L1.4 Introducing the A Level Equations of Motion

Prior GCSE Knowledge

- Edexcel require use of the following equations at GCSE:

- $a = \Delta v/\Delta t$
  acceleration = change in velocity / time

- $a = (v-u)/t$
  acceleration = (final velocity – initial velocity) / time

- $v^2-u^2 = 2ax$
  final velocity^2 – initial velocity^2 – 2 x acceleration x distance travelled

Other specifications have very effectively the same equations but not necessarily the same symbols

Required A - Level Knowledge

- $a = \Delta v/\Delta t$
  acceleration = change in velocity / time

- $v = u + at$
  final velocity = initial velocity + (acceleration x time)
  This is a rearrangement of $a = (v-u)/t$

- $v^2-u^2 = 2as$
  final velocity^2 – initial velocity^2 – 2 x acceleration x displacement
  Edexcel use s for displacement (rather than x) at A-Level

- $s = ut + \frac{1}{2} at^2$
- displacement = (initial velocity x time) + ½ x acceleration x time^2

What do the equations mean?

- $v = u + at$

  final velocity = initial velocity + (acceleration x time)

Each of the terms v, u and ‘at’ are velocities.

If we start at a velocity of u and accelerate for a time t the change in velocity will be ‘at’ .

- $v^2-u^2 = 2as$

  final velocity^2 – initial velocity^2 = 2 x acceleration x displacement

  Here v^2, u^2 and ‘2as’ all give us velocities^2. Their units will all be m^2/s^2.

  (2 x a x s has units of m/s^2 x m = m^2/s^2)

What do the equations mean?

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

  displacement = (initial velocity x time) + ½ x acceleration x time^2

  s, ‘ut’ , and ‘½ at^2’ are all displacements with units of m.

‘ut’ is the displacement if you travelled at u m/s for t seconds without accelerating

‘½ at^2’ is the extra displacement caused by the acceleration, over an above the displacement that occurs at constant velocity

What do the equations mean?

- $s = \frac{(u + v)}{2} \times t$
- (u+v)/2 is the average velocity so the equation is really saying ‘displacement = average velocity x time’ which is the vector equivalent of ‘distance = average speed x time’.

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration? (Have a look at the next slides to see how we need your answer shown)

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

Assign the correct letter to each piece of data, plus the unknown quantity. To do this write suvat as shown below (as these equations are often referred to as the 'suvat' equations):

s = N/A (not applicable –as we're not given it, nor do we need to calculate it)

