H

Exam Question Practice

Section 1 — Multiple Choice Questions for UNIT 1 - DYNAMIC UNIVERSE

DATA SHEET

COMMON PHYSICAL QUANTITIES

Quantity	*Symbol*	*Value*	*Quantity*	*Symbol*	*Value*
Speed of light in vacuum	c	$3{\cdot}00 \times 10^{8}\ \mathrm{m\,s^{-1}}$	Planck's constant	h	$6{\cdot}63 \times 10^{-34}\ \mathrm{J\,s}$
Magnitude of the charge on an electron	e	$1{\cdot}60 \times 10^{-19}\ \mathrm{C}$	Mass of electron	m_e	$9{\cdot}11 \times 10^{-31}\ \mathrm{kg}$
Universal Constant of Gravitation	G	$6{\cdot}67 \times 10^{-11}\ \mathrm{m^3\,kg^{-1}\,s^{-2}}$	Mass of neutron	m_n	$1{\cdot}675 \times 10^{-27}\ \mathrm{kg}$
Gravitational acceleration on Earth	g	$9{\cdot}8\ \mathrm{m\,s^{-2}}$	Mass of proton	m_p	$1{\cdot}673 \times 10^{-27}\ \mathrm{kg}$
Hubble's constant	H_0	$2{\cdot}3 \times 10^{-18}\ \mathrm{s^{-1}}$			

REFRACTIVE INDICES

The refractive indices refer to sodium light of wavelength 589 nm and to substances at a temperature of 273 K.

Substance	*Refractive index*	*Substance*	*Refractive index*
Diamond	2·42	Water	1·33
Crown glass	1·50	Air	1·00

SPECTRAL LINES

Element	*Wavelength*/nm	*Colour*
Hydrogen	656	Red
	486	Blue-green
	434	Blue-violet
	410	Violet
	397	Ultraviolet
	389	Ultraviolet
Sodium	589	Yellow

Element	*Wavelength*/nm	*Colour*
Cadmium	644	Red
	509	Green
	480	Blue

Lasers

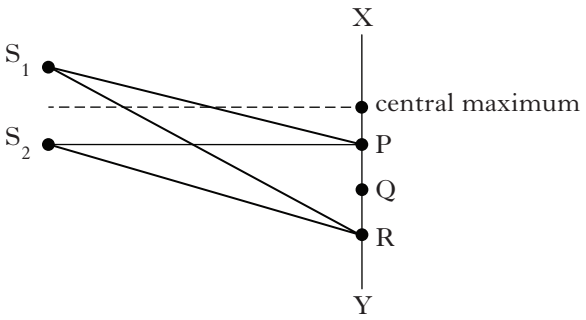
Element	*Wavelength*/nm	*Colour*
Carbon dioxide	9550, 10590	Infrared
Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	*Density*/kg m^{-3}	*Melting Point*/K	*Boiling Point*/K
Aluminium	$2{\cdot}70 \times 10^{3}$	933	2623
Copper	$8{\cdot}96 \times 10^{3}$	1357	2853
Ice	$9{\cdot}20 \times 10^{2}$	273	. . . .
Sea Water	$1{\cdot}02 \times 10^{3}$	264	377
Water	$1{\cdot}00 \times 10^{3}$	273	373
Air	1·29	. . . .	. . . .
Hydrogen	$9{\cdot}0 \times 10^{-2}$	14	20

The gas densities refer to a temperature of 273 K and a pressure of $1{\cdot}01 \times 10^{5}$ Pa.

9. S_1 and S_2 are sources of coherent waves. An interference pattern is obtained between X and Y.



The first order maximum occurs at P, where $S_1P = 200$ mm and $S_2P = 180$ mm.

For the third order maximum, at R, the path difference ($S_1R - S_2R$) is

A 20 mm

B 30 mm

C 40 mm

D 50 mm

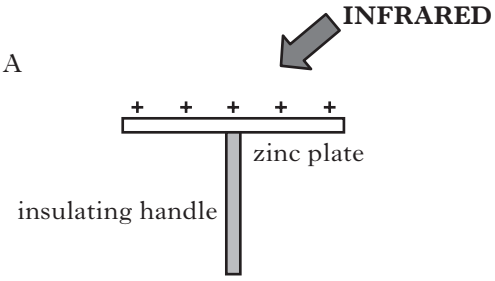
E 60 mm.

10. Clean zinc plates are mounted on insulating handles and then charged.

Different types of electromagnetic radiation are now incident on the plates as shown.

