Exam Choice

Student Number

2020 TRIAL EXAMINATION

Physics

General Instructions

- Reading time – 5 minutes.
- Working time – 3 hours.
- Write using black pen.
- Draw diagrams using pencil.
- For questions in Section II, show all relevant working in questions involving calculations.
- NESA approved calculators may be used.

Total marks: 100

Section I – 20 marks (pages 3 – 12)

- Attempt questions 1 – 20.
- Allow about 35 minutes for this section.

Section II – 80 marks (pages 13 – 27)

- Attempt questions 21 – 36
- Allow about 2 hours and 25 minutes for this section.

Section I – 20 marks

Attempt Questions 1-20

Allow about 35 minutes for this section

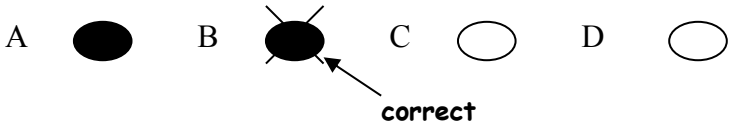
Use the multiple-choice answer sheet.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



1. How would an increase in the value of "g", the acceleration due to gravity, affect the flight of a projectile launched with the same initial conditions?

(A) decreased range; decreased maximum height

(B) decreased range, same maximum height

(C) same range, decreased maximum height

(D) same range, same maximum height

2. The magnetic permeability of a material, μ_0, is:

(A) the measurement of force between two wires carrying current.

(B) a measure of the strength of a magnetic field in a material subject to an external magnetic field.

(C) related to the electric current flowing through the material.

(D) a measure of the electromagnetic resistance of a material.

3. Early measurements of the speed of light were able to determine that light:

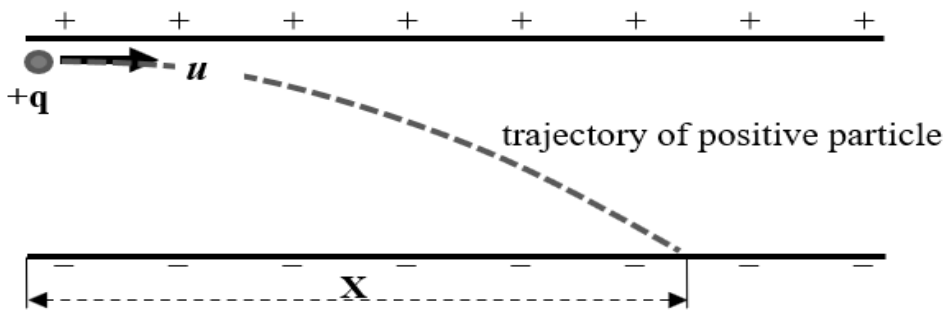
(A) has a particle nature.

(B) can travel through a vacuum.

(C) travels too fast to measure its speed.

(D) travels at a finite speed.

4. A positively charged particle enters an electric field between two charged parallel plates with an initial horizontal velocity ***u***, as shown, very close to the positive plate.



Neglecting the force due to gravity, which formula would be useful to help calculate the distance "**X**", shown in the diagram?
(The distance between the two plates is known.)

(A) $v = u + at$

(B) $v^2 = u^2 + 2as$

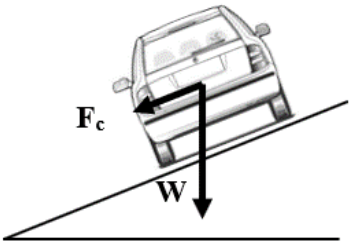
(C) $W = Fs$

(D) $s = ut + \frac{1}{2} at^2$

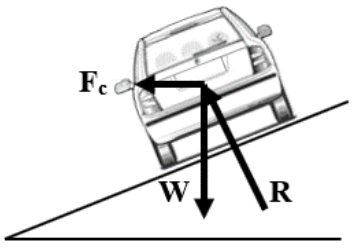
5. A vehicle is travelling with a constant speed around a circular banked track.

A force diagram is drawn from a position behind the vehicle, where **W** is weight and **R** is the reaction force. Which diagram is correct?

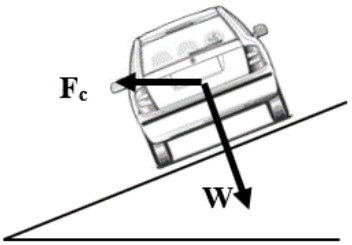
(A)



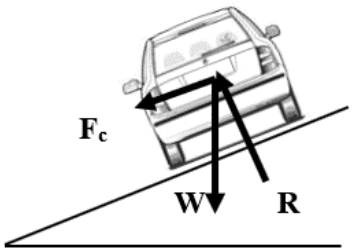
(B)



