OCR

A Level

A Level Mathematics

SI Units (Answers)

Name:

M M E

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Total Marks:

P1- SI Units- Answers

OCR

1) Convert the following into the units stated. [7]

i) 340 km/h to m/s

[1 mark]

$$\frac{340\ km}{1\ h} = \frac{340000\ m}{1\ h} = \frac{340000}{3600\ s}$$
$$= 94.94\ m/s$$

ii) 12 m/s to km/h

[1 mark]

$$\frac{12\ m}{1\ s} = \frac{0.012\ km}{\frac{1}{3600}\ h} = 43.2\ km/h$$

iii) 19.3 g/cm³ to kg/m³

[1 mark]

$$\frac{19.3\ g}{1\ cm^3} = \frac{0.0193\ kg}{0.0000001\ m^3} = 19300\ kg/m^3$$

iv) 929 kg/m³ to gm⁻³

[1 mark]

$$\frac{929kg}{1\ m^3} = \frac{929000\ g}{1\ m^3} = \frac{929000\ g}{1000000\ cm^3}$$
$$= 0.929\ g/cm^3$$

v) 0.9 gcm⁻³ to kgm⁻³

[1 mark]

$$\frac{0.9\ g}{1\ cm^3} = \frac{0.0009\ kg}{0.000001\ m^3} = 900\ kgm^{-3}$$

vi) 5.24 g/cm³ to kg/L

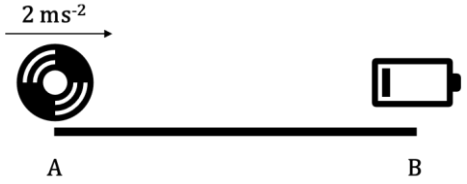
[1 mark]

$$\frac{5.24\ g}{1\ cm^3} = \frac{0.00524\ kg}{0.000001\ m^3} = 5240\ kgm^{-3}$$

[1 mark – $1000\ cm^3 = 1\ L$]

$$\therefore \frac{5240\ kgm^{-3}}{1000} = 5.24\ kg/L$$

2) **A robotic vacuum cleaner is moving in a straight line from its cleaning area (A) to battery (B) constant acceleration 2 ms^{-2}. Its speed at A is 3 ms^{-1} and it takes 8 seconds to move from A to B.**



Find:

For particle movement questions, we always require:

s = Displacement (distance), u = Starting (initial) velocity, v = Final velocity,

a = Acceleration, t = Time

i) **The speed of the vacuum cleaner at B**

[1 mark]

$$v = u + at$$

$$v = 3 + 2 \times 8$$

$$v = 19\, ms^{-1}$$

ii) **The distance from cleaning area (A) to battery(b)**

[1 mark for correct formula, 1 mark for correct answer- 2 max]

$$s = \left(\frac{u + v}{2}\right) t$$

$$s = \left(\frac{2 + 19}{2}\right) 8$$

$$s = 10.5 \times 8$$

$$s = 84\, m$$

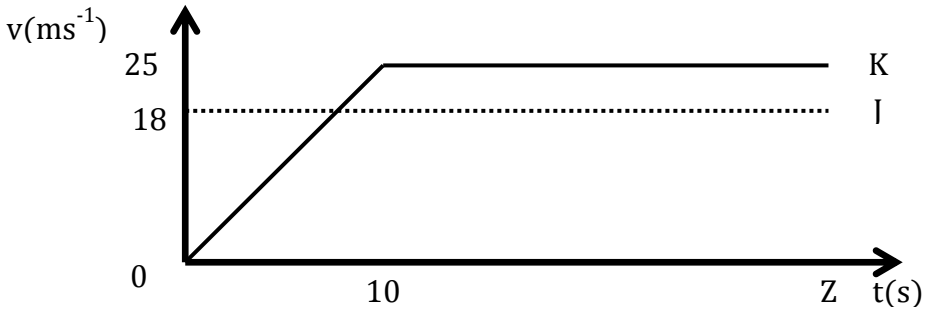
3) **John, *J*, is moving in a car along a straight road with constant speed 18 ms^{-1}. At time t = 0, J passes a car-park. Also at time t = 0, a second person in a car, *K*, leaves the car-park. Car K accelerates from rest to a speed of 25 ms^{-1} in 10 seconds and then maintains this speed. K passes J at the point Z.**

i) Sketch a speed-time graph to show the motion of the cars

[1 mark both axes drawn correctly – 1 max]

[1 mark for J drawn correctly (with 18 indicated)]

[1 mark for K drawn correctly (with point of inflection at (10,25)]



ii) Calculate the distance between the car-park and point Z

At point Z, both J and K have covered the same distance and at the same time. A simultaneous equation allows us to solve it. The distance is given by the areas under the curves J and K.

