**1** Here is a list of combinations of base units of the SI system.

Which combination of units is equivalent to a newton, N?

**A** kg m s–1

**B** kg m s–2

**C** kg m2 s–2

**D** kg m2 s–3

**Your answer [1]**

**2** Here is a list of combinations of base units of the SI system.

Which combination of units is equivalent to watt, W?

**A** kg m s–1

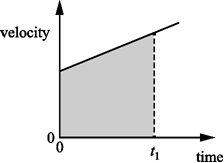
**B** kg m s–2

**C** kg m2 s–2

**D** kg m2 s–3

**Your answer  [1]**

**3** Here is a velocity–time graph.



Which statement/s about the graph is/are correct?

**1** The gradient represents acceleration.

**2** The shaded area represents the change of displacement from time = 0 to time = *t*1.

**3** The graph shows that velocity is proportional to distance.

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

**Your answer  [1]**

**4** A ball rolls up a ramp which is at angle of 20o to the horizontal. The speed of the ball at the bottom of the ramp is 2.2 m s–1. *L* is the distance the ball moves along the ramp before coming to rest.



What is distance *L*? Ignore the effects of friction and rotation in your answer.

**A** 0.25 m

**B** 0.26 m

**C** 0.68 m

**D** 0.72 m

**Your answer  [1]**

**5** A firework rocket with a mass of 0.40 kg is launched vertically upwards with an initial acceleration of 6.2 m s−2.

What is the force on the rocket from the burning fuel?

**A** 1.4 N

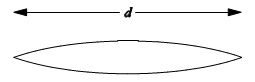
**B** 2.5 N

**C** 3.9 N

**D** 6.4 N

**Your answer  [1]**

**6** A standing wave is formed on a string of length *d* as shown.



Which of the following statements is/are true?

**1** Progressive waves are travelling along the string in both directions.

**2** The standing wave is an example of superposition.

**3** The wavelength of the standing wave is *d*.

**A** 1, 2 and 3

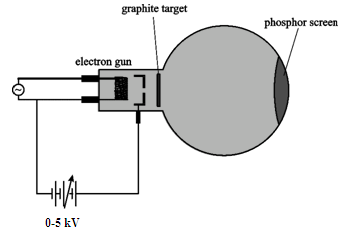
**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

**Your answer  [1]**

**7** In the apparatus shown in the diagram, a beam of electrons hits the graphite target. This target acts as a diffraction grating. Diffraction maxima are seen on the phosphor screen.



When the voltage of the power supply is increased, the diffraction maxima become brighter and closer to the centre of the pattern.

Which of the following statements correctly describe the effect of increasing the voltage?

**1** The kinetic energy of the electrons increases.

**2** The wavelength of the electrons increases.

**3** The charge of the electrons increases.

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

**Your answer  [1]**

**8** An electron has a kinetic energy of 2.0 × 10–17 J. The mass of an electron is 9.1 × 10–31 kg.

What is the value for the de Broglie wavelength of the electron?

**A** 1.1 × 10–10 m

**B** 1.5 × 10–10 m

**C** 3.3 × 10–17 m

**D** 6.6 × 10–17m

**Your answer  [1]**

**9** This question is about an experiment to determine the Planck constant using LEDs. To achieve a reliable value it is important to measure the value at which the LEDs just turn on, the threshold voltage.

**(a) (i)** Describe **one** technique you could use to measure the threshold voltage for LEDs.

…………….…………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………..

**[2]**

**(ii)** Draw a diagram of a circuit you would use to make these measurements.

**[1]**

**(b)** A student obtains several results for red, green and blue light LEDs as shown in the table in **Fig. 29.1** below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **LED**  **colour** | **manufacturer's stated frequency *f* / Hz × 1014** | **threshold voltage** | | | **processed data** | | |
| ***V*1 / V** | ***V*2 / V** | ***V*3 / V** | ***V*av/ V** | ***eV*av**  ***/* J ×10−19** | ***h = eV*av**  ***f***  **/ J s × 10−34** |
| red | 4.58 | 2.43 | 2.49 | 2.25 | 2.39 | 3.82 | 8.3 |
| green | 5.94 | 2.95 | 3.10 | 2.80 | 2.95 | 4.72 | 7.9 |
| blue | 6.98 | 3.50 | 3.25 | 5.38 |  |  |  |

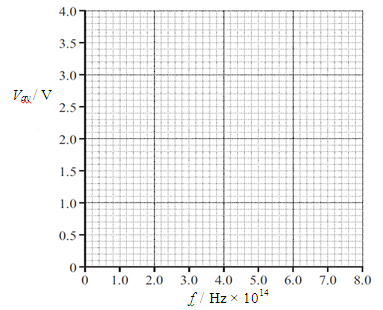
**Fig. 29.1**

1. The table in **Fig. 29.1** contains a recording error. Complete table **Fig. 29.1.**

Calculate the Planck constant *h* using this data with an estimate of its uncertainty and comment on your result.