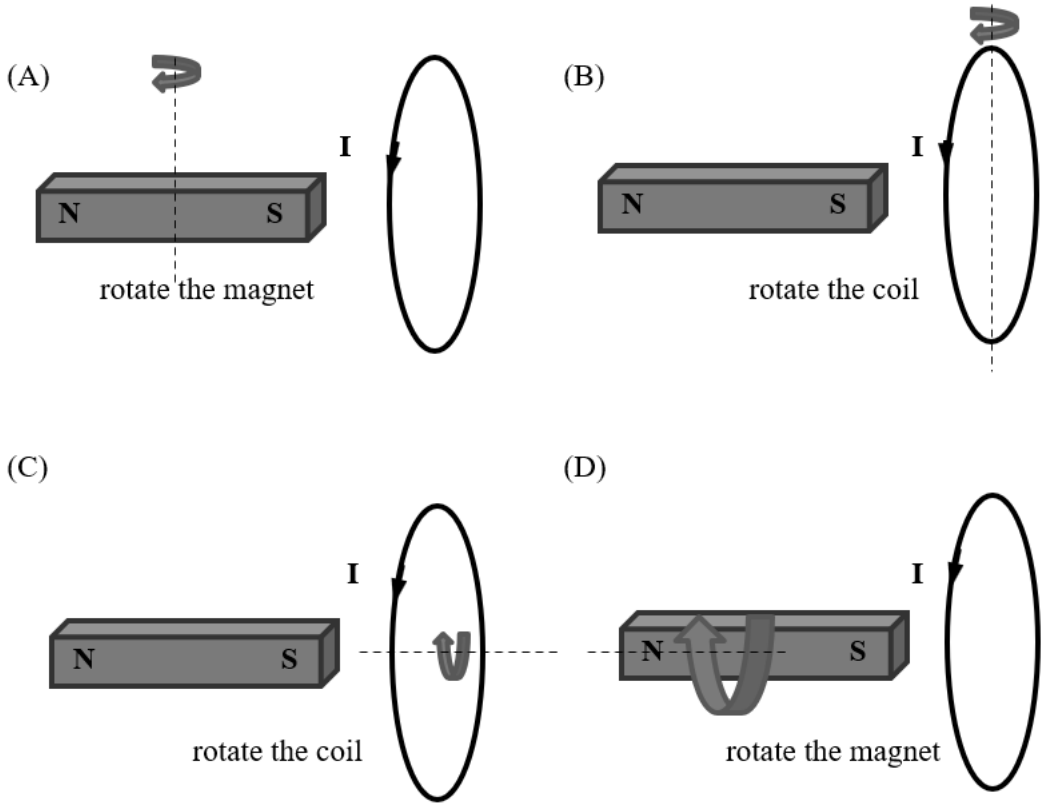
(C)



(D)



6. In which situation would the average current, **I**, be the greatest?



7. Friction braking on cars obeys the law of Conservation of Energy by generating heat energy from the car's kinetic energy.

With magnetic braking, the same law is obeyed by the generation of:

(A) elastic potential energy

(B) magnetic fields

(C) eddy currents and heat energy

(D) gravitational potential energy

8. Which planet would have the lowest escape velocity?

	Planet name	Planet mass (kg)	Planet radius (km)
(A)	Newton	5×10^{24}	8000
(B)	Einstein	8×10^{24}	7800
(C)	Bohr	5×10^{24}	9500
(D)	Hawkins	8×10^{24}	10200

9. Uranium-235 can undergo an uncontrolled chain reaction under the right conditions.

This can occur because uranium-235:

(A) has such a large mass it is more likely to undergo fission.

(B) releases three neutrons when it undergoes fission.

(C) undergoes spontaneous fission in a short period of time.

(D) does not lose mass when it undergoes fission.

10. When light of a certain wavelength, λ_o is shone on a metal surface, it is observed that no electrons are emitted.

When the intensity of this light is increased, still no electrons are emitted.

This shows that light:

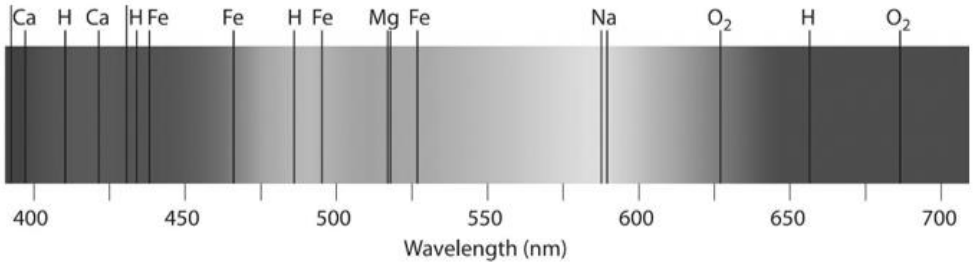
(A) is behaving as a wave.

(B) is not a behaving as a wave.

(C) does not transfer energy.

(D) has no energy.

11. An absorption spectrum from a star is shown.



The dark lines in the spectrum indicate that:

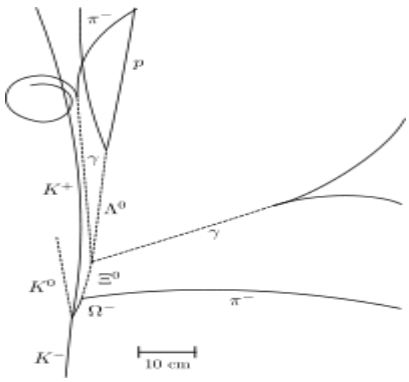
(A) the star is moving away from us.

(B) atoms in the star's atmosphere are absorbing light and not re-emitting it.

(C) several elements are present in the star's atmosphere.

(D) only some atoms in the star's atmosphere are contributing to the spectrum.

12. The diagram depicts the paths of subatomic particles observed after a certain event.



These paths would be typically observed:

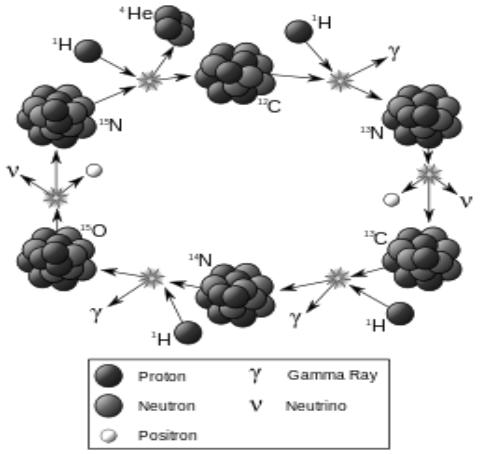
(A) using an X-ray imaging machine.

