SECTION B

B1. Part 1 Momentum and energy

(a) (impulse =) force × time for which force acts;
impulse $(F\Delta t)$ = change in momentum (Δp); *[2]*

(b) *The following points are needed for maximum marks.*
from Newton 3;
when objects are in contact, the forces exerted by the objects on each other are equal and opposite;
from Newton 2 / collision time is the same;
impulses are equal and opposite;
therefore changes in momentum are equal and opposite / total change in momentum is zero;

or

Accept algebraic solution.
from Newton 3;
$F_{AB} = -F_{BA}$;
from Newton 2;
$F_{AB}\Delta t = m_A \Delta v_A$;
$= -m_B \Delta v_B$; *[5]*

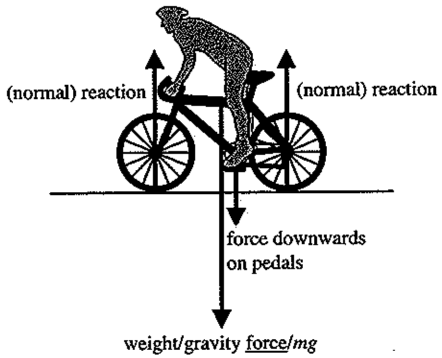
(c) (i) $v = \sqrt{2gh}$;
to give $v = 2.2\ \text{m s}^{-1}$; *[2]*
Award full marks for bald correct answer.

(ii) from conservation of momentum / $V \times 5.2\times10^{-3} = 0.38\times2.2$;
$V = \frac{0.38\times2.2}{5.2\times10^{-3}}$;
to give $V = 160\ \text{m s}^{-1}$ *[2]*

Part 2 Force and energies

(a) (i) zero; *[1]*

(ii)



correct position and labelling of:
weight/gravity force/*mg*;
two reactions drawn as shown;
force downwards on pedals; *[2 max]*
Ignore any other vertical forces and all horizontal forces. The total upward vector lengths should approximately equal the downward vector lengths.

(iii) drag force = thrust/forward force/driving force;
net force = zero therefore acceleration is zero; *[2]*

(b) 320 W; *[1]*

(c) (i) acceleration $= \left[\frac{40}{70}\right]$;
$= 0.57\ \text{m s}^{-2}$; *[2]*

(ii) use of $F\Delta s = \frac{1}{2}mv^2$;
56 m; *[2]*

or

$v^2 = u^2 + 2as$ equivalent seen and substituted correctly;
56 m;

(iii) sensible physical reason *e.g.* air resistance / bearing friction/brakes' effectiveness varies with speed;
attempt at explanation:
e.g. air resistance drops as speed drops, underestimate / distance travelled will be further; *[2]*

A2. (a) satisfies $pV = nRT$ (at all p, V and T) / point molecules / no intermolecular forces; *[1]*
Allow any other kinetic theory assumption.

(b) (i) the (total random) kinetic energy of the molecules (of the gas); *[1]*

(ii) the (absolute kelvin) temperature is proportional to/is a measure of the average kinetic energy of the molecules of the gas;
and hence the internal energy is proportional to the temperature (and the total number of molecules in the gas) / $U \propto NT$; *[2]*
Do not accept T increases U increases. Award [0] for any reference to potential energy.

(c) (i) 2.0×10^5 Pa; *[1]*

(ii) correct positioning of point on graph; *[1]*

(iii) concave curve (hyperbola) joining A to B; *(judged by eye)* *[1]*
Do not check points, general shape of curve only.

A3. (a) the rocket exerts a force on the gases and so the gases exert a force on the rocket / there is a reaction force on rocket from gases / *OWTTE*;
force on the rocket causes the rocket to accelerate; *[2]*

(b) the net external force on the rocket and gases/system is zero / system is closed/isolated, therefore the total momentum of the system stays the same;
change in momentum of the gases = (–) change in momentum of the rocket; *[2]*

(c) after 1.0 s momentum of gases $= 1.4 \times [7.2 \times 10^3 - v]$ Ns and momentum of rocket $= (280 - 1.4) \times v$ Ns;
application of momentum conservation $\left(\text{to give } v = \frac{1.4 \times 7.2 \times 10^3}{280}\right)$;
$36\,\text{m s}^{-1}$; *[3]*

Part 2 Mechanics

(a) the rate at which work is being performed / work (done) divided by time (taken); *[1]*

(b) $W = F\Delta s$
$P = \frac{W}{\Delta t}$;
$= F\frac{\Delta s}{\Delta t}$;
$= Fv$ *[2]*
Accept word equation answer.

(c) (i) (energy supplied in 5.0 s =) $54 \times 10^3 \times 5 (= 2.7 \times 10^5\ \text{J}) = \frac{1}{2} \times 1200 \times v^2$;
giving $v = 21\,\text{m s}^{-1}$; *[2]*

(ii) $54 \times 10^3 = F \times 21$;
$54 \times 10^3 = 1200 \times a \times 21$;
giving $a = 2.1\,\text{m s}^{-2}$; *[3]*

(d) straight line;
through origin; *[2]*

Multiple choice

PG1 14. A, 5. B, 6. C
PG2 6. A, 7. B
PG3 12. C, 13. B
PG4 12. D, 13. C
PG5 9. D, 10. D
PG6 7. C, 8. A
PG7 5. A, 6. A
PG8 5. D, 6. B