Which of the zinc plates is most likely to discharge due to photoelectric emission?

A



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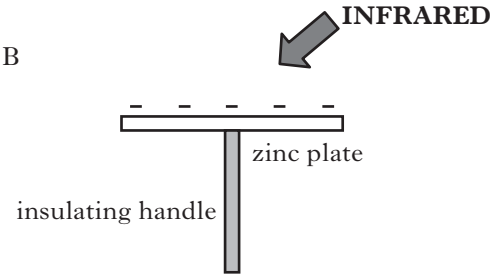

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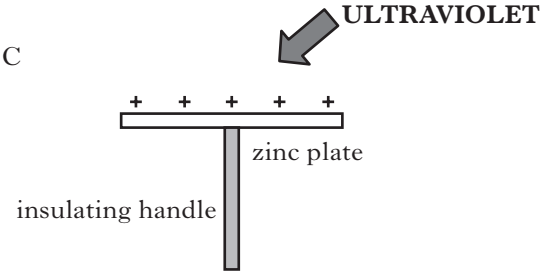

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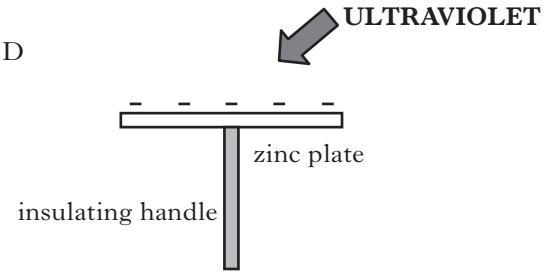
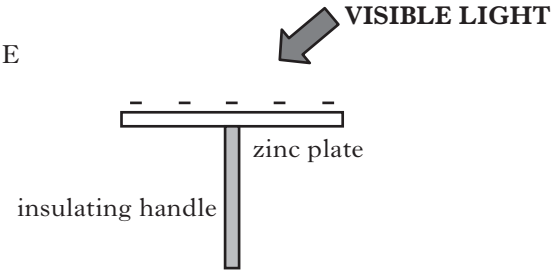


E



11. Electromagnetic radiation of frequency $9{\cdot}0 \times 10^{14}$ Hz is incident on a clean metal surface.

The work function of the metal is $5{\cdot}0 \times 10^{-19}$ J.

The maximum kinetic energy of a photoelectron released from the metal surface is

A $1{\cdot}0 \times 10^{-19}$ J

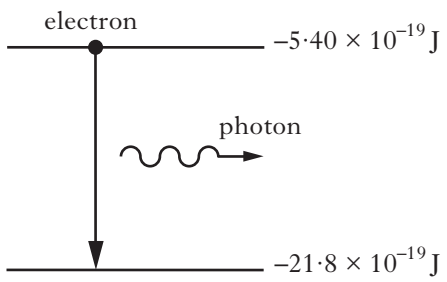
B $4{\cdot}0 \times 10^{-19}$ J

C $5{\cdot}0 \times 10^{-19}$ J

D $6{\cdot}0 \times 10^{-19}$ J

E $9{\cdot}0 \times 10^{-19}$ J.

12. In an atom, a photon of radiation is emitted when an electron makes a transition from a higher energy level to a lower energy level as shown.



The wavelength of the radiation emitted due to an electron transition between the two energy levels shown is

A $1{\cdot}2 \times 10^{-7}$ m

B $7{\cdot}3 \times 10^{-8}$ m

C $8{\cdot}2 \times 10^{6}$ m

D $1{\cdot}4 \times 10^{7}$ m

E $2{\cdot}5 \times 10^{15}$ m.

13. Which of the following statements describes a spontaneous nuclear fission reaction?

A $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{144}_{56}Ba + ^{90}_{36}Kr + 2\,^{1}_{0}n$

B $^{7}_{3}Li + ^{1}_{1}H \rightarrow ^{4}_{2}He + ^{4}_{2}He$

C $^{3}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$

D $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ^{4}_{2}He$

E $^{216}_{84}Po \rightarrow ^{216}_{84}Po + \gamma$

14. The statement below represents a nuclear reaction.

$$^{3}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$$

The total mass on the left hand side is $8{\cdot}347 \times 10^{-27}$ kg.

The total mass on the right hand side is $8{\cdot}316 \times 10^{-27}$ kg.

The energy released during one nuclear reaction of this type is

A $9{\cdot}30 \times 10^{-21}$ J

B $2{\cdot}79 \times 10^{-12}$ J

C $7{\cdot}51 \times 10^{-10}$ J

D $1{\cdot}50 \times 10^{-9}$ J

E $2{\cdot}79 \times 10^{15}$ J.

