Y12 Open Book Assessment

Physics

This assessment will cover:

- Particles and Radiation
- Waves and Optics
- Mechanics and Materials
- Electricity

To carry out the assessment you will need:

- AS Physics Data and Formulae Sheet
- Calculator

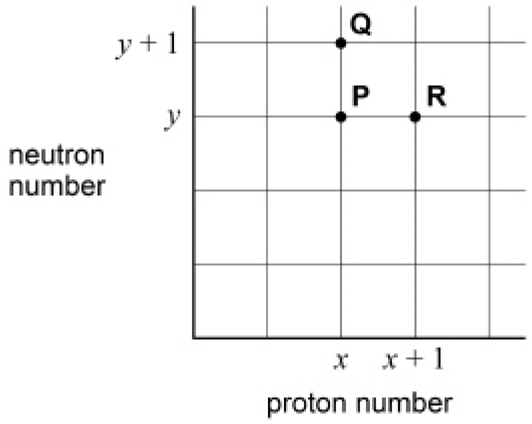
Time

The assessment should take 65 minutes

Submitting Answers

Please enter your name and answers in spreadsheet *Open Book Test Answer Grid.xlsx* and email to rgowers@dronfield.derbyshire.sch.uk

Q1. The graph of neutron number against proton number shows three nuclei **P**, **Q** and **R**.



Which row identifies an isotope of **P** and the nucleon number of this isotope of **P**?

	Isotope of P	**Nucleon number of isotope of P**
A	**Q**	$y + 1$
B	**Q**	$x + y + 1$
C	**R**	$x + y + 1$
D	**R**	$x + 1$

Q2. Fluoride ions are produced by the addition of a single electron to an atom of fluorine $^{19}_{9}F$.

What is the magnitude of specific charge of the fluoride ion?

A 3.2×10^{-26} C kg^{-1}

B 8.4×10^{-21} C kg^{-1}

C 5.0×10^{6} C kg^{-1}

D 4.5×10^{7} C kg^{-1}

Q3. $^{236}_{92}U$ undergoes a series of decays to produce $^{204}_{82}Pb$.

How many alpha decays are involved in this decay series?

A 5

B 6

C 8

D 10

Q4. The nucleus of ${}^{9}_{4}Be$ captures a proton and emits an α particle. What is the product nucleus?

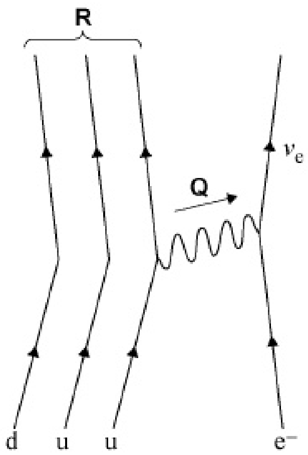
A ${}^{10}_{6}C$

B ${}^{7}_{3}Li$

C ${}^{6}_{3}Li$

D ${}^{6}_{2}He$

Q5. The partially completed diagram represents electron capture.



Which row identifies the exchange particle **Q** and the quark structure of particle **R**?

	Particle Q	Quark structure of particle R
A	W^-	uuu
B	W^+	dud
C	W^+	uuu
D	W^-	dud

Q6. The decay of a neutral kaon K^0 is given by the equation

$$K^0 \rightarrow X + Y + \bar{\nu}_e$$

What are X and Y?

	X and Y
A	e^+ and e^-
B	μ^+ and e^-
C	π^+ and e^-
D	π^- and e^+

Q7. Which equation shows the process of annihilation?

A $\pi^- + \pi \rightarrow \gamma$

B $p + \bar{p} \rightarrow \gamma + \gamma$

C $\beta^- + p \rightarrow \gamma$

D $\gamma + \gamma \rightarrow \beta^+ + \beta^-$

Q8. Which line correctly classifies the particle shown?

	Particle	**Category**	**Quark combination**
A	neutron	baryon	$\bar{u}d$
B	neutron	meson	udd
C	proton	baryon	uud
D	positive pion	meson	$\bar{u}d$

Q9. Electromagnetic radiation incident on a metal surface can cause electrons to be emitted.

