MHS

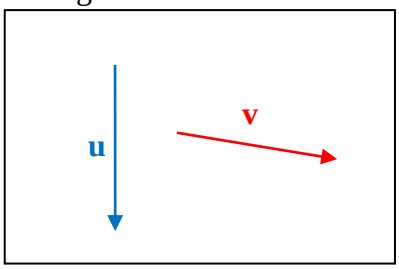
Applied Math

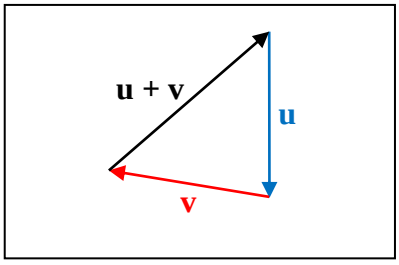
Exam to go from grade 11 to grade 12

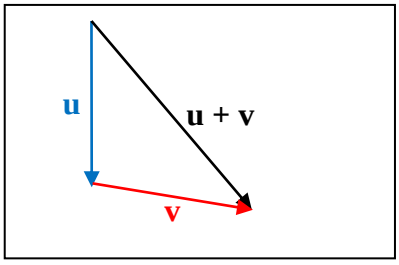
Sample Questions

1. $\overrightarrow{OP} + \overrightarrow{PA} + \overrightarrow{AR} =$
    1. $\overrightarrow{OPAR}$
    2. $\overrightarrow{AR}$
    3. $\overrightarrow{OR}$

2. Given two vectors **u** and **v** in the box below, how can we correctly find their sum, **u + v** , using the triangle law?



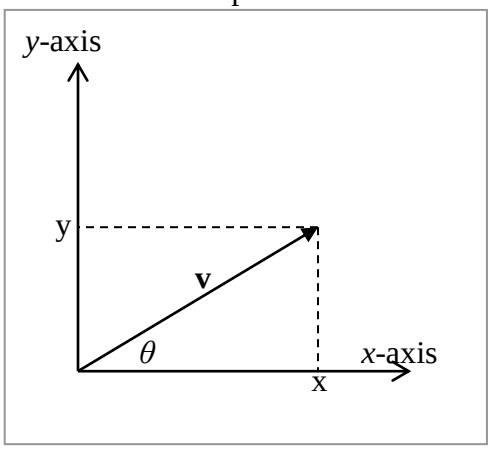
1. 

2. 

3. Given two vectors **d** and **e**, **d – e** is equal to:
    1. **e – d**
    2. **d + (–e)**
    3. **–d + (–e)**

4. Given the vectors **q** = 3**i** + 4**j** and **t** = 15**i** + 2**j**, calculate 5**q**–2**t**.
    1. 2**i** + 6**j**
    2. –15**i** + 16**j**
    3. 11**i** + 15**j**

5. Consider a vector $\mathbf{v} = x\mathbf{i} + y\mathbf{j}$ with magnitude $|\mathbf{v}| = r$ and making an angle θ measured anti-clockwise from the positive x-axis.



The **i** component of **v** can be calculated using:

1. $x = r\cos\theta$
2. $x = r\sin\theta$
3. $x = r\tan\theta$

6. Find the magnitude and direction of the vector $\mathbf{q} = (-15\mathbf{i} - 2\mathbf{j})$ m in polar coordinates.

7. A vector **d** has magnitude $|\mathbf{d}| = r = 78$ m and $\theta = 155^o$. What is **d** in the form $x\mathbf{i} + y\mathbf{j}$?

8. A vector with $\theta = 125^o$, where θ is the angle measured anticlockwise from the positive sense of the x-axis, has a bearing of:

9. Calculate the distance between points **A** and **B** given ***A*** (3, 18) m and ***B*** (21, –5) m.

10. Given two vectors $\mathbf{a} = \mathbf{OA} = (7\mathbf{i} - 9\mathbf{j})$ ms^{-1} and $\mathbf{b} = \mathbf{OB} = (14\mathbf{i} + 20\mathbf{j})$ ms^{-1}, calculate **AB**.
    1. $\mathbf{AB} = (17\mathbf{i} + 59\mathbf{j})$ ms^{-1}
    2. $\mathbf{AB} = (7\mathbf{i} + 29\mathbf{j})$ ms^{-1}
    3. $\mathbf{AB} = (-\mathbf{i} + 9\mathbf{j})$ ms^{-1}

11. How can the dot product of two vectors **u** and **v** be expressed in terms of their magnitudes and the angle θ between them.
    1. $\mathbf{u}.\mathbf{v} = |\mathbf{u}||\mathbf{v}| \sin\theta$
    2. $\mathbf{u}.\mathbf{v} = |\mathbf{u}||\mathbf{v}| \cos\theta$
    3. $\mathbf{u}.\mathbf{v} = |\mathbf{u}|^2|\mathbf{v}|^2 \sin\theta$

12. Calculate the new position, **x**, for a body that started from a position, $\mathbf{x_0}$, of 6.9 m up and moved with a velocity, **v**, of 0.5 ms^{-1} down for a time, t, of 20 s. [Don't forget the direction in your position vector!]

