**Kinematics – 2022 Nov AS**

**1.** Nov/2022/Paper_9709_41/No.5

A particle $P$ moves on the $x$-axis from the origin $O$ with an initial velocity of $-20\,\text{m s}^{-1}$. The acceleration $a\,\text{m s}^{-2}$ at time $t$ s after leaving $O$ is given by $a = 12 - 2t$.

**(a)** Sketch a velocity-time graph for $0 \leqslant t \leqslant 12$, indicating the times when $P$ is at rest. [5]

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**(b)** Find the total distance travelled by $P$ in the interval $0 \leqslant t \leqslant 12$. [5]

**2.** Nov/2022/Paper_9709_42/No.7

A particle $P$ travels in a straight line, starting at rest from a point $O$. The acceleration of $P$ at time $t$ s after leaving $O$ is denoted by $a$ m s$^{-2}$, where

$$a = 0.3t^{\frac{1}{2}} \quad \text{for } 0 \leqslant t \leqslant 4,$$
$$a = -kt^{-\frac{3}{2}} \quad \text{for } 4 < t \leqslant T,$$

where $k$ and $T$ are constants.

**(a)** Find the velocity of $P$ at $t = 4$. [2]

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**(b)** It is given that there is no change in the velocity of $P$ at $t = 4$ and that the velocity of $P$ at $t = 16$ is 0.3 m s$^{-1}$.

Show that $k = 2.6$ and find an expression, in terms of $t$, for the velocity of $P$ for $4 \leqslant t \leqslant T$. [4]

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**(c)** Given that $P$ comes to instantaneous rest at $t = T$, find the exact value of $T$. [2]

**(d)** Find the total distance travelled between $t = 0$ and $t = T$. [4]

**3.** Nov/2022/Paper_9709_43/No.1

A particle $P$ is projected vertically upwards with speed $u\,\text{m s}^{-1}$ from a point on the ground. $P$ reaches its greatest height after 3 s.

**(a)** Find $u$. [1]

**(b)** Find the greatest height of $P$ above the ground. [2]

**4.** Nov/2022/Paper_9709_43/No.4

A particle $P$ travels in the positive direction along a straight line with constant acceleration. $P$ travels a distance of 52 m during the 2nd second of its motion and a distance of 64 m during the 4th second of its motion.

**(a)** Find the initial speed and the acceleration of $P$. [5]

**(b)** Find the distance travelled by $P$ during the first 10 seconds of its motion. [2]

**5.** Nov/2022/Paper_9709_43/No.5

Particles $X$ and $Y$ move in a straight line through points $A$ and $B$. Particle $X$ starts from rest at $A$ and moves towards $B$. At the same instant, $Y$ starts from rest at $B$.

At time $t$ seconds after the particles start moving

- the acceleration of $X$ in the direction $AB$ is given by $(12t + 12)\,\text{m s}^{-2}$,
- the acceleration of $Y$ in the direction $AB$ is given by $(24t - 8)\,\text{m s}^{-2}$.

**(a)** It is given that the velocities of $X$ and $Y$ are equal when they collide.

Calculate the distance $AB$. [6]

**(b)** It is given instead that $AB = 36$ m.

Verify that $X$ and $Y$ collide after 3 s. [2]