Which of the following statements is correct?

A Every photon incident on the surface causes an electron to be emitted.

B All the emitted electrons have the same energy.

C The range of energy of the emitted electrons depends on the intensity of the radiation.

D If the incident radiation is of a single frequency, the number of electrons emitted per second increases if the intensity of the radiation increases.

Q10. Monochromatic radiation from a source of light (source A) is shone on to a metallic surface and electrons are emitted from the surface. When a second source (source B) is used no electrons are emitted from the metallic surface. Which property of the radiation from source A must be greater than that from source B?

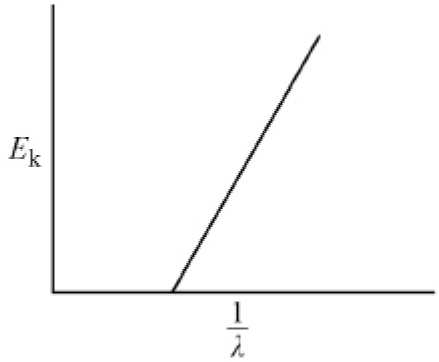
A amplitude

B frequency

C intensity

D wavelength

Q11. The graph shows how the maximum kinetic energy E_k of photoelectrons emitted from a metal surface varies with the reciprocal of the wavelength λ of the incident radiation.



What is the gradient of this graph?

A c

B h

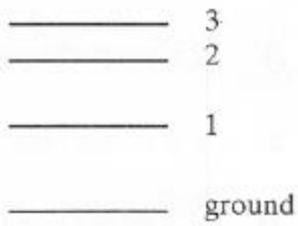
C hc

D $\frac{h}{c}$

Q12. The values of the lowest three energy levels in a particular atom are shown in the table.

The diagram shows these levels together with the ground state of the atom.

Level	Energy/eV
3	−0.85
2	−1.51
1	−3.39



When an electron moves from level 3 to level 1, radiation of frequency 6.2×10^{14} Hz is emitted.

What is the frequency of the radiation emitted when an electron moves from level 2 to level 1?

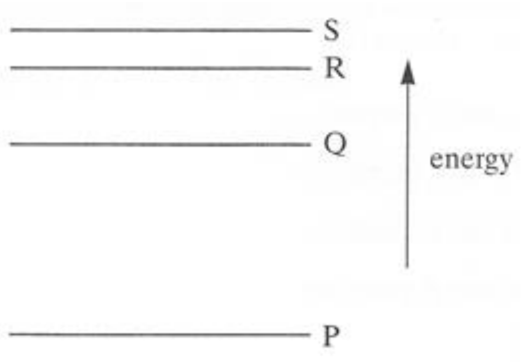
A 2.3×10^{14} Hz

B 3.5×10^{14} Hz

C 4.6×10^{14} Hz

D 8.3×10^{14} Hz

Q13. The diagram shows the four lowest energy levels for an electron in an atom. P, Q, R and S represent, to scale, the relative energy values of these energy levels.



An electron transition from level R to level Q is accompanied by the emission of a photon of visible light.

Which electron transition would be accompanied by the emission of a photon of infrared radiation?