13. A car accelerates from rest at 1.2 ms^{-2} to reach a top speed of 48 ms^{-1}. What time did the acceleration take?

14. A ball is rolled across the floor and comes to a stop in a time of 10 s covering a distance of 20 m. What was the initial velocity of the ball?

15. A train initially travelling at 5 ms^{-1} accelerated for 5 s covering a distance of 100 m. Calculate the acceleration of the train.

16. A car accelerates from rest at 3.5 ms^{-2} to reach a top speed of 49 ms^{-1}. What was the distance traveled during the acceleration?

17. A car accelerated from rest at 8 ms^{-2} for 5 s and then immediately began to decelerate for a distance of 240 m and came to rest. Calculate the total time that the car was in motion.

18. What is the acceleration experienced by a body undergoing free fall? **(select one correct answer)**
    1. g upwards
    2. 8.9 ms^{-1} downwards
    3. g downwards

19. A tennis ball is hit vertically upwards with an initial velocity of 85 ms^{-1}. Neglecting air resistance, calculate the maximum height that will be achieved by the ball. [Use g = 9.8 ms^{-2}]

20. A bullet was shot vertically upwards with an initial velocity of 600 ms^{-1}. Neglecting air resistance, calculate the height of the of the bullet after 8 s. [Use g = 9.8 ms^{-2}]

21. For two bodies *R* and *T* moving past each other what can we say about the velocity of *R* with respect to *T* and the velocity of *T* with respect to *R*? **(select one correct answer)**
    1. $\mathbf{v}_{TR} = -\mathbf{v}_{TR}$
    2. $\mathbf{v}_{RT} = -\mathbf{v}_{RT}$
    3. $\mathbf{v}_{RT} = -\mathbf{v}_{TR}$

22. A train, *t*, is moving at a velocity of 10 ms^{-1} East. A man, *m*, on the train is running at 2 ms^{-1} West with respect to the train. [**Take East as the positive sense**; ground = g] What is the velocity of the man with respect to the ground?

23. In the study of kinematics, what is a "Frame of Reference"? **(select one correct answer)**
    1. The frame containing the *references* for studying time
    2. The *timepieces*, *measurement rods* and a *material body* relative to which the characteristics of motion are measured
    3. The frame that is always totally independent to the *material body* and the *timepiece* attached to it

24. A body moves from coordinates (13 km, 22 km) to (16 km, 44 km). Calculate the displacement vector for the body?

25. A body moves from position $\begin{pmatrix} -8 \\ 19 \end{pmatrix}$ m to position $\begin{pmatrix} -8 \\ -29 \end{pmatrix}$ m in 8 s. Calculate the average velocity vector?

26. A body moves in the coordinate plane with an instantaneous velocity of $\begin{pmatrix} -8 \\ 6 \end{pmatrix}$ m/s . Calculate the instantaneous speed of the body.

27. A body moves in the coordinate plane with an instantaneous velocity of (–12, 19) ms^{-1}. What is the direction of motion of the body given in the Mariner's compass?

28. The velocity of a body moving in the coordinate plane changes from $\begin{pmatrix} 14\ ms^{-1} \\ 22\ ms^{-1} \end{pmatrix}$ to $\begin{pmatrix} -21\ ms^{-1} \\ 1\ ms^{-1} \end{pmatrix}$ in 7 s. What is the average acceleration?

29. Which formula can we use to find the magnitude of the instantaneous acceleration, $|\mathbf{a}|$, from the instantaneous acceleration vector $\begin{pmatrix} a_x \\ a_y \end{pmatrix}$? **(select one correct answer)**

    1. $|\mathbf{a}|^2 = \sqrt{a_x{}^2 + a_y{}^2}$
    2. $|\mathbf{a}| = \sqrt{a_x{}^2 + a_y{}^2}$
    3. $\sqrt{|\mathbf{a}|} = a_x{}^3 + a_y{}^3$

30. A body moves in the coordinate plane with an instantaneous acceleration of $(-34\mathbf{i} - 28\mathbf{j})\ ms^{-2}$. What is the direction of the instantaneous acceleration of the body given as a bearing?

