Question			Answer	Max mark	Additional guidance
3.	(a)		(Total momentum before = Total momentum after) $p = mv$ OR **(1)** $(m_x u_x + m_y u_y) = (m_x v_x + m_y v_y)$ $(0 \cdot 75 \times 0 \cdot 50) + (0 \cdot 50 \times -0 \cdot 30) = (0 \cdot 75 \times 0 \cdot 02) + (0 \cdot 50 \mathrm{v}_y)$ **(1)** $v_y = 0 \cdot 42$ m s^{-1}	**2**	**"SHOW" question** If sign convention is not applied then max 1 mark for formula.
	(b)		$Ft = mv - mu$ **(1)** $Ft = (0 \cdot 50 \times 0 \cdot 42) - (0 \cdot 50 \times -0 \cdot 30)$ **(1)** $Ft = 0 \cdot 36$ N s **(1)**	**3**	Accept: 0·4 Accept: $\text{Impulse} = mv - mu$ v and u must have opposite sign. Accept: kg m s^{-1}
	(c)		Calculate the <u>total</u> kinetic energy before and (<u>total</u> kinetic energy) after. **(1)** If E_k before is equal to E_k after the collision, is elastic. **OR** If E_k before is greater than E_k after, the collision is inelastic. **(1)**	**2**	Look for a statement relating to calculating/finding the <u>total</u> E_k before and after first, otherwise 0 marks. There must be an indication of total kinetic energy or equivalent term. Accept: If kinetic energy is not the same, collision is inelastic. Can show by calculation but would still require a statement for the second mark. Do not Accept: If kinetic energy is gained, collision is inelastic. If candidate says energy is lost then max 1 mark.

Q3(a) **Maximum Mark: 2**

RESPONSE 1

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$(0.75 \times 0.5) + (0.5 \times -0.3) = (0.75 \times 0.02) + (0.5v_2)$

$0.225 = 0.015 + 0.5v_2$

$0.21 = 0.5v_2$

$v_2 = 0.42 ms^{-1} \rightarrow$

RESPONSE 2

$mu + mu = mv + mv$

$(0.75 \times 0.5) + (0.5 \times -0.3) = (0.75 \times 0.02) + 0.5v$

$0.5v = 0.225 - 0.015$

$0.5v = 0.21$

$v = 0.42 ms^{-1}$

RESPONSE 3

$m_xv_x + m_yv_y = m_xv_x + m_yv_y$ (− ←, + →)

$(0.75 \times 0.5) + (0.5 \times -0.3) = (0.75 \times 0.02) + (0.5v_y)$

$0.225 = 0.015 + 0.5v_y$

$0.5v_y = 0.21$

$v_y = 0.42 ms^{-1}$ to the right

Q3(b) **Maximum Mark: 3**

RESPONSE 1

$Ft = \Delta p$

$= m_2v_2 - m_2u_2$

$= m_2(v_2 - u_2)$

$= 0.5 \times (0.42 - (-0.3))$

$= 0.35\,Ns$

RESPONSE 2

impulse $= mv - mu$

impulse $= (0.5 \times 0.42) - (0.5 \times 0.3)$

impulse = 0.06 N to the right

RESPONSE 3

~~$Ft = 0.5 \times -0.3 - 0.5 \times 0.42$~~

$Ft = 0.5 \times 0.42 - 0.5 \times -0.3$

$= 0.36\,kgms^{-1}$

Q3(c) **Maximum Mark: 2**

RESPONSE 1

Calculate the kinetic energy (total) before the collision and after the collision. If the total kinetic energy before and after the collision is the same, the collision was elastic. If the total kinetic energy after the collision is less than the total kinetic energy before the collision, the collision was inelastic.

RESPONSE 2

Work out the Kinetic energy of both cars before and after the collision and compare. If they have the same Kinetic energy it ~~is~~ was elastic, if they dont it was inelastic.

RESPONSE 3

Calculate the kinetic energy of Vehicle x and Vehicle before the collision → 9 Seperate then add the kinetic energy of both together.

Then calculate the kinetic energy of the two vehicles after the collision and add them together.

If kinetic energy before = kinetic energy after, the the collision is elastic

If the kinetic energy before ≠ kinetic energy after, the collision is inelastic

Q5(a) **Maximum Mark: 1**

RESPONSE 1

red shift

RESPONSE 2

(a) State one other piece of evidence that supports the Big Bang theory.

Cosmic microwave background radiation. ~~Cosmic background microwave radiation~~ • Also redshift of light from planets.

RESPONSE 3

(a) State one other piece of evidence that supports the Big Bang theory.

If something is moving away fast to the observer it shifts to the red end of the spectrum. (Red shift). This is what is observed looking at distant galaxies.

Q5(b)(i) **Maximum Mark: 2**

RESPONSE 1

$$\text{age of universe} = \frac{1}{H_0}$$
$$= \frac{1}{2 \times 10^{-17}}$$
$$= 5 \times 10^{16} \text{ s}$$
$$= 1.6 \times 10^{9} \text{ years}$$

RESPONSE 2

$$\text{age} = \frac{1}{H_0}$$
$$= 5 \times 10^{16} \text{ years}$$

Q5(b)(ii) **Maximum Mark: 1**

A

RESPONSE 1

~~As~~ This is because the students calculation of hubbles constant is not as accurate as the universally used version.

RESPONSE 2

More advanced technology has been invented so the value for H_0 is more accurate now than in 1929.

RESPONSE 2

Work out the kinetic energy of both cars before and after the collision and compare. If they have the same kinetic energy it ~~is~~ was elastic, if they dont it was inelastic.

RESPONSE 3

Calculate the kinetic energy of Vehicle x and Vehicle y before the collision → Seperate then add the kinetic energy of both together.

Then calculate the kinetic energy of the two vehicles after the collision and add them together.

If kinetic energy before = kinetic energy after, the the collision is elastic

If the kinetic energy before ≠ kinetic energy after, the collision is inelastic

Q3(a)	**2**	
Response 1	**2**	The candidate has explicitly stated an appropriate relationship and substituted data correctly, stating the given final answer.
Response 2	**2**	The candidate has explicitly stated an appropriate relationship and substituted data correctly, stating the given final answer.
Response 3	**2**	The candidate has explicitly stated an appropriate relationship and substituted data correctly, stating the given final answer.
Q3(b)	**3**	
Response 1	**2**	The candidate has selected an appropriate relationship, substituted correctly but given an incorrect final answer due to an arithmetic slip.
Response 2	**1**	The candidate has selected an appropriate relationship, but has not substituted correctly (should be u= –0·3, using the candidate's sign convention). Even if the unit in the final answer had been correct, the mark for the final answer cannot be accessed.
Response 3	**3**	The selection of an appropriate relationship can be implied by the candidate's correct substitution of data. The candidate's final answer is correct.
Q3(c)	**2**	
Response 1	**2**	The candidate's explanation covers both the determination and correct comparison of the total kinetic energies before and after the interaction.

Question /Response	Mark	Commentary
Response 2	**0**	The candidate neither states nor implies that the *total* kinetic energies of the system before and after the interaction should be determined and compared, and so the marks are not awarded.
Response 3	**2**	Through their description, the candidate implies the determination of the total kinetic energies of the system before and after the interaction. The comparison is also correct.