u = 0m/s

v = 30 m/s

a = a

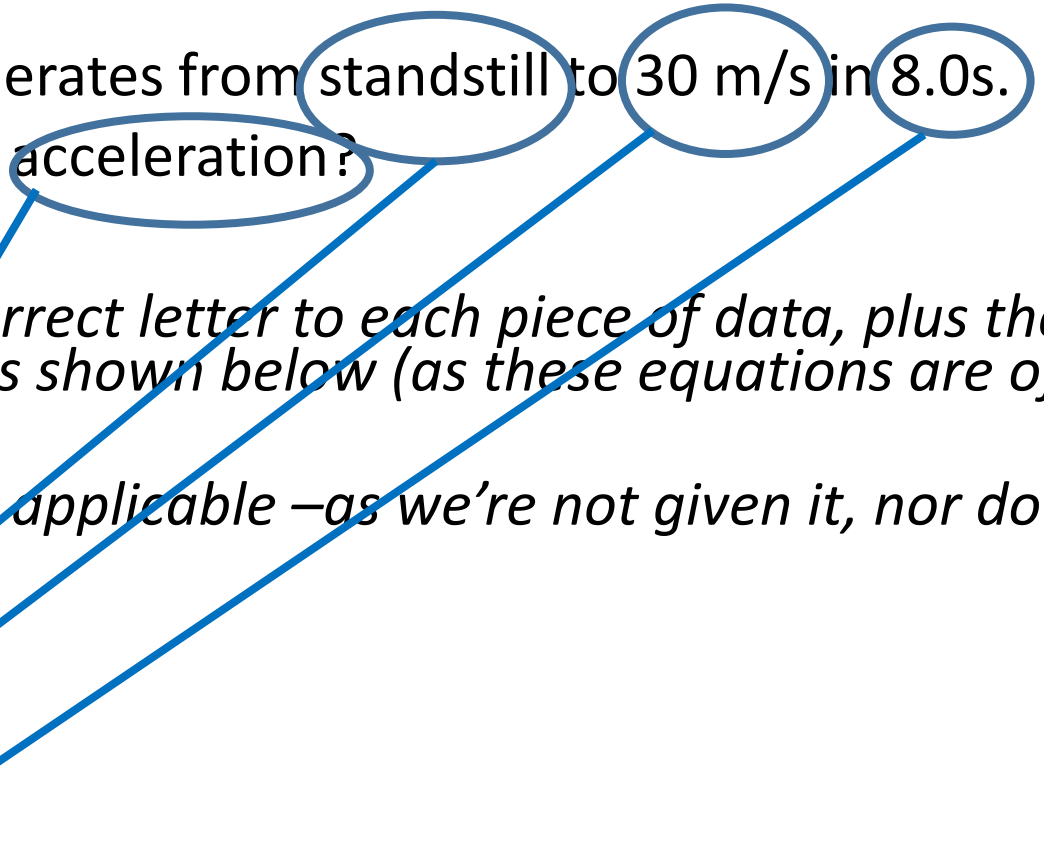
t = 8.0 s

Find an equation which has all these terms.

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?



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u = 0m/s

v = 30 m/s

a = a

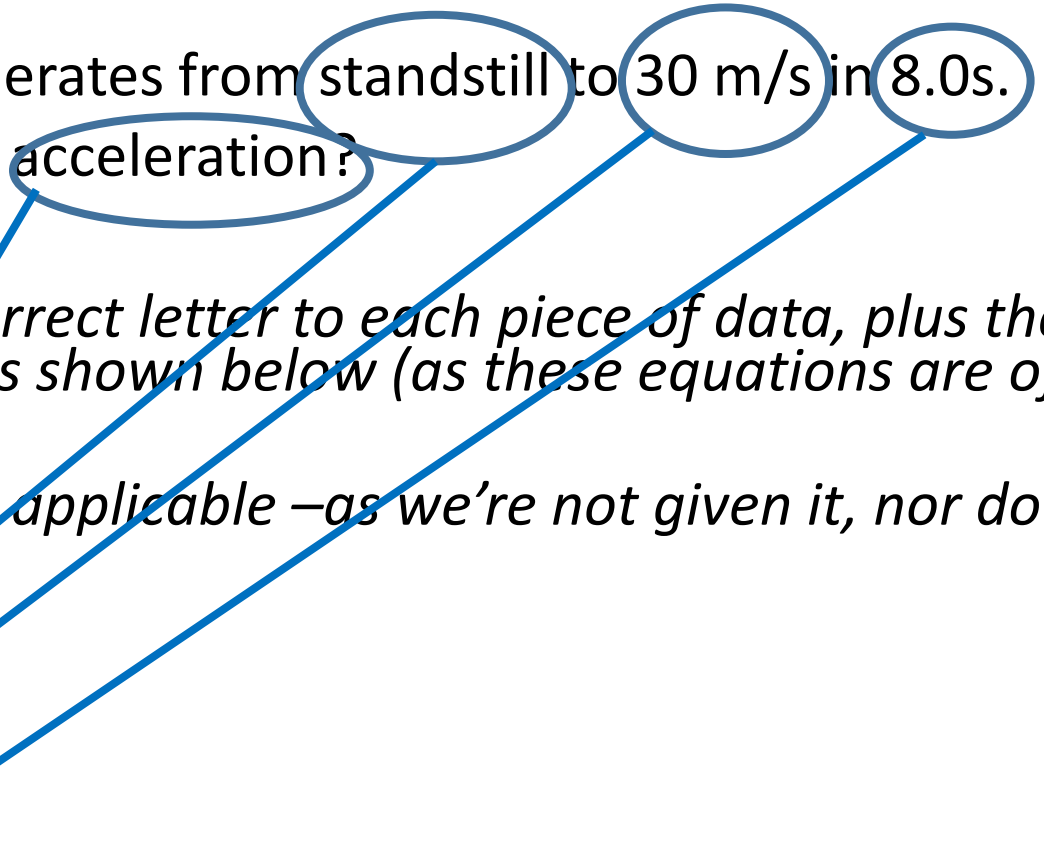
t = 8.0 s

Find an equation which has all these terms, but not 's'.

