Pages 162–167 Exam practice questions

1 D

2 A

3 C

4 C

5 B

6 B

7 C

8 D

9 C

10 D

11 B

12 a) Volume = $\pi r^2 h$

$= \pi \times (0.06\ \mathrm{m})^2 \times 0.15\ \mathrm{m}$

$= 0.0017\ \mathrm{m}^3$

mass = density × volume

$= 720\ \mathrm{kg\ m^{-3}} \times 0.0017\ \mathrm{m}^3$

= 1.22 kg

weight = *mg*

$= 1.22\ \mathrm{kg} \times 9.8\ \mathrm{N\ kg^{-1}}$

= 12.0 N

b) A body remains at rest or continues to move in a straight line at a constant speed unless acted on by an unbalanced force. (1)

c) A : contact force from × = 12 N (1)

B : weight of Y = 12 N (1)

C : contact force from table = 24 N

d) i) 12 N (1)

ii) upwards (1)

iii) gravitational (1)

iv) the Earth (1)

13 a) $W = 580 + 2\ \mathrm{kg} \times 9.8\ \mathrm{N\ kg^{-1}}$

= 600 N (2 sig figs) (1)

b) i) She accelerates the weight upwards by applying a force. It pushes back on her so the force on the scale increases. (1,1)

ii) She slows the weight down, so applies a downwards force on it. The weight pulls her up, so the force on the scales is less. (1, 1)

iii) The weight is stationary above her head, the forces on it balance. (1)

So the scale reads first the weight of the student and the 20 N of the weight. (1)

14 a) $F = ma$

$50\ \text{N} - 5\ \text{N} = 25\ \text{kg} \times a$

So: $a = (45/25)\ \text{m s}^{-2}$

$a = 1.8\ \text{m s}^{-2}$

b) $T - 2\ \text{N} = 10\ \text{kg} \times 1.8\ \text{m s}^{-2}$

$T = 20\ \text{N}$

15 a) i) $F = ma$

$= 96\ \text{kg} \times 1.2\ \text{m s}^{-2}$

$= 115\ \text{N}$(2)

ii) $F = 250\ \text{N} - 115\ \text{N}$

$= 135\ \text{N}$ (1)

b) Resultant force on Q:

$F = ma$

$= 48\ \text{kg} \times 1.2\ \text{m s}^{-2}$

$= 58\ \text{N}$

$F_{\text{resultant}} = 250\ \text{N} - F_p - \frac{135}{2}\ \text{N}$

$\Longrightarrow F_p = 250\ \text{N} - 67.5\ \text{N} - 58\ \text{N}$

$= 124.5\ \text{N}$ or $125\ \text{N}$ (to 3 s.f.)

16 a) The high pressure pushes water out of the bottle. Newton's third law tells us that the water exerts and equal and opposite force on the plane. (2)

There is now an unbalanced force which acts on the plane. So Newton's second law tells us the plane will accelerate forwards. (2)

b) i) $a = \frac{v-u}{t}$

$= \frac{2.8\ \text{m s}^{-1} - 2.0\ \text{m s}^{-1}}{1\ \text{s}}$ (1)

$= 0.8\ \text{m s}^{-2}$ (1)

ii) $a = \frac{v-u}{t}$

$= \frac{4.0\ \text{m s}^{-1} - 2.8\ \text{m s}^{-1}}{1\ \text{s}}$ (1)

$= 1.2\ \text{m s}^{-2}$ (1)

(In an AS exam you will not be asked to do the same calculation twice – but this gives you practice.)

iii) The mass of the plane has decreased as water escaped;

$a = \frac{F}{m}$ so the acceleration increases.(1,1)

c) *F* = *ma*

= 1.3 kg × 0.8 m s^{-2} (1)

= 1.0 N (1)

d) At E. There is only the drag force acting, so the plane decelerates. (1,1)

e) i) The drag force is increasing so the resultant force is less, so the acceleration is less. (2)

ii) The drag force balances the forwards force on the place from the water. (1)

iii) The drag force decelerates the plane. The drag force gets less as the plane slows. (2)

iv) The plane hits the ground and stops abruptly. (1)

f) 35 m. (The area under the graph.) (2)

g) i) The energy is transferred from the air due to its excess pressure in the bottle. (2)

ii) The water (and air as it is pushed out of the way). (1)

