1 (a) energy and power S **B1**
velocity and displacement V **B1**
(if more than two answers are given then –1 for each one incorrect. Minimum score is zero)

(b)(i) average speed = 200 / 24 **C1**
= 8.3 (m s^{-1}) **A1**

(ii) velocity is less/speed is greater **B1**
displacement (SF) is less than distance (SF) **B1**

TOTAL [6]

2 (a) weight = 60 x 9.81 (allow 9.8 but not 10)
= 589 (N) (allow 590) **B1**

(b) correct shape triangle/link given between **R** and the component of the weight down the slope e.g. R = Wcos55 **B1**
scale given /working shown **C1**
resistive force R = 340 (N) (± 20 (N) for scale diagram) **A2**

(c) component of W = 589 cos 35 **C1**
= 482 (N)(allow 480) **A1**
(or from triangle and = -P)
If the answers are reversed in (b) and (c) then -1

(d) resultant force is zero (so no acceleration)/in equilibrium **B1**
force up the slope equals force down the slope **B1**
(resistive force up slope = component of W down slope scores two)

TOTAL [9]

3 (a) acceleration = rate of change of velocity/ a = (v-u)/t with symbols defined **B2**
(rate of change of speed or minor errors in above scores 1)

(b)(i) acceleration = (v –u) / t **C1**
= (65 – 0) / 25 **C1**
= 2.6 (m s^{-2}) **A1**

(ii) force = ma **C1**
= 150000 x 2.6
= 390000 (N) /3.9 x 10^5 **A1**

(iii) distance = (u + v) t / 2 **C1**
= (0 + 65) x 25 / 2
= 813 (m) (allow 810) **A1**

3 (c) reduce the mass **B1**
remove baggage / people / fuel / use of F = ma to explain smaller mass gives greater acceleration (for the same force) **B1**

TOTAL [11]

4 (a)(i) power = work done / time taken /rate of energy transfer **B1**

(ii) joule is the unit of work / energy used when a force of one newton moves through one metre (in the direction of the force) **B1**

(b)(i) potential energy = mgh / weight x height **C1**
= 500 x 9.81 x 3.9 **C1**
= 19. (130) (kJ) **A0**

(ii) work done = 25 - 19
= 6 (5.870) (kJ) **A1**

(iii) distance up the slope = 7.8m **B1**
work done = force x distance **C1**
force = 5870 / 7.8
= 753 (N) (769 N if 6000 J is used) **A1**
note ecf from (b)(ii)

TOTAL [8]

5 (a) extension is proportional to force **B1**

(b) where Hooke's law is obeyed or force is proportional to extension / the stiffness of the spring **B1**
spring constant = force / extension **B1**

(c)(i) correct pair of values read from graph / correct gradient **C1**
spring constant = 12 / 80 **C1**
= 0.15 N mm^{-1} / 150 N m^{-1} **A1**
(note unit penalty)

(ii) energy stored = ½ x F x *x* / area under the graph **C1**
= ½ x 12 x 80 x 10^{-3} **C1**
= 0.48 (J) **A1**
(an answer of 0.96 scores one only)

TOTAL [9]

6 (a) distance travelled from when the brakes are applied to when the car comes to rest **B1**

(b) kinetic energy = ½ m v^2 **C1**
= ½ x 800 x $(20)^2$ **C1**
= 160000 (J) **A1**

(c) link made between the loss of kinetic energy and the work done **B1**
k.e. is proportional to v^2 **B1**
work done by braking force is proportional to the braking distance **B1**
(hence) braking distance is proportional to v^2 **B1**
MAX 3

(d) (using the 20 m s^{-1} distance) for 2x speed gives 4x distance **C1**
braking distance = 96 (m) **A1**
(alternative is to calculate the acceleration, 8.3 m s^{-2} or the force and then to solve the distance for a speed of 40 m s^{-1})

(e) **Seat belts:**
Driver (initially) continues at the same speed when the car is in a collision **B1**
Seat belt designed to keep driver in the seat/restrain driver **B1**
Seat belt prevents driver colliding with the windscreen **B1**
Seat belt can stretch slightly so that the driver is not brought to a halt too quickly **B1**
force applied in opposite direction to motion of driver **B1**
force applied over wider area to reduce pressure and injury **B1**
force (from seat belt) reduced by the time or distance being increased/not too small/not instantaneous **B1**

MAX [4]

Air bags:
distance / time force acts for is increased hence force is less **B1**
work done / energy lost over greater distance **B1**
force acting on driver is less **B1**
much wider area reduces pressure **B1**
deflates quickly to prevent whiplash/suffocation **B1**
prevents driver hitting steering wheel/dashboard/windscreen **B1**

MAX [2]

only allow the prevention of a collision with the windscreen once in part (e)

PART (e) MAX [6]

QWC:

Use of technical language **B1**
SPAG **B1**

QWC [2]

Total [17]