(B) on a photographic plate.

(C) in a bubble chamber.

(D) using a microscope.

13. The CNO cycle is depicted below.



The CNO cycle is proposed as a likely process for the production of energy in the core of stars as it:

(A) releases more energy than other processes.

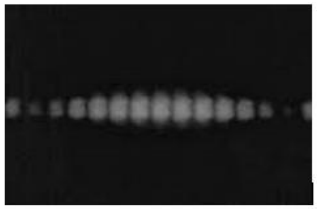
(B) only occurs in the core of small mass stars.

(C) is not a true example of a nuclear process.

(D) occurs via a series of collisions where only two particles collide at any step.

14. Laser light with a wavelength of 621 nm was passed through a double slit. The slits are 100 μm apart.

The resulting interference pattern is reproduced below. The screen is placed 1.50 m from the slits.



NOT TO SCALE

What is the distance from the central maximum to the 2nd bright spot on the screen?

(A) 19 mm

(B) 15 mm

(C) 12 mm

(D) 3.0 mm

15. An electron enters a region where a uniform magnetic field is perpendicular to an electric field between two charged plates, as shown.

The electron passes through the crossed fields without being deflected.

The electron's speed is:

(A) 8.0×10^{-15} m s^{-1}

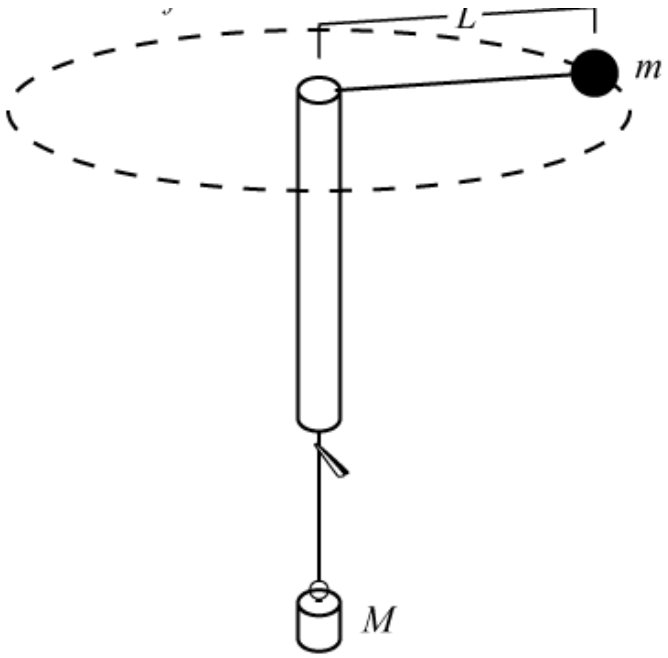
(B) 1.6×10^{3} m s^{-1}

(C) 5.0×10^{4} m s^{-1}

(D) 2.5×10^{6} m s^{-1}

16. A student conducted an investigation into the relationship between the speed of a mass undergoing uniform circular motion and the centripetal force required.

The apparatus used consisted of a metal tube, two masses *m* and M, string and a stopwatch.



There is an assumption made regarding the force of gravity on the moving mass, as represented in the diagram.

This assumption made will make the investigation:

(A) more accurate.

(B) less precise.

(C) more reliable.

(D) less valid.

17. A consequence of having DC rather than AC electricity transmission from power stations to consumers would be:

(A) using lower voltages in household appliances.

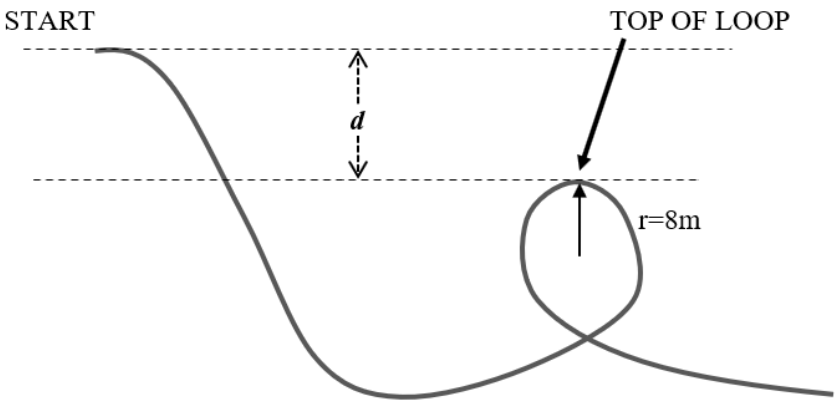
(B) having power stations located much closer to the consumers.

(C) needing fewer power stations.

(D) less efficient appliances such as light globes.

18. A roller coaster track is designed so that at the top of the loop, passengers will be upside-down and undergo an acceleration equal to *g* while in their seats, making them feel weightlessness.

A view of the track from the side is shown.



The rollercoaster rides starts with negligible speed and there is no friction. The radius of curvature at the top of the loop is 8.0 m.

What is the height, ***d***, of the starting position vertically higher than the top of the loop?

(A) 4.0 m

(B) 8.5 m

(C) 12.3 m

(D) 14.7 m

19. The combustion of 1.00 kg of ethanol releases 29.6 MJ of energy.

Our Sun is converting 4.0×10^9 kg of mass into energy each second.

If the energy released from the Sun was sourced from the combustion of ethanol, what mass of ethanol would be being combusted each second?