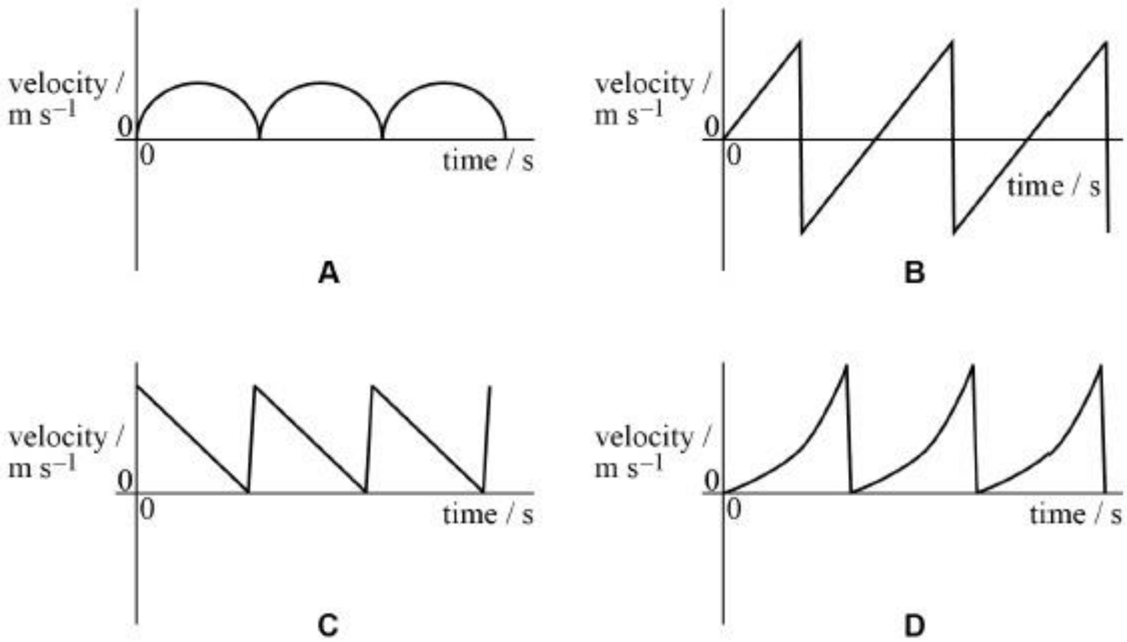
A S to R

B S to Q

C Q to P

D R to P

Q14. Which graph best represents the velocity–time graph for a ball that is dropped from rest and bounces repeatedly?



Q15. Two identical balls, **X** and **Y**, are at the same height and a horizontal distance of 25 cm apart.

X is projected horizontally with a velocity of 0.10 m s^{-1} towards **Y** at the same time that **Y** is released from rest. Both **X** and **Y** move freely in the absence of air resistance.

What is the distance between the balls 1.0 s later?

A 0.15 m

B 0.25 m

C 2.4 m

D 4.9 m

Q16. What is a correct unit for the area under a force−time graph?

A N m

B kg m s^{-1}

C kg m s^{-2}

D N s^{-1}

Q17. Which row correctly states whether momentum, mass and velocity are scalar or vector quantities?

	Momentum	**Mass**	**Velocity**
A	scalar	scalar	vector
B	vector	scalar	scalar
C	scalar	vector	scalar
D	vector	scalar	vector

Q18. A bullet of mass 10 g is fired with a velocity of 100 m s^{-1} from a stationary rifle of mass 4.0 kg. Consider the rifle and bullet to be an isolated system.

What are the recoil velocity of the rifle and the total momentum of the rifle and bullet just after firing?

	Recoil velocity / m s^{-1}	**Total momentum / kg m s^{-1}**
A	0.25	0
B	0.25	1.0
C	0.40	0
D	0.40	1.0

Q19. Immediately after take-off from the surface of the Earth, a rocket of mass 12 000 kg accelerates vertically upwards at 1.4 m s^{-2}

What is the thrust produced by the rocket motor?

A 1.7×10^4 N

B 1.0×10^5 N

C 1.3×10^5 N

D 1.6×10^5 N

Q20. Two spheres, **P** and **Q**, have the same volume but **P** has a greater mass. The spheres fall in air at their terminal velocities v_P and v_Q respectively.

Which row states the relationship between v_P and v_Q and the reason?

	Relationship between v_P and v_Q	**Reason**
A	$v_P = v_Q$	Terminal velocity is unaffected by mass
B	$v_Q > v_P$	The mass of **Q** is less and it accelerates more
C	$v_Q > v_P$	**P** reaches equilibrium at a lower terminal velocity
D	$v_P > v_Q$	**Q** reaches equilibrium at a lower terminal velocity

Q21.

A girl is bouncing on a trampoline.

