

Q5 **D**

Objects given: A particle with mass  $m$ , position  $x$ , velocity  $v$  and acceleration  $a$  at time  $t$ .

To be found: The single expression given in these variables, which remains invariant under rotation of the coordinate axes.

Direct solution: If one expression does not refer to particular components of the vectors  $x$ ,  $v$  and  $a$ , that will be the right expression.

Result: Item (D).

Corroboration: Item (D) refers only to magnitudes of vectors.

Q6 **B**

Objects given: A particle with mass  $m$ , position  $x$ , velocity  $v$  and acceleration  $a$  at time  $t$ .

To be found: The single expression given in these variables, which changes under a rotation about the 3-axis but not under a rotation about the 2-axis.

Direct solution: If one expression involves only 2-components, that will be the right expression.

Result: Item (B), whose numerator is a 2-component.

Corroboration: Items (A, E, F) are invariant under rotation about the 1-axis, and item (C) is invariant under rotation about the 3-axis.

Q7 **A**

Objects given: A particle with mass  $m$ , position  $x$ , velocity  $v$  and acceleration  $a$  at time  $t$ .

To be found: The single expression given in these variables, which changes under a reflection of the 2-axis but not under a reflection of the 1-axis.

Direct solution: If only one expression involves some components but no 1-components, that will be the right expression.

Result: Item (A).

Corroboration: Reflection of the 1-axis changes the signs of items (B, C, E, F); reflection of the 2-axis changes the signs of items (A, C).

Q8 **E**

Objects given: The law of conservation of momentum.

To be found: The principle, assumption or law which is most closely related.

Direct solution: Conservation of momentum is only possible because no position in space is special. Otherwise, a free particle could not move from one point to another with uniform linear motion.

Result: Item (E): the Homogeneity of Space.

Corroboration: Homogeneity of Time and Isotropy of Space are not relevant.

Q9 **B, E**

Objects given: The law of conservation of angular momentum.

To be found: The two principles, assumptions or laws which are most closely related.

Direct solution: Conservation of angular momentum is only possible because no direction or position in space is special. Otherwise, two particles could not revolve around one another with uniform angular motion.

Result: Items (B, E): the Isotropy and Homogeneity of Space.

Corroboration: Isotropy of Time is not relevant.

Q10 **D**

Objects given: The law of conservation of energy.

To be found: The principle, assumption or law which is most closely related.

Direct solution: Conservation of energy is only possible because no instant in time is special. Otherwise, an isolated physical system could not retain the same energy from one instant in time to another.

Result: Item (D): the Homogeneity of Time.

Corroboration: Isotropy and Homogeneity of Space are not relevant.