12\,\mathrm{m}$ before their bungee is taut. $k = 200\,\mathrm{N\,m^{-1}}$.

Calculate how far the bungee jumper falls before they first come to rest. You may assume that the *total* potential energy of the jumper relative to the equilibrium position is given by $\frac{1}{2}ky^2$.