15. Which of the following lists the particles in order of size from smallest to largest?

A helium nucleus; electron; proton

B helium nucleus; proton; electron

C proton; helium nucleus, electron

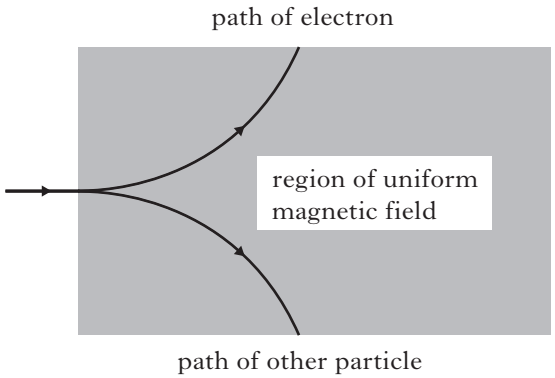
D electron; helium nucleus, proton

E electron; proton; helium nucleus

[Turn over

16. An electron and another particle of identical mass pass through a uniform magnetic field.

Their paths are shown in the diagram.



This observation provides evidence for the existence of

A neutrinos

B antimatter

C quarks

D protons

E force mediating particles.

10. Three students each make a statement about antiparticles.

I An antiparticle has the same mass as its equivalent particle.

II An antiparticle has the same charge as its equivalent particle.

III Every elementary particle has a corresponding antiparticle.

Which of the statements is/are correct?

A I only

B II only

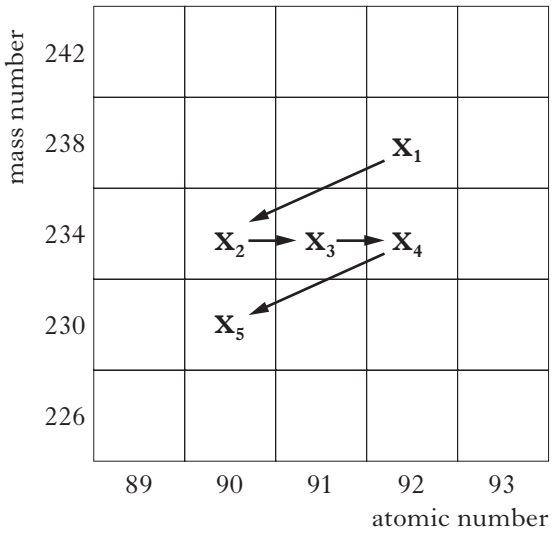
C I and III only

D II and III only

E I, II and III

12. Part of a radioactive decay series is shown in the diagram.

The symbols $\mathbf{X_1}$ to $\mathbf{X_5}$ represent nuclides in this series.



A student makes the following statements about the decay series.

I Nuclides $\mathbf{X_2}$ and $\mathbf{X_3}$ contain the same number of protons.

II Nuclide $\mathbf{X_1}$ decays into nuclide $\mathbf{X_2}$ by emitting an alpha particle.

III Nuclide $\mathbf{X_3}$ decays into nuclide $\mathbf{X_4}$ by emitting a beta particle.

Which of these statements is/are correct?

A I only

B II only

C III only

D II and III only

E I, II and III

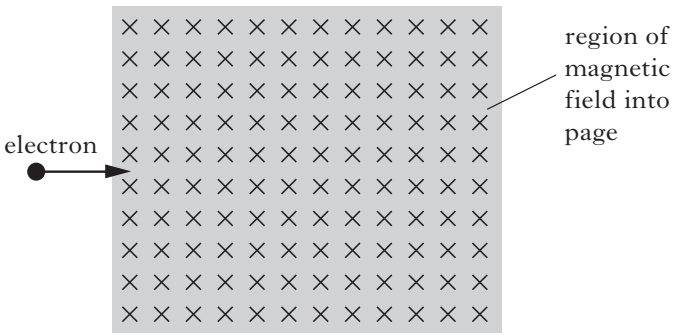
13. Ultraviolet radiation causes the emission of photoelectrons from a zinc plate.

The irradiance of the ultraviolet radiation on the zinc plate is increased.

Which row in the table shows the effect of this change?