17 a) These measurements could have been could have been measured more accurately than the nearest millimetre, or half millimetre. As they stand, the error is large – perhaps 0.5 mm in 2 mm for the first interval, which corresponds to 25%. The error is much smaller for the larger intervals. 0.5 mm in 25 mm is a 2% error.(2)

b) $a = \dfrac{\frac{11\ \text{mm}}{0.02\ \text{s}} - \frac{2\ \text{mm}}{0.02\ \text{s}}}{3 \times 0.02\ \text{s}}$ (2)

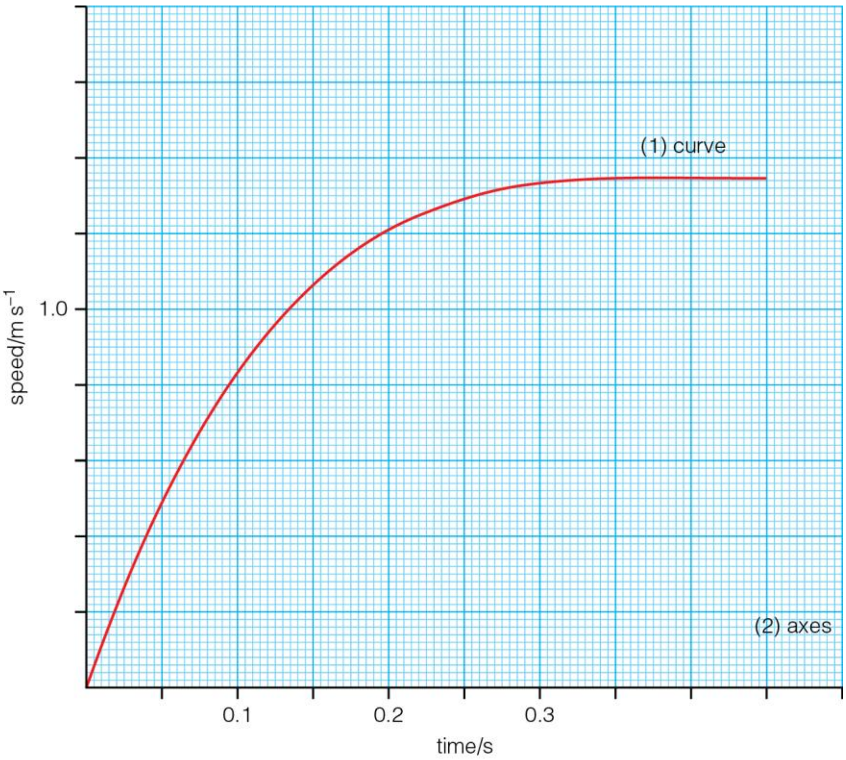
= 7500 mm s^{-2} = 7.5 m s^{-2} (1)

c) The acceleration decreases because the rate at which the speed increases gets less. The gaps increased by 3 mm per interval at the start, and eventually the gaps remain roughly constant. (2)

d) Terminal speed = $\frac{25.5\ \text{mm}}{0.02\ \text{s}}$ = 1.3 m s^{-1} (2)

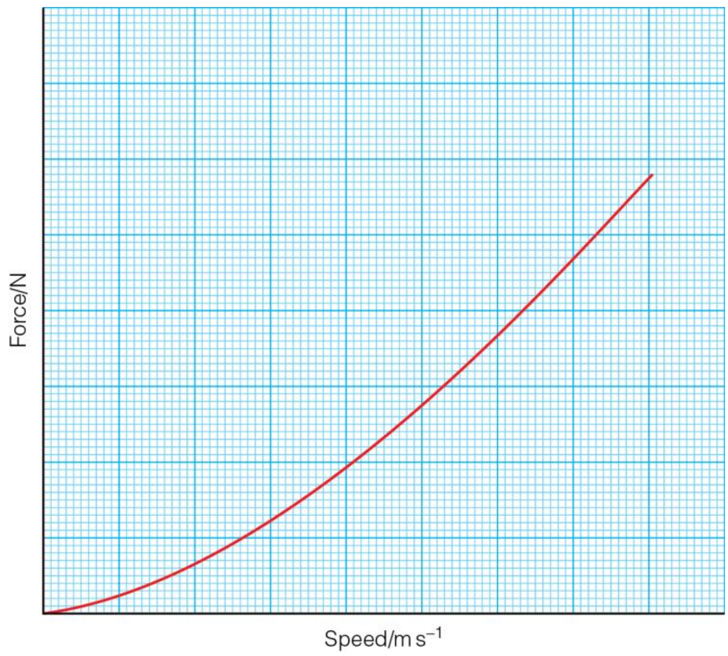
e) See graphs.

