GCSE Physics AQA Topic 5: Forces Mark Scheme-

Q1. Unit of force [1]

- Newton (N) (1)

Q2. Forces on a box [2]

(a) Contact force: friction / air resistance / normal contact force (any 1) (1)
(b) Non-contact force: gravity / magnetic force / electrostatic force (any 1) (1)

Q3. Mass and weight [3]

(a) Equation: weight = mass × gravitational field strength (1)
(b) Calculation:

- Substitution: 10 × 10 (1)

- Answer = 100 N (1)

Q4. Resultant force [2]

(a) 8 – 3 = **5 N** (1)
(b) Direction: to the right (1)

Q5. Speed [3]

(a) Equation: speed = distance ÷ time (1)
(b) Calculation:

- Substitution: 600 ÷ 50 (1)

- Answer = 12 m/s (1)

Q6. Vectors [3]

(a) Vector: has both size (magnitude) **and** direction (1 + 1)
(b) Example: velocity / force / acceleration / momentum (1)

Q7. Hooke's law [3]

(a) Equation: force = spring constant × extension (1)
(b) Calculation:

- Substitution: 200 × 0.1 (1)

- Answer = 20 N (1)

Q8. Work done [3]

(a) Equation: work done = force × distance (1)
(b) Calculation:

- Substitution: 15 × 2 (1)

- Answer = 30 J (1)

Q9. Falling objects [3]

(a) Force = gravity / weight (1)
(b)

- As it falls, air resistance increases (1)

- Eventually balances weight → no acceleration (1)

Q10. Pressure [3]

(a) Equation: pressure = force ÷ area (1)
(b) Calculation:

- Substitution: 20 ÷ 2 (1)

- Answer = 10 Pa (1)

Q11. Density [3]

(a) Equation: density = mass ÷ volume (1)
 (b) Calculation:

- Convert 500 g → 0.5 kg (1)

- 0.5 ÷ 0.0002 = 2500 kg/m³ (1)

Q12. Distance–time graphs [2]

(a) Horizontal line = object is stationary (1)
 (b) Gradient = speed (1)

Q13. Velocity–time graphs [2]

(a) Gradient = acceleration (1)
 (b) Area under line = distance travelled (1)

Q14. Momentum [3]

(a) Equation: momentum = mass × velocity (1)
 (b) Calculation:

- Substitution: 1200 × 15 (1)

- Answer = 18 000 kg·m/s (1)

Q15. Stopping distances [3]

(a) Two parts: thinking distance (1) + braking distance (1)
(b) Factor affecting braking distance: wet/icy road / worn brakes / greater speed / poor tyres (any 1) (1)

Q16. Resultant force [5]

(a) Resultant force = single force that has the same effect as all forces combined (1)
Vector sum of all forces acting (1)

(b) Horizontal component = F × cosθ (1)
Vertical component = F × sinθ (1)
Use trigonometry / resolve force into perpendicular directions (1)

Q17. Weight and mass [3]

(a) Weight = mass × gravitational field strength (1)
(b) Substitution: 30 × 2.5 (1)
Answer = 75 N (1)

Q18. Newton's 2nd law [4]

(a) The acceleration of an object is proportional to the resultant force (1) and inversely proportional to the mass (1).
(b) a = F ÷ m = 50 ÷ 10 (1)
Answer = 5 m/s² (1)

Q19. Springs [6]

(a) Elastic deformation: object returns to original shape when force is removed (1 + 1)
(b) F = k × e = 300 × 0.04 (1) = 12 N (1)
(c) Beyond elastic limit: deformation is permanent (1) spring will not return to original length (1)

Q20. Pressure in a fluid [4]

(a) p = hρg (1)
(b) Substitution: 5 × 1000 × 9.8 (1)
= 49 000 Pa (1)
Answer with correct unit (Pa) (1)

Q21. Resultant force on a car [4]

(a) 3000 – 2200 = 800 N (1) with working (1)
 (b) Resultant force forwards → car accelerates (1) in direction of driving force (1)

