Worked Solutions for ENGAA Papers by Topic

Section 1

Topic: Matter & Thermal Physics

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ENGAA 2020 - Section 1 - Question 1

1 A soldering iron has a copper tip of mass 2.0 g.

The tip is heated with 30 W of thermal power. In 50 s, the temperature of the tip increases by 200 °C.

How much energy is transferred from the tip to the surroundings in this time?

(specific heat capacity of copper = 400 J kg^{-1} °C^{-1})

A 160 J

B 500 J

C 1340 J

D 1500 J

E 1660 J

F 1840 J

G 2500 J

ENGAA 2020 - Section 1 - Question 1 - Worked Solution

$$E = m.c.\Delta T$$
$$E = 0.002 \times 400 \times 200$$
$$E = 160J$$
$$E_{null} = E_{supplied} - E_{tip}$$
$$= 30 \times 50 - 160$$
$$= 1340J$$

Answer is C

ENGAA S1 2019 - Question 6

6 A water-tight cylinder with a thin, freely moving piston contains $2.0 \times 10^{-3}\,m^3$ of trapped air at atmospheric pressure of $1.0 \times 10^{5}\,Pa$.

When the cylinder is submerged in water of constant density $1000\,kg\,m^{-3}$, the volume of air in the cylinder decreases to $4.0 \times 10^{-4}\,m^3$.

The piston is at a depth h below the surface of the water and the water surface is open to the atmosphere.

What is the depth h?

(gravitational field strength – $10\,N\,kg^{-1}$; assume that the temperature of the air remains constant and that air is an ideal gas)

A 40 m

B 50 m

C 60 m

D 400 m

E 500 m

F 600 m

ENGAA S1 2019 - Question 6 - Worked Solution

$$P_1V_1 = 1 \times 10^5 \times 2 \times 10^{-3} = P_2V_2 = P_2.4 \times 10^{-4}$$

$$P_2 = 5 \times 10^5$$

$$P_2 = P_1 + h\rho g = 10^5 + h(1000)(10)$$

$$h = 40m$$

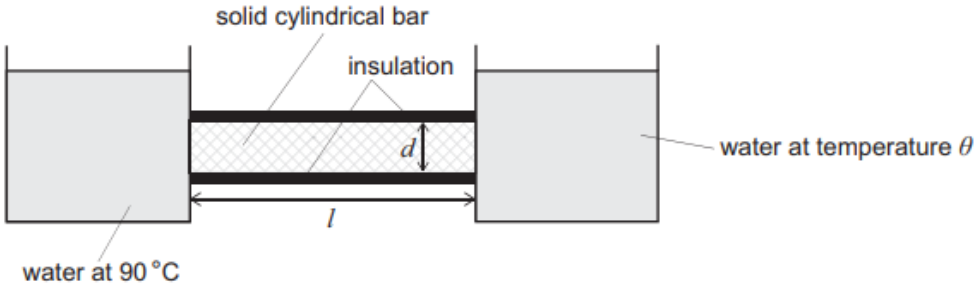
Answer is A

ENGAA S1 2019 - Question 10

10 Two tanks of water are connected by a solid cylindrical copper bar of length l and diameter d.

The bar is insulated.

One tank contains water at 90 °C and the other tank contains water at temperature θ.



For which of the following conditions is thermal energy conducted along the bar at the lowest rate?

	l / m	d / cm	θ / °C
A	0.40	4.0	20
B	0.40	4.0	40
C	0.40	8.0	20
D	0.40	8.0	40
E	0.80	4.0	20
F	0.80	4.0	40
G	0.80	8.0	20
H	0.80	8.0	40

ENGAA S1 2019 - Question 10 - Worked Solution

For lower thermal transfer

$$how\ temperature\ difference - \theta = 40°C$$

$$thin\ pipe - d = 4.0$$

$$long\ pipe (so\ thermal\ energy\ has\ long\ way\ to\ travel) - l = 0.8$$

Answer is F

ENGAA S1 2017 - Question 4

4 When a saucepan of water is heated from below, convection currents form and transfer heat through the liquid.

Here are three statements about the water as it is heated:

1 The mass of a fixed volume of the water increases.

2 The density of a fixed mass of the water decreases.

3 The volume of a fixed mass of the water increases.

Which of these statements help(s) to explain how convection currents are formed?

A none of them

B 1 only

C 2 only

D 3 only

E 1 and 2 only

F 1 and 3 only

G 2 and 3 only

H 1, 2 and 3

ENGAA 2017 - Question 4 - Worked Solution

$$\rho = \frac{m}{v}$$

- When water is heated , water molecules vibrate more
- So become more spaced out
- This means the value increases so ③ holds it mass is fixed
- So as $\rho = m/v$ and volume increases,, density decreases and ② holds , if mass is fixed
- If the volume was fixed however ρ would till decreases , so m would have to decrease , so ① is false.
- Convection currents are created when this hot, less dense water rises , and is replaced by the cooler, move dense water

Answer is G

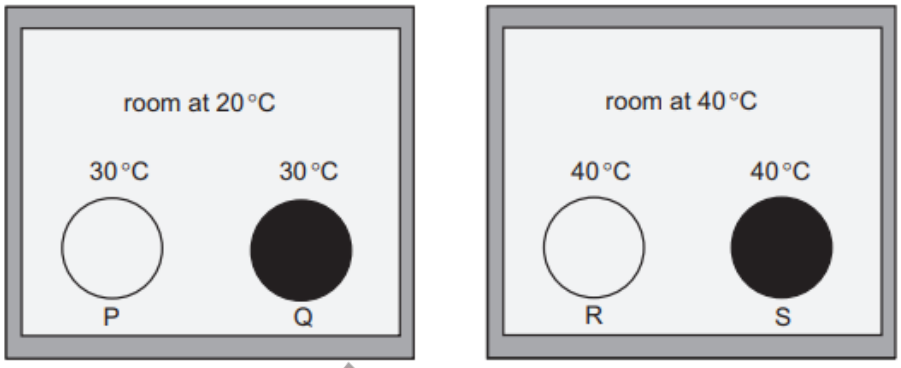
ENGAA S1 2016 - Question 20

20 The diagram shows four solid steel balls P, Q, R and S which are of identical size.

Balls P and R have shiny surfaces. Balls Q and S have dull surfaces.

Balls P and Q are in a room at 20 °C. Balls R and S are in a room at 40 °C.

The temperature of each ball at a given moment in time is shown on the diagram.



Which two balls lose thermal energy by convection, and which ball emits thermal radiation at the greatest rate?

	lose thermal energy by convection	*greatest rate of emission of thermal radiation*
A	P and Q	P
B	P and Q	Q
C	P and Q	R
D	P and Q	S
E	R and S	P
F	R and S	Q
G	R and S	R
H	R and S	S

ENGAA S1 2016 - Question 20 - Worked Solution

As P & Q are hotter than their surroundings, they lose heat by convection.
As S & Q are dull, they act more like black bodies than P & R. Therefore they radiate more heat than if they were shiny.
S radiates heat at the highest rare as it has the highest temperature.
NB: S will gain the heat it radiates back by convection, so although it radiates heat it will maintained a constant temperature

Answer is D

ENGAA 2019 - Section 1 - Question 6

Insert

ENGAA 2019 - Section 1 - Question 6 - Worked Solution

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