*h* = ………………….. ± ……………….. J s **[4]**

1. Plot a suitable best fit linear graph *V*av against *f* on **Fig. 29.2.**

****

**Fig. 29.2**

Using the graph gradient and the equation ehfV=, make a further estimate for the Planck constant h with an estimate of the uncertainty.

*h* = ………………….. ± ……………….. J s **[4]**

1. Comment critically on your values for *h* and suggest how you might go about trying to improve the method or equipment used for this experiment.

……………………………………………………………………………………..

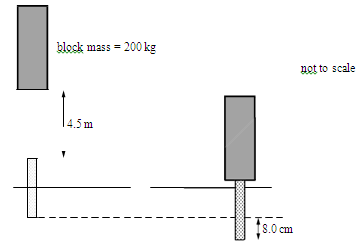
……………………………………………………………………………………..

…………………………………………………………………………………......

…………………………………………………………………………………......

………………………………………………………………………………. **[2]**

**10** This question is about driving a cylinder into the ground. A block of mass of 200 kg is released from rest at a height of 4.5 m above a steel cylinder already in the ground. The cylinder is driven into the ground a further 8.0 cm by the falling block. It is assumed that the mass of the block is far greater than that of the cylinder.

****

**Fig.1.1**

1. Calculate the change in potential energy of the block from release point to the point it comes to rest.

change in potential energy = …………..………. J **[2]**

**(b)** Use your answer to **(a)** to calculate the average force exerted on the block by the cylinder as it decelerates.

average force = …………..………. N **[2]**

**(c)** The process is repeated and the cylinder is pushed into the ground by a further 6.0 cm. Suggest and explain why the depth did **not** increase by 8.0 cm.

……………………………………………………………………………………………

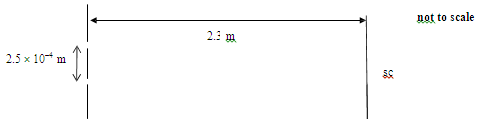
……………………………………………………………………………………………

……………………………………………………………………………………………

………………………………………………………………………………………  **[2]**

**11** This question is about different models of light.

A coherent beam of light passes through two slits and forms a pattern on a distant screen. The slit spacing is 2.5 x 10-4 m. The distance from the slits to the screen is 2.3 m.



**Fig. 4.1**

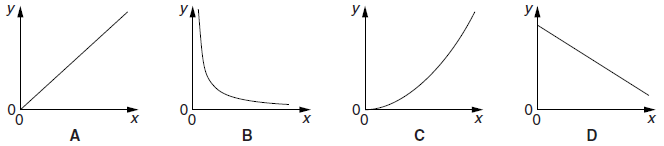
Explain what the term *coherent* means in this context.

…………………………………………………………………………………………….………

…………………………………………………………………………………………….………

………………………………………………………………………………………………. **[1]**

**12**

****

Which graph, **A**, **B**, **C** or **D**, is obtained when the *y-* and *x-* axes represent the two quantities given in each case below?

1. y-axis: the potential energy gained when an object is lifted a given height

x-axis: the mass of the object

........................................................... **[1]**

**(b)** y-axis: the distance moved by an object accelerating at a constant rate from rest

x-axis: the time for which the object has been accelerated

........................................................... **[1]**

**(c)** y-axis: the energy of a photon of electromagnetic radiation

x-axis: the wavelength of the radiation

........................................................... **[1]**

**13** An 11 W compact fluorescent lamp emits 45% of the input power as visible light.

**(a)** Calculate the energy of the visible light emitted in 1 second.

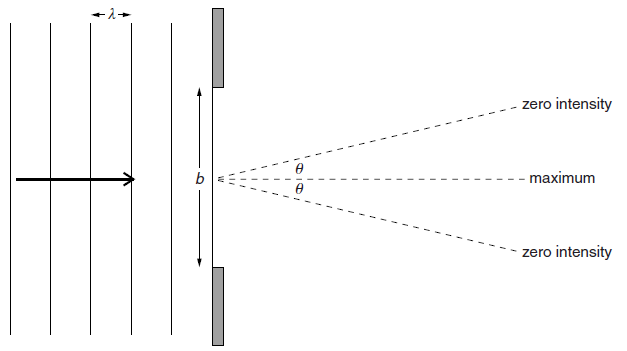
energy = ...................................................... J **[2]**

**(b)** Assuming that all the light is emitted at a frequency of 6.0 × 1014 Hz, calculate the number of photons of visible light emitted in one second.