31. An object moving in one sense along the circumference of a circle in such a way that its instantaneous speed is constant is said to be executing what? **(select one correct answer)**
    1. Non-Uniform Circular Motion
    2. Uniform Rectilinear Motion
    3. Uniform Circular Motion

32. The position vector of a particle is $\mathbf{r} = (3\mathbf{i} - 6\mathbf{j})$ m and its velocity vector is $\mathbf{v} = (2\mathbf{i} + \mathbf{j})\ ms^{-1}$. By calculating **r.v**, say whether it is possible that the particle is executing Uniform Circular Motion or not. **(select one correct answer)**
    1. Since $\mathbf{r.v} < 0$, it is **not** possible that the particle is executing UCM
    2. Since $\mathbf{r.v} = 0$, it is possible that the particle is executing UCM
    3. Since $\mathbf{r.v} > 0$, it is possible that the particle is executing UCM
    4. Since $\mathbf{r.v} < 0$, it is possible that the particle is executing UCM
    5. Since $\mathbf{r.v} = 0$, it is **not** possible that the particle is executing UCM

33. What formula gives the instantaneous speed, v, for a particle moving with UCM around a circle of radius r with period T? **(select one correct answer)**
    1. $v = \dfrac{2\pi r}{T}$
    2. $v = \dfrac{\pi r^2}{T}$
    3. $v = \dfrac{\pi^2 r}{T^2}$

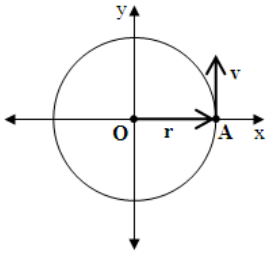
34. What is the angular velocity of a body moving in UCM? **(select one correct answer)**
    1. The rate of change of circumference, with respect to time
    2. The rate of change of angle, in degrees, with respect to time
    3. The rate of change of angle, in radians, with respect to time

35. In Uniform Circular Motion, what is the Frequency, f, of the motion defined as? **(select one correct answer)**
    1. Frequency, f, is defined as the angular displacement in one complete rotation
    2. Frequency, f, is defined as the number of complete rotations performed per second
    3. Frequency, f, is defined as the time taken to complete one rotation

36. Which formula below can we use to calculate the magnitude of acceleration of a body executing UCM? **(for each one say <u>yes</u> or <u>no</u>)**

    1. $|\mathbf{a}| = \sqrt{a_x^{\,2} + a_y^{\,2}}$
    2. $|\mathbf{a}| = \dfrac{v^2}{r}$
    3. $|\mathbf{a}| = \dfrac{4\pi^2 r^5}{T^2}$
    4. $|\mathbf{a}| = r\omega^2$
    5. $|\mathbf{a}| = \dfrac{4\pi^2 r}{T^2}$

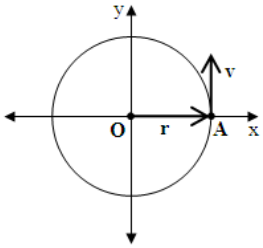
37. A body of mass 29 kg executes UCM around a circle of radius 3 m and period 0.1 s. Assume that at t = 0 s the body is at position **A** and that the rotation is in the anti-clockwise sense.



What is the frequency of the motion?

---

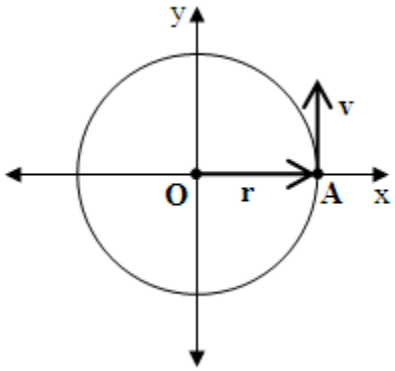
38. A body of mass 22 kg moves in a uniform circular motion of radius 5 m and period 4 s. Assume that at t = 0 s the body is at position **A** and that the rotation is in the anti-clockwise sense.



Find the angular velocity of the motion. **(select one correct answer)**

    1. π rad s^{-1}
    2. $\dfrac{\pi}{2}$ rad s^{-1}
    3. $\dfrac{\pi}{4}$ rad s^{-1}
    4. $\dfrac{1}{5}\pi$ rad s^{-1}

39. A particle of mass 29 kg moves with a constant speed of 4π ms^{-1} in UCM of radius 8 m. Assume that at t = 0 s the body is at position **A** and that the rotation is in the anti-clockwise sense.



Calculate the period of the motion.