	Maximum kinetic energy of a photoelectron	*Number of photoelectrons emitted per second*
A	increases	no change
B	no change	increases
C	no change	no change
D	increases	increases
E	decreases	increases

9. An electron enters a region of magnetic field as shown.



The direction of the force exerted by the magnetic field on the electron as it enters the field is

A to the left

B into the page

C out of the page

D towards the top of the page

E towards the bottom of the page.

15. Light travels from air into glass.

Which row in the table describes what happens to the speed, frequency and wavelength of the light?

	Speed	*Frequency*	*Wavelength*
A	increases	decreases	stays constant
B	decreases	stays constant	decreases
C	stays constant	decreases	decreases
D	increases	stays constant	increases
E	decreases	decreases	stays constant

16. The irradiance of light can be measured in

A W

B $W\,m^{-1}$

C W m

D $W\,m^{-2}$

E $W\,m^{2}$.

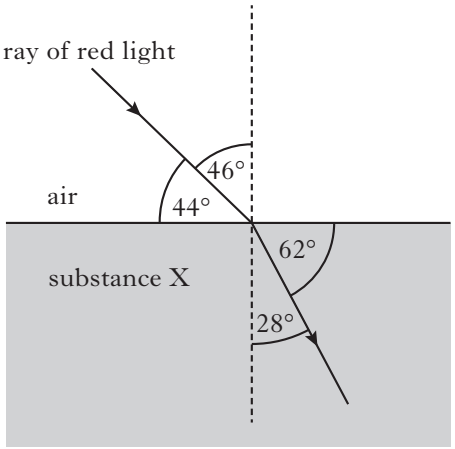
10. An isotope of uranium decays into an isotope of protactinium in two stages as shown.

$$^{238}_{92}U \xrightarrow[\text{stage 1}]{} {}^{234}_{90}Th \xrightarrow[\text{stage 2}]{} {}^{234}_{91}Pa$$

Which row in the table identifies the radiations which must be emitted at each stage?

	stage 1	*stage 2*
A	alpha	gamma
B	beta	gamma
C	gamma	beta
D	beta	alpha
E	alpha	beta

13. The diagram shows the path of a ray of red light as it passes from air into substance X.



The critical angle for the light in substance X is

A 32°

B 41°

C 45°

D 52°

E 90°.

14. The irradiance of light from a point source is 160 units at a distance of 0·50 m from the source.

At a distance 2·0 m from this source, the irradiance is

A 160 units

B 80 units

C 40 units

D 10 units

E 5 units.

11. The following statement represents a fission reaction.

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{139}_{57}\text{La} + ^{95}_{42}\text{Mo} + 2\,^{1}_{0}\text{n} + 7\,^{0}_{-1}e$$

The total mass of the particles before the reaction is $391{\cdot}848 \times 10^{-27}$ kg.

The total mass of the particles after the reaction is $391{\cdot}478 \times 10^{-27}$ kg.

The energy released in this reaction is

A $3{\cdot}53 \times 10^{-8}$ J

B $3{\cdot}52 \times 10^{-8}$ J

C $3{\cdot}33 \times 10^{-11}$ J

D $1{\cdot}67 \times 10^{-11}$ J

E $1{\cdot}11 \times 10^{-19}$ J.

12. The spectrum of white light from a filament lamp may be viewed using a prism or a grating.

A student, asked to compare the spectra formed by the two methods, makes the following statements.

I The prism produces a spectrum by refraction and the grating produces a spectrum by interference.

II The spectrum formed by the prism consists of all the wavelengths present in the white light and the spectrum formed by the grating consists of only a few specific wavelengths.

III The prism produces a single spectrum and the grating produces more than one spectrum.

Which of the statements is/are correct?

A I only

B II only

C I and II only

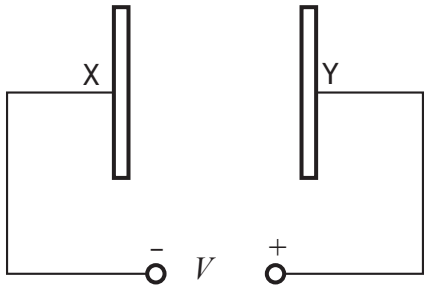
D I and III only

E I, II and III

9. The emission of beta particles in radioactive decay is evidence for the existence of

A quarks
B electrons
C gluons
D neutrinos
E bosons.

