Worked Solutions for ENGAA Papers by Topic

Section 1

Topic: Forces & equilibrium

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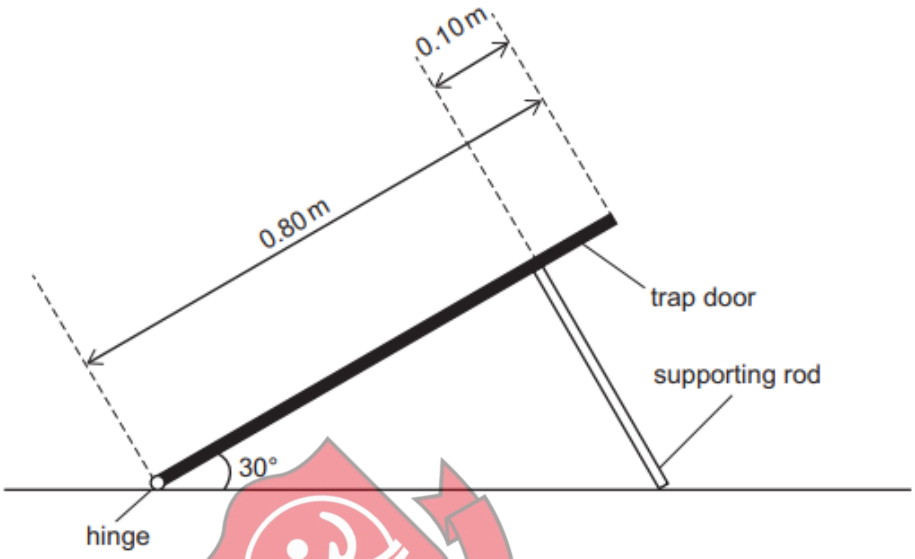
ENGAA S1 2019 - Question 28

28 A uniform square trap door of side 0.80 m and mass 14 kg has a smooth hinge at one edge and is held open at an angle of 30° to the horizontal. It is supported by a single rigid rod placed so that it meets the surface of the trap door at 90° at a distance 0.10 m from the top edge of the trap door, as shown.



What is the normal contact force exerted on the trap door by the rod?

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

A 40 N

B $35\sqrt{3}$ N

C $40\sqrt{3}$ N

D 80 N

E $80\sqrt{3}$ N

F $280\frac{\sqrt{3}}{3}$ N

ENGAA S1 2019 - Question 28 - Worked Solution

Rotational moments / torques about hinge

$$(14kg \times 10Nkg \times cos\ cos\ 30\ ) . 0.4m = N = 0.7m$$

$$R = 40\sqrt{3}$$

Answer is C

ENGAA Specimen S1 - Question 36

36 A particle of weight 5 N is held in position by two light ropes.

One of the ropes makes an angle of 60° with the upward vertical, the other is horizontal.

What is the tension in the horizontal rope?

A $1.25\sqrt{3}$ N

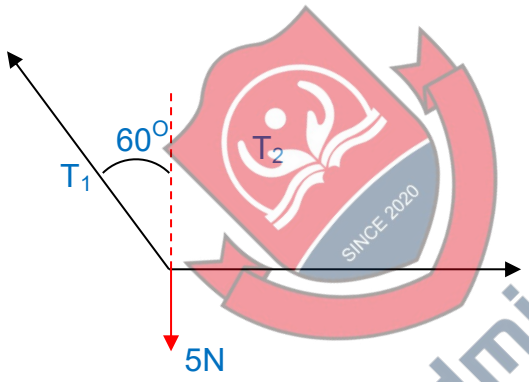
B 5 N

C $5\sqrt{3}$ N

D 10 N

E $10\sqrt{3}$ N

ENGAA Specimen S1 - Question 36 - Worked Solution



$$T_1 \cos 60 = 5N$$

$$T_1 \sin 60 = T_2$$

$$T_2 = \frac{5}{\cos 60} \sin 60$$

$$= 5 \tan 60°$$

$$= 5\sqrt{3}\ N$$

Answer is C

ENGAA S1 2018 - Question 16

16 A rock falling vertically experiences an air resistance force of 12 N at an instant when its acceleration is 2.0 m s^{-2} downwards.

What is the mass of the rock?

