Question Number	Answer	Mark
***1**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** (When submerged) there is an upthrust acting on the ball **Or** there is a force equal to the weight of water displaced **Or** the ball is less dense than water **(1)** upthrust > weight of the ball (+ drag) **(1)** Creates an upwards acceleration **Or** there is an upwards resultant force **(1)**	**3**
	Total for Question	**3**

Question Number	Answer	Mark
2(a)	Resistance (of a fluid) to flow **(1)**	**1**
2(b)(i)	Rate of flow is inversely proportional to the viscosity **Or** rate of flow decreases with increasing viscosity (and vice versa) **(1)** The time to empty the cup is proportional to the viscosity **Or** the time to empty the cup is inversely proportional to the flow rate **Or** the time to empty the cup decreases as viscosity decreases **Or** the time to empty the cup decreases as the flow rate increases **(1)** (Accept converse explanation in terms of time increasing for MP2)	**2**
2(b)(ii)	The temperature was greater on the first day **Or** the temperature was lower (on the second day) **Or** the paint/room was colder (on the second day) **Or** the time is greater when the temperature is lower **Or** the time is lower when the temperature is greater **(1)**	**1**
2(c)	Error 1 **(1)** Correct outcome from error 1 **(1)** Error 2 **(1)** Correct outcome from error 2 **(1)** (Do not credit descriptions of changing temperature) Examples of answer Reaction time Measured time greater than actual time Initial paint level in cup could be higher/lower than the level Time would be greater /less Hole/opening becomes blocked Time to drain would be greater Paint left in cup after pouring **Or** paint spilt Reduces time to drain	**4**
	Total for Question	**8**

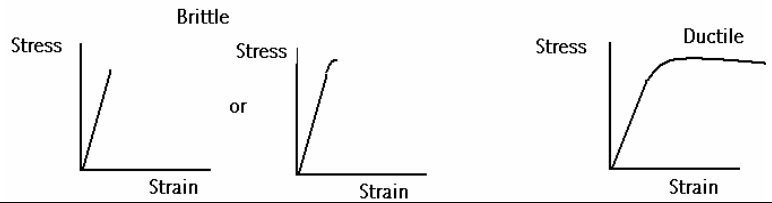
Question Number	Answer	Mark
3	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** Electrons spread out **Or** electrons form a diffraction/interference pattern **Or** undergo superposition **(1)** Electrons must behave as waves **Or** Electrons have a wavelength (similar to the atomic spacing) **(1)** Because diffraction/interference is wave behaviour **(1)**	**3**
	Total for question 12	**3**

Question Number	Answer	Mark
4	**Either** (Unpolarised) light has oscillations in all planes **(1)** Vertically polarised light has oscillations in a <u>vertical</u> plane only **(1)** The vertical plane includes the direction of propagation of the light (dependent mark) **(1)** **Or** (Unpolarised) light has oscillations in all directions **(1)** Vertically polarised light has oscillation in a <u>vertical</u> direction only **(1)** … perpendicular to the direction of propagation (dependent mark) **(1)**	**3**
	Total for question	**3**

Question Number	Answer		Mark
5(a)	Idea of two or more waves meeting Displacement is sum of individual displacements	**(1)** **(1)**	**2**
5(b)	Electromagnetic waves are transverse, with oscillations ***perpendicular*** to the direction of ***energy transfer*** **Or** ***wave travel*** **Or** ***propagation*** When they pass through a polarising filter all the components of the oscillations perpendicular to the plane of polarisation are ***absorbed***. (accept ***blocked***) **Or** When they pass through a polarising filter all the components of the oscillations ***parallel*** to the plane of polarisation are ***transmitted***. The oscillations of the polarised wave are all in the same plane which ***includes*** the direction of energy transfer. **Or** The oscillations of the polarised wave are all in the same ***direction*** which is perpendicular to the direction of energy transfer	**(1)** **(1)** **(1)** **(1)**	**4**
***5(c)(i)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate – e.g. if the term 'superimpose' is used this mark is not awarded) When in phase constructive interference/superposition occurs **Or** when path difference is $n\lambda$ constructive interference/superposition occurs When in antiphase destructive interference/superposition occurs **Or** when path difference is $(n + ½) \lambda$ destructive interference/superposition occurs Light band forms when in phase **Or** path difference is $n\lambda$ **Or** constructive **Or** Dark band forms when in antiphase **Or** path difference is $(n + ½) \lambda$ **Or** destructive	 **(1)** **(1)** **(1)**	**3**
5(c)(ii)	Oscillations of light from the two filters are perpendicular to each other So there are no opposite components to cancel each other out **Or** so the waves do not interact/interfere So zero amplitude not possible **OR** (If the candidate assumes that it is a source of polarised light) One filter is parallel to the plane of polarisation of the light source, so light is transmitted but the other one absorbs light So light now only reaches the screen from one filter, so there is no interference So zero amplitude not possible	**(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for Question		**12**