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?



Assign the correct letter to each piece of data, plus the unknown quantity. To do this write suvat as shown below (as these equations are often referred to as the 'suvat' equations):

s = N/A (not applicable –as we're not given it, nor do we need to calculate it)

u = 0m/s

v = 30 m/s

a = a

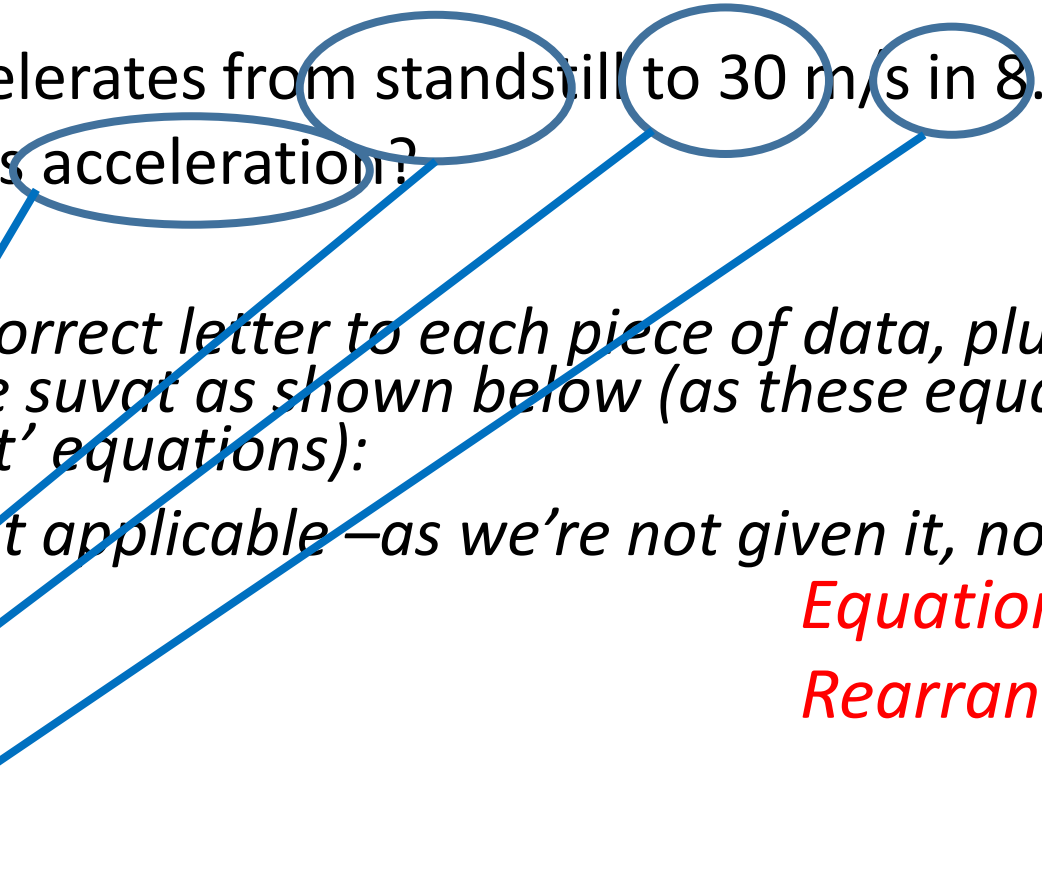
t = 8.0 s

Find an equation which has all these terms, but not 's'. *v = u + at*

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?