(A) 3.6×10^{26} kg

(B) 3.0×10^{7} kg

(C) 1.2×10^{19} kg

(D) 2.0×10^{30} kg

20. de Broglie proposed that any mass which has momentum also has a wavelength.

In keeping with this assumption, a student attempted to calculate the mass of a photon with a wavelength of 500 nm.

The student's result for the mass of this photon is closest to:

(A) 4.4×10^{-36} kg

(B) 6.7×10^{-3} kg

(C) 1.32×10^{-27} kg

(D) 3.0×10^{-8} kg

2020 | TRIAL EXAMINATION

Physics

Section II
Answer Booklet

80 marks

Attempt Questions 21 – 36

Allow about 2 hours and 25 minutes for this part

Instructions

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which questions you are answering.

Marks

Question 21 (6 marks)

In an investigation into the value of gravitational acceleration, a device was used which launches a ball bearing at exactly 7.8 m s^{-1}.

(a) Describe a suitable method using the principles underpinning projectile motion that could be used to calculate the value of gravitational acceleration **without** the use of a stopwatch or other timing device. **3**

A length measuring device is available.

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(b) Calculate by how much the value of measured gravitational acceleration would change at the equator if the Earth were to stop rotating on its axis. **3**

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Marks

Question 22 (4 marks)

The performance characteristics of a rotating motor such as a car engine include the engine's torque and power.

(a) Given that:

power (P) = force (F) x velocity (*v*)

calculate the power output of a motor which is rotating at 2500 rpm (revolutions per minute) when producing a torque of 180 N m. **2**

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(b) How much work is done by an electric screwdriver generating a torque of 12 N m that takes 15 rotations to tighten a screw? **2**

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Marks

Question 23 (6 marks)

(a) Define what is meant by the term "geostationary" when applied to satellites orbiting Earth. **1**

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(b) Calculate the orbital radius of a satellite which is in geostationary orbit. **3**

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(c) Discuss the relationship between Kepler's Second Law of Planetary Motion and the law of the conservation of energy. **2**

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Marks

Question 24 (9 marks)

Explain how the motor effect is used to produce torque in electric motors, including induction motors. **9**

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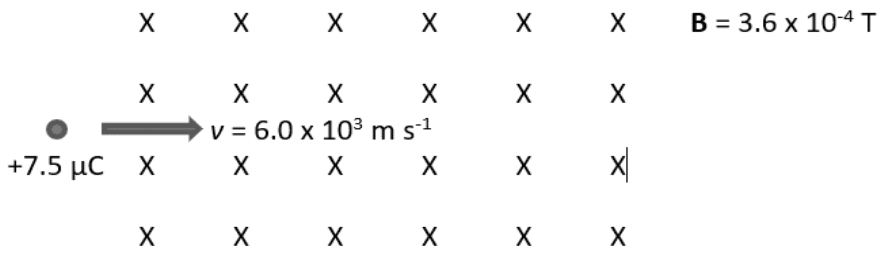
Marks

Question 25 (4 marks)

A small charged particle with a charge of + 7.5 μC and a mass of 4.0 x 10^{-15} kg enters a uniform magnetic field with a speed of 6.0 x 10^{3} m s^{-1} as shown.



(a) What is the initial force on the charged particle when it enters the magnetic field? **2**

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(b) Hence quantitatively describe the subsequent motion of this particle, assuming that it remains within the magnetic field. **2**

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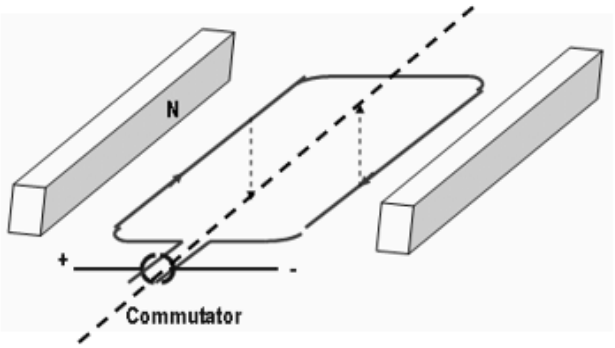
Marks

Question 26 (4 marks)

A single current-carrying loop is within a magnetic field produced by two magnets, as shown. A commutator connects the loop to a battery that has a constant voltage.



As the loop begins to rotate about the axis, its speed increases with time.

(a) On the axes below, sketch how the speed of rotation of the loop would change with time. **2**

(b) Explain how the speed of a motor changes from the time it is started until it reaches its operating speed with reference to back EMF. **2**

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Marks

Question 27 (5 marks)

Describe an investigation to examine the spectra produced from a variety of sources. Include the name of the sources and a description of the spectra seen. **5**

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Question 28 (4 marks)

Huygens' wave model of light was supported by a number of observations. **4**

Outline these observations and explain how they support a wave model of light.