Planck constant, *h* = 6.6 × 10–34 J s

number of photons = .......................................................... **[3]**

**14** When parallel waves of wavelength *λ* pass through a gap of width *b* as shown in **Fig. 5.1**, they spread out by diffraction. The intensity is a maximum in the forward direction, dropping away to zero intensity at an angle *θ* on each side.

****

**Fig. 5.1**

**(a)** Which one of the following changes to the wavelength *λ* and the gap spacing *b* would result in an increase of the angle *θ* ?

Put a tick (✓) in the correct box.

doubling λ and halving *b *

halving λ and doubling *b *

doubling λ and doubling *b *

halving λ and halving *b *

**[1]**

**(b)** The way in which the intensity varies can be explained in terms of phasors from each tiny part of the wavefront in the gap.

State how all these phasors together can produce zero intensity at the angle θ.

You may sketch phasor arrows in your answer if you wish.

**[1]**

**15** Here is a list of units.

kg m s–1 J s–1 kg m2 s–2 J m kg m s–2

**(a)** Which unit is equivalent to a watt? ............................................... **[1]**

**(b)** Which unit is equivalent to a newton? ............................................... **[1]**

**16** Which one of the following comparisons between red light of wavelength 650 nm and violet light of wavelength 400 nm is correct?

Put a tick (✓) in the box after the correct statement.

The red light has the higher frequency. 

The red light will diffract though a wider

angle when passing through a narrow slit. 

The red light travels slower in a vacuum. 

The interference maxima formed on a distant

screen by light passing through two narrow

slits will be closer together for red light. 

**[1]**

**17** An aircraft is in level flight through still air.

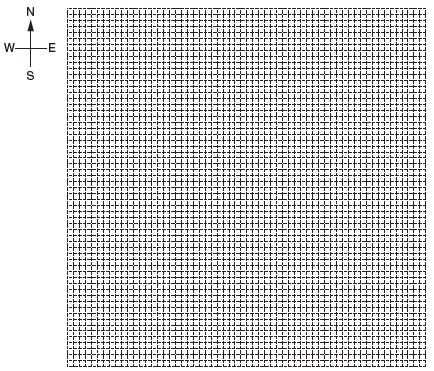
It has the following components of velocity:

north-south: 50 m s –1 towards the south

east-west: 35 m s–1 towards the east

**(a)** Using a suitable scale, draw these components on the grid below.

Hence or otherwise find the speed and direction of flight of the aircraft.

****

speed = ...................................................... m s–1

direction = ...................................................... **[4]**

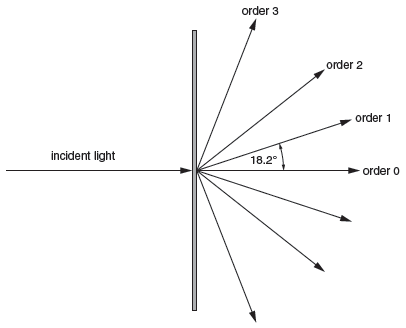
**(b)** A wind later acts upon the aircraft, changing the aircraft’s direction so that it travels due south.

Deduce the speed and direction of this wind.

speed = ...................................................... m s–1

direction = ...................................................... **[2]**

**18** Light of wavelength 590 nm is incident on a diffraction grating as shown in **Fig. 7.1**. Three orders of diffraction are produced.

****

**Fig. 7.1**

The first-order angle of diffraction is 18.2°.