Assign the correct letter to each piece of data, plus the unknown quantity. To do this write suvat as shown below (as these equations are often referred to as the 'suvat' equations):

s = N/A (not applicable –as we're not given it, nor do we need to calculate it)

u = 0m/s

v = 30 m/s

a = a

t = 8.0 s

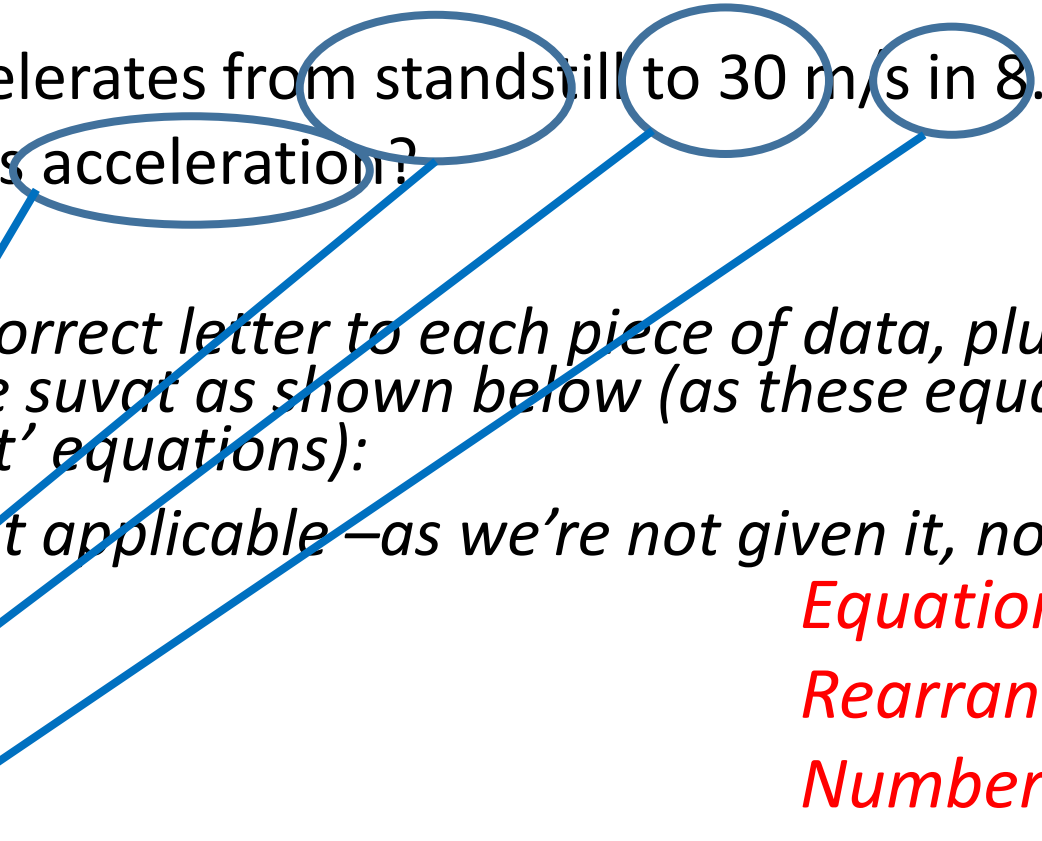
Equation: $v = u + at$

Rearrangement: $a = (v-u)/t$

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?



Assign the correct letter to each piece of data, plus the unknown quantity. To do this write suvat as shown below (as these equations are often referred to as the 'suvat' equations):

s = N/A (not applicable –as we're not given it, nor do we need to calculate it)

