

PART E Advanced Mathematics and Advanced Physics

- 73** Find the area of the shape bounded by the four lines:

$$2y + x = 4$$

$$x = -6$$

$$x = 0$$

$$y = 0$$

- A** 4
B 12
C 21
D 25
E 27
F 30
- 74** 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** $6.48 \times 10^4 \text{ m}^3$
B $7.20 \times 10^4 \text{ m}^3$
C $8.00 \times 10^4 \text{ m}^3$
D $6.48 \times 10^7 \text{ m}^3$
E $7.20 \times 10^7 \text{ m}^3$
F $8.00 \times 10^7 \text{ m}^3$

75 The curve

$$y = x^3 + px^2 + qx + r$$

has a local maximum when $x = -1$ and a local minimum when $x = 3$

What is the value of p ?

- A** -9
- B** -3
- C** -1
- D** 1
- E** 3
- F** 9

76 A car P of mass 1000 kg is travelling north at 30 m s^{-1} along a straight, horizontal road when it hits another car Q which is directly ahead of P and travelling in the same direction. Car Q has a mass of 500 kg and is travelling at 20 m s^{-1} .

The collision lasts for 0.20 s and immediately after the collision car Q is moving north at 30 m s^{-1} .

What is the speed of P immediately after the collision and what is the size of the average resultant force that acts on Q during the collision?

(Assume that no external forces act on the cars during the collision.)

	<i>speed of P / m s^{-1}</i>	<i>average force on Q / N</i>
A	20	25 000
B	20	50 000
C	20	100 000
D	20	125 000
E	25	25 000
F	25	50 000
G	25	100 000
H	25	125 000

- 77 It is given that

$$7\cos x + \tan x \sin x = 5$$

where $0^\circ < x < 90^\circ$

What are the possible values of $\tan x$?

- A $\frac{1}{2}$ or $\frac{1}{3}$
- B $\frac{1}{\sqrt{3}}$ or $\frac{1}{2\sqrt{2}}$
- C $\frac{\sqrt{3}}{2}$ or $\frac{2\sqrt{2}}{3}$
- D $\sqrt{3}$ or $2\sqrt{2}$
- E 3 or 2

- 78 A metal wire of length 0.50 m has a uniform cross-sectional area of $4.0 \times 10^{-7} \text{ m}^2$.

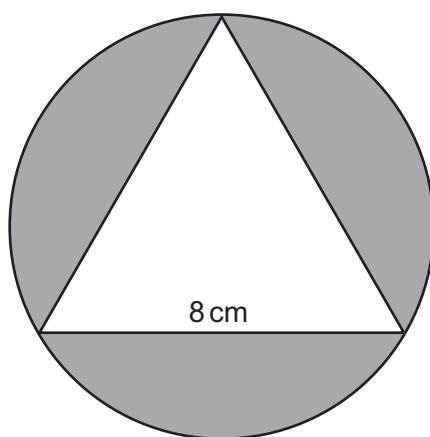
There is a current of 4.0 A in the wire.

What is the potential difference across the ends of the wire?

(resistivity of the metal = $1.6 \times 10^{-7} \Omega \text{ m}$)