Assuming that air resistance is negligible, her acceleration

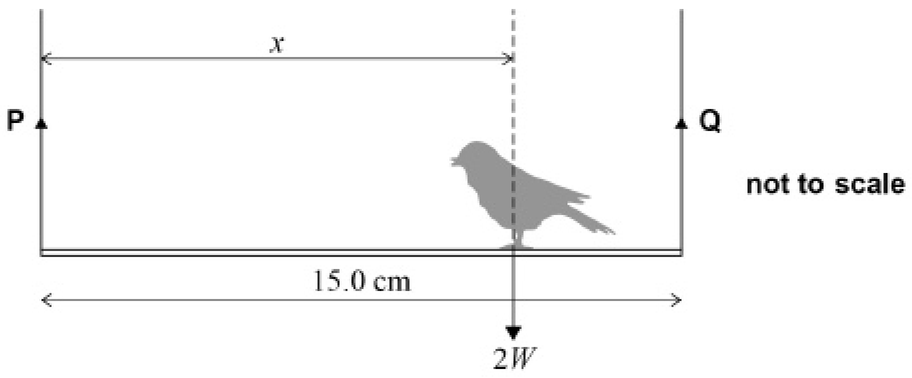
A is zero when she is at maximum height.

B is constant when she is in the air.

C changes direction as she rises and then falls.

D is maximum just before she lands on the trampoline.

Q22. A bird sits on a uniform rod suspended from vertical wires **P** and **Q**.



The rod has a weight W and is 15.0 cm long.
The weight of the bird is $2W$ and acts at a distance x from **P**.

What is the value of x when the tension in **P** is half the tension in **Q**?

A 7.50 cm

B 10.0 cm

C 11.3 cm

D 15.0 cm

Q23. Which list puts the forces in order of increasing magnitude?

A 2 pN < 2 fN < 2 TN < 2 GN

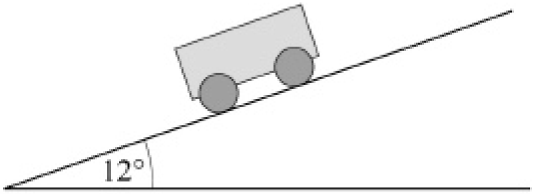
B 2 pN < 2 fN < 2 GN < 2 TN

C 2 fN < 2 pN < 2 TN < 2 GN

D 2 fN < 2 pN < 2 GN < 2 TN

Q24. A car's engine produces a useful output power of 6.5×10^4 W

The car of mass 950 kg is moving up a hill at a steady speed.
The slope of the hill is 12° to the horizontal. Resistive forces on the car are negligible.



What is the steady speed of the car?

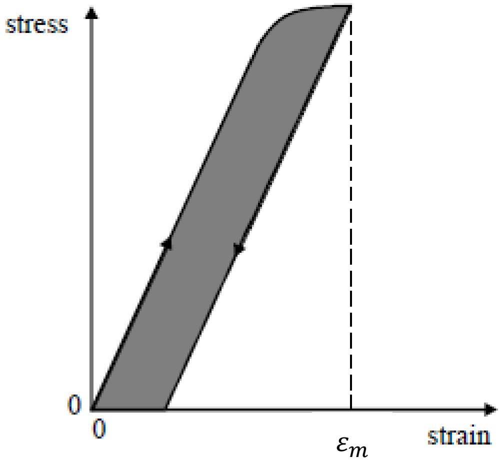
A 7.0 m s^{-1}

B 12 m s^{-1}

C 34 m s^{-1}

D 68 m s^{-1}

Q25. The graph shows the variation of stress with strain for a ductile alloy when a specimen is slowly stretched to a maximum strain of ε_m and the stress is then slowly reduced to zero.



The shaded area

A represents the work done per unit volume when stretching the specimen

B represents the energy per unit volume recovered when the stress is removed

C represents the energy per unit volume which cannot be recovered

D has units of J m^{-1}

Q26. A sample of wire has a Young modulus E. A second sample of wire made from an identical material has three times the length and half the diameter of the first sample.

What is the Young modulus of the second sample of wire in terms of E?