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

A 1.0 kg

B 1.2 kg

C 1.5 kg

D 6.0 kg

E 10 kg

F 12 kg

G 15 kg

H 60 kg

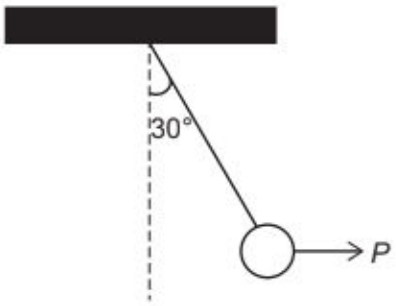
ENGAA S1 2018 - Question 16 - Worked Solution

$$F = ma$$
$$mg - 12 = m \times 2$$
$$10m - 12 = 2m$$
$$8m = 12$$
$$m = \frac{12}{8}$$
$$m = 1.5\ kg$$

Answer is C.

ENGAA S1 2018 - Question 46

46 A metal ball suspended from a steel cable is held at rest by a horizontal force P. The cable makes an angle of 30° to the vertical as shown in the diagram. The cable exerts a force T on the ball.



What is the magnitude of P?

A $\frac{T}{2}$

B T

C $2T$

D $\frac{T}{\sqrt{2}}$

E $\frac{T}{\sqrt{3}}$

F $\frac{2T}{\sqrt{3}}$

G $\frac{\sqrt{3}T}{2}$

ENGAA S1 2018 - Question 46 - Worked Solution

Resolve horizontally:

$$T\ sin\ sin\ 30 = P$$

$$\frac{T}{2} = P$$

Answer is A.

ENGAA S1 2017 - Question 50

50 A suitcase of mass m is on a conveyor belt which moves upwards at a constant speed at an angle of θ to the horizontal. The coefficient of friction between the suitcase and the slope is μ. The suitcase does not slip, even if angle θ is made slightly larger.

Which expression gives the friction force between the suitcase and the belt?

(gravitational field strength $= g$)

A μmg

B $mg \sin \theta$

C $mg \cos \theta$

D $\mu mg \sin \theta$

E $\mu mg \cos \theta$

ENGAA S1 2017 - Question 50 - Worked Solution

Resolving ∥ to slope:

$$F - mg\ sin\ sin\ \theta = ma = 0 \quad (as\ speed\ is\ constant)$$

$$F = mg\ sin\ sin$$

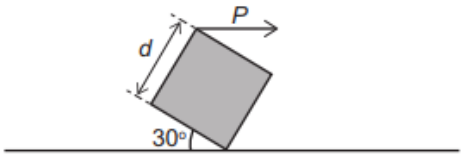
Can not use $F = \mu N$ as friction might not be limiting so $F \leq \mu N$

Answer is B

ENGAA S1 2016 - Question 40

40 The diagram shows a uniform, solid, heavy cube with side *d*. The cube rests with one of its edges in contact with a table that is perfectly level. A horizontal force *P* acts on another edge of the cube, and the cube is stationary.

[diagram not to scale]



Below are four statements about the forces on the cube.

1 It is possible that there is no frictional force between the cube and the table.

2 There must be a frictional force acting to the left between the cube and the table.

3 There must be a frictional force acting to the right between the cube and the table.

4 Force *P* has a clockwise moment about the edge in contact with the table equal to $P \times d$.

Which of the statements is/are correct?

A 1 only

B 2 only

C 3 only

D 1 and 4 only

E 2 and 4 only

F 3 and 4 only

ENGAA S1 2016 - Question 40 - Worked Solution

P acts to the right, therefore there must be a force to the left to counteract it as the cube I > in
equilibrium.
The normal reaction force can only act straight upwards.
This force must therefore be friction
1 is false
2 is true
3 is false
4 is false as P is not perpendicular to any sides of the cube.

Answer is B

ENGAA S1 2016 - Question 54

54 An object of weight 40 N hangs from the end of a light inextensible string of length 0.35 m, which is attached to the ceiling. A constant horizontal force of 30 N is applied to the object, causing it to move to a new equilibrium position with the string no longer vertical.

By how much has the gravitational potential energy of the object increased as a result of its change of position?

A 2.1 J

B 2.8 J

C 3.5 J

D 4.2 J

E 4.9 J

F 5.6 J

ENGAA S1 2016 - Question 54 - Worked Solution

$$T\ sin\ sin\ \theta = 40$$

$$T\ cos\ cos\ \theta = 30$$

$$tan\ tan\ \theta = \frac{4}{3}$$

$$h = 0.35\ sin\ sin\ \theta$$

$$sin\ sin\ \theta = \frac{4}{5}$$

$$h = 0.28m$$

The object is 0.07m higher in the new equilibrium

$$\Delta GPE = mg\Delta h = 40 \times 0.07 = 2.8J$$

Answer is B