u = 0m/s

v = 30 m/s

a = a

t = 8.0 s

Equation: $v = u + at$

Rearrangement: $a = (v-u)/t$

Numbers: $a = (30 – 0)/8.0$

Answer and unit: $a = 3.8\ m/s^2$ *(2sf)*

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

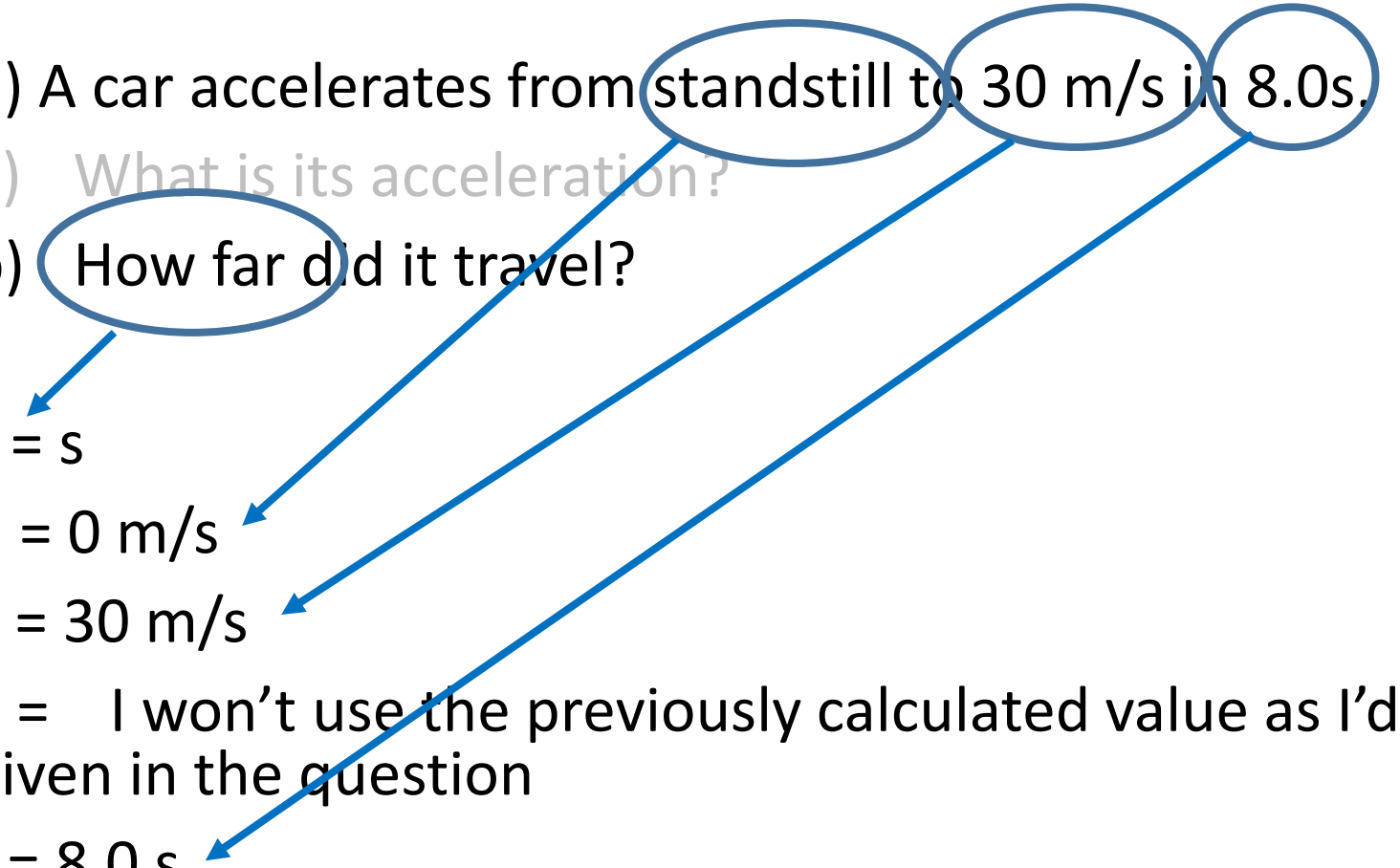
b) How far did it travel? (Try this for yourself, then check using the next slides)

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

b) How far did it travel?



s = s

u = 0 m/s

v = 30 m/s

a = I won't use the previously calculated value as I'd rather use the data given in the question