_____

_____

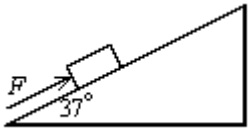
40. A man is running West at 14 ms^{-1} relative to a fixed point *Q*. At the same time a boy is running South from *Q* at 12 ms^{-1}. Taking **i** as east and **j** as north, calculate the velocity of the man relative to the boy?
    1. (–14**i**) ms^{-1}
    2. (0**i** – 12**j**) ms^{-1}
    3. (–14**i** + 12**j**) ms^{-1}

41. A boat is sailing across a river at a velocity of 1.8 ms^{-1} North relative to the water. The river is flowing from West to East at a velocity of 1 ms^{-1} relative to the ground. Taking **i** as east and **j** as north, calculate the velocity of the boat relative to the ground?
    1. (1.8**j**) ms^{-1}
    2. (1**i** + 1.8**j**) ms^{-1}
    3. (–1**i** – 1.8**j**) ms^{-1}

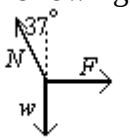
42. What does $\sum \mathbf{F} = 0$ for a body mean?
    1. The sum of all forces in the universe is zero
    2. The sum of all forces acting on the body is zero
    3. Some of the forces acting on the body are zero

43. A brick of mass m = 7.5 kg is placed on a *frictionless* surface inclined at 37° with respect to the horizontal.

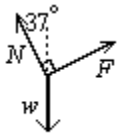
A force F, parallel to the plane of the inclined surface, is exerted on the brick, preventing it from sliding along the plane, as shown in the diagram below.



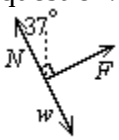
Which of the following *free-body diagrams* best illustrates the body in question.



1.

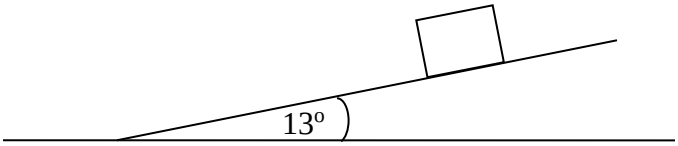


2.



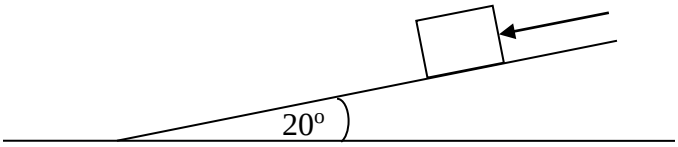
3.

44. A box of mass 1.5 kg is sitting, in equilibrium, on a rough plane inclined at 13° to the horizontal.



Calculate the value of the friction force acting on the box. [Use g = 9.8 ms^{-2}]

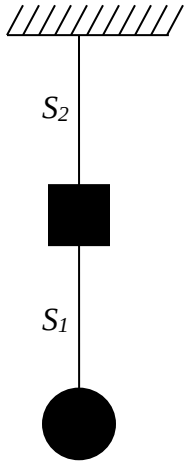
45. A body of mass 55 kg is being pushed at a constant velocity **down** a rough plane inclined at 20° to the horizontal. The push has a value of 20 N parallel to the plane.



Calculate the value of the friction force acting on the body. [Use g = 9.8 ms^{-2}]

46. A massless rope (for each one say **true** or **false**)
    1. Is a real rope that has zero mass
    2. Is an ideal rope that has zero mass
    3. Is an ideal rope with tension the same throughout its length

47. A steel sphere of mass 9 kg hangs by a string S_1 from an aluminium cube of mass 4 kg which hangs from the ceiling by a string S_2.



Calculate the force exerted on the ceiling by the string S_2. **[Use g = 9.8 ms^{-2}]**

48. A table with a horizontal surface can carry a load of 50 kg without breaking. Calculate the normal push on a book of mass 25 kg that is resting on the table. **[Use g = 9.8 ms^{-2}]**

49. Static friction plays a role: **(select one correct answer)**
    1. prevent the body from the sliding
    2. To help the body slide and move faster
    3. To increase the value of the magnitude of pushing force

50. A brick of mass m = 10.0 kg is placed on a horizontal surface S. Given that the coefficient of static friction is μ_s = 0.200 and taking $\boldsymbol{g = 9.8\ m\ s^{-2}}$, find $\boldsymbol{f_{max}}$ between the brick and S.

51. Which of the following is/are **<u>correct</u>**?

Kinetic friction, f_k, is the force of friction that exists when two surfaces in contact:

1. move with respect to each other
2. do not move with respect to ground
3. do not move with respect to each other

52. A box of mass 8 kg is pushed across a floor with a force of 49 N right. The box is moving with a constant velocity. Calculate the coefficient of kinetic friction, μ_k, between the box and the floor. [Use g = 9.8 N/Kg]