A $0.25E$

B E

C $6E$

D $12E$

Q27. What is the name given to a material that breaks without deformation when a force is applied to it?

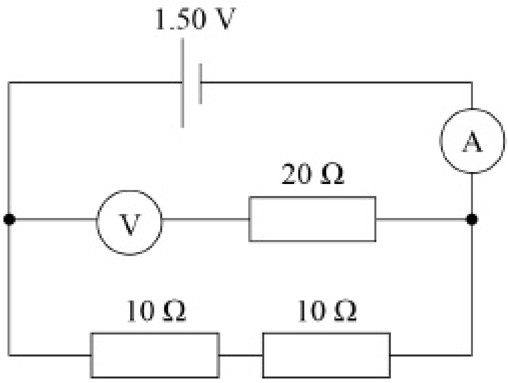
A Plastic

B Brittle

C Stiff

D Elastic

Q28. The circuit shows a cell with negligible internal resistance connected in a circuit with three resistors, an ammeter and a voltmeter.

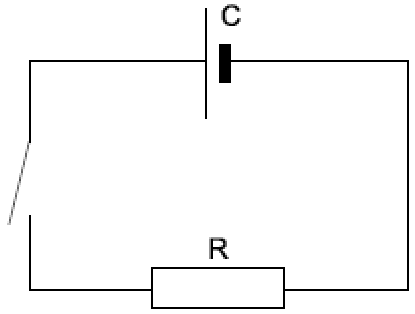


Which row shows the readings on the ammeter and voltmeter?

	Current / A	Voltage / V
A	0.075	0.75
B	0.075	1.50
C	0.150	0.75
D	0.150	1.50

Q29. A cell C of negligible resistance and a switch are in series with a resistor R. The switch is moved to the on (closed) position for a time *t*.

Which change reduces the amount of charge flowing through R in time *t*?



A add an identical cell in parallel with C

B add an identical cell in series with C

C add a second resistor in series with R

D add a second resistor in parallel with R

Q30. A mobile phone operates at a constant power of 200 mW
It has a 3.7 V lithium-ion battery that has a charge capacity of 9400 C

What is the time taken for the battery to discharge completely?

A 2 hours

B 48 hours

C 120 hours

D 140 hours

Q31.
A voltmeter is used to measure potential difference for a component **X**.

Which row gives the position and ideal resistance for the voltmeter?

	Position	Ideal resistance
A	in series with X	infinite
B	in series with X	zero
C	in parallel with X	infinite
D	in parallel with X	zero

Q32. A student carries out an experiment to determine the resistivity of a metal wire.
She determines the resistance from measurements of potential difference between the ends of the wire and the corresponding current. She measures the length of the wire with a ruler and the diameter of the wire using a micrometer. Each measurement is made with an uncertainty of 1%

Which measurement gives the largest uncertainty in the calculated value of the resistivity?

A current

B diameter

C length

D potential difference

Q33. A wire has a resistance R.

What is the resistance when both the length and radius of the wire are doubled?

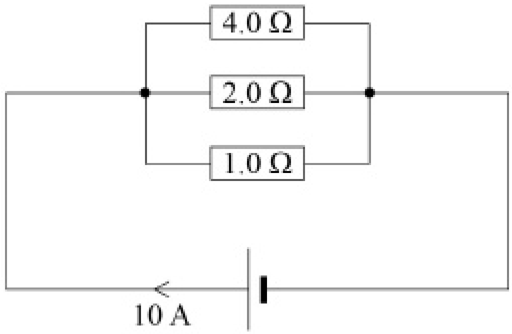
A $\frac{R}{4}$

B $\frac{R}{2}$

C $2R$

D $4R$

Q34. The current in the cell is 10 A as shown.



What is the current in the 2.0 Ω resistor?

