Mark schemes

1 D

[1]

2 C

[1]

3 B

[1]

4 (a) a force/1300 (condone power of ten error)

C1

6200 ÷ 1300

C1

4.77 (m s^{-2})

A1

3

(b) use of suitable kinematic equation

C1

eg distance = $27^2/(2 \times 4.8)$ correct sub

C1

76/76.4 m/72.9 from a = 5/75.9 from a = 4.8

A1

3

[6]

5 (a) $a = \frac{44}{4.0} = 11$ ms^{-2} **(1)**

$F = ma = 1.1 \times 10^5$ N **(1)**

(b) $\Delta v = 236$ m s^{-1}

$a = \frac{236}{8.0} = 29.5$ m s^{-2} **(1)**

(c) $s_{one} = v_{av} \times t = \left(\frac{44+0}{2}\right) \times 4.0 = 88$ m **(1)**

$s_{two} = v_{av} \times t = \left(\frac{280+44}{2}\right) \times 8.0$ **(1)** = 1296 (m) **(1)**

total distance = 1384 m **(1)**

[6]

6 (a) *GPE* to *KE* to *GPE* ✓

no energy lost (from system) / no work done against resistive forces ✓

initial *GPE* = final (*GPE*) / initial (*GPE*) = final *GPE*

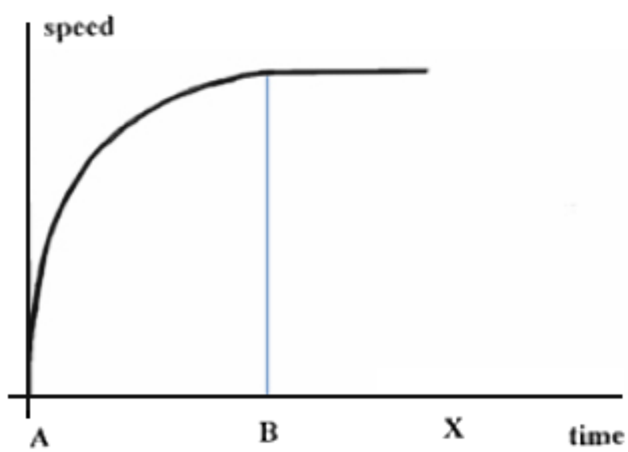
OR *h* = *GPE /mg* and these are all constant so *h* is the same ✓

3

(b) Initial curve with decreasing gradient and reaching constant maximum speed before X and maintaining constant speed up to X ✓

B labelled in correct place ✓

B labelled in correct place **AND** constant speed maintained for remainder of candidates graph and line is straight ✓



3

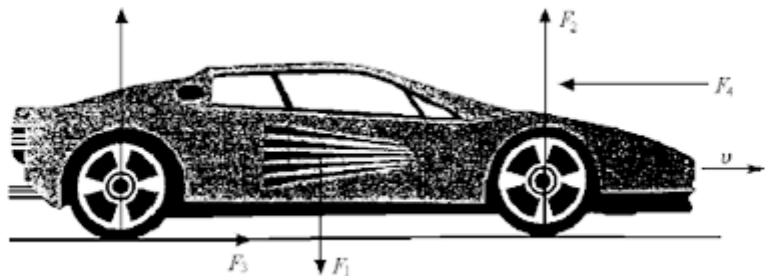
(c) (first law) ball travels in a straight line at a constant speed / constant velocity / (maintains) uniform / no change in motion / zero acceleration ✓

there is no (external) **unbalanced / resultant** force acting on it ✓

2

[8]

7 (a) (i)



F_1 weight / mg **(1)**
F_2 reaction or normal contact force **(1)**
F_3 driving force **(1)**
F_4 friction or air resistance **(1)**

(ii) zero acceleration **(1)**
zero resultant force **(1)**

The Quality of Written Communication marks were awarded primarily for the quality of answers to this part.

