Worked Solutions for ENGAA Papers by Topic

Section 1

Topic: Energy

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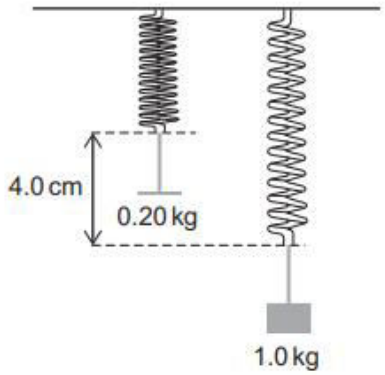
ENGAA S1 2020 - Question 35

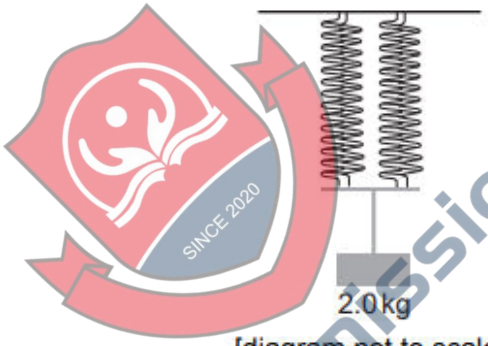
35 The diagram shows the relative positions of two identical light springs, both in equilibrium.

The springs are supporting loads of mass 0.20 kg and 1.0 kg as shown.



[diagram not to scale]

The same two springs are now connected in parallel, supporting a 2.0 kg mass as shown.



[diagram not to scale]

In this parallel arrangement, what is the total strain energy in the springs?

(gravitational field strength = 10 N kg^{-1}; assume that the springs obey Hooke's law)

A 0.25 J

B 0.40 J

C 0.50 J

D 1.0 J

E 25 J

F 40 J

G 50 J

H 100 J

ENGAA S1 2020 - Question 35 - Worked Solution

$$0.8kg \ = 8N \ causes \ extension \ of \ 4cm$$
$$F = kx \ so \ k = 200Nm^{-1}$$
$$In \ the \ parallel \ system, each \ spring \ is \ under \ force \ of \ 10N$$
$$x = \frac{10}{200} = 0.05m$$
$$EPE \ of \ 1 \ spring = \frac{1}{2}kx^2 = \frac{1}{2} \times 200 \times 0.05^2 = 0.5J$$

Answer is C

ENGAA S1 2019 - Question 22

22 A hydroelectric power station uses the water in a reservoir to power the generators. The water falls through a vertical height of 150 m to the turbines which power the generators.

The efficiency of the power station is 90% and the output power of the power station is 1800 MW.

The gravitational field strength is $10\,N\,kg^{-1}$ and the density of water is $1000\,kg\,m^{-3}$.

What volume of water passes through the turbines in one minute?

A $6.48 \times 10^4\,m^3$

B $7.20 \times 10^4\,m^3$

C $8.00 \times 10^4\,m^3$

D $6.48 \times 10^7\,m^3$

E $7.20 \times 10^7\,m^3$

F $8.00 \times 10^7\,m^3$

ENGAA S1 2019 - Question 22 - Worked Solution

$$Energy\ in\ one: E = \frac{1800MW}{0.9} \times 60s$$

$$E = 120 \times 10^9 J$$

Power is generated by GPE

$$U = mgh = 1000kgm^{-3} \times V \times 10Nkg^{-1} \times 150m$$

$$let\ U = E_0$$

$$V = \frac{120 \times 10^9}{150 \times 10^4}$$

$$V = 0.8 \times 10^5$$

$$V = 8 \times 10^4$$

Answer is C

ENGAA Specimen S1 - Question 8

8 A ball is thrown vertically upwards and leaves the thrower's hand with a speed of $12\,m\,s^{-1}$. You may assume that all of the initial kinetic energy of the ball has been converted into gravitational potential energy when the ball reaches its highest point.

What is the height above the thrower's hand to which it rises?

(gravitational field strength = $10\,N\,kg^{-1}$)

A 7.2 m

B 14.4 m

C 24 m

D 60 m

E 120 m

ENGAA Specimen S1 - Question 8 - Worked Solution

Assuming no air resistance,

$\frac{1}{2}mv^2 = mgh_f \quad (KE = GPE)$

where h_f denotes the final height.

$$h_f = \frac{v^2}{2g}$$

$$= \frac{12^2}{20}$$

$$= 7.2m$$

Answer is A

ENGAA S1 2018 - Question 8

8 A filament lamp working at its operating voltage converts electrical energy at a rate of 100 W.

The lamp has an efficiency of 5.0%.