10. Two parallel metal plates X and Y in a vacuum have a potential difference V across them.



An electron of charge e and mass m, initially at rest, is released from plate X.
The speed of the electron when it reaches plate Y is given by

A $\frac{2eV}{m}$

B $\sqrt{\frac{2eV}{m}}$

C $\sqrt{\frac{2V}{em}}$

D $\frac{2V}{em}$

E $\frac{2mV}{e}$

12. The following statement describes a fusion reaction.

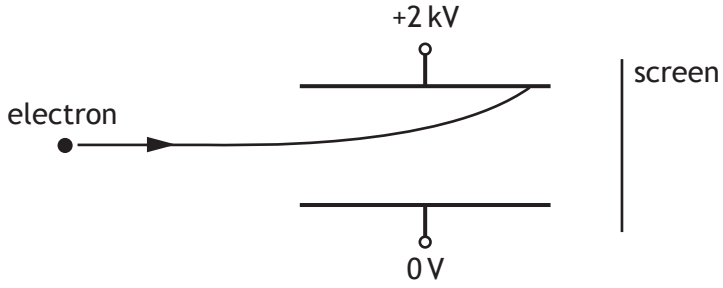
$$^{2}_{1}\text{H} + ^{2}_{1}\text{H} \rightarrow ^{3}_{2}\text{He} + ^{1}_{0}\text{n} + \text{energy}$$

The total mass of the particles before the reaction is $6{\cdot}684 \times 10^{-27}$ kg.
The total mass of the particles after the reaction is $6{\cdot}680 \times 10^{-27}$ kg.
The energy released in the reaction is

A $6{\cdot}012 \times 10^{-10}$ J
B $6{\cdot}016 \times 10^{-10}$ J
C $1{\cdot}800 \times 10^{-13}$ J
D $3{\cdot}600 \times 10^{-13}$ J
E $1{\cdot}200 \times 10^{-21}$ J.

11. A potential difference of 2 kV is applied across two metal plates.

An electron passes between the metal plates and follows the path shown.



A student makes the following statements about changes that could be made to allow the electron to pass between the plates and reach the screen.

I Increasing the initial speed of the electron could allow the electron to reach the screen.

II Increasing the potential difference across the plates could allow the electron to reach the screen.

III Reversing the polarity of the plates could allow the electron to reach the screen.

Which of these statements is/are correct?

A I only

B II only

C III only

D I and II only

E I and III only

14. An experiment is carried out to measure the wavelength of red light from a laser.

The following values for the wavelength are obtained.

650 nm 640 nm 635 nm 648 nm 655 nm

The mean value for the wavelength and the approximate random uncertainty in the mean is

A (645 ± 1) nm

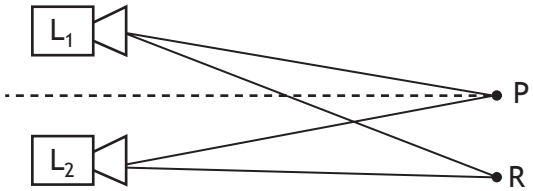
B (645 ± 4) nm

C (646 ± 1) nm

D (646 ± 4) nm

E (3228 ± 20) nm.

13. Two identical loudspeakers, L_1 and L_2, are operated at the same frequency and in phase with each other. An interference pattern is produced.



At position P, which is the same distance from both loudspeakers, there is a maximum.

The next maximum is at position R, where $L_1R = 5{\cdot}6\,\text{m}$ and $L_2R = 5{\cdot}3\,\text{m}$.

The speed of sound in air is $340\,\text{m}\,\text{s}^{-1}$.

The frequency of the sound emitted by the loudspeakers is

A $8{\cdot}8 \times 10^{-4}\,\text{Hz}$

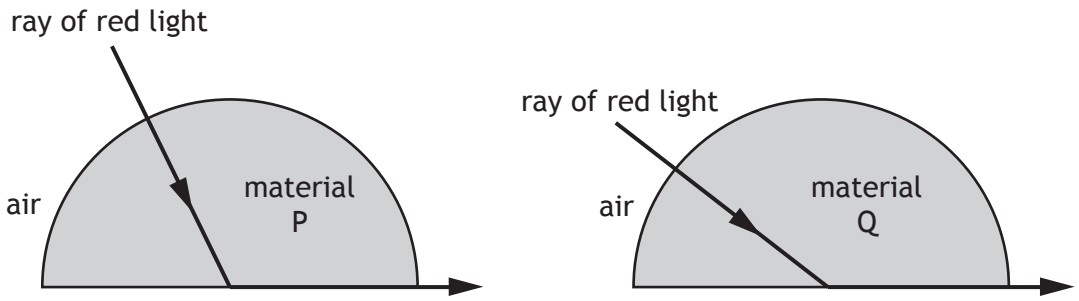
B $3{\cdot}1 \times 10^{1}\,\text{Hz}$

C $1{\cdot}0 \times 10^{2}\,\text{Hz}$

D $1{\cdot}1 \times 10^{3}\,\text{Hz}$

E $3{\cdot}7 \times 10^{3}\,\text{Hz}$.