(i)



One mark for increasing speed, one mark for showing a constant speed at the end.

(ii)



Two marks for showing increasing drag with speed – including a linear relationship.

(There is insufficient data to be sure of the relationship.)

f) There are several issues here: the water exerts an upthrust on the weight, which has not been considered; the tape exerts a drag force; there will be an upthrust on the tape from the water. A better method could be devised using light gates, as they do not interfere with the motion of the mass.

Page 167 Stretch and challenge questions

18 a) To every force there is an equal and opposite force. So if one fragment goes one way it is balanced by a fragment going in the opposite direction.

This is a simplification. One fragment could be balanced by two or more fragments going in the opposite direction. (You could also think of the conservation of momentum.)

b) For P and R, the initial vertical velocity is 0.

So:

$s = \frac{1}{2}gt^2$

$t^2 = \frac{2s}{g}$

$= \frac{2 \times 100\ \text{m}}{9.8\ \text{m s}^{-1}}$

$t = 4.5$ s

For the next calculations, you need to use the formula for solving a quadratic equation.

$ax^2 + bx + c = 0$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

For Q:

$s = ut + \frac{1}{2}gt^2$

$100 = -30t + 4.9t^2$

$\Longrightarrow 4.9t^2 - 30t - 100 = 0$

$t = \frac{30 \pm \sqrt{900 + 4 \times 4.9 \times 100}}{2 \times 4.9}$

$t = \frac{30 \pm 53.5\ \text{s}}{9.8}$

$t = 8.5$ s

There is only one real solution as we cannot have negative time.

For S:

$s = ut + \frac{1}{2}gt^2$

$100 = 30t + 4.9t^2$

$\Longrightarrow 4.9t^2 + 30t - 100 = 0$

$t = \frac{-30 \pm \sqrt{900 + 4 \times 4.9 \times 100}}{9.8}$

$= \frac{-30 \pm 53.5\ \text{s}}{9.8}$

= 2.4 s

c) Q and S land below the centre of gravity. For P and R the horizontal distance travelled is:

s = 30 m s^{-1} × 4.5 s

= 135 m

R : 135 m to the right; P : 135 m to the left.

d) Final kinetic energy = initial kinetic energy + GPE transferred.

KE = $\frac{1}{2}mv^2 + mgh$

= $\frac{1}{2} \times 0.1 \times 30^2 + 0.1 \times 9.8 \times 100$

= 45 J + 98 J

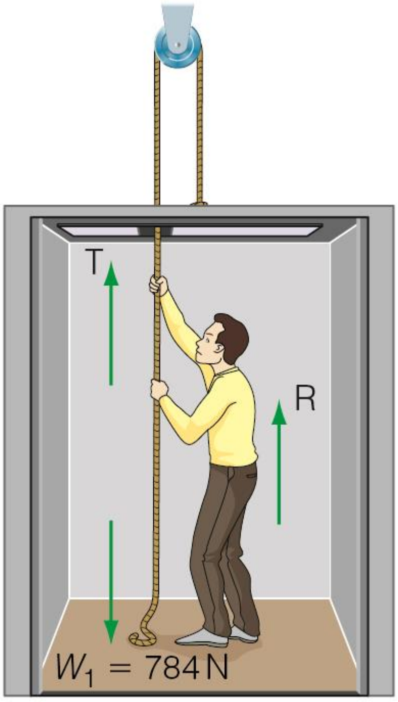
= 143 J

or 140 J (to 2 s.f.)

This is the same for all fragments as energy is a scalar.

e) Again all fragments have a kinetic energy of 140 J on landing.

19 a)



From the man: $T + R$ = 784 N

From the lift: $T - R$ = 392 N

So $2T$ = 1176 N

T = 588 N

R = 784 N – 588 N = 196 N

b) $2T - W_1 - W_2 = (m_1 + m_2)\,a$

1296 N – 784 N – 392 N = 120 kg × a

120 N = 120 kg × a

a = 1.0 m s^{-2}