(max 5)

(b) ($P = Fv$ gives) $18 \times 10^3 = F \times 10$ **(1)** (and $F = 1.8 \times 10^3$ N)

(1)

(c) (i) $1800 - 250 = 1.6 \times 10^3$ N **(1)** (1.55×10^3 N)

(ii) force = $4 \times 1.55 \times 10^3 = 6.2 \times 10^3$ N **(1)**
(allow e.c.f. from (i))

(iii) total force = 6200 + 250(N) **(1)** (= 6.45×10^3 (N))
($P = Fv$ gives) $P = 6.45 \times 10^3 \times 20 = 1.3 \times 10^5$ W **(1)** (1.29×10^5 W)
(allow e.c.f. for value of total force)

(4)

[10]

8 (a) (i) air resistance/drag

B1

(normal) reaction (of the ground on the skier)

B1

2

(ii) no resultant force (in any direction)/forces in equilibrium

B1

1

(b) any closed triangle with *W* as a complete side

M1

closed triangle with correct lengths or angles even if *P* and *Q* are reserved

A1

correct triangle by eye

A1

force correct 490 ± 20 N

B1

4

(c) (i) appropriate force/87 **ecf**

C1

5.4 to 5.9 ms^{-2} **cao**

A1

2

(ii) deceleration would decrease

B1

resistance forces increase with speed/are proportional to $speed^2$/

resultant force gets smaller as speed gets less

B1

2

[11]

9 (a) (i) $\left(a = \frac{F}{m}\right) = \frac{(-)30(000)}{15100}$ **(1)** = (–)2.0 (= 1.99 m s^{-2}) **(1)**

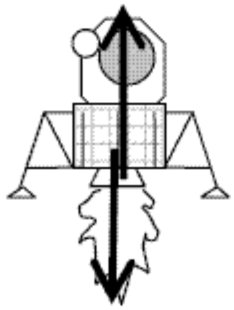
2

(ii) ($v = u + at$) $t = \frac{v-u}{a}$ or substitution **(1)**

$= \left(\frac{150 - 20401}{-1.99}\right)$ = 950 (s) **(1)** ecf from (i)

2

(b) (i)



opposing vertical arrows of roughly equal length **or** labelled weight/mg/gravity/W **and** thrust/reaction/R/F/TF/engine force/rocket force/motor force/motive force/driving force **(1)**

correctly labelled
+ arrows vertical
+ not more than 2 mm apart
+ roughly central
+ weight arrow originates within rectangular section and thrust originates within rectangular section or on jet outlet **(1)**

2

(ii) new mass = 15100 × 0.47 = 7097 (kg) **(1)**

(F = *mg* = 7097 × 16(1)) = 11000 (= 11426 N) **(1)**

2

(c) ($v^2 = u^2 + 2as$ $v = \sqrt{0.80^2 + 2 \times 1.61 \times 1.2}$) correct *u*, *a* and *s* clearly identified **(1)**

= 2.1 (= 2.122 m s^{-1}) **(1)**

2

[10]

10 (a) (momentum of air) increases ✓

words implying increase

1

(b) (rate of change of momentum so) <u>force</u> acting <u>on</u> the <u>air</u> (Newton 2) ✓

1

<u>it/air</u> exerts <u>force</u> (on engine) of the <u>same/equal magnitude/size</u> ✓

1

but <u>opposite</u> in direction (Newton 3) ✓

allow backwards and forwards to indicate opposite

1

(c) *(use of F = Δmv/t)*
F = 210 × 570 = 120 000 (N) (119 700) ✓

1

(d) momentum/velocity is a vector OR momentum/velocity has direction ✓

1

there is a change (in the air's) direction ✓

1

(e) *(use of F = ma)*

$a = (-)\ 190\ 000/7.0 \times 10^4 = 2.7\ (2.71)\ (\text{m s}^{-2})$ ✓

1

(f) *(use of $v^2 = u^2 + 2as$)*

CE from 01.5

accept range 850 − 860

if forget to square u or double a score 1 mark

1

$0 = 68^2 - 2 \times 2.7 \times s$ ✓

$s = 68^2/(2 \times 2.7) = 860\ (\text{m})\ (856)$

accept alternatives using $s = ut + 1/2at^2$ OR average speed – first mark for time calculation AND correct substitution

1

(g) rate of intake of air decreases (as plane slows) OR volume/mass /amount of air (passing through engine) per second decreases ✓

allow argument in terms of (air) resistance

(air) resistance decreases as speed of aircraft decreases for 1 mark

1

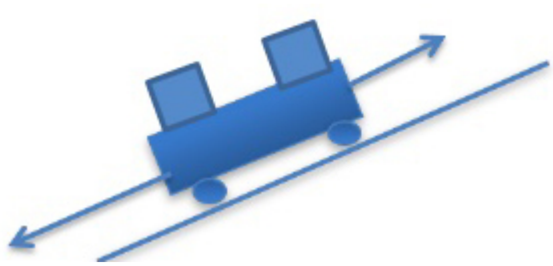
(as) smaller rate of change of momentum OR momentum change ✓