15. Red light is used to investigate the critical angle of two materials P and Q.



A student makes the following statements.

I Material P has a higher refractive index than material Q.

II The wavelength of the red light is longer inside material P than inside material Q.

III The red light travels at the same speed inside materials P and Q.

Which of these statements is/are correct?

A I only

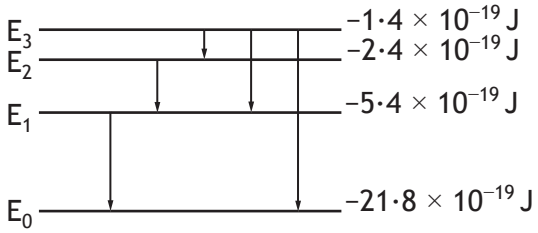
B II only

C III only

D I and II only

E I, II and III

16. The diagram represents some electron transitions between energy levels in an atom.



The radiation emitted with the shortest wavelength is produced by an electron making transition

A E_1 to E_0

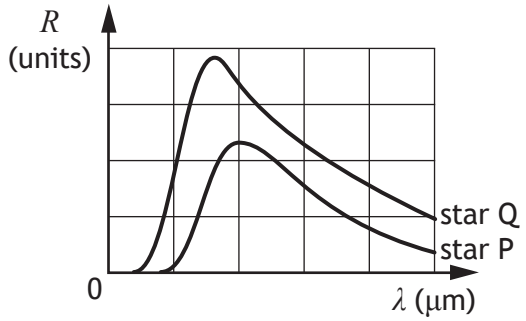
B E_2 to E_1

C E_3 to E_2

D E_3 to E_1

E E_3 to E_0.

7. The graphs show how the radiation per unit surface area, R, varies with the wavelength, λ, of the emitted radiation for two stars, P and Q.



A student makes the following conclusions based on the information in the graph.

I Star P is hotter than star Q.

II Star P emits more radiation per unit surface area than star Q.

III The peak intensity of the radiation from star Q is at a shorter wavelength than that from star P.

Which of these statements is/are correct?

A I only

B II only

C III only

D I and II only

E II and III only

8. One type of hadron consists of two down quarks and one up quark.

The charge on a down quark is −⅓.

The charge on an up quark is +⅔.

Which row in the table shows the charge and type for this hadron?

	charge	*type of hadron*
A	0	baryon
B	+1	baryon
C	−1	meson
D	0	meson
E	+1	meson

9. A student makes the following statements about sub-nuclear particles.

I The force mediating particles are bosons.

II Gluons are the mediating particles of the strong force.

III Photons are the mediating particles of the electromagnetic force.

Which of these statements is/are correct?

A I only

B II only

C I and II only

D II and III only

E I, II and III

10. The last two changes in a radioactive decay series are shown below.

A Bismuth nucleus emits a beta particle and its product, a Polonium nucleus, emits an alpha particle.

$$^{P}_{Q}\text{Bi} \xrightarrow[\text{decay}]{\beta} {}^{R}_{S}\text{Po} \xrightarrow[\text{decay}]{\alpha} {}^{208}_{82}\text{Pb}$$

Which numbers are represented by P, Q, R and S?

	P	*Q*	*R*	*S*
A	210	83	208	81
B	210	83	210	84
C	211	85	207	86
D	212	83	212	84
E	212	85	212	84

11. The table below shows the threshold frequency of radiation for photoelectric emission for some metals.

Metal	*Threshold frequency* (Hz)
sodium	$4{\cdot}4 \times 10^{14}$
potassium	$5{\cdot}4 \times 10^{14}$
zinc	$6{\cdot}9 \times 10^{14}$

Radiation of frequency $6{\cdot}3 \times 10^{14}$ Hz is incident on the surface of each of the metals.

Photoelectric emission occurs from

A sodium only

B zinc only

C potassium only

D sodium and potassium only

E zinc and potassium only.

12. Radiation of frequency $9{\cdot}00 \times 10^{15}$ Hz is incident on a clean metal surface.

The maximum kinetic energy of a photoelectron ejected from this surface is $5{\cdot}70 \times 10^{-18}$ J.

