Q17 [D]

Objects given: A free particle P with position $x(t)$ in a non-inertial frame S.
To be found: The acceleration $a(t)$ of P in S.
Direct solution: Take the second derivative of each component of $x(t)$.
Result: Item (D).
Corroboration: Items (A, B, C, G) cannot be right because the 1- and 2-components must be zero. Item (E) is out because the 3-component cannot depend on t. Item (F) is out when care is taken with the derivative. This leaves item (D).

Q18 [B]

Objects given: A different free particle P' with position $x(t)$ in the non-inertial frame S.
To be found: Up to two expressions for $x(t)$ which could describe the motion of P'.
Direct solution: Seek an equation yielding the same acceleration (second derivative) as the original.
Result: Item (B).
Corroboration: Items (C, D, E, F, G) are out because the 3-component has the wrong powers of t, and item (A) is out because it has the wrong sign.

Q19 [G]

Objects given: A free particle P with mass m and acceleration $a(t)$ in a non-inertial frame S'.
To be found: The force needed to make P *look* free in S'.
Direct solution: Multiply a by m to yield the apparent force on P, and reverse the sign.
Result: Item (G).
Corroboration: Item (F) has the wrong sign, items (D, E) have forgotten m, item (A) has m in the denominator and items (B, C) have the wrong power of t. This leaves only item (G).

Q20 [C, E, F]

Objects given: All free particles in any non-inertial frame.
To be found: Up to three true statements about them.
Direct solution: Eliminate the absurd statements. That gets rid of items (A, B, D, G).
Result: Items (C, E, F).
Corroboration: Item (C) is true for free particles in a purely rotating non-inertial frame; item (E) is true by the analysis in Q18, item (F) is true since the particles have the same acceleration.

Q21 [F]

Objects given: A planet which has the same mean distance from its star as Earth has from the Sun, but which orbits twice as fast.
To be found: The mass of its star.
Direct solution: $v^2/r = GmM/r^2$ so v^2 is proportional to M/r.
Result: If v is doubled, v^2 is quadrupled, so the mass of the star is four times that of Earth: item (F).
Corroboration: By Kepler's third law, planetary comparisons depend on the square of the orbital period.

Q22 [F]

Objects given: A second planet which is four times as far from its star as is the first.
To be found: The period T of its (circular) orbit.
Direct solution: By Kepler's third law, T^2/r^3 is constant for any planetary system.
Result: T is eight times the period of the first planet: item (F).
Corroboration: From Q21, (rv^2) is a constant, so v for the second planet is cut in half while its orbit is four times as large.