Q22. SUVAT equation [4]

(a) $v^2 – u^2 = 2as$ (1)
 (b) Substitution: $(20^2 – 12^2) ÷ (2 × 64)$ (1)
 $= (400 – 144) ÷ 128 = 256 ÷ 128$ (1)
 Answer = 2 m/s² (1)

Q23. Momentum [6]

(a) Momentum = mass × velocity (1)
 (b) 2000 × 12 (1) = 24 000 kg·m/s (1)
 (c) Conservation: in a closed system, no external forces (1)
 Total momentum before = total momentum after (1)
 Momentum transferred between objects during collision (1)

Q24. Inertia [5]

(a) Inertia: tendency of an object to stay at rest or continue moving at constant velocity (1 + 1)
 (b) Inertial mass = ratio of force applied to acceleration produced (1)
 Measure force applied (1) and measure resulting acceleration (1)

Q25. Distance–time graphs [2]

(a) Gradient = speed (1)
 (b) Gradient = 4 → speed = 4 m/s (1)

Q26. Velocity–time graphs [5]

(a) Gradient = acceleration (1)
 (b) $a = Δv ÷ Δt = 25 ÷ 10$ (1) = 2.5 m/s² (1)
 (c) Distance = area under graph = ½ × 10 × 25 (1) = 125 m (1)

Q27. Stopping distance [6]

(a) Thinking distance (1) + braking distance (1)
 (b) Factors for thinking: reaction time (tiredness, drugs, alcohol, distractions) (1 + 1)
 (c) Poor road conditions = less friction (1) longer time to stop / greater braking distance (1)

Q28. Levers [4]

(a) Make task easier by increasing distance from pivot / provide mechanical advantage (1)
 (b) Moment = force × distance (1)
 (c) 40 × 0.25 (1) = 10 Nm (1)

Q29. Gas pressure [5]

(a) Heating = particles have more kinetic energy (1) move faster (1) collide more often and with more force on container walls (1)
 (b) Balloon expands → area increases (1) collisions per unit area decrease (1)

Q30. Resultant force [4]

(a) a = F ÷ m = 600 ÷ 1500 (1) = 0.4 m/s² (1)
 (b) Double mass = acceleration halves (1) so car accelerates less with same force (1)

Q31. Elastic potential energy [3]

(a) Ee = ½ k e² (1)
 (b) Substitution: 0.5 × 200 × (0.15)² (1)
 = 2.25 J (1)

Q32. Free-body diagram [4]

(a) Upward arrow labelled "normal contact force" (1)
 Downward arrow labelled "weight" (1)
 (b) Forces are balanced (1) so no resultant force / book does not accelerate (1)

Q33. Force, mass and acceleration [3]

(a) F = m × a (1)
(b) a = 80 ÷ 20 (1) = 4 m/s² (1)

Q34. Atmospheric pressure [4]

(a) At higher altitude: fewer air molecules above (1) so less weight of air → lower pressure (1)
(b) Less oxygen available (1) makes breathing difficult (1)

Q35. Force and extension [5]

(a) Force ∝ extension (1)
(b) k = F ÷ e = 10 ÷ 0.05 (1) = 200 N/m (1)
(c) Straight line through origin shows proportionality (1) obeys Hooke's law (1)

Q36. Resultant force (at right angles) [5]

(a) Use Pythagoras: $\sqrt{(12^2 + 9^2)}$ (1) because forces are perpendicular (1)
(b) Calculation: $12^2 + 9^2 = 144 + 81 = 225$ (1)
$\sqrt{225} = 15$ N (1)
Final answer with correct working (1)

Q37. Moments [4]

(a) 500 × 2 (1) = 1000 Nm (1)
(b) Balance by equal and opposite moment (1) place second child at correct distance so clockwise = anticlockwise (1)

Q38. Stopping distance [4]

