

**Q20** Select from the key the statements that are true for free particles in non-inertial frames of reference. Pencil across no more than three cells in row 20.

KEY for Q20

- ☒ A All free particles have the same velocities in all non-inertial systems.
- ☒ B All free particles have the same velocities in one particular non-inertial system.
- ☒ C There exists particular non-inertial frames in which free particles can travel in a closed path.
- ☒ D Free particles cannot travel in straight lines.
- ☒ E All free particles have the same accelerations with respect to a given non-rotating non-inertial frame.
- ☒ F If two free particles have the same velocities at  $t_0$ , their paths will be parallel at  $t > t_0$ .
- ☒ G If two free particles are seen to travel in parallel paths, their velocities must be the same.

Q21 and Q22 share the same key and concern a star, S, with two planets, A and B, each of which describes a circular orbit around S and has a mass that is negligible in comparison with that of S. The distance from A to S is one astronomical unit, i.e. the same as the mean distance from Earth to Sun. The period of A's orbit is 6 months. The distance from B to S is 4 astronomical units.

**Q21** Select from the key the mass of S in units of the Sun's mass. Pencil across one cell in row 21.

**Q22** Select from the key the number of years that it takes for B to orbit S. Pencil across one cell in row 22.

KEY for Q21 and Q22

A	$\frac{1}{8}$	E	2
B	$\frac{1}{4}$	F	4
C	$\frac{1}{2}$	G	8
D	1	H	16

$$a = \frac{v^2}{r} = \frac{(2\pi r / (183.5 \times 24 \times 3600))^2}{1.5 \times 10^{11}} = 0.02356$$

$$a = \frac{GM}{r^2}$$

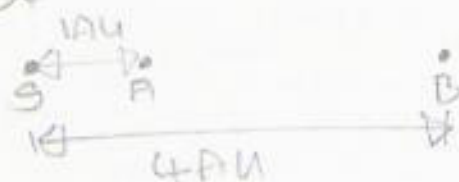
$$v = 29724$$

$$0.25 = \frac{T^2}{64}$$

20) C E F

$$a = \frac{v^2}{r} = \frac{(2\pi r / (1.58 \times 10^7))^2}{1.5 \times 10^{11}} = 0.02372 \text{ m/s}^2$$

$$a = \frac{GM}{r^2} \Rightarrow 0.02372 = \frac{GM}{r^2}$$



21) F