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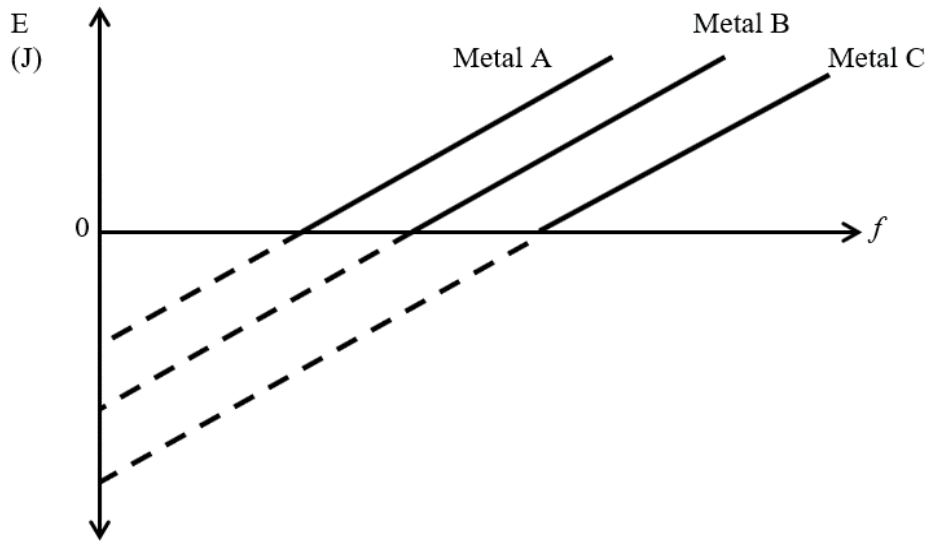
Marks

Question 29 (4 marks)

The stopping voltage was measured while varying the frequency of incident light for an investigation of the photoelectric effect. Three different metals, A, B and C were used and the results plotted, as shown below.



(a) Outline the significance of the value of the frequency of light where the lines intercept the x-axis on the graph for each metal. **2**

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(b) Discuss why the plotted results for all of the metals are parallel. **2**

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Marks

Question 30 (5 marks)

(a) Describe what is meant by the term "inertial frame of reference" and give an everyday example. **2**

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(b) A spaceship is 220 m in length.

With what speed would the spaceship need to be travelling relative to an observer if that observer measures the length of the spaceship as 70 m? **3**

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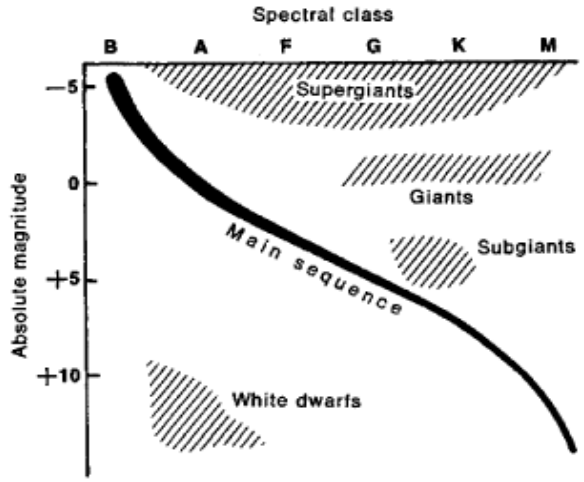
Marks

Question 31 (5 marks)

A Hertzsprung-Russell diagram is shown below.



(a) Explain how the region labelled "Main sequence" can include stars from all of the spectral classes shown by referring to what they have in common. **3**

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(b) There does not appear to be a relationship between the surface temperature and luminosity everywhere on the HR diagram.

Explain quantitatively why giant stars can have high luminosities while having relatively low surface temperatures. **2**

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Marks

Question 32 (4 marks)

Chadwick discovered the neutron in 1932. He used alpha particles to bombard a material rich in neutrons, causing neutrons to be emitted. These neutrons then displaced protons from paraffin wax, a proton rich material. The protons were detected and measured.

(a) Given that neutrons and protons have approximately the same mass, explain how the unknown rays, now known to be neutrons, were easily able to displace the protons from the paraffin wax. **2**

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(b) Why were neutrons difficult to observe, and therefore late to be discovered? **2**

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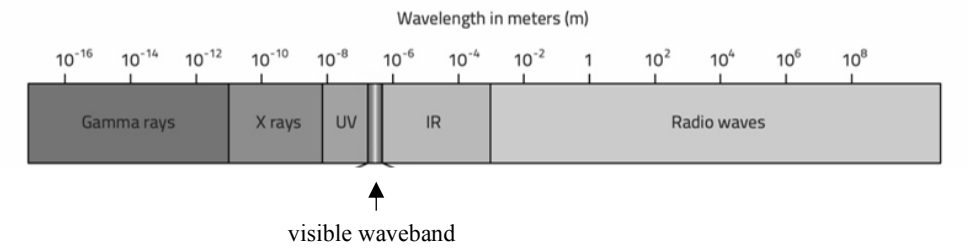
Marks

Question 33 (5 marks)

The visible waveband is only a small part of the full electromagnetic spectrum.



(a) Using the diagram provided, show in which waveband of the electromagnetic spectrum a photon would be if it resulted from the transition of an electron in a hydrogen atom from energy level n=4 to energy level n=3. **3**

Show all your working.

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(b) Calculate the speed that an electron would need to travel so that its wavelength, according to de Broglie, would be equal to the wavelength of the photon emitted in part (a). **2**

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Marks

Question 34 (7 marks)

Outline, in the form of a table, the various reasons for the spontaneous decay of unstable nuclei, and the properties and a use of the radiation emitted. **7**

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Marks

Question 35 (4 marks)

It is now known that quarks are constituent particles of nucleons.

(a) Describe how quarks combine to form stable nucleons. **2**

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(b) Outline how a magnetic field could be used to distinguish between the two types of beta particles. **2**

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Question 36 (4 marks)

Discuss the requirements of the planning necessary to ensure that a first-hand investigation will collect data which is both valid and reliable. **4**

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Section II extra writing space.

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Section II extra writing space.

If you use this space indicate clearly which question you are answering.

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Exam Choice

2020 Physics Trial Examination.

Marking Guidelines and Model Answers.

Section I Multiple Choice

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	B	D	D	B	B	C	C	B	B	C	C	D	A	D	D	B	A	C	A

Section II

21 a.