**(a)** Show that the separation of lines in this grating is about 2 μm.

**[2]**

**(b)** Calculate the longest wavelength of light which will produce three orders of diffraction with this grating.

**[1]**

**[Total Marks: 50]**

**MARK SCHEME**

| **Question** | **Mks** | **Answer** | **Question Source and Guidance Notes** | **Topics** | **Demand** |
| --- | --- | --- | --- | --- | --- |
| **1** | 1 | B | *Q1 - GCE - Physics B - Specimen - H157/01* | Space, time and motion | L |
| **2** | 1 | D | *Q2 - GCE - Physics B - Specimen - H157/01* | Space, time and motion | M |
| **3** | 1 | B | *Q15 - GCE - Physics B - Specimen - H157/01* | Space, time and motion | L |
| **4** | 1 | D | *Q16 - GCE - Physics B - Specimen - H157/01* | Space, time and motion | H |
| **5** | 1 | D | *Q17 - GCE - Physics B - Specimen - H157/01* | Space, time and motion | M |
| **6** | 1 | B | *Q18 - GCE - Physics B - Specimen - H157/01* | Waves and quantum behaviour | L |
| **7** | 1 | D | *Q19 - GCE - Physics B - Specimen - H157/01* | Waves and quantum behaviour | M |
| **8** | 1 | A | *Q20 - GCE - Physics B - Specimen - H157/01* | Waves and quantum behaviour | H |
| **9(a)(i)** | 2 | 1 a sensitive ammeter in series with LED as V increased find the p.d. value when it starts conducting ✓  2 black-out and shaded vision tube to judge V value when visible light is first observed as V increased ✓ | *Q29(a)(i) - GCE - Physics B - Specimen - H157/01*  **accept** galvanometer or μA or mA meter  **accept** 1 & 2 either way round | Waves and quantum behaviour; Practical skills assessed in a written examination; Planning; Implementing | L,M,H |
| **9(a)(ii)** | 1 | fully functioning circuit with variable supply / potential divider, LED with voltmeter in parallel(if ammeter used must be in series ) ✓ | *Q29(a)(ii) - GCE - Physics B - Specimen - H157/01*  with series current limiting resistor good but  **NOT** a series variable resistor to control circuit |
| **9(b)(i)** | 4 | bottom line of table completed correctly ✓  h = 8.0 ± 0.3 x 10-34 Js ✓  estimate with uncertainty in range (0.2 to 0.5) x 10-34 Js ✓  anomaly of 5.38 identified in the table ✓ | *Q29(b)(i) - GCE - Physics B - Specimen - H157/01*  **allow** table    **allow** 1 S.F. estimates i.e. (8 or 9) x 10-34 Js  **allow** ecf if outlier counted in | Waves and quantum behaviour; Practical skills assessed in a written examination; Analysis; Evaluation | L,M,H |
| **9(b)(ii)** | 4 | points with uncertainties plotted by dot plot or ± bars ✓  extended best fit line, not through origin – see below ✓  V = hf/e → h =e xgradient / 1.6 x 10-19 x 0.41 x 10-14 ✓  h = (6.6 ± 0.3) x 10-34(Js) ✓ | *Q29(b)(ii) - GCE - Physics B - Specimen - H157/01*  **allow** ecf if outlier is used for a point  **allow** ecf if outlier used in best fit line  correct method attempted: algebra / numbers / words  **accept** uncertainties in range (0.2 to 0.5) x 10-34 (Js)  **NOT** ecf on use of outlier for evaluation mark |
|  |  |  | |  |  |
| **9(b)(iii)** | 2 | better value *h* from gradient of graph because: range includes *h*true or smaller ± uncertainty or more precise or effect of systematic error can be seen and eliminated✓  repeat and check linearity for more colours of LED or systematic error on voltmeter used of + 0.50 V due to graph intercept or check calibration of voltmeter or change voltmeter and repeat due to graph intercept ✓ | *Q29(b)(iii) - GCE - Physics B - Specimen - H157/01*  comment on *h*  suggestion for improvement | Waves and quantum behaviour; Practical skills assessed in a written examination; Analysis; Evaluation | L,M,H |
| **10(a)** | 2 | *mgΔh* = 4.58 x 9.8 x 200 ✓  = 8980 (J) ✓ | *Q1(a) - GCE - Physics B - Specimen - H157/02*  No sf penalty. | Space, time and motion | L |
| **10(b)** | 2 | Force = 8980/0.08 ✓  = 1.1(2) x 105 N ✓ | *Q1(b) - GCE - Physics B - Specimen - H157/02*  ecf from (a)  or equivalent | Space, time and motion | L,M |