A 0.35 A

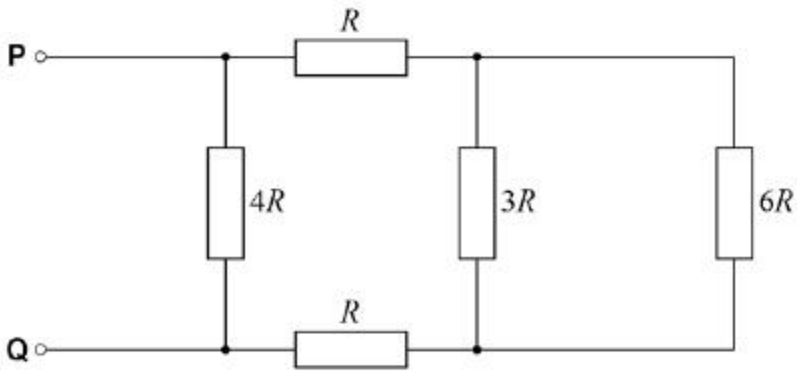
B 2.86 A

C 3.50 A

D 7.14 A

Q35. The diagram shows a network of resistors connected between the terminals **P** and **Q**.

The resistance of each resistor is shown.



What is the effective resistance between **P** and **Q**?

A R

B $2R$

C $3R$

D $4R$

Q36. Which statement about superconductors is correct?

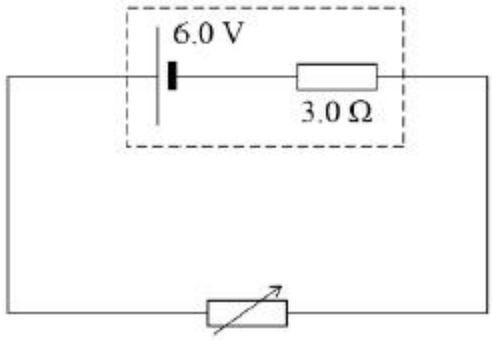
A When a material becomes a superconductor, its resistivity is almost zero.

B The temperature at which a material becomes a superconductor is called the critical temperature.

C When current passes through a superconductor the pd across it becomes a maximum.

D Copper is a superconductor at room temperature.

Q37. The cell in the following circuit has an emf (electromotive force) of 6.0 V and an internal resistance of 3.0 Ω. The resistance of the variable resistor is set to 12 Ω.



How much electrical energy is converted into thermal energy **within the cell** in 1 minute?

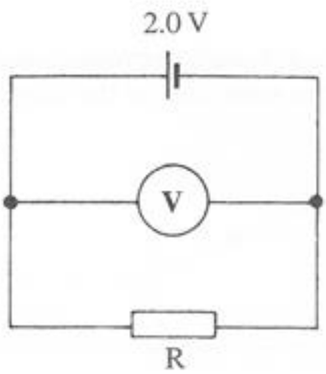
A 0.48 J

B 29 J

C 45 J

D 144 J

Q38. The cell in the following circuit has an emf of 2.0 V and an internal resistance of 1.0 Ω.



The digital voltmeter reads 1.6 V. What is the resistance of R?

A 0.4 Ω

B 1.0 Ω

C 2.0 Ω

D 4.0 Ω

Q39. Two points on a progressive wave have a phase difference of $\frac{\pi}{6}$ rad
The speed of the wave is 340 m s^{-1}

What is the frequency of the wave when the minimum distance between the two points is 0.12m?

A 240 Hz

B 470 Hz

C 1400 Hz

D 2800 Hz

Q40. Which row correctly shows electromagnetic radiations in order of decreasing wavelength?

A gamma > ultraviolet > microwave

B ultraviolet > gamma > microwave

C microwave > ultraviolet > gamma

D gamma > microwave > ultraviolet

Q41. Which row shows the change in velocity, frequency and wavelength of an electromagnetic wave as it travels from an optically less dense to an optically more dense medium?

	Velocity	**Frequency**	**Wavelength**
A	decreases	decreases	unchanged
B	increases	unchanged	increases
C	decreases	unchanged	decreases
D	increases	increases	unchanged

Q42. Which of the following statements about the behaviour of waves is **incorrect**?

A All waves can be diffracted.

B All waves can be made to undergo superposition.