Marking Criteria	Marks
• Method is suitable and appropriate and would lead to a correct outcome using analysis included	**3**
• An appropriate method is stated with missing steps or incomplete analysis	**2**
• One aspect of an appropriate method is stated	**1**

Sample answer

- Set up the launching device so that it launches a ball bearing horizontally from a table or desk top
- Measure the height of the launcher from the ground
- Launch the ball bearing and measure the horizontal distance it travels, Δx
- Divide the distance by the constant horizontal speed of the ball bearing: $\Delta x/7.8$ = time of flight
- Now use $s = ut + 1/2at^2$, where s is the height of the desk, u=0 and a is the vertical acceleration due to gravity, i.e. g

21 b.

Marking Criteria	Marks
• Recognition of factors involved in calculation • Calculation is complete and correct	**3**
• Recognition of factors involved in calculation • Calculation attempted but is incomplete or error made	**2**
• One aspect of a factor involved is recognised OR • A step in an appropriate calculation provided	**1**

Sample answer

Recognising that T = 24 x 60 x 60 = 86400 s; r = radius of earth = 6370 km

$$v = \frac{2\pi r}{T} \qquad a_c = \frac{v^2}{r}$$

$$= \frac{2\pi \times 6370 \times 10^3}{86400} \qquad \text{and} \qquad = \frac{(463.2)^2}{6370 \times 10^3}$$

$$= 463.2 \text{ m s}^{-1} \qquad = 3.37 \times 10^{-2} \text{ m s}^{-2}$$

So that the value of *g* at the equator increase by 3.37 x10^{-2} m s^{-2} at the equator.

22 a.

Marking Criteria	Marks
• Correct calculation with units given	**2**
• A calculation attempted but with an error or omission	**1**

Sample answer

Need to find the velocity when rotating with a 1 m radius:

$v = 2\pi r \times 2500/60$ m s^{-1} then: $P = F \times v$

$= 261.8$ m s^{-1} $= 180 \times 261.8$

$= 4.71 \times 10^4$ W or 47.1 kW

22 b.

Marking Criteria	Marks
• Correct calculation with units given	**2**
• A calculation attempted but with an error or omission	**1**

Sample answer

Again, using a circular motion with radius = 1 m and therefore a force applied of 12 N:

$W = F \times$ distance $= 12 \times 15 \times 2\pi \times 1$

$= 1.1 \times 10^3$ J

23 a.

Marking Criteria	Marks
• A correct definition given	**1**

Sample answer

A geostationary satellite orbits Earth such that its orbital period exactly matches Earth's rotational period. The satellite is in orbit above the equator and stays over the same place on Earth's surface.

23 b.

Marking Criteria	Marks
• Calculation is complete with units and sig. figs correct	**3**
• An error or omission from the above	**2**
• A correct step is taken toward solving the question posed	**1**

Sample answer

Use: $\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$ where T = 24x60x60 s; M = mass of Earth

$$r^3 = \frac{GMT^2}{4\pi^2}$$

$$= \frac{(6.67\times10^{-11})\times(6.0\times10^{24})\times(24\times60\times60)^2}{4\pi^2}$$

$$= 7.567\times10^{22}$$

$$r = \sqrt[3]{7.567\times10^{22}}$$

$$r = 4.23\times10^{7} \text{ m}$$

23 c.

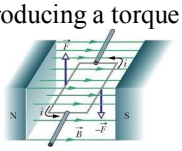
Marking Criteria	Marks
• Kepler's 2nd Law correctly identified • Law of conservation of energy related correctly	**2**
• Kepler's 2nd Law correctly identified OR • Law of conservation of energy related to planetary orbit – i.e. loses GPE but gains KE if planet "falls" towards Sun	**1**

Sample answer
Kepler's 2nd Law of Planetary Motion states that a planet will sweep out equal area in equal time as it orbits the Sun. The reason for this is that as the planet orbit takes it closer to the Sun, it loses gravitational potential energy and thus gains kinetic energy, and thus speed, as energy is conserved. The planet then sweeps out an equal area regardless of its distance to the Sun.

24

Marking Criteria	Marks
• Response comprehensively addresses the question • The motor effect is clearly explained • Production of torque is explained clearly • Induction motors are included with a clear explanation • Response is logical and sequential	**9**
• The motor effect is explained clearly • Production of torque is explained • Induction motors are included	**7-8**
• The motor effect is explained clearly • Production of torque is explained in at least one type of motor	**5-6**
• Several aspects of the motor effect, including the production of torque, are identified	**3-4**
• Basics of the motor effect identified	**1-2**

Sample Answer (answers may include refernces to):
The motor effect is where a current-carrying conductor, when placed within a magnetic field, experiences a force calculated by F = BIlsinθ, where θ is the angle between the magnetic field and the current. This force can be employed in electric motors using a loop that can rotate on an axis, where the force on one side of the loop produces a torque, where τ=Fxd, with d the perpendicular distance from the axis. This is matched by the corresponding force on the other side of the loop, producing a torque in the same direction.

(A diagram to aid the explanation is advisable), e.g. 

A commutator is required for a DC motor so that the torque remains in the same direction as the loop rotates, or AC can be used that will reverse the current each half rotation of the loop/coil.
In an induction motor, a rotating magnetic field surrounding a "squirrel-cage" device that can rotate induces a current in the bars of the cage, in turn producing a magnetic field around the bars that interacts with the externally applied field. The forces on the bars act to produce a torque on the cage, as Lenz's law states that any change in flux will be opposed by the induced current producing a magnetic field that opposes the change experienced. This causes the cage to rotate without direct electrical connection.

