Note that u_x is positive as expected, because the initial direction of travel of the rocket and fuel tank is away from the Moon's surface.

Q13 D is correct.

Choose the x-axis to point in the direction of motion. Then, applying Newton's second law to the combined object car + trailer (of mass $M = 1400$ kg) gives

$$a_x = F_x/M = 5000 \text{ N} / 1400 \text{ kg} = 3.57 \text{ m s}^{-2}.$$

Because the towing rope is inextensible, the trailer (of mass $m = 400$ kg) also has acceleration 3.57 m s^{-2}. The only force acting on the trailer is the force F_x^{tow}, due to the tow rope, so applying Newton's second law to the trailer alone gives

$$F_x^{\text{tow}} = m\, a_x = 400 \text{ kg} \times 3.57 \text{ m s}^{-2} = 1428 \text{ N}.$$

Q14 B and H are correct.

The velocity vector of the particle is found by differentiating the position vector. Differentiating each component in turn gives

$$\boldsymbol{v} = \frac{d\boldsymbol{r}}{dt} = (2\,At,\ 4\,Bt^3)$$

At time $t = 0.5$ s the velocity vector is

$$\boldsymbol{v} = (2 \times 3 \text{ m s}^{-2} \times 0.5 \text{ s},\ 4 \times 8 \text{ m s}^{-4} \times (0.5 \text{ s})^3) = (3 \text{ m s}^{-1},\ 4 \text{ m s}^{-1}).$$

The speed of the particle is

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(3 \text{ m s}^{-1})^2 + (4 \text{ m s}^{-1})^2} = 5 \text{ m s}^{-1}.$$

Because both components of the velocity are positive, the direction of motion is between the positive x- and y-axes. Denoting the angle between $\boldsymbol{v}$ and the x-axis by θ, it is clear from our expression for the velocity components that θ is between 0° and 90°. In fact,

$$\tan\theta = v_y/v_x = 4/3 \quad \text{so } \theta = 53°.$$

The angle between $\boldsymbol{v}$ and the y-axis is $90° - 53° = 37°$.

Q15 C is correct.

The forces from the ropes cancel out in a direction perpendicular to the x-axis. The x-component of the force due to each rope is $F \cos 30°$, so the total force provided by the ropes is $2\,F \cos 30°$. These forces are opposed by friction. The maximum possible