How much energy is wasted by the lamp in 10 minutes?

A 50 J

B 950 J

C 1000 J

D 3000 J

E 57 000 J

F 60 000 J

ENGAA S1 2018 - Question 8 - Worked Solution

Lamp wastes 95% of energy
Energy transferred per second = Power

$$P = 100\ W$$

Energy wasted in 10 min:

$$= Pt \times 95\%$$
$$t = 10 \times 60s$$
$$= 100 \times 10 \times 60 \times 0.95$$
$$= 57000J$$

Answer is E.

ENGAA S1 2018 - Question 42

42 A ball of mass 0.20 kg is thrown vertically downwards at an initial speed of 4.0 m s^{-1} and travels a distance of 0.45 m to the ground.

The ball hits the ground, and rebounds with an initial speed of 2.0 m s^{-1}.

How much energy does the ball lose in the bounce?

(gravitational field strength = 10 N kg^{-1}; air resistance can be ignored)

A 0.10 J

B 0.40 J

C 0.50 J

D 0.90 J

E 1.2 J

F 1.6 J

G 2.1 J

ENGAA S1 2018 - Question 42 - Worked Solution

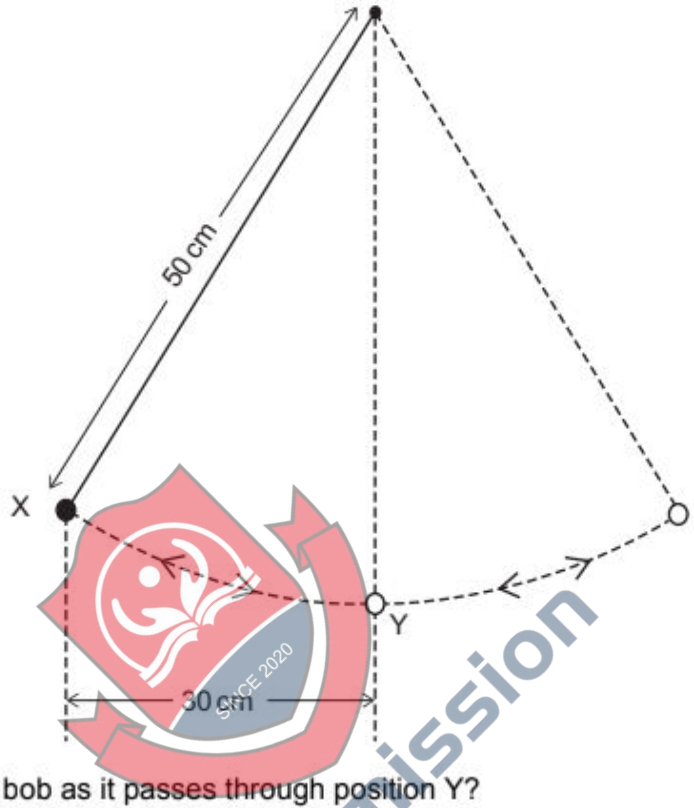
$$\Delta Ep = mgh$$
$$= 0.2 \times 10 \times 0.45 = 0.95$$
$$= \Delta Wk \ \ by\ conservation\ of\ energy$$
$$initial\ \ Ek = \frac{1}{2}m \times 4^2 + 0.9$$
$$= \frac{1}{2} \times 0.2 \times 16 + 0.9 = 2.55$$
$$kinetic\ energy\ lost = 2.5 - final\ Ek$$
$$= 2.5 - \frac{1}{2}m \times 2^2$$
$$= 2.5 - 0.4$$
$$= 2.15$$

Answer is G.

ENGAA S1 2018 - Question 48

48 A pendulum bob of mass 10 g is suspended by a light, inextensible string of length 50 cm.

The bob is released from rest at position X.



What is the speed of the bob as it passes through position Y?

(gravitational field strength $g = 10\,\text{N kg}^{-1}$; assume that resistive forces are negligible)

A $\sqrt{2}\,\text{m s}^{-1}$

B $\sqrt{4}\,\text{m s}^{-1}$

C $\sqrt{6}\,\text{m s}^{-1}$

D $\sqrt{8}\,\text{m s}^{-1}$

E $\sqrt{10}\,\text{m s}^{-1}$

ENGAA S1 2018 - Question 48 - Worked Solution

$$L = \sqrt{50^2 - 30^2} = 40$$
$$h = 50 - L = 10cm = 0.1m$$
$$\Delta Ep = Ek \text{ at } Y$$
$$mgh = \frac{1}{2}mv^2$$

$$v = \sqrt{2gh}$$
$$= \sqrt{2 \times 10 \times 0.1}$$
$$= \sqrt{2}\, ms^{-1}$$

Answer is A.