Question Number	Answer		Mark
6(a)	Unpolarised – oscillations/vibrations in many directions	**(1)**	
	Polarised – oscillations/vibrations in single direction	**(1)**	
	oscillations/vibrations are perpendicular to direction of propagation	**(1)**	
	Or Unpolarised – oscillations/vibrations in many planes	**(1)**	
	Polarised – oscillations/vibrations in single plane	**(1)**	
	Plane includes direction of propagation	**(1)**	**3**
6(b)	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.)		
	The idea that light transmitted only when in same plane/direction as plane/direction of polarisation of filter **Or** The idea that light not transmitted when plane/direction at 90° to plane/direction of polarisation of filter	**(1)**	
	Rays for each image are (polarised) in different planes/directions, (so only one image is seen)	**(1)**	
	When the (polarising) filter is rotated the image becomes fainter **Or** When the (polarising) filter is rotated the other image becomes visible	**(1)**	
	A statement correctly linking image(s) seen with angle. • at 90° only the other image is seen • at 180° only the 1st image is seen • at 270° only the other image is seen • at in between angles both images will be seen, (but neither at full intensity)	**(1)**	**4**
	Total for question		**7**

Question Number	Answer		Mark
7 (a)	Reference to oscillations of electric / magnetic field (accept vibrations)	**(1)**	
	Oscillations/vibrations in one plane only	**(1)**	
	Plane includes direction of propagation/travel (of the light) **Or** Plane includes direction of energy transfer (third mark dependent on second mark)	**(1)**	**3**
	Alternative mark scheme Reference to oscillations of electric / magnetic field (accept vibrations)	**(1)**	
	Oscillations/vibrations in one direction only…	**(1)**	
	… perpendicular to direction of propagation/travel (of the light) **Or** … perpendicular to direction of energy transfer (third mark dependent on second mark)	**(1)**	
7(b)	Identifies 90 degree difference	**(1)**	
	Light aligned/intended for one filter will be blocked/absorbed/stopped by the other filter **Or** light aligned/intended for one filter will only be transmitted by that filter (2^{nd} mark dependent on 1^{st})[accept reference to lens]	**(1)**	**2**
7 (c)	(Polarisation) absorbs/blocks/stops the unaligned part of the radiation		
	Or only aligned part of radiation is transmitted	**(1)**	
	So intensity / flux / amplitude (reaching each eye) reduced	**(1)**	**2**
7 (d)	Angle between one filter/lens/eye and plane (of polarisation) of the light (intended for the other filter) has changed	**(1)**	
	The light for one eye has component in plane of polarisation of the other filter (and passes through to the other eye)	**(1)**	**2**
	Total for question		**9**

Question Number	Answer	Mark
8(a)	Explain the meanings of the terms brittle and ductile. brittle – undergoes no / little plastic deformation (before breaking) / tends to break when subject to impact [accept breaks just beyond / soon after limit of proportionality / elastic limit] (1) graph (1) ductile – undergoes a lot of plastic deformation (before breaking) / able to undergo permanent deformation under tensile stress / can be drawn into wires (1) graph (1) [Assume axes labels if not given, accept force, extension labels] [1 graph mark max if stress strain labels reversed] [Ductile graph can be curved from start] 	**4**
8(b)	give an example of a ductile material and situation where behaviour desirable material example, e.g. copper (accept metal or any metal) (accept chewing gum, silly putty …) (not rubber)(1) example of desirable application, e.g. making wires (1) [NB Not examples of moulding or malleable behaviour]	**2**
	Total for question	**6**

Question Number	Answer		Mark
9	Identifies (electron) <u>diffraction</u> (Electron) has wave properties/behaviour (Electron) has wavelength similar to atomic size/spacing (do not accept defraction for 1st mark)	**(1)** **(1)** **(1)**	**3**
	Total for question		**3**