The work function of the metal is

A $2{\cdot}67 \times 10^{-19}$ J

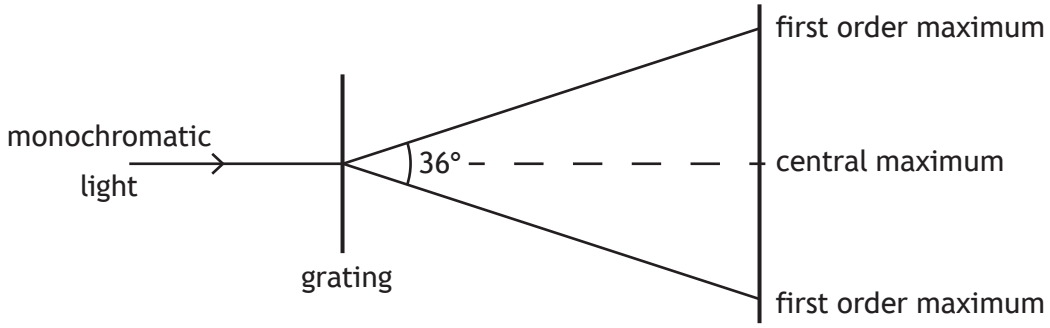
B $5{\cdot}97 \times 10^{-18}$ J

C $1{\cdot}17 \times 10^{-17}$ J

D $2{\cdot}07 \times 10^{-2}$ J

E $9{\cdot}60 \times 10^{-1}$ J.

13. A ray of monochromatic light is incident on a grating as shown.



The wavelength of the light is 633 nm.

The separation of the slits on the grating is

A $1{\cdot}96 \times 10^{-7}$ m

B $1{\cdot}08 \times 10^{-6}$ m

C $2{\cdot}05 \times 10^{-6}$ m

D $2{\cdot}15 \times 10^{-6}$ m

E $4{\cdot}10 \times 10^{-6}$ m.

14. Light travels from **glass** into **air**.

Which row in the table shows what happens to the speed, frequency and wavelength of the light as it travels from glass into air?

	Speed	*Frequency*	*Wavelength*
A	decreases	stays constant	decreases
B	decreases	increases	stays constant
C	stays constant	increases	increases
D	increases	increases	stays constant
E	increases	stays constant	increases

15. The irradiance of light from a point source is $32\,\mathrm{W\,m^{-2}}$ at a distance of 4·0 m from the source.

The irradiance of the light at a distance of 16 m from the source is

A $0{\cdot}125\,\mathrm{W\,m^{-2}}$

B $0{\cdot}50\,\mathrm{W\,m^{-2}}$

C $2{\cdot}0\,\mathrm{W\,m^{-2}}$

D $8{\cdot}0\,\mathrm{W\,m^{-2}}$

E $128\,\mathrm{W\,m^{-2}}$.

7. A student makes the following statements about the radiation emitted by stellar objects.

I Stellar objects emit radiation over a wide range of frequencies.

II The peak wavelength of radiation is longer for hotter objects than for cooler objects.

III At all frequencies, hotter objects emit more radiation per unit surface area per unit time than cooler objects.

Which of these statements is/are correct?

A I only

B III only

C I and II only

D I and III only

E I, II and III

8. The following statement represents a nuclear reaction.

$$^{256}_{103}\mathrm{Lr} \rightarrow \mathrm{Z} + {}^{4}_{2}\mathrm{He}$$

Nucleus Z is

A $^{252}_{101}\mathrm{Md}$

B $^{252}_{101}\mathrm{No}$

C $^{256}_{101}\mathrm{Md}$

D $^{260}_{105}\mathrm{Db}$

E $^{252}_{103}\mathrm{Lr}$.

9. Radiation is incident on a clean zinc plate causing photoelectrons to be emitted.

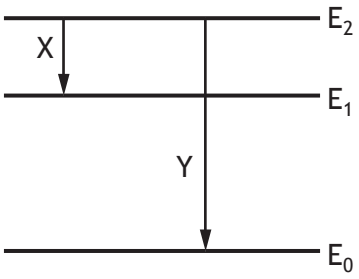
The source of radiation is replaced with one emitting radiation of a higher frequency.

The irradiance of the radiation incident on the plate remains unchanged.

Which row in the table shows the effect of this change on the maximum kinetic energy of a photoelectron and the number of photoelectrons emitted per second?

	Maximum kinetic energy of a photoelectron	*Number of photoelectrons emitted per second*
A	no change	no change
B	no change	increases
C	increases	no change
D	increases	decreases
E	decreases	increases

16. Part of the energy level diagram for an atom is shown



X and Y represent two possible electron transitions.