(a) Thinking distance factor: tiredness / alcohol / distractions (1)
(b) Braking distance factor: wet/icy roads / worn tyres (1)
(c) At higher speeds, more kinetic energy (1) requires longer braking distance to remove it (1)

Q39. Terminal velocity [4]

(a) At first weight > air resistance (1) so object accelerates downwards (1)
(b) As speed increases, air resistance increases (1) until it balances weight → no resultant force (1)

Q40. Velocity–time graph (car) [4]

(a) a = Δv ÷ Δt = 30 ÷ 15 (1) = 2 m/s² (1)
(b) Distance = ½ × 15 × 30 (1) = 225 m (1)

Q41. Principle of moments [4]

(a) Principle: For equilibrium, total clockwise moment = total anticlockwise moment (1) about a pivot (1).
(b) Balanced beam → clockwise moment = anticlockwise moment (1) no resultant moment / beam does not turn (1).

Q42. Pressure in liquids [5]

(a) Pressure increases with depth because weight of liquid above increases (1) causing greater force on deeper layers (1).
(b) p = hρg (1)
= 20 × 1025 × 9.8 (1)
= 201, 500 Pa (≈2.0 × 10⁵ Pa) (1)

Q43. Pendulums [3]

(a) Factor: length of pendulum (1).
(b) SHM: restoring force towards equilibrium (1) proportional to displacement from equilibrium (1).

Q44. Momentum [5]

(a) Conservation: In a closed system (1) total momentum before = total momentum after (1).
(b) Initial momentum = (2 × 3) + (1 × 0) = 6 (1)
Final combined mass = 3 kg (1)
v = 6 ÷ 3 = 2 m/s (1)

Q45. Car safety [5]

(a) Seat belts: increase stopping time (1) reduce rate of change of momentum (1) so reduce force on passenger (1).
 (b) Crumple zones: absorb energy in collision (1) increase stopping time → reduce force (1).

Q46. Gas pressure [4]

(a) pV = constant (1).
 (b) 200 kPa × 1.5 = p_2 × 0.5 (1)
p_2 = (200 × 1.5) ÷ 0.5 (1) = 600 kPa (1).

Q47. Atmospheric pressure [4]

(a) Air is removed between cup and window (1) so higher atmospheric pressure outside pushes cup onto surface (1).
 (b) Air pressure acts in all directions (1) and is balanced by pressure inside body (1).

Q48. Floating [3]

(a) Condition: Upthrust = weight (1).
 (b) Ship floats: shape displaces large volume of water (1) so average density < water (1).

Q49. Elastic energy [3]

(a) $Ee = \frac{1}{2} k e^2$ (1).
 (b) Substitution: 0.5 × 250 × (0.20)^2 (1) = 5.0 J (1).

Q50. Upthrust [4]

(a) Pressure increases with depth (1) so greater force on bottom than top → upward resultant (1).
 (b) Archimedes: Upthrust = weight of displaced fluid (1 + 1).

Q51. Balloons [5]

(a) As altitude ↑, external pressure ↓ (1) balloon expands because internal pressure > external pressure (1).
 (b) pV = constant (1)

100 × 1.0 = 25 × V (1)
V = 100 ÷ 25 = 4.0 m³ (1).

Q52. Pressure, force, area [3]

(a) p = F ÷ A (1).
 (b) F = p × A = (300 000 × 0.02) (1) = 6000 N (1).

Q53. Parachutist [4]

(a) At first weight > air resistance → accelerates (1) until forces balance → terminal velocity (1).
 (b) Parachute ↑ area → ↑ air resistance (1) new balance with weight at lower speed (1).

Q54. Levers [4]

(a) Levers increase distance from pivot (1) so less force is needed for same moment (1).
 (b) Moment = 50 × 0.4 (1) = 20 Nm (1).

Q55. Gas pressure [3]

(a) Increase pressure by raising temperature / reducing volume / adding more gas particles (1).
 (b) Higher temperature = particles have more kinetic energy (1) more frequent, harder collisions with walls → higher pressure (1).