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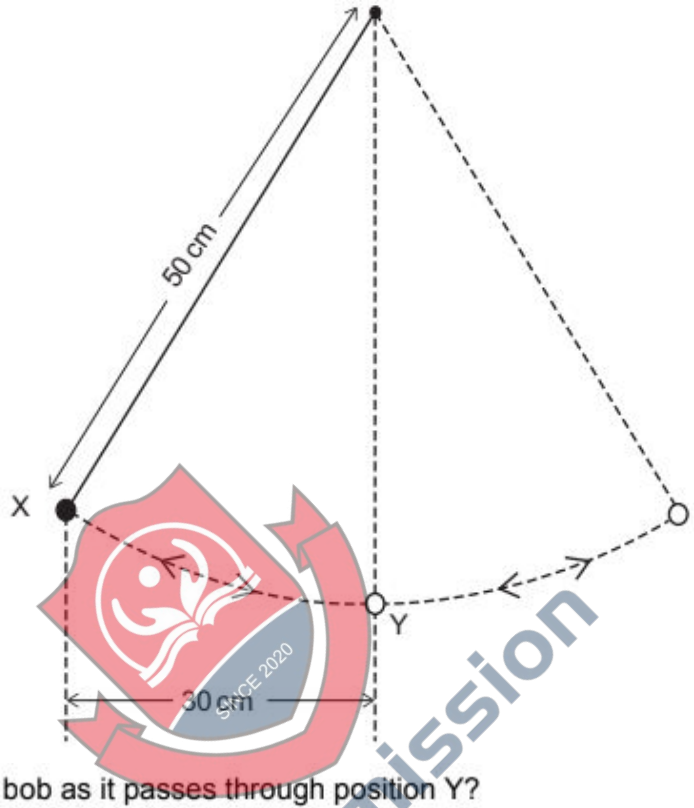

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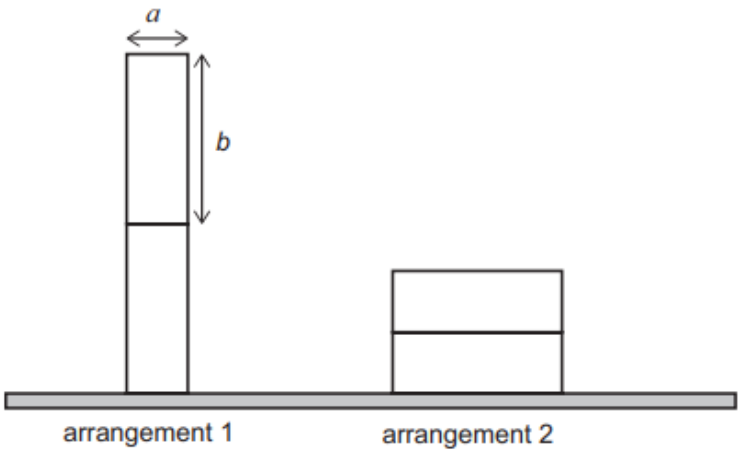
Answer is A.

ENGAA S1 2016 - Question 42

42 The diagram shows two identical blocks, each of mass m, in two different arrangements.

[diagram not to scale]



Which expression gives:

$$\left[\begin{array}{c}\text{gravitational potential energy}\\ \text{of arrangement 2}\end{array}\right] - \left[\begin{array}{c}\text{gravitational potential energy}\\ \text{of arrangement 1}\end{array}\right] ?$$

(g is the gravitational field strength.)

A $2mg(a-b)$

B $2mg(b-a)$

C $-mg(b+a)$

D $mg(a+b)$

E $\frac{3}{2}mg(a-b)$

F $\frac{1}{2}mg(a-b)$

ENGAA S1 2016 - Question 42 - Worked Solution

Assuming the blocks are uniform:

$$GPE_1 = mg\left(\frac{b}{2}+\frac{3b}{3}\right) = 2mgb$$

$$GPE_2 = mg\left(\frac{a}{2}+\frac{3a}{2}\right) = 2mga$$

$$GPE_2 - GPE_1 = 2mg(a-b)$$

Answer is A