A student makes the following statements about transitions X and Y.

I Transition Y produces photons of higher frequency than transition X

II Transition X produces photons of longer wavelength than transition Y

III When an electron is in the energy level E_0, the atom is ionised.

Which of the statements is/are correct?

A I only

B I and II only

C I and III only

D II and III only

E I, II and III

15. A point source of light is 8·00 m away from a surface. The irradiance, due to the point source, at the surface is 50·0 mW m^{-2}. The point source is now moved to a distance of 12·0 m from the surface.

The irradiance, due to the point source, at the surface is now

A 22·2 mW m^{-2}

B 26·0 mW m^{-2}

C 33·3 mW m^{-2}

D 75·0 mW m^{-2}

E 267 mW m^{-2}.

10. Ultraviolet radiation of frequency $7{\cdot}70 \times 10^{14}$ Hz is incident on the surface of a metal.
Photoelectrons are emitted from the surface of the metal.
The maximum kinetic energy of an emitted photoelectron is $2{\cdot}67 \times 10^{-19}$ J.
The work function of the metal is

A $1{\cdot}07 \times 10^{-19}$ J
B $2{\cdot}44 \times 10^{-19}$ J
C $2{\cdot}67 \times 10^{-19}$ J
D $5{\cdot}11 \times 10^{-19}$ J
E $7{\cdot}78 \times 10^{-19}$ J.

11. A student makes the following statements about waves from coherent sources.

I Waves from coherent sources have the same velocity.
II Waves from coherent sources have the same wavelength.
III Waves from coherent sources have a constant phase relationship.

Which of these statements is/are correct?

A I only
B II only
C I and II only
D I and III only
E I, II and III

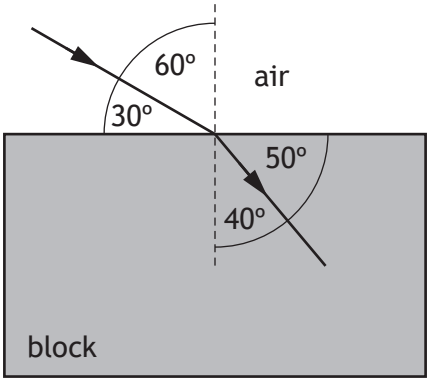
12. A ray of red light passes from a liquid to a transparent solid.

The solid and the liquid have the same refractive index for this light.

Which row in the table shows what happens to the speed and wavelength of the light as it passes from the liquid into the solid?

	Speed	*Wavelength*
A	decreases	decreases
B	decreases	increases
C	no change	increases
D	increases	no change
E	no change	no change

13. A ray of blue light passes from air into a transparent block as shown.



The speed of this light in the block is

A $1{\cdot}80 \times 10^8\ \mathrm{m\,s^{-1}}$

B $1{\cdot}96 \times 10^8\ \mathrm{m\,s^{-1}}$

C $2{\cdot}00 \times 10^8\ \mathrm{m\,s^{-1}}$

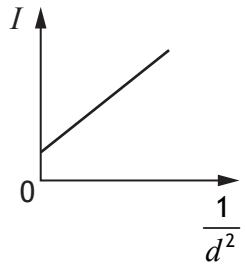
D $2{\cdot}23 \times 10^8\ \mathrm{m\,s^{-1}}$

E $2{\cdot}65 \times 10^8\ \mathrm{m\,s^{-1}}$.

14. A student carries out an experiment to investigate how irradiance varies with distance.

A small lamp is placed at a distance d away from a light meter. The irradiance I at this distance is displayed on the meter. This measurement is repeated for a range of different distances.

The student uses these results to produce the graph shown.



The graph indicates that there is a systematic uncertainty in this experiment.

Which of the following would be most likely to reduce the systematic uncertainty in this experiment?

A Repeating the readings and calculating mean values.

B Replacing the small lamp with a larger lamp.

C Decreasing the brightness of the lamp.

D Repeating the experiment in a darkened room.

E Increasing the range of distances.

15. A point source of light is 8·00 m away from a surface. The irradiance, due to the point source, at the surface is 50·0 mW m^{-2}. The point source is now moved to a distance of 12·0 m from the surface.

The irradiance, due to the point source, at the surface is now

A 22.0 mW $^{-2}$m

B 26.0 mW $^{-2}$m

C 33.0 mW $^{-2}$m

D 75·0 mW m^{-2}

E 267 mW m^{-2}.