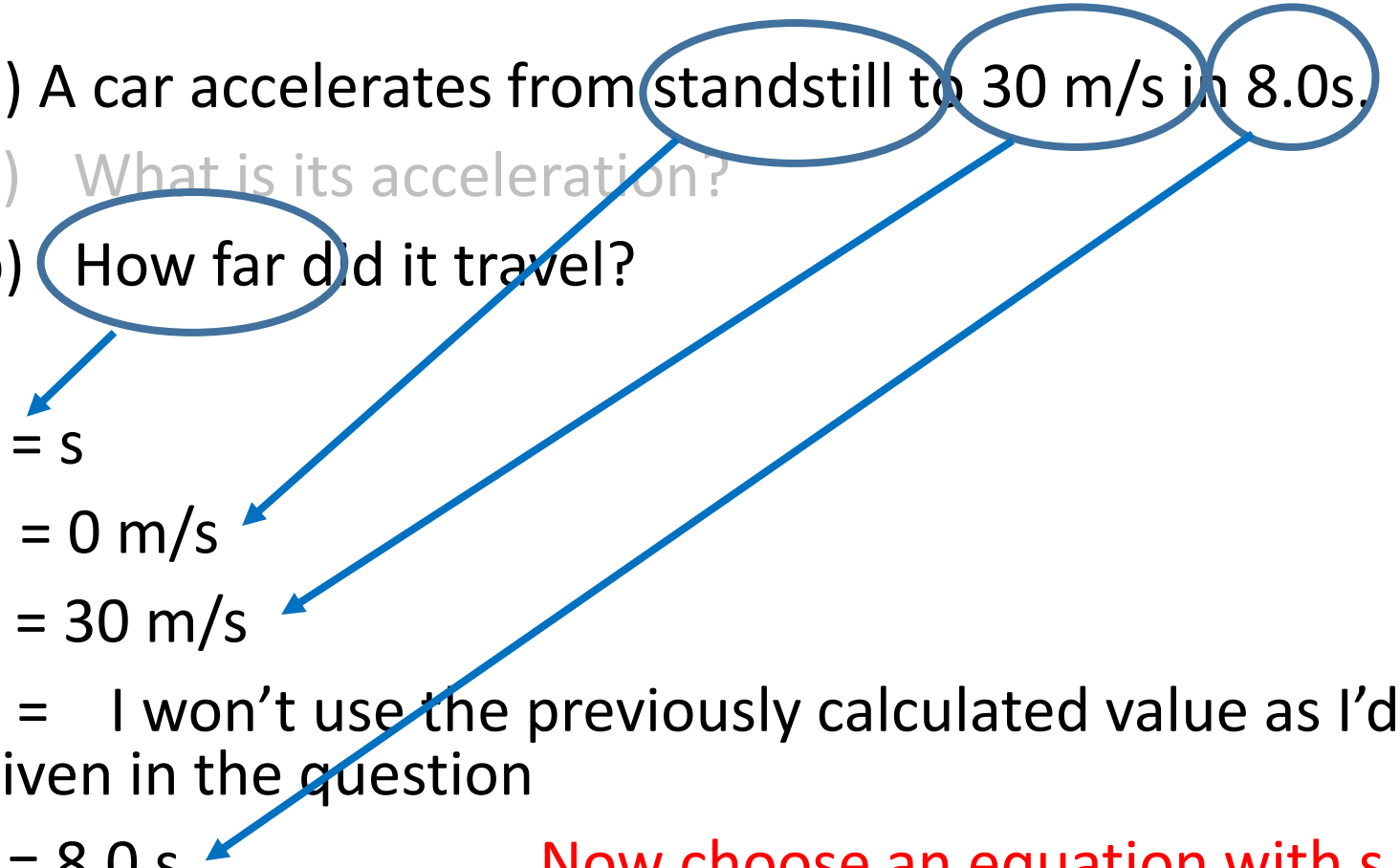
t = 8.0 s

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

b) How far did it travel?



s = s

u = 0 m/s

v = 30 m/s

a = I won't use the previously calculated value as I'd rather use the data given in the question