C All waves can be refracted.

D All waves can be polarised.

Q43. Two radio transmitters emit waves at a frequency of 1.4 MHz. A stationary wave is set up between the two transmitters due to the superposition of the radio waves.

What is the minimum distance between two nodes in the stationary wave?

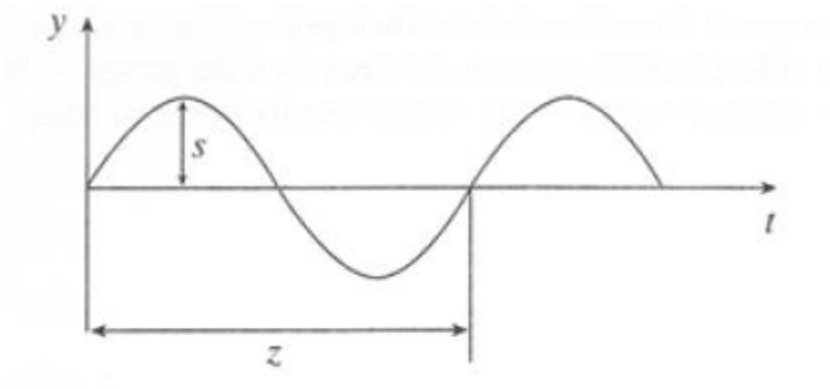
A 107 m

B 214 m

C 428 m

D 857 m

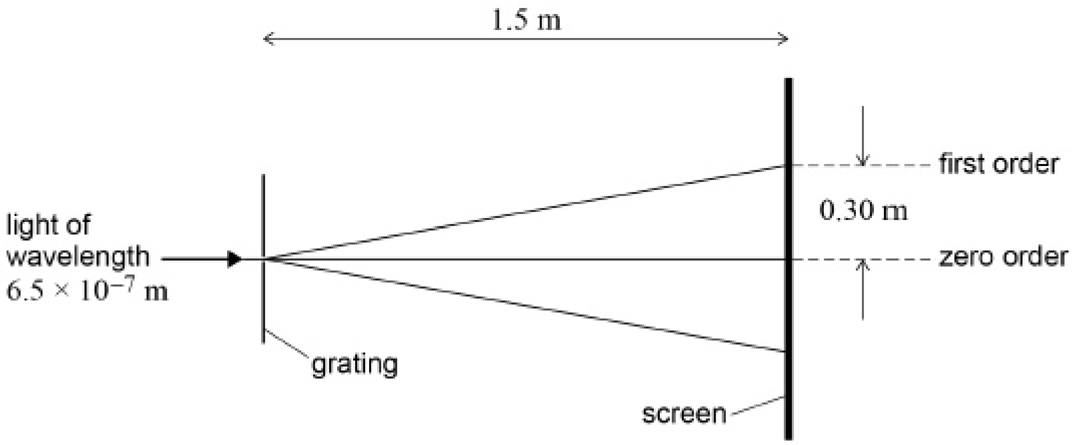
Q44. For waves on a water surface, the following graph shows how the displacement *y* of a water particle in the surface varies with the time *t*.



What are the quantities ***z*** and ***s***?

	z	***s***
A	frequency	amplitude
B	period	half-amplitude
C	wavelength	half-amplitude
D	period	amplitude

Q45. A diffraction grating is illuminated normally with light of wavelength 6.5×10^{-7} m
When a screen is 1.5 m from the grating, the distance between the zero and first-order maxima on the screen is 0.30 m



What is the number of lines per mm of the diffraction grating?