25 a.

Marking Criteria	Marks
• Force is calculated correctly with correct units and sig. figs	**2**
• An error or omission is made	**1**

Sample answer:
$F = qvB\sin\theta$
$= 7.5 \times 10^{-6} \times 6.0 \times 10^{3} \times 3.6 \times 10^{-4} \times \sin 90°$
$= 1.6 \times 10^{-5}$ N up the page initially

25 b.

Marking Criteria	Marks
• Nature of path and radius both correct	**2**
• Nature of path, i.e. circular stated	**1**

Sample answer:
The charged particle will follow a circular path in an anticlockwise direction with a radius found by:

$$F_c = \frac{mv^2}{r}$$

$$r = \frac{mv^2}{F_c}$$ (answer obtained retaining the value of F_c from part a)

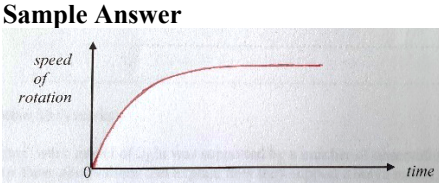
$$= \frac{4.0\times10^{-15}\times(6.0\times10^{3})^2}{1.6\times10^{-5}}$$

$$= 8.9\times10^{-3} \text{ m}$$

26 a.

Marking Criteria	Marks
• Correct appropriate shape drawn showing an upper limit and gradient decreasing	**2**
• One aspect of the graph shown	**1**

Sample Answer



26 b.

Marking Criteria	Marks
• Thorough explanation provided that describes the way in which the rate of increase in speed decreases until operating speed is reached as back EMF increases with speed of motor.	**2**
• One aspect of back EMF is described	**1**

Sample answer
Initially, as a motor begins to rotate, there is no back EMF being produced so a larger current and hence large torque accelerates the motor quickly. As the motor's rotational speed increases, the flux through the coils in the motor changes faster, increasing the back EMF which opposes the supplied EMF. This decreases the net EMF and thus current in the coils, in turn reducing the torque until at a certain speed, the reduced torque is equally opposed by the friction and the motor's speed remains constant.

27

Marking Criteria	Marks
• Investigation is described thoroughly, including all apparatus required • Three sources included • Description of each observed spectra is clear • Response is logical, sequential and structured	**5**
• Investigation is described, including all apparatus required • Three sources included • Description of each observed spectra is clear	**4**
• A suitable investigation is identified and at least two spectra described	**3**
• One aspect of a suitable investigation is provided AND • One spectrum is described	**2**
• One aspect of a suitable investigation is provided OR • One spectrum is described	**1**

Sample answer
An incandescent globe, a fluorescent light and a sodium (or other elemental) discharge lamp were set up and switched on in separate darkened areas. A hand-held spectroscope was used to observe each source. The incandescent globe was observed to produce a continuous spectrum, rather like a rainbow, with no features such as dark or bright lines present. The fluorescent globe produced a spectrum with bright emission lines especially at purple and green against a fainter background continuous spectrum. The sodium discharge lamp produced only bright emission lines, especially at orange. Finally, indirect sunlight was observed by focusing the spectroscope at the sky away from the sun. Many faint dark absorption lines were observed against a background of a continuous spectrum.

28

Marking Criteria	Marks
• Several wave model-supporting observations outlined • Observations linked to wave model with clear explanations	**4**
• Several wave model-supporting observations outlined • Observations linked to wave model	**3**
• Several appropriate observations outlined OR • An observation identified and linked to the wave model	**2**
• An appropriate observation outlined	**1**

Sample answer
Observation: Young's double-slit interference patterns. These patterns are the result of alternating constructive and destructive interference of the light waves from the 2 slits as the path length differences change from integer multiples of the wavelength used (constructive – bright spot) to integer + ½ wavelength (destructive – dark spot).
Observation: Interference pattern around a sharp edge – such a pattern again can only be produced by a wave model, as particles would not bend or be diffracted.

29 a.

Marking Criteria	Marks
• Correct outline provided	**2**
• Incomplete outline provided OR • frequency identified, i.e. threshold frequency	**1**

Sample answer
These frequencies are known as the threshold frequencies for each metal. It is the minimum frequency of light required for the photoemission of electrons from the surface of the respective metals.

29 b.

Marking Criteria	Marks
• Reason for parallel lines explained fully	**2**
• Gradient of lines identified i.e. Planck's constant	**1**

Sample answer
The gradient of each line represents the quantity E/f. As E = hf, the gradient is therefore equal to the value of Planck's constant, which is the same for all photons.

30 a.

Marking Criteria	Marks
• IFoR described thoroughly and example given is correct	**2**
• IFoR identified OR • example of an IFoR given	**1**

Sample answer
An IFoR is one which is not accelerating and in which the laws of physics appear to operate normally, i.e. no inertial forces are required to be added. For example, an aircraft moving at a constant velocity with no turbulence.

30 b.

Marking Criteria	Marks
• All calculations correct	**3**
• Several appropriate steps taken OR an error made	**2**
• One appropriate step taken	**1**

Sample answer

$$l = l_o\sqrt{1-\frac{v^2}{c^2}}$$

$$\frac{l}{l_o} = \sqrt{1-\frac{v^2}{c^2}}$$

$$\left(\frac{l}{l_o}\right)^2 = 1-\frac{v^2}{c^2}$$

$$\frac{v^2}{c^2} = 1-\left(\frac{l}{l_o}\right)^2$$

$$\frac{v}{c} = \sqrt{1-\left(\frac{l}{l_o}\right)^2}$$

$$\frac{v}{c} = \sqrt{1-\left(\frac{70}{220}\right)^2}$$

$$= 0.948$$

$$v = 0.95c$$

or 2.8 x 10^8 m s^{-1} (either answer acceptable)

31 a.