t = 8.0 s

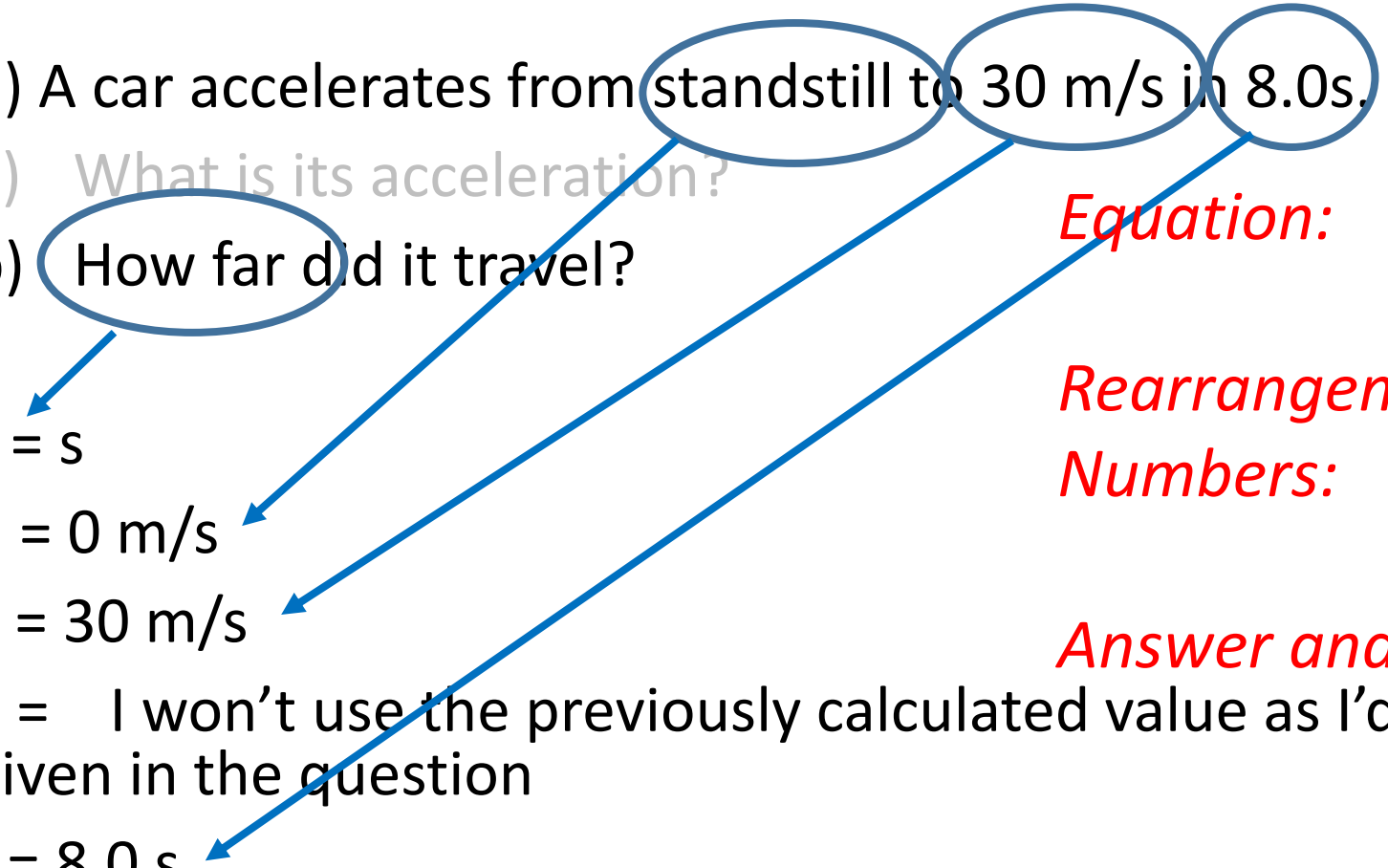
Now choose an equation with s, u, v and t, but not a

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

b) How far did it travel?



s = s

u = 0 m/s

v = 30 m/s

a = I won't use the previously calculated value as I'd rather use the data given in the question

t = 8.0 s

Equation: $s = \frac{(u + v)}{2} t$

Rearrangement: *not required*

Numbers: $= \frac{(0 + 30)}{2} 8.0$

Answer and unit: *s = 120 m*

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

b) How far did it travel?

c) The driver then applies the brakes and slows down to 10 m/s travelling a further 200m. Calculate its acceleration.