[1 mark]

Under J- the area of a rectangle

$$s = 18 \times Z$$
$$s = 18Z \quad (1)$$

[1 mark]

Under K- the area of a trapezium

$$s = \frac{1}{2}\big((Z - 10) + Z\big)25$$
$$s = 25Z - 125 \quad (2)$$

Setting (1) = (2)

$$18Z = 25Z - 125$$
$$125 = 13Z$$
$$Z = 9.62\ s \quad (3)$$

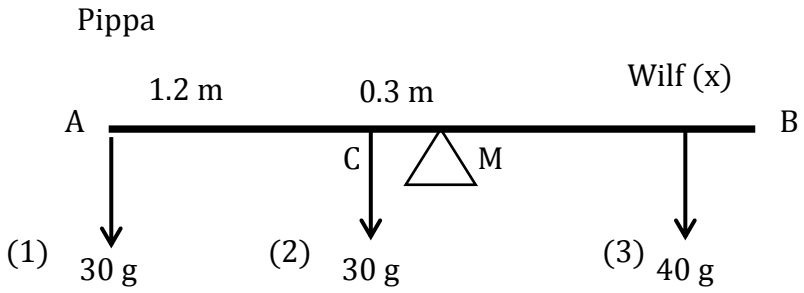
[1 mark]

Sub (3) into (1)

$$s = 18(9.62)$$
$$s = 173.16\ m$$

4) **Wilf and Pippa are sitting on a non-uniform see-saw AB, with a mass of 30 kg and length of 3 m. The see-saw is pivoted, the midpoint of AB, called M. The centre of mass, C is 1.2 m from A. Pippa has mass 30 kg and sits at A. Wilf has mass 40 kg.**
How far should Wilf sit from A to balance the plank?

Sketching the problem helps us picture the moments.



Here, Wilf's distance from A is defined as x.

[1 mark for each correct moment- 3 max]

Taking moments about M:

(1) $1.5 \times 30\ g = 45\ g\ anticlockwise$

(2) $0.3 \times 30\ g = 9\ g\ anticlockwise$

(3) $x \times 40\ g = 40\ gx\ clockwise$

[1 mark for correct distance of x]

As the rod is in equilibrium anticlockwise = clockwise

$(1) + (2) = (3)$

$45\ g + 9\ g = 40\ gx$

$54 = 40\ x$

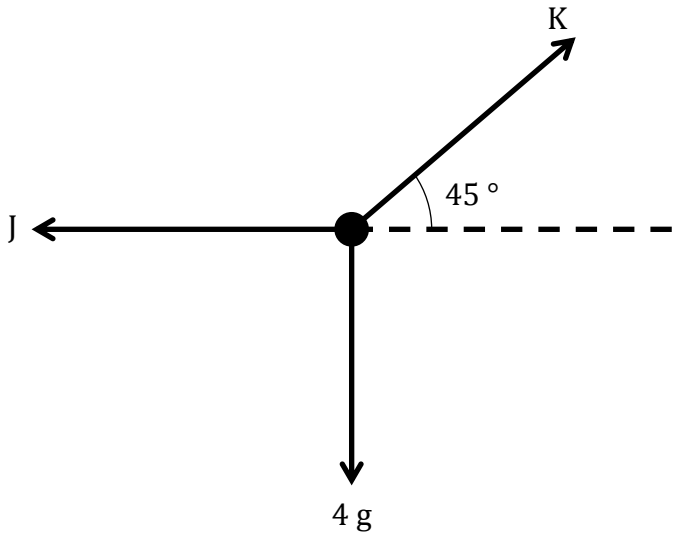
$x = 0.74$

[1 mark for observing distance from A, rather than M]

∴ Wilf should sit 3.74 m from A.

5) **A particle, mass of 4 kg is held by two fixed-length inextensible strings. One of the strings is horizontal and the other is inclined at 45 ° to the horizontal. The tension in the strings are J and K for the horizontal string and 45 ° string, respectively.**

Find the values of J and K.



Recall that $F = ma$ where $a = 0$.

[1 mark for each correct +- vertical force – 2 max]

[1 mark for correct K]

For K, we need to resolve vertically

$$Ksin45 - 4\ g = 0$$

$$Ksin45 = 4\ g$$

$$K = \frac{4g}{sin45}$$

$$K = 5.66\ N$$

[1 mark for each correct +- horizontal force – 2 max]

[1 mark for correct J]

For J, we need to resolve horizontally

$$Kcos45 - J = 0$$

$$Kcos45 = J$$

$$5.66cos45 = J$$

$$J = 4.00\ N$$