NOT FRICTION

1

[12]

11 (a) arrow parallel to slope labelled (M+2m)gsin35 and label parallel to slope labelled tension OR T ✓



Ignore arrows not parallel to ground e.g. weight

Ignore friction

W not acceptable for (M +2m)g

1

(b) T – Mgsin35 = Ma
AND (M+2m)gsin35 – T = (M+2m)a ✓

add two equations

(M + 2m)gsin35 – Mg sin35 = Ma + (M +2m)a ✓

HENCE
(a= mgsin35 / (M+m))

OR
(M +2m)gsin35 – Mgsin35 ✓ (= (2M+2m)a)

a = 2mgsin35 /(2M +2m) ✓

HENCE
(a= mgsin35 / (M+m))

1
1

(c) SECOND MARK CONDITIONAL ON FIRST
mass / impulse / acceleration (of trollies) is the same ✓
momenta (trolley A and B) the same

SECOND MARK CONDITIONAL ON FIRST

both have same <u>*speed / magnitude of velocity*</u> *but different masses* ✓

(hence) momentum of A is greater / momenta in opposite directions ✓

1
1

(d) $\text{acceleration} = \frac{1}{4} \times \frac{30 \times 9.81 \times \sin 35°}{(30 + 95)} = 0.338$ ✓

(use of $v^2 = 2as$)

$v = \sqrt{(2 \times 0.338 \times 9.0)} = 2.47$ ✓

$t = \frac{2.47}{0.338} = 7.3\text{s}$ ✓

OR
(use of $s = 1/2at^2$)
$9 = ½ \times 0.338 \times t^2$ ✓
$t = 7.3$ s ✓

CE from acceleration calculation

If used g for acceleration then no marks awarded

1
1
1

(e) number of journeys = (1800/(12 + 7.3) = 93 or 94 ✓

number of blocks = 2 × 93 = 186 or 2 × 94 = 188 ✓

Allow CE from 06.4

Allow between 93 to 94

Allow CE from incorrect number of journeys

Allow 186 to 188

1
1

[10]

12 (a) (i) (use of F = ma gives) $1.8 \times 10^3 = 900\ a$ **(1)**
$a = 2.0\ \text{m s}^{-2}$ **(1)**

(ii) (use of $v = u + at$ gives) $v = 2.0 \times 8.0 = 16\ \text{m s}^{-1}$ **(1)**
(allow C.E. for a from (i))

(iii) (use of $p = mv$ gives) $p = 900 \times 16$
$= 14 \times 10^3\ \text{kg m s}^{-1}$ (or N s) **(1)** ($14.4 \times 10^3\ \text{kg m s}^{-1}$)
(allow C.E. for v from(ii))

(iv) (use of $s = ut + ½at^2$ gives) $s = \frac{1}{2} \times 2.0 \times 8^2$ **(1)**

$= 64$ m **(1)**

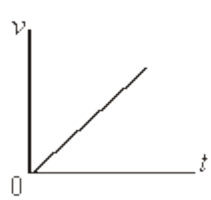
(allow C.E. for a from (i))

(v) use of $W = Fs$ gives) $W = 1.8 \times 10^3 \times 64$ **(1)**
$= 1.2 \times 10^5$ J **(1)** (1.15×10^5 J)
(allow C.E. for s from (iv))

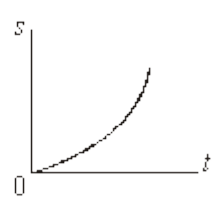
[or $E_k = ½mv^2 = ½ \times 900 \times 16^2$ **(1)**
$= 1.2 \times 10^5$ J **(1)**
(allow C.E. for v from (ii))]

9

(b)



(1)



(1)

2

(c) (i) decreases **(1)**
air resistance increases (with speed) **(1)**

(ii) eventually two forces are equal (in magnitude) **(1)**
resultant force is zero **(1)**

hence constant/terminal velocity (zero acceleration) in accordance with Newton's first law **(1)**

correct statement and application of Newton's first or second law **(1)**

max 5
QWC 2

[16]