d) Calculate the time taken during braking

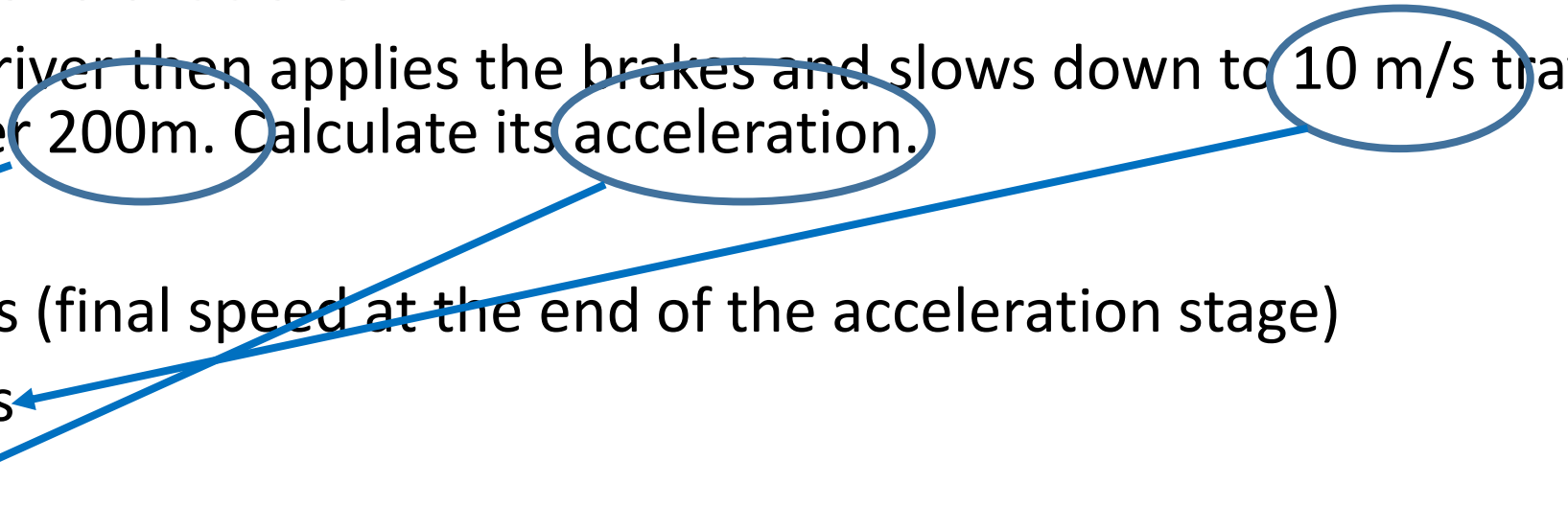
Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

b) How far did it travel?

c) The driver then applies the brakes and slows down to 10 m/s travelling a further 200m. Calculate its acceleration.



s = 200 m

u = 30 m/s (final speed at the end of the acceleration stage)

v = 10 m/s

a = a

t = N/A

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

b) How far did it travel?

c) The driver then applies the brakes and slows down to 10 m/s travelling a further 200m. Calculate its acceleration.

s = 200 m

u = 30 m/s

v = 10 m/s

a = a

t = N/A

Equation: $v^2 = u^2 + 2as$

Rearrangement: $a = \frac{(v^2 - u^2)}{2s}$

Numbers: $= \frac{(10^2 - 30^2)}{2 \times 200}$

Answer and unit: $a = -2.0\ m/s^2$

Questions to try.

1) A car accelerates from standstill to 30 m/s in 8.0s.

a) What is its acceleration?

b) How far did it travel?

c) The driver then applies the brakes and slows down to 10 m/s travelling a further 200m.

d) Calculate the time taken during braking

Questions to try.

d) Calculate the time taken during braking

s = 200 m

u = 30 m/s

v = 10 m/s

a = N/A Again I won't use this, as I'd rather use the data given

t = t

Questions to try.

d) Calculate the time taken during braking

s = 200 m

u = 30 m/s

v = 10 m/s

a = N/A t = t

Equation: $s = \frac{(u + v)}{2} t$

Rearrangement: $t = \frac{2s}{(u + v)}$

Numbers: $= \frac{2 \times 200}{(30 + 10)}$

Answer and unit: $t = 10\ s$

Now answer the ‘Equations of Motion’ question sheet (2 sides)…

… and then the sheet entitled LO 73b Rev A on momentum

Hand in a photo of all work (with your name and date and the title ‘Physics Lesson 1 – Numeracy’ either via Google Classroom (for existing Math school students) or by email (for external students)