Marking Criteria	Marks
• Explanation includes reference to the commonality of MS stars • Includes reference size and therefore surface temperature differences	**3**
• Commonality of MS stars referred to	**2**
• Main sequence stars described	**1**

Sample answer

Stars on the Main sequence of the H-R diagram are believed to be fusing hydrogen in their cores. The mass of these stars determines their luminosity – larger stars are more luminous and also have higher surface temperatures so they can cover the range of spectral class and have very different luminosities.

31 b.

Marking Criteria	Marks
• Response includes a thorough explanation • Star size is described and quantified	**2**
• Star size is identified	**1**

Sample answer

Stars vary in size. The surface area of a star is proportional to the square of its diameter. A star twice as big as another, with the same surface temperature, will therefore be 4 times more luminous. L α $size^2$. Therefore giant stars, with relatively low surface temperatures but very large diameters can have high luminosities.

32 a.

Marking Criteria	Marks
• Thorough answer referring to collision mechanics	**2**
• A similarity between protons and neutrons identified	**1**

Sample answer

Neutrons and protons have approximately the same mass and are approximately the same size. In a collision between a proton and a neutron, the momentum of the proton can be given to the neutron, and the proton stops while the neutron can be emitted with a similar speed to the original proton that was used to bombard the material.

32 b.

Marking Criteria	Marks
• Response refers to the property and nature of neutrons	**2**
• Response includes a reference to a property of the neutron.	**1**

Sample answer

Neutrons are held in the nucleus of atoms and are difficult to remove except under extreme conditions. They are also neutral, so do not interact with other particles, nuclei or atoms in the same way or as easily observed as charged particles. This made them harder to detect and therefore late to be discovered.

33 a.

Marking Criteria	Marks
• Wavelength of photon calculated • Correct waveband identified using diagram	**3**
• Correct formula employed with error made in calculation OR • Correct calculation made but waveband incorrect	**2**
• One correct step undertaken	**1**

Sample answer

$\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$ where $n_i = 4$ and $n_f = 3$

$\frac{1}{\lambda} = 1.097 \times 10^7 \left[\frac{1}{3^2} - \frac{1}{4^2}\right]$

$= 5.33 \times 10^5 \text{ m}^{-1}$

$\lambda = 1.87 \times 10^{-6} \text{ m}$

So this photon would be in the infra-red waveband. (or near infra-red)

33 b.

Marking Criteria	Marks
• Correct answer provided	**2**
• Appropriate formula identified but with subsequent error(s)	**1**

Sample answer

$\lambda = \frac{h}{mv}$

$v = \frac{h}{m\lambda}$

$= \frac{6.626 \times 10^{-34}}{(9.1 \times 10^{-31}) \times (1.87 \times 10^{-6})}$

$= 3.89 \times 10^2 \text{ m s}^{-1}$

34

Marking Criteria	Marks
• All types of decay are analysed, with conditions that would give rise to such decay • Decay emissions are described clearly, with various properties • Response is clear, thorough and logical	**6-7**
• Most types of decay are analysed with reasons given	**4-5**
• Several aspects of decay are outlined	**2-3**
• An aspect of nuclear decay is identified	**1**

Sample answer

Decay type	Reason	Decay particle	Ionising ability	Penetrating power	Use
alpha	nucleus too large	He nucleus 2 protons + 2 neutrons	very high (large size and +2 charge)	low (stopped by paper/skin)	smoke detectors
beta +	proton:neutron ratio too high	positron (positive electron)	moderate	moderate (stopped by sheet of aluminium)	PET scans
beta -	neutron: proton ratio too high	electron	moderate	moderate	thickness gauges
gamma	energetic nucleus	gamma photon/ray	low	high (penetrates lead and concrete)	bone scans; aircraft engine checking

35 a.

Marking Criteria	Marks
• Correctly described quark combinations for protons and neutrons	**2**
• Quark combination for either protons or neutrons described OR • Reference made to three quarks in each	**1**

Sample answer
An up quark has a charge of +2/3, while a down quark has a charge of -1/3. Alone, quarks are not stable but 2 up quarks combine with one down quark to form a proton (charge +1) which is stable. Two down quarks combine with one up quark to form a neutron (charge =0), which is, of course, stable.

35 b.

Marking Criteria	Marks
• Suitable application of magnetic to identify path deflection outlined • Both types of beta particle (electron and positron) identified	**2**
• Suitable application of magnetic to identify path deflection outlined OR • Both types of beta particle (electron and positron) identified	**1**

Sample answer
The application of a perpendicular magnetic field to the path of emitted beta particles will result in the deflection of the path for a negative particle (an electron) or for a positive particle (a positron), both particles being beta particles.

36

Marking Criteria	Marks
• Validity and reliability both addressed in a clear, logical manner	**4**
• Validity and reliability both addressed with some omission	**3**
• An aspect of both is outlined	**2**
• An aspect of either is identified	**1**

Sample answer
For an investigation to be valid, it must be testing what it is said to be testing, so that the independent variable is the only factor that is being changed, causing a change to the dependent variable. All other factors/variables must be identified, accounted for, and controlled in the procedure. For an investigation to be reliable, its results must be able to be repeated by another person following the same procedure, which would normally mean that the procedure must also be valid to prevent changes to the dependent variable from unknown or unaccounted for factors. Repeating an investigation may be a test of its reliability, but not necessarily its validity, as the same unaccounted for factor may be having the same effect on the observed results.