A 3.3×10^{-6}

B 3.3×10^{-3}

C 3.0×10^{2}

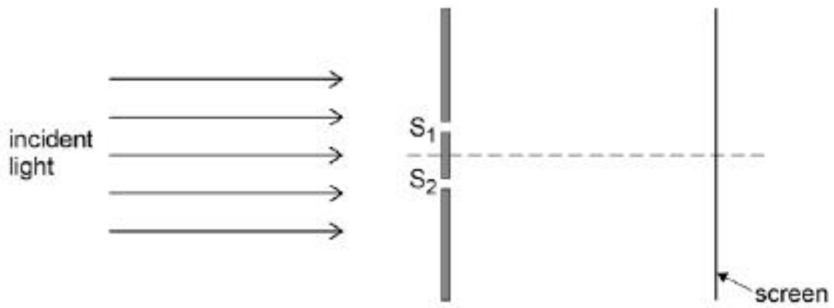
D 3.0×10^{5}

Q46. Intensity maxima are produced on a screen when a parallel beam of monochromatic light is incident on a diffraction grating. Light of a longer wavelength can be used or the distance from the diffraction grating to the screen can be increased.

Which row gives the change in appearance of the maxima when these changes are made independently?

	Longer wavelength	**Distance from grating to screen increased**
A	closer together	more widely spaced
B	more widely spaced	more widely spaced
C	more widely spaced	closer together
D	closer together	closer together

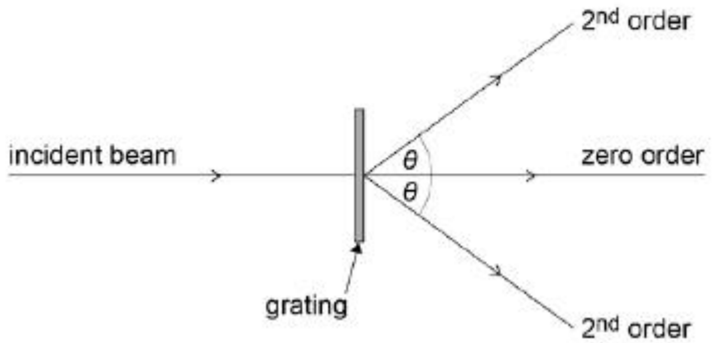
Q47. When a parallel beam of monochromatic light is directed at two narrow slits, S_1 and S_2, interference fringes are observed on a screen.



Which line in the table gives the changes that will increase the spacing of the fringes?

	Slit spacing	Distance from slits to screen
A	halved	halved
B	halved	doubled
C	doubled	halved
D	doubled	doubled

Q48. A parallel beam of monochromatic light is directed normally at a plane transmission grating which has N slits per metre. The second order diffracted beam is at angle θ to the zero order transmitted beam.



The grating is then replaced by a plane transmission grating which has $2N$ slits per metre.

Which one of the following statements is correct?

A With the first grating, the first order beam is at angle 0.5θ to the zero order transmitted beam.

B With the second grating, the first order beam is at angle 0.5θ to the zero order transmitted beam.

C With the second grating, the first order beam is at angle θ to the zero order transmitted beam.

D With the second grating, the second order beam is at angle θ to the zero order transmitted beam.

Q49. What is the speed of light in glass of refractive index 1.42?

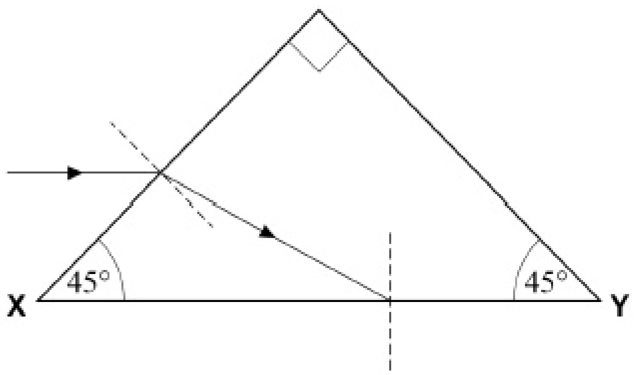
A 4.26×10^{7} m s^{-1}

B 2.11×10^{8} m s^{-1}

C 3.00×10^{8} m s^{-1}

D 4.73×10^{8} m s^{-1}

Q50. The diagram shows part of the path of a ray of light through a right-angled prism.



The prism is made of glass of refractive index 1.5
The incident light ray is parallel to the face **XY**. The ray is refracted towards the face **XY**.

What is the path of the ray after it is incident on face **XY**?