- A 0.05 V
- B 0.20 V
- C 0.80 V
- D 3.2 V
- E 5.0 V
- F 20 V

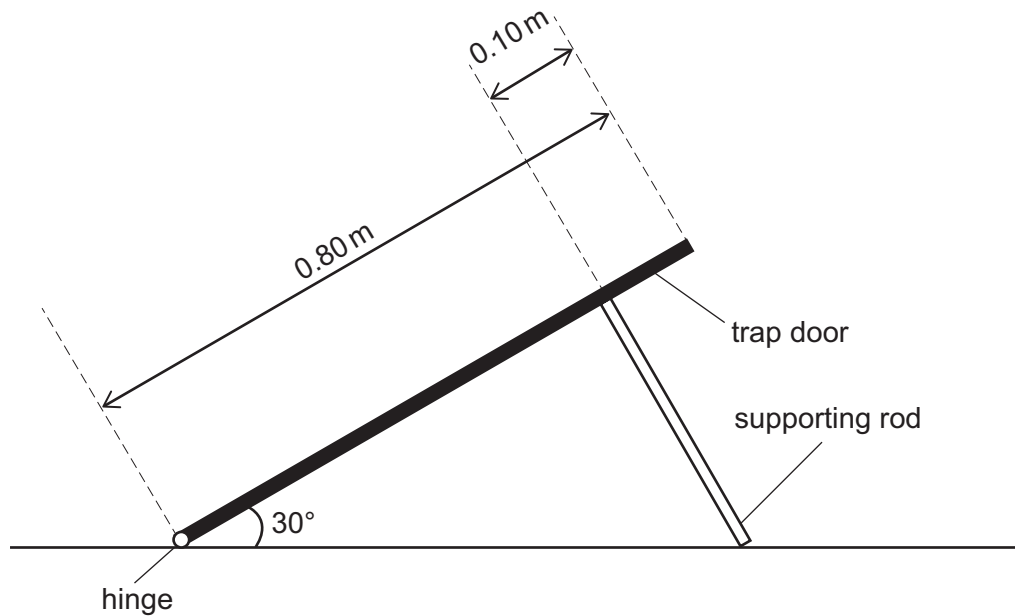
- 79** An equilateral triangle of side 8 cm is drawn so that its vertices lie on the circumference of a circle, as shown in the diagram.



What is the total of the three areas shaded in the diagram, in cm^2 ?

- A** $8(2\pi - 3)$
B $24(\pi - \sqrt{3})$
C $48(4\pi - \sqrt{3})$
D $\frac{16}{3}(4\pi - 6 - 3\sqrt{3})$
E $\frac{16}{3}(4\pi - 3\sqrt{3})$

- 80** 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

- 81** Which one of the following is the real solution of the equation

$$3 \times 5^{2x+1} - 5^x - 2 = 0$$

A $x = \log_5\left(\frac{1}{3}\right)$

B $x = \log_5\left(\frac{2}{5}\right)$

C $x = \log_5\left(\frac{3}{5}\right)$

D $x = \log_5\left(\frac{2}{3}\right)$

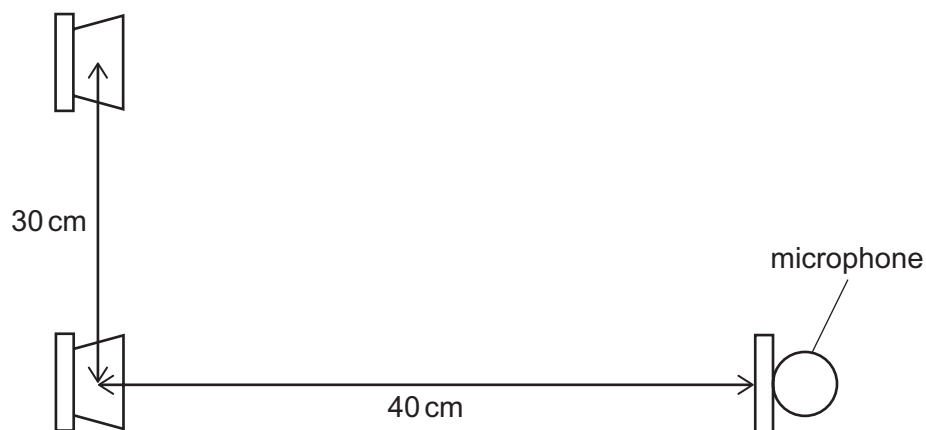
E $x = \log_5\left(\frac{5}{3}\right)$

F $x = \log_5\left(\frac{5}{2}\right)$

- 82** Two small loudspeakers are placed side by side 30 cm apart.

They are connected to the same signal generator so that they emit sound of frequency 400 Hz in phase with one another.

The sounds both reach a microphone placed 40 cm directly in front of one of the two loudspeakers as shown.



What is the phase difference between waves from the loudspeakers as they arrive at the microphone?

(speed of sound = 320 m s^{-1})

- A** 30°
- B** 36°
- C** 45°
- D** 60°
- E** 72°
- F** 90°
- G** 120°