| **10(c)** | 2 | Force acting on cylinder from ground has increased ✓  Sensible reason, e.g. increased friction, compression of soil. ✓ | *Q1(c) - GCE - Physics B - Specimen - H157/02*  Can gain second mark from discussing energy  transfer; if a greater force is acting on the cylinder  the same work is done over a shorter distance. AW | Space, time and motion | M |
| **11** | 1 | (light at both slits) has constant  phase relationship/difference ✓ | *Q4(a) - GCE - Physics B - Specimen - H157/02*  AW | Space, time and motion | H |
| **12(a)** | 1 | A | *Q2(a) - GCE - Physics B - June 2013 - G492/01* | Waves and quantum behaviour; Space, time and motion | L,M |
| **12(b)** | 1 | C | *Q2(b) - GCE - Physics B - June 2013 - G492/01* | Waves and quantum behaviour; Space, time and motion | L,M |
| **12(c)** | 1 | B | *Q2(c) - GCE - Physics B - June 2013 - G492/01* | Waves and quantum behaviour; Space, time and motion | L,M |
| **13(a)** | 2 | energy per second, *E* = 11 W × 0.45 = 4.95 J (1)m; (1)e | *Q4(a) - GCE - Physics B - June 2013 - G492/01*  **Allow** rounding to 4.9 or 5.0 J | Space, time and motion; Waves and quantum behaviour | L,M,H |
| **13(b)** | 3 | photon energy, *E* = *hf* = 6.6 × 10 -34 J s × 6.0× 10 14 Hz  = 3.96 × 10 -19 J (1)m (1)e  number of photons s -1 = 4.95 J/3.96 × 10 -19 J = 1.25 × 10 19 (1) | *Q4(b) - GCE - Physics B - June 2013 - G492/01*  **Allow** ecf from (a)  **Allow** use of **own** value for photon energy for the 3rd marking point as this mark is independent.  **Allow** rounding 1.2 or 1.3 × 10 19 | Space, time and motion; Waves and quantum behaviour | L,M,H |
| **14(a)** | 1 | 1st box (doubling λ and halving *b*) | *Q5(a) - GCE - Physics B - June 2013 - G492/01*  No marks if any extra tick present | Waves and quantum behaviour | M,H |
| **14(b)** | 1 | Added tip-to-tail they form a closed shape/they curl up and close | *Q5(b) - GCE - Physics B - June 2013 - G492/01*  **allow** a sketch of at least 3 similar arrows tip-to-tail.  **allow** other valid vector representations of zero resultant from at least 3 components | Waves and quantum behaviour | M,H |
| **15(a)** | 1 | J s -1 | *Q1(a) - GCE - Physics B - June 2014 - G492/01* | Space, time and motion | L |
| **15(b)** | 1 | kg m s -2 | *Q1(b) - GCE - Physics B - June 2014 - G492/01* | Space, time and motion | L |
| **16** | 1 | 2nd box and no others | *Q4 - GCE - Physics B - June 2014 - G492/01* | Waves and quantum behaviour | M |
| **17(a)** | 4 | speed: evidence of scale drawing or trig. / Pythagoras (1);  answer of 61 m s -1 (1);  direction: angle of 35 ° or 55° correctly indicated (1);  E of S (1) or equivalent, e.g. bearing 145 °; | *Q6(a) - GCE - Physics B - June 2014 - G492/01*  a bald 61 m s -1 gets both marks (±3 for scale drawing)  labelled angle on diagram in range 33 – 37 ° gets both marks  4th mark not awarded if no angle/incorrect angle given  ecf from speed | Space, time and motion | L,M |
| **17(b)** | 2 | 35 m s -1 (1);  (towards the) west or equivalent, e.g. bearing 270 °(1) | *Q6(b) - GCE - Physics B - June 2014 - G492/01*  (If wind not E-W, any southerlyish wind with westerly component of 35 m s -1 is acceptable) allow ecf from part (a) | Space, time and motion | M,H |
| **18(a)** | 2 | 1 × 590 × 10-9 m = *d* sin(18.2°)(1);  *d* = 590 × 10-9 m / sin(18.2°) = 1.89 × 10 -6 m (≈ 2 × 10 -6 m) (1)m; (1)e | *Q7(a) - GCE - Physics B - June 2014 - G492/01*  Watch for 590 × 10-9 m × sin(18.2°) = 1.84 × 10 -7 m which gets 0. | Waves and quantum behaviour | L,M |
| **18(b)** | 1 | largest θ = 90 ° / sin θ = 1  so λ =*d* sin θ /3 = 1.89 × 10 -6 m/3 = 630 nm | *Q7(b) - GCE - Physics B - June 2014 - G492/01*  *d* = 2 × 10 -6 m gives 667 nm | Waves and quantum behaviour | H |
| **Total** | **50** |  |  |  |  |

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